Funding Matters: A Study of Internationalization Programs in Science, Technology and Innovation

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Abstract

Research funding is essential for promoting internationalization of science, technology and innovation. It is a key mechanism to advance international science, technology and innovation (STI) cooperation. This thesis argues that funding is a dominant driver of internationalization of science, technology and innovation but it is viewed as less than an optimal mechanism because of the trade-offs and dilemmas associated with specific research funding initiatives. This thesis examines three government-funded policy instruments for STI cooperation. The purpose is to gain a better understanding of the dynamics of this broader research and innovation policy context as it relates to the internationalization of science, technology and innovation.

One of the main findings of this thesis is that these government-sponsored programs represent internationalization efforts that are coupled with other policy goals. Thus, the three policy instruments can be viewed as intervention measures and policy actions in response to a perceived need to strengthen science and technology ties with specific countries such as Brazil and China and to promote strategic research areas across universities. Finally, internationalization practices are deeply dependent on funding and on the actions of the actors who shape it and on the policy making processes from where decisions on international efforts emerge. Hence, government actors, researchers and companies give direction to internationalization and use it as a tool to achieve a variety of goals. Although policy actors intervene by articulating policies and putting forward proposals to promote international STI cooperation, the actions of public administrators at the higher government level are often undirected, leading to irregular and provisional types of decisions. The absence of a defined purpose of internationalization leads to oscillation and inconsistencies in decision-making processes.

Key words Internationalization, scientific collaboration, international cooperation, decision making, policy implementation, science and technology, innovation

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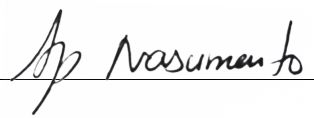
Signature  Date 2017-04-12

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To my daughter Milla and my husband Ingvar

Content

Acknowledgments

I come from a family in South America where most view education as a distant goal; some of which is a reflection of the widespread inequalities in my country of origin, Brazil. I am fortunate to have had the opportunity to live in three countries and to pursue my dreams. This PhD journey has been part of that dream that started many years ago but it has also been a transformative process. My PhD studies helped me become more aware of my writing and of the many choices I had to make during this process – to distance myself from the research material and take a step back to look at the big picture. The big picture sometimes gets blurred. Seeing the big picture from above, like the Bald eagle, my favorite bird, is not easy. But I was fortunate to have had an amazing advisor, Mats Benner, who has not only guided me through my PhD process but has also helped me see the big picture. Thank you, Mats, for your support, your kindness and for inspiring me every step of the way. Smiling, Mats said to me at our last meeting, "You can do it!"

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Staffanstorp, Sweden, April 2017

Ana Paula

Chapter 1 Introduction

1.1 Setting the scene

In 2001, a Swedish scholar traveled to Vietnam with his family and lived in the country for five years. Upon his return to Sweden, the scholar reflected on his experience abroad which he regarded as rewarding. In the scholar's own words, "*I felt that I had developed quite a lot over the years while living in Vietnam. I [had] challenges and found that it was quite an interesting experience but when I came back [to Sweden], I did not feel at home*." During a conversation about his international experience, the professor spoke about his background and research projects. One of the projects focused on the modernization of the legal systems in Vietnam, Cambodia, Indonesia and Laos. The professor argued that in spite of being a rewarding learning experience, the international program promoted by the Swedish International Development Agency (SIDA) lacked two components: context awareness and a better understanding of program rationales and purposes. From the professor's perspective, funding to promote internationalization and development programs, well-intentioned domestic policies and humanistic motivations are not sufficient to achieve successful outcomes. According to the respondent, having a thorough understanding of the local context and a clearly defined purpose for establishing international programs are the first steps toward the formulation of policies, including international development instruments. This context constitutes of the institutional set up or political structures, policy decision making and political traditions that although resistant to changes at times, are constantly affected by global trends. The scholar further argued that in this context, a country's laws are connected to and emerge from old traditions.

Similarly, I contend that research and higher education institutions are part of the old and the new. A country's research and innovation policy, which is embedded in the institutional fabric, are linked to past traditions. The

understanding of this unique context precedes any international development efforts to assist research and technology capacity building in other countries.

The following story is about a Swedish business owner who participated in the Eco-Innovation Cooperation program with Brazil and who stands at the intersection of domestic policies and global trends. This individual is part of a constellation of actors who engage in internationalization through means of international science and technology cooperation, some of which are funded by the government. When discussing some of the challenges of internationalization, the interview subject explained that funding limitations along with geographic distance and better business opportunities in Europe influenced his decision to focus on business opportunities in Europe instead of Brazil. According to the respondent, overall, the resources needed to finance environmental technology projects are insufficient and the larger financial system does not support start-up companies. The participant claimed that investors in the European and Swedish markets are investing their money in the stock market and in large companies instead of supporting startups.

The continuing need to secure funding to ensure project completion encourages actors to respond to public research funding opportunities and to engage in science, technology and innovation (STI) cooperation programs. Actors also respond to global changes such as the global dispersion of innovation, technology and production outside the traditional triad Japan, Europe and the U.S. These endogenous and exogenous forces are combined with a range of imminent challenges present in the internationalization of science, technology and innovation.

These stories reflect similar concerns expressed by the actors participating in the three government-funded STI cooperation programs I describe. First, the two narratives illustrate how government policies (e.g. economic, development aid and research funding) affect individuals' decisions and activities and how these shape their views of internationalization. Second, the two narratives suggest that funding and decisions concerning the formulation of government-sponsored internationalization programs matter. In a time of global transformations, with increased focus on internationalization, it has gone almost without saying that funding is an essential tool for the promotion of the internationalization of STI and science and technology linkages. However, it is not merely research funding that is the most relevant aspect in research and innovation policy and in the internationalization of STI. Central to the broader internationalization debate

are the rationales for promoting internationalization programs in science, technology and innovation and decisions regarding program design. Program design or the "how" question is reflected in the decision-making processes. It concerns the intents of policy actors to devise instruments that foster international cooperation in science, technology and innovation. The "how" also entails the execution of ideas in the form of collaborative activities at the level of universities and research organizations. The implementation of ideas is carried out through different funding possibilities and approaches.

Argument in brief

I contend that different rationales, ambitions and ideas coexist in the crafting of new science, technology and innovation cooperation instruments. These ambitions include connecting Sweden to the world, setting export-technology goals and strengthening science and technology capabilities through STI linkages and policy measures. I presume that government policies are fraught with political aims and implementation is not always consistent with these objectives. If this is the case, policy actors in government rely on implementing agencies to interpret and to make sense of political aims formulated in the form of government directives and mandates. I discuss how policy actors, possibly motivated by the need to fulfill policy goals, search for solutions to address a policy problem and how practical concerns relate to ideal goals.

I problematize some aspects of the governance of research and innovation policy. Some of these aspects include rationales for promoting strategies for the internationalization of STI, the Swedish research funding system and decision making processes shaping specific government-supported STI cooperation instruments. This thesis takes a closer look at rationales and policy processes that produce internationalization programs with specific purposes. I examine decision making processes as a core problem of how the government operates in practice. I provide one perspective on the formulation of the three government-supported STI programs.

Regarding the drivers of internationalization of STI, I contend that internationalization is motivated by a complex blend of rationales that originate in the macro (ministries) and meso (funding agencies) levels where decisions concerning policy instruments emerge. I look at how these rationales play out in

one specific context: Sweden and policy actors' motivations to sponsor and to participate in STI cooperation programs.

In practice, the three case studies and the two stories presented in the introduction reflect real world decision making processes. These experiences represent a realistic view of policy making and less of an idealized perspective where actions and procedures tend to be followed in a linear manner to produce policy. The complexity of the modern governance of political systems and policy making processes makes it unlikely that policies are fully rational. Successful or ideal implementation can be vague characterizations of the policy cycle and possibly disassociated with the actual practice of policy. Policy actors might interpret "success" or "ideal" in different ways. Success in policy making might be simply understood as achieving a satisfactory or acceptable solution to a policy problem. This means to achieve a solution that is "good enough" in the short run.

As this dissertation sets out to demonstrate, government-sponsored programs do not reflect a linear policy cycle. Influenced by time pressure, the need to respond to government mandates and pragmatism, policy actors occasionally employ the "best possible" solution to a policy problem. Real world decisions might require speedy decision making processes and must be made in a short time frame. This means that the need to simplify complex situations is paramount in order to enable the management of potential challenges and complexities.

The next issue in research and innovation policy in addition to policy formulation and implementation is deep dependence on external funding. In chapter 9, I discuss how the current research funding system affects researchers' views of and responses to the internationalization of science, technology and innovation. For instance, research funding enables science, technology and innovation cooperation but it might also hinder this activity given its implicit dilemmas. One such dilemma refers to the difficult choices researchers and business owners might face regarding their projects and activities.

Finally, some aspects of the Swedish science and innovation policy and governance have been fairly stable over time. The attention to and reliance on stable funding schemes and the utilization of flexible and more temporary funding mechanisms are two examples of such aspects. The funding that the universities received from the Swedish Government to establish the Areas of Advance is an example of a more committed and fixed type of research funding

allocated to the Swedish universities as illustrated through the Chalmers University Transport Area of Advance case study. In contrast, the funding allocated to the Eco-Innovation Cooperation initiatives with Brazil and China are examples of short-term investments. What emerges from this is a mixture of steering signals – partly to afford long-term funding, partly to offer more temporary funding schemes.

From a historical institutionalist perspective, which is adopted in this thesis, these tendencies may be interpreted as a reflection of the properties in the Swedish system of research governance (see chapter 6). This system of research governance is characterized by interventions in the form of flexible funding as a complement to core funding.

1.2 Selection of country

A number of factors motivate the choice of Sweden as the geographic context. First, in Sweden, a degree of political and institutional stability is noted but at same time, policy experimentation is accepted. Therefore, ingrained administrative and political arrangements coexist with novel efforts and interventions. The Swedish state, therefore aggregates traditional conventions and new approaches. The political system is continually being molded both by the persistent institutional arrangements and by the transient challenges and changes in the public sphere. The establishment of the Swedish Innovation Agency, VINNOVA is a manifestation of a more proactive attitude toward the promotion of innovation and a new direction in innovation policy. This type of 'institutional dynamism' (Steinmo et al. 1992) is also illustrated by the emergence of new policy ideas within the internationalization of science, technology and innovation channeled through STI policy instruments Swedish funding agencies design.

Second, the discussion surrounding the Swedish context has implications for the interpretation of the empirical material. In Sweden, the political set up translates into specific relationships between higher level government offices and meso level administrative agencies. The policy decisions in Sweden are both centralized and decentralized in the government. The government sets overarching goals for internationalization of science, technology and innovation which are then interpreted and implemented by government agencies such as

the Swedish Innovation Agency (VINNOVA). Thus, the selection of Sweden as the setting is an opportunity to examine the interplay between the political levels, where overarching goals and the need for action are identified and the administrative level, where implementation objectives and procedures are determined. The administrative level also serves as an important source of information and intelligence for the political level.

Third, Sweden is a highly industrialized nation with international ambitions and a significant level of international connectivity. In spite of showing a trend of relative stagnation in research impact (Öquist and Benner, 2012), it is one of the OECD countries with the highest research and development expenditure as a percentage of GDP – 3.26 in 2015 (Eurostat News release, 2015). Thus, the discussion in this thesis centers around the motivations behind the design of different policy interventions to fulfill a variety of purposes and possibly to tackle inconsistencies and contradictions as high investment in R&D and relative stagnation in research impact.

1.3 Selection of field of study

The international orientation and the changing geography of science, technology and innovation are a result of globalization, foreign policies and the emergence of new economic powers. This is manifested in scientific cooperation programs (domestic and international) and in the conditions under which they develop and are implemented. Science, technology and innovation is a timely subject and it has been central in the research and innovation policy debate.

In addition to having international properties, science, technology and innovation have been the focus of governments of both developing and industrialized countries around the world. Also, science, technology and innovation involve multiple dimensions and cross the micro, meso and macro levels. Science, technology and innovation extend beyond national borders and influence and are influenced by endogenous and exogenous changes. Finally, science technology and innovation are areas that encompass the dualities of competition and cooperation and of national and international. In this arena, successful research groups are rewarded and competition for international awards and funding is encouraged. On the other hand, science, technology and innovation policy is also viewed as embedded in the so called national systems of

innovation, NSI (Lundvall, 1988, 1992) and is an important feature of NSI. All of the above are compelling reasons for selecting the areas science and technology and innovation.

1.4 Selection of programs

This section describes the rationales for selecting the three programs[1]: the Cooperation for Eco-Innovation with Brazil and China and the Chalmers University Transport Area of Advance. This section outlines the general characteristics of the three programs.

First, the three programs were selected since they represent the Swedish Government's efforts for the promotion of science, technology and innovation. The two international programs, in particular are examples of internationalization strategies in science, technology and innovation. The three programs provide an opportunity to examine the three dimensions of the science, technology and innovation: the policy level, the administrative level and the performing level. The latter consists of the daily activities of the participants in STI cooperation programs. The three dimensions were selected because of the central roles of ministries, government agencies and practitioners in shaping internationalization programs for science, technology and innovation. These practitioners include researchers across universities and research institutes, business owners and CEOs of micro and SMEs (small and medium sized enterprises).

Second, the programs give us a glimpse into the explicit or implicit political processes that influence policy actors' decisions about internationalization activities. Most importantly, the selection of these case studies is an attempt to address a timeless question in policy making, reflected in research question number 2. This timeless question concerns how certain policy decisions involving internationalization programs emerge and gain momentum.

The Sino-Swedish and Swedish-Brazilian Eco-Innovation Cooperation programs are part of the VINNOVA's international programs for innovation. Through

[1] The three government-sponsored programs represent the case studies described in this dissertation. In this thesis, the terms "programs" and "case studies" are sometimes used interchangeably.

the two international case studies, I explore the government's rationales for promoting STI cooperation programs targeted to specific countries (e.g. China and Brazil). I also examine researchers' responses to emerging research funding opportunities. Overall, the Eco-Innovation Cooperation programs with China and Brazil aim to facilitate the internationalization of science and innovation in Sweden and to strengthen Sweden's international linkages, competiveness and innovation capacity. The facilitation of internationalization of STI is accomplished by means of STI cooperation instruments that can include targeted interventions with specific goals, research priority areas and partner countries.

The Sino-Swedish and the Brazil-Sweden STI cooperation programs are small programs in scope but they reflect the ambitions of policy actors to consolidate these programs and turn them into more sustainable projects. These projects had a two-year cycle that started in 2012 and ended in 2014. The initiatives were financed and coordinated by VINNOVA, the Swedish Innovation Agency. The overall aim of the Sino-Swedish Cooperation program for Eco-Innovation has been to "strengthen Swedish actors' international networks for cooperation in research and development, leading to innovations for a sustainable development – eco-innovation" (Lundin & Schwaag Serger, 2014, p. 17).

The Chalmers Transport Area of Advance program, also funded by the Swedish government, differs from the two Eco-Innovation Cooperation programs with respect to focus, geographic scope and research priorities. The Transport AoA is not targeted to any particular country. In addition, it is a multidisciplinary and cross-disciplinary project. In this context, cross-disciplinary and multidisciplinary mean that the Transport Area of Advance program focuses on research leading to the sustainability, efficiency and safety of transportation and it engages different disciplines and different actors. The Chalmers Transport Area of Advance works closely with industry to find solutions for transport-related issues in a variety of ways: student exchange initiatives, the funding of industrial PhD programs and science-industry collaboration.

The government-supported research cooperation programs are the instruments that bring researchers together and are the locus of these research partnerships. The three programs exhibit the following characteristics (table 1).

Table 1 Description of STI Cooperation Programs

	Transport Area of Advance	Sino-Swedish and Brazil-Sweden International Cooperation for Eco-Innovation
Description	Focus: Science-oriented and cross-disciplinary; research collaboration for sustainable transport involving science-industry partnerships.	Focus: science, environmental technology and eco-innovation. Call A (Phase A of the project): shorter-term; partnership formation, consortia, feasibility studies stage. Call B (Phase B of the project): longer-term compared to Phase A; implementation stage (e.g. product prototype, product demonstration, experimentation, research results).
Overarching Goals	To promote cross-disciplinary research in the transport field to find solutions for transport-related issues and challenges having sustainability, efficiency and safety as integral parts of the main vision.	To foster science and technology linkages with emerging markets; boost domestic industry; advance priority areas relevant to Sweden's innovation and strenghten competitiveness.
Priority areas	Transport as a strategic area; oriented toward avancing research in the transport field: Sustainable transportion.	Environmental technology; Sustainable Urban Development and Energy efficiency.
Scope	National but with established international linkages	International
Partnerships	Collaboration across university departments and science-industry partnerships.	Consortia comprised of universities-research institutes-industry.

1.5 Aim and research questions

This thesis aims *to analyze the drivers of the internationalization of science, technology and innovation, the factors shaping the design of government-supported STI cooperation initiatives, and views of internationalization*. I accomplish this aim by addressing three research questions.

In order to address the three research questions, I target different dimensions of the internationalization of STI: *policy formulation*, reflected in political rationales and intentions, *implementation* efforts or turning ideas and intentions into practice and *outcomes* or turning intentions into accomplishments. Given the uncertainties and challenges actors across the three programs face, the first question aims to provide a better understanding of *the rationales for promoting the internationalization of science, technology and innovation (STI).* One internationalization strategy governments employ is public funding for international STI cooperation instruments. Thus, the first research question is: *Why do governments promote the internationalization of science, technology and innovation?*

The second question looks at political efforts and intentions to design and implement policy instruments for STI cooperation. This question focuses on how decisions to establish new internationalization programs emerge. Thus, the second research question is: *What factors shape the formulation of government-supported programs for the internationalization of science, technology and innovation?*

Given the centrality of funding for advancing domestic and international STI linkages, a third question relates to how the practitioners of STI - who have been targeted by the programs – view and respond to internationalization. The third question is formulated as follows: *How does the current research funding model affect researchers' views of and responses to the internationalization of science, technology and innovation?*

The research questions attempt to accomplish more than just describing the three programs. For instance, research question number 2, discussed in chapter 8, extends beyond the discussion surrounding government's rationales for promoting international cooperation in science, technology and innovation. Drawing on Davis's view of what constitutes interesting research (1971), I focus

on an everlasting and timely issue of how policy decisions arise. More specifically, I discuss how intentions to design STI cooperation programs turn into practice.

Research questions:

1. *Why do governments promote the internationalization of science, technology and innovation?*

2. *What factors shape the formulation of government-supported programs for the internationalization of science, technology and innovation?*

3. *How does the current research funding model affect researchers' views of and responses to the internationalization of science, technology and innovation?*

1.6 Contribution of the study

The literature review in chapter 2 highlights the multidisciplinary nature of the broader internationalization topic. Overall, internationalization crosses different fields - higher education, business administration, law, sciences, and technology. In spite of the perceived broad connotation of the term internationalization, this research study focuses on a more specific definition of internationalization as it falls under the research and innovation policy umbrella. In a broader sense, internationalization has been part of the generation and dissemination of knowledge and it has been an integral component of research and innovation policy studies.

Based on the existing literature, this dissertation defines internationalization not only as a phenomenon that is intrinsic to today's modern society and a response to global trends but also as a central mechanism and as a practice in research and innovation policy. Internationalization plays a role in the research governance and in the dissemination of scientific results. This mechanism for disseminating and exchanging information serves specific purposes: to foster collaborative research and learning, to facilitate international scientific mobility, to strengthen

a country's competitiveness and to build strong science, technology and innovation capabilities.

Internationalization refers to activities outside national borders, foreign or global. It also indicates continuous change. Certainly the institutions that are involved in promoting internationalization activities are the same but the mechanisms developed to support internationalization activities and the perspectives on the phenomenon change over time. A number of studies have offered different views about internationalization.

Guellec et al. (2001) define internationalization of research and development as inventions that tend to cross borders while Aksnes et al. (2008) view internationalization of science as efforts to integrate an international dimension into the research and higher education. Féron & Crowley (2003) link internationalization to political science and argue that the two cannot be viewed as separate from each other. Féron & Crowley (2003) argue that internationalization is an example of a policy shift that emerges from external pressures and not an organized and designed process. In the field of higher education, Knight (2004) describes internationalization as the incorporation of an international or intercultural dimension into the purposes, functions and delivery of post-secondary education. Jones (2013) argues that in spite of Knight's definition being broad, it allows one to consider that there can be other rationales and drivers of internationalization.

This dissertation aims to contribute to the existing literature on internationalization. I attempt to accomplish the above aim by looking at internationalization from the perspective of how it is practiced, enabled and carried out at the meso and micro levels, comprised of funding agencies and research organizations/companies, respectively. I highlight aspects of how individuals' actions and efforts are influenced by global trends and the political structure of a country. Therefore, this is an actor-driven research study. The second contribution this dissertation makes concerns the contextualization of internationalization. This dissertation discusses internationalization of STI as a tool and a practice in broader research and innovation policy.

This thesis makes other contributions in addition to the ones mentioned above. For instance, a few knowledge gaps are identified. This thesis examines actor-driven internationalization and the relationships between government, industry and research organizations. A number of scholarly articles discuss

internationalization of firms and of higher education (Knight, 2004, 2006 and 2010; Altbach and Knight, 2007; Kehm and Teichler, 2007; Brennan and Delow, 2013). Other studies (Boekholt et al. 2009; Adams, 2008; Technopolis, 2005) focus on the drivers of internationalization programs and international research collaboration. So far, only a few studies have focused on actor-driven research cooperation activities. The exceptions include Katz and Martin (1997), Melin (2000), Sonnenwald (2007), (Edler et al. 2011) and Ponti (2010 and 2012). By shifting the focus to implementing and research performing actors, this study calls attention to the need to highlight the role of individual actors within an organization instead of merely focusing on the organization although I discuss the three levels of interaction in chapter 6.

Second, drawing on the literature on policy implementation and on the interviews with actors across universities, research institutes and firms, this study contributes to the general understanding of how the internationalization of science, technology and innovation is enabled and promoted in the Swedish research and innovation policy context. By uncovering how decision making processes about internationalization and STI cooperation take place, this dissertation hopes to contribute to the policy implementation field in theory and in practice.

Third and more specifically, this dissertation attempts to make a contribution by linking research about internationalization practices to the institutional logics perspectives. In so doing, this dissertation highlights how the different logics can be interpreted within STI program decision making. Fourth, drawing on the street-level bureaucracy concept, this study complements Evans's (2016, p. 603) work by highlighting the insufficient attention given to the role of managers as actors with significant discretion in policy implementation "and the extent to which decisions of senior managers influence both policy implementation directly and the context of discretion encountered by street level bureaucrats."

Furthermore, this dissertation contributes to the existing literature on street-level bureaucrats and the level of discretion they have (Lipsky, 1980; May and Winter, 2007; Evans, 2016) by offering a different perspective on the topic. The freedom and discretion street-level bureaucrats have should not be viewed as absolute because these actors are also constrained by a number of factors over which they do not have control. In the real world of politics, the degree of

power and discretion that actors in government agencies believe they have might be limited.

Fifth, internationalization is a relatively new area that has attracted significant attention. Several studies about internationalization concern scientific cooperation (for a view of research partnerships, see Hagedoorn et al. 2000; Wagner, 2008; Boekholt et al. 2009; Desai, 2009) or international networks (Glänzel, 2001; Slaughter, 2004; Roberts, 2006; Horvat and Lundin, 2008; Woods and Martinez-Diaz, 2009; Hoekman et al. 2010) or funding (Grimpe, 2014 p. 8-10 on funding trends; Georghiou and Laredo, 2006; Hicks, 2012). Given that the case studies I describe are examples of scientific cooperation, rooted in domestic and international networks and are deeply dependent on funding, this thesis aims to contribute to the above mentioned scholarly work by highlighting challenges, complexities and dualities in STI cooperation.

Finally, the facilitation of internationalization requires the actions and decisions of a constellation of actors whose ideas and strategies get translated into practice (implementation). The above-mentioned studies and the concepts in chapters 3 and 6 are relevant and provide the background for this thesis. The literature helps us understand the benefits, challenges and rationales for promoting domestic and international research collaboration which is an activity practiced in academia, research institutes and industry. For instance, changes in funding allocation and funding models impact scholars and impact the very activity that is central to the academic setting: research cooperation. It can cause dilemmas and trade-offs between teaching and research in the case of academics and between investing in the European market and conducting business outside Europe in the case of small or medium sized enterprises.

Internationalization has been well documented in the literature (Eisend and Schmidt, 2014; Henriques and Laredo, 2013; Cardoso et al. 2010; Hoekman et al. 2010; Edler et al. 2011; Treib et al. 2007; Bozeman and Corley, 2004; Féron and Crowley, 2003). However, studies linking internationalization to decision-making processes as a mechanism to achieve specific goals have been limited. We lack a deeper understanding of the processes behind policy decisions to foster internationalization. This thesis is an opportunity to address these gaps in the literature and to explore the actual practice of policy-making in STI cooperation.

1.7 Limitations of the study

This thesis focuses on Sweden only. A comparative study would further the understanding of internationalization practices. It would be useful and desirable to benchmark internationalization practices for instance, in order to have a point of reference for comparison purposes.

Regarding sampling limitations, only Swedish actors participating in innovation programs with China and Brazil were interviewed. Interviews with Chinese and Brazilian researchers and companies working with their Swedish counterparts were not included. One reason relates to logistical issues such as difficulties contacting Brazilian and Chinese research partners such as time constraints.

In the context of this research, interviews were conducted with the actors on the Swedish side participating in the Eco-Innovation Cooperation programs. It was not feasible to conduct interviews with research partners in China and Brazil. The reasons are connected to the following factors: 1) no easy access to Chinese and Brazilian researchers and companies located in China and in Brazil. For instance, not all the researchers in Sweden whom I interviewed provided their contacts in Brazil or China. When asked, a number of Swedish researchers did not feel comfortable sharing information about their foreign partners. They argued that it had taken them a long time to build a strong relationship with their foreign partners and they were concerned that outside interferences would compromise the research project. 2) cultural differences, language barriers and different working routines and practices (e.g. delayed replies to electronic mail and trust issues) were among other factors limiting access to interview subjects in China and Brazil. More concretely, a Swedish company provided me with the contact information of a partner organization in Brazil. However, even though I am originally from Brazil and speak Portuguese, my attempts to reach the employees of the Brazilian organization were unsuccessful. 3) time constraints and logistics: Identifying and scheduling interviews with the Brazilian and the Chinese partners working with the Swedish researchers would have been time consuming and it would not have been feasible.

Regarding the Chalmers University Transport Area of Advance case, the sample was also limited to academic researchers (e.g. professors and post-docs). Partner companies working with researchers in the Transport Area of Advance were not interviewed. Additional limitations concern the selection of the STI cooperation

programs and size of programs. For instance, not all government-funded domestic and international instruments are examined and other programs may differ regarding focus, goals, design and properties. The International Eco-Innovation Cooperation programs are small initiatives in scope; therefore, attempts to generalize to other contexts might be impractical and not feasible.

1.8 The thesis outline

First, I provide a brief explanation about the organization of the research questions before delving into the structure of the thesis. In order to guide the reader while maintaining an appropriate structure of the thesis, the empirical material is organized according to the three research questions. These research questions are represented and discussed in chapters 7, 8 and 9. These three chapters link the context and theoretical chapters to the discussion and conclusions in chapter 10. The organization of the research questions into separate chapters offers a number of benefits. First, given the extensive amount of empirical material generated mostly from interviews, organizing chapters 7, 8 and 9 according to the research questions helps with structuring the dissertation. Second, this form of organizing the material enables the reader to focus on each research question and its findings. Third, this way of structuring the dissertation provides greater flexibility when reading the material. Fourth, this seems to be a more direct way of linking findings with the data.

The introduction sets the stage for the remainder of this study. The two stories represent internationalization practices in the context of Sweden. Chapter 2 reviews the literature on the phenomenon internationalization and discusses the different meanings attributed to internationalization. Chapter 3 lays out the theoretical building blocks of this thesis. Given the multi-disciplinary nature of the topic discussed, it is appropriate to anchor the findings in more than one concept. Therefore, the Theory chapter presents the following theoretical concepts: institutional logics, bounded rationality, street-level bureaucracy, the principal-agent relation, historical institutionalism and drivers of international STI cooperation. Chapter 4, Methodology, discusses the research process, methods of data gathering, the approach for conducting analysis, the choice of a case study and research challenges. Chapter 5 describes the three case studies in great length. Chapter 6 examines the Swedish context in which the cases are embedded and provides an overview of the political structure and the changes in

the research funding system in Sweden. The purpose of chapter 6 is twofold: a) it connects the theory and the broader context to the remainder of the thesis; b) it sets the tone for the subsequent chapters. Chapter 7 explores the rationales for promoting internationalization of science, technology and innovation. Chapter 8 analyzes decision making with respect to the design of the three government-funded STI cooperation programs, two of which are examples of internationalization of STI. Center to the discussion in chapter 8 is the practice of policy and how decision making takes place in the real world of policy making. Chapter 9 addresses the third research question regarding how the current research funding model influences researchers' views of and responses to internationalization. Chapter 10 discusses the main findings and implications for science, technology and innovation policy as well as possibilities for future research.

Chapter 2 Internationalization: A Literature Review

2.1 Introduction

2.1.1 Contextualizing internationalization

In this thesis, internationalization is discussed in relation to research and innovation (R&I) policy and to STI cooperation. Internationalization of STI is an element in research and innovation policy. Research and innovation policy encompasses internationalization, policies for knowledge production and dissemination, strategies for developing centers of excellence and for funding and managing science (Figure 1). In addition, the internationalization of STI has been operationalized through government-supported programs that promote the mobility of scientists and international research collaboration. Internationalization encompasses scientific mobility and science and technology collaboration. Both mobility and STI cooperation are elements in internationalization and support internationalization goals. According to Boekholt et al. (2009), science and technology cooperation is both a policy goal and an instrument to support other goals (e.g. diplomacy, development, internationalization and others). According to Defazio et al. (2009), the concept of research collaboration as commendable objective is a view shared by many policymakers and also the European Union. For instance, EU science policy which aims to promote the "overall advancement of knowledge" is focused on the role of networks and collaboration as tools to achieve such objective. As a consequence, EU-supported research collaboration requires researchers to work together in order to secure research funding.

One can argue that internationalization is a tool to achieve other goals. For instance, increased internationalization might give an academic department

international recognition, it might boost university rankings and it certainly gives firms a competitive advantage. In addition, a number of authors (Aksnes et al. 2008; Nerdrum and Sarpebakken, 2006; Hwang, 2008) suggest that international mobility of students and researchers, conference attendance, co-authorship and research collaboration reflect the increasing internationalization of science phenomenon.

2.2 Internationalization: A brief history

Internationalization in science, technology and innovation as a continually evolving practice has played a significant role in research and technology policy. Internationalization has a dual role in research and innovation policy. Internationalization can be utilized as an intervention tool to achieve general or specific goals in science, technology and innovation. It can also be seen as an element and end goal in science and innovation policy. This dual nature of internationalization is evidenced through large-scale research facilities and through research cooperation linkages across nations. Large-scale projects have become central in American science policy and played a key role in facilitating strategic partnerships across different organizations worldwide (Lauto & Valentin, 2013). Internationalization has been essential for scientific projects as collaborations enable efficient use of resources reducing costs.

The contribution of scientists is an example of a big transformation in the role of science and technology in military affairs (Smit, 1991). The Manhattan Project is a good example as a collaborative effort that aimed to develop a variety of technologies (Smit, 1991). The project involved the participation of approximately 82,000 people and cost about 1 billion US dollars (Larson, 2013). It was also after the WWII period that science policy as a public policy area was developed (Elzinga and Jamison, 1995) and that research and innovation policy emerged as a field and as a special policy area mainly in Western Europe, the U.S. and the USSR. Moreover, from 1950s to the 2000s, research and science policy in Europe focused mainly on applied science and technology and on "broad social conditions for research such as collaboration and networking" (Nedeva and Stampfer, 2012).

Also, different discourses highlight the different meanings and interpretations of internationalization. Vannevar Bush's (1945) speech, "Science: The Endless

Frontier," suggests scientific progress as essential to economic growth. Contributions to economic growth and research excellence are good examples of internationalization narratives. These narratives also emphasize the 'international' as a value in science and internationalism (Elzinga, 1997; Manzione 2000; Jacob & Hellmström, 2005). Scientific internationalism was based on the idea that scientific and technical information should be shared as an open-source approach to guarantee democracy and peace (Jacob and Hellström, 2005).

Mustar and Larédo (2002) argue that science and technology gained importance with WWII. It was after this period that international collaborative programs became popular and new narratives about a united Europe emerged. For instance, Winston Churchill's call for a "United States of Europe" in 1945, a federation of European states to promote strong economic cooperation among nations and a European identity (Mauter, 1998). Certain collaborative research projects in Europe such as CERN (The European Organization for Nuclear Research) and the European Molecular Biology Laboratory implied that an European scientific culture could deliver more than a national one (Dienel et all, 2002).

The internationalization of science started long before science policy developed as a public policy area. The field of marine science is a good example of a European collaborative effort for protection of fisheries. In fact, since 1900 and particularly since 1945, several projects in ocean science involved collaboration efforts, expertise and resources from many nations (Rozwadowski, 2004). Concerns over overfishing inspired the founding of the International Council for the Exploration of the Sea, ICES in 1902 (Rozwadowski, 2004). One idea shared by ICES' scientists is that international collaboration enables ocean science research to be conducted more effectively (Rozwadowski, 2004). Internationalization in science did not only occur in different periods in history but also across a variety of scientific fields. Seismology also benefited from transnational collaboration which was motivated by a common desire to try to predict earthquakes in different locations of the globe (Rozwadowski, 2004).

Since the creation of ICES and other scientific and research organizations, the world has become more complex where one can be part of internationalization through scientific cooperation and part of the broader globalization. One view is that globalization manifests itself though worldwide connectivity linking biomedical researchers in a country to patients in the same country or in other

nations. Similarly, globalization links Chinese workers to Brazilian consumers in surprising ways (e.g. through the global trade of commodities such as shoes). For instance, while globalization provides jobs in shoe manufacturers in China, the import of Chinese shoes into the Brazilian market increases competition with shoe producers in Brazil.

2.3 Internationalization and globalization

Both globalization and internationalization cover a range of activities and both phenomena seem to be connected. Globalization is present in higher education and researcher mobility debates and both terms – globalization and internationalization are often used interchangeably. Therefore, it can be inferred that their use becomes over simplified and generalized. The terms internationalization and globalization are often used interchangeably but they are not synonymous (Nilsson, 2003). Internationalization has emerged as the response to globalization (der Wende, 1997:18). According to Smerby & Trondal (2005), globalization refers to developments in the world where countries become increasingly interconnected and integrated. Elzinga (2012) suggests that the difference between internationalization and globalization refers to a shift in the economy, organization and policy of research. Aksnes et al (2008) argues that process of globalization explains the increase in internationalization of science as globalization enhances interconnectedness through trade and travel and the sharing of knowledge and information with the help of internet, all affect science. According to Archibugi and Iammarino (2002, p. 98), globalization "is not a single phenomenon, but a catch-all-concept to describe a wide range of forces." The authors argue that it has been defined differently by social science scholars. The concept globalization of innovation, means, as the authors suggest, the increase generation and diffusion of technologies worldwide. "Globalization itself, defined as "increasing cross border flows of information, knowledge, commodities and capital" (Archibugi et al. 1999, 533).

Globalization has played a role in connecting big companies and universities. For instance, multinational corporations have established research collaborations with research universities to develop products that can be commercialized.

Globalization has enabled new ways for communication and knowledge sharing among researchers through internet and information technology. For instance, approximately 25 billion devices are expected to be connected to the internet worldwide in the year 2015 (Leber, 2013). Castels (2000) characterizes globalization as a network society. Research collaboration and networks have changed over the years. More traditional distinctions and perceptions about scientific centers and peripheries have increasingly been replaced by new ways of communicating and networking (Smerby & Trondal, 2005). International networks are increasingly more complex with many connections and relationships among researchers and their institutions (Smerby & Trondal, 2005).

Scholars such as Gibbons et al (1994) recognize that scientific research continuously undergoes changes regarding international competitiveness as new countries are participating in a new scientific knowledge network and old patterns break up. According to Hwang (2008), studies by Wagner and Leydesdorff (2004) show that center-periphery patterns of scientific collaboration are being replaced by a different model. This new model refers to the emergence of a number of centers which not only collaborate but also compete for resources (Wagner and Leydesdorff, 2004). Competition and collaboration patterns have emerged with globalization (Hwang, 2008). One problem, Hwang (2008) notes, is that the homogenization of knowledge and scientific activities are formed in the transmission of core science to science in the periphery and does not benefit people in the peripheral nations. Globalization of science and technology implies that there is inequality of scientific distribution as a result of this unbalance (Hwang, 2008).

Inequality in scientific distribution and in research makes it a challenge for researchers in less developed countries who lack adequate equipment necessary for advanced biological research to find solutions to health problems and to participate in the international research community (Greenwald, 2013). Entrepreneurs offer alternatives and are helping scientists who do not have access to equipment to do advanced research. The scientist provides "open-source, do-it-yourself designs for a range of common lab gear" such as a kitchen blender that can be transformed into a lab centrifuge (Greenwald, 2013).

Regardless of which view on globalization is predominant and preferred by scholars, it appears that individuals all over the world are affected by globalization. The influence of globalization on people's lives occurs through the

discoveries of new medicines, sometimes outside of our country borders or through the importation of cheaper clothing made in sweatshops in Bangladesh and Mexico. Moreover, just as different nations interpret internationalization in different ways, there are a broad range of perceptions about the effects of globalization and what globalization means.

As Brown (2008) noted, the way in which globalization is conceptualized depends on one's views of and relationship with its processes and the way in which these processes affect one's life. For instance, a remote African villager perceives globalization as contributing to the lack of economic development in his region or as the international response to AIDS (Brown, 2008). Others might interpret globalization as having an adverse effect in the economy. One example of such effect is the disappearance of traditional white-collar jobs such as many in the post office and in customer service. W. Brian Arthur, a former economics professor at Stanford University uses the term "autonomous economy," to describe why some types of jobs have disappeared. He suggests that today's digital system makes it possible for more tasks to be done with fewer people, making other human jobs outdated (Rotman, 2013).

The relationship between and the complexity surrounding internationalization and globalization should come as no surprise as both themes are increasingly being discussed in the context of today's global economy and linked to R&D and economic growth debates. Both topics are interconnected and globalization is often used to motivate the development and implementation of STI internationalization practices. Nevertheless, globalization has enabled the formation and the strengthening of research interconnectivities and it has contributed to a more systematic integration of research.

Over the years, globalization has played a role in science and technology as it reinforces and promotes the sharing and distribution of knowledge carried out by scientists and researchers participating in mobility and research collaboration programs. Globalization has enabled S&T internationalization activities such as scientific mobility and trade and political agreements between countries. These practices might occur simultaneously. For instance, two scholars from different nationalities can form research partnerships at the same time that these scholars' countries sign science and technology cooperation agreements. Science and technology internationalization is a layered process that operates in multiple dimensions and involves different actors and institutions, different types of

funding schemes and distinct programs that support a broad range of national goals.

There are some opposing views concerning the definitions of internationalization and globalization, even though there is some overlapping. The presumption that both phenomena are related makes their use interchangeable. Nevertheless, it implies that the scale and degree of scientific interconnectivity and research collaboration have changed over the years as a result of recent changes in the global economy. On the one hand, positive discourses view globalization as contributing to integration of research and increased scientific mobility. On the other hand, less favorable interpretations see globalization as linked to inequality in terms of scientific distribution as suggested by Hwang (2008).

Others may argue that globalization is linked to discrepancies in research internationalization and collaboration between Eastern and Western European countries. For instance, due to economic conditions, social science financing in Eastern European countries is smaller compared to Western European countries and the United States (ESF, 2010). Moreover, a particular problem among Eastern European countries is the attraction and the retention of young scientists who often leave to work in Western Europe (ESF, 2010).

2.4 Internationalization: Perspectives and meanings

According to Schwaag Serger and Wise (2010), the internationalization of science, technology and innovation has increased in recent decades. In some ways, the internationalization of STI is a response to new global trends. These recent global developments include the dispersion of and access to knowledge and innovation processes and global knowledge being generated in regions outside Europe, North America and Japan (Schwaag Serger and Wise, 2010).

Another perspective considers internationalization of science, technology and innovation as evolving according to national policies and programs that are created to foster it and according to human and financial resources mobilized to facilitate internationalization activities. Thus, internationalization stems from decision making processes embedded in traditional and new models of policy

making. It is also embedded in the plurality of institutional logics that shape decisions regarding internationalization activities and goals.

Historically, internationalization is not a new phenomenon but it has, in the past decades undergone changes. These changes are due to globalization and the changing geography of innovation. These transformations in internationalization are seen in the increase of research collaboration worldwide, in the rise of number of scientific publications, in governments' increased focus on policies to foster international linkages for science and technology and others.

2.4.1 What is internationalization?

Some view recent internationalization of science, technology and innovation as a new endeavor. Others argue that internationalization of STI needs to be redefined and broadened to include other activities. For instance, according to Schwaag Serger and Wise (2010, p. 31), "efforts at EU level to promote internationalization of science, technology and innovation – that is, efforts at promoting linkages with countries outside the European Union – are still dominated by initiatives aimed at promoting research cooperation (e.g. increasing international S&T agreements, researcher mobility and joint research infrastructures)".

Also, since 1974, a number of reports and government bills have focused on the importance of internationalization of higher education. Most recently, the report, Gemensamt ansvar: Sveriges politik för global utveckling or "Shared Responsibility: Sweden's Policy on Global Development," highlights the role of sustainable development and education in achieving this goal (Utrikesdepartementet, 2003). Internationalization refers to activities outside national borders, foreign or global. It also indicates continuous change. Certainly the institutions that are involved in promoting internationalization are the same but the mechanisms developed to support internationalization activities and the perspectives on the phenomenon change over time.

It is, therefore, a dynamic process and governments and local actors (researchers) in both developed and developing countries drive the pace and the intensity of internationalization. The concept of internationalization has been used broadly overtime given that there are different types of internationalization – internationalization of accounting standards, internationalization of research and

development (R&D) or internationalization of higher education. This thesis discusses internationalization in the context of science, technology and innovation. First, internationalization is not only a phenomenon that is intrinsic to today's modern society and the globalization process but is also a central mechanism and a practice in research and innovation policy. Second, the internationalization of STI plays a role in the governance and the practice of science and in the dissemination of ideas about science and technology. Third, this mechanism for disseminating and exchanging information serves specific purposes: to foster collaborative research and learning, to facilitate international scientific mobility and to build capacity in science and technology.

More recently, countries worldwide have been promoting internationalization in the research area as a policy tool for the governance and management of research. Internationalization among other goals, aims to increase scientific mobility and research collaboration. Countries accomplish this by promoting scientific mobility and knowledge sharing, moving researchers and students around the world and across research projects. Through the process of diffusing research activities, ideas and people, knowledge is transferred to different localities and research practices become more standardized. In addition, internationalization as a practice in STI policy aims to promote research interconnectivity among developed and developing countries and enhance international collaboration and scientific mobility resulting in a more integrated research system.

In addition to the movement of scientists, ideas and research practices, there are a number of ways in which internationalization is taking place and spreading within the process of globalization. This can be illustrated by the increase in the numbers of patent applications filed by individuals from multiple countries and the growth of technological agreements and alliances. (Elzinga, 2001). In addition, international research collaborations and scientific mobility represent the different ways in which research internationalization gets promoted and spread around the world.

Therefore, internationalization in research and innovation policy is a continuous and evolving process and changes at the international, national and local levels. It is a mechanism to increase scientific mobility and to disseminate ideas, new discoveries and research approaches and standards. It is dependent on a constellation of actors and institutions to be further developed, promoted and sustained in the long-run. It is also an elective process which means that actors

and their institutions (e.g. policy makers, firm owners/managers and researchers) choose whether to support and participate in internationalization or not. At the international level, research internationalization changes according to trends and external factors (e.g. European Union science and technology cooperation agreements). At the macro (government) level, internationalization practices and activities might change according to government's ambitions and domestic needs for research skills and for strengthening science and technology capabilities. And at the micro (research organizations/firms) level, internationalization as an evolving and dynamic process, changes according to researchers' interests and possibilities to work with their foreign counterparts.

Furthermore, the internationalization of a research cooperation program or an academic activity does not only mean an opportunity but it might also mean that internationalization practices are associated with concerns over the need to "catch up." Such concerns might relate to perceptions of exclusion from internationalization activities. These concerns and perception of exclusion might lead to short-term and "low road" approaches to comparative disadvantage. Countries around the world appear to be following each other's steps in the pursuit of high-technology competition. However, this popular strategy of pursuing high-technology competition might be misleading and uncertain (Ornston, 2014). "First, high-technology growth is notoriously difficult to stimulate because of the high barriers to entry and the intrinsically uncertain character of these industries" (Ornston, 2014, p.459; Lundvall, 2002, p. 37).

It seems that researchers worldwide are also following each other's progress and development. This perpetuates a cycle in internationalization where countries follow each other in the internationalization path. However, the act of "following others" is no longer regarded as unique to developing countries; all countries, developed and developing are focusing on internationalization and turned into observers of each other's internationalization policies and actions. One argument is that the more research advanced nations lead the way and the countries with poorer internationalization history will follow. But globalization slightly shifted this pattern as emerging economies like China, Brazil and India are now being followed and the opportunities their markets offer are being sought after.

2.4.2 Perspectives and meanings of internationalization

It is useful to identify internationalization as a process and a tool that is part of research and innovation policy. Several interpretations and concepts of internationalization have emerged over the years. The subject internationalization has appeared in various studies, but the focus has been mostly on the internationalization of firm R&D. Internationalization as a practice in research and innovation policy has been addressed to a lesser extent and the definitions have not been clear. Business and Management journal articles might have a more pragmatic and straightforward view on internationalization as firms moving their R&D operations abroad or the expansion of research activities outside a country's boundaries.

Féron & Crowley (2003) bring a political science perspective to internationalization and argue that internationalization cannot be viewed as separate from policy which considers the "functional dynamic to influence and to a certain extent, reshape it." Féron & Crowley (2003) argue that internationalization is an example of a policy shift that emerges from external pressures and not an organized and designed process. In the higher education field, Knight (2004) describes internationalization as the incorporation of an international or intercultural dimension into the purposes, functions and delivery of post-secondary education. Jones (2013) argues that in spite of Knight's definition being broad, it allows one to consider that there can be other rationales and drivers of internationalization. Altbach (2012, p. 1), offers a different perspective on internationalization and argues that "some universities look at internationalization as a contribution to the financial "bottom line," in an era of financial cutbacks."

There are other realities embedded in internationalization and different ways in which internationalization of STI is manifested. For instance, Boekholt et al (2009) argue that internationalization of research is most evident through the growth of the English language utilization in science worldwide and in international journals in the Thomson-ISI Science Citation Index. Internationalization as an evolving effort is not static. Internationalization is shaped by external forces inside and outside an institution and institutional, national and cultural aspects need to be considered (Chan and Dimmock, 2008). As Bartell (2003) suggests, institutionalization of internationalization

recognizes the cultural aspects in which it occurs. Furthermore, Bartell (2003). These interpretations of internationalization, according to Bartell (2003, p. 46), these views of internationalization range anywhere from a minimalist, instrumental and static view, such as securing external funding for study abroad programs, through international exchange of students, conducting research internationally, to a view of internationalization as a complex, all-encompassing and policy-driven process, integral to and permeating the life, culture, curriculum and instruction as well as research activities of the university and its members." Elzinga (2001) characterizes internationalization as an uneven process and argues that a multitude of conditions play a role in the movement of information and scientists across nations.

Others argue that internationalization is a "tool aimed at developing the human resources needed for a nation to stay internationally competitive" (Kreber, 2009, p. 4). Hwang and Soete (2008) refer to the implicit tensions – inequality of scientific distribution as a result of this unbalance - within the globalization of science and technology. Okubo and Zitt (2004) argue that internationalization in science as a process is overestimated and explain that the reason is that the majority of journal articles are still a national effort, produced within each country's borders. A similar perspective is shared by Elzinga (2001) who suggests that although scientific ideas and practices cross borders, science is mostly being conducted in "national scientific communities."

Frølich (2006) posits that the term internationalization refers to transformations in three different levels and Aksnes et al. (2008) argues that these transformations can occur at the macro, meso and micro levels. According to the authors, at the macro level, internationalization means changing environments in which both research and higher education policy are planned and developed. At the meso level, internationalization refers to the international dimension of the activities of research and higher education and at the micro level the term refers to international cooperation, publications and student mobility.

Although some of the previous views and definitions of internationalization might be useful in other fields (e.g. higher education, political science), a different conceptualization of internationalization in the context of S&T policy is needed. Therefore, it is relevant to science and technology policy to define internationalization in terms of what it represents. It is equally important to

define internationalization in terms of what purposes it serves and the role it plays in connecting research practices and researchers.

Internationalization is a tool of research and innovation policy that is used to achieve different goals, including S&T capacity building and knowledge exchange between researchers across nations. The question that arises concerns what society wants to achieve through internationalization of STI. Internationalization in the context of research and innovation policy needs to have a more clear definition so that the outcomes are aligned with the goals of internationalization.

Jacob (2009) defines research and innovation policy as the governance of public science. It involves, among other mechanisms, the distribution of resources for research, the prioritization of research to ensure that the practice of science has usefulness to society's problems and the production and dissemination of knowledge. Research and innovation policy concerns the level of maneuvering of science and the participation of science in research. More engagement of science in research includes the development of strategies to organize and manage research activities for public and private supported research. These strategies follow guidelines on how research is carried on and funded, and how investments in certain research areas should be prioritized according to socio-economic goals.

2.5 Internationalization and research collaboration

In this chapter, I contextualize internationalization of STI in relation to research and innovation policy and to STI cooperation. STI internationalization is an element in S&T policy. Research and innovation policy encompasses research internationalization, policies for science and research, for developing centers of excellence and for funding and managing science.

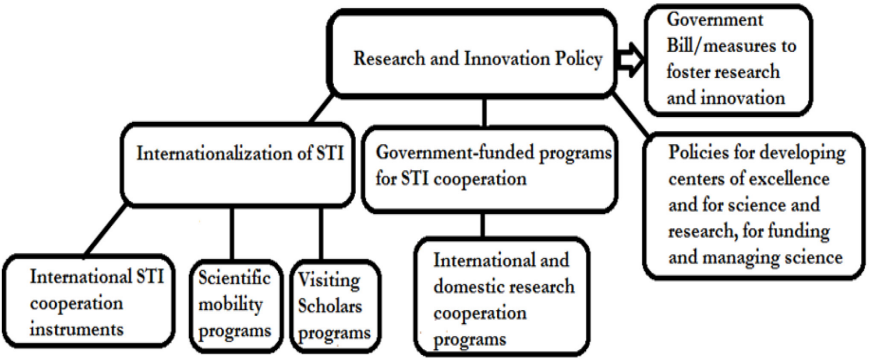


Figure 1
Elements in research and innovation policy (Source: the author)

Figure 1 suggests that the availability of human resources is closely connected to the quality of science collaboration because the latter depends on access to skilled researchers and high quality teamwork. Without qualified researchers who are highly motivated, the overall quality of a research collaboration project will diminish. These two factors – human resources and quality teamwork can never be taken for granted and assumed too simplistic. Team work is defined here as a group of researchers (scientists or non-scientists) who are employed by a university, working at the same location for an extensive period of time to produce new knowledge leading to outside recognition as a distinct department or entity (Barjak and Robinson, 2008). This definition of teamwork draws on the institutional approach and organizational affiliation (Cohen, 1981; Hagstrom, 1965) and a functional approach connected to specification of joint research activities (Andrews, 1979). McKinsey's 1998 report, "Better talent is worth fighting for" confirms the global need for talent. The McKinsey report concludes that the most important corporate resource over the next 20 years would be smart, sophisticated and technologically literate and international. In another report, McKinsey argues that "labor markets around the world have not kept pace with rapid shifts in the global economy" (McKinsey, 2015, p. 8).

2.5.1 Defining research collaboration

Science is increasingly an international activity and as such, it is important to promote research and technology development not only to tackle grand

challenges (e.g. climate change) but also to address the inequalities between the South and the North and development discrepancies.

Although research cooperation is one important component of domestic internationalization strategies and helps science to advance, it needs to be developed further. To bring domestic or international research cooperation to their full potential, and from an informal and improvised style into a more systematic and coordinated activity, it may be necessary for the actors involved (policy makers and researchers) to have a clear vision of the purposes of such collaborations and a thorough understanding of the roles of all the actors involved as well as the funding system.

I discuss research collaboration first because of its deep dependency on external funding to survive and second because it is important to understand what this activity means and the potential benefits, limitations and challenges of research collaboration as integrated in the research and innovation system. It is reasonable to assume that the term research collaboration means two researchers or a team of researchers working together towards a common goal driven by their personal interests or/and funding opportunities. However, there is more to research collaboration than researchers working together. Collaboration activities can be complex particularly when individuals from different countries are involved and when collaboration entails more than one project or when it has a specific timeframe.

Research collaboration can also be complex in terms of expectations of the convergence of academic and corporate research. As Godin and Gingras (2000) and Van Looy et al. (2004), have argued, it is not an either-or situation; successful universities and university researchers are able to combine academic excellence with industrial contacts and/or entrepreneurial contributions (Godin and Gingras, 2000; Van Looy et al., 2004).Therefore, research collaboration as an activity is far from simple. Next, I examine how other scholars define research collaboration.

Katz and Martin (1997) argue that the concept of research collaboration has been taken for granted as though it was a well understood practice; its meaning considered obvious and unproblematic by most. They argue that research collaboration often entails costs in terms of time and resources needed for a successful collaboration. Katz and Martin (1997) do not provide a definition of research collaboration and suggest that it encompasses several elements.

According to the authors, research collaboration means researchers working together "to achieve a common goal of producing new scientific knowledge" Katz and Martin (1997, p. 7). Or in their definition of collaborator, it could mean "anyone providing an input to a particular piece of research." Although broad, McNamara (2012) provides a definition of collaboration. The author suggests that the practice means that actors work together in the pursuit of complex objectives motivated by common interests and a shared responsibility for interconnected tasks. Bozeman and Boardman (2014) argue that some researchers associate their research activities with co-authorship while others have a broader perspective on the topic. For instance, using co-authorship to measure collaboration in science and technology has been the standard method, reflecting the increase in international research collaboration (Carayannis & Laget, 2004; Tijssen, 2004; Beaver 2001; Price, 1986). Other scholars (Engels and Ruschenburg, 2008; Duque et al. 2005; Katz and Martin, 1997) contend that co-authorship is only a partial indicator of research collaboration and a tool to measure research collaboration; however, they are not the same.

Bozeman and Boardman (2014, p. 2) define research collaboration as "social processes whereby human beings pool their experience, knowledge and social skills with the objective of producing new knowledge, including knowledge as embedded in technology." In the authors' view, research collaboration and scientific and technical human capital (STHC) are interconnected. Others (Dietz and Bozeman, 2005; Bozeman et al., 2001) adopt the same view arguing that collaboration is mainly about scientific and technical human capital. STHC "is the sum of scientific and technical and social knowledge, skills and resources embodied in a particular individual" (Bozeman and Boardman, 2014, p.6). Therefore, STHC is the set of resources and individual brings to her or his own work activities and collaboration projects (Bozeman and Boardman, 2014). Edler (2010, p. 7) suggests that intention and desire to work together are also part of scientific mobility as the experience facilitates collaborative work to "enhance the effectiveness of knowledge production." Georghiou (1998) uses the term collaboration and cooperation interchangeably and defines global cooperation in science and technology as international cooperation across two or more continents between researchers from advanced industrial countries. Moreover, Leydesdorff and Wagner (2008) studied international scientific collaboration and concluded that the network of scientific cooperation is increasing and it is becoming denser with more core countries participating in these networks but the number of core

countries has decreased. Huang et al (2012) use outputs to measure collaborative creativity in science and technology: papers as outputs of scientific research and patents as outputs of technical creativity.

Most literature on research collaboration (national or international) discusses the activity as a tool to achieve other goals. These other goals might include to promote technology development, to enhance the quality of research and scientific networks, to facilitate knowledge sharing, to reduce costs (e.g. through sharing lab equipment), for political purposes (e.g. when scientific cooperation is used to improve dialogue between nations), to obtain more funding, for international recognition, etc. However, research collaboration is rarely discussed as a function of human interactions. In other words, research collaboration can also be viewed as a by-product of interactions between researchers. In this particular case, personal contact, communication, networking and meeting people precede research collaboration but not necessarily result in collaborative work.

In summary, this literature review has discussed the topic internationalization in broader terms as it relates to higher education, political science, science and technology and international scientific cooperation. This dissertation treats internationalization of science, technology and innovation as an element in research and innovation policy and as a tool to forge scientific linkages. Internationalization and globalization are used interchangeably although there are differences concerning what they represent. The internationalization of higher education, for instance, can be viewed as a response to the latest global trends. One such trend is the growth of the English language utilization in science worldwide (Boekholt et al. 2009). This latter view of internationalization means that there are opportunities to continue to promote internationalization. There are also opportunities for governments, research organizations and companies to play a role as catalyzers of internationalization.

Finally, this thesis examines internationalization in the context of research and innovation policy. In other words, internationalization is viewed as a tool to promote different goals and to further scientific cooperation instruments. Therefore, this dissertation aims to contribute to the existing scholarly work on internationalization in two ways: 1) by examining internationalization as an element in research and innovation policy; 2) by taking a closer look at internationalization from the perspective of how it is practiced, enabled and carried out at the meso and micro levels.

Chapter 3 Theoretical Building Blocks

3.1 Introduction

This chapter reflects the multidisciplinary character of the topic studied. Internationalization crosses different fields - higher education, business administration, innovation, public policy, law and sciences. Therefore, this chapter draws on a series of theoretical concepts. A central theme in this thesis is how internationalization, which stands at the intersection of decision-making and practice, develops and is enabled. This study examines government's rationales for promoting internationalization programs[2]. It explores how decision making about the design of specific internationalization initiatives takes place. As seen in the literature review, internationalization can have a broad range of interpretations. This thesis draws on the following six theoretical concepts: institutional logics, bounded rationality, street level bureaucracy, principal-agent relation, historical institutionalism and drivers of international STI cooperation.

The selected theoretical concepts help us understand the complex and diverse ways in which internationalization processes and decisions have played out in research and innovation policy in the context of Sweden. This thesis draws on the above theoretical concepts to address two policy issues. One issue relates to the question of rationales for promoting internationalization instruments. The second is how decision making regarding particular internationalization programs takes place. The latter is associated with the selection of interventions, based on the concept of institutional logics and how actors' intentions, views

[2] This dissertation uses the terms programs, initiatives and policy instruments interchangeably. This dissertation also uses the term "case studies" to refer to the three government-sponsored programs described.

and practices are aligned and conflict with each other. The institutional logics concept is a framework for analyzing actors in their institutions and how they shape each other. The views on institutional logics examined by Pache and Santos (2013), Grant, 2012, Reay & Hinings (2009), Hwang & Powell (2009) and Meyer & Hammerschmid (2006) are useful to explaining cases of mixed institutional logics, juxtaposed experiences and backgrounds. These play a role in actors' responses to calls for proposals involving research collaboration projects funded by the government. These responses reflect the broader academic institution's logics of seeking external funding. The latter is embedded in the broader research funding context.

The institutional logics concept was first formulated by Friedland and Alford in 1991. According to Thornton et al. (2012, p. 2), "institutional logics represent frames of reference that condition actors' choices for sense making, the vocabulary they use to motivate action, and their sense of self and identity. The principles, practices, and symbols of each institutional order differentially shape how reasoning takes place and how rationality is perceived and experienced."

Bounded rationality (Simon, 1947, 1979) sheds light on decision-making within the framework of intervention. These strands of research – institutional logics and bounded rationality - highlight rationales in decision-making processes which are relevant for this study given that they offer possible explanations for why individuals act and behave in a certain way. The material drawn from interviews used in this thesis points to different rationales for grant seeking behavior in the case of universities, research institutes and firms. It points to rationales in decision making processes for turning ideas into practice at the funding agency level. Funding agencies provide expert advice to higher government offices and serve as intermediaries, linking the goals of the government to research practitioners' interests and aims.

The street level bureaucracy concept can illuminate our understanding of the alignment of policy goals with practices at the 'street level' where research and STI cooperation programs are carried out. The principal-agent relation model is also useful in explaining the relationship between ministries, government agencies and the practitioners of internationalization (academic researchers and project leaders in firms). For instance, the principal-agent relation model helps us understand the tensions emerging from interactions involving gains and losses and expectations of implementation of decisions. This interaction is also based on the expectation of mutual benefits and incentives. This expectation implies

that funding agencies will act in accordance with their responsibilities as the implementing and expert agency and will abide by the instructions ministers (the principal) transmit to the funding agencies (the agent).

There is a range of approaches to study motivations and decision making processes concerning internationalization programs. Some would suggest examining the topic through an international comparative analysis. This dissertation focuses on internationalization and its role in research and innovation policy from the point of view of practice. Therefore, this dissertation examines what government actors and academic actors do, why and how as opposed to what they have done or should do in the future.

3.2. Institutional logics

Institutional logics is a key concept that aids in the understanding of how organizations and individuals act within the policy process. The concept was pioneered by Friedland and Alford who critiqued the ''nonfunctionalist conception of society as a potentially contradictory interinstitutional system'' (Friedland & Alford, 1991, p. 240). The initial work on institutional logics focused on industry - and field-level analyses with a broader historical account, examining the effects of logics as they changed over time (Lounsbury, 2002; Thornton, 2002; Thornton & Ocasio, 1999). Studies by Lousburry and Boxenbaum (2013), Greenwood et al (2011) Pache and Santos (2010), Thornton and Ocasio (1999) and the book by Thornton et al. (2012) offer a comprehensive review of the concept institutional logics.

Borum and Westenholz (1995) show how an organization incorporates elements of new institutional logics into its organizational practice without fully eliminating old ones. Similarly, the STI cooperation programs I describe in this study illustrate the overlap between intents and ambitions to create new programs and traditional practices. In other words, the three government-led STI cooperation initiatives are rooted in old traditions of science-industry partnerships while some of the key components of the three programs – eco-innovation linkages and strategic research areas – represent fairly new ideas.

Therefore, the programs might be rooted in ambitions and intents to experiment with new ideas.

Furthermore, the institutional logics concept sheds light on the question of preferences and factors shaping policy outcomes. At the government level, a novel approach rooted in the government's logic of promoting internationalization is to stimulate and support international linkages through domestic policies and through funding from the government. From the historical institutionalism perspective, this approach to internationalization can generate tensions between old models and traditional ways of implementing decisions and new contexts and goals.

At the academic institutions level, the model of research governance, comprised of a mix of resource competition and incentives to foster relationships with funders, industry and other researchers, can be viewed as the institutional logics of a research system of funding and management. These institutional logics, represented by the governance of research such as funding, provide the means by which research is conducted and organized, internationalization programs are formulated and knowledge is generated.

Also, the institutional logics concept offers not only frames of reference, as suggested by Meyer et al. (2013), but also vocabularies of motives for actors. In the context of this study, these motives are combined. From the perspective of institutional logics, the three programs this dissertation describes are examples of how the logic of the government - to set goals and to align Swedish research and innovation policies with the wider world - is combined with the logic of academic and company actors who are the performers in science and innovation. Academic and industrial researchers abide by the specific logic of responding to funding opportunities, raising money, organizing activities and building research networks. At the same time, the intermediaries (funding agencies) try to bridge the two logics – the logic of the government and the logic of research and innovation performers. Other logics guide actors' actions. One example of such institutional logic is the "Swedish model." This concept is found in a wide range of literature – the evolution of the Swedish economy (Henrekson & Jakobssson, 2001; Lindbeck, 1997), R&D management (Håkanson & Zander, 1988); the Swedish welfare system (Lapidus, 2015). By the late 1960s, Sweden as a country could be characterized as having a high degree of stability, no structural imbalances, rapid industrialization and traditional means of solving social conflicts (Lundberg, 1985; Lindbom, 2001; Henrekson and Rosenberg, 2001;

Krivorotko, 2009). These features of the Swedish economy were accompanied by rapid progress in labor market policies, social reforms and income distribution. Sweden gained international reputation and was known for its measures for increasing labor mobility, generous pension plans and wage policies aimed at minimize wage differences. The perceived success of the Swedish economic model created among Swedish citizens a nationalistic sentiment built on a "myth of political and economic superiority," a country that emerged as the most socially advanced place in the world and a model for other countries (Lundberg, 1985, p. 4). However, the concept "has been used in a vague and unscientific way by economists, journalists and politicians since the 1930s The expression has been loaded with value judgements of varying kinds – shifting with the passage of time." (Lundberg, 1985, p. 1).

Finally, in the context of the three case studies, there are conflicting and overlapping logics. These two dynamics – conflicting and overlapping multiple logics – exist because STI cooperation programs are based on multi-actor activities. Individuals and their practices are embedded in the logics of their own institutions or in more traditional and strong logics of stability, social welfare and development. Certainly, these multiple logics give rise to different interpretations of rationales to act and might result in ambiguities and inconsistencies for individuals in their organizations.

3.3 Bounded rationality

> *"What is rational for administrators to do depends on the situations in which they work. Pressed for quick recommendations, they cannot begin long studies. Faced with organizational rivalries, competition, and turf struggles, they may justifiably be less than wholly candid about their own plans. What is sensible to do depends on the context one is in, in ordinary life no less than in public administration."*
>
> *John Forester, 1984, p. 23.*

This thesis draws on the bounded rationality (Simon, 1947, 1979) concept to examine decision-making within the framework of intervention. Bounded rationality highlights the constraints in decision-making. For instance,

individuals' intended "rational" actions are bounded by a number of factors. These might include actors' own beliefs, limited resources, time constraints, the need to meet the terms of bilateral agreements or fulfill policy goals. Thus, the bounded rationality and institutional logics concepts offer an explanation for why individuals, who would otherwise act rationally, are constrained and behave in a certain way and how a particular institutional logic might shape individuals' actions. The above formulations suggest the unpredictability in decision making processes.

Politics is often shaped by unpredictable circumstances and global forces accelerate the timeframe in policy processes (Benner, 2012). Unpredictable events, time constraints, vague and limited information are factors that bound even those individuals who intend to make rational choices.

From the rational choice perspective, internationalization reflects deliberate choices made by actors to reach optimal solutions (Gornitzka et al. 2003). However, given the complexity of decision-making processes, we should assume that deliberate rational choices are influenced by a number of factors. Political actions and choices policy actors make are often subject to uncertainties, disjunction of intentions, random processes, and possibly conflicts. Elements such as lack of clarity regarding purpose and long-term vision of STI cooperation programs and the need to be pragmatic and practical when implementing policies bound individuals' choices by steering them not to maximization of results but towards satisficing. Satisficing is defined as the attainment of satisfactory results instead of optimal. Given the above influences, achieving an "ideal" form of policy making might be unrealistic. In efforts to simplify complex decision making processes, policy actors might act in a pragmatic way. This approach might also be taken in order to shorten potential long problem-solving processes. "Satisficing is a 'weak method,' which problem-solvers apply when task domains are ill-structured or are unknown; it allows them to halt the search process when a solution meets their aspiration threshold" (Fiori, 2011, p. 590).

A presumably linear policy-making approach would involve the identification of problems and goal, search for solutions to address problems, establish the outcome and make a choice that will accrue the most benefits to society. This policy path, however assumes no inconsistency or tensions. It assumes engaged and motivated actors, easy access to information and reasonable expectations on

outcomes. Also, "comprehensive rationality," a term used by economist Gary Becker (1976) presumes that individuals have preferences and respond to incentives by maximizing. March and Simon (1958) challenged that assumption. Jones (2003, p. 395) argued that comprehensive rationality does not offer satisfactory scientific predictability and that bounded rationality is a superior mechanism. "Bounded rationality emerged as a critique of fully rational decision making" (Jones, 2003, p. 397).

In his article, "A Behavioral Model of Rational Choice" (1955, p. 99), Hebert Simon challenged the concept of rational choice used in economics – "an economic man is also a rational man who has 'knowledge of relevant aspects of his environment." Simon criticizes the simplification of the rational choice concept. The author argued that other factors enter the equation to determine an individual's choice and some of these factors are related to human behavior as for instance, psychological limitations or the computational capacity of an individual. It is possible that in the policy arena, decision-makers look for a 'satisficing,' rather than an optimal or maximizing alternative to a policy issue.

Charles Perrow (1972) summarized the implications of the bounded rationality on decision-makers:

> "Given the limits on rationality, what does the individual in fact do when confronted with a choice or situation? He constructs a simplified model of the situation. This "definition of the situation," as sociologists call it, is built out of past experience (it includes prejudices and stereotypes) and highly particularized, selective views of present stimuli. Most of his responses are "routine"; he invokes solutions he has used before. Sometimes he must engage in problem solving. When he does so, he conducts a limited search for alternatives along familiar and well-worn paths, selecting the first satisfactory one that comes along. He does not examine all possible alternatives nor does he keep searching for the optimum one. He "satisfices" instead of "optimizes." That is, he selects the first satisfactory solution rather than search for the optimum. His very standards for satisfactory solutions are part of the definition of the situation. They go up and down with positive and negative experience. As solutions are easier to find, the standards are raised; as they are harder to find, the standards fall" (p.149).

In summary, the concept of bounded rationality is used in this context as a tool to better understand how political intentions are forged and molded. Bounded rationality highlights that political intentions are continuously being expressed and policy decisions that emerge from those intentions are always emerging to solve problems according to established routines. Bounded rationality emphasizes that there are unpredictable events and other factors that bound individuals who intend to make rational choices. Thus, decision-making does not always entail a linear and sound process because the conditions under which decision-makers work and what they actually do play a role in policy-making. The policy implication is that bounded rationality predicts policy outcomes.

3.4 Implementing programs at the "Street Level"

Another theoretical concept aiding in the analysis and discussion of the empirical material is street level bureaucracy. This thesis draws on the concept to highlight the alignment of policy goals with decision making and practices at the "street level" where policy instruments to promote international cooperation in science, technology and innovation are designed and research projects are carried out.

A number of scholars have acknowledged the role individual officers play in interpreting government policies and translating them into practice. The street level literature highlights the tasks of government officials working at the street level and the influence of politicians, managers and street level bureaucrats in shaping actions at the forefront of policy implementation (May and Winter, 2007).

Michael Lipsky's seminal work, *Street-level Bureaucracy: Dilemmas of the Individual in Public Services* (1980) introduces the concept of street level bureaucrats. Although Lipsky's study focuses on the tasks performed by teachers, police officers, clerks and social workers, others have expanded on the concept to incorporate workers in other sectors or government branches (Sevä, 2015) who studies environmental bureaucrats; May and Winter, 2007; Nielsen, 2006; Kieser, 2010; Sandström, 2011; Trusty and Cerveny, 2012; Winter, 2003). This thesis uses the term street-level bureaucrats to refer to individuals who hold

management positions working in government agencies such as funding agencies. In this thesis, these individuals are also referred to as government officials, government officers or implementing actors.

Street-level bureaucrats are the front-line employees of public administration (Brodkin 2008; Hill and Hupe 2014: 53; Hupe and Buffat 2013, 550). They have been considered key players in the policy-making processes (Brodkin 2011; Gofen, 2013; Smith 2012), and function as policymakers in the sense that they informally create and re-create their organizations' policies (Brodkin 1990) and influence the lives and fate of the citizens to whom they provide service (Lipsky 2010, 3-4).

The policy implementation process is shaped by the actions of the front-line workers who interpret and carry out the policy directives formulated by higher level government offices such as the ministries. In other words, policy implementation integrates the macro world of policy formation to the micro world of policy practice (McLaughlin, 1987). From this perspective, "the understanding and discussions surrounding policy conceptualization and policy action or implementation shift the focus to the individual implementers, their intentions and motivations. What actually is delivered or provided under the aegis of a policy depends finally on the individual at the end of the line" (McLaughlin, 1987, p. 174).

Discretion that front-line public workers have in their jobs is one of the elements that run across the street-level literature as first observed and studied by Lipsky (1980). Cohen (2015), suggests that public policy cannot be understood as a top-down process, imposed by senior managers but rather one that is molded in lower-level (Bovens and Zouridis 2002). In the context of the three STI cooperation programs described, funding agencies exercise freedom to make decisions about the design of government-driven STI cooperation initiatives. Their freedom to act can be seen as embedded in a bottom-up process. However, their power to make decisions can be constrained by financial and human resources and mandates that are set by the ministries.

Lipsky's work (1980) has contributed to the understanding of the role of front-line public employees (e.g. police officers, teachers, judges, health care workers, public defenders, etc.). Lipsky argues that it is through their discretionary

power, autonomy and coping mechanisms that they are able to shape public policy. Lipsky (1980, p. xii) stated, "the decisions of street-level bureaucrats, the routines they establish, and the devices they invent to cope with uncertainties and work pressures effectively become the public policies they carry out." Lipsky's work shifts the attention to the relevance of multilayered policymaking. The assumption, according to Lipsky (2010, p. 12) is that street-level bureaucrats are policymakers in their own right; teachers are "ministers of education." Lipsky focuses on the daily practices and routines of these front-line workers – "the daily practice of governing in contact with citizens" or as Hupe (2014) has formulated, what happens on the ground.

The literature on street-level bureaucracy highlights the roles of street-level workers who follow administrative routines and apply administrative protocols to specific situations. However, front-line government officials such as street-level bureaucrats do not just act in conformity with policy protocols or do what they are told but they also do what is possible given the resources available (Brodkin, 2008). These actions suggest that practicality is a function of resource capacity. Thus, these individuals' practices, intentions and routines are influenced by work place routines, norms and protocols which enforce accountability (Brodkin, 2008). This means that although individuals have freedom to act, they are also held accountable for their actions and practices.

Lipsky (2010) argues that street-level bureaucrats are not only tasked with implementing public policy, they shape it as front-line actors who deliver services to the public. "Judges determine who gets probation and who goes to prison, teachers decide what students get special attention and "who is teachable", and parole officers decide who gets sent back to prison and who gets a second chance" (Lipsky, 2010). In parallel to this argument, in the context of Sweden, front-line public service employees working in funding agencies design programs, decide on funding allocation to different science and technology initiatives, determine grant cycles and establish programs timeframe.

Literature on street-level bureaucracy also highlights the disjunction between the actions at the front-line of policies with the original intentions of policies (Lipsky, 1980; May and Winter, 2007). There have been a number of studies that have emphasized the need to control the actions of street-level bureaucrats and how to influence the behaviors of the front-lines of service delivery. These

include signals by political superiors (Keiser and Soss 1998; Langbein 2000), organizational arrangements (Hill 2006), administrative emphasis of policy goals (Ewalt and Jennings 2004; Hill 2006; Riccucci et al. 2004), enhancements of staff capacity (Winter 2003), and managerial supervision (Brehm and Gates 1997; Brewer 2005). These studies support the well-known element in implementation studies, that the translation of higher level goals into street-level actions is subject to disjunctive influences (May and Winter, 2007).

This thesis utilizes the street-level bureaucrat concept as one of the theoretical building blocks because it brings attention to the role of government officials at funding agencies, who have considerable discretion in the policy implementation process. Managers in these funding agencies are not only interested in achieving results consistent with agency goals or logics (Evans, 2016). They are also interested in implementing decisions according to their own preferences and views (Evans, 2016). They are not simply interpreters of policy directives and implementers; they are strategists and experts, and have a take on how policy should be implemented and how programs should be designed and managed. They actively seek to implement policy and determine policy goals (Kirkpatrick et al. 2005).

3.4.1 Turning intentions into practice

Decision-making approaches have traditionally identified and followed a series of steps that help policy makers to find the best solution to address a specific political problem (Korte, 2003). Bazerman (1994) summarizes the linear decision-making process as follows: 1. Define the problem. 2. Identify the criteria or objectives of the decision. 3. Weight or prioritize the criteria or objectives of the decision. 4. Generate alternative courses of action to solve the problem. 5. Evaluate the alternatives against each criterion or objective. 6. Compute the optimal decision. However, the views about policy-making and implementation have changed over the years. Reality shows that decision making does not always follow such a logical structure (Korte, 2003). In other words, "dominant models of policy processes are unrealistic" (Hallsworth, et al. 2011, p. 30) because in the "real world of policy making," policy actors are regularly faced with pressures. Thus, as Hallsworth et al. (2011, p. 38) argue, "pressures of the real world of policy frequently lead to the identification of a policy goal and the selection of options for action becoming fused

together…plans may be present at the same time, or before, a need to act has been identified." Similarly, the data from the empirical material supports the above claims and suggests that idealized views of policy processes are disassociated from reality.

Complex decisions are often contingent upon situational, preferential, and political factors than a rational process of diagnosis, evaluation, and selection of the best solution (Korte, 2003; Mintzberg et al. 1976). Benner (2012) argues that politics is often shaped by unpredictable events with an acceleration of the political time-frame due to globalization forces. Politics in modern societies centers on timing and immediate response to national or global events (Scheuemann, 2004).

The process of turning ideas into practice used in this thesis as *turning intentions into practice* was long considered as "a series of mundane decisions and interactions unworthy of the attention of scholars" (Van Meter & Van Horn, 1975, p. 450). Since then the field has evolved and there are today a wide range of approaches on how policy formation is aligned with the implementation process. Policy implementation is therefore a key part of public policy and how policies come into being. According to Jenkins (1978), as cited in (Howlett and Ramesh, 2003, p. 6), public policy is "a set of interrelated decisions taken by a political actor or a group of actors concerning the selection of goals and the means of achieving them within a specified situation where those decisions should, in principle, be within the power of those actors to achieve." Jenkins (1978) acknowledges that a policy process consists of a series of interrelated decisions.

Policies to foster internationalization of science, technology and innovation often are a result of interrelated decisions. They are frequently intertwined, formed and shaped in parallel processes; therefore, they are coupled with and related to other goals. These goals are geo-political in nature (e.g. to strengthen international relations). They might serve the economic goals and interests of particular countries or a region as for example, trade and export. Research and innovation policy entails a series of strategies and decisions, represented by formulation processes and by actions, represented by implementation efforts related to different policy issues. These include the allocation of financial resources, the design of technical and scientific programs, the prioritization of research areas and the development of institutional apparatus to support the goals of science to benefit society as a whole. These separate but interrelated

decisions in research and innovation policy are made by different government agencies and policy actors. These decisions are implemented through different processes and streams. Government agencies can also work together during the design and implementation phases of programs to foster specific goals for science, technology and innovation.

Jenkins (1978, p. 6) suggests that there are limits to any decisions concerning policy articulation and implementation and claims that "a government's capacity to implement its decisions is also a significant consideration affecting the types of decisions it takes" and that certain limitations constrain the number of options in a policy area. Funding allocation to science and technology projects, the prioritization of research areas and the interpretation and execution of government directives (implementation of decisions) are typical issues embedded in research and innovation policy.

Policy implementation also involves decisions about strategic planning. Setting goals and defining strategies entail preparing an action plan to achieve the best possible outcome given the context and present circumstances. A question arises: do policy implementers usually follow a step-by-step procedure that involves a clear and long-term plan when they launch a new initiative? The ideal pre-established "clear goals" scenario might not be representative of the practice of policy making in the real world. The steps involved in the articulation of a policy to address a societal problem and the steps taken to transform intentions, recommendations and purpose into practice can be complex but they can also be simplistic and accepted as "good enough." Other implementation approaches involve the selection of options that will yield the highest expected utility also known as maximization (Simon, 1979). Yet other decision making styles might combine both strategies. In addition, some scholars suggest that policymaking should be informed by evidence based on knowledge from the best available research.

Sanderson (2009, p. 700) proposes intelligent policy making as an alternative to evidence-informed policy making. The former takes into account the complexity of policy making, treating policies as hypotheses to be tested in practice and treating learning as an important element in policy thinking and decision making. In addition, according to Sanderson (2009, p. 713), "policy making is not just a technical exercise of harnessing evidence and expertise but a broader exercise in 'practical rationality', a communicative process.

The approach to implementation also matters for the outcome of policy processes. Noble (1999, p. 120) defines strategy implementation as "the communication, interpretation, adoption, and enactment of strategic plans." According to Andrews et al (2011, p. 644), the style of implementation is important. Long and Franklin (2004, p. 311) argue that the approach that each agency uses in implementation is a key variable. Within the strategy implementation literature there is a range of possible approaches such as the five models in strategic management – Commander, Change, Collaborative, Cultural and Crescive – laid out in Bourgeois and Brodwin (1984, p. 242). Bryson et al. (2009), Andrews et al. (2011) and others who have written extensively on policy implementation (O'Toole, 2000; Pressman and Wildavsky,1973; Fernandez & Rainey, 2006; Pettigrew,Woodman, and Cameron, 2001; Stone, Bigelow, & Crittenden, 1999), suggest that there is a paucity of studies linking implementation processes to performance.

This thesis does not draw on implementation strategies or approaches in order to analyze the performance of the three government-sponsored programs. However, implementation strategies are important to discuss because they showcase administrative routines of organizations and the intentions of policy makers and implementation actors. These routines reflect the institutional set up within a government and the relationship between different government branches (e.g. ministries and funding agencies). The implementation style of an organization embodies part of its administrative routine, which is key to understanding the dynamics of implementation (Pollitt and Bouckaert, 2000).

Simply put, implementation style is the approach that organizations adopt when turning strategies or proposals into practice (Andrews et al, 2011). There are two central elements worth considering: the extent to which responsibility is centralized or decentralized, and whether formulation and implementation are distinct and sequential activities are interconnected (Long & Franklin, 2004). This seems particularly pertinent to internationalization within the context of this study which unfolds as a blend of policies with specific and discreet but interrelated goals. These policy goals are subject to government's responses to international trends or changes resulting from the need to address a problem or to fulfill a political objective. These goals are also subject to the intentions and ambitions of individual officers who play a significant role given the

government's dependence on expertise and networks held by such officials in the area (Edqvist, 2009).

Decision making at the government level might entail the utilization of different styles and logics. Political styles can involve pragmatism, goal fulfillment and satisficing. Satisficing refers to the selection of an alternative that will meet the minimum requirements necessary to attain a particular objective. Political logics can involve interpreting and making sense of policy directives coming from ministries. It can entail the logics of bridging political intentions to research and company actors. The use of different styles and logics in the political arena does not mean that decision making is always consistent and that implementation strategies or approaches are always systematic. In some instances, as it will be demonstrated chapter 8, there is an absence of internationalization strategy or "no discernable or consistent style of implementation (Andrews, et al, 2011, p. 648; Hickson et al., 2003, p. 1812, 1817) or a lack of a clearer approach to policy implementation.

Regarding the concept of 'sense making,' Weick (1995) claims that managing consists of making sense of complex and chaotic circumstances and policies that surround organizational actor and humans. Weick (1995) and Weick et al., (2005) argue that perceptions about a 'significant' cue are determined by assumptions that arise out of previous experiences. Thus, actions that are a result of cues will be influenced by these assumptions. According to Weick, this process does not entail a rational consideration of facts or alternatives. Rather, it entails instinctive responses to complex situations that arise. "Sense making is about the interplay of action and interpretation rather than the influence of evaluation on choice" (Weick, et al., 2005 p. 409). Weick et al. (2005 p. 411-413) provides a series of definitions and characterizations of sense making. Sense making as *action – what is going on here?/what is the next step* - and sense making as *presumption* in connecting the abstract to the concrete are helpful in the context of this thesis. Actions, interpretations and the translation of abstract into concrete are sense making characterizations that can be applied to circumstances of decision-making, design and implementation of public policies or government programs.

Drawing from the sense making concept, in some instances, policy actions performed at the street level (by the front line workers in the public sector)

emerge from the need to fulfill broader government goals at the higher government level. Prior to acting, individuals first need to understand and make sense of the circumstances surrounding them as for example, their environment and policy aims and intentions. These policy intentions can be in the form of government directives that are transmitted to implementing agencies containing general guidelines for the design of STI cooperation programs.

The public policy literature has stressed that "the implementation of public policy is not the simple transmission of instructions from the political center to the periphery (Pressman and Wildavsky, 1973, p. 289) or from ministries to implementing agencies. This suggests that interpretation of policy directives, implementers' intentions and beliefs coupled with their organizational environment shape the implementation process. Hill (2003, p. 267) argues that a significant part of the implementation and public administration literature assumes that policy meanings are shared among policy actors (implementers, policy makers, government officials, members of ministries) beforehand. However, policy directives from higher level government offices might not be clear. The terms of policy directives might also be too general. Following this line of argument, Hill (2003) suggests that it is important to understand how implementers interpret and understand policy in order to execute it.

Yanow (1996, p. 127; 1993) argues that context plays a role in policy because policy is created not only from words in policy texts (e.g. legislation, government directives, government bills) but also from the knowledge and values implementing actors bring to their jobs and from the setting in which implementation occurs. Thus, actors who are tasked with designing programs that are funded by the government or who are responsible for interpreting and executing government directives construct meaning based on context-bounded messages about policy (Hill, 2003, p. 272).

3.4.2 Policy experimentation

According to Zahariadis (2014, p. 33) "the policy stream includes a "primeval soup" of ideas that compete to win acceptance in the policy networks. Ideas are generated by specialists in policy communities and are assessed in various forums and forms such as hearings, papers and conversations. Some ideas survive this

initial period basically unchanged, others are combined into new proposals, and still others just disappear. In addition, experimenting with new ideas in policy depends on actors that can carry out those novel ideas – policy entrepreneurs – and who can advocate for solutions to particular issues, taking advantage of a window of opportunities. "When windows open, policy entrepreneurs must immediately seize the opportunity to initiate action" (Zahariadis, 2014, p. 35). Thus, policy windows are defined by Kingdon (1995) as opportunities for advocates to push their preferred solutions to an issue.

The existing literature on the topic provides some insights on the rationales for policy innovation or experimentation in policy design (Van der Heijden 2012, Campbell, 1969; McFadgen and Huitema, 2017 on how policy makers are influenced by policy experimentation). Teets (2015, p. 82) defined "policy innovation" or "policy experimentation" as creating or adopting a new policy to address perceived governance problems." Building on Teets's definition, I view policy innovation as the practice of pursuing and implementing a new idea with the intention to, not necessarily address a perceived problem, but to fulfill multiple needs or policy goals (e.g. political). Kingdon (1984, p. 123) defines policy entrepreneur by "their willingness to invest their resources —time, energy, reputation, and sometimes money—in the hope of future return. That return might come to them in the form of policies of which they approve, satisfaction from participation, or even personal."

Chen and Yang (2009) argue that concerns about party-state reputation and legitimacy drive policy innovation and experimentation behavior. Others suggest that local policy innovation is motivated by top-down decisions when local officials follow orders from higher levels of government in order to receive promotion (Kindgon, 1995; Teets, 2015). Another less explored argument in the literature, according to Teets (2015) is that local officials innovate for pragmatic reasons especially when they face an ungovernable situation – need-based argument for policy innovation. The need-based argument for policy innovation is helpful and partly explains the launching of the two Eco-Innovation Cooperation initiatives. Evidence shows that pragmatism, not an ungovernable situation led to a *practical approach to policy decision* and to the launching of two pilot programs.

While "policy entrepreneurs" or policy innovators can pioneer innovations in public sector through the formulation and implementation of new ideas, they cannot do so alone (Roberts and King, 1991). These actors play a key role in policy making but do not control the policy flow, according to Roberts and King.

3.5 Principal-agent relation and STI programs

The fourth mode of theorizing draws on the principal-agent concept. The principal-agent model (Ross, 1973; Coleman, 1990; Braun, 1993; Braun and Guston, 2003) emphasizes a social exchange between two actors – the principal and the agent. This interaction is based on the expectation of mutual benefits and incentives. It is based on the expectation that the agent will act in accordance with the instructions received from the principal.

The principal–agent relation sheds light on public policymaking. From this perspective, authority is often delegated by one political player to another (Delreux and Kerremans, 2010). In international negotiations within the European Union, the delegated authority has the authority to negotiate international agreements on trade or on the environment (Delreux and Kerremans, 2010). Also, in the context of international agreements, where principals and agents interact, negotiate and decide on international issues, science diplomacy can be used as a tool to improve relations between countries. Science diplomacy is a driver of internationalization and international cooperation in STI and it can be a motivating factor in the establishment of science and technology agreements. Science diplomacy is also part of the regulatory measures and agreements (labor market policies, research policies, technological standards such as IPR) to reduce transaction costs (Schwaag Serger and Remoe, 2012).

In this dissertation, the principal is represented by the government (e.g. ministries) and the agent is represented by the research performers across universities, research institutes and companies. Funding agencies in this context have a dual role: they are agents in relation to ministries and they are principals in relation to research practitioners. The principal is the actor who disposes of

the financial resources for the implementation of policy goals. The agent is the actor who accepts the principal's resources and furthers the principal's interests (Coleman, 1990). The agent responds to the funding opportunities put forward by the principal and accepts these resources willing to work accordingly (Braun and Guston, 2003). In the Swedish context, the principal represented by the ministries sets the budget. Funding is channeled to the agent, represented by the participants of STI cooperation programs. Funding agencies decide on funding allocation to participants of government-sponsored research cooperation programs.

The principal-agent model offers insights on issues concerning dependency-driven behavior and how this behavior drives governments' interests in promoting STI cooperation. Government-funded research programs might attract opportunity-driven entrepreneurship. Opportunity-oriented entrepreneurship views business as an opportunity. Within the economic perspective, scholars argue that given the self-interest rationales of social actors or market competition, decision makers in firms seek the maximization of profits (Buckley and Casson, 2009).

In this study, the principal is the actor that disposes of the financial resources through which goals get implemented. The agent is the actor who accepts the principal's resources and furthers the principal's interests (Coleman, 1990). The relationship between these two actors can be characterized as a social exchange and as mutually-dependent or dependency-driven. In this relationship, funding agencies have the decision power to determine the amount of financial resources that will be allocated to the research project grantees.

3.6 Historical institutionalism

Historical institutionalism provides a different perspective on processes and transformations and at the same time, on stability in the field of science, technology and innovation. For instance, concerning government-funded programs that are created to forge university-industry cooperation, one perspective is that university-industry partnerships are not new and have been traditionally pursued. They are anchored on traditional ways of setting up collaborations at the discretion of the partners involved. However, the programs

that foster these partnerships can be considered new because they might emerge from a novel idea. They can also be characterized as innovative and a result of policy experimentation. Another perspective is that these programs might not be entirely new but renewed.

Science, technology and innovation programs have been focusing on creating linkages but a number of research cooperation programs are mainly focused on the domestic context. A novel approach is to stimulate and support international linkages through domestic policies and through funding from the government. This potentially generates tensions between old models and new contexts and goals.

Historical institutionalism provides a few insights that can shed light into the question of policy preferences and factors shaping policy outcomes. Thus, the utility of historical institutionalism as an conceptual tool is not for the purpose of a historical account but to highlight how solutions to current policy issues might be built out of past experiences and might have been used before because they are part of old traditions.

Steinmo et al. (1992) argue that institutions can influence the formation of preferences by political actors – endogeneity of preferences. It is based on the idea that institutions for representing interests affect the politicization of interests but looks closely at interactions between preferences, interests and institutions (Immergut and Anderson, 2008). In addition, the organization of interests and the political structures within which they organize shape the issues in the political agenda and whether or not they are of interest at all (Immergut and Anderson, 2008).

More recently, a blend of rationalistic and institutional traditions have been highlighted in which policy outcomes are explained by the relations between actors who may not possess complete information and whose interests may be molded by institutional arrangements, but who nevertheless may engage in rational negotiations (Scharpf, 1990, 2012). In a study regarding pre-conditions for policy change in the Nordic countries, Benner (2012) examines the factors influencing policy outcomes. Benner (2012) argues that even semi-rationalist traditions acknowledge that politics is often shaped by unpredictable events with an acceleration of the political time-frame due to globalization forces. Politics in modern societies centers on timing and immediate response to national or global events, rather than reflecting social and political interests (Scheuemann, 2004).

And, even when time-frames are constricted, reactions to "events" do not emerge in a historical vacuum but rather relate to responses in earlier events (Benner, 2012). Benner's argument resonates with Berger's statement about the adherence to traditional political structures even in processes of political modernization because new institutions have been built on institutions of the past.

3.7 Drivers of international STI cooperation

Boekholt et al. (2009) argue that the increased focus on internationalization activities and on cross-border STI cooperation policies have been influenced by exogenous events that have triggered policy debates (Boekholt, et al. 2009) and governments' decisions to invest in internationalization instruments. Among recent international developments is the emergence of the BRICS nations - Brazil, Russia, India, China and South Africa - particularly China as a country with strong research and development (R&D) capacities (Boekholt et al. 2009). Also, pressing world health and environmental issues (e.g. climate change, efforts to eradicate the world's most infectious diseases) have triggered "mission-oriented interventions" through the funding of international research cooperation to address global challenges (Schwaag Serger and Remoe, 2012).

Other specific and general rationales for promoting internationalization activities include: to improve international relations through science and technology agreements reflected in science diplomacy, to strengthen international image and competitiveness (e.g. Sweden as a "role model" in research collaboration practices and in innovation) and to gain access to large markets to promote domestic technologies. Additional drivers of internationalization and of international STI cooperation constitute the following: perceived benefits of the principal-agent arrangement, the interest in disseminating "best practices and the Swedish model" and the need to strengthen perceived weak international linkages in science, technology and innovation. Before delving into the drivers of internationalization, I first discuss the three levels of intervention to support internationalization to advance international STI cooperation[3].

[3] Note that this thesis uses both terms, drivers of internationalization and drivers of international STI cooperation interchangeably as they are connected and denote international activities.

Schwaag Serger and Remoe (2012) developed a framework showing the three levels of intervention to support internationalization which encompasses broad policies (economic, industrial, labor, etc.) and science diplomacy. The first and basic level comprises of frameworks to forward techno-globalization and international STI cooperation. Examples are frameworks for technological standards, common IPR and anti-plagiarism regulations. These measures are put in place to reduce legal costs, communication costs and adaptation costs (Schwaag Serger and Remoe, 2012). This ground level framework addresses different policy levels including labor market policies, economic policies, research policies, competition policies and can be incorporated into the science diplomacy category. The second level of intervention to support internationalization includes national programs to facilitate the mobility of researchers, funding of foreign researchers and helping international researchers to access domestic labor markets (Schwaag Serger and Remoe, 2012). The third level includes targeted internationalization interventions. These are generally based on bilateral and multilateral agreements and implemented via joint calls for proposals including narrowly defined science and technology fields (Schwaag Serger and Remoe, 2012).

One important aspect of this framework concerns the role of the third aggregate level, the targeted instruments. According to Schwaag Serger and Remoe (2012), there are two main rationales for implementing targeted instruments for international STI cooperation. For the purpose of simplification, I refer to these as conditions instead of rationales. The first condition for targeted instruments to be implemented is that the other two levels (regulatory measures and opening measures including scientific mobility) are fulfilled. I infer that the targeted instruments are used as complementary activities. The other condition for the implementation of targeted interventions is inadequacy in fulfilling overarching objectives: when the other two levels are not working properly (Schwaag Serger and Remoe, 2012). For instance, the authors argue that in this case, targeted interventions might be deployed to prompt international STI cooperation that would not otherwise be spontaneously realized and as pilot programs to test strategies to STI cooperation initiatives (e.g. scale-up or roll-out).Therefore, one can conclude that in the case of the latter, targeted interventions are used to fulfill a policy gap, to address a policy problem and as experiments in international STI cooperation.

The following section examines the rationales for promoting internationalization and international scientific collaboration. Some of these include: challenges in

STI and the perceived need to respond, science diplomacy, addressing societal challenges, changing knowledge and innovation geography, access to markets and strengthening international reputation through competitiveness. I classify these into specific and general drivers, based on Boekholt, et al.'s (2009) broad and narrow cooperation paradigm. The specific drivers which Boekholt et al. (2009) refer to as narrow STI cooperation drivers are mainly used to "improve the quality, scope and critical mass in science and research by linking national (financial and human) resources and knowledge with resources and knowledge in other countries" (Boekholt, et al. 2009, p. ii). These drivers can be used to gain access to high quality knowledge produced abroad and to attract skilled individuals to the home country.

In the general STI cooperation paradigm, the non-science policy objectives interact with "intrinsic" science oriented goals and STI cooperation becomes a tool to achieve other policy ends (Boekholt, et al. 2009). The specific "intrinsic" STI paradigm forms the core of the international research collaboration motivated by achieving research excellence, to attract qualified labor force and to build STI capabilities through human resources and infrastructure. In the broad STI cooperation paradigm, the main four drivers of STI cooperation are: improving national competitiveness, supporting less developed countries by helping to develop STI capabilities, tackling global challenges and creating stable diplomatic relations with other countries (Bokeholt, et al. 2009).

3.7.1 Challenges of STI: The need to respond

One obvious rationale for promoting internationalization programs in science, technology and innovation is the perceived economic benefits resulting from cross border STI collaboration. It follows that if governments perceive the benefits of STI collaboration to be positive, they will provide financial support to these activities. These STI cooperation programs can be in the form of university-industry as in the three case studies I describe. According to Henrekson and Rosenberg (2001, p. 211), "the Swedish Government has been keenly aware of the importance of an efficient university/industry interface for some time…" According to Boekholt et al. (2009), such benefits of STI collaboration fall into the narrow STI cooperation paradigm. This narrow STI cooperation paradigm aims to improve the quality of science and research, to

gain access to knowledge generated abroad and to attract qualified labor force to the home country.

Furthermore, it has become common knowledge that science, technology and innovation all contribute to economic growth (Bernenke, 2011; Boutellier and Henzen, 2014; Salmenkaita and Salo, 2002). According to the former chairman of the U.S. Federal Reserve Board, Ben Bernanke (2011, p. 2), "innovation and technological change are undoubtedly central to the growth process; over the past 200 years or so, innovation, technical advances, and investment in capital goods embodying new technologies have transformed economies around the world." Thus, governments want to ensure that science, technology and innovation yield benefits to society.

In spite of the known benefits of STI cooperation, there are a number of intrinsic challenges within science, technology and innovation. One perspective is perceived complexities and challenges drive governments' intervention efforts and responses. Policy actors respond to the challenges of STI collaboration by engaging in decision-making processes for the funding and the prioritization of science and technology programs and by designing and launching new STI cooperation instruments. Often these consist of targeted government instruments that are crafted to fulfill specific purposes. Such instruments enable the operationalization of internationalization and international STI cooperation to advance research quality, to develop technology and to promote innovation.

One of the challenges relating to decisions about internationalization activities and cooperation in science, technology and innovation is that these decisions do not always emerge from a linear policy processes or involve a straightforward policy cycle with well-defined stages. Second, science, technology and innovation are multidisciplinary areas and the governance of the STI areas depends on the actions of a constellation of actors. This multi-actor context can lead to more complexities because there are different participants who have distinct goals and interests. Third, other challenges and complexities might arise given that STI stands at the intersection of politics and science. These can be in the form of increased expectations. This means that researchers often need government funding to ensure the continuity of their projects and on the other hand, the government relies on academic scholars to deliver research results.

Finally, science, technology and innovation require financial and human resources for their long-term sustainability and to ensure benefits to society at

large. Thus, given the complexities and challenges of STI and its organization around multi-level instruments and multi-actor participation, one possibility is the need for coordination and intervention. I define intervention in this context as increased government involvement in technology and innovation programs to foster scientific collaboration. The form of government involvement can vary on the basis of need, availability of resources and policy goals and intentions.

Regarding the policy process, another challenge affecting decision making in science, technology and innovation is resistance to change. Path-dependency shapes policy as past policies coexist with new ones (MacKinnon, 2010; Mytelka and Smith, 2002; Wittrock and de Leon, 1986). According to Löfgren and Benner (2003, p. 27), "path-dependency perspectives emphasize the 'stickiness' of institutional arrangements: once a nation has developed a particular institutional set-up, it is difficult to change track. "However, it can be argued that institutional legacies matter less at times of profound changes in technology and production systems". In addition to the policy process, there are other complexities associated with the field of science, technology and innovation that can justify the need for coordination and the need for intervention.

Braun (2008) argues that the most challenging issue for successful outcomes in the coordination of governance of research and innovation policies is institutional complexity. I infer that institutional complexity is one symptom of the larger political context namely stickiness (the tendency to keep former institutional legacies) and the presence of different levels in the public arena (vertical and horizontal). Braun (2008) claims that the existence of vertical governance levels such as the cabinet, ministries and agencies and horizontal levels of governance illustrate that political coordination cannot be the result of voluntary and unprompted processes; it must be promoted and acted upon.

The following are three reasons explaining the complexities of STI: 1) the widening and deepening of innovation policy; 2) the policy-mix concept; 3) multi-level governance (Borrás, 2009; Edquist and Borrás, 2013; Flanagan et al. 2011; Magro and Wilson, 2013). STI policy encompasses other areas and policy domains such as industrial policy, environmental policy, health, education, energy (Magro et al. 2014). Also, STI policy now includes innovation due to the need to incorporate non-technological elements of innovation to policy (Magro and Wilson, 2013). Also, public engagement in STI aiming to improve and foster innovation and S&T capabilities is comprised of multiple instruments and rationales (Magro et al. 2014). This interaction between instruments from the

same or different domains is called policy-mix described by a number of scholars (Edquist and Borrás, 2013; Flanagan et al., 2011; Magro and Wilson, 2013; OECD, 2010). Policy-mix represents the diversity of innovation mechanisms involving different spheres, multi-level governance that denotes the levels in which policies are designed and administered (MacKinnon, 2010; Mastroeni et al. 2013; Weber and Rohracher, 2012).

3.7.2 Science diplomacy

Science and technology coupled with diplomacy can be used as a tool to foster stable relations with other countries or to sustain existing international ties. Creating good and stable diplomatic relations are part of a broad STI cooperation model and one of the main drivers of STI cooperation (Boekholt et al. (2009). Science diplomacy is a driver of international STI cooperation but also an instrument that is part of the regulatory measures and agreements (labor market policies, research policies, technological standards such as IPR) to reduce transaction costs (Schwaag Serger and Remoe, 2012).

Féron and Crowley (2003) bring a political science perspective to internationalization and argue that internationalization cannot be viewed as separate from policy which influences and to a certain extent, reshapes internationalization. Féron and Crowley (2003) argue that internationalization is an example of a policy shift that emerges from external pressures and not an organized and designed process.

The interplay between science and technology cooperation and diplomacy has been well documented (Royal Society, 2010; Stein, 2002; Stein and Ahmed, 2007; Chung, 2002; Dufour, 2002; Georghiou, 1998). Governments view science diplomacy as a tool to promote international relations in science, innovation and education and to promote domestic scientific environment in foreign countries (Schlegel et al., 2011). From the European perspective, STI cooperation has been beneficial for the region's prosperity and security and an important factor in integration (Flink and Schreiterer, 2010). In 2005, former European Commission President, José Manuel Barroso addressed the participants of the EU-China 7th Summit:

> "We are at a dynamic moment in our relationship with China. Our Chinese partners have acknowledged the importance of the EU as a strategic partner and

> our relationship is growing in the political as wells as trade fields. Developing this relationship will be one of our top foreign policy objectives in the years to come".

The above statement does not mention the role of science and technology in EU and China relations. In 2012, however, in a communication from the European Commission to the European community - European Parliament, Council, EU Economic and Social Committee – the narrative changed to include not only cooperation in research and innovation but also science diplomacy as an objective of international collaboration:

> "Science diplomacy will use international cooperation in research and innovation as an instrument of soft power and a mechanism for improving relations with key countries and regions. Good international relations may, in turn, facilitate effective cooperation in research and innovation[4]."

In the 1980s and 1990s, efforts by the Swedish Government to establish science cooperation with China were driven by 'science diplomacy' motivations, using science to improve political relations between countries (Lundin & Schwaag Serger, 2014). Since the mid-1990s, and in response to China's growing economy but also its rapidly increasing S&T resources, the Swedish Government has been focusing on consolidating S&T cooperation with China (Lundin & Schwaag Serger, 2014). This motivation is driven, more importantly, by the desire to facilitate Swedish firms' access to the Chinese market, and to enable and encourage Swedish academia and industry to tap into and link up with China's increasing knowledge resources (Lundin & Schwaag Serger, 2014).

Science and technology and international affairs influence each other (Flink and Schreiterer, 2010) and can have an important role in the support of foreign policy goals through scientific advice and in fostering international relations between countries through scientific cooperation (Royal Society, 2010). For governments and foreign policy-makers, scientific cooperation is driven by the need to support higher level objectives. For the scientific community, on the other hand, participating in international science cooperation is motivated by the desire to work with the best people in the world, access to research facilities and research discoveries and new sources of funding (Royal Society, 2010).

[4] Commucation from the European Commission to the European Parliament, to the Council, the European and Social Committee, and the Committee of the Regions. Enhancing and Focusing EU international cooperation in research and innovation: A strategic approach. (COM2012497) September, 14, 2012, Brussels.

Motivations for engaging in STI cooperation can also fulfill political purposes. According to Georghiou (1998), science and technology cooperation can be seen as key to broader political or economic goals. One example is the European Framework Programs which are political instruments to implement EU policies in different areas (SFIC official, 2015). The European Commission has been engaging in S&T in its foreign policy by sending delegations abroad to promote the European Commission's Research Framework Programs and the European Research Area as "beacons for security and prosperity through transnational cooperation and R&D" (Flink and Schreiterer, 2010, p. 667). Through these missions, the EU also pursues foreign investment and cooperation partners for expensive and large-scale research projects (Flink and Schreiterer, 2010).

3.7.3 Addressing societal challenges

According to Boekholt et al. (2009), tackling societal challenges is one of the main drivers of STI cooperation. These can be medical-related issues that scientists wish to address. Today, international S&T cooperation encompasses working towards finding solutions for a whole range of global 'grand' challenges (Aho et al. 2006; Edler, 2010). According to Boekholt et al (2009), "traditional drivers of effectiveness (complementary knowledge) and efficiency (shared infrastructure) of knowledge production have been complemented by attempts to integrate international collaboration into problem driven, mission oriented research." Researchers in one country reach out to researchers in another country. Together, they form science, technology and innovation consortia as in the two Eco-Innovation Cooperation programs I describe in this dissertation.

There is great potential for international cooperation with China to promote eco-innovation for mutual benefit and to contribute to addressing global challenges (Lundin and Schwaag Serger, 2014). Schwaag Serger and Wise (2010) argue that countries around the world are identifying the need to address global challenges as an important driver of international science, technology and innovation cooperation.

Views about grand challenges and what they mean can affect prioritization in science and technology cooperation between countries. Different countries might have distinct priorities with respect to global challenges. For instance, societal challenges such as health, food security, transport, energy, climate

action, society and security are priorities within the European Union with a budget of 31 billion Euros (McGrath et al. 2014). In China, one of the main priorities are renewable energy (Zhao et al. 2011) and biotechnology while in India, one of the most important priorities for the government is to have better preventive care (McGrath et al. 2014).

3.7.4 Changing knowledge and innovation geography

> *"Rapid expansion of research in countries outside Europe and North America, led by China, is causing a major rebalancing of the global research system in a process that has only just started and is certain to continue." (Stenberg, 2013, p. 8).*
>
> *"There is a general agreement that the developments in the science, technology and innovation system in China are most important and relevant and are about to change the whole global landscape of knowledge production and innovation." (Horvat and Remóe, 2010, p. 6)*

The perceived need to strengthen internationalization is a result of increased research and development costs and skills shortages, the emergence of new markets and persistent European and global challenges (Schwaag Serger and Remoe, 2012). In the past, countries such as India, China and Singapore have been the source of scarce researchers to developed countries. Today, the high research quality of their institutions has propelled them to be considered interesting partner countries (Boekholt, et al., 2009). In addition, China's international position in science and technology has intensified the coordination and cooperation of agreements with this country (Horvat and Lundin, 2008; Arnold et al. 2009). Therefore, these new developments have changed the drivers for promoting STI cooperation policies with regard to their nature and content and with regard to their geographical focus (Boekholt, et al., 2009).

Furthermore, recent shifts in the knowledge and innovation geography mean that the new knowledge and innovation centers are emerging in countries outside Europe, such as China, India and Brazil (TAFTIE, 2009). For instance, today, approximately 70% of knowledge creation occurs outside the EU, and

around 50% of the human resources for research and innovation live outside the triad Japan, U.S. and Europe (European Commission, 2013). According to Schwaag Serger & Wise (2010), the term 'new knowledge and innovation geography' refers to four distinct factors. Firstly, communications technology has enabled changes in innovation processes with more open and user-driven approach to innovation. Secondly, increased international mobility has led to an increase in internationalization of science, technology and innovation, linking local innovation hubs within global knowledge networks. Third, shifts in the knowledge and innovation geography are associated with the transition economies accounting for a growing share of R&D investments and human resources for science and technology. Lastly, growing internationalization combined with current global challenges (climate change, air and water pollution, infectious diseases, etc.) require countries to cooperate in science, technology and innovation to find solutions to societal problems.

These transformations are a result of a variety of factors that have played a key role in the improvement of research and development infrastructure, particularly in emerging economies such as China. Among these factors are the rapid development of high-tech industries, R&D investments, globalization and the emergence of key players in the world economy (e.g. the BRICS countries). China's development is part of a fundamental shift in the international distribution of knowledge (Schwaag Serger and Breidne, 2007). For instance, in the last 25 to 30 years, China has systematically implemented policies and strategies restructuring its research organizations, increasing S&T funding, developing the human resource base, improving research performance and outputs, and investing in research infrastructures (Horvat and Remøe, 2010*).*

Another example is the production and innovative manufacturing, particularly in wind and solar power generation as in the case of Chinese firms (Locke and Wellhausen, 2014). According to Wen and Chen (2007), in the last decades, East Asia has become an important manufacturing base.

In addition, the share of the United States and Japan in total world patents and scientific publications is decreasing, giving way to S&T production by the BRICS, especially China. The BRICS produced about 12% of top-quality scientific publications globally in 2013, compared to 28% in the United States (OECD, 2014). The share of the BRICS is almost twice what it was ten years

ago. This shift in scientific leadership is also apparent in patents, although it is less striking (OECD, 2014).

Furthermore, technology has become increasingly globalized (Petrella, 1989; Guellec and van Pottelsberghe de la Potterie, 2001; Kaufmann and Tödtling, 2001). According to Chen (2003, p. 18-1), these changes are "reshaping the structure of the global innovation system and the landscape of global technology." Ernst (2002) argues that developing nations need to incorporate international and domestic sources of knowledge to compensate for weak national production and innovation systems. And based on the premise that developing countries need to compensate for weaker research and innovation infrastructure, these nations are increasingly investing in programs that forge international linkages in science and technology. These programs exist in the form of science and technology cooperation where both sides are motivated to forge and sustain STI ties. This is particularly the case with respect to the Sino-Swedish relations where Sweden and China view scientific collaboration involving researchers from both nations as mutually beneficial.

3.7.5 Access to markets: exporting solutions

Access to markets is one of the main motivations for actors, particularly firms to engage in international STI cooperation projects with their foreign counterparts. Widely distributed technological and scientific expertise, improved business climate in host countries and improved patent agreements have driven the increased R&D internationalization of multinational firms (Schwaag Serger and Remoe, 2012).

Furthermore, motivated by export opportunities and national competitive advantage, governments around the world direct their attention to the BRICS nations. Solutions and technology from the North meet problems of the South. The Nordic countries also follow this trend. Strong innovation capabilities, quality R&D and long history in developing environmental technologies are advantages that can be tapped into. "The Nordic countries' efforts to promote sustainable development and a strong focus on environmental protection, clean energy and environmental technologies has further strengthened Chinese interest – both from the public and private sector – to seek S&T cooperation with Nordic actors" (Schwaag Serger, 2014, p. 2).

Access to foreign markets and desire to bring solutions to developing economies emerge as drivers for actively joining international STI cooperation, including the companies participating in the two Eco-Innovation Cooperation programs with China and Brazil. This purpose is reflected in one of the goals of the two international programs: to facilitate access to emerging markets through research partnerships with Brazil and China.

Another perspective is developing countries and emerging economies are viewed as new business opportunities and places with raising economic and environmental problems (Ong, 2011). These emerging global spaces are perceived as sites of intervention for which a team of actors - researchers, companies and governments of other countries - come together to offer a solution (Ong, 2011).

3.7.6 International reputation and competitiveness

The term competitiveness (Porter, 1990) comes from the business school literature and is understood as the ability to compete. The term can only make sense if applied in the context of competition among two or more actors in supplying a product (Fougner, 2006). In the business management field, the governmental problem of competitiveness is connected to the strategies employed by the government to boost firms' ability to compete and succeed (Fougner, 2006). The focus is still on competitiveness but now new actors – the state (government) and scientists – in addition to industry have embraced the concept and incorporated it into their activities, routines and policy actions.

The term competiveness has evolved since the 1992 OECD's definition to encompass science, technology and innovation as important elements for the economic growth of a nation. Today, the competitiveness and prosperity of countries are dependent on their "ability to harness the forces of globalization, science, technology and innovation to generate economic and social value." (Schwaag Serger & Wise, 2010, p. 9) "Countries and regions seek to optimize the use of global knowledge and innovation resources for their own benefit" (Schwaag Serger & Wise, 2010, p. 9). According to Boekhold et al. (2009) competiveness is one of the drivers of science, technology and innovation cooperation part of the broad STI cooperation paradigm. Scientific linkages help to improve a nation's competitiveness.

There are two basic strategies to enhance national competitiveness: outward-targeted strategies that provide national actors access to expertise abroad and inward-oriented strategies which are created to attract business and investment to the home country (Boekholt, et al., 2009). Boekholt et al (2009) found a number of assumptions on the improvement to competiveness stemming from STI collaboration. First, if clusters build up international STI ties they will gain access to the best science and technology. Second, providing national companies with relevant information and contacts in specific/interesting countries could improve their market access. Third, forging cooperation with STI countries could also improve R&D related foreign direct investment. Finally, improving the attractiveness of domestic science and technology infrastructure will support the performance of national industries as a whole and attract foreign direct investment in R&D.

Another view of competitiveness relates to the ability of countries to stay up-to-date with the latest scientific discoveries and the ability to boost and modernize domestic industries. Andersson and Henrekson (2014) argue that one of the premises of competitiveness is that cities and countries that do not adapt to global trends by for example, diversifying industries will lag behind. Governments in emerging economies and in developing countries invest in science and technology driven by concerns about lagging behind. The policy leaders in these countries recognize the consequences of lagging behind and take measures to "catch up." Thus, competitiveness and technology development in some instances have been equated with "catching up" when it should in reality be addressing the inequalities that exist between the North and the South concerning science and technology capabilities (e.g. research and development infrastructure, research collaboration, innovation). Governments worldwide strive to stay competitive. To stay competitive, a country needs to tap into knowledge, innovation and technology generated at home and abroad and to promote domestic and international STI partnerships. Governments encourage research competition with other countries at the same time that they facilitate, through a variety of instruments, international scientific cooperation.

According to Bristow (2005, p. 285), "competitiveness is portrayed as the means by which regional economies are externally validated in an era of globalization, such that there can be no principled objection to policies and strategies deemed to be competitiveness enhancing, whatever their indirect consequences." In

other words, competitiveness becomes an undisputable goal. Competing with other countries in the global arena is a choice and this choice becomes a broader goal for governments and for academic and company actors. Governments use the 'competitiveness' logic to justify their policy actions; local actors in society (e.g. university researchers, company managers and owners) engaged in science and technology cooperation use it to justify their engagement in research networks. Becoming a competitor or becoming a competition state – a notion coined by Phillip G. Cerny (1990; 1997) - is embedded in the language of 'competitiveness'.

3.8 Summary and conclusions

In this chapter, I have discussed the theoretical building blocks that align with my research questions which revolve around policy formulation, implementation and motivations. This chapter has focused on the following concepts: 1. institutional logics, 2. bounded rationality, 3. street level bureaucracy, 4. the principal-agent model, 5. historical institutionalism and 6. drivers of international STI cooperation.

The theoretical building blocks enrich our understanding of a complex phenomenon such as internationalization of science, technology and innovation. Internationalization which is part of research and innovation policy has emerged as a tool to strengthen science and technology capabilities of countries through international STI cooperation or through scientific mobility. As such, internationalization highlights relations among countries. Thus, internationalization as a tool and an element in research and innovation policy emphasizes relationships among the individuals that fund, design and participate in science, technology and innovation. The selected building blocks provides us with lenses through which we can view internationalization as a practice, as a tool and as an evolving phenomenon in R&I policy.

The theoretical building blocks presented here are different but their different focus share a common characteristic. All of six building blocks are oriented toward the understanding of the internationalization of science, technology and innovation and STI cooperation as actor-driven practices. These theoretical concepts are in some ways interconnected and given that this study revolves

around rationales, implementation of decisions and interpretations of internationalization, all six are relevant and useful.

The institutional logics concept is utilized as a tool for understanding and analyzing actors' motivations for designing STI programs and how the logic of the government and of research practitioners may differ and overlap. For instance, policy actors may either steer decision making processes in a preferred direction or their actions may be consistent with their agency's objectives. The latter implies that individuals might be influenced by the broader institutional logics of their organizations. The historical institutionalism literature highlights not only historical perspectives but also the role of institutions and how the behavior and actions of actors are shaped by the institutions in which they are part. The intent here is not to apply institutionalist perspective in order to highlight the central role of institutions as I take it for granted that they matter too. Institutions can determine policy processes and outcomes by influencing policy actors' behaviors, intentions and actions. After all, "an institution can only exist if people have particular and related beliefs and mental attitudes (Hodgson 2006, p. 4; Searle, 2005). An institutionalist perspective is adopted because it sheds light on behaviors, intentions, ambitions and motivations of different actors. Therefore, by applying a historical institutional approach, the purpose is to examine policy actors and academic practitioners and companies as catalyzers of internationalization but also as actors shaped by the logics of their educational and governmental institutions. These logics often reflect dualism: the logic of competition, normally seen in the business arena and the logic of cooperation in research. Certainly, competition is also a feature of academic life.

The bounded rationality concept is adopted here not to demonstrate relational processes as the principal-agent model but to demonstrate the limitations of actions instead of the expansion of actions. The concept brings attention to the deviations from rationalist assumptions in the policy making context. It is not so uncommon that a number of factors might hinder individuals' actions when trying to act rationally. Limited access to information can impact individuals' actions or/and decisions. Additional factors hindering rational choices might include time pressure or the need to quickly respond to domestic or international circumstances. Given the above-mentioned factors, policy actors might employ policy solutions that are satisfactory only instead of optimal. When constrained by multiple factors, actors might change their implementation strategy and make a decision or design a program based on pragmatism and objectivity. In this context, different logics (e.g. the logic of

allocating funding to particular programs) and implementation styles and approaches (e.g. pragmatism, objectivity) might influence the design of programs in science, technology and innovation and internationalization.

Government officers are faced with multiple challenges in the policy arena. One challenge is to mediate between external pressures/international trends and internal demands to abide by certain logics of individuals' institutions as for example the continuity of traditional policy decision models. Adding to this complexity, funding agency officers, who at times act as street level bureaucrats, bridge different interests and goals (e.g. the government and researchers). They also coordinate, manage and design government programs that promote science, technology development and innovation.

The principal-agent model is utilized in this context because it sheds light on the complex relationships and interactions that characterize the context of some of the STI cooperation programs I examine. Scholarly studies on the principal-agent relation focus on the issues emerging from contractual agreements and social exchange between principal and agent. This thesis does not focus on the formal and contractual agreements among participants. Instead, I use the principal-agent model to highlight the opposite.

Finally, this chapter aims to examine the interplay between the macro level (ministries), the locus of policy making, with tendencies at the meso (funding agencies) and micro levels (research organizations and companies). This interplay is one of the core elements in my analysis. Furthermore, it is in the meso level, where molded by sense making, influenced by institutional logics and bounded by multiple factors, that implementing actors, who are also agents from the perspective of the P-A model, interpret and implement political goals and serve as experts. These implementing actors, who at times act as street-level bureaucrats, exercise power and freedom to act. However, this freedom is not absolute because these actors are constrained by the responsibilities entrusted to them and by the resources available to them which often limit their actions.

Furthermore, the two levels – macro and meso – coexist and are embedded in relative institutional stability. However, eventually external forces break the continuation of established structures. Thus, personal and political interests, the need for change, policy experimentation and global events steer policy actors in different directions. Timing and immediate responses to national and international events influence the actions of policy actors. As street-level

bureaucrats, from the agent side of the principal-agent relation, funders have the choice, the ability and the possibility of altering the implementation of decisions or the design of programs on the basis of their expertise, beliefs, interests and pragmatic behavior. The need to fulfill policy goals is an example of a practical and pragmatic decision. The nostalgic view of street level bureaucrats as individuals who merely act in accordance with top-down instructions seems far-fetched.

As Hall points out, some institutions and actors may facilitate rather than hinder policy change. And while we tend to think of institutions as stable and resistant to change, institutions can also encourage innovation (Steinmo et al., 1992). This innovation can also take place in policy making, what I refer to as policy experimentation. Also, although policies tend to be 'sticky' and durable, they are not immune to global trends, to pressures from different actors in society, to political interests and to economic goals. This thesis emphasizes the possibility of choices actors have when designing and launching new international or domestic initiatives. These choices are also affected by the same institutions of which these actors are part.

Table 2 Summary of theoretical concepts

Theoretical concepts	Description	Practical application
Institutional Logics	A framework to gain a better understanding of how organizations and individuals act within the policy process (Friedland & Alford, 1991; Thornton, 2002).	To gain a better understanding of actors in their institutions and how their logics and motivations are related.
Bounded Rationality	Multiple factors bound individuals' decisions: time constraints, limited information and interpretation of data (Simon, 1947; 1979).	Sheds light on individuals' behavior and actions (e.g. satisfactory solutions to policy issues instead of optimal).
Street level bureaucracy	Street-level bureaucrats (Lipsky, 2010) are not only tasked with implementing public policy, they shape it as front-line actors who deliver services to the public.	Aids in the understanding of alignment of policy goals and implementation of decisions with practices at the "street level," where policies are implemented and research is carried out.
Principal-Agent	A relationship based on a social exchange between two parties (Braun, 1993; Braun & Guston, 2003).	Interaction based on the expectation of mutual benefits and incentives; The concept sheds light on the issue of dependency-driven behavior and how this behavior drives governments' rationales to promote STI cooperation.
Historical Institutionalism	Steinmo et al. (1992) argue that institutions can influence the formation of preferences by political actors – endogeneity of preferences.	Historical institutionalism provides insights to the question of policy preferences and factors shaping policy outcomes. New national and international circumstances can influence processes rooted in conventional beliefs.
Drivers of STI internationalization	It encompasses different rationales for promoting international activities in science, technology and innovation.	STI internationalization is often coupled with other goals (e.g. economic and political). Science and technology agreements are forged to improve diplomatic relations.

Chapter 4 Research Methodology

4.1 Introduction

This chapter focuses on the methodological approach used in this thesis: three in depth case studies. In addition, this chapter discusses the research design, methods of data collection, the research process, data analysis and the challenges encountered. As discussed in chapter 1, the aim of this thesis is to further our understanding of the drivers of internationalization programs and how decision making about the design of internationalization initiatives takes place. I have accomplished this by examining three case studies which illustrate how views of internationalization are translated into government-sponsored STI cooperation initiatives. Two of these STI cooperation programs are the International Cooperation for Eco-Innovation (ICE) instruments funded by the Swedish Innovation Agency (VINNOVA). The two policy instruments were designed to foster environmental technology collaboration between Sweden and China and Sweden and Brazil. The third case study – Chalmers Transport Area of Advance (AoA) - is part of the Strategic Research Areas (SRAs) launched by the Swedish Government and enacted by VINNOVA and the Swedish Research Council from 2009 onwards.

4.2 Research Design

4.2.1 An interactive research design

This thesis has adopted an interactive model in qualitative research. Interactive means that this research process is not based on a pre-determined and linear approach on how to conduct a research study. Rather, it is a process that involves moving back and forth between the different elements of the research

process (e.g. conceptual framework, research questions, and empirical material). According to Maxwell (2012, p. 3), "you can't just develop (or borrow) a logical strategy in advance and then implement it faithfully." This approach consists of five elements that are interconnected: goals, conceptual framework, research questions, methods and validity. In this model, the research questions are not the starting point but rather form the center of the research. The research questions are not fixed at the start of the study but they might need to be revisited and modified as a result of changes in the purposes or conceptual frameworks or what the researcher has been learning during the research. The relationship among the five components is showed below.

Personal insights about the research design
As I was formulating the questions I intended to use in my interviews with the participants in the Eco-Innovation Cooperation programs, I realized that the earlier interviews conducted for a different study could complement my research project. Although this is not a comparative study, there are similarities and differences that can be drawn from the three STI cooperation programs and conclusions that can be elicited from the case studies. I interviewed the actors who translate policy into practice (e.g. academic and industrial researchers, company managers and business owners) and who continually respond to funding opportunities. I also interviewed policy actors and government officials across Swedish funding agencies and ministries. Interviews with these individuals enabled me to reach the conclusion that the motivations, decision-making processes, design and implementation of these programs differed. In addition to having contrasting purposes, design and implementation, the common feature among the three case studies is their embeddedness in the Swedish research system illustrating the importance of external funding. Regarding the research process, acknowledging potential research biases and discussing them with my supervisors was a good exercise but writing them down regularly was equally important. Note-taking after interviews and meetings where I was an observer, helped me to identify my research goals and to improve my research questions. In addition, taking in-depth notes during and after meetings with my PhD advisors aided in gaining new insights. These

practices also helped me to see how the different components of my research design are interrelated. In the beginning of the research project, I wrote down several pages of potential research questions. As my research progressed and as interviews were conducted, I narrowed down the questions. More importantly, I tailored them to my topic. As I continued to design my study, I revisited the elements of my research design. On the map that I constructed (see below), I lay out the different elements and explain how they are connected. This is based on Maxwell's (2012) design model which has been adapted to fit my research subject. The map below shows five elements in the research design that are closely related: the research questions, the theoretical building blocks, methods, research purpose and validity. Note that the research questions are positioned at the center as they affect the other components of the design and, in turn are affected by them. The research questions have been regularly revisited and improved; therefore, they were not predefined. Also, they have not emerged from or followed a strict and linear process. I have chosen this research design that follows a cyclic characteristic because it is most appropriate for explorative qualitative research which is the kind of study I have conducted. This design is useful when not much is known about an issue or a phenomenon. In this case, my aim has been to gain a better understanding of the underlying issues concerning decision-making processes, rationales and views of internationalization. For instance, I am interested in how certain policy ideas gain traction and emerge giving rise to specific science, technology and innovation cooperation programs. Following the research design map, I present the relationship between the research questions (what), research purpose and interests (why) and the methods I have selected in order to answer my questions (how). Also, I present some of the conclusions and potential explanations for the questions I am posing. Finally, I have included how I have tried to establish validity for the results of my study.

Research Design map

The research design map below (Figure 2) shows an interactive research process in cyclic format. In this type of model, all five parts of the cycle interact with each other and are closely related. For instance, the methods chosen are influenced by the types of questions asked. The purpose of the research can be answered based on the research questions and in some instances, declarative purposes are derived from research questions. Given the multidisciplinary characteristic of my research topic, it was appropriate to select a series of building blocks as the theoretical framework for this research. From the beginning, I did not have one pre-determined theoretical concept or concepts that were selected in advance. Instead, I decided to first conduct interviews and embrace the explorative model of approaching the field to try to familiarize myself with the issue and learn as much as possible about the topic STI internationalization and research and innovation policy.

Based on data gathered through interviews, observations and government reports, I began to understand the types of concepts that were a better fit to the topic of study. Although I had already selected a few theoretical concepts for my research, based on feedback I received from faculty at the university and an external reviewer and based on my own assessment, I made changes to the theory chapter later on. This shows that the five components of the research design are integral moving parts. As the research questions were refined and the theory chapter was redefined, I also revisited my research purpose a number of times. To establish validity, this study has undergone a number of verifications. These include asking clarifying questions to respondents/check interpretation with them. Given the challenges and limitations of this study, I consider this model to be the best possible approach applied to this study as there are no perfect research projects or ideal research design.

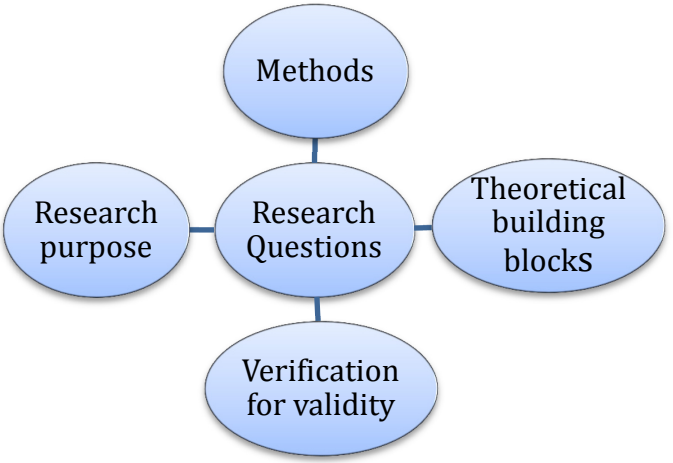


Figure 2 Research design map. Source: Maxwell (2012)

Table 3 Relationship between questions, purpose and methods

What **What do I want to know (research questions)**	**Why** **Why the interest in the topic (Purpose)**	**How** **What type of data will answer the research questions (methods)**	**Analytical tools**	**Potential conclusions**	**Motives/Explanation**	**Validity**
Why do governments promote the inter-nationalization of science, technology and innovation?	To understand motivations that support decisions	Interviews with government officials in funding agencies and ministries (semi-structured and open-ended)	Text interpretation, coding	There could be several interests supporting decisions to invest (e.g. political, economic). These interests not always contrast; they might overlap	To help domestic companies to gain access to large markets; boost domestic industry	Follow-up and clarifying questions; four readers

What factors shape the formulation of government-supported programs for the internationalization of STI?	To understand the factors involved in the design and implementation of policies; to understand how programs emerge; to inform contribute to the policy implementation field; to understand how government intentions are formulated and implemented funding by agencies	Interviews with government staff in Swedish funding agencies responsible for program design	Text interpretation, coding	Discrepancies between policy formulation as we know it and policy implementation as "the reality" on the ground. Initially the intentions for policy formulation are one but in practice they can be different	Pragmatism; bounded rationality; need to fulfill policy goals; need to meet the terms of existing government agreement (e.g. MoUs)	Follow-up and clarifying questions; 4 readers
How does funding affect researchers' views of and responses to STI internationalization?	To understand actors' conceptualization of S&T internationalization; to understand the meaning and interpretation attributed to S&T internalization and the functions it fulfills	Interviews with actors most affected by government funding: researchers at universities and research institutes and businesses participating in programs funded by government	Text interpretation, coding	Research institutes, universities and companies as well as funding agencies are part of a larger funding system for research coop in STI that is quasi-centralized, funding-laden and project-based	Emerging research dilemma and trade-offs; resource competition more relevant and as relevant as collaboration but not less	Follow-up and clarifying questions; 4 readers

4.2.2 The choice of a qualitative research approach

This study uses a qualitative method for a number of reasons. First, it provides an opportunity to examine and to understand a broader phenomenon – internationalization of science, technology and innovation. The qualitative research method is my choice of approach because it has enabled me to uncover rationales for promoting, designing and funding three policy instruments in science, technology and innovation. I have accomplished this through in-depth interviews with program participants and government officials across Swedish ministries and funding agencies. Often there were surprising elements encountered during interviews with respondents. The qualitative method is an optimal tool to uncover such surprises. The qualitative method has enabled me to gain insights into how decisions about the design of the three government-sponsored initiatives took place.

Second, a qualitative method is better fit for this type of study given that this research is exploratory. The term exploratory in this context means the freedom and flexibility to explore the field to identify issues and to understand a phenomenon. In addition, the method provides the opportunity to uncover possible inconsistencies or dichotomies reproduced in the narratives of the participants. Exploratory means that the initial intention was to "test the field" without having pre-conceived notions and theories about a phenomenon or without having a set of hypotheses to be later tested. Third, the results of this qualitative research are descriptive in that the aim is to identify, explore and describe and analyze and not to predict, anticipate or evaluate.

Qualitative data enables one to capture the views of a range of actors concerning internationalization and STI cooperation. Furthermore, the qualitative method employed captured the nuances concerning the design of new STI cooperation initiatives and the core role of the research funding system in internationalization. The qualitative method captures the social and cultural contexts in which policy actors formulate policies. The qualitative method aids in the understanding of the context of decision making - where researchers translate government policies into practice.

According to Marshall and Rossman (2006), the views of actors and the broader setting in which these actors are embedded matter in qualitative research because the study is done in the context where complexities may occur over time and where data on different perspectives of a reality can be gathered. The "reality"

Marshall and Rossman (2006) refer to, in the context of this study, relates to the locus where cooperation programs in science, technology and innovation described here are developed, managed and translated into practice.

Furthermore, qualitative research helps researchers to have an in-depth understanding of people's perspectives on a subject as well as the institutions where they work and the socio-economic contexts in which they live (Myers, 1997). Such nuances would be more difficult to detect using a quantitative research approach such as surveys or structured questionnaires. As Denzin and Lincoln (2005: 3) argue, "qualitative researchers study things in their natural settings, attempting to make sense of, or interpret, phenomena in terms of the meanings people bring to them. Similarly, Ezzy (2002, p. 5) suggests that "qualitative data analysis is typically a statement or a set of statements about relationships and between variables or concepts that focus on meanings and interpretations". Thus, meanings and interpretations cannot be easily studied and measured in terms of quantity, amount, intensity, or frequency (Denzin and Lincoln, 2005).

Also, qualitative research requires an approach for investigating an issue that enables researchers to interact with people even if such interactions are over the phone or skype such as most interviews conducted for the purpose of this study. But more importantly, as Ezzy (2002) argues, it requires the research to shift from the role of an observer (typically in quantitative research) into the role of a participant researcher who engages not only in dialogue but in discussion with the interview subject. A number of the interviews conducted for the purpose of this study were interactive. This means that the interviewer and the interviewee engaged in a discussion about the topic in question. In other instances, discussions were at a minimal level.

When conducting research about individuals' perspectives on a phenomenon and on a particular context of which individuals are part, information can be lost when textual data is quantified (Myers, 1997). A survey was not the preferred method for data gathering in this case because a survey does not give the interviewee the opportunity to convey in-depth messages when talking about a phenomenon or when discussing complexities, tensions or inconsistencies in policy making or program design. The details of the several interview accounts would be lost and the answers would be shorter and succinct in a survey form of data gathering. The goal with qualitative research using interviews as one of the methods to gather data is to give interviewees the opportunity to have in-depth

conversations and explain or/and describe their perspectives without having any time constraints and without feeling restricted by a more structured questionnaire.

4.3 Selection of case study

Several reasons motivate the selection of the three case studies. First, the three government-sponsored research cooperation programs provide an opportunity to examine decision making and rationales for promoting internationalization. For instance, the two International Cooperation for Eco-Innovation programs represent internationalization efforts that are coupled with other policy goals. One possibility is that these new programs might be viewed as a policy action in response to a perceived need to strengthen S&T ties with specific countries such as Brazil and China. The implementation cycle of the two Eco-Innovation Cooperation programs is short-term and the formulation and design process differ from the Chalmers Transport Area of Advance case study. The latter stems from a plan to invest in a number of Strategic Research Areas (SRA) and involves a long-term research investment cycle.

Second, the case studies represent an opportunity to explore how the macro, meso and micro levels interact and intersect. For instance, the principal-agent concept sheds light on the relationship between higher government offices (macro), funding agencies (meso) and researchers/companies (micro) and how policy directives and decisions move through these levels. The choice of case studies was appropriate given that the actors who are actively engaged in internationalization are not only the funding agencies developing, implementing and coordinating the programs but grant recipients who actively seek financial support to participate in the STI cooperation programs. Third, although this is not a comparative study, the case studies provide an opportunity to examine how the two Eco-Innovation initiatives differ from the Chalmers Transport Area of Advance program in terms of goals and program timeframe.

Finally, the two Eco-Innovation Cooperation programs represent internationalization efforts. These instruments are part of a broader government intervention to promote domestic innovation, to improve Sweden's innovation competitiveness and to facilitate access to emerging markets.

4.4 Research process

Regarding the research process, one challenge has been to move deeper into the meaning of the respondents' statements to gain a better understanding of how actors relate to internationalization of science, technology and innovation. How they relate to internationalization can be translated into policy actors' rationales for promoting new STI cooperation programs and researchers' responses to government's incentives.

Furthermore, it is equally relevant and helpful to understand the context and the "interrelationship of their constituent events" (Mink, 1966). However, I moved away from a mere description of the changes in the Swedish research funding system (see chapter 6). Instead, I discuss the shifts in the research governance in Sweden as a way to provide insights into how these shifts have influenced the formulation of new government-sponsored STI cooperation programs. The explanation for the above selection lies in the utility and the need to understand a case in its context. This is important because it is one way a researcher demonstrates that the research findings are related to the broader context and that the three cases are not studied in isolation. This brief historical account is relevant to this study because today's characterization of the Swedish research system is a reflection of the transformations in the governance of research that occurred in the 1990s. These transformations include the distribution of research funding which in turn gave rise to a funding model based on resource competition and project-driven research.

As referred to earlier, the research process in this study resembles a circle rather than a straight line (Creswell, 2003, page 181-190). This can be described as a cyclic method of alternation, going back and forth from research questions to data collection, delving into the material during analysis, to problem reformulation and back and forth again. Through this iterative process, the researcher delves deeper into the data, seeking to find more information that confirms initial assumptions. This iterative research process enabled the understanding of connections between different concepts in order to interpret the phenomenon studied. Sometimes during analysis new insights or questions emerged. When these were considered intriguing and relevant to the study, these concepts were corroborated by literature or incorporated into the questionnaire when further interviews were conducted.

The research process in this study consists of the integration of data collection and data interpretation and analysis (Eisenhardt, 1989). The research questions emerged along the research process as more data was gathered and analyzed particularly through interviews. This process is known as the abductive approach (Alvesson & Sköldberg, 2009). In this non-linear research process, interviews, which will be further discussed, were conducted in different periods of time. Particularly, the interviews with actors involved in the Chalmers Transport Area of Advance case study were conducted from November 2012 to August of 2013. A few interviews with participants in the Chalmers Transport Area of Advance were conducted in 2015. The transcribed texts from the interviews conducted in 2012 and 2013 were reused and now comprise the empirical material of the third case study of this thesis – the *Chalmers Transport Area of Advance.*

4.4.1 The research process: challenges and solutions

There are always challenges involved in any research process which makes this an interesting endeavor. Personal satisfaction in a thesis project is a result of the following factors: 1) problem and challenge awareness; 2) responsiveness, and 3) anticipation. Number one has to do with the recognition that challenges exist and the researcher must be prepared to solve obstacles, to be flexible and creative and to anticipate difficulties. Often there is a gap between the researcher's own goals and expectations regarding the research project and practice – what is feasible to accomplish. Responsiveness means that a researcher is not only receptive to new ideas and changes but also flexible. Awareness enables the researcher to make pragmatic decisions and to be objective, by determining the feasibility of the research project. Finally, anticipation means to be prepared for unexpected circumstances. In the context of a PhD study, it means not only to anticipate changes but to turn new circumstances or challenges into opportunities. The next paragraphs examine some of the challenges that emerged throughout the research process and the solutions provided to address some of the obstacles encountered. The first challenge encountered refers to re-use of data.

The first round of interviews with the Chalmers Transport Area of Advance researchers was conducted between November 2012 and July 2013. The interviews with researchers working with the Chalmers Transport Area of Advance were initially conducted for a different research purpose. The initial goal of these interviews was to assess and to map the different kinds of utilities

that are and can be created from academic research or in the Swedish language, "nyttigörande av akademisk forskning." The transcribed interview material was intended for a different research project. However, the data resulting from interviews with researchers in the Chalmers Transport Area of Advance (AoA) program provided the opportunity to further explore how internationalization is viewed and practiced in a context where establishing international linkages was not the initial focus but an unintended and expected outcome.

In the beginning of this research project, there were specific goals, interests and expectations. Flexibility, pragmatism and creativity in the research process enabled me not to conform to one particular research direction. I decided to divert from the initial intentions and research study plan and added a third case study. My choice helped me to examine how three government-sponsored programs with the same overall goal – to encourage collaborative research and to inspire technology development and innovation – compare in terms of goals, design and key actors involved. One of the premises is that the two Eco-Innovation programs differ from the Chalmers Transport AoA regarding formulation, goals and focus. Thus, the inclusion of the Chalmers case in this study enriched the overall quality and diversity of the research. It was also a result of unforeseeable circumstances such as time constraints and changes in the research project. I remained flexible and open to reinterpret and use the data from the Chalmers Transport Area of Advance interviews in this investigation and to realign the content of the material with the research questions of this thesis, translating it into the internationalization context.

In addition to the above challenges, another endemic problem in qualitative research is the exercise of sorting through large amounts of data, particularly when hundreds of pages of transcribed notes are produced from interviews. Initially, it is tempting to code everything and to use the majority if not all categories produced during the coding process as part of the findings and analysis. Being selective in relation to the data is part of being an objective researcher. Personally, filtering data and gradually eliminating unnecessary or trivial interview passages, concepts and discussions was a difficult but important exercise throughout this research process. Attributing meanings to interview accounts and dissecting interview passages to elicit relevant patterns and concepts is a subjective action. Researchers can elicit meanings and concepts from the material but cannot make the data "talk." It is subjective because meanings are attached to the researcher's own interpretations, views and pre-conceived ideas. Subjectivity means that the above mentioned research process

would be different and would result in a different interpretative exercise had the author of this study been a different person.

Nevertheless, another challenge I encountered during the thesis writing process concerns the relationship between the researcher and the data itself. Over the course of the PhD research process, I strived to discern between the appropriate moment when it was useful to get close to the empirical data (e.g. interview notes and transcripts) to gain insights and when I needed to distance myself from the material to draw general conclusions. Often I would be too involved in the transcribed text, getting carried away or dawdling on a particular topic and spending too much time on it. In a few occasions, being too close to the transcribed material impaired my analytical clarity and the orientation towards more general formulations. I addressed this problem by discussing the issue with my advisors and by distancing myself from the transcribed texts from time to time. Another solution was to write down a set of broad conclusions based on the evidence I had gathered through the interviews and used these broad considerations to guide me and to keep me focused on the larger research issues.

4.5 Data gathering methods

This study uses selected data gathering methods to produce qualitative results with a focus on a case study research to explore policy practices, and rationales for formulation, implementation and participation in government-funded research cooperation initiatives. This thesis used the same data gathering methods to explore researchers' views of and responses to internationalization. The choices for empirical data collection include in-depth interviews, participant observations and government reports (publicly available).

Table 4 Overview of data gathering methods

Data source	Methods	Purpose
At macro level: Interviews with government officers across ministries and funding agencies. At meso level: interviews with Swedish funding agencies. At micro level: interviews with researchers across Swedish universities and research institutes; interviews with managers/CEOs/business owners of large, micro and SMEs in Sweden.	Interviews with researchers and companies who were grant recipients of the two eco-innovation programs: semi-structured questionnaire comprised of approximately 10 questions.	Questions aimed to elicit actors' views of internationalization, research funding, challenges of research collaboration, motivations for participating in the projects and views or intriguing statements and perspectives.
	Interviews with researchers working in the Transport Area of Advance: semi-structured questions (Appendix B). These questions differ from the ones used in interviews with the participants in the eco-innovation program.	These questions aimed to gain a better understanding of the types of utilities (value) that emerge from research projects and activities (teaching and research).
	Policy actors (e.g. government officials across Swedish funding agencies and ministries): approximately 10 semi-structured questions tailored to government personnel (see Appendix A). These questions differed from the ones used for researchers and companies.	Broad and open questions aimed to elicit actors' views of internationalization, the role of the Swedish government in promoting internationalization and how they work with internationalization in their daily actitivities.
Observations and participation in meetings (all meetings were held in Stockholm some of which at VINNOVA's headquarters in Stockholm).	Observations and note taking during five meetings/events organized by VINNOVA and one workshop in Malmö about doing business with emerging economies, particularly China.	Observations and participation in meetings provided the opportunity to listen to the presentations of some of the funding grantees of the Sino-Swedish Innovation Cooperation. Observed interactions among different project leaders. Meetings enabled me to observe communication dynamics between participants and interactions and relationships between funder (VINNOVA) and funding recipient (research actors).

		Presence in meetings at VINNOVA headquarters in Stockholm were valuable experiences. These meetings enabled me to meet VINNOVA employees and to listen to their views about the innovation cooperation projects. These particular meetings provided insights and information on the role of VINNOVA in promoting innovation in Sweden.
Reports	Use of reports and documents produced by the Swedish Government (Ministries and funding agencies – TAFTIE, VINNOVA, Swedish Government, Tillväxtanalys, the Swedish Agency for Growth Policy Analysis). Use of data on research collaboration compiled by Chalmers University (power point format).	In many instances, these government reports served to provide clarification and new insights into how programs emerge and the factors shaping policy decisions regarding internationalization. Examples: The Strategi för Utveckling och Export av Miljöteknik, 2011-2014 (refer to Section 7.4, Chapter 7); TAFTIE Task Force on Internationalization, 2009; VINNOVAs Internationella Strategi, 2009; Föreslå områden för förstärkt långsiktigt forsknings-, innovations- och utbildningssamarbete med Kina, 2010; Sino-Swedish Eco-Innovation Collaboration: Towards a New Pathway for Shared Green Growth Opportunity

4.5.1 Interviews

In total, 78 interviews were conducted with researchers across universities, research institutes, CEOs, managers and owners of large, micro and SMEs in Sweden. Interviews were also conducted with government officials in ministries and funding agencies in Sweden. Three interviews were conducted in Portuguese, and subsequently translated into English; most interviews were conducted in English. These were in-depth interviews which lasted between 30

minutes and two hours. Table 5 shows the number of interviews conducted and how many in which sector.

Table 5 Number of interviews by sector

Sector	Swedish Government	Swedish universities	Swedish Research Institutes	Large, micro and SMEs
Number of Interviews	17	34	12	15
Government branches/research institutions/firms	Funding agencies: Vinnova, Formas, Energy Agency, STINT Ministries: Ministry of Enterprise and Innovation, Ministry of Education and Research	Luleå University of Technology, Lund University Institute of Technology (LTH), Borås University, Chalmers University, Royal Institute of Technology (KTH), Mälardalens College, Uppsala University, University of Gothenburg	Innventia AB, SP, Acreo, Swedish Institute for Agricultural and Environmental Engineering, Swerea KIMAB AB, Swedish Environmental Institute	Reformtech, Teroc AB, Lindholmen Science Park, Biorecro AB, Stena Metal, Trevo, Terrigio AB, Wallenius Water AB, Volvo, AB Två Punkt Ett

Table 6 Sino-Swedish Eco-Innovation Cooperation[5]

Actors	How many interviewed?	Comments
Researchers across Swedish research institutes	3	Researchers of mixed background and nationalities. A few researchers with business background and marketing perspectives.

[5] Note that more interviews were added after tables 5 and 6 were first constructed.

Researchers across Swedish universities	8 researchers in 6 Swedish universities; one staff at international office at KTH = 9 individuals	Researchers of mixed backgrounds and nationalities. Some individuals had previous experience in industry. Regarding universities, two more traditional universities and one newer university.
Small companies in Sweden	2 total	One startup company created in 2008 and a small company created in 1999.
Medium size companies in Sweden	2 total	One of the companies has about 45 employees and has a daughter company in China with most Chinese employees and one French employee.
Large Companies	**0**	

Source: do Nascimento, 2014

Table 7 Sweden Brazil Eco-Innovation Cooperation

Actors	How many interviewed?	Comments
Researchers across Swedish research institutes	7 individuals	One of the research institutes participating in the program is 55% owned by industrial companies and 45% owned by the Swedish Government. Another research institute has 210 employees working within the group and works with innovation based on raw materials.
Researchers across Swedish universities	4 universities involved: 2 larger universities, and two smaller; 4 scholars interviewed.	Two of the university professors interviewed are from Brazil and have been living in Sweden for several years. Both have extensive experience working with Brazil and strong connections with Brazilian companies, universities and research institutes (especially with universities). The professor at one of the universities has connections with Brazil; another scholar at a Swedish university also had prior connections with Brazil.
Small Companies	5 small companies interviewed; mostly small companies.	One small company focuses on biomass and carbon storage, created in 2007; another

		small company, located in the Gothia Science Park, specializes in irrigation systems. One micro company with about 4 employees was also interviewed and it is a technical consulting company. The owner of another small company speaks Portuguese fluently and has been working with Brazil for several years.
Medium companies	0	
Large companies	1	This particular company has operations in 13 countries and the main office is in Gothenburg.
Kommunalt Bolag	1	Borås Energi och Miljö

Source: do Nascimento, 2014

4.5.1.1 The Chalmers Transport Area of Advance program

A total of 21 people from two centers of the Chalmers Transport Area of Advance – the Competence Center for Catalysis and the Lighthouse Maritime Competence Center - were interviewed between 2012 and 2013. These are two of the eight centers within the Transport Area of Advance at Chalmers University.

The interviewees were mostly with professors and some were PhD candidates and post docs from both competence centers. The participants comprised of individuals with diverse backgrounds and were from different departments at Chalmers University and Gothenburg University. These departments included: Business Economics and Law at Gothenburg University, Department of Shipping and Marine Technology at Chalmers University of Technology, Chemical Engineering. Topics such as research governance, concerns over the current Swedish funding model and internationalization emerged from the interviews with researchers working with the Transport Area of Advance.

The majority of the researchers in both centers were professors. Two of the interviewees hold higher level positions at Chalmers University: Anna Dubois, former director of the Transport Area of Advance and currently vice-president of Chalmer's Areas of Advance and Magnus Blinge, co-director of the Chalmer's Transport Area of Advance. A few post doc researchers from both centers were

also interviewed. The interview subjects had diverse backgrounds and worked in different departments at Chalmers University of Technology and the University of Gothenburg. The semi-structured interviews were comprised of a series of pre-established questions divided into four areas: 1) researcher's history and background, 2) the institutions researchers collaborate with, 3) researcher's role in his or her research project(s) and 4) conditions for creating benefits from research. Each area included specific questions relating to a particular topic. Interviews with the director and co-director of the Chalmers Transport Area of Advance and with the director of the Competence Center for Catalysis were conducted in May of 2015. See Appendix B for the complete questionnaire.

The interview questions used in 2015, with the director and co-director of the Chalmers Transport Area of Advance were open-ended in general and the interview type was unstructured. This means that there was no structured interview guide. Instead, the interviewer provided the opportunity for the interview subjects to open-up and discuss the topic in question and express themselves in their own way. In other words, there was no pre-established questionnaire. For instance, the director and co-director described their recent research projects and their roles within the Transport Area of Advance Program at Chalmers, the rationale for the implementation of the program as well as future goals. A list of interviewees comprised of researchers working with the strategic research area (SRA) of transportation at Chalmers University and the University of Gothenburg was obtained through one of my PhD advisors.

4.5.1.2 The Eco-Innovation Cooperation programs

Interviews with government actors, researchers and companies involved in the Sino-Swedish and the Brazil Sweden Eco-innovation programs were conducted between 2014 and 2016. Access to interview subjects and grant recipients of the Eco-Innovation Cooperation programs was made possible through an employee of VINNOVA and adjunct professor at Lund University, also one of the PhD advisors in this research study.

In total, 38 grant recipients of the two Eco-Innovation Cooperation programs were interviewed on the Swedish side; 16 participating in the Sino-Swedish Eco-innovation Cooperation program and 22 participating in the Sweden-Brazil program. The list of the participants awarded funding was obtained through

VINNOVA's staff. The information is public and available on VINNOVA's website. The list is also included in Appendix C.

The in-depth interviews conducted with the participants of the Eco-Innovation Cooperation programs were semi-structured and comprised of in-open-ended questions. The duration of the interviews varied between a minimum of 30 minutes to a maximum of two hours. The average interview length was one hour. The questionnaire aimed to capture the actors' views about participating in international STI collaboration, their perceptions about the role of the government, their motivations for engaging in international research cooperation with Brazil and China and challenges encountered. The interviews with the different participants were transcribed in full, resulting in texts comprising of 7 to 16 pages each. Through the empirical data, different categories of research collaboration were elicited and were categorized into taxonomy of research collaboration (see Appendix D).

Furthermore, interviews are not linear or static processes and researchers should move away from naïve notions about the interviewer-interviewee relationship. For instance, pre-conceived ideas by the researcher and the interview subjects can play a role in interview experiences. Self-awareness of such tendencies can be beneficial to the researcher. There were instances when the respondents implied I represented VINNOVA. This association occurred in spite of stating, in the beginning of each interview, that I was a PhD candidate at Lund University; therefore, an independent researcher and not a VINNOVA employee representing the agency's interests.

As mentioned earlier, one of my PhD advisors is also a VINNOVA employee and her affiliation with the funding agency enabled me to gain access to the interview subjects. Such uncommon arrangement meant that the majority of the people contacted for an interview agreed to be interviewed and seemed positive about sharing their views regarding their research projects with someone who they perceived as working on behalf of VINNOVA.

4.5.1.3 Moving away from naïve notions

During the interviews and analyses, the following questions guided the interpretation of the empirical data: What are the intentions that emerge from the respondents' statements and from the transcribed interview material? Are

there any inconsistencies that can be identified in the interview accounts or implicit views that were not apparent? I listened attentively to the participants during the interviews and I adjusted to their responses and reactions. This means that I accepted the participants' statements as true representations of circumstances. In other words, I presumed a minimum level of rationality and coherence from the interview subjects, while remaining skeptical of the participants' assertions.

As researchers or as PhD candidates, we aim to achieve truthfulness and validity in our accounts; our desire is for the text to represent some kind of truth or facts. At the same time, we bring in our own interpretations and views when writing a dissertation. Facts, as Hacking (1999. p 22) argues, are words that are used "to say something about the world or what we think about the world." For instance the words truth, reality and knowledge are not objects in the world but they represent a view about something else. They are widely used and a researcher must exercise skepticism about arguments in which these words are contained. It is presumably challenging to include the interview subject's own words or perhaps his or her beliefs because we cannot access what is in the individual's mind. Thus, in reality, we write down our interpretations of what others describe and interpret. This means that we interpret others' interpretations of the world.

4.5.1.4 Interpretation as a conscious act

Careful interpretation, according to Alvesson and Sköldberg (2009) considers language, assumptions, pre-understandings, ideas, and thoughts and are major determinants of interpretation. When we interpret our data, we reflect on it. Thus, reflection involves interpretation of the interpretation and a critical view of how we understand and make sense of the empirical material. What is the implication for a PhD student or for any academic researcher? It means that interpretation of research material is a conscious act and an exercise in awareness. This awareness is the understanding that knowledge extracted from research is constructed by the researcher. Elements such as culture, language, narratives, norms and theories all influence researchers' interpretations of the empirical data but ultimately, it is the researcher who constructs knowledge. Regardless of how collective or participatory a research process is (others judge and read our work; we interact with others to receive feedback and to produce research), how knowledge is constructed by the researcher matters at the individual level. Thus, research as an individual activity is ultimately the result of the interpretations and insights that originate from the researcher's own

thinking and choices. The researcher decides which information to leave out and which data to include. The researcher is critical of his or her own interpretations of the empirical material.

Alvesson and Kärreman (2007) argue that being aware of the importance of language in research is vital. What they mean is not simply that one should pay attention to vocabulary or written text. They claim that sensitivity to language is important because "vocabularies don't simply mirror the world; they produce and reveal as much as they conceal. The language used in a study to a large extent determines the results" (Alvesson and Kärreman, 2007, p. 1267). Thus, researchers not just encounter empirical material and see where the data leads them but they are always interacting with the empirical material and revisiting the text. The text can be seen as a modeling clay; the researcher, though vocabularies is continuously molding it.

The data coming from interviews, observations or reports are not immune to interpretations and therefore, intervention from individuals or from events. Individuals and the context shape interview statements, observations and written reports. It goes without saying that in reality, everything is affected. This means that there is no research material that is free from interpretation or pre-conceptions. The words we hear from interviewees are their views about a phenomenon or a topic. These words are loaded with meanings. Alvesson and Sköldberg (2000, p. 9) claim that "there is no such thing as unmediated data or facts; they are always the result of interpretation." In social life, as individuals, we are often interpreting other people's behaviors and actions but also other people's interpretations of the world.

Empirical analysis was conducted not only by using coding as an analytical method but also by interpreting the statements of the actors represented across the three case studies. In addition, coding and re-coding was performed which means that first I coded an interview account and months later returned to the same interpretation of that account, read it and re-interpreted it. This enabled me to extract additional information from the material and gain different insights complementing initial analysis. During interviews, I gave interviewees the opportunity to talk about their projects in general terms. Certainly, I conducted semi-structured interviews to guide me but they were often comprised of open-ended questions and used to initiate a conversation when necessary.

4.6 The analytical approach

This thesis relies on data sources such as government reports, transcribed notes from interviews with program participants, notes from discussions with PhD advisors, peer reviewed articles and participant observations to interpret and analyze empirical data in order to address the three research questions. There is a broad range of methods employed to analyze data produced from qualitative research methods of investigation. According to Tesch (1990) and Creswell (2003), there is no "right way" to analyze data. Therefore, the approach to data analysis in qualitative research may vary significantly. Some scholars (Merriam, 1998; Creswell, 2003) suggest data collection in parallel with data analysis to generate categories and to build theories. The approach suggested by Merriam (1998) and Creswell (2003) was employed in this thesis as a way to identify patterns from the empirical material that could be used in preparation for further interviews with actors.

In addition, iteration, described as a method of data analysis that enables the researcher to move back and forth between theory and data (Bennett & Checkel, 2012; Brady & Collier, 2010), was used as an analytical tool in this thesis. The iteration approach utilized during the analysis consisted of moving back and forth between the empirical material (e.g. texts of transcribed interviews, notes produced from observations, two unpublished reports commissioned by VINNOVA and reports by the Swedish Government) and the theoretical concepts, described in chapter 3. This approach enabled the refinement of interpretations, alignment of the theoretical building blocks and the discovery of surprising patterns.

The empirical material for this study was gathered through interviews and through analysis of government reports and policy documents. Interviews were coded to identify categories and patterns and to facilitate interpretation of interview accounts. The responses were compared between and within categories. This approach is referred to as constant comparative analysis as described by Glaser and Strauss (1967). This method of analysis can generate theoretical properties of categories and findings of the study (Anfara et al, 2002). Therefore, constant comparative analysis helps the researcher to identify patterns, coding data and categorizing (Anfara et al, 2002). Patton (1990) suggests we first examine what is there in the data and label it as the first part of the content analysis.

4.6.1 The coding approach

Coding can mean different things to researchers. I view coding as the act of assigning meaning to and interpreting an interview account or parts of the account. One challenge I encountered during the research process is related to data sorting. Sorting of the material was necessary in order to identify what was relevant. This is a result of the large amount of material generated from 78 interviews. Saldana (2008) advises novice researchers to qualitative research to code everything and anything that was gathered. Certainly there were short phrases or simplistic statements or observations that were noted throughout the interview transcripts. These passages were excluded from the coding exercise. Pre-coding was used extensively throughout this process by circling, highlighting relevant parts of the text, bolding relevant interview accounts that surprised me or that were found to have any relevance to the topic(s) of this study. According to Layder (1998), in addition to coding with words and phrases, pre-coding should never be overlooked.

Furthermore, three other analytical strategies were used during the research process to complement pre-coding and coding: 1) interpretations that emerged from the transcribed interviews were checked with a number of respondents; 2) interpretations that emerged from the transcribed interviews were discussed with PhD advisors and notes from these meetings were generated and used to refine interpretations; 3) Coding was done in parallel with interview transcription; 4) notes from reflections on the material were also kept and used; 5) notes from observations at various meetings conducted at VINNOVA headquarters in Stockholm were also interpreted and used in the thesis.

4.6.1.1 Coding phases

First phase: Filtering data and using Values coding

The first phase of the coding exercise was filtering the data, a term previously used by Saldana (2008). This first phase requires the researchers to perceive and interpret what is happening in the data. Thus, during this first phase, a Values coding was used to capture and label subjective perspectives. Although still in the initial phase, this process goes beyond In Vivo coding which keeps the data based on the respondent's own words. The first phase of the coding process started in the year 2014.

Example of Values coding (with more subjective interpretation) used in the phase I of coding:

Table 8 Example of Values coding

Interview passage	Corresponding interpretation
"So, I think the model is that we have developed many interesting innovations in Sweden and I think many other countries are also and the VINNOVA support reinforces this and also the opportunities for bringing forward innovation and also finding new markets for innovation. So, VINNOVA reinforces the Swedish model. I mean in Sweden you have, the development… a strong collaboration between universities, municipalities and companies, you know…So, this is also an opportunity to show-case this type of development models for employment and for project development."	In Vivo coding (words rooted in respondent's own words) Example: Reinforce; Swedish model; show-case development models Values coding (raised level of subjectivity) Example: Dissemination, homogenization through international activities/practices Reinforce Swedish model = Reproduction of approaches in other contexts, translation to other contexts, North-South relationship embedded in international development policies; solutions emerging from developed nations (providers) flowing to developing countries (receivers); hierarchical relationship.

Table 9 Phase II: Categories, subcategories and concepts

Category	Dissemination of practices
Subcategory	(through) Internationalization mechanisms
Code	International research collaboration practices
Example:	Can science and innovation policy, through the dissemination of internationalization practices to other countries, result in the standardization of research cooperation practices?

During phase II of the coding exercise, questions emerged as shown in table 9. However, questions also emerged during phase I of the coding exercise. Not all the questions that emerged during the interpretation and analysis were given consideration. Some of them served as guiding principles while others were discarded and can be used for future research studies.

Chapter 5: The Case Studies

5.1 Introduction

This chapter describes the three government-supported cooperation programs: the Sino-Swedish and the Sweden Brazil International Cooperation for Eco-Innovation (ICE) and the Chalmers University Transport Area of Advance initiatives. The latter differs significantly from the two Eco-Innovation Cooperation programs in terms of program formulation, purpose, design and motivations. First, the two innovation cooperation initiatives with Brazil and China are examples of internationalization from formulation to practice. The Chalmers Transport Area of Advance program, on the other hand, is a national program and not aimed to foster international linkages as its primary goal. The transport group at Chalmers University has significant research collaboration with universities and other organizations abroad. According to an evaluation of the transport area of advance, conducted by the Swedish Research Council (2015, p. 59), "the proportion of publications based on national and international collaboration is 31% and 43% respectively, which compared to other environments are high."

Second, building consortia that includes industry has been part of the transport area research collaboration model. An evaluation of the strategic research area initiative conducted by the Swedish Research Council in 2015 characterizes the Chalmers transport research group as working closely with industry. For instance, 135 researchers out of 557 have been working with 202 companies and 58 PhDs have been working in industry. These are referred to as industrial PhDs. In the context of the Eco-Innovation Cooperation programs, although some of the research groups participating in collaborative projects with Brazil and China had been working closely with industry prior to joining the two international initiatives, some of the networks that included industry were established as a response to the terms and conditions of the eco-innovation call for proposals with China and Brazil.

Third, the formulation and implementation processes in the context of the Chalmers Transport Area of Advance are based on a longer term vision to invest in strategic research areas (SRAs). In contrast, the two eco-innovation programs were crafted based on short-term cycles. In total, Chalmers University of Technology or CTH (Chalmers Tekniska Högskola in the Swedish language) was allocated approximately 701 million Swedish Crowns by the government for the SRAs from 2010 to 2014 (Swedish Research Council, 2015). During 2014, the SRA funding corresponded to 11% of the basic funding for education and research given to Chalmers University of Technology from the government (Swedish Research Council, 2015). The Transport area received 4.6 million Euros in 2014.

5.2 The partnerships in brief

The research and technological development as well as innovation partnerships discussed in this thesis are a result of self-organized research collaboration teams composed of a diverse group of actors across Swedish ministries and funding agencies, research institutes, universities and firms compared to other forms of research collaboration teams. It is self-organized regarding the selection of the partners – actors can choose their research counterparts in China and in Brazil for the two ICE programs – but must follow Swedish funding agencies' guidelines for establishing consortia where industry must be involved in the research projects. With respect to the Transport Area of Advance case study, it is self-organized in terms of the freedom researchers have in the selection of their collaborating partners. One of the goals of the program is to foster cross-disciplinary research in the sustainable transport field.

These networks are different from the networks formed with the specific intent to co-publish or to file for patent; the innovation teams involving Swedish, Chinese and Brazilian researchers and companies are more focused on the development of technology, testing larger markets and on product commercialization. These research networks represented by the three case studies follow priority areas of research set by the government. There are more general research networks that do not follow any specific guidelines. However, such programs are not under consideration in this thesis.

Some of the research networks described here might have been established prior to the calls for proposals launched by the Swedish Innovation Agency, VINNOVA or they might have initiated at the onset of the cooperation program. In other cases, it took longer to find partners and to build partnerships because as a first step, interested parties interact and then they discuss possibilities to work together based on their shared interests and goals. Finally, the two international innovation initiatives and the Chalmers Transport AoA program differ regarding network. The Chalmers Transport program comprises of research networks that are more general in nature given that they do not follow specific guidelines set by funders and do not have an international orientation. The Eco-Innovation Cooperation programs are more specific research networks, where consortia must include industry and the selected countries are Brazil and China.

Phases A of the Eco-Innovation Cooperation programs with Brazil and China can be characterized as exploratory in nature as they involve building research partnerships with partners in Brazil and China and conducting feasibility and exploration studies for marketing possibilities in both countries. These consortia comprised of partners from universities, research institutes and companies and focused on innovation and development of Swedish technology that can be used in emerging markets to address environmental issues such as poor waste management systems, recycling technology, and environmental solution for water pollution, among others. Some of these government instruments have brought together key players and in so doing there is a great potential that these networks will sustain for a longer period of time, reinforcing connectivity among researchers and across organizations (Protogeou et al. 2010). In addition, the Chalmers Transport Area of Advance partnerships were comprised of actors from Chalmers University, Gothenburg University and Swedish companies such as Volvo and ABB. Finally, the establishment and the continuation of research the STI collaboration projects across the three case studies are deeply dependent on the availability of funding.

5.3 Sino-Swedish S&T relations

Emerging economies and industrialized nations including Sweden share common interests regarding environmental sustainability. The Nordic countries, known for their advanced democratic system, welfare policies and strong

environmental awareness, have a long history of sustainable practices compared to other nations and can work collaboratively with other countries and offer solutions to emerging economies' existing environmental problems. In addition, the Nordic countries such as Sweden are very attractive to emerging markets. One of the reasons for Sweden's attractiveness is the country's strong research and technology infrastructure and consistent and systematic investment in research (Schwaag Serger, 2014). For instance, Sweden has one of the highest research and development spending as a percentage of GDP - 3.26 in 2016 (Eurostat News release, 2016). The 2008 Research and Innovation Bill increased government funding for R&D, in particular in environment and energy, identified as strategic areas.

Sweden has a strong innovative capacity and Swedish companies have a stable foundation and a strong presence abroad. "The Swedish economy is continuing to perform well. Growth was 3.3 % in 2016 – among the highest in the EU" (European Commission, 2017, p. 1). The country scored 87.9 in science and technology excellence in 2012 compared to 47.8 in the EU and 58.1 in the U.S. (European Commission, 2014). All of these factors make Sweden an attractive partner. In recent years, the Chinese Government has been focusing on innovation and looks to the Nordic countries for inspiration on how to enhance its research and technology system to achieve sustainable development goals (Lundin & Schwaag Serger, 2014).

Sweden and China signed their first science and technology agreement in 1978. Since then S&T relations between the two countries have been increasing. In recent years, the focus of the Sino-Swedish ties has shifted (Schwaag Serger, 2014). For instance, in the past, China has been mainly an aid recipient and Sweden has invested considerable resources on capacity building and development projects in China (Schwaag Serger, 2014). More recently, however, Sino-Swedish relationship has transitioned from aid projects to science and technology cooperation between the two nations. One good example is the research biological environmental monitoring in the Yangzi Delta region in China, a collaboration between Stockholm University, Sweden and Tongji University between 2010 and 2013 funded by the Swedish International Development Agency (SIDA). The project included student and personnel exchange to promote scientific research capabilities and sustainable cooperation (Schwaag Serger, 2014). While this project was successful and provided the opportunity for both Chinese and Swedish researchers to build up strong research ties, SIDA funds were discontinued as a result of a decision that China

would be no longer be part of SIDA's foreign aid recipients list by the end of 2013. The Swedish Research Council and the Natural Science Foundation of China got involved and launched the first Sino-Swedish Joint Call providing the opportunity for the Sino-Swedish partnership to continue to develop towards a more permanent cooperation model (Schwaag Serger, 2014).

It is clear that there is a great potential for international cooperation with China in the field of sustainable development and renewable energy to address societal challenges. Solving global environmental problems is also a viewpoint echoed by the scientists engaged in the VINNOVA-supported research cooperation programs with Brazil and China.

The Swedish Government has commissioned its governmental agencies to jointly coordinate research cooperation activities with China. The Swedish Innovation Agency, VINNOVA is one of the agencies implementing science and technology agreements between Sweden and China. In recognition of the strategic importance of China as a growing market, great human resources potential and growing research capabilities, the Swedish government has been pursuing new ways to build S&T cooperation with the country. As a result, in 2012, VINNOVA launched its first Sino-Swedish Eco-Innovation Cooperation. The program aims to strengthen Sino-Swedish relations and to identify priority areas where the two nations can cooperate.

5.3.1 Sino-Swedish Eco-Innovation Cooperation

Both China and Sweden have embraced the "green" and environmental sustainability concepts which call for a more environmentally friendly way of doing business and growing the economy (Lundin and Schwaag Serger, 2014). Embedded in both concepts is the development of new environmental technology that has the potential to create sustainable products through which an eco-innovation partnership between the two countries can facilitate. A more pro-active and unique innovation partnership with China resonates with the current trends in the global science and technology developments in addition to the pressing need for low-carbon transformation (Lundin & Schwaag Serger, 2014) and more environmentally friendly ways to achieve economic growth. This partnership between China and Sweden goes beyond the scope of international development in the traditional way of "capacity building" or trade agreements and political alliances where developed nations export their

economic "models" and particular "ways" of governing a country (Lundin and Schwaag Serger, 2014).

The International Cooperation for Eco-Innovation (ICE) program between China and Sweden has been designed and implemented by the Swedish Innovation Agency and it consists of two phases: 1) Call A or Type A project is a unilateral Call (grants awarded to participants in Sweden) for applications that provide a smaller amount of grants for partnership building and feasibility studies and 2) Call B or Type B project with two simultaneous Calls for Proposals by VINNOVA, in collaboration with the Swedish Energy Agency (STEM) on the Swedish side and by the Ministry of Science and Technology (MoST) on the Chinese side. For both Calls A and B the Call for proposals are designed for research and innovation needs of consortia designated and specified by industrial actors. The priority areas defined in the Calls are environmental technology and sustainable urban development (see Box 1 below for details).

Box 1 Sino-Swedish Cooperation for Eco-Innovation

The overall goals of the program

Build and strengthen Swedish actors' international networks and partnerships for collaboration in research and development of new technology, leading to environmental innovations for sustainable development.

Specific aims

▪ Build innovation partnerships and strengthen research networks with Chinese partners.

▪ Increase the export of Swedish green technology to the global market through the development of innovative products and services in collaboration with key actors in local markets.

Groups targeted in this program

Consortia (a form of collaborative working involving individuals from different sectors in society with a defined structure and governance arrangements) are

driven by research and innovation needs defined by industrial actors.

Priority areas

- Environmental technology
- Sustainable urban development

Cooperation with the Swedish Energy Agency on energy-related projects: Energy in China-(ISMEK) as a bridge to national priority energy areas:

- Fossil-free vehicle fleet
- Power systems handling renewable electricity production
- Energy efficiency in buildings
- Increased use of bioenergy
- Energy efficiency in the industry sector

Type A projects – Partnership building and feasibility studies (planning)

Key requirements:

- Identify areas or solutions with strong market potentials in emerging economies
- Partner or foreign group for implementation
- Active partnership
- Previous successful results
- Implementation period 3-12 months
- Maximum grant amount of 750 000 SEK for technical feasibility studies and maximum amount of 250 000 SEK for planning grants and other types of feasibility studies in total per project.

Type B projects – Implementation of international research and innovation projects

Key requirements:

- Identify clear needs and solutions or a way to integrate existing solutions in a new concept
- Proposed solutions should have a great market potential
- Implementation should be carried out by a consortia that is driven by research and innovation goals and needs, defined by industrial partners
- The majority of the budget will be spent on implementing a research and development project
- Implementation period – 2 to 3 years
- Maximum of 5 MSEK in total per project with a total budget of at least 10 MSEK (Swedish side)

Source: Lundin & Schwaag Serger (2014) (In "Sino-Swedish Eco-Innovation Collaboration: Towards a new pathway for shared green growth opportunity," VINNOVA Analysis, 2014).

This thesis focuses on the Type-B Sino-Swedish Eco-Innovation projects and the perspectives discussed in this study are of the actors who participated in Call B projects with China, although some of the grant recipients in Type-B projects also participated in the Type-A calls with China. The Type-A projects aimed at providing support for those applicants also interested in Type-B calls but it was not a requirement for Type-B applicants to have applied for or been granted Type-A project funding. Therefore, Type-B and Type-A projects are separate and independent funding mechanisms.

The call for proposals for Type-A projects received a total of 35 applications with the majority from universities (15 applications) and companies (13 applications). Overall, the number of applicants was greater than the number of applications with 106 individuals involved in these 35 applications, of which 52 were from companies (Lundin and Schwaag Serger, 2014). A total of 15 projects were approved for planning grants and technical feasibility studies. Most of the applications were in the field of environment, matching one of the two priority areas – environmental technology and sustainable urban development.

The call for proposals for Type-B projects received 69 applications while 65 applicants submitted applications to the Ministry of Science and Technology

(MoST) on the Chinese side (Lundin and Schwaag Serger, 2014). The largest number of applications for Type-B Calls were energy-related; 4 of which were in the environment field (e.g. biogas, fuel cells, CCS and waste-to-energy), 2 in Transport (fuel cell and energy storage), one in Communication and one in production process (solar capped landfill). The above have a focus on renewable energy production or energy efficiency through demand-side management. About 5 applications in the field of environment are linked to energy and resource efficient production process, using a more integrated approach to address energy and environment (Lundin & Schwaag Serger, 2014).

The participants in the Sino-Swedish program

In total, 16 Swedish actors participating in the Sino-Swedish Eco-Innovation Cooperation program were interviewed. The 16 participants in the eco-innovation program are spread across Swedish universities, research institutes and micro, small and medium size companies in Sweden. Two projects have the direct involvement of large corporations such as Volvo.

One staff person from a large Swedish university was interviewed although the individual did not have a direct involvement in the ICE project but played a coordinating role by providing assistance to one of the Swedish partners.

Types of actor groups

The composition of the participants in the Sino-Swedish Eco-Innovation program and their affiliations show that the majority of individuals engaged in the Sino-Swedish Eco-Innovation program were from universities. The majority of the project leaders were also from Swedish universities. There were two Chinese professors participating in the Sino-Swedish program working in Sweden. Both Chinese researchers have extensive network in China.

Industry-university interaction

Empirical material indicates that companies and research groups across Swedish universities involved in the Sino-Swedish ICE program complemented each other as each contributed to the project by bringing in a different set of expertise and skills. In the case of a Swedish start-up company participating in the Sino-Swedish program, one of the partners, a university in Stockholm, was responsible for conducting the instrument lab tests and research while the start-up company supplied the raw material to China and to the university in addition to preparing the raw material for use. Another Swedish company, with approximately 4,800 employees working with a university professor in the Sino-Swedish innovation cooperation program, had some specific roles in the eco-innovation project. In this case, the company was an active partner helping with the development of technologies, materials, providing human resources, testing sites, machinery, lab work and analysis. The university researchers working with the large company had a specific project and research coordinating tasks.

In addition to the afore-mentioned benefits of collaborating with businesses, respondents stated that input from industry on a specific technology or technique functioned as a complementarity to the partnership. For instance, companies provided suggestions on how universities could meet industry needs or how universities could develop a technology that is tailored more specifically to businesses. According to the interview subjects, researchers from universities can adjust and adapt their work according to the input they receive from companies. This also reinforces the learning process cycle in research collaboration and makes the collaboration between industry and science stronger.

Different project timeframes between universities and companies play a big role in the interactions between these two actors. The interviews confirm a certain discrepancy between businesses and universities in the types of outputs that would make such collaborations seem beneficial. While companies focus on developing a product and on the commercialization phase, academics might place a high value in publications and in achieving excellence in research. For instance, a university professor in Stockholm and a project leader in the ICE project, expressed frustration with his partner company in Sweden and how the company is pressuring him to provide a specific timeframe for when a product will be ready for commercialization: *"That is true because in this case it is not just applied research for industry. In this case we have a specific goal to get this*

commercial product but this Swedish company they really want us to promise right now within one year." (Professor and researcher, July 9th, 2014, interview no. 1). As discussed earlier, universities and companies operate with different target dates and deadlines when it comes to projects and they also have a different focus and they might even perform different tasks (or complementary tasks) as seen in the example of a Swedish university and its partner company.

Views on funding and perceptions of trade-offs

The perception that scarcity of funding affects international research cooperation was predominant among respondents. In addition, interview subjects indicated that there are trade-offs associated with these types of research programs. Such trade-offs are embedded in a funding system such as in Sweden and the way in which funding agencies choose to prioritize grant allocation. One possible conclusion is that this shift in funding priority could mean a diminished focus on applied research and less collaborative work and interaction with industry.

Nevertheless, other interviewees argued that their partner companies have been frustrated with how funding between universities and companies is allocated and that industries are often times required to contribute money to the research project instead of receiving part of the funding for participation in the project. Others stressed that VINNOVA funding has been very important because it is very difficult to get funding from Swedish companies for collaborative projects such as these.

Science and technology ties with China

Regarding ties with China and presence in the Chinese market, there is evidence of dynamic effects. For instance, one participating company is quickly expanding in China and it has now 10 employees at its daughter company in that country. The company had problems with a previous Chinese partner and later switched to a partner with which it had existing relations. According to the Swedish company's Vice President, it was easy to find a new partner because they had contacts with the same Chinese company from previous years and the

company was familiar with the Swedish company's products. Hence, collaboration seems to be facilitated and reinforced by earlier interactions.

Other examples reinforce the importance of existing networks. One company CEO explained, *"I worked 10 years in China so I have my network there. We don't use channels like that, it is personal relationships… so it is our connections, it is not that we use any channels to enter the market."* The same CEO highlighted the importance of internationalizing companies and stated, *"…I see it as one company, one world. International is the day one. When we start the company we are international from day one…I don't understand how a single company could be only national… If you do products then you are global day one. Now it is extremely simple within the EU but it is also simple with China, the U.S. and everything. So, I think that if you start a new company today, you are global from day one." (CEO, Swedish company, August 22, 2014, interview no. 21).*

The CEO of the other Swedish start-up company emphasized the importance of establishing good connections in China and the importance of having knowledge of the local context. According to the same company CEO, it should be part of the business strategy to make an effort and learn about the Chinese culture before engaging in collaboration with China. The same CEO works closely with his partner at a Swedish university who is originally from China. The CEO explained, *"…The researcher is Chinese and he can communicate with the people in China in his mother tongue and that is fundamental…good communication is essential as is to correct mistakes right away when they happen, and know how to talk to Chinese people in a familiar way, not in a demanding way, be humble and learn." (CEO, Swedish company, March 20, 2014).*

All individuals at universities seem to be experienced researchers and experts in their fields and have had international experience. Some of the academic partners have had experience with industry and some have had experience working with China. One professor has Chinese PhD students in his group and has had other projects with China funded by VINNOVA. One of his Chinese students found out about the VINNOVA eco-innovation call B with China and informed the professor about the funding opportunity. Other academics have had contacts with other Chinese scholars through more informal visiting scholars programs at their universities or when Chinese delegations have visited their institutions. Only a few academics have had extensive experience with industry.

A recurrent theme is the participants' diverse background, both in terms of their affiliation and their cultural experiences. One particular scholar at a small Swedish university had extensive experience with industry as he worked for a large Swedish company for more than 20 years before starting to work at the university. Another scholar at a different university in Gothenburg has worked for a large corporation in Sweden. Two of the professors interviewed are originally from China and are well connected and have good contacts with companies and universities in China as well as government officials. One researcher at a university in Sweden split her time between two working places. She previously worked half time at the spinoff company, which has been recently bought by a Chinese company - and half time at the at a research center at the same Swedish university. One research team has now a more direct relationship between the Chinese owner (the company that has recently bought the partner company) and the research and development company.

5.3.2 Sweden Brazil Innovation Cooperation

The Swedish Government Agency for Innovation Systems (VINNOVA) launched its first International Cooperation for Eco-Innovation Program between Brazil and Sweden in 2012. The program has been implemented through two calls for proposals: calls A and B. In total, 29 applications were received for the Swedish Brazilian Eco-Innovation Cooperation Program and VINNOVA awarded funding to 18 projects.

Interviews were conducted with the Swedish actors participating in the Type-A projects with Brazil, whereas the Sino-Swedish Eco-Innovation program, the focus was on the Type-B grant recipients. The observations contained in this report are based on interviews with 22 actors across 17 projects engaged in the Swedish Brazilian Type-A projects. Out of the 22 individuals interviewed, 7 worked for Swedish companies (one CEO and one company manager; the remaining 5 were company owners), 5 were from universities, 9 people from research institutes and one employee at the municipality of Borås.

Box 2 Brazil-Sweden Cooperation for Eco-Innovation

Type A projects, 2014

The overall goals of the program

Lead to innovation and increased competitiveness for the participating parties as well as reduce environmental impact.

Specific aims

▪ Increase Swedish actors' knowledge of Brazilian needs and promote stronger ties with foreign research milieus, prospective customers and markets.

▪ Increase the export of Swedish green technology to the global market through the development of innovative products and services in collaboration with key actors in local markets.

▪ Develop long-term and lasting ties between Swedish and Brazilian actors by supporting existing and new networks.

▪ Increase knowledge and insights about cooperation models for innovation collaborations in growth markets.

▪ Reduce environmental impact and promoting sustainable development at the national and international levels.

Groups targeted in this program

Consortia (a form of collaborative working involving individuals from different sectors in society with a defined structure and governance arrangements) are driven by research and innovation needs defined by industrial actors.

Priority areas

▪ Environmental technology

▪ Sustainable urban development

▪ Resource efficiency

Type A projects – Partnership building and feasibility studies (planning)

Key requirements:

▪ Identify distinct needs and problems and submit proposals for solutions (e.g. product, service or process) or identify a way to integrate existing solutions into a new concept.

▪ The Swedish side of the consortium must consist of at least one party from Brazil.

▪ The project is to be conducted over a period of 2-3 years.

▪ Each bilateral project must present a joint project plan for the entire international consortium.

▪ All Swedish parties must be legal entities

▪ If the coordinator is a company, it must be a limited liability company (Swedish designation AB) registered in Sweden

▪ Companies that apply must conduct research or development activities and have business operations in Sweden.

▪ The consortiums' members must be able to demonstrate prior experience of innovation work within the field specified by the call for proposals.

▪ The call for proposals' budget is SEK 25 million for the period 2014-2017. The maximum allowed grant per project is SEK 5 million. Only Swedish members of the consortium are eligible to receive grants from VINNOVA.

▪ VINNOVA will provide a maximum of 50 percent of the Swedish consortium's total project costs.

Source: VINNOVA Call for proposals, 2014. Reference number: 2014-01762

5.3.2.1 The participants in the Sweden-Brazil eco-innovation program

A total of 22 individuals who participated in the International Cooperation for Eco-Innovation program between Sweden and Brazil were interviewed across businesses, universities and research institutes in Sweden. Five interviews were conducted in Portuguese; four interviews were with Brazilian individuals, three of which have been living in Sweden for more than 15 years. One interview was

conducted with the owner of a Swedish consultancy who has lived and worked in Brazil for several years. Because of the individual's extensive experience in Brazil, he had the opportunity to establish connections in the country. The respondent's collaborative project was developed as part of a formal interaction with a Swedish university, which led to the formation of a consortium comprised of a university professor from Sweden, two start-up companies also from Sweden and a partner company in Southern Brazil.

Out of the 4 interviews with Brazilian actors participating in the Brazil-Sweden Eco-Innovation Cooperation program on the Swedish side, two of them were with university professors in Sweden. Large companies with operations in multiple countries and a large company in the food, energy and agriculture business sectors have participated in the ICE Sweden Brazil Program. Most of the companies interviewed are small Swedish businesses with fewer than six employees.

Types of actor groups

Most Swedish businesses participating in the Eco-Innovation Cooperation projects with Brazil were small companies with little or no previous experience working with the country. Another observation is that national linkages matter to participation. There were four researchers of Brazilian nationality participating in the Sweden-Brazil Eco-Innovation Cooperation program, all with extensive research networks in Brazil.

The size of participating companies

The Swedish companies participating in the Sweden Brazil Eco-Innovation Cooperation program were heterogeneous and from different areas (e.g. waste management, recycling, energy, technical consultancy, irrigation technology, paint technology, transport, etc.). Some Swedish companies had very little or no prior connections with Brazil and some had strong research networks in the country. Out of the 7 companies interviewed, 5 were small companies with less than 5 employees. Two big companies participated in the ICE Swedish Brazilian Program.

Industry-university interaction

The Swedish actors – companies, research institutes and universities - participating in Eco-Innovation Cooperation programs with Brazil view themselves as playing different roles, from helping small companies to access the Brazilian market to connecting Swedish partners to their Brazilian counterparts, and to providing technical advice to companies. An important motive seemed to be to further long-term collaboration between Swedish firms and the Brazilian market. One pertinent example was a researcher at a research institute who argued that one motivating factor for getting involved in international projects such as the innovation cooperation with Brazil is the opportunity to help Swedish companies to access large markets. As the researcher puts it, *"I think we are involved because it fits our general mission as an institute which is to be a bridge from helping companies, bringing their technology to the market, that involves not just technical innovation but also business development, marketing, all of that, everything that is required to actually bring a product to the market. This is what we see our role is, to try to help Swedish companies to try to do that." (Researcher, Swedish research institute, August 20, 2014).*

Science and Technology ties with Brazil

Building strong ties with Brazil is a time-consuming task, according to most individuals interviewed and it requires long-term planning, adequate business approaches tailored to different company size and company needs, determination and financial support. Among those interviewed, a few expressed concerns about working with Brazil, claiming that it is particularly difficult for startup companies to access the Brazilian market when companies do not have prior well-established relationships with their Brazilian counterparts. On the other hand, universities and research institutes find it simple and effortless to work with Brazil even in the absence of prior connections with Brazilian partners or contacts in the country.

5.4 Eco-Innovation Programs: A comparison

Degree of interaction

Data from the interviews suggests that company-research institute and university-industry interactions were more pronounced and visible in the Sino-Swedish Eco-Innovation Cooperation program. For instance, in the Sino-Swedish Program, Swedish companies provided input to researchers regarding product or technology development according to the needs of the industry and researchers made attempts to adapt by tailoring their research to company needs. That was not the case with the Sweden Brazil program. Even though there were interactions between companies and researchers in the Brazil program, these relationships did not seem to be as strong as in the case of the Sino-Swedish program. One possible explanation lies in the focus of the two programs. The Sweden-Brazil Eco-Innovation program Phase A had a shorter cycle and building consortia and conducting feasibility studies were part of this first phase. Thus, a number of participants had to establish relations with their Brazilian counterparts from the beginning.

Diversity of participants

Overall, actors across universities and research institutes in both the Sino-Swedish and the Sweden Brazil Eco-Innovation Cooperation programs were experienced researchers and experts in their fields with relevant international experience. The majority of the people interviewed in both Eco-Innovation Cooperation programs with China and Brazil had experience working with industry and some had more interaction with businesses than others. The Sino-Swedish innovation program benefited from experience with large firms, an element which seemed to be lacking in the Sweden Brazil Eco-Innovation Cooperation program.

Partnership building

The participants stressed that building relationships with their Brazilian and Chinese counterparts takes time and is a process that requires a long-term vision

and planning. The importance of tailoring government-supported research cooperation programs to the specific needs of small Swedish companies was emphasized. Several interview subjects stressed the strategic importance of the two emerging economies to Sweden as both China and Brazil are now key players in the international research and innovation landscape.

Moreover, concerns regarding finding the "ideal" or the "right" partner or "getting cooperation projects right" were shared among those interviewed. In some cases, it was necessary to build relationships with Brazilian or Chinese potential partners as a first step in the establishment of the eco-innovation consortia. In other instances, Swedish actors built on and strengthened existing ties with their foreign partners. For others, building research partnerships that included Chinese partners was a natural step given researchers' previous connections with Chinese counterparts. In other cases, specific steps and planning were taken in the search for a partner in a foreign country. One Swedish consultancy utilized the following questions to guide his search: 1. How many companies are there in Brazil that would be interested in a specific technology from Sweden? 2.What do Swedish companies expect from a partner in Brazil? 3. What would this "ideal" partner look like? 4. What role would this partner play in the project? 5.What is the best company in Brazil that could play this specific role?

After establishing the profile of the partner, the company owner contacted the International Office at a university in Sweden which provided him with the name of a Brazilian professor who, from that point on, served as the intermediary between the Swedish company and potential Brazilian collaborators. It was through the Brazilian professor in Sweden that the owner of the consultancy who was working with two Swedish companies found a partner university in Brazil. The Brazilian university, Federal University of Rio Grande do Sul (UFRGS) had close connections with a Southern Brazilian company and served as an intermediary in Brazil to establish the contact between the Brazilian firm and the Swedish consultancy working with the other two Swedish firms.

The actors in Sweden who were originally from either China or Brazil or had connections in either country faced less challenges when searching for partners in Brazil and China. In some cases, the researchers in Sweden who were of Brazilian or Chinese origin and who had previous ties with their counterparts in China or Brazil, had an advantage compared to those with no connections in either country. In addition, researchers with related backgrounds and interests

were able to form partnerships and connect more easily compared to those researchers with different backgrounds.

Most of the Swedish companies involved in the Sweden Brazil Eco-Innovation Cooperation program had no prior experience working with Brazil. Only one company had worked with Brazil before and its owner has a strong international background and strong connections in Brazil. In contrast, three companies engaged in the Sino-Swedish cooperation program had well-established connections with China either through Chinese employees working on the eco-innovation project, through their daughter company operating in China and through previous contacts in China.

A recurrent theme across the interviews relates to the need for small businesses to develop strategies to work internationally and to have a clearer vision of how they see the development of their companies in 5 or 10 years from now. In addition, there is a shared view among interview subjects that the Swedish companies must decide whether they should expand internationally or focus on the domestic market only. According to some respondents, "opening doors" for Swedish companies through innovation programs such as with China and Brazil is helpful but there are also risks and uncertainties associated with these programs. One example is the risk that these international activities will cease after the end of the project cycle.

Different perceptions about government funding

Differences in funding profiles had a clear effect on the degree of satisfaction among the participants. The grant allocated to Type-A projects was tailored to the planning stage of the research cooperation project, to conduct feasibility studies and for building partnerships in Brazil. Therefore, the Type-A Sweden-Brazil Eco-Innovation Cooperation program received less funding than the Type-B Sino-Swedish cooperation program. The participants of the Sino-Swedish program expressed more optimism about the outcomes of the VINNOVA funding and about the program in general compared to the Swedish actors participating in the Brazil-Sweden Eco-Innovation program. One possible explanation relates to the type and focus of the project. Type-A projects were shorter and exploratory in nature, whereas the Type-B innovation partnerships were more advanced and based on concrete activities. None of the actors in

Sweden working with their Chinese counterparts suggested the discontinuation of the Sino-Swedish eco-innovation program, whereas a few actors in Sweden collaborating with Brazil questioned the benefits of government-funded international cooperation programs, particularly with emerging markets.

Five out of the seven companies participating in the Sweden Brazil innovation program stated that they did not have sufficient human and financial resources to continue working with Brazil and that the eco-innovation cooperation grant (Type-A) was insufficient.

Overall, the sentiment regarding government support for Eco-Innovation Cooperation among the Swedish actors collaborating with Brazil was negative. Participants in the Swedish Brazil program pointed out that different strategies need to be developed for different companies according to size, company human and financial resources, knowledge of international markets and company's maturity level. Together, these factors play a role in the process of internationalization of the Swedish companies, particularly in small businesses (do Nascimento, 2014).

Language and culture

In terms of language and culture, most respondents considered familiarity with the Brazilian and Chinese traditions and markets as important factors in the internationalization process and also in international cooperation programs. The respondents emphasized the sheer size of Brazil and China and the cultural differences between the two countries and Sweden. Although some of the Swedish actors participating in the Sino-Swedish innovation program had strong ties with China or had prior collaboration with the country, only two who were originally from China, spoke Chinese. Language barrier was also a factor that was perceived to adversely impact the partnerships. Some respondents mentioned miscommunication and misunderstanding issues as a result of language obstacles when discussing contracts and details about team members' tasks and responsibilities in the project.

With respect to the Sweden Brazil Eco-Innovation Cooperation program, translation or interpretation services were not used. Some of the participants were fluent in Portuguese while others had basic knowledge of the Portuguese

language. Speaking Portuguese did not seem to be necessary or required in order to establish partnerships in Brazil. There was also a positive bias toward collaboration based on cultural belonging. The actors who were originally from China and Brazil appeared to have stronger personal motivations to participate in the innovation cooperation programs and seemed enthusiastic about the projects. The Brazilian and the Chinese researchers working in the innovation cooperation programs stated that it was simple and effortless to establish partnerships in Brazil and in China because they spoke the language and were familiar with the culture. Some of the respondents were also knowledgeable of the Chinese and the Brazilian markets and industries. In addition, the interview subjects indicated that being from Brazil and China, the two countries participating in the Eco-Innovation Cooperation initiatives with Sweden, was beneficial and advantageous.

Geographic proximity

Geographic distance is often mentioned as an obstacle to international collaboration but it did not seem to have been a significant factor hindering eco-innovation linkages with China, expect for the expected difficulties related to travel costs and time spent on travel. Views on Brazil were less positive, and the theme of collaborative incongruences recurred in the interviews. As an example, one respondent claimed that S&T cooperation projects with other countries other than Brazil would be more feasible, realistic and less costly to his company.

Country Bureaucracy

A theme that emerged across conversations with participants in both eco-innovation programs concerns the overall challenges of conducting business in China and Brazil. One apparent challenge interview subjects mentioned refers to the high degree of bureaucracy in the two emerging economies. On the Brazil side, factors such as protectionist policies and customs and import laws were mentioned. Technical issues were reported by respondents participating in the Sino-Swedish eco-innovation program such as transporting samples to the country.

5.5 Chalmers Areas of Advance

The Chalmers University Transport Area of Advance (AoA) program represents one of the Strategic Research Areas (SRAs) or in the Swedish language, "Strategiska Forskningsområden" (SFO) launched by the Swedish Government in the 2008 Research Policy Bill.

In 2009, the Swedish Research Council, Forte (Swedish Research Council for Health, Working Life and Welfare - then called FAS), FORMAS (Swedish Research Council for Environment, Agricultural Sciences, and Spatial Planning), VINNOVA (Swedish Governmental Agency for Innovation Systems), and the Swedish Energy Agency submitted recommendations to the Swedish Government regarding the allocation of funding to the 20 strategic research areas in the Research Policy Bill.

The Government used a set of criteria to identify the strategic areas: a) research that, in the long term is considered of the highest international quality; b)research that can address major needs and solve societal problems; c) research in areas that have a connection with the Swedish business sector (Research Policy Bill[6], 2008 p. 67). The following is an excerpt of the Bill (the translation is the author's):

> For Sweden as a country to be internationally competitive requires focus and specialization in areas where Swedish research is considered to have special opportunities. The existing funding system has not sufficiently accomplished such a mobilization. One goal of public investments is that the research funding must be of the highest international level, and the other goal is that it should be largely conducted in areas that are of importance for the development of society and industrial competitiveness. Described here are a number of strategic areas where Swedish research belongs to the international research or have the potential to get there. The point is that the strategic initiatives will relate to research and have the long term potential to be of the highest international quality, research that can help to meet major needs and solving important problems in society as well as research in areas related to Swedish industry. The strategic investments can therefore help to strengthen Sweden and Swedish

[6] The 2008 Research Policy Bill or Regeringens proposition 2008/09:50 Ett lyft för forskning och innovation is available on the internet.

industry's international competitiveness. Efforts should be made based on the criteria described above primarily in three broad areas: medicine and life sciences, technology and climate.

The Chalmers University Transport Area of Advance (TranAoA) is one of the eight Areas of Advance (AoA) of Chalmers University. Areas of advance in Chalmers' terminology are platforms that align research, education and collaboration in areas described as challenge-driven (see also Chalmers University AoA webpage). One of the intended goals of the AoA is to function as the host organization for the SFOs or SRA (strategic research areas).

This section provides an overview of the Chalmers University's strategy with respect to the eight Areas of Advance (AoA). Chalmers University has been reorganized and according to its new strategy, it has incorporated eight Areas of Advance aimed to increase cross-disciplinary collaboration and build inter-disciplinary research teams as well as collaboration with industry. The main intended goal is to improve research quality and reduce compartmentalization among research groups (Swedish Research Council, 2015). The eight Areas of Advance include: Information and Communication Technology, Materials Science, Life Science, Built Environment, Production, Nanoscience & Nanotechnology, Energy and Transport.

Overall strategy of the eight Areas of Advance

The eight AoA at Chalmers are driven by sustainability, innovation and education with basic and applied science as key for the vision of excellence.

Vision

The main vision of the Chalmers Areas of Advance is to match the university's scientific expertise to solutions for global challenges where the eight areas of advance can make a difference in global sustainability.

Mission

The mission of the eight AoA at Chalmers is to integrate the knowledge triangle – research, innovation and education – by fostering collaboration between academia, industry and society.

5.5.1 The Transport Area of Advance at Chalmers

The Chalmers Transport Area of Advance has as its premise that traffic safety, transport efficiency and sustainable vehicle technologies cannot be achieved by the government, industry or academic actor alone but by combining the efforts, expertise and perspectives of the different actors and sectors of society. According to the Chalmers Transport Area of Advance team, the current challenges related to transport (traffic safety, environmental pollution, growing transport volumes, etc.) can only be addressed through collaboration between industry, the public sector, academic actors and society as a whole.

Figure 3 shows Chalmers Transport of Advance's vision: to become leaders in research and education in three areas of environment, safety and efficient transport.

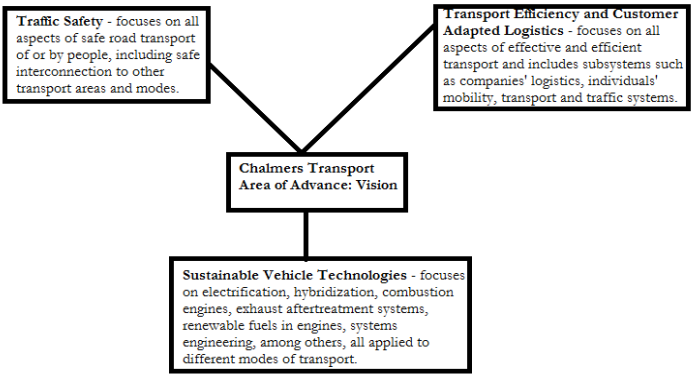


Figure 3

Source: Area of advance transport folder found on Chalmers Transport of Advance website[7]

The Transport Area of Advance encompasses research and teaching and also collaboration between academics and industry and between academics of different universities. Scholars in the Transport Area of Advance group not only teach at Chalmers but they are also involved in teaching activities at other universities in Sweden and abroad. Examples of universities in Sweden where

[7] Also available at: http://www.chalmers.se/en/areas-of-advance/Transport/research/Documents/Area_of_Advance_Transport_spread.pdf

the scholars in the Transport Area of Advance are engaged in teaching practices: University of Gothenburg School of Business, Economics and Law (or In Swedish, Handelshögskolan), KTH, Linköping University, Linnaeus University, Lund University, Stockholm University to name a few. Outside of European Union universities where Chalmers' scholars teach include: Aalto University School of Economics in Finland, Tongji University in China, University of Nairobi, Kenya and the University of North Florida, in the U.S. Within the EU, other universities where scholars at Chalmers University transport area have collaborations with include Portugal, UK and Germany. Out of 20 higher education institutions outside Sweden, where Chalmers Transport Area of Advance scholars have teaching activities, 3 of these institutions are in China, 3 in Kenya and 3 are in Finland. This list provides insights about the current state of internationalization of higher education at the Chalmers Transport Area of Advance. The international connectivity within the Transport program could be an indicator of the following: a) diversity in international collaboration; b) intensity of scientific mobility; c) the degree of internationalization of the Transport area of Advance research group; d) the nature of the research networks; e) the degree of international orientation and openness and f) the diversity in the internationalization activities in relation to location and global spread of the teaching and research activities.

The participants in the Chalmers Transport AoA

A total of 75 individuals, including management and support staff were involved in the activities within the Chalmers Transport Area of Advance in 2010. That number increased to 105 in 2011. Regarding gender, in 2010, 17 out of the 75 individuals were females and 58 were males compared to 24 females and 81 males in 2011. In the year 2011, 34 out of the 75 people were professors and 14 were associate professors. These numbers increased to 40 and 30 respectively in 2011. Senior lectures decreased from 18 in 2010 to 11 in 2011 while the number of post docs increased from 9 in 2010 to 15 in 2011. The remaining 9 individuals are males and females spread across the above mentioned academic positions.

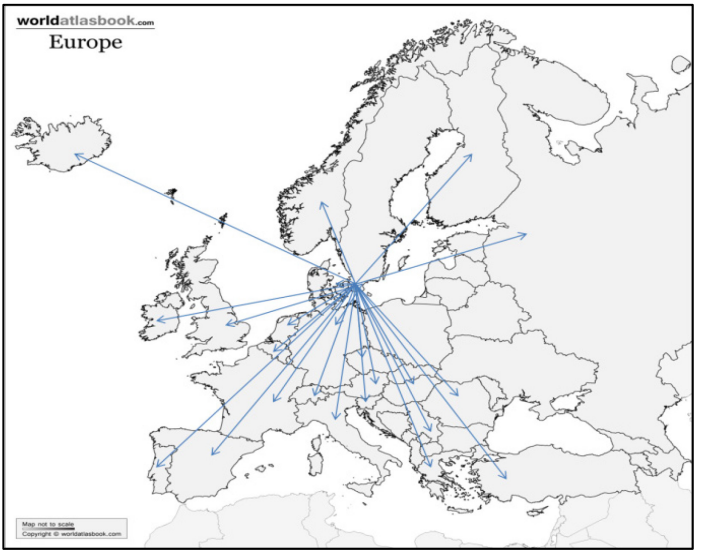
In terms of size (number of participants), the Chalmers Transport of Advance is a larger program. It comprises of ten centers:

- SAFER or center for excellence for vehicle and traffic safety, Northern LEAD, provides logistical support for research at Chalmers and University of Gothenburg;
- Swedish Hybrid Vehicle Center (SHC) is a national center of excellence for electric and hybrid vehicles and helps to integrate academia and industry.
- Combustion Engine Research Center (CERC) is a university-industrial partnership that performs engine research on reduced fuel consumption
- Competence Center for Catalysis (KCK) is a national interdisciplinary research center focusing on environmental catalysis and energy-related catalysis
- Swedish Knowledge Center for Renewable Transportation Fuels (F3) is a national center that helps with research on future renewable fuels
- The Lighthouse Maritime Competence Center is a national center of excellence for maritime research and innovation
- CHARMEC is a national center of excellence in railway mechanics
- GAC coordinates atmospheric research
- CLOSER is the Swedish arena for research, development and innovation within transport efficiency and this arena is part of the Lindholmen Science Park AB.

Domestic and international ties: the Transport AoA

Interviews with researchers at Chalmers University of Technology indicate that the network of international collaboration in transport-related research is continuously evolving. Below is a map of the international collaboration network system in transport research at Chalmers University that shows the degree of diversity in the research collaboration network including countries from Western and Eastern Europe.

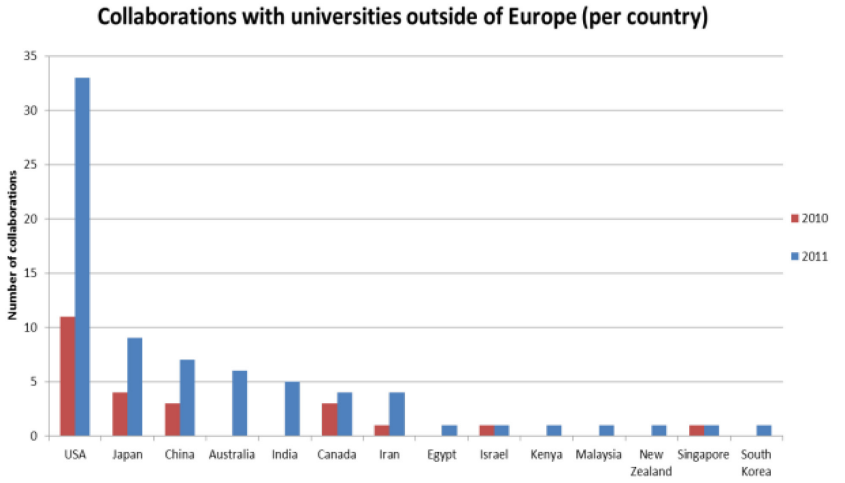
International collaboration: Chalmers Transport area within the EU

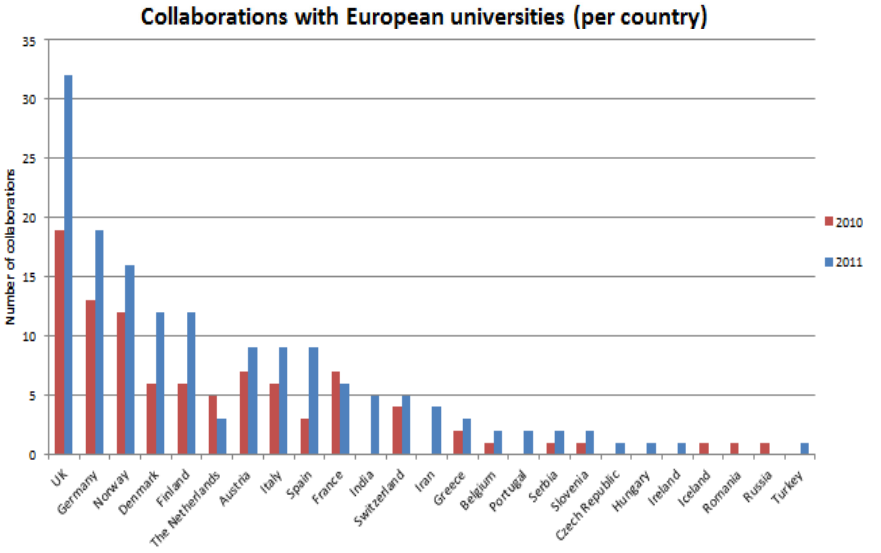


Source: Map constructed based on results of 2011 follow up quantitative data for Chalmers Transport Area of Advance.

The empirical data on research collaboration in the transport area at Chalmers University does not support the claim made by Hoekman et al. (2010). The author suggests that researchers closer to the European core countries are less likely to collaborate long-distance. The two graphs below show an increased trend, between 2010 and 2011, in long-distance collaborations between Chalmers and universities within Europe and outside. The most significant change refers to the number of collaborations between Chalmers and the U.S. which increased from 11 in 2010 to 33 in 2011, a 200% increase, while the number of collaborations with Norway grew from 12 in 2010 to 16 in 2011 which represents a 30% increase. Based on the views expressed by Hoekman et al. (2010) about the likelihood of long-distance collaborations, one would expect a greater variation in the number of collaborations with Norway compared to the U.S., given Norway's geographical proximity to Sweden, cultural and language similarities. Collaboration with Japan also increased from 4 in 2010 to 9 in the following year, an increase of 120%. The number of collaborations with The Netherlands, a country geographically closer to Sweden, decreased from 5 in 2010 to 3 in 2011.

Number of collaborations between Chalmers University of Technology Transport Area of Advance and universities in Europe and outside Europe.





Source: Results of 2011 follow up quantitative data for Chalmers Transport Area of Advance.

A number of conclusions can be drawn from the data in the above graphs and from interviews with researchers in the Chalmers Transport Area of Advance. First, collaboration between Chalmers and universities abroad has been increasing. Good examples are the number of research collaborations with U.S., Japan, China, Iran, Germany and Denmark. Second, in the context of the Chalmers Transport Area of Advance and based on interviews conducted with researchers working in the transport area, there is no evidence that long-distance hinders or delays research collaboration. This is contrary to what data from the two eco-innovation programs suggest; geographical distance was a major obstacle for the sustainability of the two international programs. Moreover, in the context of the Transport AoA, there is no data supporting claims that language and cultural differences are factors that might hinder collaboration among researchers. On the contrary, the above figures show that the biggest percentage increase in research collaboration occurred between Chalmers University and universities in the U.S.

5.6 Comparing the three case studies

There are similarities and differences among the three case studies. A major similarity across the three programs is that they involve a variety of stakeholders including scholars at research institutes and universities, companies and other organizations in Sweden.

The locus of the Chalmers Transport Area of Advance program is Chalmers University of Technology or CTH, where the administration of the program is located. Therefore, until January of 2016, the person in charge of the administration of the program at Chalmers who was the director of the program is presently a professor at Chalmers who manages the program. The two Eco-Innovation Cooperation programs, on the other hand, do not have a designated administrative office. The program was funded and operationalized by VINNOVA with headquarters in Stockholm. However, the program does not have an administrative location as in the case of the Chalmers Transport Area of Advance case study.

There are also similarities between the two VINNOVA-funded programs for eco-innovation. Both programs have international cooperation with partners from Brazil and China, part of an innovation program launched in Sweden to

support innovation development in key sectors in Sweden. They are also part of the broader challenge innovation model in which a variety of actors across companies, academia and the government identify societal problems and work collaboratively to find solutions to these problems. Both programs focus on three broad areas: environment, urban sustainability and energy efficiency. Both programs involve participation of research institutes, universities and companies in Sweden and have similar design: both programs have similar funding cycles for Calls A and B. The programs utilize the 2+ 2 approach, involving joint projects with the participation of universities and industry and require partnership formation with Brazilian and Chinese research partners. The eco-innovation grants support the planning stage, involving partnership building and feasibility studies (Type-A projects). The grants also support projects at implementation phases (Type-B projects).

Table 10 Actors' perspectives on the policy programs

Programs	Negative Aspects	Positive Aspects
Sino-Swedish Eco-Innovation program	Science-industry interaction viewed as positive and important.	Geographic distance; difficult to recruit PhDs due to lack of funding; unilateral funding viewed as major problem; Type-B actors mostly satisfied with funding; pressure from the Swedish industry to deliver results.
Sweden-Brazil Eco-Innovation program	Science-industry interaction viewed as positive and important.	Geographic distance; difficult to recruit PhDs due to lack of funding; unilateral funding viewed as major issue; Type-A actors expressed relative dissatisfied with government funding.
Chalmers Transport Area of Advance	Funding not viewed as a problem; close partnership with industry and science-industry partnership viewed as crucial.	Difficult to recruit PhD students due to lack of qualifications; implicit teaching-research trade-offs

Source: author

All three case studies exhibit differences but the differences are greater between the two Eco-Innovation programs and the Chalmers Transport Area of Advance. First, the two Eco-Innovation Cooperation programs can be viewed as a

response to recent strategies put forward by the Swedish Government. These strategies include the promotion of domestic industry and investment in R&D. Implicit in this strategy is forging science and technology partnerships with emerging markets. A good example is the 2011 strategy for export and development of environmental strategy. The Swedish Government allocated 400 million SEK between 2011 and 2014 to promote environmental technologies and services (OECD, 2014). By the end of 2013, 20 state-sponsored assignments were given to ten governmental agencies (Tillväxtanalys, 2013). Some of the outputs of the strategy included the launching of approximately 100 projects, technical visas and trips by delegations, the establishment of Swedish and international cooperation consortia (OECD, 2014). Additional results from this strategy include, better knowledge of export markets and products tailored to export markets, the establishment of business relations, cooperation between Swedish and foreign partners (OECD 2014).

The above indicates that forging S&T ties with emerging economies have been coupled with other goals (e.g. economic such as export promotion and trade; political objectives). One perspective is the apparent increase in interest in forging bilateral S&T linkages with emerging markets is motivated by interests to promote innovation and enhance research quality at home and strengthen S&T ties between countries. Thus, the two eco-innovation programs have primarily an international focus, whereas the Chalmers Transport Area of Advance program does not originate in internationalization ambitions and purposes. Second, the two innovation cooperation programs are strategic in their design, following the 2+2 approach, discussed earlier. They are also unique in terms of their formulation and implementation processes. The two Eco-Innovation Cooperation initiatives emerged to fulfill a number of goals and are short-term programs whereas the Transport AoA has long-term goals and emerged from the 2008 Research Policy Bill.

Third, the two Eco-Innovation Cooperation programs can be characterized as innovation cooperation instruments that focus on three priority areas: environmental technology, urban sustainable development and energy efficiency. Regarding the Chalmers Transport AoA, although the research is within the transport area, the focus can be more general, multidisciplinary and cross-disciplinary centered on transport sustainability, efficiency and safety.

Both international Eco-Innovation Cooperation programs involve the participation of actors from industry and academia (2+2 approach), whereas in the Chalmers case, researchers have a greater degree of freedom in the selection of their partners (there are no specific requirements that researchers have to collaborate with actors from designated countries or that research has to be conducted in pre-selected research fields which is the case in the two innovation programs).

Moreover, it seems that in the Chalmers Transport Area of Advance, the majority of research collaborations are between scholars in the transport-related fields and university-industry partnerships, whereas in the two Eco-Innovation Cooperation programs, the composition of the research partners seemed more diverse involving actors from industry, research institutes and universities. Regarding program goal and aim, the innovation programs combine strategic innovation, challenge innovation and strategic internationalization in one single program. In the case of the Transport Area of Advance, the three concepts are not part of the program design and aim; their focus is on science-industry research cooperation and cross-disciplinary and multidisciplinary research.

5.7 Summary and conclusions

This chapter has discussed the three research cooperation programs and their purposes, research areas and key actors involved. The three programs are embedded in a broader Swedish research and innovation policy context. The case studies demonstrate how the three levels of policy making process – macro, meso and micro - interact with each other. Policies are articulated in an interdependent manner with the meso level comprised of funding agencies. These autonomous agencies play a key role in policy design. They also develop their own functions within the innovation landscape and operate not only as implementers but also as expert advisors to higher levels of government. In addition, agencies can also promote collaboration between universities, companies, research institutes and the public sector as in the case of the Swedish Innovation Agency, VINNOVA.

This chapter has shown that the three programs differ regarding their purposes, composition and design. The Chalmers Transport Area of Advance represents a different type of government strategy to promote specific research areas. The

Transport Area of Advance is rooted in the principal of cross-disciplinary research where researchers from different fields work together to find solutions to environmental problems in the transport area. Thus, the Transport AoA program originated from an inward decision making process, whereas the Eco-Innovation Cooperation programs with Brazil and China were based on both domestic policies and on existing bilateral agreements with Brazil and China. The Eco-Innovation programs are internationally-oriented and although they emerged from domestic policies, they can also be viewed as a response to recent global trends. All three initiatives are part of a funding-laden system where there is a significant dependency on external funding.

Finally, all three initiatives involve actors across universities and companies at domestic and international levels. Also, the multi-actor and multi-dimensional nature of the three case studies suggests that there are variations regarding the interpretation of internationalization and in modes of research collaboration. There are also variations regarding the degree of complexities seen across the case studies as research networks formed by these actors extend beyond national borders and are cross disciplinary. These networks are unique and highly specialized resulting in distinguished collaboration ecosystems.

Chapter 6 Sweden and the Research Funding System

6.1 Introduction

In this chapter, I first discuss Sweden in the global context. The section that follows examines the evolution of the Swedish research funding system and the changes in the governance of science, technology and innovation policy.

6.2 Sweden in the global context

In the last two decades, there has been an increase in complex international partnerships between universities in one country and governments of another country (Pfotenhauer et al., 2016). The increase in scholarly publications across nations is not a new topic. Sweden is part of the recent transformations in science, technology and innovation, and as a nation, it also shapes the global STI system. Regarding the strength and stability of large Swedish companies, Swedish corporations such as Scania, ABB and Volvo have had long tradition of international presence. These large companies focus mainly on exports while most small and medium size enterprises (SMEs) in Sweden sell most of their products within the Swedish market (Andersson and Wictor, 2003). Certainly, there are examples of Swedish SMEs that conduct business abroad. Also, Sweden has corporate presence in emerging markets such as Brazil. Brazil has attracted Swedish corporations and today, big names such as Scania, Volvo, Ericsson and ABB are part of the industrial complex in Brazil. Nowadays, more than 200 Swedish companies operate in Brazil and employ between 30,000 to 50,000 people. Swedish companies such as TetraPak and Nobel Biocare also have worldwide presence. A similar expansion of Swedish companies happened

during the 1990s when Swedish corporations established R&D mainly in the EU15 and the U.S. (Tillväxtanalys[8], 2009).

Regarding small and medium sized enterprises (SMEs), a larger proportion of SMEs in Sweden are internationalized – one in every four firms. Out of the medium sized companies, about every other firm is internationalized – internationalization in this case is defined by firms' exports and imports of goods and services, whether the SME is a branch of a foreign firm, by cross-border collaborations and whether the firm has operations abroad (Tillväxtverket[9], 2011). According to Schwaag Serger and Remoe (2012), a number of changes in the international and technological environment have driven the increased in R&D internationalization of firms. One of these factors includes the global dispersion of scientific expertise. Another factor driving the internationalization of firms is the rapid increase in R&D combined with rapid growth in markets and income in countries such as China (Schwaag Serger and Remoe, 2012).

In 2002, the percentage of small Swedish firms that had exported to foreign markets was 13.3%. The number increased to 14.1% in 2008 but declined to 12.7% in 2011 (Tillväxtverket, 2011). Most export destinations are within Europe, 71.2% and within Asia, representing 12.7%.

Nevertheless, Sweden plays a role in the global science, technology and innovation system not only through its corporate presence abroad but also through cross-border research cooperation, through science and technology agreements at the government level, through scientific publications and university research.

[8] English translation: Swedish Agency for Growth Policy Analysis.

[9] English translation: Swedish Agency for Economic and Regional Growth

6.3 The national context

6.3.1 Changes in the Swedish research system

The importance of university research was emphasized throughout the 1990s in all OECD countries as a necessary precondition for new innovations. An important trend in the governance of research in a number of countries is the reduction of the core funding for university research compared to contract-based resources (Lemola, 2001; Geuna and Martin, 2003; for reduction in research funding in the U.S., refer to Howard and Laid, 2013). In general, government research institutes have been more affected than universities by the reduction of government support (Lemola, 2001). Another trend in Sweden is the transformation in research cooperation patterns as private firms have been encouraged to participate in international networks by collaborating with a number of international and domestic partners, including universities (Okubo and Sjöberg, 2000).

At the national level, although the Swedish Government has taken a stronger role in developing the technology infrastructure in Sweden and the social welfare system, its approach to internationalization has been less directed. The science, technology and innovation policy in Sweden and the historical evolution of intermediary agencies such as VINNOVA or the Energy Agency are rooted in the country's political system. Also, the distribution of administrative tasks across the government agencies has shaped the STI policy in Sweden and the historical evolution of intermediary agencies. In Sweden, there is a historically engrained relationship between two government bodies: the ministries and its agencies (e.g. Swedish Innovation Agency, Swedish International Development Cooperation Agency, the Swedish Research Council FORMAS, etc.). This relationship is characterized by a certain degree of elasticity and informality concerning the governmental bodies' modes of communication and the way in which information and decisions flow across their departments and offices. Government bodies in this context refer to ministries and funding agencies. This context is embedded in the Swedish political institutional set up. The system of layered science policy (Edqvist, 2003) of the past is the basis for the understanding of today's institutional set up in Sweden. This institutional set up plays a role in STI policy formulation, research funding and implementation. The next paragraphs examine these transformations in more detail.

In the mid-1990s, the research governance structure in Sweden comprised of a mix of organizations that emerged over time during the last half century (cf. Stevrin, 1978). This long process that gave origin to the current governing system of research policy in Sweden started during the WWII, in the 1940s when separate research councils for medicine, science, technology and social science/humanities were founded (Eklund, 2008).

In most industrialized countries and certainly in Sweden, present science, technology and innovation policies can be viewed as a system with three superimposed layers (Ruivo, 1994; Edqvist, 2003). The first layer of STI policy is the science as a motor of progress from the 1940s. The second layer in the 1960s refers to the perception of science as a problem solver, a "magic bullet" tool that can resolve scientific problems (Edqvist, 2003). During this second period of the funding system in Sweden, in the 1960s and 1970s, sectoral research expanded and the research performed by the universities was commissioned and funded by government agencies. One of the rationales for government funding to universities was to increase the knowledge base in their policy areas or to support the process of technical change (Eklund, 2008). During the third phase of STI policy, science is viewed as a source of strategic opportunities (Edqvist, 2003). This last phase of the 1980s, led to the increased focus on strategic research areas in Sweden.

Starting in the late 1970s through the 1990s new reforms were implemented (Benner & Sörlin, 2007). In 1968, a new organization was created – the Board for Technical Development (STU). The tasks of the STU included support to technical development and industrial research and support to the innovative activity of companies to strengthen them (Edqvist, 2003; Weinberger, 1997). The establishment of the STU meant a shift towards support to technical development projects in cooperation with industry. The late 1970s saw two main policy changes. The first one was to support the industrial innovation system through STU. The other policy change consisted in the establishment of a stable and discipline-organized research council system under the control of the scientific community (Edqvist, 2003). Thus, two different strands of research policy were operating: the view of research as a motor of progress and the view of research as a problem-solver (Edqvist, 2003). Tensions between these two directions in research and innovation policy have become sources of contestations and they still persist today in the Swedish research system context.

During the 1970s there was also growing dissatisfaction with the research funding system. This dissatisfaction led to the widespread search for a more robust system of funding research with different purposes. After almost a decade of governmental investigations into the matter, a new outline of research funding and research policy making was incepted. (Edqvist, 2003; Schilling, 2003, 2005; Stevrin, 1978; Landberg et al., 1995). It was during this period that the three (later four) year Research Bill was launched as a measure to enhance the coordination of policy instruments and to try to align different goals, including support to basic research and international collaboration (Premfors, 1986).

In the 1980s and 90s, research became the focus again and hopes to steer research in the pursuit of critical issues were still alive (Edqvist, 2003). During that period, the research system incorporated one more layer to the already two existing dimensions – science as source of strategic opportunities (Schilling, 2003). The main vehicle for the pursuit of the strategic opportunities of research emerged in the form of a string of research foundations established in the early 1990s. The explicit purpose of these research foundations was to foster new combinations of research and exploitation with a particular bearing for the competitiveness of the Swedish economy (Sörlin, 2005). More recently, the strategic designation shaped initiatives such as the Strategic Research Areas that includes the Transport area and strategic innovation areas, in the 2008 and 2012 Research Policy Bills.

The case studies discussed in this thesis illustrate how Sweden's financial resources for research purposes, including STI cooperation, are channeled and how these funding mechanisms reflect how specific international collaboration activities are governed and funded. For instance, in the case of the Chalmers University Transport Area of Advance, strategic areas are the focus and strategic research is carried out in the university but the research is also linked to industrial and societal interests and issues. One good example is the sustainability in the transport area as one of the visions of the Transport Area of Advance. The Chalmers Transport Area of Advance example reflects the typical research council mode of funding in which specific areas are the focus and funding is conditioned upon performance evaluations and also on the research quality of teams (Geuna and Martin, 2003; Auranen and Nieminen, 2010; Hicks, 2012; see Kelly, 2016 for the Research Excellence Framework).

The VINNOVA approach to funding on the other hand, compared to the research councils' model of funding, is based on the articulation of broader policies and goals for industrial development and for tackling societal challenges. Thus, the implementation of the programs in the three government-sponsored cooperation initiatives discussed in this thesis illustrates the specific design of research funding in Sweden. In this research funding model, the layers represent different interests and networks, and therefore, distinct rationales for promoting and funding internationalization and STI cooperation schemes.

Furthermore, since the Swedish Government's strategic reforms of the 1970s, there have been a series of efforts put forward by the Government of Sweden that suggests that government officials have been more proactive towards the promotion of internationalization. For instance, in 1994, the Swedish Government allocated money from the wage earner funds to the foundation STINT – The Swedish Foundation for International Cooperation in Research and Higher Education - to promote internationalization of higher education in order to improve the attractiveness of Swedish universities and improve the quality of research in Sweden. In addition to the above goal, STINT had a broader purpose. It was first and foremost established to serve as a bridge between Swedish research and the rest of Europe. This goal has been accomplished through the facilitation of scientific mobility and research collaboration in Europe. However, STINT has since broadened its mandate. Therefore, institutions tend to remain by identifying new roles and purposes. Identifying new goals enables these institutions to renew themselves and survive.

In addition to STINT, the establishment of VINNOVA in 2001 reflected a national interest in innovation systems combined with an international focus which symbolized an attempt to revitalize the R&D and technology areas in Sweden. It also meant a step towards more systematic policy learning and towards a better understanding of the different roles and relationship with the ministries in this context (OECD, 2005). Some of the Swedish Innovation Agency's responsibilities include the development and implementation of an adequate policy within the framework of the EU agenda (Andersson, et al., 2012). The expression "adequate" is broad and it can have different interpretations. It also reflects the nature of science, technology and innovation policies which also tend to be broad. The descriptions of VINNOVA's tasks are general. Such tasks include: to strengthen the knowledge bases of growth areas in the Swedish economy, promote the development of strong research and innovation environments, work for more effective use of R&D, and act as an

expert agency contributing to the development of an effective innovation policy in Sweden - Prop. 2000/01:3. (Rickne et al., 2012).

The establishment of an innovation agency was supposed to symbolize a departure and separation from the agency's predecessors and other funding agencies in Sweden (Rickne et al., 2012). The purpose was to contextualize VINNOVA as a funding agency focused on forging collaboration between different actors with a focus on effects, innovation and growth (VINNOVA, 2002). In addition, the purpose was to position VINNOVA as an agency that works in a modern and trade-shaping mode (VINNOVA, 2002). However, VINNOVA and the Ministry of Industry, Employment and Communication were not necessarily set up as a result of the need to integrate these areas but part of a broader goal to improve communication between policy domains and to make coordination and organization within the government more flexible (OECD, 2005).

Andersson et al. (2012) refer to VINNOVA's implementation of a policy agenda as a complex task and that within this policy agenda, cooperation has been central to strengthening the collaboration between the public and private sectors and research in universities. In addition to establishing STINT and VINNOVA, more recently, the Swedish Government has been investing in research, development and innovation. The government's Research and Innovation Bill 2013-2016 is an example of such efforts. The Research and Innovation Bill 2013-2016 focuses on a more specific and quality-based funding system coupled with a significant increase in budget for R&D. For instance, in the Research and Innovation Bill, innovation plays an important role in addressing social challenges. The Swedish Innovation Agency (VINNOVA), the Swedish Energy Agency and the Swedish Research Council FORMAS have launched a new program, the Strategic Innovation Areas (SIA).

Moreover, VINNOVA has initiated the Challenge-Driven Innovation (CDI) to address specific social challenges and international competitiveness through "systems innovation". The challenge-driven innovation approach is being pursued to orient innovation towards global challenges by enhancing service and product innovations. For instance the current proposal to focus on a transport system based on non-fossil fuels by 2030 is an example of such a broad innovative approach (European Commission, 2014). In both programs, the actors in industry and the public sector have developed the agendas and defined the goals. Funding for SIA was around SEK 145 million (corresponding to USD

16.8 million) in 2013, including approximately SEK 20 million (corresponding to USD 2.3 million) from the private sector. The funding was predicted to increase to SEK 1.25 billion (corresponding to USD 145 million) in 2016, with around 50% from the private sector (OECD, 2014).

Therefore, the new reforms discussed above, aimed not only to encourage new linkages between academia and industry but also to foster international quality assessment (Benner & Sörlin, 2007) and internationalization of higher education and research. Some of the major funding organizations in Sweden, such as SSF (Swedish Foundation for Strategic Research) were part of a broader goal to foster excellence and competitiveness, inspired by the American system, where the Ford, and the Rockefeller foundations assisted in the academic excellence towards entrepreneurship and commercial results (Benner & Sörlin, 2007).

These series of transformations and government reforms were not limited to education in general and in the 1990s Sweden underwent changes regarding policies for research and strategies geared to internationalization of research and innovation. Among the areas that underwent changes in Sweden is the governance, coordination and funding of research. The Swedish research system has been transformed over the last 20 years (Öquist and Benner, 2012), particularly within the Swedish funding model, university governance and career systems. The authors' central argument is that a complex mix of goals and missions, hindering the universities' ability to pursue high-quality research (e.g. commitment to international standards and practical utility; focus on basic research while addressing societal needs), is a key factor explaining the decline of the Swedish research.

Views and interpretations of internationalization of science, technology and innovation in the Swedish context changed as well. Innovation and entrepreneurship have become part of research and development. Together, science, technology and innovation have become key elements in economic growth and in the international competitiveness of a nation. In addition, like in Germany and in Austria, Sweden has varying degrees of multi-level governance in research and innovation policies and a significant degree of diversity in their innovation systems (Kaiser and Pranke, 2004). This high degree of diversity is reflected in the international case studies presented in this thesis, where different groups belonging to different sectors form a large science, technology and innovation network. This network is part of the Swedish national context with

cross-border extensions and ramifications. The flow of people and ideas are also part of this diverse network.

6.3.2 Research governance in Sweden

The Swedish system of research governance is comprised of the financing and implementing bodies (funding agencies) and the performing bodies or research practitioners (the business sector, individual researchers and research groups at universities and research institutes). In order to study how these research groups view their research setting as part of a broader STI policy agenda and how they respond to and practice internationalization, it is crucial to gain a better understanding of this system of research governance. Given that funding is an important incentive within the research system in Sweden, and in most cases, *a sine qua non* for conducting research and engaging in technological development, researchers across universities and research institutes and small and medium sized firms view public research funding as a driving mechanism to promote internationalization activities. In other words, a strong emphasis and time is put on seeking new opportunities such as grant applications to support research projects.

At the same time that in Sweden researchers at universities and research institutes are continuously looking for sources of funding including government-sponsored grants, funding agencies encourage the sustainability of these funding-dependent initiatives because they are tangible and easily quantifiable. The research funding-laden system present in the Swedish research funding model comprises of financial incentives provided by the government. These incentives matter the most in the form of general or specific research, technology and innovation cooperation programs. Also, within the broader context of science, technology and innovation and broader national goals, one perspective is the main priority has increasingly been on securing funding as opposed to focusing on research interests. Since the cuts in scientific funding in the 1990s, additional resources have been allocated to strategic areas and networks rather than to supporting free research (The Royal Swedish Academy of Sciences, 2013).

It is worth considering that in a funding-driven system, researchers are encouraged to apply for external grants. The reality is that academic actors do not have a choice; they must adapt and be receptive to funding opportunities.

They devote time and energy to search for financial support. For instance, in Sweden, only about one third of the research funds in technical sciences come in the form of fixed funding (SCB, 2001). On the average, the fixed funding comprises of slightly less than 50% of the total funding of research in Swedish universities and university colleges (Göransson and Brundenius, 2011). Research in the technical sciences is mostly externally funded (2/3) while research within the humanities area is the least externally funded area (Government Bill, 2004, p. 18).

These resources are limited and they are supposed to cover essential research needed to support teaching (e.g. the cost of teaching PhD students) and other costs (Jacobsson, 2002). Thus, a researcher's leeway and freedom to maneuver is contingent upon external funding because only then a researcher enjoys the flexibility that comes from secured funding. In other words, as Jacobsson (2002, p. 31) states, "The freedom to maneuver for management is probably very limited." Jacobsson (2002) further argues that the paucity of fixed funding might even limit the ability of the universities to respond to international scientific trends without relying on the funding decisions of external agencies and actors. This also means that funding seekers in higher education settings rely extensively on external funding but also adapt to the needs of big industries at times.

The initiative-oriented approach refers to the ways in which on the one hand, individual researchers are continually looking for project grants, are dependent on external money and are receptive and responsive to funding opportunities. This is what Morris and Rip (2006) termed *adaptation*. This form of academic adaptation involves adjustment to the loss of the right to be free from control and to the right to grant funding (Morris and Rip, 2006, p. 253). Benner and Sandström (2000) argue that funding is a central mechanism of change as its reward structure influences the performance of research. Morris (2003) argues that university researchers benefit from the inflow of funding but might be negatively affected by the conditions attached to it or mismatches between the expectations of funders and researchers' own abilities to deliver results. Such changes in the governance of university funding and regulation made it more appealing and necessary for university researchers to rely more on soft money and external funding, thus rewarding and fostering quasi-market strategies (Etzkowitz, 2003).

Another factor playing a role in the Swedish research funding system refers to the election of a conservative government in the early 1990s (Jacob et al. 2003). The newly elected Swedish Government encouraged the transition of what some might refer to as a science system to an innovation system with the universities as key players (Jacob et al. 2003). Thirdly, until the early 1990s, Sweden had a fragmented institutional structure that consisted of a series of research foundations with money from the dismantled wage earner funds (Eklund, 2007). The private foundations were technically not a mechanism of public research policy but their purpose was to promote basic research in areas relevant to industry (Eklund, 2007). This fragmented institutional structure was seen as a problem and there were public investigations and discussions about how the system could be reformed (Eklund, 2007). The debates led to a reorganization of the public research funding in 2001 and the reform process occurred simultaneously with another shift where innovation became associated with research and the university sector (Eklund, 2007).

In addition to domestic factors, exogenous events also influenced the re-arrangement of the Swedish research landscape. In the 1980s, entrepreneurship thinking and funding started to be influential in the USA with increased commercial interest in academic research (Benner and Sörlin, 2007). In Sweden in particular, this series of external circumstances led to the increasing employment of academics in commercial contexts (Benner and Sörlin, 2007).

6.3.3 Institutional set up and the three levels of interaction

Motivations to design, manage and actively engage in science, technology and innovation initiatives are intrinsically connected to the modes of STI governance and the way institutions are set up. Institutions and actors depend on each other. Thus, factors compelling different group actors to act cannot be seen as an isolated phenomenon but as part of a larger institutional set up. Organizations are made up of individuals and change is inherently present all the time in them; therefore, individuals shape the organization and the organization shapes individuals (Liebhart and Lorenzo, 2010; Hosking and Morely, 1992).

The organization of research funding in Sweden is an example where research cooperation programs encourage collaboration and competition among researchers and across sectors. The reason is that scholars across research

organizations in Sweden are deeply dependent on external funding for the survival and sustainability of their research projects. Therefore, one might conclude that a strong driver of research collaboration is research funding. The system is based on the premise that researchers are independent and competitive actors; therefore, it treats dichotomies such as collaboration and competition as inheritably natural. From this perspective, securing funding is one of the several tasks researchers perform. Thus, from an institutionalist perspective, the motivation for participating in research cooperation programs is not irrespective of the contextual setting but it is dependent on it.

In addition, actors' motivations for engaging in publicly-funded research collaboration programs are molded by institutions' trajectories. However, actors also have the opportunity to change these institutional trajectories and not merely follow them. From the point of view of funders, they might change established trajectories by shaping decisions concerning research funding allocation and prioritization of research. Or they can influence trajectories by launching new policy instruments. In this case, they become agents of policy experimentation and not merely observers in the policy process. From the point of view of grant recipients such as university researchers, they might change stable trajectories by selecting not to participate in government-funded research programs.

Nevertheless, this section examines how actors act in relation to institutions trajectories. One such trajectory refers to Sweden's international industrial policy which has followed a certain direction for several decades. At the same time that organizations seem undisturbed during periods of stability, new ideas emerge and are implemented and new programs are created, not clashing with stability but complementing it. Innovation collaboration programs are a new mechanism available for the realization of industrial policy goals utilizing the same institutional set up for the consolidation of industrial policies. This means that the organizational structure remains stable. However, as new concepts emerge, individuals in institutions adapt to external changes and policies get renewed. Industrial policies tend to be top down and linear in their conceptualization and implementation. Sector, research area and region are central in industrial policy. This top down approach conflicts with scientists' approach to science, technology and innovation. In general, scientists are motivated by research interests, funding opportunities or international recognition and do not rely on the government to carry on with their projects and are not under government control.

The three government-sponsored research cooperation initiatives illustrate how the first two levels of policy-making process interact with each other and with the micro level. Figure 4 below illustrates the policy path and how policy directives and resolutions move across the different levels of interaction within the political system in the context of Sweden. The top level is the macro level, where broader policies are conceptualized and articulated and policy directives are prepared. Policy directives articulate, in an interdependent manner with the meso level which is represented by funding agencies, the locus of policy design and operationalization. Finally, the micro level is represented by the actors that carry out research and technology development.

More specifically, the macro level focuses on the Swedish Government's motivations to design, deploy resources and promote research collaboration initiatives that have specific and non-specific goals that are strategic and non-strategic in nature. Governments promote cross-border innovation cooperation in spite of risks of failure and the uncertain outcomes of these programs. Uncertainty is defined as the "inability to accurately predict an event" (Sabatier and Weible, 2014).

The macro level focuses on policy instruments such as internationalization activities that encompass international research cooperation. Governments are continually reinventing themselves and creating new ways to enhance research and innovation at home or to forge cross-border linkages. The government, through funding agencies is the facilitator of international relations. The micro level focuses on the performing actors in science, technology and innovation. These include researchers across research institutes and universities, project leaders, CEOs and managers across Swedish firms. The micro level concerns how these individuals view and respond to internationalization and their motivations for engaging in government-supported research cooperation projects.

Figure 4 (below) illustrates the interactions between the levels of the institutional set up (articulation, interpretation and translation), the path of decision making and actors' roles.

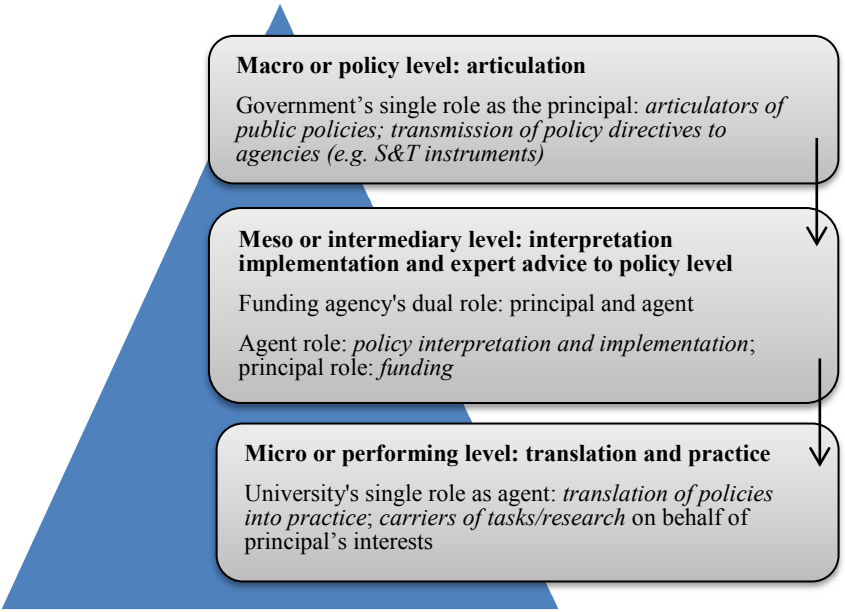


Figure 4 The path of decision making, actors' roles and interactions according to the institutional set up (Source: the author)

6.4 Summary and conclusions

The research funding landscape in Sweden has gone through significant transformations and the 1990s is seen as a turning point in the Swedish research policy (Öquist and Benner, 2012) marked by a series of endogenous events that led to changes in the governance of research funding in the country. For instance, the contextual discussion in this chapter has shown that the Swedish research landscape has been driven by the need to obtain funding. This dependency on external funding reinforces the funding-laden model. It is

common knowledge that one of researchers' primary tasks is to secure funding. Financial resources are necessary for the expansion of research teams and to hire PhDs and post-docs. Funding enables researchers to devote more time to research projects and less time to other administrative tasks. Thus, it follows that in a funding-laden system, researchers who engage in international research projects do so in part driven by the need to obtain funding.

The Swedish research system has been increasingly governed by agencies and ministries which rely on resource competition and various incentives to foster linkages with the world, with industry and other actors. This structural arrangement generates and perpetuates a funding-laden model where resource competition and initiative-driven programs have become more prevalent. Within this quasi-centralized context, ministries have divested themselves from administration and implementation tasks and have replaced these with goal and budget setting commitments.

In this quasi-centralized research governance model, Swedish government agencies such as VINNOVA or the Energy Agency are autonomous entities and play a key role as implementing and intermediary agencies. They also serve as expert advisors to the policy level. Given Sweden's implementation structure, funding agencies are independent because they have the freedom and power to decide on the allocation of research money to different projects. The funding or government agencies also have the autonomy to design and to coordinate calls for proposals inviting candidates to apply for government grants. On the other hand, funding agencies might also be dependent on established government budget and on government implementation directives. This means that the autonomy, flexibility and power of funding agencies might be limited by decisions of political leaders.

In summary, the Swedish funding agencies as well as the sectors it serves – universities, research institutes and industry - are embedded in a larger funding model for research cooperation in science and technology that is quasi-centralized in its governance of science, technology and innovation.

Chapter 7 Promoting the Internationalization of STI

7.1 Introduction

This chapter takes a closer look at the rationales for promoting internationalization of science, technology and innovation (STI). To better understand internationalization in general one needs to understand the drivers of internationalization in particular and what prompts governments to adopt initiatives to foster international STI cooperation. Governments worldwide are focusing on efforts to expand, consolidate and internationalize science, technology and innovation. The internationalization of STI has two dimensions: at the global level, it has become important for countries to consolidate their international reputation and to participate in knowledge generation and sharing. At the national level, it has become crucial for any country to address shortages of highly skilled labor in certain science and technology areas and to create incentives to boost domestic science, technology and innovation capabilities. Given the challenging task of bridging these two dimensions of internationalization, interventions are at times put in place to enable internationalization.

Internationalization is enabled through a variety of interventions involving multi-actor participation and decision-making at different government levels. Schwaag Serger and Remoe (2012) identify a series of processes through which the internationalization of STI is implemented. These efforts include student and researcher mobility in higher education institutions through student exchange and visiting scholar programs. Internationalization also occurs at the firm level. Companies develop R&D activities at home and abroad. Companies might recruit foreign employees or they might relocate part of their R&D to another country and promote and commercialize their technology in foreign countries. Finally, internationalization is materialized through international STI

cooperation where domestic or international partners across universities, research institutes and firms form research teams to develop technology, to innovate and to discuss research results, contributing to knowledge generation. The three government-sponsored STI cooperation programs described in this thesis illustrate how internationalization is enabled. Also, internationalization via international research cooperation does not occur automatically or spontaneously. There are specific reasons for establishing targeted interventions to promote internationalization, some of which are conspicuous while others are not. Some might take internationalization or scientific collaboration for granted and view them as integral part of government activities and already incorporated into action plans and visions of different public or private organizations. If such views exist, I argue that they are far-fetched and not representative of the real world where internationalization requires continuing intervention in the form of funding and in the form of joint efforts in order to materialize.

Based on the above elucidation, this chapter addresses the first research question: *Why do governments promote the internationalization of science, technology and innovation?* There are many suggested responses to the above question. This chapter addresses this question by drawing on the concepts discussed in chapter 3. One of the most apparent economic rationales explaining government support for science and technology programs is based on the notion of market failure (Nelson, 1959; Arrow, 1962; Joseph and Johnston, 1985) and systemic failure (Hauknes and Nordgren, 1999). For instance, according to the authors, the lack of coherence among institutions in an innovation system requires government intervention.

In spite of the tendency and impulse to examine government's funding of and greater involvement in science, technology and innovation as either a market or a system failure and in spite of the broad applicability of the topics, this dissertation does not utilize these concepts. This thesis focuses on other equally relevant drivers of international science, technology and innovation cooperation.

Other rationales for promoting and funding domestic and international science, technology and innovation cooperation programs are linked to the perceived benefits of research collaboration. These benefits include improved research quality, expansion of research networks, the establishment of joint scientific discoveries, the facilitation of diplomatic relations and the development of innovative technologies. Science, technology and innovation (STI) cooperation

is also perceived to enhance domestic research infrastructure and capabilities. In addition, it propels international competitiveness.

Furthermore, expectation of successful research outcomes by the government, which reinforces a results-driven behavior, is another rationale for supporting these initiatives. Also, funding agencies' adherence to multi-stakeholder approaches for research and technology development and the intention to create strategic research programs that require the management of large research groups, sometimes involving foreign actors, drive the funding of the research cooperation programs. The next paragraphs discuss the levels of intervention in internationalization (Schwaag Serger and Remoe, 2012) and the drivers of international STI cooperation. More specifically, these include: complexities in STI and the perceived need to respond, science diplomacy, addressing societal challenges, changing knowledge and innovation geography, access to markets, strengthening international reputation through competitiveness, the perceived benefit of the principal-agent interaction, dissemination of best practices and responses to perceived weak STI linkages.

7.2 Levels of intervention

Greater government involvement in the facilitation of STI cooperation is linked to the prioritization of internationalization instruments. In other words, if the priority is to improve international relations with other countries or to promote domestic technology in foreign markets, policy instruments will be tailored to that particular goal. Certainly, a motivation to promote STI cooperation might be to fulfill multiple policy goals or *multi-goal fulfillment*. This section draws on the framework for international STI cooperation (Schwaag Serger and Remoe, 2012), discussed in the Theory chapter. The framework helps us better understand the types of policy instruments and the types of government interventions needed to support internationalization.

There are three levels of intervention to support STI international cooperation: framework for regulatory measures to standardize and to create comparable conditions for international exchanges (Schwaag Serger and Remoe, 2012). These are technological standards such as intellectual property rights (IPR). The second level of intervention encompasses opening measures such as the

facilitation of mobility of researchers and students (Schawaag Serger and Remoe, 2012). The third level includes targeted instruments such as bilateral and multilateral agreements. The two Eco-Innovation Cooperation programs I describe are examples of the third level of government intervention. These bilateral agreements are usually implemented via joint calls for proposals. These STI cooperation instruments represent a way through which governments promote internationalization of science, technology and innovation.

The targeted interventions like the two Eco-Innovation Cooperation programs with China and Brazil enable international STI collaboration. The initiatives were also established to attain other policy goals such as to satisfy the terms of existing bilateral agreements. Other rationales for their targeted international STI collaboration include cooperation to address global challenges, regional priority rationales such as R&D policies and to address other thematic priorities (Schwaag Serger and Remoe, 2012). In addition, they can also be seen as experiments to test new strategies for international STI cooperation: what has produced results and what has not.

I argue that one strong motivation for promoting targeted STI cooperation instruments is the intention to fulfill policy goals. Targeted interventions are also complementary; they are used when the two other levels such as opening measures and regulatory measures are not working properly. According to Edler et al, 2016, p. 545), innovation policy measures also aim to mobilize innovation to achieve other policy goals, including regional development, sustainability and social inclusion. The next paragraphs discuss motivations to foster STI cooperation. I begin by examining the challenges of STI cooperation and the perceived need to address these challenges as one of the driving forces to facilitating international STI cooperation.

7.3 Promoting STI cooperation

7.3.1 Challenges in STI: The need to respond

In spite of the uncertainties and challenges when establishing or negotiating research cooperation programs or agreements, governments support internationalization. One way governments foster internationalization is through

the funding of cross-border STI cooperation mechanisms. The three government-sponsored initiatives I describe are new STI cooperation programs and examples of such STI cooperation mechanisms. What drives these efforts? There are a number of answers to this question. One rationale for sponsoring new STI cooperation programs and to forge S&T relations with other countries is political. For instance, from the perspective of science diplomacy, science and technology can be important elements in the formulation of foreign policy goals. Another rationale is export promotion through access to emerging markets. It follows that the pursuit of internationalization is often linked to other goals

There is a general consensus that transboundary research cooperation is a growing phenomenon (Wagner and Leydesdorff 2004, 2005; NSF-NSB 2008; Sonnenwald, 2007; Glänzel, 2001; Cummings and Kiesler, 2005; Georghiou, 1998). It is seen as a strategy to address complex societal problems and the rising costs of research (Luukkonen et al. 1992; Gibbons et al. 1994; Adams et al., 2005). The increased mobility of scientists across borders is also contributing to the growing research collaboration phenomenon (Ordanez-Matamoros, 2008). However, only measuring the growth of research collaboration provides little insights into their benefits, successes and challenges (Benjamin, 2009; Parker and Kingori, 2016).

Overall, the focus on international research collaboration as a mechanism in the internationalization of science, technology and innovation is increasing. This increase is a manifestation of a number of trends at the global level (Boekholt et al. 2009). One such trend is the rise in the number of internationally co-authored publications (Georghiou, 1998; Wagner and Leydesdorff, 2005). Another trend is the presence of new global economies (e.g. Brazil, Russia, India, China, and South Africa) and the development of their science and technology infrastructure. Finally, pressing global challenges and the scarcity of human resources in research (Boekholt et al. 2009) are signifying elements of the trend. In addition, "the last few years have seen an increasing public policy focus on what promotes greater innovation (OECD, 2007 p. 10).

In spite of the importance of and focus on research cooperation, collaboration in science, technology and innovation face challenges (Varshney et al., 2016; Adler et al. 2009; Brocke and Lippe, 2015; Southwood, 2012). These challenges might be reflected in the inherited complexities of science, technology and innovation. Challenges and tensions are encountered at all levels of decision

making about scientific cooperation programs and at the implementation and performing levels. In addition, the way in which science, technology and innovation activities are organized (e.g. multi-actor/multi-level), might require greater government involvement. This greater public intervention has become one key element in the governance of science, technology and innovation. It is worth noting that one challenge within the internationalization of STI is political coordination among government agencies. In addition, "many OECD countries face difficulties in strengthening innovation" (OECD, 2007 p. 9).

Examples of challenges of STI cooperation at the national and international levels are consensus among participants, standardization of bilateral contracts and co-funding. According to a researcher at a Swedish university participating in the Sino-Swedish Eco-Innovation Cooperation program, one challenge encountered was the relative difficulty in coordinating the terms and conditions of research contracts, involving two funding sources in different countries: VINNOVA and MOST (Chinese Ministry of Science and Technology) The researcher stated:

> Another thing I want to mention, you know, it might be a special situation, in this program, we got the funding from VINNOVA, and our partners got the funding from the Chinese MOST, the Ministry. But when we tried to formulate the so called consulting agreement, we needed to define the responsibility and even the consequences if someone tries to break the contract. But then the situation is quite complicated because they don't get the funding from VINNOVA and we don't get funding from the Chinese society. Okay, we can define what kind of obligations we have to each other but it is not that easy to set certain rules since you don't get the funding from the same source. That is another challenge I experienced […] In this case, we get our funding and they get their funding but still, we have to have a joint-project. In a joint-project of course we have to define different tasks. But then since we have different funding for different partners, we have to discuss a lot to reach an agreement and we did that because we had this consulting agreement signed by all the partners. But that was not an easy process because there were a lot of discussions. And the Chinese partners, of course they have their own tasks which are not always exactly the same as us here because they have a slightly different interest in this research project (professor at Swedish university, July 9th, 2014). (Interview no. 1)

Furthermore, there are challenges with respect to the governance of research. For instance, the types of multi-actor and cross-disciplinary research collaborations that have been increasingly supported by funding agencies have become more

complex to manage (Brocke and Lippe, 2015; Adler et al., 2009). The management of research collaboration might become more complex when it involves collaboration between different countries as in the two eco-innovation case studies I describe.

Also, the context for many academic researchers has changed as funding agencies have been launching strategic research programs that require the management of large cross-disciplinary programs with multi-actor involvement (Adler, et al., 2009). University researchers who manage these types of research programs face several challenges. The researchers have to lead a group comprised of individuals from multiple disciplines and different universities or different countries but the time available to the specific research program is limited. Many of these university researchers have teaching commitments and they find themselves having to split their time between managing a research group, securing funding to the projects and teaching. The funding system is also complex with the presence of multiple funders each with different goals, set of funding rules, funding cycles and research priorities. The complexity of the funding system is also characterized by the launching of research programs that are rooted in the logics of models such as the triple helix which includes academic, industry and government partners.

My analysis corroborates the literature on the challenges and uncertainties of research collaboration discussed above. Some of the factors perceived as hindering research cooperation noted in the three case studies were paucity of financial resources, contrasting views between science and industry regarding project goals, the durability of research partnerships and insufficient human resources. In the context of international collaboration, in addition to the above hindrances, geographic distance, travel costs, cultural differences, country bureaucracy and language barriers are some of the obstacles respondents mentioned.

From the perspective of research organizations and companies, the three case studies, represented by the STI cooperation programs shed light on the motivations to join research networks as well as the obstacles research actors face when engaging in science, technology and innovation partnerships. Concerns and issues have emerged across all levels of decision-making. For instance, discrepancies occur at the macro and meso levels of government when there is a dissonance between ministries' and funding agencies' views on the overall

purpose of policy instruments. At the micro level, challenges occur when project goals and timeframe are unclear and subject to recurrent adjustments.

Nevertheless, in any work relationship there is a degree of unpredictability and uncertainty, it involves a length of time under which the partnership/relationship takes place and there is a question of whether the exchange is consequential for either party (Biscotti et al. 2012; Zelizer, 2012). The outcomes of research collaboration are often uncertain; some result in discoveries with high levels of scientific and commercial value and others do not (Biscotti et al. 2012). Also, research collaborations might take place over extended periods of time, which may reinforce relations but also strain them. In addition to the issue of uncertainties associated with some research cooperation projects, these research partnerships can also be affected by a misalignment of expectations between team members, possibly aggravated when they are from different countries. The challenges extend beyond communication problems or language barriers. They are also rooted in perceived notions of team members' roles in the research project, lack of clarity regarding project goals and diminished trust among participants.

The following example illustrates some of the challenges in research cooperation. Misunderstandings and miscommunications emerged during the negotiation process between researchers in Sweden and in China concerning expected means and ends of the collaboration.

> I mean, I think contract-wise and everything, discussions and everything were all clear but then it turned out that the expectations were somehow different, maybe my interpretation is that they do this consciously to gain more out of it. So that is how they first put it out but I think at the end when we communicated and everything I think they actually knew the expectations. That was more sort of a negotiation trick to push us as much out of us to make us promise that yes, we can do this (researcher at research institute, June 18, 2014) (Interview no. 2).

In addition to these external framework challenges to STI collaboration, internal dimensions of challenges may emerge. While universities are primarily driven to produce new knowledge through scientific investigation and to teach and prepare students for future careers, companies are focused on the application of the knowledge produced in universities and on the utilization of knowledge for

competitive advantage (Bruneel et al. 2010; Dasgupta and David, 1994). On the other hand, university researchers have increasingly become proactive managers of their collaborations with industry, in efforts to generate business opportunities (e.g. create valuable intellectual property) to facilitate technology transfer (cf. Bruneel et al. 2010). As a result, university-industry interactions are becoming subject to more formal exchanges and agreements based on established guidelines and regulations (Bruneel et al. 2010).

Moreover, universities and industry have a different focus with regard to relationship-building and this mismatch can also be a hindrance to fruitful research collaborations. From the perspective of the university researchers interviewed, and in the context of Sweden, companies are too focused on product development and commercialization and do not have enough time to focus on building relations with other key actors in society (e.g. universities or the government). Therefore, according to these scholars, the Triple Helix model of stakeholder cooperation and interaction might provide companies opportunities to be part of the "knowledge/learning alliances." The TH concept has been studied extensively (Leydesdorff, 2010; Carayannis and Campbell, 2010; Benner and Sandström, 2000; Etzkowitz and Leydesdorff, 1995). Another argument is that often, it is challenging for SMEs to engage in formal innovative efforts such as R&D because they lack the necessary resources. Thus, networking and building research partnerships become essential strategies for innovation process of SMEs because it enables collective learning and the introduction and diffusion of new ideas and knowledge (Cainelli et al. 2012). Engaging in networks becomes a natural activity and an extension of the firm but an internal activity of the local innovation system and it becomes crucial for achieving more radical and new innovations such as environmental innovations (Cainelli et al. 2012).

7.3.1.1 Challenges across government agencies and between countries

Challenges also occur across government agencies concerning coordination and the identification of strategies and purposes for international cooperation. I draw on an interview with an employee of a Swedish government agency, who argued that more coordination across ministries in Sweden could lead to more efficient use of bilateral agreements. The same government official spoke of the need for a more formalized criteria or framework for bilateral collaboration. Such framework or template for establishing bilateral cooperation would serve as a

guidance that enables categorizing and organizing the different types of collaborations according to their goals (e.g. cooperation for trade promotion, collaboration for institutional capacity building, research collaboration). The template for international cooperation serves as a framework for identifying the purposes and the reasons for establishing bilateral cooperation with other countries. Having identified the purpose and reasons for STI cooperation, it becomes easier to follow-up and evaluate how the collaboration has functioned. (Government official, Swedish funding agency, December 4, 2015).

In addition, difficulties involving the coordination of government agencies' work and goals were discussed as one of the challenges in the public sector. Other obstacles mentioned are of logistical nature (e.g. time constraints, planning and management of research collaboration programs).

> […] I hope that the results and the reflections around this governmental task would be more deeply evaluated to see what incentives and what advantages and disadvantages there are in developing this type of collaboration among funding agencies even more , sort to say on a more ordinary basis […]I think the intentions are very good but then of course we represent various agencies and which one with its own task and … individual culture sort to say and time schedules and it is not very easy to formulate these long term collaborations. And you have to have a long period of preparation to manage this in a more ordinary way. But I think if you could find the right procedures to go on with this, there are a lot of advantages to the collaboration process (Government official, Swedish funding agency, November 25, 2015). (Interview no. 3)

> It is a lot of work to run these international cooperation programs, a lot of work, lots of meetings, travel and negotiations. The reason that we do include more than 4 or 5 countries is that we don't have time and resources to do more. Once we have rolling, we get things started and it is difficult also to review things; it is time and effort because of lots of meetings and negotiations (Government official, Swedish funding agency, May 6th, 2014). (Interview no. 4).

Finally, challenges can occur when negotiating the terms and conditions of research cooperation agreements between two countries. According to the participants in the Eco-Innovation Cooperation programs with China and

Brazil, one of the main barriers to successful research cooperation relates to co-funding arrangements. Often respondents expressed concerns regarding the lack of funding from their foreign counterparts. Several projects involving Chinese and Brazilian partners experienced difficulties because the projects were not co-funded (e.g. project delays and risk for termination of partnership). In some cases, only projects on the Swedish side received financial support. In a few occasions, attempts to secure Chinese and Brazilian funding failed because of administrative bureaucracy, differences in research funding systems and financial constraints.

The example below is based on notes I took during meetings I attended in Stockholm as an observant (August 27th 2014). Present in the meeting were FINEP and VINNOVA officials. FINEP is the Brazilian Agency for Innovation and Research and VINNOVA is the Swedish Innovation Agency. The two agencies met to discuss work synergy and ways to align their interests. FINEP promotes economic and social development in Brazil through the support of science, technology and innovation in companies, universities and technology institutes.

The following dialogue between officials of the two government agencies indicates that science and technology cooperation between two countries face challenges. It also suggests that differences regarding funding approaches and modes of operation are rooted in the country's institutional set up and political structures. These organizational challenges might hinder internationalization of science, technology and innovation. In the Brazilian case, decision-making authority is centralized in the federal government. Government agencies do not have as much power and autonomy as Swedish funding agencies to allocate funding and to formulate and launch new R&D initiatives. Below is an excerpt from the dialogue between FINEP and VINNOVA officials.

Senior level employee 1, Brazilian Agency FINEP:

> The exchange of people experience is easy but this type of cooperation is not so easy. The other purpose was to promote and fund joint projects on innovation. If you have projects on innovation we are talking about business, it is inevitable and in the end we want to reach the market. It is difficult among companies in the same country. But it is not easy when you involve companies from other countries as we have other types of difficulties. There are lots of things to be taken into

> account; we have trust, language, distance, all of which make this process more difficult. When we signed the [bilateral] agreement, VINNOVA launched the first call and we received [information] about the projects at FINEP. We analyzed the projects but we are different countries and have different processes for supporting the projects. We had a seminar, we had a match making meeting and in the end, we concluded that we could not support any project. We had lots of meetings, personal meetings and virtual meetings [with VINNOVA] and discussed procedures. That is why VINNOVA has launched the call without FINEP because we have agreed not to do this. Because then it was not possible for us. However, these days I want to discuss how this innovation system works and how VINNOVA works, to try to have a joint project and support each one having our own characteristics. We are going ahead. We have discussed projects, some of them are very nice but I am not sure at this moment if we have a project that we can support (statement 1: senior level employee at FINEP, August 27, 2014).

Senior level employee 2, Brazilian Agency, FINEP:

> What would an ideal project be? Maybe technology development, truly developing something and inception of a joint business, something that could lead to a Brazil Sweden joint venture or a company. Not just taking something Sweden has and bring it to Brazil but something both countries would do together, innovate together. And these two [countries] would engage to have a smart solution and create a new company (statement 2: different employee at FINEP, August 27, 2014).

Remarks from a VINNOVA employee in reply to the above statements by FINEP officials:

> I think we have a positive start, a positive climate, and the same goals, co-creation, and a win-win. Researchers and the exchange of ideas, and export to markets are not really VINNOVA's role. We have the same

> objective. About this joint venture, that could materialize. It could be a new company, or two companies developing separately. Sometimes that could be more achievable than creating something together. We have big consortia addressing challenges in society and they complement each other finding different solutions for the same problem (reply by a VINNOVA employee, August 27, 2014).

The next example illustrates some of the complexities associated with research cooperation programs in general and international collaboration in particular. In 2015, I conducted an interview with an employee who works at STINT, the Swedish Foundation for International Cooperation in Research and Higher Education. STINT is a private foundation that supports a broad range of scholar and student mobility initiatives and funds bilateral programs with other countries. When asked to identify some of the complexities concerning international collaboration, the respondent described the barriers to fostering internationalization. One issue, according to the STINT official, relates to cultural and organizational differences between two countries. During the interview, the respondent commented on the Brazilian system as an example. He explained that it can be difficult for outsiders to navigate through the many administrative layers of the Brazilian system. One obstacle, according to the same respondent relates to the overall state of the economy of a country. In the context of Brazil, the state of the Brazilian economy has had adverse effects on the execution of bilateral programs with Sweden. For instance, there has been no decision regarding the possibility to secure funding from CAPES, a Brazilian government agency, under the ministry of higher education, whose task is to allocate grants to graduate students and research centers. This means that at the moment, CAPES lacks the financial resources to co-fund programs and to launch calls for proposals (Interview, STINT staff, November 20, 2015). I argue that these external factors adversely affect internationalization goals by delaying international activities and bilateral agreements.

In summary, as discussed in chapter 3, the challenges and complexities in science, technology and innovation (STI) cannot be overlooked. The three case studies show that although some of these complexities are of international dimension, they affect decisions at the national level. The challenges of internationalization begin at the national level; policies that promote internationalization through funding incentives are designed within domestic

borders. In the next section, I discuss the core issues pertaining to STI policy such as rationales for government's investment in internationalization programs.

7.3.2 Science Diplomacy

Drawing on the discussion in chapter 3, in general terms, science and technology and international affairs influence each other (Flink and Schreiterer, 2010). They can have an important role in the support of foreign policy goals between countries through scientific cooperation (Royal Society, 2010). Some emphasize the central role of science diplomacy as a tool to foster international relations in science, innovation and education, enabling the promotion of domestic science in foreign countries (Schlegel et al. 2011). Others argue that international S&T cooperation is both a policy goal and an instrument to achieve multiple objectives such as development, competitiveness, health and diplomacy (Boekholt, et al. 2009).

At a national level, in the 1980s and 1990s, efforts by the Swedish Government to establish science cooperation with China were driven by 'science diplomacy' motivations, using science to improve political relations between countries (Lundin and Schwaag Serger, 2014). Since the mid-1990s, and in response to China's growing economy and increasing S&T resources, the Swedish Government has been focusing on strengthening S&T cooperation with China (Lundin and Schwaag Serger, 2014). The consolidation of S&T cooperation ties between Sweden and China cannot be viewed in separation from economic policies.

The following is an example of how international cooperation programs in science and environmental technology are used to gain access to emerging markets and to promote domestic science and technology in foreign countries.

> [There are] lots of environmental technology companies that have techniques that lead to more sustainable society in Sweden but they are small, not strong players, so what they want to do is they started this effort some time ago to get them to be visible to the outside world. Most of them are selling in Europe. Get them out in the international market. So the BRICS countries have lots of environmental problems, they are growing fast and also the pace of growth. And environmental aspects are put in low priority. Then you have problems with sanitation. So the idea was that this kind of R&D cooperation will benefit Swedish companies with knowledge of these countries and their conditions. We

> will run international cooperation within that area. We started with China and Brazil but we realized that we have less reason now to have as a separate program (Official[10], Swedish funding agency May 6, 2014).

For governments and foreign policy-makers, scientific cooperation is driven by the need to support higher level objectives. For the scientific community, on the other hand, participating in international science cooperation is motivated by the desire to work with the best people in the world, access to research facilities and research discoveries and new sources of funding (The Royal Society, 2010).

In addition, as stated by a Swedish ministry official (2014), establishing international science and technology cooperation "can be motivated by a common interest […] to formalize an agreement because one of the parties might desire to have a formal agreement." For others, as discussed earlier, it is important to have legitimacy-oriented partnerships to give a research collaboration project more credibility.

From the micro level perspective, the involved scientists shared this view, namely that it is important to have legitimacy-oriented partnerships to give a research collaboration project more credibility. A researcher participating in the Sino-Swedish Eco-innovation program reiterated how research cooperation programs give the collaboration between Sweden and China political legitimacy, enabling the Swedish Government and Swedish researchers to communicate and negotiate with the different levels of the Chinese Government.

> This is very important. The first thing is that it shows the national level collaboration. This is very important for the Chinese partners. It makes it easier to communicate with the different levels of the government and authorities. You know, this is an international collaboration… Because VINNOVA is a symbol of the Swedish Government, so this collaboration is classified as a national level collaboration between China and Sweden… (Professor, Swedish university, August 21, 2014). (Interview no. 5).

Another Swedish participant reinforced the perceived importance of scientific cooperation promoted by the Swedish Government in partnership with MOST, the Chinese Ministry of Science and Technology.

[10] The same government official as interview no. 4.

> […] and it is beneficial because there is VINNOVA and MOST collaboration. You know, this gives quite a lot of credit for potential investors because this is the kind of collaboration between two countries, an official collaboration […] (Professor[11], Swedish university, July 9th 2014).

Féron and Crowley (2003) suggest that internationalization in general cannot be viewed as separate from policy. Similarly, Weiss (2015) argues that international research cooperation agreements are often linked to other goals such as economic or political. By the same token, scientific cooperation with countries such as Brazil, China and India is part of efforts to attain broader goals. The following remarks, from government employees and researchers, discuss the role of science in international relations. Also, the statements are aligned with the claim I have made earlier that internationalization is coupled with other goals. In this case, perceptions might change after countries sign S&T agreements because establishing such agreements can make them more official and legitimate in the public eye. Thus, this can be one regulatory measure in international STI cooperation used not only to reduce future transaction costs but also to achieve legitimate public policy. In addition, through such regulatory interventions, government officials can affirm that such S&T agreements can closer and more regular scientific collaboration between two nations.

> Establishing science and technology cooperation with other countries can be motivated by a need from the two countries involved to formalize an agreement because one of the parties might desire to have a formal agreement. If we take Sweden in [the] research [field], we think it is important to have these bilateral contracts with different countries and often the research area, when you meet and have bilateral contacts, it is usually combined with other policy areas. Brazil, for example as you might know about industry and concretely our Swedish aircraft which we want to sell. Of course it is not easy to do that at the European level because of competition among countries. That is why most members they like to have these bilateral contracts. (Government Official, Swedish funding agency, January 28th 2015).(Interview no. 6).

> [of course] the background, the basis for all the activities towards China, from our viewpoint is renewable energy and climate, yes, the background, is of course based on political agreements. And there were 3 or 4 political agreements between Sweden and China which were signed several years ago which[is the] formal background for the activities that we have put into place after this. And

[11] The same respondent as interview no. 1

> this agreement, the political agreements are often very general …when it comes to content and what is agreed upon the political level (Government official, Swedish funding agency, November 25, 2015). (Interview no. 7).

> For the bilateral agreements this is very much steered from the government's point of view. Usually Sweden has bilateral agreements with countries that the government wants to have trading. I mean, there are political reasons and research is a good way for keeping contact and increase the collaboration between countries in a nice way. We have bilateral agreements with China and South Africa. We are starting up with Brazil and Japan also. So, I mean generally I can say that [our agency] does not pick countries specifically. Internally, we have no process to select countries, so usually we start from the Nordic perspective and from the EU perspective and we look further and also the EU has a lot of this regional networks that you have EU based and then you have a specific collaboration with countries in South America, you have specific collaborations with countries in Africa, you have Southeast Asia and so on. We don't have a preference towards certain countries from the [agency's] point of view […] I mean the Swedish government has certain… when it comes to the bilateral agreements, the Swedish government has a lot of say on that because usually the bilateral agreements are because the Swedish government wants collaboration in a certain area. (Government official, Swedish funding agency, May 16, 2016). (Interview no. 8).

This discussion sheds light on the factors informing actors' decision-making about funding and about joining research cooperation activities and the broader roles and functions they serve. Governments may deploy S&T collaboration to disseminate good international relations practices and development models, to gain access to foreign markets, to sign trade agreements, among other purposes. Thus, S&T can be used as a tool to improve bilateral relations (Dolan, 2012) and as part of a broader objective to maintain good relations with a country.

In summary, political and international relations interests drive the formulation and funding of research cooperation programs. Ministries sign agreements with countries of interest and commission funding agencies to design and launch research cooperation initiatives with selected countries. This process is captured through the above statements.

7.3.3 Addressing societal challenges

As discussed earlier, according to Edler (2010, p. 5) and Boekholt et al. (2009), "traditional drivers of effectiveness (complementary knowledge) and efficiency (shared infrastructure) of knowledge production have been complemented by attempts to integrate international collaboration into problem driven, mission oriented research." The Eco-Innovation Cooperation programs with China and Brazil are examples of targeted public instruments that prioritize research areas and facilitate scientific collaboration between different domestic and international actors to address pressing global challenges. As noted in Schwaag Serger and Remoe (2012), international STI cooperation to address global challenges stem from a need to complement and fulfill overarching policy goals.

Targeted interventions might be implemented because other measures might not be working properly or as a policy experiment to assess the benefits of having targeted instruments with mission-oriented purposes (e.g. international research cooperation to tackle global challenges). I refer to these as necessary conditions for implementing targeted instruments. Boekholt et al. (2009) suggest that tackling global societal challenges is part of the broad STI cooperation paradigm. In the broad STI cooperation paradigm, non-science policy goals interact with science-oriented objectives and STI cooperation becomes a tool to reach other policy goals.

In addition, as discussed earlier, the challenge-driven innovation approach that VINNOVA has initiated, is being pursued to orient innovation towards global challenges by enhancing service and product innovations. Often these entail the development of new environmental technologies that have the potential to address environmental problems in other countries. One perspective is that this new trend oriented toward global challenges is embedded in the logic of disseminating models and solutions generated in the Global North to meet perceived problems of the Global South. In this case, both sides benefit (the producer of technology and the receiver of the technology).

From a national perspective, following the Research and Innovation Bill of 2012, the Swedish Innovation Agency, the Swedish Energy Agency and the Swedish Research Council launched the Strategic Innovation Area (SIA) initiative to enhance international competitiveness and to find solutions that

address societal challenges (OECD, 2016). Parallel to SIA, the Challenge Driven Innovation (CDI) program addresses societal challenges such as health care and urban sustainability to cite a few (OECD, 2016). The establishment of these two initiatives represented a shift in policy focus in Sweden from supporting specific industries or sectors to facilitating cross-sectoral and multi-disciplinary collaboration with longer-term visions and funding to address societal challenges (OECD, 2016).

Lundin and Schwaag Serger (2014) offer a different perspective based on a more symmetric relationship between countries with similar interests. The authors argue that there is great potential for international cooperation with China to promote eco-innovation for mutual benefit and to contribute to addressing global challenges (Lundin and Schwaag Serger, 2014). From the perspectives of the actors in Sweden participating in the Eco-Innovation Cooperation program with China, finding scientific and technological solutions for challenging environmental problems was another driving factor to forge STI relations with China. As a researcher at a Swedish University stated, *"…you have to solve problems, not only the research and development part…"*Thus from a micro-level perspective (academic researchers), findings from the empirical data complement studies by Boekholt et al. (2009) and Edler, (2010) who argue that international collaboration have integrated problem driven and mission oriented research components. In the following interview account, an academic researcher emphasizes his motives for engaging in internationalization practices from the point of view of addressing societal challenges. A researcher stated:

> So it is just a possibility to see if we can make a difference […] if you can get the Chinese to take up the technology we are developing and do something with it, we know that it can be 1 billion people instead of 10 million who can benefit from it. I think that is the major reason that you can see that you can make a big difference if you can get this type of technology to lift because it is not primarily commercially because the commercial aspect can be that VINNOVA wants very much to promote it. But, for me personally, it is to see that I can do something that can benefit a lot of people. (Professor and researcher, Swedish university, September 2014).(Interview no. 9).

In summary, the above section has discussed the rationales for promoting international STI cooperation. The intention to use science as a tool in international diplomacy is one rationale for the formulation and implementation of research collaboration initiatives. Access to markets, particularly emerging economies is another rationale for the facilitation of STI cooperation. Endogenous factors such as desire to enhance competitiveness drive international STI cooperation. Exogenous factors driving international STI cooperation include the changing knowledge and innovation geography.

7.3.4 Changing knowledge and innovation geography

The changing knowledge and innovation geography can be viewed as a driver of the internationalization of science, technology and innovation. One perspective is that this trend influences the focus on specific nations as cooperation partners. Countries such as India, China and Singapore have a large pool of human resources and they have become important players in science and technology. In the last two decades, these nations have been supplying researchers to developed countries. Today, the high research quality of their institutions has propelled them to be considered interesting partner countries (Boekholt, et al. 2009). Thus, China's international position in science and technology has prompted interests in establishing bilateral agreements with this country (Horvat and Lundin, 2008; Arnold et al. 2009). One way governments respond to such global trends is by planning and promoting a variety of STI cooperation interventions. One way to promote S&T cooperation is through the funding and the operationalization of targeted STI collaboration projects. Such instruments might be focused on particular countries and research areas.

Government-targeted programs become key elements in the internationalization of STI. More specifically, the two Eco-Innovation Cooperation programs with China and Brazil are examples of targeted interventions that prioritize certain research areas and countries. This trend involves shifting the focus from the BRICS countries to the broader emerging markets. There are two implicit notions embedded in this recent attention shift. First, these are linked to events that extend beyond national borders. They are also tied to the development and economic growth potential of other nations.

Nevertheless, from the development policy perspective, the most recent focus on forging scientific collaboration with emerging markets is driven by the idea of

strengthening STI capabilities in less developed nations (Boekholt, et al. 2009). It also reinforces the perception of Asia as a symbol of modernity where new innovation and knowledge hubs are emerging (Ong, 2011). In this idealized spaces where developing economies emerge, selected countries are perceived as places that provide endless supplies of qualified human resources to the Global North and are viewed as emerging powers.

This idealized world is inclusive; it expands by incorporating other emerging economies as more countries become key players in science and technology. In this idealized world, the spatial location of internationalization continually shifts to include more nations. Paradoxically, the spatial locus of internationalization might be constricted at times by programs that select particular countries for science and technology purposes. They are selective because they include specific countries and prioritize certain research areas. Therefore, internationalization shifts. It might expand beyond the BRICS countries due to economic and political interests but it might also narrow in scope at times when internationalization practices are restricted to certain countries.

What do the above arguments mean in terms of the larger context of internationalization? It means that although the mentioned trends are of global scale, they are seen through the eyes of the national institutional setting and are also molded in an interdependent form. This national institutional setting is comprised of diverse government offices and branches and of multiple actors. These policy actors are affected by global trends which might in turn influence their policy decisions at home. These international events permeate national borders and in so doing, they confront established political habits and structures and traditional policy models of policy formation.

What does this mean from the perspective of Sweden as a country? It means that Sweden continues to interact in global settings, through the funding of scientific mobility programs and research cooperation and through other mechanisms. In addition, this orientation to the world and the view and application of internationalization as a means to achieve other goals is not entirely independent from past events. The government draws on past experiences and earlier patterns of behavior and decision-making processes. It relies on traditional approaches to international relations (e.g. how it has interacted with other countries before). Finally it depends on the types of structures and administrative capacities Swedish government agencies have and on notions of economic development (e.g. export, domestic manufacturing, production, agriculture, science and

technology development, labor policies). The following statement by a government official highlights the interplay between new and established elements in policy-making.

> I would not say over the last 20 years but perhaps over the last 10 years there has been an increase in interest and I would say more in terms of rhetoric rather than actually pushing agencies to do something. But as an indication of the interest from the [Swedish] government, we got also government assignment to develop collaboration strategies with China and India. With China back in 2012 and with India I think it was in 2013. You should interpret those assignments to VINNOVA and to some other research councils and agencies, to develop these strategies on how we should strengthen research and innovation collaboration with those countries, as a sign of increased interest in emerging economies. But I would say up until the current government there was a lot of focus on the BRICS but now this is slowly changing more to the broad emerging economies… I would also say that the incoming government or the current government is more focus on export rather than specifically on research and innovation even though they see the great competitive advantage that Sweden has in terms of research and innovation. So, it is more… while the previous government was much more focus on how we can strengthen collaboration just in the field of research and innovation, I would say that the current government has a more sophisticated view seeing research and innovation as part of the overall strategy to strengthen exports in both innovation and commercial ties with other countries. (Official, Swedish funding agency, November 11, 2015). (Interview no. 10).

7.3.5 Access to markets: solutions from the North address problems of the South

The internationalization of science, technology and innovation is shaped by international events and external dimensions. As discussed in chapter 3, external forces inside and outside an institution shape internationalization and institutional, national and cultural aspects need to be considered (Chan and Dimmock, 2008). For instance, examples of external forces are international economic trends. One example of such trend is the rise of new actors in the world economy such as China and India. One view is that these external forces might influence actors' perceptions (e.g. governments and researchers) of the benefits of forging relations with certain countries. International trends might shift behavior at home. For instance, domestic companies or academic researchers with a business orientation might respond to global trends such as

the rise of new economic power houses motivated by the idea of gaining to access to emerging markets (e.g. China, Brazil, India).

Furthermore, there has been an increased recognition that science and technology can be used as essential components of strategies to achieve sustainable development (Cash et al. 2003). Embedded in this perspective are the use and the development of technologies articulated as ideal solutions to wicked environmental problems. There is also a common belief that these environmental solutions can quickly diffuse and can be adopted by other nations through international networks and S&T alliances. Thus, the expectation that environmental technology developed by the research teams in the Global North will meet the environmental needs of the Global South can be seen as rationales for collaboration in this sphere.

> […] if you can leverage something that is very good, that can spread very quickly in this international world, it opens up a lot of opportunities and also it can improve things. I mean, a good solution, whatever it is, in this case environmental solutions can quickly spread and be adopted in the international collaborating world. (Manager, large Swedish company, June 12, 2014). (Interview no. 11)

According to Boekholt et al. (2009, p. i) "in international cooperation in science, technology and innovation (STI), countries do not only seek partner countries solely on the basis of STI characteristics." There are other rationales for forging scientific partnerships with countries. As discussed above, economic drivers explain actors' interests in entering international research cooperation such as facilitating access to emerging markets, exporting technologies and boosting domestic industry. Furthermore, countries such as China are viewed as a locus for business opportunities where technology solutions from developed nations can potentially address domestic environmental issues. The expectation is that a new technology successfully tested in China will be disseminated to other countries.

The making of S&T relations and internationalization is also founded on marketing possibilities with emerging economies and on ideals. Such ideals include the view of an Asian world (Ong, 2011), represented by a group of

countries such as China, India and Singapore as the center of technology development and innovation. Particular regions are viewed as emerging business opportunities and places with rising economic and environmental problems for which solutions can be imported from other countries (Ong, 2011). These emerging global spaces are constructed as sites of intervention for which a team of actors comprised of researchers, companies, funding agencies and government leaders come together to present a solution (Ong, 2011). These claims support previous discussions regarding the need to address societal challenges as a driver for promoting STI cooperation.

> The plan is to build first hand plant and then later on another 50 plants so it will really be a big thing in Honan province. Honan province is about half million people so it is vast thing. If you can get it through there on the large scale then you know that it will spread around in the rest of China and sort of later will spread to many countries in the world I guess, Germany and other countries. So, from my perspective, the expectation is that we will have good results… and this will lead to building a lot of plants […] (Professor[12] and researcher, Swedish university, September 4 2014).

The above statements suggest that emerging economies should be part of efforts to forge S&T linkages with other countries, therefore, part of research collaboration activities because of their sheer market size and the market opportunities they represent. Thus, not only internationalization is used as a means to bring technology produced in the Global North to other countries but also solutions to perceived environmental problems in the Global South. Access to markets is one of the main drivers of research cooperation. In addition, internationalization functions as a channel for sharing and communicating environmental solutions from the Global North to the Global South. One issue is that ambitions to tackle problems in the developing world or in emerging economies through international cooperation instruments might reinforce the notion that there are countries that are perpetually in need of assistance. This might imply that these nations are continually attempting to catch up with the world's technology development. Catching up implies that one is continually "lagging behind", that one lacks the capabilities to reach a certain status and that

[12] The same interviewee as interview no. 9

one is "not there yet." It also highlights science and technology asymmetries among nations.

> So for us we work with the car market and China, yes, the biggest market in the world so a lot of things happen in China. So we are there because of the development of the Chinese market and we believe that a lot of drivers regarding electrical hybrid cars are going to happen in China. So, we are working with several of the big car makers, both here in Europe for cars that they have been launched in China but also with the Chinese car manufacturers. So for us China is really an important strategy with our solutions for electric hybrid vehicles. So, therefore we are a lot in China and it has been from the beginning when we started the company. China has been really important for us. (CEO, Swedish start-up, August 22, 2014). (Interview no. 12).

> We are mainly looking now into two areas. One is this sustainable fish farming which is not the farming itself but the treatment systems that are needed to circulate the water, the same water so you won't consume fresh water to the extent that is actually going on right now and especially in China where this is a giant environmental concern because the ground water is dropping rapidly in some areas, partly due to a very, a very big industry around fish farming. You know, you just bring in new fresh water and pass it out to the environment. So, this is to circulate the same water; it is a huge savings of fresh water. So, this is identified as China is the biggest fish farming nation in the world, more than 60% [...] (Manager[13], large Swedish company, June 12, 2014).

Emerging markets (e.g. China, Brazil, India) are perceived as the locus of new promises and of dissemination of practices developed in industrialized nations exported to less developed countries. This view is shared among several participants in the Sino-Swedish Eco-Innovation program. China and Latin America are also seen as new testing grounds for ideas and for environmental technologies where solutions generated in developed countries are perceived to have the potential to tackle environmental problems in other countries. These solutions also represent market opportunities for the technology developers. This interpretation of the world might also suggest that less developed countries might not have the capability to find their own solutions to local problems. The following examples by different actors reflect the similar interpretations of desire

[13] The same respondent as interview no. 11

to access foreign markets as rationales for promoting science, technology and innovation cooperation with other countries.

> […I think part of my responsibility as working in a research institute in Sweden it is to try to introduce Swedish companies to other markets and also in a more holistic global perspective, to spread knowledge about technology and competence that could help the development of environmental work in other parts of the world. And I know that Sweden is doing a pretty good job at this […] and I don't want to sound like I am doing some kind of missionary work here, because there is a lot of good development in other countries, like let's say Brazil for example. But I think when it comes to biogas production, then Scandinavia has a lead there. So, there we have something to offer but I don't think we should be too, we should not go on missions there and solve everything. But from my point of view, that is part of my responsibility, to try to get this knowledge introduced where I see that it is possible (Researcher, Swedish institute, August 20, 2015). (Interview no. 13).

> But you have to consider that we have advantages and we have some niches and in certain areas Sweden is more advanced than our colleagues in Europe and in the United States, we know that. And it comes to the area of sanitation, and reuse and closing the loop in nutrients and energy. […] we can also see potentials that if we start collaborations, we can also find solutions not only for Brazil but for the rest, many areas in Latin America and also of course, the rest of the world, in Africa for example. So, there is a big potential in this kind of collaboration you know, it can be within a triangular collaboration. And we know there is demand: 2.6 billion people are lacking sanitation, and in Brazil it is 19 million. They don't have any sanitation at all. It is a big number but in Brazil it is still small but for us 19 million is double the Swedish population. (researcher, research institute, august 15, 2015). (Interview no. 14).

> We had actually amazing network here in Borås related to international collaboration to spread the Swedish idea of waste management. It is a very strong network. (University professor, Sweden August 28, 2014) (Interview no. 15).

A professor participating in one of the Eco-Innovation Cooperation programs shared similar views about how internationalization, through research

cooperation mechanisms, can help the dissemination of technologies from China to the rest of the world. The motivation for applying to government grant and participating in international research projects with his Chinese counterparts was twofold: 1) to find sustainable solutions for difficult environmental problems; 2) to use the successful stories of the past as justification for undertaking current research projects. The researcher also expressed his positive expectations about the research project. In his view, like the electrical bikes, working with biogas and bioethanol technology is a future promise and a safe bet, given the general perception that because of its sheer market size, any technology or project that succeeds in China is certain to succeed in other countries. Thus, internationalization is also interpreted as a means of dissemination of good practices, technologies and business opportunities.

> So we are working with biogas and bioethanol. We know this is very important because the most difficult thing is to replace this fuel for vehicles. We can solve a lot of the other problems but the vehicles is still the key issue and what we are working with in this case is to try to solve these type of problems in an efficient way. So, the driving force is to see how we can get things up and running in a good way. If we can get it through in China we know it will spread all over the world also like electrical bikes. Look at the electrical bikes. You have like 60 million in China and now they are spreading out all over the world from there. So, they have a very strong impact (Swedish professor[14], September 4 2014).

Access to markets emerges as one of the main drivers for actively joining international S&T cooperation for the government, companies and researchers. This purpose is also reflected in the goals of the Eco-Innovation Cooperation programs: to facilitate access to emerging markets through research partnerships with Brazil and China.

In summary, embedded in these cooperation instruments are discourses of intent with significant emphasis on how such initiatives can benefit Sweden; rightly justified and well-articulated in how the benefits would trickle down to the rest of the world. Moreover, the emphasis is on how such programs can help to

[14] The same respondent as interview no. 9

disseminate useful knowledge about Sweden's competency and competitive advantages. Paradoxically, the environmental issues that these particular business-like individuals try to tackle extend beyond their capacity to solve them. Likewise, the societal challenges that governments try to address extend beyond their capacity to resolve them. Naturally, in spite of good intentions and meaningful goals, solving today's societal challenges cannot be achieved solely through the investment and dissemination of research cooperation programs or through short-term S&T collaboration instruments. The results are often rather a diffuse set of solutions and lose networks and projects that will accomplish the minimum, forming scattered international linkages.

7.3.6 Strengthening international reputation through competitiveness

The notion of competitiveness has been enthusiastically adopted as a policy goal across different regions and certainly in Europe. Competitiveness is one of the broad STI cooperation paradigms discussed in Boekholt et al. (2009). Moreover, "while improving national competitiveness is becoming a major driver for many countries, in this policy domain the objectives and goals of international STI cooperation are operationalized in a very broad manner (Boekholt et al. 2009, p. 14).

Current policy documents present competitiveness as one of the goals in science and technology cooperation policy. The Strategic Forum for International Science and Technology Cooperation (SFIC) is a good example. On December 8, 2008, the European Union Competitiveness Council established the Strategic Forum for International Science and Technology Cooperation (SFIC). SFIC[15] was created to assist in the implementation of a European Partnership for international scientific and technological cooperation. Below is an excerpt of a speech[16] by the Chair of SFIC:

> Today international cooperation in research and innovation plays an increasing role in contributing to the quality of European research, the strengthening of the

[15] ERAC-SFIC 1354/11 contains the work program for SFIC and SFIC's role in international STI cooperation.

[16] The letter was addressed to SFIC Member/Observer/Reader by Riitta Mustonen in reference to the SFIC Annual Report March 2011-Feb 2012. The letter can be retrieved at: http://ec.europa.eu/research/era/pdf/sfic-chair-letter_en.pdf

> economic, industrial and technological competitiveness of Europe, as well as the development of the research-innovation-education knowledge triangle. In this context, SFIC holds a key role in achieving the objectives of the Europe 2020 and the Innovation Union (Brussels, April 25, 2012).

In the 2012 Swedish Innovation Strategy, then Minister of Enterprise, Annie Lööf emphasized the importance of strengthening Sweden's competitiveness. Below is an excerpt of the 2012 Innovation Strategy:

> Sweden stands relatively strong in most international comparisons of countries' innovation capacities and competitiveness. However, global competition is increasing between companies and nations. The rising pressure on the earth's resources also requires new solutions that combine ecological, social and economic sustainability. In Sweden, we need to be more innovative to meet the global societal challenges, to increase the competitiveness and to renew the future welfare and public services. This calls for an innovation climate that provides the best possible conditions for individuals, businesses, the public sector and civil society organizations to be innovative… (Annie Lööf).

The political attention to terms such as innovation (open innovation, innovation capacity), competitiveness, global competition, knowledge society has been increasing. It appears that governments worldwide are using discourses of competitiveness in science, technology and innovation policies. The international competitiveness discourse has become central to national policy debates at the same time that countries continuously look for ways to foster science and technology cooperation. Therefore, competition and cooperation co-exist and seem to contradict each other in science, technology and innovation. They are also manifested in policy instruments that facilitate both simultaneously.

Competitiveness is an implicit driver of the continuing focus on S&TI cooperation in Sweden. Government agencies are constantly asserting their role as promotors of innovation and as contributors to Sweden's international reputation as a leader in innovation. A government official explained:

> For VINNOVA I think it is very important to find this role where we can really help and strengthen the perception of Sweden as an innovative country. I think

> that is actually where we do the most benefit (Government[17] official, November 11, 2015).

The Eco-Innovation Cooperation programs I describe formed consortia involving companies and a diverse group of stakeholders in efforts to expand research cooperation networks. These international networks might serve as feedback and information mechanisms by providing input on how funding agencies can strengthen Sweden's image as a leader in innovation. The following example also suggests that coordination and operationalization of international research cooperation programs are not necessarily the tasks where funding agencies might have the most direct impact at the country level.

> We have the center for traffic safety with China. We have Volvo, the car company and the truck company involved and some other companies and now we are starting collaboration with United Arab Emirates and we also have a similar, actually more broad network of companies and really listen to them, what do they need, what role do they see for VINNOVA. Because I think it is really about putting forward and strengthening the image of Sweden as an innovative country. I think this is where we can really do the most and have the greatest impact, perhaps more so than setting up these programs. I would say that the benefit is for the companies. In terms of the academia and research institutes, I think they can work with companies. (Funding agency official[18], November 11, 2015).

The following statement illustrates the importance of global competition, of being self-sufficient in STI and of continuing participation in scientific cooperation with other countries referred to as "being open." Finally, implied in the following interview account is the notion of "expansion of research frontiers" through internationalization instruments such as international scientific cooperation. According to the interview subject, this expansion of research frontiers is reflected in the need to shift perspectives from a European research area to a global research area.

> Then of course there is the aspect of competition, I mean for Sweden, we have always been quite open there, saying that we have been cooperating with the best, regardless if you are in Europe or outside Europe. And of course in some areas we also have to make sure we don't depend on other countries. And that in Sweden,

[17] The same respondent as interview no. 10.

[18] The same respondent as interview no. 10.

> we don't see strictly from a kind of European perspective. European research area which I explained to you, which I think is needed but I think now we should talk about the global research area instead because we cannot isolate problems in Europe and for me that is the internationalization that we started to talk about, the global research area instead of a European research area. (Government official[19], Swedish funding agency, January 28, 2015).
>
> I see this as a good way to continue to increase knowledge and competence knowing how and what to do in policy development. But it is also fundamental for the long term competitiveness of Sweden (Official, Swedish ministry, May 26, 2015). (Interview no. 16).

Achieving competiveness implies that countries must form international alliances to diffuse knowledge and research practices, augment learning and stay up-to- date with the latest scientific discoveries. The fear of "lagging behind" and ambition to "catch up" with technology development drives governments' efforts to promote science, technology and innovation. Following this logic, competiveness can be viewed as a driving force of international science and technology cooperation. On the other hand, as a broad STI cooperation paradigm (Boekholt, et al., 2009), STI cooperation is also used to enhance national competitiveness.

Furthermore, the theme competiveness has emerged from interviews with participants of the Sino-Swedish Eco-Innovation Cooperation program. Interview subjects have acknowledged that it is crucial for Sweden to establish scientific linkages with China. One researcher at a Swedish university argued, "It is important to develop high level technology to reinforce Sweden's competiveness in the world" (August 21, 2014). This statement suggests that developing high level technology is accomplished through building scientific partnerships with Chinese counterparts to develop environmental technologies that can be applied in the Chinese context and at the same time, boost Swedish industry (do Nascimento, 2014). Also, competiveness drives international S&T ties as researchers expand their networks and form teams to work in projects to tackle societal challenges (e.g. air and water pollution, lack of basic sanitation and climate change) (do Nascimento, 2014).

[19] Same respondent as interview no. 6.

> […]For Sweden, we can export our technology, we can develop our technology. Sweden is a small country but Sweden needs to be strong in technology development so we have to reinforce our force to be good in the world… And the environmental problems, these are global issues, but not only one country. If we put the money to develop bioenergy then we will reduce the global environmental problems. I would say air pollution in China is terrible, terrible problem. (Researcher at a Swedish University, August 21, 2014). (Interview no. 17).

Sweden might engage in internationalization practices (e.g. research cooperation) because it is relevant for the country's long-term aspirations to become a visible nation in innovation networks of various kinds. Certain research collaborations thus emerge as more relevant than others. By the same token, other types of alliances may not need much government intervention because they are with countries that have high level research capacity as illustrated by the following statement:

> I see international collaboration as a really vital issue and for Sweden's long term competitiveness […] I would say that we have quite well- functioning collaborations with for instance, the U.S., with developed countries with high level of research and knowledge and there are […] collaborations that work quite fine without any bigger interventions. But I think when it comes to some of the countries with maybe a bit lower research performance… then usually the normal logic for scientific collaboration might not work by themselves […] So, trying to have some formalized collaborations with high growth countries that do not have very high research performance, ah, that I would say would be an issue where it would be good to improve a bit also. I mean from a national point of view or from a ministerial point of view, some kind of intervention, state intervention […] Today, it is much more natural to have collaboration with Chinese partners that we created state collaboration with a number of years ago. I think it would be relevant also to see which countries will be the future BRIC-like countries and it would be quite interesting to position Sweden in collaboration with those countries. It is not only that it should be good research countries but also countries subject to high growth and then to use research collaboration as a vehicle to be integrated in the global value chain. So this would be that Swedish companies would also collaborate with foreign actors and bring forward products that will be easier to reach the market. For us, research is not only research. We are interested in the results. I mean, not only in the scientific

> results but how it will contribute to Sweden continuous prosperity." (Official[20], Swedish ministry, May 26, 2015).

The above example indicates that international research cooperation through internationalization efforts is seen as a search processes for new partnerships and new relations within a changing global system of science and innovation. It also makes internationalization practices conditional on exogenous events such as the economic development of other countries, and the search for new growth poles in global economy (such as the role of the BRICS countries). Finally, internationalization appears to be categorized into two distinct efforts: internationalization practices with high research performing countries and internationalization with high growth nations. The latter is perceived as in need of more government intervention whereas the former is perceived as being self-sustained.

Thus, internationalization processes are dependent on funding as the main enabler for the continuation of and the application of internationalization tools to achieve different goals. Internationalization is also dependent on predictions of which countries might become BRIC-like nations. This categorization of the world substantiated in the above statement, classifies nations into categories (e.g. BRICS). This category represents a selected group of nations that exhibit certain characteristics, have specific patterns of economic development and are perceived as having high growth potential. In other words, the statement above highlights a pattern of aligning international engagement with domestic interests. This alignment of multi-dimensional interests might create fluctuation in internationalization practices. It also suggests that there is an expectation that other countries will become BRICS-like nations. These expectations influence policy actors' actions and it might steer them into a certain direction. It is possible, based on the above, that they might influence policy makers to prepare policy directives that include cooperation programs with specific countries.

Finally, I bring the example of the owner of a Swedish start-up I describe in chapter 1, who has expressed concerns about the challenges of doing business with emerging economies. One of the assumptions found in the study by Boekholt et al. (2009, p. 14) is that "providing national businesses with relevant information and contacts in interesting countries could improve their market access." This is part of the strategies to improve national competitiveness that

[20] Same respondent as interview no.16

would stem from STI collaboration. However, there is no indication that such strategy alone would have helped the business owner and would have swayed his decision to conduct business in Brazil instead of Europe. Even when proven attractive, often small businesses face bigger challenges. Strangely enough, enhancing national competitiveness and enhancing domestic companies' competitiveness seem disconnected from broader policy goals to strengthen Sweden's international reputation as a world leader in innovation.

> We have already connections with Brazil in different levels, at academic level and we have with private companies. But it is only e-mail and phone and so on. But if we want to start up to open the door, as we say, that requires the follow up and if we can't do the follow up… we are idiots if we start the project without having that kind of money behind us. So, then we have to focus on other markets before we… until we get the funding, the money enough to open the door (Owner, Swedish start-up, August 15, 2015). (Interview 18).

7.3.6.1 Growing interest in forging S&T relations with China

Since the mid-1990s and given China's growing economy, there has been a growing interest by the Swedish government to intensify science and technology cooperation with China to open up research and innovation opportunities and to help Swedish firms to access emerging markets. In 2010, the Swedish government commissioned research councils in Sweden and other government agencies to together provide suggestions for areas of relevance to Sweden's international competitiveness. The report discussed the importance of the Swedish public sector to provide the necessary and the right conditions for firms and academic institutions to build cooperation partnerships with Chinese actors and to establish presence in Chinese markets (Schwaag Serger, 2014). Among specific recommendations are the promotion of student exchange, academic cooperation and increase companies' access to individuals with expertise and knowledge of China seen as an important factor for promoting innovation cooperation with China and for helping to gain access to the Chinese markets.

The Swedish government's motivations to engage in more science and technology cooperation with China is a response to external changes in the global S&T enterprise, including the emergence of new international players (e.g. Brazil, Russia, India and China) with growing research capabilities. The motivation for building more sustainable S&T cooperation with China also

stems from a growing interest by Swedish researchers and firms to intensify research collaboration in the form of scientific mobility and co-authorship with Chinese partners. Initiatives to form new innovation and research partnerships with Chinese scholars are visible at macro (e.g. government), meso (e.g. funding agencies) and micro (e.g. universities, research institutes, firms, municipalities) levels through different policy instruments. One such instrument is international cooperation for science and technology.

At the national level, Swedish science and technology cooperation with China is part of a broader research and innovation policy. For example, the Swedish government's research and innovation policy focuses on enhancing the nation's international competitiveness through the advancement of the quality of research in Sweden which is expected to contribute to the development of the Swedish industry and society as a whole (Government Bill, 2012). From a general perspective, the Swedish government is increasingly engaging in cooperation with countries like China and Brazil to intensify Swedish competitiveness in the global knowledge economy. It tasks funding agencies to provide input and ideas on how to 'stay ahead' and strengthens Sweden's competitiveness through innovation strategies.

7.3.7 Perceived benefits of principal-agent relation

This section aims to explain the connection between research actors' (agent) motivations to participate in STI cooperation programs and the principal's rationales for sponsoring STI collaboration initiatives. I draw on the Theory chapter to illustrate my argument. Braun and Guston (2003) suggest that the principal-agent (P-A) interaction model highlights the presence of a social exchange between two players – the principal and the agent. Based on the theoretical foundation in chapter 3, I argue that the principal-agent relationship is more than a social exchange between research funder and funding recipient. This interaction also perpetuates a relation based on mutual dependency. I refer to this mutual dependency as dependency-driven relationship that generates a business-driven behavior. What is the relevance of the above in the context of this dissertation? I address this question by arguing that because of the deep dependence on external funding in the Swedish research system, the implicit benefits of the principal-agent arrangement are incentives for promoting and funding STI cooperation programs. In other words, the perceived benefits of the principal-agent relation drive the continuing promotion and funding of STI

cooperation. This can have implications for program formulation and implementation and for the funding agencies' perceptions of academic researchers and their needs.

Funding agencies in the context of Sweden are more than grant providers and interpreters of government's directives through the implementation of programs. They are also transmitters and catalysts of opportunity-driven behavior. In their dual role as principal and agent, depending on the level of interaction and the functions they serve, funding agencies create opportunities for researchers to perform tasks on behalf of the principal (ministries or funding agencies).

Funding agencies can also serve as experts to policy issues; therefore, they might directly or indirectly influence policy. The principal or funding agency provides financial resources through calls for proposals but they depend on the agent's (researchers) skills and expertise to realize the principal's interests. By distributing grants, the funding agency serving now as principal in relation to research performers prompts researchers' work by enabling them to participate in government-funded programs. One implication is that financial incentives such as research funding that the principal (funding and implementing actors) provides attracts business-like individuals (researchers and companies) and might encourage a opportunity-driven behavior.

7.3.7.1 Opportunity-driven behavior

Some of the core reasons for engaging in internationalization activities are rooted in economic rationales (e.g. internationalization is oriented towards profit maximization). For instance, as discussed earlier, Altbach (2012, p. 1), argues that "some universities look at internationalization as a contribution to the financial "bottom line," in an era of financial cutbacks." In addition, from the firm perspective, scholars argue that given the self-interest rationales of social actors or market competition, decision makers in firms seek the maximization of profits (Buckley and Casson, 2009).

A number of respondents across the three case studies have associated internationalization or international research cooperation with entrepreneurial opportunities. My interpretation of the interviews conducted with researchers at universities and research institutes has led me to conclude that some interview subjects view themselves as "brokers," helping Swedish companies bring their

products out in the market. A number of individuals framed internationalization as a business transaction. Thus, different individuals perceive internationalization instruments such as cross-border research cooperation as business opportunities. Business opportunities include boosting national industry by helping Swedish companies access large markets, promoting product and technology export, bringing environmental solutions to other countries and helping SMEs to internationalize.

There were a number of individuals interviewed who discussed their personal ties to Brazil and China through their spouses who are citizens of those nations. One Swedish business discussed his experience in Brazil as a long-term resident of that country which enabled the individual to learn the language and to gain significant knowledge of the Brazilian market. In a few other cases, researchers interviewed were themselves citizens of either China or Brazil. In all of these instances, individuals were also driven by personal motivations when applying for government-sponsored scientific cooperation programs with Brazil and China. However, based on the interview statements from respondents, I conclude that helping Swedish companies to access foreign markets was one of the most important motivations for participating in the Eco-Innovation Cooperation programs with China and Brazil.

In spite of the challenges associated with forging domestic and international research cooperation, actors in research organizations tend to respond to funding opportunities. They use these opportunities to affirm their role within a domestic region but also across borders. For instance, individuals use their existing networks and bring these existing connections into the context of government-sponsored research programs. Thus, government-funded research programs attract opportunity-driven entrepreneurship[21]. Opportunity-oriented entrepreneurship views business as an opportunity rather than primarily a need to earn an income. The following comments by a Swedish professor who received government funding for his research project with Brazil suggest that academic researchers might play two different roles. It also shows that there is a level of compromise or perceived trade-off between actively participating in research projects and meeting academic obligations (e.g. administrative, teaching, managing research projects) versus joining entrepreneurial activities.

[21] The distinction between the two terms originates in the 1980s (Williams, 2009) and it became popular with the adoption of these terms bythe Global Entrepreneurship Monitor (GEM) in 2001 (Reynolds, et al. 2002).

The interview account suggests that the scholar views himself as an academic. At the same time, the scholar is deeply involved in setting up a business in Brazil.

In the following example, the professor is behaving entrepreneurially by identifying external funding sources to perform his research activities which are linked to potential business opportunities in another country.

> Yes, the cooperation has developed and we have rather good platform here to bring the companies from the X region to Rio… But on the other hand, for the region as X it is important that we have, that we start to learn to work internationally… So we want to help companies to get into the international market, teach them how to communicate and so on… Ah, I think it is just to learn and I am here (in Brazil) more and more. And it is also the fact that I am a scientist. It is different, I mean for maybe a person who is coming from a business background in Sweden. But on the other hand, it is not so easy for Swedish companies to be established here. (Professor, Swedish university, August 18 2014). (Interview no. 19).

Nevertheless, the interview shows that some individuals are continuously searching for and responding to new opportunities to expand their research networks; therefore, they take advantage of new collaboration projects. Given the context of Sweden, characterized by dependency on external funding (chapter 6), it is not surprising that such government-sponsored research cooperation programs intend to both forge linkages and increase Sweden's competitive advantage in environmental technology. On the one hand there are specific environmental issues in Brazil (e.g. lack of waste management in certain regions). On the other hand, there are business-like individuals in academia, who have personal connections or research connections with particular countries in addition to regional networks at home. These individuals are receptive to new government-funded research cooperation programs and view these initiatives as business opportunities. Thus, they respond accordingly.

Drawing on the principal-agent perspective, by applying to government funding and by accepting the terms and conditions of the research grant, the researcher and the funding agency engage in a social exchange where their roles are well defined. Regardless of their awareness of such interaction, both parties are enablers of each other's functions and practices in the context of government-sponsored research cooperation mechanisms. This relationship reinforces an opportunity-driven behavior. Hence, academics are not only academics,

scientists are not only scientists and business people are not only motivated by business interests.

Interviews conducted with different actors suggest that Swedish companies and university researchers are driven by both research interests and potential business opportunities when they embark in government-sponsored initiatives. Also, research actors perceive emerging economies, particularly China as a country whose environmental problems can be addressed with technology from developed nations. Expectations of research results, optimism about research collaboration between Sweden and China and 'betting' on the future are factors that contribute to researchers' response to government-sponsored innovation projects, according to my interpretation of the empirical material. These interests also drive government's support to cross border STI cooperation.

> China is also the country that needs a lot of energy; it needs to improve the environment, to increase the energy resources. That is why I think there is a big chance. So also during these years, I have known so many Swedish companies. I know what kind of technologies will be good not for transfer but for, you know, collaborative development would be good for both China and Sweden. I think another part is that this is a chance to develop Swedish technology. As I mentioned, for me, I am a researcher. If I want to develop something I must have funding, right? This gives me a chance to develop Swedish technology. And this Swedish technology is still classified, is identified as Swedish technology. This is important. It is based on old technology but they have something new, to fit the Chinese market and other international markets. So, it is important to have this chance for our researchers and for Swedish technology export (Researcher[22], Swedish university, August 21, 2014).

However, these views are not symmetric and some of the statements by a number of respondents counter the conventional wisdom about the way society traditionally sees academics versus business people. For instance, among those interviewed, there were company owners who had altruistic motivations for participating in environmental technology cooperation with Brazil or China.

> We want to become like IKEA but with energy systems. And in Brazil we could do this and in some other countries we could do this. That is what we are aiming for but we are not there yet. And we think also this could make a big change for people both for the environment and also for the social situation. What I

[22] The same respondent as interview no. 17.

> explained is probably because I have a background as an environmentalist so you know, that is a motivation to do this, to work with environmental technology (owner, small company, August 21, 2014). (Interview no. 20).

It would be misleading to claim that the participants of the government-funded international programs are driven by business interests only. A number of participants declared that in addition to business opportunities, long-term research was also an important motivation for participation in these programs. One researcher argued that access to markets is one of the main reasons for his participation in research cooperation programs. The researcher's comments also indicate that the project provides an opportunity to strengthen the network of researchers.

> One is that this is a possible future market for us and both being active in Brazil and having resources in Brazil and short term transporting different waste … which are not handled in a correct way in Brazil today compared to Europe where you can recycle elements which are present in landfills in Brazil. And the other one is we are financing a professorship at Chalmers University, we have financing KTH and Linköping University. We are interested in having a network of researchers all over the world more or less in their specific area of recycling and design for the environment. So, it is not just business but it is also long term research we are interested in (Department director, Swedish company, August 22 2014). (Interview no. 21).

In summary, the above discussions illustrate how individual researchers (agents) are proactive by seeking and responding to new business opportunities and reactive when they respond to calls for proposals and comply with the terms of the funding. These individuals support the same system that creates the international opportunities by actively participating in the programs motivated by business and research interests. The research funding system represented by funding agencies (dual principal and agent roles) sponsors the activities of the same individuals who receive grants to accomplish the principal's interests.

Finally, by applying to government funding and by accepting the terms and conditions of the grants, the researcher and the funding agency engage in a social exchange where the roles of principal and agent are well-defined, explicitly or implicitly. Regardless of their awareness of such interaction, both parties enable each other's functions, asserting their roles in the context of government-sponsored STI cooperation programs. This principal-agent relationship

encourages business-driven and results-driven behavior, attracts opportunity-oriented individuals.

7.3.8 Disseminating best practices and models

This section takes a closer look at the logic of disseminating best practices and exporting "models" as drivers of efforts to promote international STI cooperation. Certainly, project outcomes and expectations of results might be included in the terms of the contract between principal (funder) and agent (funding recipient). But these expectations can also be implicit, informal and subjective which means subject to one's own interpretation. Also, one implicit desired goal by the funder could entail the dissemination of best practices or models through STI cooperation activities. I argue that it is less likely that interests such as to "export the Swedish model" or "best practices" would be clearly stated in the terms and conditions of research funding agreements or application forms, reason why such interests would be inconspicuous. Naturally, the dissemination of Swedish best practices can also be achieved through STI cooperation programs. The notion of diffusion of "best practices" or "models" can also be used as a tool for strengthening a country's international image. A program director at a Swedish funding agency made the following remarks:

> For VINNOVA I think it is very important to find this role where we can really help and strengthen the perception of Sweden as an innovative country. I think that is actually where we do the most benefit … I think the projects we are funding are good, and in some cases we need these programs to develop networks and to show commitment and that we believe in collaboration with a country. I would say though, I think where it is more important is really […] what we have done now with Brazil, a bit through CISB but we have this platform network with Swedish companies which are collaborating with Brazilian partners. We have the center for traffic safety with China. We have Volvo, the car company and the truck company involved and some other companies and now we are starting collaboration with the United Arab Emirates and we also have a similar, actually more broad network of companies and really listen to them, what they need, what role do they see for VINNOVA. Because I think it is really about putting forward and strengthening the imagine of Sweden as an

> innovative country. I think this is where we can really do the most, have the greatest impact (Official[23], Swedish funding agency, November 11, 2015).

As seen in chapter 3, the perceived success of the Swedish economic model created among Swedish citizens a nationalistic sentiment built on a "myth of political and economic superiority" (Lundberg, 1985, p. 4). Moreover, the "Swedish model" narrative is embedded not only in socio-economic and political discourses but also in development discourses such as the North-South relations and how developed nations can help developing countries to build their science and technology capacities.

The internationalization of STI which is enabled through government-sponsored research cooperation instruments can be a mechanism for strengthening a country's image. This can be achieved by exporting models (e.g. development and research models). Models are associated with practices - a certain "way of doing things" but they are also associated with physical structures that become symbols of excellence in S&T. This means that internationalization is constructed as a channel for the production and reproduction of research practices and science parks models that are constructed on previous work in the developed world. Notions of modernity, perfection, innovation and research quality are articulated in the form of imaginary symbols. These idealized sites of innovation and expensive lab experiments become symbols of perfection and are manifested into "role model" science parks with "the best structures in Sweden." These notions might be produced, reproduced and transferred from developed countries to developing nations. An interview subject participating in the innovation cooperation between Brazil and Sweden stated the following when explaining the idea behind the construction of CISB, Centro Inovacao Sueco Brazil (or the Sweden Brazil Center for Innovation) located in Sao Paulo, Brazil:

> And when he got this task he said that if we should do something in Brazil we needed a model and he had the view that Science Park X – from this perspective – is the best structure in Sweden and wanted to use the Science Park in Sweden as a role model for what they were supposed to build in Brazil and they started a journey to create CISB, Centro Innovacao Sueco Brazil (CEO, Science Park, August 20, 2014). (Interview no. 22).

[23] Same respondent as interview no. 10

The following statements by a researcher at a research institute complement the arguments above. In the first part of her statement, the researcher highlights the marketing and business motivations to engage in international collaboration with other countries and the role of the Swedish Innovation Agency in consolidating Sweden's international image of a leader in innovation. The second part of the statement suggests that it is not just the construction of ideas and ideals of cooperation and internationalization but it is also about replicating these ideals in other contexts.

At the center of the argument are the best practices in Sweden that can be reproduced in other countries as models of strong cooperation between universities, municipalities and companies (see Figure 5), also known as the Triple Helix concept. The third part of her statement emphasizes the role of the Swedish Government in creating jobs and supporting businesses, and in reinforcing this model. These roles are interpreted as Swedish traditions where political leaders look at past practices to transform them into best practices. The statement suggests that certain practices and way of doing things are engrained in old traditions and continue through the years. This means that Swedish models based on the country's traditional political structure, institutional set up and continuation of past practices can be replicated and assimilated into other contexts.

The fourth part of the statement defines the Swedish system as virtous and provides practical suggestions to market the Swedish model. For instance, according to the researcher, this can be achieved through the funding of international STI cooperation and VINNOVA support. In addition, international STI cooperation is viewed as a tool to educate other nations about international development practices from the perspective of developed countries. Thus, government agencies such as VINNOVA are seen as intermediaries between the government whose role is to develop "models" and facilitate their dissemination and developing countries, sites for the replication of these models. One perspective is that research cooperation practices, international development, labor, welfare policies and job creation strategies circulate around the world through international collaboration instruments. Funding enables government agencies together with performing actors to show case Swedish traditions through cross-border collaborations. According to a respondent:

> So, I think the model is that we have developed many interesting innovations in Sweden and I think many other countries are also and the VINNOVA support

> reinforces this and also the opportunities for bringing forward innovation and also finding new markets for innovation. So, VINNOVA reinforces the Swedish model. I mean in Sweden you have, the development… a strong collaboration between universities, municipalities and companies, you know. These are very important and key actors and I think the Swedish Government has been in the center of this, how to get business going, how to create employment and how to launch. This is an old Swedish tradition and I think this is also what VINNOVA can export also. In the Brazilian case for example, this is not normal. A lot of innovation takes place in the universities and this kind of getting innovation, trying it and implementing it a little bit and adjusting, that is not so normal in Brazil. Very few of the academic institutions have connections with the private sector, and those are not so easy to find. But there are some that are trying. So, VINNOVA can strengthen it and show-case it that this is a good model - that way you have also a lot of interesting development. So, this is also an opportunity to show case this type of development models for employment and for project development (Researcher[24], research institute, August 15, 2014).

There is a certain level of expectation that such collaboration models are reproduced in different localities within a country and also disseminated to other countries. The Triple Helix model of collaboration as explained by the scholars interviewed comprises of a local partnership between a town, university and a company within a country (e.g. Sweden) that connects to similar partnerships formed within a different country (see Figure 5). This model is disseminated in other contexts (e.g. a foreign country) to form other alliances. The linkages between a municipality, a university and a company are then established within a second country. The process continues and after being established, these alliances are replicated in other regions within the same country. Through this approach, the goal is to diffuse not only the Triple Helix model but to connect it, strengthen it and sustain it in the long-run.

According to a few respondents participating in the Eco-Innovation Cooperation programs, the Triple Helix model promotes academy-industry collaboration minimizing potential risks to all parties. It enables companies to share the costs of the time spent on a joint project. Another argument is that the collaboration model in Figure 5 is embedded in the narratives about exporting models that are developed in Sweden to other countries. These practices are

[24] Same respondent as interview no. 14

presumed to yield positive results and to assist other nations to build their science and technology capabilities.

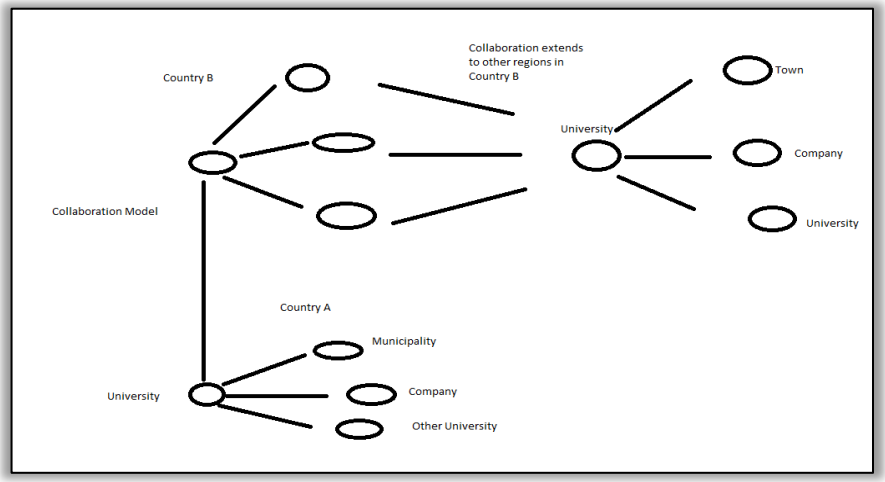


Figure 5 Research collaboration practices might be reproduced in other countries
Source: the author (based on interviews with researchers at Swedish universities, 2014).

Nevertheless, the institutinal logics perspective might be useful in this context. I would argue that the Swedish model and the dissemination of Swedish "best practices" to other countries can be viewed as the institutional logics of the current research system. This research system not only is based on external funding and incentives to foster relationships with funders, industry and researchers but it is also based on the assimilation and the reproduction of stakeholder collaboration and interaction termed Triple Helix. This institutional logics represented by the governance of research such as funding and research cooperation practices provide the means by which research is conducted, organized and new STI cooperation initiatives are established. Internationalization becomes a tool through which modes of collaboration might be disseminated; therefore replicated into other contexts.

7.3.9 Responses to perceived weak STI linkages

One perspective is that rationales for pursuing internationalization activities, particularly outside the Japan, U.S. and Europe triad might be a response to perceived weak STI linkages with other regions outside the triad. In 2010, China passed Japan to become the second-largest economy in the world (Hout and Ghemawat, 2010). The Chinese Government plans to increase China's R&D expenditures from the current level of 1.7% of GDP to 2.5% of GDP by 2020 (Hout and Ghemawat, 2010), making China a more important partner in science, technology and innovation than Japan.

One possible argument is that the rationale for promoting STI cooperation with emerging markets is a response to international trends such as the rise of new international players and an interest by researchers and companies to intensify Sweden's scientific partnerships with Asian countries. For instance, a 2008 internationalization survey across research groups in Sweden confirmed that the majority of the respondents declared a strong ambition and need to increase internationalization efforts and to adopt a more strategic approach to international cooperation (Schwaag Serger and Wise, 2010). A large number of respondents stated that while linkages and partnerships within Europe and with North America were comparatively well established, they had a strong interest in increasing their research cooperation activities with regions outside Europe and North America, and particularly with Asia (Schwaag Serger and Wise, 2010). Moreover, the uneven development of Sweden's research connections in Asia among Swedish universities and among Asian partner countries suggests that there is an opportunity to increase efforts to develop these linkages (Stenberg, 2013). For instance, Sweden's linkages with Asia appear to be underdeveloped in the fields of ICT and mathematics compared to other European countries (Stenberg, 2013). In addition, in the 2012 review of the Swedish innovation policy, the OECD recommended fostering strong inward internationalization via the hosting of foreign students and researchers in Swedish universities.

Furthermore, data shows that linkages between Sweden and China in the form of student and research mobility have not been historically strong. Therefore, there have been a number of strategies by the Swedish Government such as cooperation agreements to foster researcher exchange between the two countries. As Lundin and Schwaag Serger (2014) argue, a driving force of the Swedish

Government's interests towards S&T cooperation with China that has not been always explicit is the desire to compensate for the absence of strong student and research mobility linkages with China. In 2009, there were approximately 160 cooperation agreements between 29 out of 30 universities in Sweden and around 100 universities in China. The agreements include collaboration in research (EU S&T Section, 2011). The interest from Swedish scholars to establish research collaborations with their Chinese counterparts has therefore increased. It has become common for students to enroll in joint programs and receive degrees from Swedish and Chinese universities as part of their educational program. Therefore, increasing motivation in Sweden to strengthen S&T cooperation with China is driven, firstly, by an interest to facilitate or promote Swedish firms' access to the rapidly growing Chinese market, and, secondly, by an ambition to enable and encourage Swedish academia and industry to tap into and link up with China's rapidly increasing knowledge resources (Lundin and Schwaag Serger, 2014).

Based on the above, one can conclude that there are opportunities and a need to increase and to strengthen internationalization efforts. According to Schwaag Serger and Wise (2010), there seems to be common interests in terms of the geographic focus for international cooperation outside Europe, as for example, possible coordination among innovation agencies towards cooperation activities involving China as a partner country (Schwaag Serger and Wise, 2010).

The above discussion highlights the heterogeneity of rationales for promoting international STI cooperation and internationalization of STI. Not only the response to global trends such as the rise of emerging economies as important partners in S&TI is emphasized among the respondents but also the need to accelerate some of these trends. STI cooperation with emerging economies such as China is seen as a trend in internationalization practices in which the Swedish Government, including funding agencies have a central role to play as catalyzers of international STI cooperation. A number of the respondents interviewed were involved in the development of environmental technology motivated by business opportunities, research interests or altruistic perspectives. Therefore, they view the Swedish Government as playing a number of different roles in promoting international STI cooperation. Government agencies are seen as facilitators of

international STI cooperation and as monitors of industries. A company manager stated:

> I think you need these criteria as I tried to summarize them, looking at industries that for some reason are a little bit locked or in a situation where it does not move in the right direction. I mean, there are a lot of environmental issues now, there is climate change and in our case, is the water issues. There are maybe infrastructure. Industries sort of move too slow for some reason, I think that is the focus [of government agencies]. (Vice president of product development, Swedish company, June 2014). (Interview no. 23).

There seems to be a widespread interest in forging S&TI linkages with other countries, particularly with China and in the dissemination of research practices and environmental technologies to other countries, among the interviewees. There is a common view, shared by the respondents, that international cooperation in science, technology and innovation has the potential to standardize sustainable environmental practices around the world and that the government can and should play a role in this process. The individuals interviewed seem to be part of a new wave of internationalization strategies that involve efforts to increase collaboration in science, technology and innovation with regions outside the triad Japan, the U.S. and Europe. From the macro level perspective, the government continues to promote both general strategies to forge S&TI linkages and specific strategies. The latter is accomplished through policy instruments such as the Eco-Innovation Cooperation programs discussed in this dissertation.

7.4 Summary and conclusions

This chapter has discussed rationales for promoting internationalization and international STI collaboration. Science in general and international research collaboration in particular are unlikely to be funded at appropriate levels without government intervention. The latter faces even greater challenges in the long-run without government support through funding mechanisms given geographical, social and organizational constraints associated with the activity. Intervention in this context means to fund and to promote specific internationalization programs.

Research cooperation programs, particularly international initiatives face challenges. I have argued that in spite of the known challenges inherently to collaborative research initiatives, governments launch different programs and researchers and companies respond to such opportunities. Challenges in science, technology and innovation can range from paucity of funding and geographic distance to difficulties finding research partners or lack of man power to pursue further STI cooperation with countries of interest. Some of the obstacles encountered in research partnerships at the micro level relate to discrepancies between university's and industry's project timeframe and modes of operation, resulting in tensions and dilemmas. For instance, scientists participating in the International Cooperation for Eco-Innovation with Brazil and China, working together with industry were concerned about being pressured to develop a product and commercialize it. While the university actors participating were focused on the long-term results of the research, companies were focused on business opportunities and short-term gains.

Tensions also emerge because industry has certain temporal expectations of scholars. Companies expect that researchers will deliver quick results following a short-term project cycle and scholars expect patience and an attitude of understanding from companies when research outputs are not delivered within the expected timeframe. While scientists focus on long-term and collective benefits of a research project, generally speaking, businesses are driven by short-term, tangible and appropriation-based interests. Adverse effects include difficulties in sustaining the research partnership or the termination of the partnership. Also, pressure to deliver research results may impact the quality of research and the results themselves and it can affect the potential for future collaborative work.

Despite the above-mentioned challenges of STI cooperation, governments fund and promote international STI cooperation programs. At the same time, researchers and companies participate in government-sponsored STI programs motivated by diverse interests and pluralistic goals. From the government's perspective, the interest in sponsoring STI collaboration instruments can be viewed as a response to domestic and international trends and the need to fulfill multiple policy goals. These goals include helping domestic industry to gain access to foreign markets, disseminating technological solutions to tackle environmental problems and enhancing national competitiveness.

Perceptions and the understanding of the world regions and how they can be utilized as a platform for Swedish competitive advantages can play a role in policy decisions about the direction of internationalization. One possible conclusion based on interviews with respondents is that the decision to engage in scientific cooperation and knowledge exchange with Brazil, China and India are grounded in export and marketing strategies and political interests rather than in the mission of internationalization.

Findings indicate that in spite of the risks associated with promoting internationalization, funding agencies and universities engage in continuing social exchange. In this chapter I have showed how different goals and means operate in parallel and that governments try to ensure that programs meet certain expectations. Such expectations might include the facilitation of international linkages. Researchers, on the other hand, see the government-sponsored research cooperation initiatives as an opportunity to fulfill their goals and ambitions.

Also, exploring immediate opportunities as captured through a number of interview passages is an attitude that can characterize business actors (e.g. company managers/company owners) and university researchers. This characterization of researchers as opportunity-driven might challenge conventional views of academic researchers as individuals who do not cross the academic boundaries. Some participants appeared to treat these government-sponsored programs as business opportunities. Their actions and business motivations counter traditional notions that scientists do not get involved in business transactions or are not motived by the business prospects that some of these collaborative projects can offer.

Furthermore, if what drives academic researchers and industry to join international activities is the need to secure funding, another possible conclusion is that these individuals are not really engaged in internationalization practices at the most optimal level. They are simply responding to funding opportunities. In addition, researchers do not get any extra reward for applying to external funding (for the sake of this argument, I am not taking into account the actual funding individuals receive as a reward). On the contrary, applicants devote time and energy preparing grant applications. However, they might be awarded if they receive the funding they attempt to secure. Department promotion can be one type of reward and it can lead to opportunities to work with other scholars and strengthen one's research network and reputation.

Finally, there are other factors compelling different actors to join international activities. From the perspective of university researchers and industry, the expectation of successful outcomes, which reinforces the results-driven behavior, encourages these actors to respond to funding opportunities and to participate in government-sponsored STI cooperation programs. Drawing on the principal-agent interaction model, the funding agency allocates funding in exchange for meeting the funders' goals. The funder relies on researchers' expertise and skills to meet the funder's interests and expectations. Researchers understand this interdependency relation; they rely on funders to allocate money to their projects.

Chapter 8 STI Cooperation: Turning Intentions into Practice

"No politics is possible at the scale of the speed of light. Politics depends upon having time for reflection. Today, we no longer have time to reflect, the things that we see have already happened. And it is necessary to react immediately. Is a real-time democracy possible? An authoritarian politics, yes. But what defines democracy is the sharing of power. When there is not time to share what will be shared? Emotions."

Paul Virilio (2002)

French philosopher and urbanist

8.1 Introduction

In the previous chapter, I have discussed the drivers of internationalization of science, technology and innovation. One explanation is a vested interest in articulating and sponsoring internationalization programs to promote domestic industry and to strengthen Sweden's international image as a leader in innovation. The discussion in this chapter concerns one domestic program in the sustainable transport area and two internationalization programs of small scale focused on environmental technology. The two international programs are examples of policy instruments in which researchers in three countries, China, Brazil and Sweden apply for funding to pursue research projects in thematic areas. These initiatives usually emerge from bilateral agreements between two countries for the purpose of economic, scientific or political cooperation (Schwaag Serger and Wise, 2010).

In this chapter, I move beyond the discussion surrounding the rationales for promoting internationalization programs to examine how the formulation of

internationalization initiatives takes place. Based on interviews with officials across Swedish ministries and government agencies, I contend that the traditional and "idealized" model of policy decision making does not always reflect decision making in practice. In this section, I focus on the meso level, the locus of policy implementation and program design. The meso level is where policy directives are interpreted and decision making about the design and composition of research cooperation programs takes place. I look at the factors that led to the decision to establish new government-sponsored STI cooperation programs which include international scientific collaboration. I also examine the roles of different policy actors in shaping the design of these initiatives. This has been accomplished through in person and phone interviews with 15 government officials across the Swedish ministries and funding agencies.

In addition to interviews, this thesis has drawn on government documents (e.g. policy propositions, research and innovation bills, government reports and program evaluations and notes from meetings at VINNOVA headquarters in Stockholm). The two Eco-Innovation Cooperation programs emerged from the 2011-2014 Strategy for Development and Export of Environmental Technology. The Chalmers Transport Area of Advance originated in the 2008 Research Policy Bill.

Government-funded STI cooperation initiatives do not emerge spontaneously. These initiatives are prompted by continuous actions of policy and research actors that lead to the crafting of new policy instruments. This chapter addresses the second research question: *What factors shape the formulation of government-supported international cooperation programs in science, technology and innovation?*

Actors engage in policy meetings and consultations, set priorities and decide about the allocation of funding for science, technology and innovation purposes. Policy actors together with performing actors (research organizations) enable the operationalization of internationalization of STI and international STI cooperation. However, like in other decision making processes, there are steps that precede operationalization. One such intervention step in policy making is the design of policy instruments that promote international STI cooperation. The design phase of a program might include the following decisions: types of research cooperation programs and the consortia involved (e.g. science-industry), the scope (national versus international), the research areas, the countries involved, the national and international funders, the amount of funding allocated, the project cycle and timeframe for calls for proposals. Given

the above list, it is reasonable to conclude that a number of factors have played a role in the decision making process involving the three programs I describe.

Policy decisions might determine the exact format and design of these STI cooperation schemes. These cooperation programs are embedded in the broader context of research system such as interactions among government and non-government actors, the institutional set up and political structure. The decision making behind the formulation of the three programs described in this thesis is not always rooted in rationalist assumptions and choices. This chapter draws on a number of concepts, including bounded rationality and "satisficing" to show that rationality does not determine behavior. Within the area of rationality, behavior is perfectly flexible and adaptable to abilities, goals and knowledge. Behavior is determined by irrational and non-rational elements that bound the area of rationality" (Simon, 1996, p 88).

Furthermore, as discussed earlier, the institutional logics concept aids in the understanding of how the logic of the government, to set public policies and to fund and promote STI cooperation, is aligned with the logic of research practitioners which involves the organization of research activities and securing research funding. In addition, the institutional logics concept provides insights into understanding how the mixed model of research governance in Sweden constitutes the institutional logics of the Swedish research. This logic of the research model has shifted focus starting in the early 1990s. For instance, the Swedish research system has increasingly become project-driven and focused on resource competition.

Statements by government officials (e.g. policy actors and policy strategists working across ministries and funding agencies) in Sweden suggest that there are multiple factors shaping decision-making processes in international STI cooperation. These factors influence the articulation and the composition of specific STI cooperation initiatives. For instance, pragmatism and multi-goal fulfillment explain the unpredictability in the formulation of international cooperation programs in science, technology and innovation.

Based on the findings, it is possible to conclude that when a funding agency designs a bilateral cooperation program that involves joint projects with industry and academia from two countries, the selection of the country is not accidental or aleatory; it is based on a pragmatic choice. Certainly, rational decisions can be pragmatic but not all pragmatic choices emerge from a logical process. Choices

affect government-sponsored programs. Drawing on the discussion in chapter 3, a government's capacity to implement its decisions affects the types of decisions it takes (Jenkins, 1978).

As discussed in chapter 7, decisions made in the policy realm often stem from political and socio-economic interests that are aligned with internationalization instruments (e.g. international research cooperation). The two internationalization programs described in this thesis can be viewed as examples of the articulation of instruments to forge bilateral agreements for economic or scientific cooperation.

In addition, transcribed material from interviews with government officials indicates that the decisions leading to the formulation of government programs might be motivated by the need to take practical measures. Policy actors might also act in response to global trends; therefore the time frame to execute policy goals or the "right time to act" is a function of pragmatism and practicality. Policy actors might also act and implement a program in accordance with multiple policy goals. Such goals might include the fulfillment of the terms of existing bilateral agreements with selected countries.

8.2 The key actors

The Eco-Innovation Programs

There are differences and similarities between the two Eco-Innovation programs and the Transport Area of Advance initiative concerning actors and strategies employed. Regarding the Eco-Innovation Cooperation initiatives, the Ministries of Foreign Affairs, Environment and Enterprise and Innovation were involved at the macro level. Other participating actors at the meso level include agencies such as the Swedish Innovation Agency (VINNOVA) and the Swedish Energy Agency. These government agencies were tasked with the design and coordination of the programs, including preparing calls for proposals, reviewing grant applications, allocating funding and organizing 'kick off' workshops for the grant recipients. At the micro level, key participating actors include the funding recipients of the projects. These were professors, PhD students and post

docs across universities and research institutes, company owners and CEOs at SMEs, micro and large companies.

Based on interviews with government officers in Sweden, it is reasonable to conclude that the two Eco-Innovation Cooperation programs with Brazil and China originated in the 2011-2014 Swedish Strategy for Development and Export of Environmental Technology, or in the Swedish language, *Strategi för utveckling och export av miljöteknik.* Often these policy instruments, in the form of bilateral research cooperation with pre-determined thematic areas, originate in bilateral agreements between two countries for economic, scientific and political cooperation (Schwaag Serger and Wise, 2010).

The Strategy for Development and Environmental Technology differs from the policy initiative that identified the 20 key research areas to advance Sweden's science, technology and innovation development from which the Transport AoA originated. The policy document relating to the two environmental technology cooperation programs with Brazil and China is 13 pages long compared to the 2008-2012 Swedish Research and Innovation Bill which is 292 pages. The 2011-2014 Swedish Strategy for Development and Export of Environmental Technology contains general directives to government agencies. Table 10 displays the key actors involved in the three government-sponsored research cooperation programs and the policy documents from which these programs emerged.

The Transport Area of Advance program

Overall, government, businesses and research organizations have been influential in shaping the government-funded initiatives I describe. These include professors and senior researchers, PhD students and post-doctoral researchers. At the macro level, the main actors involved in the conceptualization of the Strategic Research Areas, one of the six policy initiatives in the 2008 and 2012 Swedish Research and Innovation Bill, were primarily the Ministers of Education and Research and the Minister of Finance. At the meso level, the Swedish Research Council was responsible for 10 out of the 20 research areas. The government agencies VINNOVA and FORMAS managed the assessment

and the evaluation processes while funding was allocated directly from the state to the universities. Other funders included the Swedish Energy Agency.

The Strategic Research Areas (SRA) emerged from the 2008 Government Bill, A Boost to Research and Innovation (prop. 2008/09:50) or in the Swedish language, *Strategiska forskningsområden - SFO* (Swedish Research Council, 2015). This policy initiative aimed to support 20 strategic research areas across 43 Swedish research institutions between 2010 and 2014. In total, 43 research environments across 11 host universities were funded with approximately 5270 million Swedish crowns (SEK) during 2010-2014. The funds went directly to the universities, which host the SRA-environments (Swedish Research Council, 2015 p. 7).

A steering group with representatives from the funding agencies served as intermediaries between the General Directors and the project group. The steering group was actively involved in the larger decision-making regarding the evaluation and in translating evaluation results into policy recommendations (Swedish Research Council, 2015). The development of the SRA initiative emerged as a government effort to improve universities' research capabilities in strategic areas of research. This objective was accomplished by building on the existing research strength of higher education institutions, increase cross-disciplinary research collaboration and improve conditions for commercialization (Swedish Research Council, 2015; Ministry of Education and Research, 2009).

The 2008 and 2012 Swedish Research and Innovation Bills comprise of six policy initiatives which relate to four policy areas: 1. *strengthening university research, 2. linking research and innovation, 3.addressing societal challenges and priorities and 4.strategies and governance.* I focus on the first policy area in the list - *strengthening university research* - as the Strategic Research Area (SRA) initiative emerged as an effort to achieve this goal through the allocation of funding to 20 strategic areas including transport. The 20 strategic research areas were selected based on inputs from the Swedish Research Council concerning the areas of strength in Swedish research (Ministry of Education and Research, 2009) while the final decision was made by the Ministry of Education and Research.

Three criteria were used in the selection of the 20 strategic research areas: a) Research that can contribute to finding solutions to important global problems and issues; b) Areas in which Sweden already carries out world-class research; c) Areas where companies in Sweden are carrying out their own research and development and where state investments reinforce the development and competitiveness of the business sector in Sweden (Ministry of Education and Research, 2009, p. 5)

Government funding for strategic research areas was channeled through universities in the case of the Transport Area of Advance program. Regarding the two Eco-Innovation Cooperation programs with China and Brazil, funding was channeled through universities, research institutes and businesses. Although companies may have indirectly benefited from the Strategic Research Area (SRA) initiative through university-industry partnerships, companies were not the primary focus of the SRA scheme.

Table 11 Main actors in the STI cooperation programs

	Chalmers Transport AoA	Sino-Swedish Eco-Innovation Cooperation	Sweden-Brazil Eco-Innovation Cooperation
Beneficiaries of government funding	Chalmers University and University of Gothenburg Transport – funding through the Strategic Research Area initiative	Universities, research institutes and industry as the main beneficiaries of government funding	Universities, research institutes and industry as the main beneficiaries of government funding
Policy documents	2008/09:50 Swedish Government proposition to foster research and innovation	2011-2014 Strategy for Development and Export of Environmental Technology	2011-2014 Strategy for Development and Export of Environmental Technology
Influential actors at macro level	Ministry of Education and Research, and within the Ministry of Finance, the Minister of Financial Markets and Consumer Affairs	Government offices: Ministry of the Environment, Ministry of Enterprise and Innovation and the Ministry of Foreign Affairs	Government offices: Ministry of the Environment, Ministry of Enterprise and Innovation and the Ministry of Foreign Affairs

Influential actors at meso level	VINNOVA, The Swedish Research Council (VR), The Swedish Research Council for Environment,Agricultural Sciences and Spatial Planning (Formas), The Swedish Energy Agency, the Swedish Agency for Innovation (VINNOVA) and the Swedish Research Council on Health, Working Life and Welfare (Forte).	VINNOVA and the Swedish Energy Agency	VINNOVA and the Swedish Energy Agency
Influential actors at micro level	Director and co-director of the Transport Area of Advance at Chalmers, senior professors engaged in the process of establishing the Areas of Advance	Grant recipients carrying out the research projects in Phases A and B of the program: principal investigators at universities, research institutes and businesses, company CEOs, business owners and company managers; project leaders across firms	Grant recipients carrying out the research projects in Phases A and B of the program: principal investigators at universities, research institutes and businesses, company CEOs, business owners and company managers; project leaders across firms

8.3 The P-A model and the STI programs

The rationales for promoting and engaging in science, technology and innovation initiatives are intrinsically connected to the modes of the governance of science, technology and innovation and the way institutions are set up. Institutions and actors, embedded in the broader institutional structure, form an interdependent relationship. Thus, factors compelling different group actors to act cannot be seen as an isolated phenomenon but as part of a larger institutional set up where individuals play distinct roles and perform different tasks and where actors interact.

In this section, I draw on two concepts: the principal-agent (Braun, 1993) and street-level bureaucrat (Lipsky, 1980) to show not only the different roles actors

play in research and innovation but also the changing relationships among actors. The principal agent relation model is useful because it has broad applications. In chapter 7, the concept was applied to explain how the perceived benefits of the principal-agent relation generate business-oriented behavior. This business-driven behavior encourages the continuing articulation of new STI cooperation programs. In this chapter, the principal-agent concept helps us gain insights into the triad relationship: government (principal), funding agency (dual role agent and principal) and university (agent). It also sheds light on the intentions of the actors who voluntarily join research cooperation programs through a triadic interaction.

The three-party relationship consisting of government actors, research organizations and businesses is embedded in the Swedish institutional set up and political structure characterized by the following: a quasi-decentralized model of governance, a funding-laden system and project-driven interests. Institutional set up refers to the political and administrative structures and the way in which the government is organized and how it relates to its agencies. For instance, in Sweden, the ministries are smaller in size with fewer employees and funding agencies are larger and autonomous. The findings from the empirical material lead me to conclude that the administrative structure of the government elicits a continuing response from funding agencies. This response occurs when funding agencies interpret policy directives that originate in the policy level of the government. This responsive behavior is in turn embedded in the government institutional structure where the ministries intervene less and refrain from implementing tasks. At the micro level, university researchers and companies are also receptive by responding to funding opportunities.

The active and continuing response to calls for proposals is a manifestation of an opportunity-driven and pragmatic behavior that, in the context of Sweden, is anchored in a funding-laden model where external funding plays a pivotal role in research governance. Based on the above claims, it is reasonable to argue that the pragmatic behavior of grant seekers prompts a response in government to continually promote project-driven programs. This kind of pragmatism and opportunity-driven behavior coupled with the funding-laden model that is deeply dependent on external funding might offer an explanation for the presence of the types of government-sponsored programs I describe in this thesis.

Furthermore, the same sponsors (funding agencies) have an audience (academic researchers) that is driven by funding opportunities. This audience responds to ongoing funding calls. It is possible that in other settings, where academic researchers are not as dependent on external funding, individuals would not be as proactive and diligent when seeking funding and embarking in the time-consuming task of preparing research grant applications. However, there are other forces shaping the formulation of these STI cooperation programs.

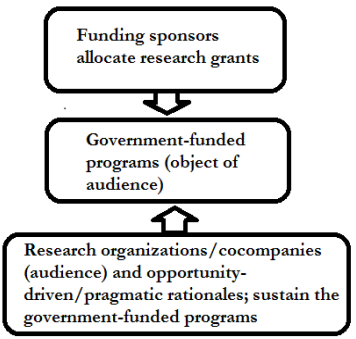


Figure 6
Interdependent relationship between actors (source: the author)

Figure 6 shows the interdependent relationship between cooperation program participants (audience/agent) and the programs (objects). The funding agencies (principal) launch calls for proposals. Actors respond to these calls based on pragmatism (the need to secure funding) and opportunity-driven behavior (the interest in pursuing business opportunities). The arrow (↑) indicates actors' response to funding opportunities. The audience or agent (e.g. academic researchers and other participants of research programs such as industry) sustains the programs by their continuing interests in and responses to grant opportunities. The very existence of these policy instruments is rooted in the presence of a constellation of actors that are receptive to the calls for proposals.

Furthermore, interviews with government officials across ministries and government agencies in Sweden suggest that the political structure influences the relationship between higher-level government and government agencies. This

influence is manifested in two ways: 1) it might affect the behavior of government officials and 2) it might introduce a degree of informality in ministry-government agency relation.

With regard to how funding agencies position themselves in relation to higher level offices, interviews with government officials suggest that funding agencies behave in a reactive manner, when they receive mandates from the government. This, of course, comes as no surprise given the political structure in the context of Sweden. Thus, funding agencies' officers respond to ministries' mandates for instance, rather than controlling the situation. At the same time, funding agencies in Sweden are autonomous entities and serve as implementing and expert agencies.

Funding agencies have a significant degree of autonomy; they make decisions regarding the allocation of research funding and the design of science, technology and innovation cooperation programs. However, their autonomy is not absolute; it is conditioned by their tasks and responsibilities, serving as the agent in relation to ministries (the principal). In other words, this autonomy is tied to policy directives articulated by higher government offices.

The government, represented by policy-makers, formulates policies and communicates policy intentions through Government Bills. Thus, higher government offices (principal) delegate some of their responsibilities to the government agencies (agent). The government employs the agencies' services to perform a number of tasks on the government's behalf. These responsibilities are not exclusive and they include the design and implementation of internationalization instruments. Other functions performed by funding agencies are the selection of grant applications, evaluation of government programs and expert advice.

Figure 7 also featured in chapter 6 illustrates the path of decision making from the policy or macro level where policies are articulated to the micro level where policies are translated into practice by research organizations. Figure 7 also shows how the roles of actors across different levels are related. Through the lenses of the principal-agent model, I demonstrate how the dynamic relationship across actor groups at the macro, meso and micro levels shape the decisions regarding the three government-sponsored research cooperation programs.

At the top level, ministries set the government budget, articulate public policies and decide on the direction of research and innovation policy. This is where policy-makers prepare policy documents and directives. These directives are then transmitted to the government agencies at the meso level of the government structure. The ministries at the macro level play the principal role by delegating funding and implementation responsibilities to government agencies. The government agencies are also referred to as the agent and as the intermediaries. Therefore, they connect higher government offices and research actors at the micro level.

Funding agencies play a dual role: they act as both agent and principal. They behave as agents when they interpret policy directives and carry out tasks on behalf of the government's interests (the principal). Coleman's (1990) claims that the agent is the actor who accepts the principal's resources and furthers the principal's interests. Coleman's interpretation helps us to gain a better understanding of the relationship between funding agencies and ministries in the Swedish context. In parallel, funding agencies behave as the principal in relation to university researchers through the design of different research cooperation instruments and allocation of funding, enabling researchers and companies to realize the funding agencies' interests.

Furthermore, the intermediary role funding agencies play serves several purposes. First, it enables the delegation of authority from principal to agent (Guston, 2001; Kassim and Menon, 2003; Dür and Elsig, 2011; Sobol, 2016) so agents have the power to act on the principal's behalf. For instance, it would be difficult for the principal to supervise the agent's tasks to know with certainty if the agent is carrying out the principal's interests. This would mean that the principal would have to manage the agent's functions closely but it is unlikely that enforcement would be feasible or if there is such need at all. Certainly this relation involves a minimum degree of trust between the participants. At the same time, it is important for the principal (government) not to be perceived as intervening in the agent's (university/companies) activities. Thus, governments are perceived as distant players in research funding and in the operationalization of STI cooperation programs. This is accomplished through the delegation of authority to the funding agencies; therefore reinforcing the funding agencies' role as intermediaries. This characterizes the quasi-centralized system of research governance discussed in chapter 6. Guston (2001) claims that this organizational relation involves a series of delegations of authority from principals to agents within and across organizations.

In addition, the work of intermediaries reduces potential problems with expectations not being met between principal (ministries) and agent (universities). To ensure that the principal's goals will be pursued further, the principal (government), through its intermediary agencies operating at the meso level, requires monitoring and reporting of government-sponsored programs. Thus, public funding grantees have a responsibility to prepare progress reports on their research projects and submit them to funding agencies who play the principal role in their relationship with universities (agents). Also, the funding agencies or intermediaries in their role as agents perform evaluations of the programs they create on behalf of the principal (government). The unique dual role of the intermediary agencies ensures that the government's goals are aligned with universities' practices on the ground and that mistrust is minimized and accountability is enhanced.

The principal-agent model is applicable to the field of research and innovation policy because it sheds light on fundamental questions of accountability and transparency in research, delegation of authority, the degree of autonomy of funding agencies and university researchers.

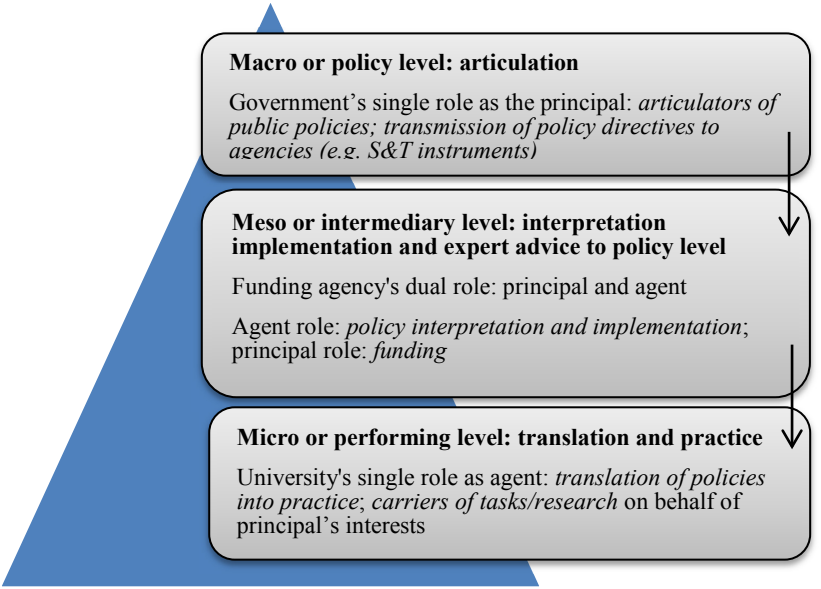


Figure 7 The path of decision making, actors' roles and interactions according to the institutional set up (Source: the author).

In summary, in a quasi-centralized mode of governance of science, technology and innovation as seen in Sweden, the government (principal) intervenes less; it forgoes some of its decisions and duties which it transfers to agencies (agent). In this transmission of tasks to the agencies (agent), the government (principal) forgoes some of its responsibilities by giving the agency (agent) a greater degree of autonomy (Braun, 1993). In this type of arrangement, the agency gives up its right to control its own actions to perform tasks on behalf of the principal (Braun, 1993). This principal-agent relationship is characterized by gains and losses (Braun, 1993). This interaction is also based on the expectation of mutual benefits and incentives; the expectation and the acceptance that a number of tasks will be performed. At the macro level, these tasks involve making decisions about policy instruments, preparing the budget and delegating tasks to government agencies. At the meso level, the expected responsibilities include the allocation of funding and the appropriate administration of resources and programs (funding agencies or agent) and to provide expert advice to ministries. At the micro level, expectations to perform and to deliver results are under the responsibility of researchers at universities and research institutes. The cycle of expectations is completed, when the funding that researchers receive is used as a mechanism to address policy intentions and to meet expectations at macro and meso levels.

Moreover, the notion of discretion I draw from the street-level bureaucracy concept is useful in this context because it might provide insights into the power dynamics, roles and behavior across government branches. The concept aids in the understanding of the degree of autonomy and power of funding agencies. I contend that the freedom and discretion of funding agencies' officers should not be viewed as absolute because these individuals are constrained by a number of factors over which they do not have control. In the real world of politics, the degree of power and discretion that actors in government agencies might believe they have can be limited at times.

8.4 Freedom to implement with trade-offs

The government officials interviewed expressed mixed views about the current system of governance of science, technology and innovation. In addition, respondents mentioned decision making about internationalization and the freedom to implement. On the one hand, the Swedish Government takes a

"hands-off" approach with no direct control over the administrative tasks of government agencies. On the other hand, it has a degree of influence, directing government agencies in the development of policy instruments to promote internationalization of science, technology and innovation. This quasi-centralized governance of science, technology and innovation policy instruments suggests possible trade-offs that might originate in this form of arrangement.

According to the officers across funding agencies and ministries, at the same time that this governance approach gives agencies autonomy regarding funding allocation, the choice of innovation and internationalization strategies and autonomy to design cooperation programs, it also suggests an ad hoc mode of operation. In this case, too much autonomy and leeway is perceived as "loose thinking", and "loose direction." The "loose direction" is not necessarily viewed as a negative factor but it is a symptom of the political structure and the relationship between the government and its agencies. Also, centralization and control seem less likely to interfere with the implementation of policies when ministries are restricted and do not have the power to interfere with agencies' decisions on policy instruments such as STI cooperation programs.

The following three statements by government officials (FORMAS, VINNOVA and former state secretary of education and research) illustrate different views on the government-funding agency relation and their role in shaping the policy-making process. Implicit in this ministry-funding agency arrangement are compromises achieved between desirable but incompatible modes of governance. For instance, a greater degree of direction from higher level government offices to funding agencies might be desired by all or some agencies. More direction could be interpreted by funding agencies' officials as less degree of freedom. It appears that the two parties strive for a compromise. But it might also mean that an arrangement that eliminates trade-offs might not be possible in this context.

> The Swedish government produced an internalization strategy some years ago and it also points more to overarching goals but it is not really…I mean this is typical Swedish way I think, that the government and the ministries they do not point in details to the agencies what they should do, they point to a general direction and then it is up to us to implement it in a way that we think that is the best. This is the Swedish system that the ministries do not dictate and exactly tell us what we should do and I think this is a very good thing. On the other hand, sometimes it could be easier for us if the Swedish Government pointed more

> clearly into certain directions. But on the other hand this is difficult because the expertise is really with the agencies, ah, because we also want a *degree of freedom* in our agencies, so in a way it is good that the government has this loose direction (Official[25], Swedish funding agency, May 16, 2016).

The internationalization strategy the FORMAS employee refers to in the above statement is the 2008 Government Policy for International Strategy, part of the Swedish research policy by the Ministry of Education. In Sweden, this was the first expression of a strategy on internationalization although international programs had been established prior to this strategy. These strategies and programs have been vaguely formulated and loosely related to an overall plan or purpose of internationalization of science, technology and innovation (STI). This means that there is an opportunity for meso level organizations such as funding agencies to play a role in shaping internationalization of STI.

The 2008 Government Policy for International Strategy outlines the direction and content of the internationalization of STI in the context of Sweden, in rather broad and sweeping terms:

> The political and economic developments in Asia, mainly China and India, mean that a global paradigm shift is imminent. The knowledge we have about the complexity of global development issues, such as policy for global development is based on developments in the international research system. The realization that developments outside our national borders increasingly affect us and that problems linked to this cannot be solely solved through national measures and it requires us to have to seek consensus and cooperation internationally […] there is a correlation between the internationalization of research and the need for an internationally based knowledge development / management of the areas we have formulated as global challenges. To successfully manage this development requires a policy that focuses on national positioning in a global system, and this system must operate in the best possible way. In order to achieve this objective, it is necessary to have a research policy that supports international and regional issues in collaboration with foreign policy… (Swedish Ministry of Education, p. 6).

[25] Same respondent as interview no. 8

Such broad articulations of internationalization strategies by the government are formulated, by Government Offices, in the form of directives or appropriations. These directives are then transmitted to government agencies and as precondition for the agency's operationalization tasks along with how much money the agency should allocate between different activities and programs. These documents contain general administrative instructions on how the government agencies will perform. The following examples highlight how roles are perceived within the government: government agencies interpret and carry out policies and government offices articulate policies.

> Sweden has a specific history and agencies have the freedom to implement policy. Traditionally the government has not told exactly what VINNOVA and other agencies should do and it is up to the agencies to achieve those goals. The government will not say exactly, you have to now spend X million SEK in cooperation with China. We have these bilateral agreements. That is how it works in Sweden; they don't get involved into the details. VINNOVA has to decide. For example they identify companies' needs to cooperate with Brazil and they have a program on that. There are exceptions. In the last research bills, the government allocated money to attract researchers from outside Sweden. The Swedish Research Council got the task to implement this task. Money ear marked; they have to set up a program to attract researchers to Sweden (Official[26], Swedish funding agency, January 28, 2015).

> […] The thinking is that it is up to the universities to decide; you have a number of agencies that have some control function but primarily their function is to support with financing. The government's role is on a more overall level to give general guidelines but not going into details and certainly not handling individual cases which is common in other countries […] going back in the history of Sweden because we had division between government that this way of working with more objective directives not independent but semi-independent and government agencies that have the role of carrying out policies. That has been for a long time the situation in Sweden and that means ministries in Sweden are small and instead we have these agencies. Going back in history that is the same with all political areas. Especially when it comes to higher education and universities, we feel that universities should have more independence regarding the government and also some of the government agencies, so that is why both government and the government agencies have a relatively small

[26] Same respondent as interview no. 6.

> controlling function or steering function than in other countries. Relatively high degree of independence for the universities themselves (Former State Secretary of Education and Research, May 12 2016). (Interview no. 23).

Informal modes of communication between ministries and government agencies are features of the political structure and institutional set up in Sweden.

> […] We have very small ministries and large, autonomous agencies like VINNOVA and that goes for all policy areas. So, what we have is small ministries and by law they are not allowed to interfere with how we conduct our affairs. I mean we get a letter of assignment each year, we get the budget, we have some things we should do and basically after that they are not allowed to have, then they can give us new government assignments but they are not allowed to interfere with how we spend that money. It is really up to us to interpret and deliver on this. This is of course the stylized version of how this works. We have a close dialogue with the ministry and we have information flow going back and forth. For instance, just recently we provided input to the next research and innovation bill and there we really propose you should boost the strategic innovation program, you should start a new program on mobility, etc. This is now processed inside the government offices but then we are involved informally, giving more advice etc and then when we get the assignment back, whatever they choose to do on this … level, they really say you should develop a program for national mobility and that is basically information we get. You have 100 million each year for four years, do it. Then it is up to us. And I would say our budget is not earmarked that way. We **…** what is said about strategic innovation programs, that is 50 million Euros a year, and it says you should do something here, it should be collaboration with industry, etc. , one page. So, it is really not that detailed structuring. In many other countries you really develop a program inside the ministries and then it is handed to the agencies and then they set up the administrative procedures and administer but we are involved much further. We are expected to have the knowledge of the system in order to develop the programs. That is where we differ. (Official[27], Funding agency, November 11, 2015).

The role of the funding agencies such as VINNOVA is constantly being shaped by ideas and ideals about the direction of Sweden's research and innovation system, including the country's international reputation and Sweden's role as a

[27] Same respondent as interview no. 10.

global innovation leader. This role is evolving and being constructed according to responses to global challenges, domestic needs and the relationship between funding agencies and the carriers of policy intentions which are the universities and companies. These pressures are evident in the constitution of activities within VINNOVA, demonstrated through the following examples:

> For VINNOVA I think it is very important to find this role where we can really help and strengthen the perception of Sweden as an innovative country. I think that is actually where we do the most benefit. Because I think it is really about putting forward and strengthening the image of Sweden as an innovative country. I think this is where we can really do the most, have the greatest impact (Official[28], Swedish funding agency, November 11 2015).

> [There] are lots of environmental technology […] companies that have techniques that lead to more sustainable society in Sweden but they are small, not strong players, so what they want to do is they started this effort some time ago to get them visible to the outside world - most of them selling in Europe – to get them out in the international market. So the BRICS countries have lots of environmental problems that are growing fast, pace of growth, and environmental aspects are put in low priority. Then you have problems with sanitation. So the idea was that this kind of R&D cooperation will benefit Swedish companies about knowledge of these countries and their conditions. We will run international cooperation with those areas. We started with China and Brazil but we realized that we have less reason now to have them as separate programs (Official[29], funding agency, May 6th, 2014).

8.5 Decision making at the "Street Level"

In this section, I draw on Lipsky's Street level Bureaucracy (1980) concept to demonstrate that through their autonomy, daily practices and relationship with principal and the citizens they serve, street level bureaucrats shape public policy.

[28] Same respondent as interview no. 10.

[29] Same respondent as interview no. 4.

Overall, it might be considered more glamorous to examine the macro or global levels in reference to research and innovation policy. However, a closer look at what takes place at the implementation level and at the daily practices of research governing deserves our attention for a number of reasons. The first reason is that reflections on research policy-making concerning research collaboration at the meso and micro levels are scarce. Exceptions are studies by Melin (2000); Katz and Martin (1997) on micro level research collaboration and definition of research cooperation; Howells (2006) on the role of intermediaries in the innovation process; Braun (1993) who argues that the role of intermediaries is underestimated in public research. Second, the details about policy formulation and the factors that shape decisions about internationalization mechanisms such as international STI cooperation programs are not easily obtained from government documents, official websites or textbooks. Finally, to better understand the research and innovation policy process and underlying political intentions requires the recreation of the events that have given origin to the translation of intentions into practice. The purpose is to highlight the personal beliefs, political intentions, institutional structures, roles and factors that shape the research and innovation policy landscape.

The actions and intentions of actors at micro and meso levels contribute to the policy formulation and implementation processes through their actions and participation. Public policy as defined by Jenkins (1978) is a set of interrelated decisions taken by a political actor regarding the selection of goals and the means of achieving these goals. In this definition, it is assumed that the political actors making policy decisions also have the power to achieve these objectives.

Street-level bureaucrats are the front-line employees of the new public administration (Hupe et al. 2016; Hupe, 2014; Hupe and Buffat, 2013; Brodkin, 2008; Hupe and Hill, 2007; Hill, 2003). They play a role in public policy; they are policy-makers in the sense that they informally shape their organizations' policies (Brodkin, 1990). They also influence the lives, networks and projects of the citizens (e.g. universities, research institutes and companies) to whom they provide service. In the context of this study, the service that street-level officials provide entail, among other functions, the allocation of funding and the administrative support in the form of operationalization of programs. Both types of services are provided by funding agencies. Funding agencies play a role as *intermediaries* between the government (principal) and third party research institutions and industry (agents). But they also have a *dual role* when they function as the agent in relation to the government and as the

principal in relation to their funding recipients. Because of their intermediary role, this thesis refers to the officials at funding agencies as the street-level bureaucrats or front-line government officials. I acknowledge this characterization of street level bureaucrat differs from Lipsky's concerning the tasks and roles Swedish funding agencies. In this study, I make clear that innovation agencies such as VINNOVA serve as expert advisers to the government and do not only play an implementing role. They can also influence policy which might differ from the street-level bureaucrats discussed in Lipsky's work.

Furthermore, front-line government officials do not just act in conformity with pre-established norms or policy protocols; they perform their tasks according to what is feasible and the resources available to them. In many instances, practicality is a function of their resource and administrative capabilities. They are not only tasked with implementing public policy; they shape it as front-line government officials who deliver services to the public and to the government. They also engage in dialogues with government agencies in the countries in which they have a vested interest as shown in the dialogue between the Brazilian Innovation Agency (FINEP) which supports science and the Swedish Innovation Agency, VINNOVA.

In the context of science, technology and innovation, the operationalization of tasks involves decisions on program design, the selection of grant applications, the allocation of research funding, the organization of information sessions and workshops and communication with grant recipients. These tasks are performed to provide information to grantees or potential applicants on the types of grants or application processes, to address questions or resolve unforeseen problems. These government agencies also bridge interests, by serving as intermediaries between researchers and users, playing an important role in providing opportunities for potential research partners to meet, in promoting the utilization of research results and in providing ways for researchers to disseminate their knowledge (e.g. through international scientific linkages).

In addition to the above-mentioned functions, services provided to the government by front-line government officials consist of policy implementation and expert advice. In the context of Sweden, it is not uncommon that the government commissions funding agencies to not only provide expert advice but also to provide recommendations and to perform program evaluations.

Moreover, scholarly work by Lispky (1980), May and Winter (2007) and others (Brewer, 2005; Winter, 2003; Langbein, 2000; Keiser and Soss, 1998) examine the disjunction between the actions at the frontline of policy decision making with the original intentions of policies. The following interview passage suggests that sometimes dissonance between the intentions of policy-makers and the actions at the front-line of policies might occur. The statement by the former state secretary of education and research indicates that mismatches concerning policy intentions at macro and micro levels exist and they are acknowledged. The interview account also indicates that the policy world consists of inconsistencies and that policy practices are never linear and straightforward. Paradoxically, this mismatch emerges from the political aim to encourage autonomy and independence in universities in the first place.

> […] there are different types of challenges. One is internally of Sweden. On [the one hand] there is the interest of the Swedish academic community. I mean, it is possible for the government to feel that it would be important to develop closer links in research and higher education with some of the fast developing countries in the world but that does not necessarily mean that there is an interest from the academic community. So, that would be one of the challenges, trying to match what could be the governments' perspectives with the perspectives of the academic community. And one of the ways to foster that interest is finance. Finance is important for the academic community […] (Former[30] State Secretary of Education and Research, May 12, 2016).

> […] Specially when it comes to higher education and universities we feel that universities should have more independence regarding the government and also some of the government agencies so that is why both government and the government agencies have a relatively small controlling function or steering function than in other countries - relatively high degree of independence for the universities themselves (Former State Secretary of Sweden, May 12, 2016).

In summary, the services and intentions of the front-line government officials (funding agencies) to the principal (ministries) and to the agent (research organizations/companies) are molded by a system of micro and macro level

[30] Same respondent as interview no. 23.

activities/practices and policies/directives within organizations. Therefore, in spite of the great degree of autonomy of street-level professionals - in the Swedish context represented by government officials at funding agencies - these individuals are held accountable for their actions.

The political structure and the actors who are part of this structure shape the trajectories of research, technology development and innovation and the overall internationalization goals. Aside from government structures, other factors play a role in policy outcomes, in the prioritization of research areas and in the composition of research cooperation programs. These other factors are examined below.

8.6 The formulation of STI cooperation programs

The Eco-Innovation Cooperation Programs

This thesis takes into account that a constellation of individuals and different elements shape policy outcomes. For the purpose of simplification, this thesis lays out some of the factors that might influence decision making processes from the most conspicuous to the less visible in that order: domestic pressures and international trends, economic interests (e.g. trade agreements), fulfillment and alignment of policy goals, desire to experiment with new programs, pragmatic and practical implementation styles. It is beyond the scope of this thesis to examine all factors that might influence decision making policy. Thus, this thesis looks at the elements that, in my view, have the potential to generate the most stimulating debate within the field of research and innovation policy. These include multiple goal fulfillment, practical and pragmatic approaches to implementation and policy experimentation. This analysis is an opportunity to take a closer look at the factors influencing policy outcomes and implementation strategies and styles. These outcomes are represented here by the specific STI cooperation initiatives.

In order to show how specific government-funded research cooperation programs have evolved from a political intention or an idea into practice, this thesis first explains why the rational choice concept is not useful in this context.

Although the "principal acts rationally based on a coherent set of preferences" (Miller, 2005, p.206), political actors' decisions are not always based on rational choices. In line with Camerer and Fehr's argument (2006), I contend that the bounded rationality approach provides a better explanation to factors influencing decision making than more traditional behavior economic concepts.

The bounded rationality concept described in chapter 3, helps us understand policy decisions that relate to broader goals which are illustrated through the two Eco-Innovation Cooperation programs. I argue that in broader decision making circumstances, policy actors at the meso level (funding agencies) are decisive, serving as intermediaries between policy articulation which takes place at the ministry level and the practice of policies which takes place at the meso and micro levels. In this distinctive role, intermediaries such as officials in funding agencies, who are also the government workers at the front line of policy implementation, produce actions that conform not only to their preferences and vision of the world but also actions that conform to government Bills and political contracts.

Most importantly, rather than taking a pessimistic view, I argue that there are advantages in aligning with policies or in "satisficing" because such behaviors help organizations and policy actors in these organizations to act within complex and policy decision-making processes. Thus, Simon's concept of satisficing can be used to describe individual behavior that seeks results that are "good enough" rather than optimal (Peters, 2002). Naturally, this explanation of satisficing should not be viewed as too simplistic or minimalist given that finding policy solutions that are "good enough" can be demanding and can be considered rational from the perspective of minimizing costs (Peters, 2002). This policy implementation strategy reduces lengthy decision-making processes and avoids tensions or conflicts in the policy process.

The bounded rationality model is useful when considering, for instance, the way in which intentions are put into practice in the context of poorly defined and broad policy goals and in the context of an organized chaos. In this organized political disorder, differences of opinions exist and the need for more synergy and coordination among government agencies has also emerged from conversations with government officials. Contrasting political goals and ways of working are acknowledged and often accepted among policy-makers and

solutions are sought. The design of the International Eco-Innovation Cooperation (ICE) programs with China and Brazil reflects the broader decision-making setting. Based on the findings from the empirical material, it is reasonable to argue that the formulation of the two programs is rooted not in a linear process, orderly organized and rationally-driven in the traditional sense of policy decision making and implementation (Roberts and King, 1991; Kingdon, 1995) but it falls outside the confines of rational behavior. This thesis does not evaluate the implementation strategy employed. My argument is that rationality is not necessarily useful or optimal in decision making; the execution of a political will might entail the search for practical solutions.

The decision to develop the two environmental technology-oriented initiatives with Brazil and China are a result of the interplay of three main factors : 1. *meso-level policy experimentation* through the launching of two pilot STI cooperation programs; 2. *practical and pragmatic approaches to policy decision* through the *fulfillment of existing agreements* with Brazil and China; 3. *policy alignment* through the 2011-2014 Strategy for Development and Export of Environmental Technology. These factors influenced the decision to develop the two Eco-Innovation Cooperation programs. The next paragraphs discuss the three factors shaping the design of the government-sponsored research cooperation programs: policy experimentation at meso level, practical and pragmatic styles in policy-making and policy alignment.

8.6.1 Policy experimentation: launching pilot initiatives

According to Schwaag Serger and Wise (2010), nowadays, government agencies in Finland, Germany and Sweden are experimenting with new instruments. These instruments include business innovation centers in emerging markets. New approaches to bilateral cooperation in science, technology and innovation are also being implemented such as '2+2' initiatives where cooperation is based on projects involving the participation of industry and academia from two countries.

Policy experimentation, as described in chapter 3 can have different meanings. One view is that new policies are created and adopted to address perceived government problems (Teets, 2015). Decisions to launch new government initiatives can also be spatial and temporal. Experimenting with new ideas in

policy depends on actors that can be persuasive and advocate for solutions to particular issues, taking advantage of a window of opportunities (Sabatier and Weible, 2014). When opportunities emerge, policy entrepreneurs must immediately initiate action (Sabatier and Weible, 2014). Thus, 'policy windows' are defined by Kingdon (1995) as opportunities for advocates to push their preferred solutions to an issue.

Policy windows define the context within which the decisions about the innovation programs took place. In the context of the two Eco-Innovation Cooperation programs, the opportunity is represented by the existing ties with China and Brazil that were created to fulfill the Swedish Environmental Technology Strategy.

An interview with a government official from a Swedish funding agency suggests that the design of new STI cooperation initiatives represents a choice the Swedish Government makes to utilize new strategies to internationalization instead of building on existing partnerships or models. Based on my own interpretation of the following interview account, I contend that when new policy instruments are continually being formulated, there seems to be more action but less of a clear vision regarding strategies that foster internationalization of science, technology and innovation. Perhaps there is also a missed opportunity to incorporate these into the government's strategies and action plan for internationalization because the process of continually establishing new initiatives might lead to inconsistency and less value creation in the long-term. In terms of overall benefit and optimization, it might be difficult to maintain a consistent plan of action for internationalization if new initiatives are constantly being established without a clear plan and purpose.

> The government chooses, through its administrative agencies such as VINNOVA, to design new initiatives from the very beginning rather than building on old frameworks or templates" (Government official, Swedish funding agency, April 12, 2016). (Interview no. 24).

Based on the empirical data, one perspective is that the idea to launch the Eco-Innovation Cooperation initiatives did not emerge from a purposeful and coordinated policy process where policy outcomes might be mainstreamed, institutionalized and adopted and even standardized across different organizations.

In the context of the two Eco-Innovation Cooperation programs, government officials at the Swedish Funding Agency played a key role in the formulation of the two new programs. However, the intentions that led to the establishment of the initiatives were coupled with *policy alignment* partially grounded on the need to meet political, scientific and economic goals and the *practical and pragmatic approaches to policy*. I define pragmatism in this context as an action based on practical and feasible options rather than theoretical formulations. From the perspective of the funding agency, this was an opportunity to experiment with a new idea: to design a project-driven STI cooperation instrument.

According to the statement by a VINNOVA official (see below), I interpret the decision to establish the two international environmental-technology programs as not accidental choices. One perspective is that the two programs represented an opportunity to fulfill a broad range of goals including political, economic and scientific. This finding is confirmed by Schwaag Serger and Wise (2010, p. 17) who argue that "the current internationalization activities of innovation agencies include both so called 'top down' and 'bottom up' initiatives. Top down initiatives are … bilateral research programs in which two countries agree upon a thematic area for cooperation.... These initiatives often originate in bilateral agreements between two countries for economic, scientific or political cooperation." The authors argue that the combination of top down and bottom up strategies might be explained by differences among countries concerning their preferred mode of cooperation. For instance, in many Asian countries, official bilateral agreements and programs are the main channel for cooperation (Schwaag Serger and Wise, 2010).

Also, the collaboration enabled participants to enter into research agreements and activities with their domestic and foreign counterparts. Based on the statement by the government official, it is possible to conclude that the country choice – China and Brazil - was convenient, timely and opportune. The selection of Brazil and China as participating countries in the Eco-Innovation Cooperation programs can partially be explained by the existing bilateral agreements with these countries. In addition, the decision to establish innovation cooperation with Brazil and China was grounded on research partnerships and networks that had been pre-established in these countries.

> […] we wanted to try something in a more programmatic form […] In terms of Brazil, that was one area that was on the table, to try something in terms of the programs […] We did not say China or Brazil but since we had the agreements, we had done some work with them, we had contacts in those countries, we said let's do something there […] And we also said this is an excellent way of trying out this collaborative approach (Government official[31], November 11, 2015).

The above statement helps us understand how the two Eco-Innovation Cooperation programs emerged. The statement illustrates the interplay between the intention to experiment with new ideas – *"…this is an excellent way to try out this collaborative approach"* - and to act in a pragmatic manner as a political strategy or approach to decision making – *"… since we had the agreements, we had done some work with them, we had contact with those countries."*

Governance is about interdependence, linkages, networks, partnerships (Mothe, 2001). Modern governance is also about coming to terms with unstructured and random decision making processes, dealing with changes and complexities. Thus, the state as the facilitator or the organizer (Ahrne, 1998) deals with complexities by developing new programs. It accomplishes this task through implementing agencies, in the case of Sweden, responsible for interpreting policy directives and for turning ideas or intentions into practice. These can be short-term scientific cooperation programs that originate in pragmatic decisions to address historically weak science and technology linkages with Asian countries, for instance, or to satisfy the terms of existing bilateral agreements.

In summary, incentives to pursue a new idea and launch a program that might originate from government directives and from the need to meet the terms of bilateral agreements and broader policy goals might lead to short-term and suboptimal outcomes. These well-meaning intentions might result in STI cooperation that is unsubstantiated, unsustainable and short-lived.

8.6.2 The practical side of decision making

The planning and design of the Eco-Innovation Cooperation program with Brazil in particular coincided with the Swedish Government's launching of the

[31] Same respondent as interview no. 10.

Environmental Technology Strategy, according to a Swedish Agency official (interview, November 11, 2015). One goal of the Swedish Environmental Technology Strategy was to forge S&T cooperation with emerging economies. When asked to describe the two Eco-Innovation Cooperation programs, the government official explained how the two initiatives emerged.

> In that case we had the bilateral agreements with China and Brazil. With China we had done some things with material science and we tried other things but we wanted to try something in a more programmatic form. In terms of Brazil, that was one area that was on the table, to try something in terms of the programs. That coincided with the Swedish government issue of the Environmental Technology Strategy where we were one of the appointed authority agencies and one part of that strategy was to develop cooperation with emerging economies. We did not say China or Brazil but since we had the agreements, we had some work with them, we had contacts in those countries we said let's do something there, and then we can just tick in the boxes of fulfilling the agreements but also doing things that we needed to do inside this new strategy. And we also said this is an excellent way of trying out this collaborative approach. So, it was basically those three things that coincided (Government official[32], Swedish funding agency, November 11, 2015).

> …When you have these agencies like ours, it is almost easier then you can tick the box and can say yes, we spent 10 million on China. Yes, then it is done, then the other stuff is more difficult, opening up trade, or research or mobility or joint standard which is probably more powerful for technology development than actually individual research projects but it is a lot harder and harder to claim. It is not a ribbon you can cut, here we inaugurate our joint testing facility… but it has more systemic effects. So, that is why it is not always beneficial to have an agency with a lot of funding because then it is easy to just say we have done it, we can take it off our conscious. (Government official[33], Swedish funding agency, April 12, 2016).

The above claims suggest that decisions to target specific countries partially emerged as a response to the need to fulfill broader policy objectives. In this context, practical solutions to political issues were the focus. This practical approach to the implementation of decisions and program design is informed by

[32] Same respondent as interview no. 10.

[33] Same respondent as interview no. 24.

the need to be pragmatic and to accomplish goals in a timely manner. In addition, the two programs represented opportunities. The interpretations of the statements made by the interview subject are anchored in the notion of bounded rationality described in chapter 3. Through the lenses of bounded rationality, policy decision-making in the public sector reflects an almost accidental junction of problems, solutions, intentions, opportunities and actors. Thus, "the rationalistic conception of problems searching for solutions and actors pursuing their interests in a purposive manner is replaced by decision-making that may be dominated by the appearance of opportunities" (Peters, 2002, p. 13).

Furthermore, the above claims by the government official suggest that the decision to create the two eco-innovation programs aimed to fulfill existing agreements with both China and Brazil. Thus, the selection of Brazil and China for the Eco-Innovation Cooperation (ICE) programs represented the best possible choice available. This set of "coincidences" and conveniences seemed to benefit both parties and characterized the choice of partner countries for the eco-innovation programs.

These findings suggest that specific internationalization strategies are absent in Sweden and in other European countries, and instead, decisions are contingent on a variety of factors, including political goals, the fulfillment of government mandates or to meet pre-established bilateral agreements with specific countries. This finding is confirmed by Boekholt et al. (2009) who argued that a comprehensive government wide strategy for international cooperation in science, technology and innovation is an exception. In addition, this finding is confirmed by the 2010 TAFTIE survey. The survey "shows that at the national level, only two of the TAFTIE member countries surveyed, Finland and Ireland had an overall international science, technology and/or innovation strategy (Schwaag Serger and Wise, 2010).

Finally, as I have argued earlier, "pure" rationality is rarely something that plays a role in public policy. Instead, decision-makers choose an alternative that will satisfy the minimum requirements to achieve a purpose – a process known as *satisficing*. In this context, the decision to create the two Eco-Innovation programs addressed the following political goals: it satisfied existing bilateral agreements, it fulfilled the terms of a national strategy and it provided opportunities for local policy experimentation.

In summary, the design of the Eco-Innovation Cooperation programs with Brazil and China fulfilled four purposes. First, it satisfied the terms of the existing bilateral agreements with China and Brazil. At the same time, the selection of partner countries aligned VINNOVA's innovation mandate with the Swedish Government's interest in forging relations with emerging markets in the area of environmental technology. Second, the launching of the Eco-Innovation Cooperation programs can be viewed as a type of policy experiment. In brief, the idea applied to this specific political realm offered a clearer and pragmatic policy solution for resolving the question of *multi-goal fulfillment* in which existing bilateral agreements with Brazil and China helped fulfill broader environmental technology goals. The two international programs were launched as targeted STI cooperation instruments to help facilitate Sweden's innovation goals (e.g. boost industrial growth, promote domestic technology abroad and augment Sweden's competitiveness; therefore, provided an opportunity for aligning policy goals.

Third, the two programs might have been viewed as better choices, effectively framed as the solution in the fulfillment of different policy objectives (e.g. to promote innovation, to further international relations purposes and to boost industry). Finally, the two Eco-Innovation programs can be seen as targeted interventions with specific goals. Such targeted instruments with often "mission-oriented" interventions complement regulatory measures such as IPR agreements or environmental agreements and complement scientific mobility measures that might not work properly (Schwaag Serger and Remoe, 2012). Thus, specific targeted instruments such at the Eco-Innovation Cooperation initiatives also have a complementary purpose.

8.6.3 Ad hoc policy making

As I have discussed earlier, a number of research cooperation programs that funding agencies design and sponsor originate from directives formulated and articulated at the ministry level. This means that when ministries decide to focus on a particular country – by the articulation of a political will – the government agencies respond to the policy directives and design programs accordingly. However, government agencies also exercise a significant degree of freedom and power to allocate funding to research projects and to design programs that meet different purposes. Although decisions may seem to be top-down regarding international STI cooperation and internationalization programs, government

agencies do not merely respond to ministries' directives; they develop their own ideas and also serve as expert agencies in policy processes. However, according to interviews conducted with government officials, it might be reasonable to conclude that ideas and strategies about which countries are most relevant to the overall internationalization goals are fragmented. One respondent described the relationship between ministries and government agencies and the unsystematic approach to internationalization. This random tendency in policy decision-making is reflected in the following statement by a government official.

> And then you have this, like I say, a lot of our international programs, I would argue, come from a direct declaration of will from the ministry. So, you know, they say we need to do something in China, and then we [do it]. So, someone articulates the will, you know what I am saying; we need to be doing something in Uruguay or we need to be doing something in Malaysia. And then you have these powerful agencies like VINNOVA going into overdrive. We go overboard when we design these programs; we allocate funding and we interpret to the wildest imagination of what that could be, but so it is this process. We don't even get a written thing. Often someone just says the minister just came back from Thailand and we need to do something. And then you start this little process. Then we would say, "well, we don't have any money for Thailand, if you want to give us money for Thailand maybe we will do something in Thailand." And then they might say: "Well, we can't give you any money but you need to do something in Thailand." And then it is up to our good will or either we just do a few show case projects, you know, and we fund some companies to go and show their research in Thailand or we actually do programs. We have a lot of leeway […] And also it seems that the government is not sure if it wants to drive the system or not. It is two steps forward and one step back. [And] all of a sudden telling you to do something with Brazil, and then the next time telling you to do something with Brazil on sustainable cities and then the next minute, "oh, I did not mean that." That is how it is. (Government official[34], Swedish funding agency, April 12, 2016).

The ad hoc approach to internationalization, reflected in the above interview passage has side effects of unintended consequences. First, this noted oscillation of ideas and random behavior in policy making drives grant seekers' behavior. One reason is that researchers continually search for funding opportunities and they become receptive to such opportunities, regardless of the country choice.

[34] Same respondent as in interview no. 24.

Thus, grant applicants will follow grant opportunities when these become available. It is reasonable to argue that geographic location might be of no consequence to grant seekers.

Second, this oscillation of ideas and random behavior in the public setting might reproduce unsystematic processes in internationalization. For instance, at times, higher level government officials abstain from intervening and adopt a "hands-off" approach to internationalization. In other instances, the same individuals wish to intervene but they appear uncertain about how to spearhead this process. The risk is that portions of internationalization will be fragmented and unplanned compromising its outcomes. Third, at the same time that there is randomness in policy decisions, this process is dependent on policy actors who intend to turn their ideas or intentions into practice. The above statement also shows that internationalization does not emerge spontaneously; it is constructed and it is dependent on different actor constellations. This is mostly seen in the broad STI cooperation paradigm (Boekholt, et al. 2009) where STI cooperation becomes a means to achieve other policy goals (e.g. improve national competitiveness, tackle societal challenges, forge stable diplomatic relations).

Moreover, the steps that define policy processes described above reflect the political structure in Sweden and the often convoluted and informal practice of internationalization in policy making. It means that internationalization is a multi-actor practice enabled by the decisions of actors across the three levels of the institutional set up. For instance, political leaders in the government make decisions about how Sweden will become more internationally competitive. Some of these decisions affect national programs such as the funding and focus on thematic research areas or forging ties with specific countries that are of strategic importance to Sweden. Therefore, internationalization is continuously being steered by actors and policy processes. Here is the contradiction and, that is, in spite of efforts to steer internationalization activities in certain direction, its purpose might be vague and might lack direction.

The above interview passage suggests that random behavior may be present in policy processes and it can drive political behavior. In addition, shifts in political decisions and behavior transform science and technology cooperation among countries into irregular processes. Empirical data, although limited, indicates that the markedly randomness at the policy level stems from a lack of vision and understanding of the role of internationalization in general.

Randomness and the oscillation of ideas in both the way internationalization is practiced and understood at the policy level, as an "add on" activity is pervasive within internationalization processes and activities. A government official stated:

> And it would be good if international collaboration would be integrated with everyday work but sometimes it counts as an add on…So, I think to really achieve better integration and a better use of international collaboration it would be necessary with more people working with it…(Government official, Swedish Ministry, May 26,2015). (Interview no. 25).

The "*more people working with it*" the employee refers to means insufficient number of staff working on internationalization issues in government agencies, particularly ministries. As discussed in Chapter 6, this is related to the political structure in Sweden which in turn defines internationalization practices and processes.

Finally, in theory, decision making is regarded as a conscious awareness of an issue. The search for solutions to a problem emerges from this conscious awareness of the existence of a problem. However, in practice, policy making rarely follows a formal and linear model due to variations in decision-making processes as illustrated in the above examples. The two Eco-Innovation Cooperation initiatives appear to have emerged from a more informal process in which the most probable and satisfying ideas prevailed. The examples above highlight the imperfections and inconsistencies engrained in the system. The narratives suggest that decision-making and problem solving are complex endeavors under the influence of a number of factors. These factors include social and political agendas, policy actors' own ideas and interests and, finally, the political structure manifested in the evolving relationship between ministries and government agencies.

Chalmers Transport Area of Advance: A Domestic Initiative

The factors influencing the formulation of the Chalmers Transport Area of Advance differs from the factors shaping the design of the Eco-Innovation Cooperation programs discussed earlier. However, the programs overlap in a number of ways. All three initiatives fulfilled domestic policy goals. The Chalmers Transport Area of Advance initiative satisfied broader national goals for creating specific research areas to improve the quality of research in Sweden

and to elevate the country to the highest R&D and innovation standard. Therefore, the Chalmers Transport Area of Advance is a national program of significantly larger scale. The two Eco-Innovation Cooperation programs were also created to fulfill broader domestic objectives but at a smaller scale and the possibility for replicating it at a national level has been shadowed by the challenges, uncertainties and financial constraints embedded in the two international programs. The three programs involve science-industry partnerships and represent novel approaches to program design.

Chalmers Areas of Advance: An Overview

The Chalmers University of Technology applied for eight Strategic Research Areas (SRAs) and received funding for five of the eight areas, labelling these "Areas of Advance." The eight Areas of Advance (AoA) are the following: Transport, Energy, Production, Nanoscience and Nanotechnology, Built Environment, Life Science, Material Science and Information and Communication Technology. Each AoA is considered an "open meeting space where various parties can work together for a common solution – crossing the boundaries of academia, industry and society" (power point slides, Chalmers Areas of Advance). The funding for the Chalmers AoA was provided through the 2008 Government Bill.

The 2008 Bill contained two investments to improve research quality. Funding for research and research education were raised by SEK 1.55 billion (about EUR 164 million). This amount, together with 10 percent of previous appropriations (about SEK 1.1 billion [EUR 120 million]) was provided on the basis of a quality ranking based on external grants, number of articles and citations. This funding was redistributed every year so that those higher education institutions that managed to increase their quality based on the established criteria were allocated a greater proportion of the redistributed appropriations. Another reform based on quality and performance was the investment in strategic areas. Just over SEK 1.8 billion (EUR 197 million) per year were allocated for investments in areas where designated to HE institutions to build up a research environment aimed at increasing research quality (Swedish Ministry of Education and Research, 2010). In total, 701 Swedish Crowns were allocated to the Chalmers University's SRAs from the Swedish Government between 2010

and 2014 (Swedish Research Council, 2015). During the year 2014, the SRA funding corresponded to 11% of the basic funding for education and research given to Chalmers University of Technology (Swedish Research Council, 2015).

Before the calls for proposals for SRA funding, Chalmers University had begun to restructure and reorganize its research. The new strategy was based on the eight Areas of Advance and intended to increase cross-disciplinary collaboration and build interdisciplinary research teams. The overall goal was to improve the research quality and reduce compartmentalization among research groups. The launching of the SRA call for proposals coincided with the establishment of the Chalmers University's eight Areas of Advance.

The following statement by the former director of the Chalmers Transport Area of Advance provides additional details about the internal reorganization process within the university. It also shows how a few key actors at Chalmers spearheaded these internal changes and how the researchers' intentions at the micro level were aligned with policy goals at the macro level.

> It started in 2007 when I became the vice director at Chalmers, we [tried] to form a new strategy where we should work more across the disciplines and departments and try to pool strengths at Chalmers and make us more able to jointly tackle the great challenges regarding sustainability. Karin [the president at that time] has been around and […] her intention was that we should start working to make people to need one another and to connect to identify interesting things to do in cross department collaboration. I would say that it took a while to understand how [to do that]. At that time, we had 16 departments and they were working very differently. So it was not easy to find ways to collaborate because we did not have any funding at that time. So, people were thinking: what's in it for us? Karin introduced the initiative [during] seminars so we got small funding for people who wanted to arrange boundary crossing seminars. She [Karin] worked a lot on making major industrial partners. The first one was EON in a concept she called Coins which stands for Chalmers open innovation network systems. She [Karin] was also very good at influencing politics and she was part of the global advisory team. She tried to promote heavily and that was just yet another source of funding to universities, that would help universities to work like we wanted to do with the initiatives. Instead of just giving us money for research, for any kind of research

> and then for education, it gave us money that was more thematic. That was initiated in the Research and Innovation Bill of 2008 where they identified 28 research areas where universities could compete to get funding. When that bill came in the Autumn of 2008 we were pretty much prepared for that. We did not know which areas would be selected. Some of them were perfect for us. And eventually we got 5 of them and that is Transport which I am the head of, and we got the most per capita and great addition to the very slim funding that we had to start with. And as soon as we got those areas we decided to form the Areas of Advance because that was the continuation or advancement of the initiatives strategy and would match the applications and the whole idea of that Bill better. That served us well (Former Director of the Chalmers Transport Area of Advance, May 12, 2015). (Interview no. 26).

In his book "Kunskapsnation i Kris? Politik, Pengar och Makt i Svensk Forskning," Mats Benner demonstrated that the decision making process shaping the development of the Strategic Areas of Advance had a degree of informality (see below an excerpt of Benner's book). Furthermore, like the two Eco-Innovation Cooperation programs, the Chalmers University AoA, emerged from a policy experiment where a new mechanism for providing funding to university research was introduced with the purpose to improve the quality of research in higher education institutions. The new strategy also aimed to give universities more freedom and flexibility regarding the management of their own research projects. The Strategic Research Area model of research funding to universities was viewed by the Government of Sweden as a novel way of funding university research, characterized by long-term and programmatic approaches, differing from the project-oriented structure seen in the Eco-Innovation Cooperation programs. The new structure gave universities more leeway, allowing researchers to make their own decisions about how to conduct and coordinate their research projects. The following excerpt shows how the idea of creating the Strategic Research Areas emerged as part of a relatively informal search process for novel ways of supporting universities.

> The Reinfeldt Government has announced - mainly indirectly in the form of a conversation between the leaders of the Department of Education and educational institutions - that it wants a focus on selected areas of strategic importance to society (Benner, 2008, p. 371).

The following is part of the same interview with Peter Honeth and it illustrates how, more often than not, policy actors experiment with new ideas, translating *intentions into practice*. In this case, the use of the word "radical" means that this is a far-reaching proposition signaling a departure from more traditional models. In addition, in this new structure, to a certain degree, funding agencies give up their right to control research areas and universities expand (not gain) their right to control the organization of their own research. In theory, the aim is to reduce dependency of research universities on funding agencies and on traditional models of funding allocation and increase their flexibility.

> Thus, the Government turns directly to the universities, bypassing the funding agencies when about to launch such strategic initiatives. This is an original form for interaction between the government and the universities, rarely used in the past. It also radically differs from the sectoral research organization of earlier times, which mostly delegated the organizational responsibility of such research to agencies or councils. The purpose is to increase flexibility and reduce dependence on the existing funding agencies (Benner's book, 2008).
>
> The new model means that a new level of control is introduced, namely in the form of large, national programs that the government and parliament define and that are subsequently negotiated directly with the universities, without involving the funding agencies (Benner, 2008, p. 371) (author's own translation).

Based on the above, a few conclusions can be drawn. First, the strategic research areas (SRAs) evolved out of a search process which consisted in bypassing the existing funding organization. This occurred because the government deemed funding organizations unfit to manage such a large-scale operation and therefore, devised its own structure and procedure. Second, the main priorities (areas) and program structure were set by the government in informal tandem with universities and individual scholars; intermediaries were involved later on in the selection and evaluation phase. Third, universities responded in a pragmatic way. Anna Dubois indicates how universities tried to position themselves in relation to the SRA calls in a practical and objective manner. For instance, a new government initiative was underway and key university actors had insider information to draw upon and Chalmers devised internal measures to meet the upcoming call.

8.7 Summary and conclusions

This chapter has aimed to gain a better understanding of how specific STI cooperation programs have emerged. The three government-funded programs discussed in this thesis are targeted initiatives rooted in the political structure and based on the intentions of policy actors. Like the two Eco-Innovation Cooperation programs, the Chalmers University Transport Area of Advance emerged from a policy experiment and also from non-linear and informal decision-making processes. The Chalmers University Transport AoA represented an opportunity to introduce a new model of university funding – the Strategic Research Area. The purpose of this new funding mechanism was to improve the quality of research in higher education institutions. The new strategy also gave university researchers more flexibility to manage their own projects and activities. The two Eco-Innovation Cooperation programs also emerged from a policy experiment reflected on policy actors' interests to launch a new program with China and Brazil. A confluence of two other factors also influenced the formulation of the two international cooperation programs: existing bilateral agreements with China and Brazil and the fulfillment of policy goals. These two factors can be translated into practicality or pragmatism and policy alignment, respectively.

This chapter has discussed how actors in government institutions act and how certain policy choices emerge within this political structure. It also examined how opportunism and pragmatism shape political decisions which in turn played a role in the design of certain programs. The sticky nature of political structures – comprised of government and its ministries and administrative agencies (e.g. funding agencies), how government agencies function, are organized and mandated, influence how ideas are articulated. These elements also shape how opportunities and intentions define outcomes in the public arena. Policy actors are capable of strategic actions that respond to opportunities. These actions involve pragmatism in program design (agencies) and in responses to calls for proposals (researchers).

Based on interviews I conducted with government officials in Sweden, one possible conclusion refers to the implementation strategy and style employed when turning intentions into practice. For instance, the policy instruments I discuss have sponsors who are driven by the need to fulfill international agreements; therefore, taking a practical approach to policy. Program funders are

also motivated by the intention to pursue policy experimentation by turning new ideas into practice. Policy actors accomplish the above when they establish new international cooperation programs in science, technology and innovation. Such decisions might be based on a number of factors such as to meet political needs or to meet the terms of existing bilateral agreements.

Drawing on the theoretical building blocks in chapter 3, implementation style is the approach that organizations adopt when turning strategies or proposals into practice (Andrews et al, 2011). This is particularly pertinent to the practice of internationalization which unfolds as a blend of policies with specific and discreet but interrelated goals. These policy goals are subject to government's responses to international trends or changes resulting from the need to address a problem or to fulfill a political objective.

Factors such as the ones discussed in this chapter suggest that spontaneous and impromptu processes in decision making might not be suboptimal because it might lead to diversification of solutions in policy. This diversification takes place because actors might discuss a range of options to address a policy issue. At the same time, I do not assume that inconsistent and vague policy processes always lead to diversification and policy innovation.

As I argued earlier, the launching of new government programs by funding agencies or policy experimentation does not automatic translate into a suboptimal assessment of these programs. Certainly, decisions get steered in particular directions depending on the interests of the participants. But in the end, certain decision processes in policy are opportunities to look at a problem from different angles and to break with traditional and more linear models of decision making.

Regarding political mindset and institutional trajectories, these represent the ways in which governments respond and conceive internationalization by choosing to focus on particular countries and on specific areas of STI cooperation. The analysis presented in this chapter has shown how specific research programs are formulated. This chapter has illustrated that there are variations in decision making processes and that government agencies operate in complex environments. Given these complexities, I infer that the choices policy actors make are subject to volatile circumstances, uncertainties, inconsistencies, lack of clear information and direction from higher levels of government. Policy choices are also subject to domestic and international pressures. These factors

might constrain individuals' choices and might sway them towards satisfactory results instead of achieving the most optimal outcomes. In order to minimize complexities and time spent in long decision making processes, policy actors might take short-cuts; they "tick the box," sign agreements and design and fund short-term international STI cooperation programs. One possibility is decision making processes with less than optimal outcomes. As a funding agency official argued, "*It is not always beneficial to have a system in which funding agencies are autonomous and with power to allocate funding to projects because it becomes easy to check in the box, to have the mission accomplished and say: "we have done it; we can take it off our conscious*." (Government agency official interview, April 12, 2016).

Furthermore, in this chapter, I have discussed pragmatism in policy decision making. Pragmatism drives political behavior and policy decisions. This pragmatism embodies what I refer to as *undedicated time* where policy making becomes the locus for fast pace political choices and short cuts. This fast speed in politics (Virilio, 2002) is a reminder that policy making is not precise.

If we follow this line of argument, political engagement takes time and reflection. This topic opens up a new way of thinking and seeing politics and political leaders in science and technology as entities that need to be engaged. The negative effect of disengagement and speedy politics is randomness. Political decisions are characterized as random, in the absence of a conscious decision when they do not follow a coherent and consistent strategy to utilize internationalization as a tool that can be used to advance science, technology and innovation goals.

The evidence from the three case studies show that in practice, policy actors do not always conform to the rational model and not always act in order to maximize. As Jones (2001, p. ix and 184) stated:

> Much of the argument hinges on the observation that in politics, as elsewhere in life, people do not process information proportionately […] I mean that objective signals from the environment are transformed in the process of thought […] To predict behaviors, it is not enough to know the objective incentives people face in interacting with their environments. We must know also how politicians, bureaucrats, and citizens think about politics […] Fully rational decision makers using indexes will make mistakes, because the world is noisy and the data are fallible. Even the best decision makers will make mistakes, but the mistakes are mostly manageable because the index will be distributed normally.

The bounded rationality concept is useful in this context to explain how political intentions are forged and molded in a non-linear process. This non-linear process might fall outside the more predictable approach involving goal setting, the search for alternatives to procedures and value-maximizing choice based on expected utility steps. Bounded rationality is useful in this context because it highlights that political intentions are continuously being expressed and policy decision-making that emerges from those intentions suffice to solve problems according to established routines. Bounded rationality is useful because it suggests that policy making can be unpredictable and non-linear. It suggests that there are other factors that often escape the control of those involved. These factors bound individuals who have initially intended to make rational choices. It is the unpredictability and often ephemerality of events that steer outcomes, not rationality. Thus, bounded rationality predicts policy outcomes because unforeseen factors and human behavior influence policy decisions and direct decision-making processes towards solutions that are different from the expected choice.

The bounded rationality model helps us understand that in modern governance, the making of policies is not a straightforward process and that politics is about tensions, unpredictability and differences of opinions. Thus, the practice of politics has inherited complexities and challenges. But most importantly, modern politics is about the acceptance of these differences and finding solutions to address them.

Regarding decision-making processes in internationalization, findings from the empirical data suggests the presence of trade-offs. Such trade-offs take place between objectivity and pragmatism, manifested in policy decisions, and autonomy and disaggregation of internationalization from political interests.

The interactions between different policy levels and between government agencies and research practitioners are key, and I have afforded an understanding of policies that emerge from the interplay between stable institutional trajectories and forces of change. I argue that implementation has evolved as the interaction between different interests and engagements with international STI initiatives, where I highlight the related but mimetic processes of the principal-agent relation and street level bureaucratic leeway. I also assume that ideas and notions of directions of internationalization matter to the identities of those engaged in such programs.

Finally, I assume that tensions emerge such as unstable relations between political intentions, institutional stability, actors' strategies and action patterns among the participants in internationalization programs. The above generates conditional and pragmatic approaches to internationalization because of the lengthy and complex translation process where these different levels are interconnected.

Chapter 9 Funding and Views of Internationalization

9.1 Introduction

This chapter examines how the current research funding model affects actors' views of and responses to internationalization. This chapter addresses the third research question: *How does the current research funding model affect researchers' views of and responses to internationalization?* I contend that due to the facilitating role of funding agencies in advancing domestic and global research cooperation through funding mechanisms, public research funding is crucial for the promotion of internationalization goals. Research funding comes from grants from the government, foundations or the private sector. This thesis takes a closer look at three government-targeted programs that received public funding for science, technology and innovation projects. Given the dominant role of public funding in fostering internationalization goals, first I provide an overview of the respondents' opinions about public research funding. I accomplish this by mapping out the views of different actor constellations on the financial support received through the Strategic Research Areas (SRA) scheme and the two international programs.

9.1.1 Views of the research funding system

In this section, I examine the overall impact of the respective programs, and how they fit in with the participants' general views of the research funding system in Sweden. Regarding the Sweden Brazil Cooperation for Eco-Innovation, the overall impression among those interviewed was positive. The program, according to respondents, represented an opportunity to forge international linkages. While many expressed their appreciation for the funding opportunity as the project grant enabled them to travel abroad to attend meetings and to

build consortia comprised of industry, university and research institutes, others expressed discontentment with the overall funding system. They claimed that the current research funding model has resulted in short-sighted commitments and in "projectification" of research and innovation opportunities. The latter means a greater focus on projects and project management.

A recurrent theme was the paucity of funding opportunities; funding spread too thinly across too many projects. One alternative, according to those interviewed, is to increase funding to a small number of projects. Another option mentioned by a few interviewees is to allocate the same amount of funding but reduce the number of projects. Thus, the amount of funding would be the affected factor and it would vary even if the number of projects were kept constant.

Financial support was the main motivating factor in actors' decision to participate in the Transport AoA and the Eco-Innovation Cooperation programs. This was not a surprising finding, given the three models that prevail in the Swedish funding system: funding-laden, initiative-driven and quasi-centralized (chapter 6). This apparently positive appraisal of funding and dependency on external financial sources is a symptom of a number of factors that are systemic in nature. As Benner and Öquist (2012, p. 12) argue, policy decisions at the national level, the evolution of funding systems and funding prioritization and dependence on external funding influence the research performance of Swedish universities. Today, most academics in Sweden depend on external funding not only for conducting their research projects but to advance their academic careers.

The funding system context introduces a question specifically linked to the opportunities and constraints regarding funding in the context of the three case studies. Is funding a constrainer or an enabler of internationalization? Findings from the empirical data indicate that specific publicly-funded research mechanisms condition internationalization goals.

Based on interviews conducted with policy actors, researchers, company managers and owners of micro and SMEs in Sweden, four main conclusions can be drawn regarding public research funding: 1) funding has been the most important driver in the promotion of cross-disciplinary and international science, technology and innovation collaboration. However, as a tool to advance STI cooperation goals, funding might be considered less than optimal 2) the current funding model enables and constrains internationalization activities 3)

the current research funding model elicits a reactive behavior from grant seekers 4) Securing research funding is a pragmatic act, tending toward needs-based and less toward interest-driven. The above findings are laid out in the next sections and are based on the interviews conducted with the actors participating in the three government-sponsored programs.

9.2 Funding facilitates STI cooperation

Funding has been the most important driver of science, technology and innovation collaboration projects in the context of the three case studies I describe. Thus, funding matters and it enables international cooperation in science, technology and innovation. Although the most dominant factor driving participation in government-sponsored research cooperation, in the current public research funding system, funding is arguably not the most suitable tool for promoting internationalization. One possible explanation refers to the dilemmas or trade-offs it generates. For instance, some researchers and business owners stated that they might have to choose between two desirable but incompatible options. Respondents mentioned that they might forgo other activities (e.g. research projects) to focus on projects that might be more likely to receive government funding. The expression of discontentment also appeared to have originated from time devoted to prepare grant applications relating to research projects that seemed less interesting to grant seekers but more likely to receive funding from the government.

Another perceived trade-off relates to decisions involving internationalization activities of companies and whether to invest in local markets or pursue opportunities in emerging economies. The experience of the business owner, portrayed in the introduction illustrates such dilemmas. The individual claimed that funding constraints influenced his decision to focus on the European market instead of the Brazilian market. According to the participant, pursuing business opportunities in Europe was a more appropriate and practical business choice for his company. Others expressed concerns about having to choose between focusing on ongoing projects and dedicating time and resources to new endeavors perceived as "risky."

In addition, there are other trade-offs discussed by the respondents. Given the perceived scarcity of funding, a few interview subjects suggested that Swedish

funding agencies and Swedish industry steer the direction of research and prioritize particular research areas. This perceived research steering tends to produce trade-offs that adversely affect researchers' productivity and raises the level of concerns. The overall impression is that respondents were receptive and adjusted to the dependency on external funding and did not expect government funding to be unconditional. However, a few individuals criticized the selected STI cooperation within the framework of partnerships involving China and Brazil and wished they were afforded the opportunity to select their own projects and partner countries.

Moreover, researchers seeking external funding are constantly striving to find the right balance between what they believe is important to accomplish and feasible to achieve versus what funding agencies expect them to accomplish. The following interview passage by the owner of a Swedish start-up corroborates the perspectives discussed above. In spite of government officials' interests to experiment with program design and launch new pilot initiatives to facilitate STI cooperation with countries outside Europe (e.g. Brazil, China, India, South Africa), mismatches occur between different actors. In the following example, discrepancies might occur between the goals of funding agencies and the goals of business owners. The owner of a startup company stated:

> Yes it is because of lack of funding so that we can't proceed because we can't just do a project and stop directly after. We must see that we have enough funding to proceed. And that is the reason that the project has not started up. We had to put it on hold so we have enough funding in the company. So, that is a large problem for Swedish startup companies, to find enough investors, economic angels as we call them and that is really a pity because many ideas and inventions go abroad because of the lack of financing possibilities in the Swedish market […] And in this company, our company we have about 20 small investors. And from those 20 we have about 7 or 8 who are a bit larger, and they are also in the board of the company, but in total we have during the 4 years, we have invested ourselves X million SEK into this company. For that, we have invested in Spain for a test period that now has been working for 3 years […] So, we have put a lot of our own money into that […] The reason why we started up in Spain is [because it is] more or less our home market. I mean the market in Europe has dry conditions and large production in different fruits and different vegetables. So, from our point of view, Spain is the closest market using

> extremely amounts of water and at the same time they don't have that water[…] It is easier for us to go Spain. It takes 4 hours, you don't pay a lot for transport (CEO, Swedish startup, August 13, 2014). (Interview no. 27).

The following claims by a researcher and professor at Chalmers University involved in the Transport Area of Advance program suggest that applying for funding is a pragmatic decision that does not necessarily involve rationalist assumptions. What defines this pragmatic decision is one's attitude toward securing funding and the conscious anticipation and expectation of recurring funding opportunities. Therefore, doing research in areas that are not necessarily the most stimulating but the most likely to receive financial support is a reasonable and a practical choice. In this case, researchers are continuously adapting to funding institutions and funders' intentions. One possible conclusion is that applying for funding elicits a reactive behavior from researchers, a topic that will be further elaborated.

> […] So, we get input and feedback from the companies on what we are doing. They are of course interested in the products and finished things but we get information on what they think is important for the future and that can lead to interesting technological challenges. We have also to reformulate in a way that is interesting from the scientific point of view. Normally there is no problem in finding things that are important from both the industrial point of view and a scientific point of view. We get ideas and feedback on how to prioritize needs and research for the future from companies. With the university collaboration we are defining our problems together. There is a continuous dialogue to define what the important scientific questions are. We are influenced by the scientific discussions that go on in our collaborations and in scientific journals and those influence what we are doing. When it comes to the funding agencies, they set the framework because we have to have our research funded and if they don't fund us, we will not be able to do anything. I mean, we respond to their calls for proposals. So if there are calls that fit with what we are interested in then we respond to that. But we are doing research in areas where we can get the funding. So, we are adjusting to that (Professor Swedish university, May 17, 2013). (Interview no. 28).

Furthermore, the above statement underscores the contradictions and shortcomings of some of the government-funded research schemes. The researcher and professor implied that there are specific conditions that are

established prior to entering the grant competition. The same scholar explained that he responds to calls for proposals *if the call fits* his current research projects and interests. When that happens, he moves forward and enters the competition. The researcher indicated that the choice to enter a funding competition and apply for grant becomes a pragmatic one. Thus, the above example illustrates that overall, researchers continuously adjust to funding opportunities through calls for proposals and often find themselves caught between pursuing their own research interests and doing research in specific areas that are of interest to funders and in areas that are most likely to receive financial support. One implication is that researchers might respond to a call for proposals even though it might not be entirely aligned with their research interests. Regardless of "good fitness," researchers adjust, react and respond to calls for proposals.

In summary, the previous statements show that academic actors continuously search for balance in their project activities. New funding patterns and models imply that researchers in return for public funds should address research problems of industrial relevance (Gulbrandsen and Smeby, 2005). Respondents indicated that academic actors always face difficult choices. In this context, the choice involves a compromise between maintaining the quality of publications through high quality research practices on the one hand and conducting research that is relevant and applicable to industry's needs on the other hand. Researchers find it important to focus on research that is relevant to them and matches their interests. At the same time, the focus on achievement and research performance is not always aligned with funders' goals. For instance, academic scientists are motivated to publish their research findings and to ensure that the graduate students and postdoctoral scholars they supervise are able to publish and are successful in the pursuit of their career paths (Biscotti et al. 2012). Finally, private companies, when funding projects often prefer to delay publishing until their intellectual property position is secure (Biscotti et al. 2012).

There was a strong and shared view among some respondents that government funding schemes are arbitrary because they set strict guidelines for the projects that do not follow or support the intrinsic logic of knowledge development. In addition, the argument is that funding agencies do not provide researchers with the means to engage in meaningful, unconventional, long-term development of bold research ideas and projects. Also, actors argue that government and funding agencies have a pre-established agenda and that certain research ideas might be considered unconventional and for that reason, they would not be eligible for

funding. According to some respondents, this means that there are certain types of research projects that are *unfit for funding*.

The following statements, drawn on interviews with a company CEO and a university professor, expose some of the pitfalls inherent in research funding schemes. It also shows that external funding is as important for universities as it is for companies, particularly SMEs. As Laudel (2006) argues, external funding is crucial today to conduct research at all. The same author argues that in a system with high core institutional funding, external funding enables researchers to experiment more and to do unconventional research. On the other hand, in a system without core funding, researchers are dependent on external funding to conduct research. This continuous dependency on external money has two broader implications. First, it might lead to disengagement and detachment from research interests. Second, it might result in sudden changes to research plans; researchers might be discouraged from pursuing spontaneous, creative and bold research problems and projects that are considered unconventional and outside funding agencies' and government's interests. Third, this type of public research funding model might affect the content and the direction of research.

Other trade-offs and dilemmas that emerged from interviews are opportunity costs and time management. For instance, respondents expressed concerns over time and energy that could have been better used to generate results. They claimed that there is a difficult choice they have to make between devoting time to a project that they view as less meaningful but more likely to be funded or focusing on projects that are seen as more stimulating and results-oriented but less likely to receive government grants. In other words, there is a positive correlation between energy and time spent on side projects that are different from employees' primary functions and the degree of discontentment and resistance. The above means that "the more that participation appears to take time and energy away from this primary function (employees are paid to do their jobs), with no compensating rewards, the more it will be resisted" (Kanter, 1983, p. 13). And the "big decision trap" is also related to the "agenda trap" in which individuals need to feel that their time is well spent on tasks that produce tangible and visible results (Kanter, 1983). The first statement below by a company owner participating in the Eco-Innovation Cooperation program with Brazil corroborates the above arguments. The second statement, by a professor in the field of shipping and marine technology at Chalmers University also raises

the issue of research that is perceived to be *unfit for funding*. The professor's claims also indicate that in her field, private funding is more accessible than public funding. She further suggested that some research fields are perceived to stand outside of the ordinary public funding system. The underlying issue is similar to what I discussed earlier and that is research actors often comply and adapt to a particular funding approach which in turn molds research activities.

> We have lots of projects where we do research and we do internationalization in our work but we would never get funding from VINNOVA for these projects because they do not fit into the VINNOVA agenda. Instead we get money from VINNOVA for other projects that are not as interesting for us because they are part of VINNOVA's agenda. And we do these projects to get funding so we can do some projects that are not the most interesting but interesting enough to perform. I mean, I think it is the same for you, you also apply for funding and often you will have A and B interests. The B interests you do because you got money for it and the A interests you do because it is interesting and you think you will achieve some results (CEO and owner, small Swedish company, September 9, 2015). (Interview no. 29).

> We are lucky enough to work in a very positive environment because people want the results and because of course funding is always the problem. But compared to many others, yes it has been quite easy to get funding from the industry but of course the main obstacle to increasing research in this field is that it is very difficult to find the right forum to apply for public funding. We don't fit into the ordinary funding system. Everybody thinks that shipping is important but the large funding organizations they point at the each other… it has not been really established. The shipping administration, they don't have any research funding…no shipping research on the agenda. So, that has been a problem, that there has not been a real responsibility for shipping research in Sweden for a long time (Professor, Swedish university, November 16, 2012). (Interview no. 30).

The above claims support the argument that government-sponsored research is a key mechanism to facilitate internationalization activities but at the same time, it is a tool fraught with challenges and shortcomings. From the perspective of the company CEO in the example above, a specific set of conditions would have to exist to fulfill his expectations and interests. Naturally, meeting some of these conditions would entail the allocation of more funding to the eco-innovation

projects. Other conditions refer to program specifications or "ground rules" which are pre-determined by the government or/and funding agencies. These program specifications include research areas, program cycle, the partner countries, project timeline and types of consortia. These "ground rules" are usually fixed and based on a number of factors that influence the crafting of these programs.

Nevertheless, other difficult choices and dilemmas were uncovered during interviews with different actors. Some of these involved choosing between two competing alternatives. This situation generates ambivalence, particularly when it is caused by a difficulty to make a choice. These competing options might include pursuing research for knowledge's sake versus doing applied research that is more relevant to industry. The statements below by a professor at Chalmers University show the clear separation between interest-driven and needs-driven research. It also demonstrates the perceived role of the government in advancing research quality. Thus, when industry is not able to support academic research, the government steps in and supports university researchers. The example below corroborates these claims.

> The balance we struggle with is - and that is partly because of external funding, because we rely a lot on external funding as well - between the excellence in our publications and industrial relevance. Because we have close collaboration with industrial partners they are not always keen on having us publish a lot… So, that's why we also need our own funding in order for our researchers to do the kind of research that industry is not willing or able to join us in at the moment (Professor[35], Swedish university, May 12 2015).

Interviews with researchers and companies confirm that in spite of the dilemmas described by a number of respondents, funding is considered the most important driving force compelling participants to respond to calls for proposals. Particularly, in the case of the two Eco-Innovation Cooperation programs, funding was a key factor influencing actors' decisions to engage in international collaborative projects with China and Brazil. For instance, all respondents in Sweden, working with their Chinese counterparts, stated that the public funding they received was very important to the operationalization of the projects. The respondents working in projects that involved Chinese partners provided different reasons why the funding from VINNOVA helped their projects. Three

[35] Same respondent as interview no. 26.

out of sixteen individuals interviewed explained that part of the money was used for hiring a post doc while one project leader said the funding was essential for hiring a PhD to help with the project. The majority of the respondents used part of the funding to cover travel expenses to and from China to attend meetings, conduct field testing in China, and other purposes such as the installation of field equipment.

There was a greater variation in the responses of participants working with Brazil regarding funding compared to actors collaborating with Chinese partners. Those working with the Sweden Brazil innovation project did not express as favorable opinion about government funding compared to the participants in the Sino-Swedish cooperation. Regarding financial support, the responses of the participants in the Sino-Swedish Eco-Innovation initiative were uniform across the different sectors - industry, universities and research institutes. As noted below, some of the interview subjects who joined the Sino-Swedish innovation collaboration were enthusiastic about and appreciative of the funding they received. A number of factors explain the positive view about government funding for those engaged in the Sino-Swedish Innovation Cooperation. One factor relates to the expectation that the VINNOVA grants help researchers to launch pilot projects in China and that environmental solutions emerging from the Sino-Swedish cooperation can be disseminated around the world. Another factor related to the previous one is the anticipation that the outcomes of the international collaboration will be positive. In addition, there is the expectation that innovation collaborations such as these will steer Chinese industry into a more sustainable direction. According to the CEO of a Swedish start-up, the launching of the call for proposals by VINNOVA was seen as timely opportunity tailored to the company's interests. The same statement by the CEO underscores the responsive behavior of grant seekers.

> […] if we can make a difference there is something that is sometimes used but if you can get the Chinese to take up the technology we are developing and do something with it, we know that it can be 1 billion people instead of 10 million who can benefit from it. I think that is the major reason that you can see that you can make a big difference. If you can get this type of technology to lift because it is not primarily commercially-driven because the commercial aspect can be that VINNOVA wants very much to promote it. But for me personally it is to see that I can do something that can benefit a lot of people. So we are

working with these types of things, with biogas and bioethanol. We know this is very important because the most difficult thing is to replace this fuel for vehicles. We can solve a lot of the other problems but the vehicle is still the key issue and here we can see that what we are working with in this case is very much to try to solve these types of problems in an efficient way. So, the driving force is to see how we can get things up and running in a good way. If we can get it through in China we know it will spread all over the world also like electrical bikes. Look at the electrical bikes. You have like 60 million in China and now they are spreading out all over the world from there. So, they have a very strong impact (Professor[36], Swedish university, September 4, 2014).

Say long term this is the right way to go but it is very hard to get there. That is why this kind of support makes a difference… there is a strong interest from the [Chinese] local authorities and, in their view, this is the future and they need to go there but they don't know exactly how to help the industry to transform into this sustainable way of operation. So, the only way to find commercial partners to build state of the art systems in China is to get some subsidies. This would not have happened without financial support (Vice President Product Development of a mid-sized Swedish company, June 2014).

It is extremely important for us because the thing is that the project cost for a project like this is roughly around 10 million SEK to do integration like this form and we couldn't get this kind of money from our Chinese partners and customers. If it is proven, it is different, then they can pay a lot for it…But at this stage to prove that it works with their electric hybrid cars… they want us to show them that it works, and then it was crucial for us to get support [from VINNOVA to] help with partial costs to be able to do that. So, it was a perfect program for us, the timing was very good; it suited this project perfectly… We would not have done the project if it was not for this support… So to get the support for that, for us, a small Swedish start up is crucial to get into the Chinese market… (CEO of a Swedish start-up, August 2014).

The research group has been able to hire a post doc who is working on the project so I think that is very good and also we could not have done this without this project and also it has enabled us to start working with this process technology. And I don't know how we could have managed without this funding. So, I think it is very important (Researcher, Swedish university, July 8, 2014). (Interview no. 31).

[36] Same respondent as interview no. 9.

A scholar emphasized the importance of the VINNOVA support to develop Swedish technologies further but also how such cooperation programs at the national level can give the collaboration some legitimacy, therefore, making it easier to communicate and negotiate with the different levels of the Chinese Government.

> …The first thing is that it shows the national level collaboration. This is very important for the Chinese partners […] This is also easier to communicate with the different levels of the government and authorities. You know, they know this is an international collaboration […] They will put something there, they will help us. Because VINNOVA is a symbol of the Swedish Government, so this collaboration is classified as a national level collaboration between China and Sweden… This is a chance to develop Swedish technology. And this Swedish technology is identified as Swedish technology… It is based on old technology but they have something new that fits the Chinese market and other international markets. So, this is important to have this chance for our researchers and for Swedish technology export… As a researcher, if I want to develop something, I need to find funding (Researcher, Swedish university, August 21, 2014). (Interview no. 32).

A professor collaborating with his counterparts in China explained the importance of funding for the different stages of technology development.

> This is very important because this one it would not be easy for this technology to be transformed into a commercial product because you know, even though we have done good fundamental research, when the Swedish company – and because they applied for the patent – they own the patent, so they try to approach the Chinese investors but they always come to the questions, how long can I get commercial products… you need to do this you know, the last stage to test different things and to make it possible for commercial applications. So, this VINNOVA funding is absolutely necessary for this last stage and it is really important to make this possible in our case. So, without this funding, this whole idea, our project would not be easy and I don't know when it could become possible (Professor[37] and Researcher, Swedish university, July 9, 2014).

The owner of a small Swedish company discussed the relevance of the VINNOVA grant to his business.

[37] Same respondent as interview no. 1

> I would say very important. The situation for our small company is that we could at this stage not have afforded to do this without the funding, no way. Maybe in a couple of years if we grow and earn more money but we are a company now of 4 people and working… We are an ordinary family business with a very tight budget. So, going just for developing cooperation and learning a new country, yes, we could not have done it. We would have needed a concrete order to go like this otherwise. And that is very unlikely to happen, you know. It starts with you normally need to get to know people first before they can trust you to place an order. So, yes, that is why it is so important for us... (Company owner[38] and CEO August 22, 2014).

A project leader and researcher working at a Swedish research institute argued that the VINNOVA grant was crucial to the project and provided opportunities for learning and for working in a different field.

> The financial support was very important. The project would not have happened if VINNOVA had not had the Call…I mean, this was a little bit outside of my research scope – normally I would not have thought about using optic fibers to do measurements of CO2 and participate in an environmental project. But when VINNOVA had the ICE Call, I called my friend in Brazil and asked if there was any way we could use the optic fibers we make here in Sweden for something related to the environment. He promptly replied that of course there was a connection. And I said, 'oh okay I never thought about it.' I have never thought about or heard of carbon capture and storage. So, I had no idea that optic fibers could be used for such purpose. So, the role of VINNOVA in this case was fundamental. I would not have started to work in this field if it were not for VINNOVA. (Researcher[39], Swedish research institute August 20, 2014).

A different researcher at the same research institute expressed a positive view about the VINNOVA grant.

> We couldn't have done it without the funding from VINNOVA, so of course it was very important. I traveled with the president of our project partner company, an SME active in the environmental space. You know, in a startup company, the most expensive cost for a company is the members' time because their immediate focus on profitability. I went on two long trips with the president (of the

[38] Same respondent as interview no. 12

[39] Same respondent as interview no. 13

> company) and we discussed a lot of potential development opportunities in Brazil and met many many companies and institutes over in Brazil. This would not have been possible without the support from VINNOVA. Marketing and networking is a crucial aspect for developing the business concept and this is what was achieved within the project. So, it was very important. (Researcher at a Swedish research institute, August 25, 2014). (Interview no. 33).

The following statements from a researcher at another Swedish research institute, discussed the support from VINNOVA as beneficial to the entire project team. He explained that the work the team performed during phase A of the project laid the foundation for future work with Brazil. The big project the researcher refers to in the statement below is the collaboration project partly funded by the Swedish Energy Agency. He stated: *"Absolutely, I think it was very important because it got the Swedish group of partners on working together for 6 months or so. And that made it easier to get the big project in place."* (Researcher at a Swedish research institute August, 2014).

A project manager at a different Swedish research institute had a positive view about the VINNOVA grant. He stated:

> For us it was absolutely crucial. We could not have done it without it. We have had fairly easy situation in finding in-kind financing from our Swedish collaborators but it is, how should I say, the project needs to be fairly large in size and also in funding of course. And the possibility to get Swedish private companies to give us this sort of money in cash is extremely low I would say. They are happy to support this kind of project with in-kind finance but it is extremely hard to get cash contributions from Swedish companies. So, the fact that we had the funding from VINNOVA is absolutely crucial (Project manager, Swedish research institute, November 15, 2015). (Interview no. 34).

Transport AoA researchers and their views on funding

Twenty researchers participating in the Transport Area of Advance program were interviewed. My findings confirm that the research funding system in Sweden perpetuates and encourages deep dependence on external funding by researchers. During interviews, some respondents argued that the research funding system in Sweden creates frustration, dissatisfaction and forces researchers to perpetually seek outside funding to enable the continuation of

their projects. The reality is that there is always an opportunity cost embedded: researchers often forgo other activities as they must spend time preparing grant applications instead of focusing on ongoing research projects, what I have termed *the researcher´s dilemma*.

In addition to funding, human resources availability and close collaboration with industry are considered important for conducting research. The responses below from professors at Chalmers University of Technology corroborate this claim.

> Of course it is important that we have financial resources for senior researchers like me and graduate students. It is important that we have access to equipment. We do a lot of measurements onboard ships so it is important that we have access to ships and ship engines to do measurements. It is also important with the networking for research. I mean networking with the ship owners and that is mainly done through the Lighthouse and the Lighthouse is important for that. Although we haven't had problems accessing ships because that has worked well, on the other hand, of course we have limited financial resources. We could do much more if we had more people and more money. More people and more money would make a difference. (Professor, Swedish university, November 23, 2012). (Interview no. 35).

> Well, the standard answer could be money, money, money. But of course, it is important to have a good staff as well. The research we are doing to a high extent is dependent on research done by doctoral candidates. Then it is important to have doctoral candidates with the right profile both in terms of interest and energy, and that they are rather self-going. The human resource is an important investment… (Professor, Swedish university, December 19, 2012). (Interview no. 36).

Funding is critical to research as seen throughout the interviews with researchers participating in the Transport Area of Advance program. While a few expressed concerns with the current patterns of funding in Sweden and the increasing convergence between academic and corporate research, others acknowledged that that researchers can combine academic work with industry collaboration. Reiterating what was stated in chapter 3 and in line with what Godin and Gingras (2000) and Van Looy et al. (2004) have argued, it is not an either-or situation; successful universities and university researchers are able to combine academic excellence with industrial contacts and/or entrepreneurial contributions.

> In order to conduct my research I need finances to finance my project and normally this financing goes to pay PhD students and post docs and then I work together with them in research. Then it is much more fun and you can get better results if you can collaborate both with industry and other universities […] financing is always critical I guess. I mean you apply for money and then you get a project which runs for 3 or 4 years. It seems that it is a long time but it is short so you need to continuously apply for new money of course… (Professor, December 3, 2012). (Interview no. 37).

> First of all, finance is the most important factor, and then human capital in the sense that it is very important to have skilled researchers at your institution or with collaborating institutions so network is also important. And then for doing good research in my field of research you need a good understanding and a good collaboration with the shipping industry and policy makers. (Professor, Swedish university, November 13, 2012). (Interview no. 38).

> Well, it is always important to have resources […]I think one of the main things in a research is to find good people, to find senior scientists who know both about both technology shipping and the environmental issues and there are not that many people who have this double competence. And then if you talk about finance, of course you cannot do research or build up research groups without finance… (Professor[40], Swedish university, November 16, 2012).

Several respondents identified government funding as the most important reason influencing their decision to engage in collaborative research projects. They also identified public funding as the most relevant factor for the short and long-term sustainability of their projects. However, several among those interviewed suggested that human resources had equal importance compared to funding. It is not surprising that researchers engaged in the Transport Area of Advance program considered the quality of their research teams as relevant as funding, given that they value and nurture strong research teams. In addition, senior level researchers and academic professors depend on having competent and well qualified teams as well as funding for the continuation of their projects. Funding in academia is an integral part of the daily activities in universities.

[40] Same respondent as interview no. 30.

9.3 Funding enables and constrains internationalization

Funding is only one of the several mechanisms for generating research cooperation benefits. It enables researchers to organize and coordinate research activities, to travel, to present their findings in conferences and to participate in scientific mobility programs. From the institutional logics perspective, the three STI programs can be seen as examples of how two logics are linked. One is the logic of the researchers and the other one is the logic of the government. The logic of the government which is to set policy goals to align Swedish research and innovation with the wider world is conjoined by the logic of the practitioners in science, technology and innovation, represented by academia and industry. Academia and industry abide by their specific logic of raising money, organizing activities, forming networks and collaborations. The intermediaries or funding agencies aim to bridge the two interests.

As illustrated in section 8.2, funding is a key mechanism for the performance of research activities but it has limitations as a tool to advance internationalization of science, technology and innovation. Its shortcomings and often short supply causes it to generate dilemmas at times. Thus, funding is perceived as an unsatisfactory mechanism in internationalization because of the trade-offs and dilemmas associated with specific public funding initiatives. These initiatives are part of the broader research funding model.

Public funding allocation is embedded in a larger system of research policy governance as discussed in chapter 6. In this larger context, sponsors of research influence research actors at universities – the actions taking place within the academic system are dependent on and structured by the funding agencies (Benner and Sandström, 2000). I draw on a few examples based on interviews conducted with researchers in the Transport AoA to show that funders influence academic researchers. By the same token, one can argue that the current research funding system affects researchers' views of internationalization.

Research and research collaboration activities have become important assets. These activities are used as instruments to bring researchers from different countries together. They are also instruments used to inform policy-makers and they are crucial activities for advancing innovation and technology development. But in spite of their core role in science, technology and innovation, research

activities and research cooperation have been impacted by national and international trends regarding the governance of research, more specifically, the way research is funded.

Moreover, industrial and political interests have been integrated into the evaluation, organization and performance of academic research which has challenged the collegial control of research (Benner and Sandström, 2000). Sponsors of research, in addition to political and economic interests contribute to changing the institutional order of academic research by structuring research performance and institutional norms and by enabling the replication of research organization when researchers are awarded grants and receive recognition (Whitley and Gläser, 2014). Thus, actions within the academic environment are influenced by funding bodies.

The following claim reflects a negative view regarding grant distribution. The researcher at Chalmers University, participating in the Eco-innovation Cooperation program with China argues that grants are unevenly distributed with funding agencies favoring industry. The following statement highlights the challenges researchers face in a system that is dependent on external funding. One challenge mentioned by the professor is the concentrated efforts in consortia building when the consortia must meet the terms of the call for proposals. This means that internationalization as a tool to achieve different goals in science and technology also faces challenges such as funding availability, funding distribution and prioritization. Moreover, the following example implies that in the current Swedish funding model, there is also a choice to be made regarding the beneficiaries of the funding (e.g. industry versus academia).

> They have the role of distributing applied research funds in Sweden and that they should do towards innovation but I also think they should have similar programs as they have this VINNOVA-MoST (Chinese Ministry of Science and Technology) before on applied research but more with academia, more naturally in need of academia. That kind of program, because Vetenskapsrådet [is] going even more towards fundamentals in the applications they approve. So, at the moment there is a gap in between. And the EU also gives 100% funding to industry now. So it means there is more focus on really action and hands on products and needs and less money for academia in EU programs and VINNOVA is going in that direction, more innovation, closer to industry, to industry needs. So one pre requisite for this program was SMEs on board that have a business case in China. So, for me to set up this was not easy and I

> managed, I did a heroic work […] I worked 16 hours per day (Associate Professor, Swedish university, September 2nd, 2014). (Interview, no. 39).

When asked which actors have influenced her research, an associate professor at the Chalmers Competence Center for Catalysis explained that a number of actors (national and international) have been key in shaping her academic activities. The statement suggests that not only research collaboration but also student mobility is a crucial component of academic activities. She also emphasized the importance of financial support to her research projects.

> […] I would say enabled. In all these cases we have connections and overlap between the different projects. I sent one of my PhD students to Finland. That was a start of a very fruitful collaboration. He was there for 3 months and after that we continued to collaborate; they do some experiments there, we do some here. We discuss through e-mail and publish together. That is the collaboration that all of us benefit from. They have inputs and other types of equipment than we don't have and then together it is very fruitful and we get strong publications. And that is similar with others […] In order to conduct my research I need finances to finance my project and normally this financing goes to pay PhD students and post docs and then I work together with them in research. Then it is much more fun and you can get better results if you can collaborate both with industry and other universities. I think all of those are really important in this industry because you get other inputs from other universities. You, together with other universities can reach other types of equipment and combine other techniques and so on. And I also collaborate a lot among professors just around me and at Chalmers of course with both techniques and equipment (Associate professor[41], Swedish university, December 3, 2012).

The following is an interview excerpt conducted in 2015 with a CEO of a small Swedish company participating in the Sweden Brazil Eco-Innovation Cooperation program. When asked to describe some of challenges encountered when working with the project, the CEO explained:

[41] Same respondent as interview no. 37.

> […] Yes, money, it is always money. So, eventually this project was very weakly funded in the second half because there was not really any substantial second stage that we could discuss with our contacts in Brazil which made this very difficult to achieve any kind of results other than meeting people and just keeping in touch. To have a continuation and or to have, or to achieve some results you need to have some kind of funding, more substantial funding so that you can drive the project, essentially […]The most important outcome is that I realize it is very very difficult to do anything in Brazil and probably it is unlikely that we will do anything in Brazil if it is not very heavily funded in advance because everything seems to be very difficult when it comes to distance in Brazil. Especially if you are in any corporation in Sweden, if you are a Swedish SME. (CEO[42], small Swedish company, September 9, 2015).

The same CEO replied the following when asked how important the government grant was for the continuation of the project.

> It was essential, of course otherwise we would not, because you know, it is very high risk and since the outcome was very lean in our side we would never have done this project without funding from VINNOVA. Because it is very difficult to otherwise to justify this kind of project (Company CEO, September 9, 2015).

The next statement, by a business consultant in Sweden, working with two other Swedish start-up companies, illustrates the challenges encountered during Phase A of the Eco-Innovation Cooperation with Brazil. Like in the previous example, the following account also suggests that international research cooperation is risky and uncertain. These statements indicate that without sufficient funding, internationalization is hindered and confined within Europe.

> Without that money, nobody in this group would do anything related to Brazil. Why? Because they are small companies – the universities I would say are different case because they participated more with the knowledge and not with resources, contacts, they did not invested so much time except for short time. I am talking about the Phase A before we got approved so during this phase it was more intellectual support and contacts at the university. So, there is the key company, [company A] they have the technology with another company called [B] that has part of technology. So, [company A] and [company B] are small companies but with a very interesting technology. But they could not and it would not be part of their company development to travel to Brazil without

[42] Same respondent as interview no. 29.

> receiving any support. With the support, they think it was interesting as they would think China would be interesting, or the U.S. would be interesting to them or India. But daily they are focused on and where they invest their time is obviously in the region Scandinavian region here as they are small companies. They don't have the capability, structure, knowledge or financial resources to opt, let's say let's go to Brazil instead of penetrate the Danish market. So, for them this type of decision, they would first invest in Denmark before investing in Brazil. So, I would say that it would a happy coincidence, support from VINNOVA, a Brazilian at a university and I, with my company and my contacts that we got together and had a good project (Owner[43], Swedish consulting firm, August 25, 2015). (Interview no. 40).

The above claim indicates that internationalization is shaped by processes that tend to be unpredictable, that might result in uncertain outcomes and an overall lack of clear direction. This lack of a plan or conscious decision impacts internationalization and it subsequently affects STI cooperation activities. As the above example shows, this "casual attitude" was most evident among the two Eco-Innovation Cooperation programs with Brazil and China. In these two cases, some grant recipients indicated that funding reasons outweighed the geographic location factor when applying for government support. For some, the latter was not a decisive factor in the grant application process. In other words, it is likely that geographic location would not have been a factor swaying applicants' decisions to apply for funding regardless of country selection. According to the same respondent as above, "… *Would not be part of their company development to travel to Brazil without receiving any support. With the financial support, they think it was interesting as they would think China would be interesting, or the U.S. would be interesting to them or India."* (Interview no. 40, August 25, 2014).

The following example corroborates the above statement. According to the respondent, the inadequate distribution of funding or the lack thereof hinders internationalization goals. The following claims by an individual working with business development and marketing at a research institute in Sweden indicates that funding may play a key role in steering the direction of internationalization.

> […] We tried to engage Swedish SMEs and develop solutions but when it came to the possibility of traveling to Brazil for one week, they simply gave up. So,

[43] The respondent has recently sold his consultancy.

> with SMEs, even if you promote them, and open the doors for them, in the end if they have something more important in Sweden, they will go with that. They say they will go where they have the funding. SMEs in Sweden do not have time to be strategic. And to go far away, you must have a strategy, step-by-step plan and very few companies have this vision. SMEs in Sweden do not have a long-term view and they have problems penetrating foreign markets (Project manager, Swedish research institute, August 22, 2014). (Interview no. 41).

The same respondent discussed his views about internationalization and expressed his concerns about how internationalization is perceived in European countries, including Sweden.

> I follow this international view for a long time and I think that the European Union has been very closed in their research and Sweden even more and you have the idea to build up the strongest group in the world in your home country or the in the EU. This does not work, you must open your eyes to Brazil, to India, to China, to Japan, and you must not see them as enemies that you compete with. Before it was always said we should compete with Japan and the U.S. In the new globalization, you need partners everywhere and to understand each other and for that you need to build up research networks. This is the way forward for both sides. It is a win-win situation. If you look at the money from the EU, now more and more you can engage with researchers even in the Horizon 2020 which was not allowed 10 years ago. The money from Europe Aid goes more and more to strategic research cooperation. So this is the way forward for everyone. So you have to be more clever when establishing this and most countries are nationalistic (Project manager, Swedish research institute, August 22, 2014).

In summary, in a quasi-centralized system of research governance, funders promote specific priorities and interests giving applicants money to address these priorities. Government funding is translated into freedom to conduct research but this freedom is "specified" under the terms and conditions of calls for proposals. Academics regularly adjust their research interests to funding opportunities. This adjustment is perceived as necessary and routine. It is also viewed as a compromise between joining new cooperation initiatives and receiving funding on the one hand and temporarily putting aside other research projects on the other hand. In reality, there are shortcomings embedded in such public research funding schemes. These can be in the form of perceived trade-

offs. Thus, some funding instruments are not entirely optimal because they create "researcher dilemmas" which might adversely affect internationalization goals and practices.

9.4 Funding elicits reactive behavior

Government-funded research programs elicit a reactive behavior from funding applicants. In other words, applicants respond to a stimulus in the form of call for proposals. When they behave in this particular way, they are also being responsive given that researchers organize themselves and write grant applications; therefore, promptly reacting to funding opportunities. In addition, I argue that they exhibit a receptive behavior because they voluntarily join new initiatives. In chapter 8, I showed how key academic actors responded to new funding initiatives such as the Strategic Research Areas (SRA) call for proposals. During a phone interview with the vice-president of the Chalmers' Areas of Advance, in May 2015, she explained how higher education institutions are constantly preparing and anticipating funding opportunities. As she put it, *"When that Bill came in the Autumn of 2008 we were pretty much prepared for that. We did not know which areas would be selected. Some of them were perfect for us."*

Thus, it is reasonable to argue that researchers and companies engaged in research cooperation projects with universities are proactive funding seekers and also exhibit a reactive behavior to funding opportunities. In the Swedish funding-laden model, researchers are continuing responding to calls for proposals. As seen across the three case studies, academic researchers and SMEs are engaged in multiple funded activities. They try to align new funding opportunities with their overall stream of activities and research projects in a fairly rational and pragmatic fashion as I described in chapter 8. The interviews show that different actors are receptive to new government funding schemes aimed to promote internationalization and based their decisions on pragmatism, whereas the decision-making process leading to the design of these new cooperation programs emerge from less pragmatic processes.

A number of respondents across universities, research institutes and companies participating in the three programs argued that in today's funding system in Sweden, searching for new funding opportunities and meeting funding

requirements are perceived as normal and expected. This is similar to one of the strategies used by academic researchers to increase their likelihood to obtain funding discussed in Laudel (2006). This strategy is referred to as *selecting externally predetermined topics.* In this case, funding agencies define research topics and scientists try to adjust their projects, a top-down process (Morris, 2000). This is different from the strategy employed by academic actors in the context of the Transport AoA. In the context of the Chalmers Transport AoA, a group of academic researchers spearheaded institutional changes within the department through internal measures which enabled them to meet the upcoming Research and Innovation Bill that defined the Strategic Research Areas (SRA). The SRA contained in the 2008 Bill was a funding instrument from which the Chalmer's Areas of Advance benefited.

When researchers respond to funding agencies' calls for proposals, they adjust to the priorities and guidelines set by the funding agencies. This means that if the calls match researchers' interests, they respond by entering the competition for funding. From the researcher's point of view, there is a need to adjust to priorities and general guidelines set by funding agencies.

Adjustment is viewed as an integral part of researchers' daily activities. In this reactive form, researchers act as expectants of external funding, continuously searching for new grant opportunities. Some of funding expectation and anticipation are well aligned with funding opportunities. For instance, researchers might have personal connections with the country specified in a particular government-funded research call as shown in the case studies. In other instances, the researcher himself might be from the country specified in the call for proposal.

As discussed earlier, the research funding system encourages an interdependency between participants (audience) of government-sponsored programs and the programs themselves (objects). The funding agencies publish calls for proposals. Actors respond to these calls based on pragmatic and opportunity-driven behavior. The audience (e.g. academic researchers and other participants such as industry) sustains the programs by the continuing responses to the grants. The existence of these programs is rooted in the presence of a constellation of actors that are receptive to the funding opportunities and who support them. Below is an excerpt of the interview statement discussed in section 8.2 by a professor at

Chalmers University working in the Transport Area of Advance. The claim illustrates this interdependent relationship.

> […] When it comes to the funding agencies, they set the framework because we have to have our research funded and if they don't fund us, we will not be able to do anything. I mean we respond to their Calls for Proposals. So if there are Calls that fit with what we are interested in then we respond to that. But we are doing research in areas where we can get the funding. So, we are adjusting to that (Professor, Swedish university, May 17, 2013). (Interview no. 42).

9.5 Grant seeking: A pragmatic behavior

Applying for external funding emerges from a conscious and pragmatic behavior. The empirical data based on interviews shows that the act of applying for funding has implicit in it what I term *pragmatic grant seeking behavior*. In other words, the majority of those interviewed perceived not only funding as important but applying for funding as a natural act and as a necessity. Thus, policies are formulated and are implemented through a number of instruments, for instance, research collaboration programs that involve universities, research institutes and industry. These instruments are then manifested in calls for proposals to which researchers respond. These calls are integrated into research projects as researchers adjust and adapt to these calls to receive funding. For some, adjustment and compromise is well-accepted. For others, this adjustment is seen as negative.

The practicality and pragmatism of research funding seeking are engrained in the academic activities of scholars but also in the routines of SMEs who have participated in the same referred projects with their academic counterparts. This pragmatism that motivates researchers to search for funding and to engage in government-funded internationalization activities stands in sharp contrast with the ideals of internationalization expressed by those interviewed (e.g. to increase a country's competitiveness, to reach the international research frontier, to export models of research collaboration to other countries, to help Swedish companies to bring their products in the market).

> […] So, we get input and feedback from the companies on what we are doing. They are of course interested in the products and finished things but we get

> information on what they think is important for the future and that can lead to interesting technological challenges. We have also to reformulate in a way that is interesting from the scientific point of view. Normally there is no problem in finding things that are important from both the industrial point of view and a scientific point of view. We get ideas and feedback on how to prioritize needs and research for the future from companies. With the university collaboration we are defining our problems together. There is a continuous dialogue to define what the important scientific questions are. We are influenced by the scientific discussions that go on in our collaborations and in scientific journals and those influence what we are doing. When it comes to the funding agencies, they set the framework because we have to have our research funded and if they don't fund us, we will not be able to do anything. I mean we respond to their Calls for Proposals. So if there are Calls that fit with what we are interested in then we respond to that. But we are doing research in areas where we can get the funding. So, we are adjusting to that (Professor[44], Swedish university, May 17, 2013).

9.6 Summary and conclusions

This chapter has focused on the micro level dimension of international STI cooperation, the locus of research performance. I have laid out the different views about public funding across universities, research institutes and companies. In addition, this chapter has discussed researchers' responses to government-funded STI cooperation programs which include international scientific collaboration. This chapter has examined how the current research funding model affects researchers' views of and responses to internationalization. Based on interviews with different actors, I have elaborated on the four main findings regarding funding: 1. funding is a dominant and suboptimal tool; 2. funding is an enables and a constrains internationalization; 3. funding encourages and reinforces a reactive behavior from grant applicants and 4. funding seeking is a pragmatic behavior.

The continuing response to calls for proposals is a manifestation of opportunity-driven and pragmatic behaviors that, in the context of Sweden, is anchored in a funding-laden model. However, without this type of behavior, the establishment

[44] Same respondent as interview no. 42.

of these programs would be less feasible. These programs have sponsors who are driven by the need to fulfill international agreements, which characterizes a practical approach to policy, and who are driven by interests in pursuing experimentation in program design. At the same time, the same sponsors work with grant recipients who are driven by funding opportunities and focused on ongoing funding calls.

In spite of being a relevant tool to aid research practices and to advance internationalization, specific government funding schemes can also be seen as infused in a larger research system context. From an institutionalist perspective, this larger research system context is in turn shaped by a number of elements such as national policies, governance of universities and direction and funding of research (Benner and Öquist, 2012).

The empirical material and discussion in this chapter have showed that funding affects actors' perceptions of and responses to internationalization. I have provided compelling examples and have demonstrated that government research funding plays an important role in internationalization. Funding can also be used to intentionally steer the direction of international cooperation in science, technology and innovation. It might also have unintended consequences such as generating implicit trade-offs. Funding initiatives can revert the internationalization momentum when these initiatives generate trade-offs and dilemmas. For instance, dilemmas might stem from pressure to decide between two competing alternatives.

Furthermore, government support to research collaboration given in the form of specified or unspecified grants is translated into freedom to conduct research. However, this freedom may be limited at times by the terms of calls for proposals launched by funding agencies. On the other hand, this funding arrangement where funders are the money providers and the grant applicants are the consumers of this government benefit is perceived as a win-win situation and as a compromise. In reality, it masquerades interests that are often incompatible; interests of funding providers and funding consumers. T Thus, some funding instruments are suboptimal because they might adversely affect internationalization goals and practices. These dilemmas appear in different forms. For instance, researchers might forgo other activities as they must spend time preparing grant applications instead of focusing on ongoing research projects.

A few broader conclusions can be drawn from the discussion in this chapter. First, a major challenge for research policy and the governance of universities is to provide financial support to scientists primarily for scientific exploration or for quality and creative research. But because scientific exploration is perceived as risky and associated with uncertain outcomes, this activity might not be well perceived or received. Second, it is clear from the interviews conducted with different actors across universities, research institutes and industry that there is no ideal funding model that addresses all the concerns expressed by the different actors. The crafting of specific research cooperation programs are intrinsically connected to the funding mechanisms that sponsor them. The latter is in turn dependent on the policy actors that formulate policy directives. Therefore, the elaboration of proposals for government research funding depends on the goals policy-makers intend to fulfill with the funding instruments they put forward.

Chapter 10 Conclusions

The design of the two international Eco-Innovation Cooperation programs and the implementation of the Chalmers' Areas of Advance through the Strategic Research Areas (SRAs) funding mechanism reflect the interplay between responses to recent global developments and internal policy processes. In the case of the Transport AoA, these response processes across academics and industrialists entailed, among other things, informal information transmission, and in the case of the Eco-Innovation Cooperation programs, it entailed practicality and pragmatism. In both cases, the intent to launch new initiatives emerged from policy experimentation. The perceived need to invest in and to improve research quality is influenced by governments' desire to compete internationally. "Global forces and local structures work together" (King, 2010, p. 583) with globalization rooted in the national (Sassen, 2006; Appadurai, 2005).

The change in the knowledge and innovation landscape, the increased focus on emerging economies, the recent developments in information technology, and transnational trade agreements are examples of recent global developments. In addition, recent trends in innovation and knowledge-learning capabilities have shifted modes of production or as Chen and Wen (2007) have argued, the disintegration of production around the globe and the disintegration of innovation capabilities. For example, today, indigenous firms and industrial clusters in developing countries are able to undertake functions that used to be predominantly carried out by developed countries (Chen and Wen, 2007). Nevertheless, at the same time that policy making at home takes place independent of international influence, it is also linked to and shaped by exogenous circumstances. This means that global trends influence domestic decisions and policy actors' behaviors. For instance, global shifts can steer government decisions into a certain direction; policy actors might prefer to forge S&T linkages with certain countries based on their views about the relevance of

consolidating international relations with those countries. Therefore, internationalization practices are not only determined by how nations interpret them but they are also contingent upon the actors that have the autonomy and power to sway policy processes.

In this thesis, I have addressed three research questions. The first question is: *Why do governments promote internationalization of science, technology and innovation?* This question analyzes government's rationales for promoting and funding international cooperation in science, technology and innovation. The second question addressed in this thesis is: *What factors shape the formulation of government-funded international cooperation programs in science, technology and innovation?* This question analyzes the factors shaping the design of the two Eco-Innovation Cooperation programs and the Strategic Research Area for transportation, all of which are government-sponsored initiatives.

The third question addressed in this thesis is: *How does the current research funding model affect researchers' views of and responses to internationalization?* The this question has been addressed by examining the views and responses of different research actors to government-funded STI cooperation programs. I have accomplished this by interviewing actors who work in research and non-research settings and by analyzing interview transcriptions and government reports.

The aim has not been to evaluate the three STI cooperation programs but rather to explore drivers of international STI cooperation and internationalization, and processes and dynamics that shape policy choices relating to STI. I have chosen these particular cases because they reflect different approaches to the alignment of national researchers in an international context by emphasizing the linkages (VINNOVA) and international competitiveness and visibility (Areas of Advance). I selected these three programs because there are similarities and differences across the initiatives and for that reason there is an opportunity to introduce variation across the three cases and to highlight the peculiarities of each case.

In terms of comparison, the Transport AoA is a program without specific expectations of international collaboration whereas the two Eco-Innovation Cooperation programs are inherently international in nature. The conceptualization and composition of the three programs differ significantly. For instance, the Transport AoA program has emerged from a more informal

decision making process to boost broadly defined, intendedly strategic, research areas and in turn, research quality and international visibility of Swedish research. The two Eco-Innovation Cooperation programs originated from a practical approach to policy-making to forge international collaborations with countries and regions deemed politically and economically strategic for Sweden. All three cases demonstrate that internationalization is at the intersection of international events and the national setting. This means that global trends coupled with domestic policy processes shape internationalization and how it is utilized as a tool to achieve a variety of policy goals.

Moreover, I have shown that policy officials across ministries and funding agencies have emerged as key players, shaping the decisions to forge international ties and to support thematic research areas. The empirical data and the reflections presented in chapters 7,8 and 9 indicate that in addition to the macro and meso levels, influential actors at the micro level have also shaped research practices and internationalization activities in (alleged) response to both global trends, domestic policies and funding needs. These actors at the micro level are university researchers and project leaders across Swedish research institutes and businesses.

Based on the empirical evidence I have presented in this thesis, this chapter highlights and discusses four main findings. The first finding refers to the role of specific individuals and government agencies. Internationalization, which is often interpreted as a tool to improve research quality, to increase scientific mobility and to forge international research cooperation, is contingent on the actions and intentions of specific individuals and government agencies. These individuals and agencies influence decision making to finance and facilitate international relations in science and innovation. Therefore, internationalization reflects a mixture of actions and intentions from different actor constellations.

Second, internationalization policy tools do not follow a consistent and linear path. One possible explanation is that this occurs as a result of a tendency towards informality, oscillation of ideas and randomness in policy decision making from which the initiatives described here have emerged. This topic has been examined in chapter 8. Thus, internationalization follows a non-linear path characterized by unpredictability, with struggles and redefinitions of goals as highlighted in the three case studies. In addition, government officials play a key role in shaping these informal settings in policy making which influence the

crafting of specific international programs in science, technology and innovation.

Third, internationalization activities are dependent upon and driven by the role of funding at the micro level. Fourth, there is a significant gap between the meaning of internationalization in theory and in practice. Thus, internationalization is both interpreted as a tool to fulfill "ideals" (e.g. disseminating "best practices") and as an element in research and innovation policy with pragmatic rationales to fulfill political and economic goals.

10.1 Discussion of the key findings

This section discusses the main conclusions in relation to internationalization of STI. Section 10.1.4 discusses one of the main findings in relation to policy making and the last section (10.1.5) examines the role of funding as an enabler and as a constrainer of STI cooperation.

10.1.1 Internationalization: A mix of intentions and influences

Internationalization does not exist independently from the institutions and actors that shape it. A constellation of actors drive internationalization and intervene in internationalization. This intervention occurs at two levels: macro (ministries) and meso (funding agencies). Policy actors intervene by developing targeted STI cooperation instruments and by adopting policies. They might intervene by launching new programs and by advertising research funding opportunities manifested in calls for proposals. Internationalization activities that are integrated into research and innovation policies are conceptualized and articulated at the ministry level and interpreted at the meso level. The interpretation of policies at the meso level is manifested in the form of science and innovation programs with both domestic and international focus. As a government official puts it, *"The government chooses, through its administrative agencies such as VINNOVA, to design new initiatives from the very beginning rather than building on old frameworks or templates"* (Interview no. 24, government official, April 12, 2016).

Although research, business and policy actors respond to global trends, their decisions, intentions and goals are also influenced by the same institutions of which they are part. However, these international trends do not simply permeate national borders and change processes from the outside. International circumstances are filtered through national institutional settings, conventional habits and models of policy formulation. Similarly, dependency influences decisions about internationalization. This means that past decisions can play a role in present actions; political decisions are made with reference to the past. The signing of a bilateral agreement and the design of an international research cooperation program based on that agreement serve as examples. In addition, the forces that influence decision making in policy and actions toward internationalization outlined in chapter 8 are not based on the delineation of a clear goal or based on rationalist assumptions and behavior.

In chapter 8, I demonstrated, through a series of interviews with government officials, that international strategy in Swedish research and innovation policy is contingent upon actors' actions, ideas and perceptions of how global trends affect domestic issues. Policy actors' attitude towards international events will in turn affect the way they frame internationalization in research and innovation policy. This can be seen in the 2008 government strategy report, which was mentioned in Section 8.4, and which outlines a view of internationalization as urgent and as a driving force behind policy change at the national level.

The 2008 strategy document illustrates that internationalization has been loosely connected to an overall strategy and plan, serving primarily as a general background and framework for policy, and not as a binding commitment. This can be interpreted as a certain vagueness and openness in relation to internationalization, and that it can be tailored to different needs and interests depending on circumstances. Agreements between governments are examples of how internationalization functions as a tool to further different goals. For instance, when ministers travel on an international relations mission to another country and sign a bilateral agreement with the host country, that agreement might eventually result in further alliances. An agreement can be a starting point and the cornerstone of the formulation of the next international research cooperation initiative but may also only serve as a symbolic commitment. Thus, overall, internationalization is significantly dependent on the ideas and intentions of a constellation of actors in the same government branch or across different government agencies. Ideas about international cooperation continuously emerge but it does not mean that they come from a systematic and

rational process that involves a thorough assessment of potential benefits and risks of creating new programs with specific countries. One possible conclusion is that these contingent intentions by policy actors perpetuate a project-oriented internationalization model where a series of initiatives are developed to satisfy political and economic goals. This tendency is reflected in the following interview passage by a government official:

> …If you sign a cooperation agreement with a country like Vietnam then usually you agree that every two years you have a meeting with that country to discuss the project progress and at that meeting the minister is going to want to say that we funded ten projects with Vietnam and that is us. And that becomes totally symbolical or initiative-laden because that is the way you can quantify […] politicians are able to say we allocated ten million to cooperation with China, then you fund ten projects but they might be totally meaningless in the scope of things, you know it might have been much better to develop a joint biotech … with China but that did not happen because it is funding-laden (Government official[45], funding agency, April 12, 2016).

One probable implication, suggested by the above statement, is the non-systematic policy making process, resulting in inconsistencies in the political arena. The same government official declared, *"At the same time that the Swedish Government sets guidelines for STI strategies and it has strong convictions about what countries it should forge ties with and what research areas and industries should be promoted, it takes a "hands-off" approach to internationalization."* (Interview no. 24, April, 12, 2016). The premise is that Sweden promotes internationalization through the articulation of specific cross-border research programs with specific nations in the form of strategic internationalization. These can include countries with which the Swedish Government has signed bilateral agreements or countries of particular interest to Sweden that are perceived to contribute to advancing the country's overall research quality.

The above statements suggest that intentions and specific ideas are disseminated and adopted. It seems that at times there is a preference or a desire to sign memorandum of understandings with specific countries and to forge research collaborations with those countries. On the one hand the articulation of policy practices regarding internationalization seems to oscillate and it seems vague with no precise goal in the horizon. On the other hand, by delineating a future

[45] Same respondent as interview no. 24.

of which specific countries are part and by encouraging Sweden to forge S&T ties with these nations either minimizes the absence of a clear plan or may indeed be the objective. This indicates a direction but not within the framework of a planned strategy. Hence, there is a lack of overarching strategies for internationalization.

The results and analysis of this thesis indicate that policies single out internationalization of research, technology and innovation as a practice that is normally carried out in connection with other goals (international development in the form of aid assistance, export and trade, industrial policies, etc.). The discussions in chapter 7 about policy making processes reveal that internationalization is conducted in conjunction with other policy intentions, as for example, the fulfillment of multiple goals.

10.1.2 STI Internationalization: Linked to other goals

As discussed earlier, Jenkins (1978) acknowledges that a policy process consists of a series of interrelated decisions. Policies to foster internationalization of science, technology and innovation are often intertwined, formed and shaped in parallel processes. These policies are coupled with and related to other goals.

Policy actors conceive internationalization as a broader project in conjunction with other interests such as to commercialize products in foreign markets, to improve relations with other nations through science and technology agreements (science diplomacy), to promote a country's image as a leader in innovation (enhance international competitiveness) and to disseminate models of research collaboration. Internationalization is integrated into other areas such as political (e.g. foreign relations and diplomacy) and economic (e.g. export and trade).

The continuing promotion of transnational research cooperation in R&D also fulfills broader societal goals such as tackling climate change. Drawing from the Dynamic Policy Framework (Schwaag Serger and Remoe, 2012), the following example suggests that targeted instruments such as the Eco-Innovation Cooperation programs with China and Brazil are part mission-oriented interventions. These are established to address particular "arenas" (Schwaag Serger and Remoe, 2012) and include the implementation of international research cooperation programs to address global challenges. Another rationale for establishing such specific interventions through international STI

cooperation programs is to initiate "first-mover advantages with countries or regions with whom – due to political, economic or cultural reasons – bottom up STI cooperation has been traditionally less developed (Schwaag Serger and Remoe, 2012, p. 30). Moreover, the following example suggests that government agencies embark in specific cooperation programs when they are relevant to agencies' goals and overall mission. Thus, internationalization is a policy mechanism that can be used to address multiple objectives simultaneously.

> Yes, and that was of course when we went into this collaboration program, there was an agreement that we would fund projects and consortia which were relevant for our national mission, which is the transition of the energy system into an energy system based on renewable energy resources. Also, of course, under the sort to say climate umbrella. The climate is of course the overall driving issue in this respect, not only the long term supply of renewable energy (Official[46], Swedish funding agency, November 25, 2015).

According to Weiss (2015, p. 424), "science and technology rarely act on international affairs by themselves, but rather in combination with economic, political, legal and cultural forces." In the following claim, a senior level employee at a Swedish funding agency discussed the Swedish government's motivations for promoting science and technology relations with China. The following remarks might suggest that economic rationales drive interests in fostering S&T relations with China. It also implies that science and technology goals seem to be regarded as secondary and that policy was marked by the search for a viable export strategy to emerging markets.

The government official further argued that such strategy involves multiple actors and it requires cooperation and coordination among different stakeholders. These specific strategies include working together with research institutions and large corporations. The respondent's views about assisting Swedish companies with product marketing and commercialization imply that companies and research institutions function as "expert intermediaries" contributing their expertise and taking part in internationalization practices.

> Actually the reasoning I think it is often not so advanced**.** I think a lot of it is also thoughts about market potential and then there is some rather loose thinking

[46] Same respondent as interview no. 7.

> about the connection between that (market potential) and that we have to do something in science and technology…And then the other extreme is that we have now an export strategy. Because the export strategy also sort of starts out with the idea that we need to be better at exporting. But then how do you do that? And then you need quite different than just the sales channels. You need to be able to develop relations with many different actors and you need to do that in a way that sort of is legitimate and credible which means that you may need to work together with some others that have stronger competence in Sweden, for example, research institutions, either institutes or universities or some big company. So, you need to develop some relation which can then be useful in sort of finding suitable constellation in which to work before you actually get to the commercial projects at distant. And that requires – then you know the Sweden side, usually interacts between different actors and also on the promotion side if you will. (Official, Swedish funding agency, November 19, 2015). (Interview no. 43).

The above demystifies the perception that there are complex factors driving interests in forging science and technology ties with other nations, particularly with China. It also suggests that there are problematic notions in policy decisions that involve science and technology relations with other countries. One problem is the *"lose thinking"* in politics as the government official states. The other problem is the notion of *"extreme"* strategies. Regarding the former, the above claim suggests that there are two variables: market potential and science and technology (program or agreement). One issue is how to connect these two variables when there is a lack of political effort in thinking about how to link and utilize both to achieve a desirable outcome. The respondent referred to it as *"lose thinking"* in political decisions. Another factor is that seeking market opportunities and "establishing first-mover advantages" with other countries is a different goal than engaging in science and technology cooperation. And although these two policy goals are inheritably different, they are often bridged and used in narratives of international competitiveness. For instance, science and technology can be used to achieve market potential and market potential can be an economic driver for designing, funding and signing science and technology programs and agreements. The same applies to internationalization as discussed earlier; often internationalization and other goals and priorities (e.g. political, economic) occur in parallel.

Based on the above analysis, I argue that internationalization is seen as contextual and directional because it is influenced by time and events and by

actors' specific interests and goals. Its success and sustainability depend on the factors informing actors' decision-making about joining and investing in internationalization. It also relies on how policy actors choose to either integrate it with other goals or treat internationalization as an independent tool with its own mission, strategy and objectives.

Internationalization is dependent on the political structure and institutional set up which affect how it is framed. Often other interests and priorities play a role in the articulation of internationalization instruments (e.g. international STI cooperation initiatives). Overall, internationalization programs stem from economic interests such as trade agreements and political interests which permeate internationalization processes.

In summary, science and technology as well as international research cooperation agreements, accomplished through internationalization mechanisms often work in conjunction with other objectives. Second, the above formulation of internationalization as a tool that aggregates economic and political interests, leads one to believe that internationalization has disassociated itself from a basic level approach. At such a level, research actors naturally interact and form partnerships with other countries. At the grassroots level, researchers see internationalization as a channel for interacting, learning and shaping the organization and diversity of research.

10.1.3 Mismatch between ideals and practice

There seems to be a mismatch between idealized views of internationalization and internationalization in practice and between traditional forms of implementation and what happens in the real world of policy making. Today's internationalization of science, technology and innovation partly reflects the tendency among policy-makers to set goals that are broad and that can be subjected to pragmatic alterations. Such broad goals captured during interview with respondents across the three research cooperation programs include broad and specific goals. Broad objectives include: to *enhance Sweden's attractiveness and reputation as a leader in innovation in the long-run and achieve the position of international research frontier.* Specific goals at the research institution level include: *become the world's leading university, promote transnational collaboration, to help companies to promote their products abroad and to disseminate the "Swedish model" of development, employment and research collaboration around the world.*

One perspective is that the above aims reflect idealized views of internationalization. One example is the interpretation of international STI cooperation as a channel through which models of research collaboration can be disseminated. The perception is that practices or "ways of doing things" in the context of developed nations can be replicated and translated into other contexts. These ideals also include notions of how specific regions of the world (e.g. the knowledge generating nations, also known as emerging markets) also viewed as sites for environmental problems, have become the locus for environmental solutions in recent years. These solutions are developed and brought to developing nations by industrialized countries.

As seen in chapter 3, the perceived success of the Swedish economic model created among Swedish society a nationalistic sentiment built on the conception of political and economic superiority (Lundberg, 1985). Thus, Sweden became a country that is considered a model to other countries. This view of Sweden as a socially advanced nation has expanded into other areas such as the environment. As a result, the Swedish model narrative is embedded not only in socio-economic and political discourses but also in development policy discourses of how industrialized countries can help developing nations to strengthen their science and technology capabilities. Promoting the Swedish model means to export Swedish values or technology solutions to wicked environmental problems.

Furthermore, a range of issues such as constraints of funding systems, human resources shortages and goals shaped in ad hoc processes, with uneven institutional and administrative support, make the ideals of internationalization more contingent on exogenous factors and negotiated on the ground. This means that internationalization in practice might differ from a more idealized version of internationalization. I refer to one example to illustrate the above claims. It relates to how the three programs - the eco-innovation and the Transport AoA - emerged. In both cases, the gap between the practice of policy making and the idealized form of policy making widened. Given the formal structure of political settings, one would have expected that all three research cooperation programs would have emerged from a more formal decision making process. However, findings based on the empirical material suggest a different outcome in practice.

Moreover, to argue that internationalization policies and goals are about fostering international linkages, facilitating domestic companies' access to large

markets and strengthening research practices disguises disjuncture in internationalization. This disconnect can be seen in a multitude of ways. One example is the constraints of various sorts faced by respondents who participated in the Eco-Innovation Cooperation programs with China and Brazil. Some of the challenges include scarce human resources or not enough financial resources. It is not surprising that a number of micro and small and medium sized enterprises are still oriented towards the domestic or European markets, given the overall market strategies that are unfit for certain types of companies. These factors interfere with internationalization practices, halting it instead of enabling it. Therefore, there is a mismatch between the expectations researchers have of what can be accomplished using internationalization tools and the reality of what funding can or cannot enable. In addition, internationalization is to a great extent contingent on the processes outlined above – policy formulation, implementation, funding and national versus international goals.

10.1.4 Inconsistent policy making

Based on the statements by the actors interviewed, I conclude that views and actions regarding internationalization oscillate and can be vague. Stochastic policy processes emerge from a lack of clear purpose and direction in internationalization as discussed in Section 8.6.3. The absence of a definite aim leads to oscillation and inconsistencies in decision-making processes. I define randomness in this context as a process through which decisions are occasionally left to chance. I point to the fate of internationalization which is contingent on piecemeal developments, informal and casual policy discussions and on the intentions of policy actors who are influenced by global trends. These intentions are translated into new ideas for international initiatives with specific countries in the form of policy experimentation. The conclusion is that the dynamics of policy making with regard to internationalization have been characterized by unsystematic and partial measures that are provisional rather than long-term.

The selection of specific countries for international research collaboration initiatives appears to be random and devised in a hasty and inconsistent manner, even though the general strategy is not random in its entirety (e.g. interest in promoting S&T ties with high research performing countries and BRICS-focus strategy, example from May 26 2016 interview no. 25).

Moreover, shifts in political decisions, transform science and technology cooperation among countries into irregular processes. Analysis from the empirical data indicates that markedly randomness at the policy level might stem from a lack of vision and understanding of the role of internationalization in general coupled with a tendency to "go with the flow," reflected in the interviews with government officials in Sweden. Thus, when decisions are made without a careful plan or clear vision, it might lead to less than optimal outcomes. Of paramount concern is that preoccupation with fulfilling the terms of bilateral agreements seems more relevant than concerns with directional policy making. Paradoxically, internationalization is dependent on the actions of the actors who shape it and on the policy making processes from where decisions on international efforts emerge. Hence, government actors, researchers and companies give direction to internationalization and use it as a tool to achieve a variety of goals. However, although government actors intervene and articulate policies and put forward proposals about which countries to forge research cooperation with, the actions of public administrators at the higher government level might sometimes be undirected, leading to unclear, inconsistent and provisional types of decisions.

10.1.5 Funding enables STI cooperation and drives behavior

From the perspectives of the respondents coming from the academic and business sectors, funding for research and technology development channeled through government-sponsored initiatives is a dominant factor to support and sustain the goals of internationalization. Therefore, based on my interpretation of how the Swedish funding system works and the activities researchers carry out, I make the three following remarks. First, funding opportunities shape actors' receptive behavior. This means that researchers are incentivized to search for ways to secure funding to continue their research projects. Although researchers are interested in forging international research collaboration, in the form of co-publications and through visiting scholars programs, such activities are contingent on the availability of funding. What are the overall implications for internationalization? I argue that researchers not only act in direct response to funding opportunities but at times they also refrain from participating in international activities in the absence of funding; therefore, funding directs their actions and plans, regardless of what these plans entail. Funding opportunities are engrained in individuals' behavior and shape actors' practices and decisions

about internationalization. At the same time, it would be misleading to claim that scientific interests only drive internationalization efforts.

The above argument has profound implications for internationalization efforts because such efforts become irrelevant when researchers move to an opposite direction and pursue their own interests. I bring two examples to illustrate these claims. The two examples were presented in chapter 8. One refers to the Swedish consultant who has worked with two Swedish start-ups, by helping them to find business partners in Brazil. From the perspective of the two start-ups, the Eco-Innovation Cooperation project with Brazil had several challenges. The owners of the two companies expressed concerns about geographic distance, insufficient resources to conduct business in emerging markets and lack of man power to pursue business interests in Brazil or China. As a result, the company's owners decided to prioritize the Scandinavian market. The other example concerns the owner of a Swedish startup I describe in chapter 1. In this case, the owner also decided to focus on the European market as opposed to pursuing business opportunities in emerging markets in the near future. Likewise, when funding is scarce, research actors will not pursue costly projects with other countries simply because lack of funding constrains their actions. This argument corroborates the conclusion that the current funding model in Sweden perpetuates an opportunity-driven behavior.

Second, although funding drives receptive behavior and promotes opportunity-driven behavior, not all researchers seeking funding have complete freedom to decide the direction of their research. In order to illustrate the above argument, I refer to an earlier example discussed in section chapter 8, involving a researcher working with the Chalmers Transport AoA, who explained how funding had shaped his research. The professor argued that he was conducting research in areas where he could obtain funding which leads to the conclusion that his was primarily a pragmatic choice.

Relying on external funding to move research projects forward can mean adjusting the pace, goals and dynamics of one's research. Funding agencies shape the direction of funding opportunities. Moreover, the overall perception is that funding agencies have a great degree of autonomy and leeway when designing science and technology programs just as street level public workers discussed by Lipsky have relative autonomy in their line of work. Public administrators and decision makers in funding agencies serve as intermediaries between higher level

government and citizens. They are the "human face" of policy, according to Lipsky, as these workers interact directly with society.

Third, funding is the researchers' default choice regardless of their commitment to and interest in internationalization. This has significant implications. First, this situation generates what I have called a "researcher dilemma" and forces researchers to have to make difficult choices, perceiving funding as causing trade-offs. Some of these dilemmas are reflected in the interviews with various actors. These dilemmas include having to choose between pursuing business opportunities with emerging economics and focusing on the local market (e.g. Europe). Another implicit trade-off is the choice between pursuing research projects in the area of interest and focusing on research projects that are more likely to receive government funding. Given these dilemmas, I contend that funding can be less than an optimal tool to promote internationalization and international scientific collaboration.

This reduces internationalization into a secondary option and funding as the most important choice. Thus, funding opportunities tailored to specific research areas or countries isolate internationalization instead of broadening it and steer research activities into a certain direction. In the meantime, there are research networks being formed around the world and societal challenges that need to be addressed.

What do the above conclusions mean? The funding model has changed over the years. The funding system has, in Sweden and elsewhere, become more project-driven which means that actors are continuously searching for grant opportunities and are rewarded by their ability to attract funding. This means that internationalization efforts become part of this system but in a stochastic way. I argue that in some instances, political decisions emerge in random processes and at the same time, there are forces that support and sustain fluctuations in policy decision making. This includes grant seekers, driven by the need to secure funding and adjusting to the terms and conditions established in the calls for proposals. For some of these grant seekers, the requirements specified in the calls for proposals (e.g. partner countries or types of research consortia) are irrelevant and a secondary factor in researchers' choice to apply to the funding. This seemingly haphazard behavior in politics drives funding seekers' receptiveness to funding opportunities in an interdependent and mutually reinforcing manner.

10.2 Potential implications for STI policy

This dissertation has discussed internationalization as a phenomenon that is intrinsic to today's modern society and shaped by national and international forces. It is also a central mechanism and as a tool in research and innovation policy. Internationalization as it relates to science, technology and innovation plays a role in the governance and the practice of science because it is a tool for the dissemination of scientific discoveries. This mechanism for disseminating and exchanging information is believed to serve specific purposes: to foster collaborative research and learning, to facilitate international scientific mobility and to build capacity in science and technology. The implications of this research for policy are drawn from the discussion and findings laid out in chapters 7, 8 and 9. Interpretations and meanings attributed to internationalization are reproduced in the everyday practices of the actors involved. Some of the views about internationalization and its function are linked to actors' perceptions of the role and actions of the government (ministries and funding agencies in the context of Sweden) in promoting internationalization.

1. Efforts need to continue in the direction of establishing well-defined short-term and long-term goals of internationalization. It is important that internationalization goals are clearly defined before international STI cooperation programs are designed. In other words, it is crucial that the actors involved – sponsors (e.g. funding agencies) of internationalization and performers (e.g. scientific community) have a clear view about the purposes of internationalization and how it can be utilized.

2. Continue to support science and innovation cooperation initiatives but tailor the programs to the specific needs of funding recipients (e.g. universities, businesses and research institutes). Specifically, this means to distribute and allocate money accordingly.

3. Look for a common ground when developing a program and before launching it. From the perspective of researchers and companies interviewed, a bottom-up approach to government-sponsored research programs means taking into account the opinions, needs and interests of the research performers across research institutions and industry.

This requires funding agencies to stay current on specific topics of interest to researchers. The objective is to increase synergy between the applicant and the funder by aligning their interests. One proposal relates to establishing a channel of communication between funding agencies and potential grantees. For instance, donor agencies could contact academics and industrial researchers to discuss research projects and funding needs.

4. Internationalization is about recognizing opportunities and utilizing the best available tools and strategies to achieve desired goals. Internationalization policies should be tailored to specific goals. This step would help systematize internationalization efforts and link it directly to specific purposes. Scientific collaboration with emerging economies such as Brazil and China is perceived by universities, industry and government as beneficial to Swedish companies and to Sweden as a country in terms of their market potential and in terms of knowledge generation.

5. Internationalization entails simple but consistent actions and practices. It also involves the continuation of practices that have resulted in positive outcomes. At the university level, extra support in the form of reward should continue to be given to those universities committed to internationalization practices such as hiring qualified international staff, or individual researchers who maintain strong research networks outside his or her home country. A counterargument is that the government chooses not to interfere and it gives university researchers autonomy to make their own decisions. However, the government sets research and innovation policies that ultimately influence researchers. Thus, it can be argued that the government and leadership across research organizations have the responsibility to create the conditions for environments that are conducive to internationalization practices.

6. At the macro level, international STI cooperation continues to be treated as an "add on" activity instead of a practice that is incorporated into a long-term strategy to promote science and technology linkages. Findings from the empirical material suggest that international cooperation for science, technology and innovation is often seen as an "extra" activity that is disconnected from the overall vision and mission

of the organization or institution. Policy actors interviewed argued that there should be more attention to creating the conditions conducive to internationalization activities across government agencies such as more staff working on international projects.

7. At the macro level, there needs to be a concerted effort to organize different types of international collaborations according to their goals. This theme was discussed in chapter 7 and a suggestion by a government official from a Swedish funding agency. For instance a template for international cooperation is a frame of reference for identifying the purposes and the reasons for establishing bilateral cooperation with other countries. Having identified the purpose and reasons for STI cooperation, it becomes easier to follow-up and evaluate the outcomes of the collaboration. Another useful framework for measures and policy instruments is the one discussed in chapter 3 – the Intervention Framework. The latter organizes different types of government interventions according to needs and purposes. The framework helps us better understand the types of policy instruments and the types of government interventions needed to support internationalization.

8. Practice across sectors was a central theme discussed in this dissertation. When looking at internationalization practices at the university level in Sweden, for instance, I predict that these practices will be different. Therefore, internationalization practices need to be standardized so it becomes uniform across different departments. The benefit is that once uniform, these practices become easily adopted. It is not helpful that different departments within the same university have contradictory practices with regard to internationalization. For instance, one department might reward those individuals who have international backgrounds and/or have obtained their education abroad and might consider these experiences as a merit. At the same time, other departments in the same university might not view these experiences as a merit but as obstacles to an academic career. This inconsistency of internationalization practices generates confusion, unpredictability and disparities. If left unresolved, this issue might be more difficult to address in the long-run.

10.3 Summary and final remarks

One of my theoretical ambitions has been to highlight that policy is shaped by the interplay of stable trajectories and new opportunities. The decision making processes discussed in the context of the three government-funded programs are partly driven by policy inertia, interlocking relations between principals and agents, initiatives taken by the frontline government officers, and ideational currents. Together, these elements create a winding path of initiative and stability through which policy initiatives may be devised, implemented and institutionalized. It is often the case that after a mission-oriented visit to a foreign country, a government official proposes a bilateral agreement with the host country. These initiatives taken by frontline government workers or policy actors at the ministry level might influence decisions about strategies and policies to promote internationalization.

Implementation, as I have discussed, is seen as an integral part of the policy process. However, from a theoretical standpoint, my intention in this study has been to uncover the policy decision making related to the three STI cooperation programs. By disaggregating what is usually viewed as the traditional policy process with a linear approach to implementation and what takes place in practice, I have shown that in addition to academic researchers, policy actors also face dilemmas in their line of work. Some of the issues I have discussed relate to researchers' dilemmas. In the world of policy making, dilemmas are also present. There is a clear distinction between thinking about the best solution to a policy issue and choosing one that is reasonable and practical because it fulfills multiple objectives. Based on my interpretations of interviews conducted with government actors, one possible conclusion is that given the predicaments policy actors might face and oscillation in decisions involving internationalization, the gap between theory and practice widens at times.

In the course of this research, two surprising findings emerged from interviews with government officials across Swedish ministries and government agencies. One finding relates to the mismatch between theory and practice in policy making. Policy makers and strategists do not always follow a structured policy cycle to produce policies. The ROAMEF policy cycle described in Hallworth et al.

(2011) entails rationale, objectives, appraisal, implementation/monitoring, evaluation, feedback, and back to rationale. The policy process described in this thesis is divorced from theory and the more idealized view of policy making.

The second issue relates to the first. Another conclusion is that the interpreted mismatch between theory and practice that might be present in policy making might generate informal and ad hoc processes. Based on this interpretation, it follows that the policy processes that produce internationalization and STI cooperation programs might be characterized as extemporary. This dissertation has examined impromptu policy processes that produce internationalization programs with specific purposes. Idealized views of policy cycles tend to oversimplify policy making that takes place in the "real world."

Regarding the research and innovation policy field, the two models of research funding allocation reflect duality of structure. The Chalmers University's Transport Area of Advance has been supported through long-term funding allocated to university. In contrast, short-term research funding initiatives represent a deviation from the above mentioned long-term approach to university funding. Funding to transient programs is allocated on a short-term basis with fluctuations between periods depending on political vagaries rather than long-term considerations. The international research cooperation activities examined in this thesis are rooted in short-term government interventions and embedded in temporary funding cycles. This model might lead to overly crass and haphazard approaches to transnational research cooperation.

Based on the empirical material, this thesis has found that both approaches to research funding – short-term, project-driven and long-term initiatives - have emerged from informal and ad hoc policy decision making taking place at the ministry and government agency levels. This ad hoc process means that an immediate or sudden decision has been made or an action has been taken without previous planning. It also means that although policy actors across government agencies and ministries might often have a clear purpose for the STI programs they design, the decisions they make might not always originate from a structured policy process or a rational choice.

In conclusion, a complex picture of internationalization has emerged in the course of this research. A constellation of actors give direction to internationalization. Therefore, steering is an expected component of this

complex picture. Expectations from the government and government's expectations from researchers add to these complexities. Institutional conditions, political structure and principal-agent interactions, funding models (short-term cycles versus long-term), and individuals' intentions all shape internationalization.

I view internationalization as a mechanism for conciliation between actors' interests when conciliatory approaches are needed. The three programs I describe in this dissertation provide opportunities, aside from research cooperation, for merging different interests and views through science and technology linkages.

At the same time, I do not wish to merely conform with the view that internationalization is indeed a complex topic. Therefore, I have attempted to demystify and deconstruct internationalization. Drawing on the empirical material, I argue that internationalization can be seen as a practice involving compromise, adaptation, learning and experimentation. It needs intervention, resources and active participation. Internationalization generates dualities, dilemmas and tensions and it is an activity that requires continuing funding. It appears that the above characterizations are not always surprising and might be well-established and accepted across the government, research organizations and industry. Furthermore, internationalization of science, technology and innovation provides the lenses through which one can see the complex interplay between policy patterns, leeway and autonomy of policy actors, flexible-pragmatic notions of the world and interactions between higher levels of government, intermediaries and practitioners.

Responses to incentives and how academic and industrial researchers have translated these into their daily activities are themes that have emerged from this study. Incentives come in the form of research grants for which applicants apply. However, a funding-laden system based on financial incentives for research can be controversial. Individuals' research interests are at the heart of this controversy. Researchers are deeply dependent on external funding and they must set aside time and "make room" for funded projects. This need to compromise means that participants might delay other projects that they perceive as equally rewarding and interesting. It is also possible that a number of researchers engage in internationalization to augment their financial

underpinnings rather than fully engaging in international networking. Thus, for some, the incentive is not to participate in internationalization activities because of personal interests or because they view it as a good cause. The motivation is primarily driven by the need to secure funding to enable the continuation of their research projects. Therefore, one perspective is that internationalization is viewed as a secondary goal. The findings in this study do not imply that all researchers participating in the three government-funded programs are facing dilemmas. Nor does this study imply that it is always the case that researchers' interests were misaligned with grantor agencies' international programs.

Although financial incentives are a key component of this study and addressed in research question 3, internationalization is not entirely about funding and incentives. Internationalization also involves disincentives and disinvestment. These disincentives are reflected in the two company experiences I have described. The owners of these companies had compelling reasons for not wishing to pursue business opportunities with emerging economies on the account of challenges embedded in internationalization activities.

Given the above elucidations, I depict internationalization not as a static phenomenon but as a dynamic activity of increasing involvement of different constellation of actors. I acknowledge that the surrounding environment and this constellation of actors alter internationalization in time and space. While internationalization as a mechanism for exchange, dissemination, learning and experimentation is rooted in traditional forms of interaction – science/industry partnerships and political structures – its predictability is unsettled. In other words, based on the findings, I conclude that it is not possible, in the foreseeable future, to position internationalization in time and space given its stable and unstable nature and given the possible oscillations concerning the purposes of the internationalization of STI. This stable and unstable nature of internationalization reflects both the predictability and continuation of political practices. At the same time, this characterization of internationalization reflects overall changes and possible fluctuations in policy decision making perhaps in response to global trends and based on different notions of the world. It is the variation and fluctuation in which internationalization is practiced, interpreted and utilized that makes it a complex phenomenon at times, prompting researchers to further explore the topic.

Internationalization also requires intervention in the form of funding, implementation strategies, actor participation and a clear direction concerning purpose. I am inclined to argue that perhaps in countries where there is a subtle balance between intervening in internationalization and abstaining from intervention, the direction of internationalization becomes less clear because in maintaining this fine balance between intervention and less intervention, the role of the government, might be less clearly delineated too.

In addition, internationalization: it is often treated as an "add on" activity. Inability to commit to internationalization is merely a symptom of a more concerning issue which involves decisions about how internationalization efforts can be mainstreamed and be part of the daily activities and strategic plan of government offices, businesses and academic settings. These decisions are not easy ones but necessary and defining priorities precede any action. Is the priority to allocate more resources to internationalization activities or focus on national efforts? What type of geographic internationalization should a country pursue? Is it internationalization of STI to promote strong linkages with countries outside Europe, the U.S and Japan or to continue to invest in the same internationalization efforts? Whose role is it to be a catalyzer of internationalization and to spearhead internationalization so that is not merely treated as an "add on" activity?

The above entails identifying or redefining the purposes of internationalization as well as the roles of different government actors as catalyzing agents in this process. As I have shown through interviews, government agencies are still trying to define their role as enablers of internationalization of science, technology and innovation. Research institutions also face challenges when redefining their roles in internationalization and how they want to practice internationalization. There are still uncoordinated efforts regarding internationalization that result in non-standardized practices across different departments in the same higher education institution. For instance, while one university department might wish to support internationalization by attracting and giving preference to those individuals with international backgrounds and degree from a different university, another department might do exactly the opposite and hire individuals who have obtained their degree from the same department,

regardless of their background. These are two very different approaches to internationalization of higher education in the same university.

There is an opportunity for funding agencies and for ministries to decide how they wish to utilize internationalization and for what purposes. At the same time, these entities have a public responsibility to delineate clearer goals for internationalization because these actions will have impacts at the local, regional and national levels.

By deepening our understanding of possible inconsistencies embedded in internationalization practices, we increase our awareness of potential tensions. These inconsistencies reveal the interface between policy goals and administrative practices of actors operating at the different levels – macro, meso and micro. Uncovering inconsistencies and tensions can lead to transformations because it is an opportunity for learning. In addition, inconsistencies might not be so obvious or they might not be mentioned because they are difficult to confront or uncomfortable to discuss. Finally, contradictory interests can be taken for granted and participants might not recognize these tensions as problems. Regardless of how subtle and concealed these tensions may be, they still exist.

10.4 Future research

This thesis makes an analytical contribution to the study of internationalization of science, technology and innovation. I acknowledge the importance and the contribution of existing scholarly studies on the topic internationalization of STI. In this study, I have attempted to introduce my own perspectives and definition of internationalization. I define internationalization of STI as an integral component of research and innovation policies and as a tool for the generation and dissemination of research results and knowledge. Internationalization is a mechanism but also a practice that is enabled via the efforts of different actor constellations and networks across distinct sectors. In addition, this thesis looks at internationalization of STI from the perspective of how it is formulated and carried out at the meso and micro levels. Therefore, this is an actor-centered study. I have shown how the actions that enable the

internationalization of STI are influenced by global trends and by a country's administrative and political structure.

One area that is worth exploring in future research is actor-driven research collaboration. Further exploration in this area would provide additional insights about micro level STI cooperation practices which can be viewed as policy instruments to strengthen S&T linkages. Additional research is needed concerning motivations, types of collaborations and the outcomes of these research collaborations so patterns of similarities and differences can be collected and analyzed. Certainly studies can be designed in different ways. Studies might focus on collaborations across different disciplines or organized by teams or entire departments or might focus on issues of trust and team responsibility within research collaboration. The latter topics emerged during interviews with respondents. Trust in team collaboration (e.g. science-industry or university-university) would be an important area of future exploration because lack of trust might be hidden, therefore subtle and difficult to recognize and to discuss. Trust or the lack thereof can hinder research collaboration of any kind at national or international levels.

Furthermore, as discussed in this study, policy actors are constrained in their actions at times leading to *practical or pragmatic approaches* when implementing decisions. This pragmatic mode might result in policy outcomes that are satisfying and might not necessarily represent the most optimal solution to a policy issue. Future research could explore the types of outcomes and results that are obtained from particular decision making approaches or styles.

Nevertheless, the findings in this study are limited to internationalization of science, technology and innovation as it is practiced and perceived in Sweden. A comparative study that benchmarks Sweden's "way of articulating and facilitating" internationalization against other international criteria would enrich our understanding of internationalization practices across different nations.

Furthermore, future research could explore the factors shaping the formulation of STI cooperation instruments across other funding agencies in Sweden to verify whether the same or different factors have played a crucial role. This type of research would serve as a point of departure for possibly establishing a framework for program design and implementation, taking into account the different missions across government agencies but searching for potential synergies – cross-government agency learning and sharing.

Given that funding was considered one of the main drivers of international STI cooperation and internationalization, and given the relative unique funding system in Sweden, an area for potential future research would be to further our understanding of whether and how different funding models generate shifts in views of and responses to internationalization. This exploration could be in the form of a comparative study and it would bring insights into the governance of research and innovation with respect to funding mechanisms.

Finally, future research could explore the role of internationalization in research and innovation policy from the perspectives of the micro, meso and macro levels described in this study. For instance, given that this dissertation discussed the dissemination of practices to other countries, the following overarching question could guide a future research project: can research and innovation policy through internationalization instruments systematize research cooperation practices across different countries making them more consistent?

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Appendix A

Questionnaire sent to staff at Swedish ministries and funding agencies

Topic: Internationalization practices in Sweden and research collaboration

Context: Sweden

Purpose: This is part of a PhD research study on internationalization practices across Swedish businesses, research institutes, universities and the Government of Sweden.

PhD candidate and interviewer: Ana Paula do Nascimento, Lund University School of Economics and Management, Business Administration Department

The interview will be conducted over the phone and the duration will be a maximum of 30 minutes.

Questions:

1. Describe the work you do in your department.
2. Describe the work your department does.
3. Describe what you think internationalization is.
4. How do you work with internationalization?
5. Why do you work with internationalization?
6. Given your responsibilities regarding internationalization, what areas, countries, initiatives and instruments are important?
7. Tell me where you think your work could be further refined or improved.
8. What role do you see for the Swedish Government to play in promoting internationalization?
9. Is there anything more you think I should know or take into consideration?

Appendix B

The following questions[48] were used during interviews with researchers in the Transport Area of Advance program – 2012-2013

1. Tell us about your background

How did you become interested in this particular research field?
How long have you been working at this university?
What other universities or institutions have been central to the development of your knowledge in this field?

2. Your research and institutions you collaborate with

What is your research project(s) in the Competence Center for Catalysis?

Which actors are important to your research today (e.g. research groups; universities; organizations; institutions) and how do they influence (prevent or enable) your research?

Are there any actors that could have taken a bigger role?

What types of resources are important to conduct your research (e.g. human capital; finance; infrastructure; network) and how are the important?

Are there critical limitations in the availability of any of these resources?

How important is your university environment to conduct your research?

What kind of impact has your research had and what did it lead to?

[48] As mentioned earlier, these questions were used for a different research project. However, given the relevance of the responses to the topic of this dissertation, the material was included in this study.

3. Your role as a researcher

Who do you see as the direct beneficiaries of your research (example: business, other researchers, government, society at large)?

What do you see as important channels for disseminating your research (e.g. publication, teaching)?

What incentives (both formal and informal) do you see exist to perform these activities (research and teaching)?

Are you involved in teaching? If so, how does your research affect your teaching?

How does your research impact your teaching?

How do you disseminate your research results?

Can you point out some other effects regarding the development of relevant technology areas in Sweden?

4. Conditions for creating benefits

What obstacles have you encountered to perform the above activities?

Do you think that there is a trade-off between these activities?

Appendix C

List of interviews used in this dissertation in the order they appear on the text

Interview No.	Organization/Company	Interview date	Respondent's position/title
1	Swedish University	July 9th, 2014	Professor and researcher
2	Research Institute	June 18th, 2014	Researchers
3	Swedish funding agency	November 25, 2015	Government Official
4	Swedish funding agency	May 6th, 2014	Government official
5	Swedish university	August 21, 2014	Professor
6	Swedish funding agency	January 28th 2015	Government official
7	Swedish funding agency	November 25, 2015	Government official
8	Swedish funding agency	May 16, 2016	Government official
9	Swedish university	September 4, 2014	Professor and Researcher
10	Swedish funding agency	November 11, 2015	Government official
11	Large Swedish company	June 12, 2014	Manager
12	Swedish startup	August 22, 2014	Company owner and CEO
13	Swedish institute	August 20, 2015	Researcher
14	Swedish institute	August 15, 2015	Researcher

15	Swedish university	August 28, 2014	Professor
16	Swedish ministry	May 26, 2015	Government official
17	Swedish university	August 21, 2014	Researcher
18	Swedish startup	August 15, 2015	Owner
19	Swedish university	August 18, 2014.	Professor
20	Small Swedish company	August 21, 2014	Owner
21	Swedish company	August 22, 2014	Department director and CEO
22	Science Park	August 20, 2014	Director
	Swedish company	June 14, 2014	Vice president, product development
23	Swedish Ministry of Education and Research	May 12, 2016	Former State Secretary of Education and Research
24	Swedish funding agency	April 12, 2016	Government official
25	Swedish ministry	May 26, 2015	Government official
26	Chalmers University	May 12, 2016	Professor/Former Director Chalmers Transport AoA
27	Swedish startup	August 13, 2014	CEO
28	Swedish university	May 17, 2013	Professor
29	Swedish startup	September 9, 2015	CEO
30	Swedish university	November 16, 2012	Professor
31	Swedish university	July 8, 2014	Researcher
32	Swedish university	August 21, 2014	Researcher
33	Swedish research institute	August 25, 2014	Researcher
34	Swedish research institute	November 15, 2015	Project manager
35	Swedish university	November 23, 2012	Professor

36	Swedish university	December 19, 2012	Professor
37	Swedish university	December 3, 2012	Associate professor
38	Swedish university	November 13, 2012	Professor
39	Swedish university	September 2nd, 2012	Professor
40	Swedish consulting firm	August 25, 2015	Owner
41	Swedish research institute	August 22, 2014	Project manager
42	Swedish university	May 17, 2012	Professor
43	Swedish funding agency	November 19, 2015	Official

Appendix D

This compilation is based on interviews conducted with participants in the three government-sponsored STI cooperation programs this thesis describes.

Collaboration in STI: Definition, Aims and motivations

Type of collaboration	**Definition**	**Aim/Focus of collaboration**	**Motivation for engaging in research collaboration**
Complementary	Collaborations where different partners complement each other with skills and expertise.	To build skill complementarity - partners with varying but related skills and common interests.	Gains from knowledge and expertise of partners with varying skills; expected to result in a win-win kind of partnership; improving overall research quality of the team seen as motivation - partners with complementary skills learn from each other.
Productive	Collaborations that bring different stakeholders together to form a collaborative unit.	To build a productive collaborative unit composed of diverse researchers.	Perceived gains from increased research quality and high productivity.
Diplomacy-driven	Collaborations that improve international relations.	National level: to give the collaborative project legitimacy; to strengthen the S&T ties between two countries. Local level: to improve research collaboration between scientists from different countries.	'Science diplomacy': using science as a mechanism to improve international relations between countries.

Real	Collaborations that benefit both sides; "Collaboration is about accelerating the rate of progress and learning by working together, that is real collaboration."	Technology development on both sides of the collaboration.	Learning possibilities and technology development opportunities.
Pragmatic	Collaboration that serves a tool to achieve specific interests and goals.	The aim is to use collaborative partnerships with the objective to reach specific targets and to work on a specific project.	The perception that goals can be achieved more efficiently and in a timely manner, given more pragmatic way of conducting research activities.
Partner-oriented collaboration	Collaboration used to develop a new technology to apply it to the problem/need of the partner.	To use collaboration as a tool to develop technology tailored to the needs of the partner.	Finding viable solutions for environmental problems; improve the conditions of others in society (perhaps more common when collaborations are between partners from industrialized countries and less developed nations.
Market-driven; business-driven	Research collaborations that have the purpose of developing new technologies or products for commercialization purposes.	To bring products close to the market, to access markets abroad and export domestic technology.	Help companies to gain access to markets; commercialization of products.
Strong-strong	Collaboration where partners have the same level of expertise and qualifications.	To tap into the skills and expertise of collaborating partners.	Gains from partner with equal skills; expected to be a win-win collaboration with both sides benefiting from the partnership.

Successful collaboration	The type of collaboration that has a positive impact on the environment and on society.	To use research collaboration for the purpose of achieving sustainable development.	Altruistic and personal reasons (e.g. environmental sustainability, help remote communities in poor countries).

Appendix E

Interview questions
Programs: Sino-Swedish and Brazil-Sweden Eco-Innovation Cooperation
Note: These questions served as a general guideline only to interviews with program participants. Not all of the questions contained in this guideline were used in the interviews.

Interview subject's background

1. How did your company/or you as a researcher become involved in this project?
2. How long have you been working at this university/institution/company?
3. How important is this project for your company/department/institution?

Motivations for engaging in international cooperation

4. Why is your company interested in the cooperation with China/Brazil?
5. Why did you apply for funding?
6. What has your company (or institution) gotten as a result of VINNOVA's support? (e.g. VINNOVA provides support in the form of funding, contacts, advice/coaching, analysis, etc.
7. What has been the most important effect of VINNOVA's support so far? (e.g. knowledge, partners/contacts, additional funding, mobility, other?)
8. How do you perceive as being the role of VINNOVA in supporting this project?

9. How has the cooperation with China/Brazil helped your project? And in what ways has the cooperation with China/Brazil not helped your project?
10. How is the project developing, in your view?
11. Are there any challenges in the cooperation with China/Brazil?

Research collaboration network and global linkages

12. Do you have similar projects with other countries? If yes, which countries and why?
13. How would you compare the cooperation your company/institution has with other countries to your company's cooperation with China/Brazil in general terms?
14. What channels do you use to find your partners in other countries and how do you connect with them?
15. What are the difficulties in finding Chinese/Brazilian partners?
16. If the cooperation between your company/institution and China/Brazil goes well, what in your view would be the desired outcomes (best short term and long term results) of this cooperation for your company? (or perhaps the desired effects for society in general?)

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