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The Institutional Drivers of Commercialization Efficiency

How do institutions shape the commercialization of innovation in four countries?

by

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Abstract:

This thesis investigates how formal, national-level institutional factors shape the translation of R&D inputs into marketable innovation outputs in high- and medium-high-technology (HMHT) manufacturing. Focusing on Sweden's persistent "innovation paradox", high R&D intensity but comparatively modest commercialization—the study examines three institutional dimensions: domestic value added (DVA) in exports, R&D-related tax incentives, and university–industry cooperation (UIC). A balanced panel of four OECD countries (Sweden, Denmark, Austria, Poland) over 2004–2020 is constructed from harmonized OECD, Eurostat CIS, and TiVA data. Turnover from new-to-market products in HMHT manufacturing, deflated to constant 2015 USD, serves as the dependent variable. Using pooled OLS, fixed effects, and lagged specifications with standardized regressors, results indicate that UIC and tax incentives show positive but statistically insignificant associations with commercialization, while DVA exhibits a consistent negative relationship, statistically significant in lagged models. Findings suggest that institutional input levers alone are insufficient; commercialization efficiency is conditioned by structural factors such as value-chain positioning, production geography, and domestic scaling capacity. Policy implications emphasize shifting from broad input subsidies toward targeted measures that strengthen domestic appropriation, scale-up, and commercialization pipelines.

Keywords: Swedish paradox, Institutions, Innovation, Commercialization

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1 Introduction

As economies have become increasingly globalized and interconnected, unprecedented prosperity has been achieved, but this has also brought greater systemic complexity and vulnerability. The deepening interdependence of national economies, intensified by shocks such as the Covid-19 pandemic, the war in Ukraine, and intensifying US–China economic rivalry, poses challenges for small, open, export-oriented economies. The European Union now faces the dual challenge of sustaining active R&D investment while ensuring its members can compete effectively in an evolving global technological paradigm. For countries such as Sweden, the stakes are high: the coming phase of the long-run business and technological cycle, in both Kondratieff and Schumpeterian terms, will demand strong institutions capable of converting innovative capacity into tangible economic performance.

Innovation has long been recognized as a core driver of economic growth and societal progress (Robert Solow, 1956; Mokyr, 2018). Yet the determinants of innovation, and the mechanisms by which institutions foster or hinder it, remain contested in economic history and innovation studies. Sweden provides a particularly compelling case. Consistently ranked among the world's most innovative economies and praised for its strong democratic and inclusive institutions, it nevertheless displays a persistent commercialization gap. Despite high R&D intensity, Sweden has modest translation of these inputs into high-tech exports and turnover from new-to-market products, a phenomenon widely referred to as the "Swedish Innovation Paradox" (Edquist & McKelvey, 1998; Kander & Ejermo, 2009). This paradox challenges the assumption that robust institutions and sustained R&D investment necessarily yield proportionally high marketable innovation outputs.

While the Swedish Paradox has been discussed extensively in academic and policy literature, most existing studies have concentrated on descriptive analyses of R&D intensity, innovation system structure, and institutional quality. Far fewer have provided empirical, causal evidence on how specific institutional factors influence the efficiency of converting R&D inputs into marketable innovation outputs. Where quantitative work exists, it has often focused on patent counts, productivity measures, or aggregate innovation indicators, leaving the commercialization gap, particularly turnover from new-to-market products, underexplored. Moreover, much of the prior research has examined Sweden in isolation, without systematic cross-country comparisons that could distinguish country-specific features from broader structural patterns within the OECD. This gap is important because without understanding the institutional channels through which commercialization efficiency varies across similar economies, policy reforms risk targeting symptoms rather than underlying constraints. By applying panel regression methods to harmonized, multi-country data, this thesis seeks to address these shortcomings and provide more robust evidence on the institutional drivers of commercialization in Sweden and comparable economies.

1.1 Research Problem

Since EU accession in 1995, Sweden's innovation policy has been shaped by both European integration, through alignment with the European Research Area, participation in Framework Programs, and access to EU funding, and by national reforms such as Mission-Oriented Innovation Policy (MOIP) and Transformative Innovation Policy (TIP) (Avdeitchikova & Serger, 2024). These frameworks seek to steer innovation toward societal challenges, yet their measurable impact on commercialization remains ambiguous. Institutional effects are often lagged, overlapping, and non-linear, while the innovation system itself operates as a complex adaptive structure characterized by feedback loops, inertia, and path dependence.

Recent research underscores the role of formal, inclusive institutions in enabling both the creation and diffusion of innovation (Acemoglu et al., 2001; Donges et al., 2022). Yet empirical evidence on which specific institutional factors most directly affect commercialization is limited, especially in comparative analyses that can help disentangle structural effects from country-specific conditions. This thesis addresses that gap by empirically examining how three formal, national-level institutional factors, domestic value added (DVA) in exports, R&D-related tax incentives, and the intensity of university–industry cooperation, affect innovation outputs, measured by turnover from new-to-market products in high and medium-high technology firms, in Sweden, Poland, Austria, and Denmark between 2004 and 2020.

The paradox is not uniformly distributed across the economy. It is more pronounced among large firms, which have been shown to be less effective than SMEs at generating new-to-market products, and it varies across output types, with stronger performance in services and "new-to-firm" rather than "new-to-market" innovations. This thesis therefore isolates turnover from new-to-market products in high and medium-high technology sectors as the focal output measure, as it captures the most acute commercialization bottleneck. This choice comes with inherent limitations. Large firms may concentrate R&D domestically while relocating production abroad and selling in third markets, thereby depressing domestic commercialization figures without necessarily reducing innovative capacity. This raises a critical institutional question: how effectively can Sweden capture the value of innovation rents generated globally by domestically headquartered firms?

1.2 Aim and Scope

The aim of this thesis is to empirically examine how three formal, national-level institutional factors affect innovation outputs from high and medium-high technology firms in four countries for 17 years. The empirical analysis draws on harmonized panel data from OECD sources (ANBERD, MSTI, STAN, TiVA), and the Eurostat Community Innovation Survey (CIS).

Conceptually variables are understood as:

- Turnover from new to the market products - return from innovation.
- DVA in exports – value capture within national production.
- R&D-related tax incentives – policy measures to stimulate private innovation investment.
- University–industry cooperation (UIC) – intensity of collaborative innovation.

The analysis is conducted at the national level, with a sectoral focus on high-tech and medium-high technology sectors. All variables are measured at the national level, meaning that each observation corresponds to an aggregate country-year value. This allows the analysis to capture cross-country differences in institutional factors and their effects on innovation outputs, while controlling for time-invariant country characteristics through fixed effects. The geographic focus allows comparison between countries with slightly different institutional structures. The empirical strategy applies fixed-effects panel regression to estimate the associations between institutional factors and innovation outputs, controlling for relevant economic and structural variables. Robustness checks address concerns over omitted variables and model stability.

The study does not attempt to model the entire innovation system or capture informal institutional and cultural influences. It focuses exclusively on formal, measurable, national-level institutions and commercialization indicators. The results are interpreted as statistical associations, with careful attention to methodological limitations discussed in the data and methodology chapters.

1.3 Outline of the Thesis

Chapter 2 provides the institutional and economic context of the four countries' innovation systems over the last two decades, with attention to structural reforms and external shocks. Chapter 3.1 reviews the literature on institutions and innovation, highlighting empirical findings and theoretical perspectives relevant to commercialization outcomes. Chapter 3.2 presents the conceptual framework, linking institutional theory to the Swedish Innovation Paradox and the chosen variables. Chapters 4 and 5 describe the data sources, variable construction, and econometric methodology. Chapter 6 presents the empirical results, including robustness checks and cross-country comparisons. Chapter 7 discusses the findings considering the research questions, linking back to theory and policy debates. Chapter 8 concludes with key insights, policy implications, and suggestions for future research.

2 Context

Before turning to the previous research and theoretical framework, it is essential to establish the economic, institutional, innovation, and historical contexts of the countries included in this study. This section introduces four OECD member states, Sweden, Denmark, Austria, and Poland, which have been selected not only for their relevance to the research question but also for the contrasts they offer in innovation performance, institutional design, and economic structure. While it would have been valuable to include other OECD countries such as the Netherlands, Israel, and Switzerland, the absence of sufficiently complete and comparable open data for all four institutional variables across the 2004–2020 period necessitated their exclusion. The chosen countries provide a balanced mix of high-performing innovation leaders, strong innovators with institutional differences, and catching-up economies, allowing for both peer and contrast comparisons, with Sweden serving as the primary reference point.

2.1 Sweden

Sweden's innovation system has developed under the influence of national crises, long-term technological transitions, and the pressures of European integration. Despite consistently ranking among the world's highest in R&D intensity, currently investing about 3.3 % of GDP (Table 1), well above the OECD average of 2.7 % and the EU average of 2.1–2.2 % (Vetenskapsrådet, 2023; Eurostat, 2024; OECD, 2025) its performance in commercialization and new firm creation remains relatively subdued. Innovation performance is typically assessed through indicators such as high-technology exports and turnover from new-to-market-firm products or process. Swedish firms are more likely than the OECD average to introduce market-first innovations, 17.2 % of enterprises in 2020, compared to an EU average of 11.7 %, yet the share of sales from these products remains low relative to the scale of national R&D spending (see Table 2, p. 6). Sweden's high-tech exports make up about 16.8 % of manufactured exports (above the EU average), but as a share of total trade they are modest (~6–7 %, or ~27th rank globally) due to the country's large share of medium-tech exports, such as machinery and vehicles. (OECD, 2025)

Historically, the severe early-1990s recession, triggered by financial deregulation and a housing market collapse, reduced GDP by about 5% and precipitated a banking crisis and mass unemployment (Jonung, 2009). The subsequent fiscal consolidation, market liberalization, and intensified science and technology policy paved the way for EU accession in 1995, integrating Sweden into the Single Market and EU innovation programs (European Commission, 2023). Previous crises, including the oil shocks of the 1970s, had also stimulated waves of innovation

(Taalbi, 2017), embedding Sweden in the “Third Industrial Revolution” of ICT, digital infrastructure, and green technologies. Sweden’s innovation policy mix is unusual in the OECD context for its limited reliance on tax incentives. For much of the period, Sweden offered no broad-based R&D tax credit, instead favoring direct grants and program funding through research councils and agencies like VINNOVA. A limited R&D payroll tax reduction was introduced in 2014, but overall tax-based support remains less generous than in countries like France or Canada. The OECD’s TAXI metric (1 – B-index) for Sweden has been consistently below the OECD mean, reflecting this policy choice.

Institutionally, Sweden shifted from a market-failure logic before the 1980s to a systemic National Innovation Systems (NIS) approach in the 1980s–2000s, with VINNOVA’s creation in 2001 marking a major institutionalization of coordination, cluster development, and collaborative platforms (Edquist, 2011; Vetenskapsrådet, 2023). Since the 2010s, policy has moved toward Transformative Innovation Policy (TIP) and Mission-Oriented Innovation Policy (MOIP), aligning R&D directionality with societal challenges such as climate change and demographic shifts (Avdeitchikova & Serger, 2024; ed. Mazzucato & European Commission, 2018). However, the system remains highly centralized and dominated by large multinational firms (Edquist & McKelvey, 1998; Bitard, 2008; Ejermo et al., 2011). SMEs are often more efficient in producing new-to-market products per unit of R&D but receive less support and face weaker early-stage finance. One area of strength is university–industry collaboration (UIC). Sweden’s “quadruple helix” model promotes deep cooperation between academia, industry, government, and civil society. Around 8 % (see Table 2, p. 6) of university publications are co-authored with industry, well above the OECD average of 5 %, and Sweden ranks highly in global indexes for collaborative R&D. These links have been critical in sectors such as environmental technology and life sciences, accelerating research output. (OECD, 2025)

2.2 Denmark, Austria and Poland

Denmark’s innovation system matured during the 1990s and early 2000s with a strong emphasis on environmental technologies, design, and life sciences, framed by a commitment to “green growth.” Between 2004 and 2020, Denmark maintained R&D spending around 2.9 % of GDP, supported by public R&D funding at 158 % of the EU average (European Commission, 2024). With one of the highest institutional quality scores globally, CPI ~90, (ed. Transparency International, 2024) Denmark benefits from efficient governance, minimal bureaucratic delay, and predictable regulation. Its innovation strategy combines long-term sustainability goals, early-stage funding, and robust SME support, demonstrating how institutional efficiency can amplify R&D effectiveness.

Austria’s innovation system transitioned from its corporatist post-war structure to a more competitive model in the late 1990s and early 2000s, introducing reforms to boost entrepreneurship and applied research. From 2004–2020, Austria’s R&D intensity remained near 3.2 % of GDP (see Table 1) (Eurostat, 2024) and its funding agencies strengthened, but innovation output leaned toward incremental rather than radical advances. Institutional quality CPI ~75; (see Table 1) (ed. Transparency International, 2024) lags the Nordics, with slower regulatory processes. Although Austria ranks as a 'Strong Innovator' (114 % of the EU average), sales from new-to-market products are only about 9–10 % of turnover, versus Sweden's 13–14 %, reflecting persistent gaps between research strength and commercialization.

Poland's innovation system emerged from post-2004 EU accession reforms, with structural funds financing research infrastructure, ICT upgrades, and higher education expansion. R&D intensity rose from 0.7 % in 2010 to 1.4–1.5 % by 2020 (Eurostat, 2024) but remains well below the EU average. Institutional quality is comparatively weak, CPI ~55 (ed. Transparency International, 2024) with rule-of-law concerns and administrative barriers limiting innovation investment. OECD (2025) notes that Polish firms are half as likely as EU peers to introduce product or business innovations, owing to low private R&D spending, limited early-stage capital, and weak knowledge transfer. While performance is improving in ICT services and niche manufacturing, structural constraints slow down commercialization opportunities and domestic value capture. This comparison underscores the central thesis: high R&D intensity does not automatically yield proportionate innovation outputs. Sweden's high-input, middling-commercialization profile contrasts with Denmark's institutional-efficiency model, Austria's high-input but under-performing commercialization, and Poland's low-input, institutionally constrained path. The differing trajectories and institutional choices of these four countries provide a rich comparative basis for analyzing the role of domestic value added in exports, R&D tax incentives, and university–industry collaboration in shaping commercialization efficiency.

Table 1 – Economic and institutional profile (avg. 2004–2023)

Country	GDP per capita (USD 2015)	CPI score*	R&D intensity (% of GDP)	Govt. share of GERD (%)
Sweden	$50,887	82	3.3	30
Denmark	$55,109	90	2.9	35
Austria	$44,449	75	3.2	34
Poland	$13,136	54	1.3	40

Source: WB WDI (2025); OECD MSTI (2024); Transparency Int. (2022); OECD National Accounts (2024)
*CPI = Corruption Perceptions Index score, Transparency International (0–100 scale, 2023 values shown).

Table 2 – Innovation performance (avg. 2004-2023)

Country	High-tech exports (% of manuf. exp.)	TNMP turnover share (%)	Firms with UIC (%)	UIC publication share (%)
Sweden	16-17	13–14	40	8
Denmark	15-16	12–13	35	7
Austria	13-14	9–10	30	6
Poland	8-9	7	25	4

Sources: WB WDI (2025); Eurostat Comext (2024); Eurostat CIS (2023); OECD STI Scoreboard (2023); Scopus/Elsevier via OECD Science Indicators (2023)

3 Theory and previous research

3.1 Previous Research

Innovation has long been understood as a key driver of economic growth, yet its success depends heavily on the institutional and structural environment in which it occurs. Early thinkers like Adam Smith emphasized markets and productivity, while later scholars such as Marx, Veblen, and Weber drew attention to class structures, social values, and institutional norms (Veblen, 1899; Rosenberg, 1991; Kersting et al., 2020). At the beginning of the 20th century, J. Schumpeter proposed concepts of the "creative response" and “creative destruction” which positioned innovation as an endogenous force that arises from historical discontinuities and entrepreneurial agency (Aghion & Howitt, 1992). This foundational insight has inspired a range of theoretical strands, including, but not limited to, institutional theory and innovation theory. Institutional economists, such as North (1990), define institutions as the “rules of the game” that shape economic incentives and behavior. Acemoglu and Robinson (2012) differentiate between inclusive and extractive institutions, arguing that innovation flourishes where the former reduce uncertainty, protect property rights, and support broad participation. Their empirical work, notably "The Reversal of Fortune" and later extensions, highlights how historical institutional configurations shape long-term development paths, including innovation capacity. More recently, Kafka et al. (2022) provide cross-country panel evidence that institutional quality significantly influences innovation performance in an S-shaped fashion: its effects are strongest in countries with lower baseline performance. Yet even in advanced economies, the precise institutional channels, such as tax policy, university-industry collaboration, or domestic value retention, remain underexplored in empirical terms.

Parallel to institutional theory, the innovation studies literature has moved beyond linear models of R&D → innovation → growth. Nelson and Winter (2004) introduced the concept of routines and evolutionary behavior, emphasizing that firm decisions are bounded by both cognition and institutional environments. Scholars of National Innovation Systems (NIS), notably Edquist (2002), Lundvall (2006), and Freeman (1989) framed innovation as a systemic process shaped by the interactions of firms, universities, governments, and markets. This system's approach laid the foundation for systemic innovation policy, later extended into mission-oriented and transformative frameworks. Mazzucato (2013) redefined the state’s role as a "market shaper," capable of steering innovation toward societal missions (MOIP). Weber and Rohracher (2012), and Schot and Steinmueller (2018), articulated Transformative Innovation Policy (TIP), which focuses on solving “directionality failures” and promoting inclusive, reflexive governance. Avdeitchikova and Serger (2024) further show that TIP outcomes depend heavily on governance coherence, institutional flexibility, and context-specific policy mixes.

Josef Taalbi (2017) integrates Schumpeterian dynamics with complexity theory, identifying four drivers of innovation: problem signals, technological opportunities, demand conditions, and institutionalized routines. His empirical study of Swedish manufacturing (1970–2007) shows that innovation surges often emerge in waves, triggered by crises or platform shifts. Taalbi's application of the NK model explains how firms navigate innovation landscapes shaped by interdependencies and search complexity. This view complements the institutional techno-economic paradigms articulated by Carlota Perez (2010). Mokyr (2018) and Rosenberg (2001) emphasize that innovation bottlenecks are often institutional or systemic, not merely technological.

Sweden offers a rich case for institutional analysis. Despite leading globally in R&D intensity and input indicators, it consistently underperforms in commercialization outputs, what Ejermo and Kander (2009) term the "Swedish Innovation Paradox." Edquist and McKelvey (1998) observed that Sweden's production of R&D-intensive goods remained low despite high innovation input. Braunerhjelm (1998) noted that although Sweden ran a surplus in R&D-related IP exports, domestic commercialization lagged, suggesting that innovations were monetized abroad. Klofsten (2002) echoed these concerns, pointing out that Swedish R&D has generated limited returns in terms of new firm creation, job growth, and domestic sales of innovative products. Ejermo and Kander (2006) developed a "gear model" of innovation transformation: Gear B (invention to innovation) and Gear C (innovation to industrial application). Gear B is where this thesis places its empirical focus. Their work argues that structural concentration of R&D in multinationals, weak university-industry linkages, and low entrepreneurial dynamism constrain Sweden's ability to convert R&D into economic value. More recent system diagnostics by Vinnova reports confirm that knowledge diffusion, skill alignment, and commercialization mechanisms remain underdeveloped.

Most of the Swedish paradox literature remains descriptive or correlation based. Few studies attempt to identify which specific institutional factors, such as tax incentives, university–industry cooperation, or value chain positioning, statistically explain innovation output variations. A rare exception is Donges et al. (2022), who exploit quasi-experimental variation from French-occupied German territories in the 18th–19th century. Their findings show that longer exposure to inclusive institutions led to significantly higher patenting a century later. Although it wasn't the goal of this thesis to use the same advanced empirical approach, it inspired to use a similar but less complicated approach. Instead of years under occupation as proxies for institutional improvement and their effects on innovation, proxied by patenting activity, this thesis will simply use harmonized panel data (2004–2020) from Sweden, Poland, Austria, and Denmark to examine whether DVA in exports, R&D tax incentives, and UIC explain differences in new-to-market product turnover and high-tech exports. It focuses especially on Gear B transformations (Ejermo & Kander, 2006), testing whether institutions matter in converting R&D into marketable outcomes.

Recent literature also highlights the impact of offshoring on national innovation outcomes. Studies show that firms maintaining R&D domestically while shifting production abroad may boost global performance but dilute national innovation returns (Branstetter et al., 2019;

Yamashita & Yamauchi, 2019). Mion & Zhu (2013) and Baum et al. (2020) find that while innovation efforts are maintained or expanded, co-location effects such as manufacturing feedback loops and local knowledge spillovers decline. In Sweden, where R&D is heavily concentrated in large multinationals, this trend may contribute to low domestic commercialization. If innovations are commercialized abroad, turnover from new-to-market products within Sweden will underestimate actual innovation activity. Thus, institutional efficiency must also consider how innovation benefits are captured and whether policy frameworks align R&D incentives with domestic commercialization goals. This tension reinforces the need to examine how institutions like tax policies, university linkages, and domestic value retention mechanisms shape not just R&D input but innovation output. If these mechanisms fail, innovation may succeed at the firm level but bypass national economies.

3.2 Core Concepts, Debates

This chapter synthesizes the core theoretical concepts and debates drawn from previous research that frame the institutional determinants of innovation, with a focus on their relevance for this study's empirical scope. It serves to conceptually clarify key terms and mechanisms before turning to data and modeling strategies.

A foundational distinction lies between innovation inputs and innovation outputs. Inputs include R&D investments, tax support, and human capital, while outputs encompass measurable results such as new-to-market products, high-tech exports, or licensing income. Within the innovation system perspective, this transformation is not automatic: it depends on the quality of institutional mediation. Institutions which are understood as formal rules, informal norms, and organizational routines, act as filters and channels through which innovation either materializes or stalls. Institutional theory, notably developed by North and extended by Acemoglu and Robinson, emphasizes how institutions shape incentives and reduce uncertainty. Inclusive institutions tend to promote experimentation and participation, while extractive ones often reinforce elite interests and stifle innovation diffusion, however, the causal channels remain complex. Kafka et al. suggest that the relationship between institutional quality and innovation is nonlinear: in countries with weak institutions, improvements yield strong effects; in mature systems, the marginal benefits become subtler and more dependent on coordination mechanisms.

A major theoretical debate centers on what kind of failure innovation policy ought to address. Market failure theory emphasizes underinvestment due to knowledge externalities, justifying fiscal interventions such as tax credits. Systemic failure theory, rooted in the national innovation systems tradition, shifts attention to network failures among firms, research actors, and public institutions. A third view, transformative innovation policy (TIP), introduces directionality failure: innovation might be abundant but misaligned with societal needs, such as climate goals or inclusive growth. As Schot and Steinmueller argue, this necessitates a policy framework that not only supports innovation but governs its trajectory. Sweden’s case illustrates the analytical usefulness of these distinctions. With high R&D intensity and robust institutional infrastructure, Sweden has nonetheless faced persistent challenges in converting inputs into commercial outcomes. This empirical paradox is captured in Ejermo and Kander's gear model, which distinguishes between the invention-to-innovation phase (Gear B) and the innovation-to-application phase (Gear C). The core empirical interest of this thesis lies in Gear B: the institutional and structural conditions that influence whether R&D efforts result in new products and processes with market impact.

One mechanism that complicates this process is the increasing decoupling between R&D and production, often framed through global value chain (GVC) theory. Multinational firms may locate R&D in high-cost, high-skill economies while shifting production and commercialization abroad. In such cases, national innovation indicators like turnover from new-to-market products or high-tech exports may misrepresent the true innovation capacity of the domestic system. This disconnect highlights the need to incorporate measures like domestic value added (DVA) in exports to assess whether innovation translates into national economic benefit.

These theoretical positions also signal an important shift in recent literature: from describing innovation systems to measuring the magnitude and mechanism of institutional effects. While earlier studies established that institutions matter, fewer have specified which ones matter most, how they interact, or under what conditions they are most effective. There is also growing recognition that firm size, sectoral structure, and globalization exposure shape how institutions influence innovation outcomes. In response, this study disaggregates three institutional variables, DVA in exports, R&D tax incentives, and university–industry cooperation—and links them with a commercialization-oriented outputs: turnover from new-to-market products. This design aims to move beyond general claims by quantifying institutional impact within and across countries. By doing so, the study aims to contribute to debates on innovation efficiency, institutional design, and the evolving challenges of capturing innovation performance in globally fragmented production systems.

3.3 Theoretical Approach

This thesis investigates how formal, national-level institutional arrangements shape the relationship between innovation inputs and innovation outputs, specifically, the extent to which countries succeed in translating R&D investment into commercial outcomes. The empirical focus is on three institutional dimensions: domestic value added in exports (DVA), R&D-related tax incentives, and university–industry cooperation (UIC). The study applies a comparative panel analysis to four EU member states: Sweden, Poland, Austria, and Denmark, across the period 2004 to 2020, with the aim of identifying whether national differences in institutional configurations help explain divergent commercialization performance, as measured by turnover from new-to-market products.

The theoretical foundation is rooted in institutional economics, particularly the proposition that formal institutions, laws, fiscal policies, regulatory structures, and organizational frameworks, determine the incentives and constraints faced by economic actors. As developed in the work of North (1990) and Acemoglu and Robinson (2012), institutions influence how resources are allocated, how knowledge is created and diffused, and how markets evolve. Institutions do not merely shape behavior passively; they actively structure the opportunity space for innovation, particularly by defining the conditions under which innovation can be commercialized. Building on this view, the empirical strategy adopted here is inspired by the work of Donges et al. (2022), who demonstrate that institutional quality, when systematically operationalized, can be linked to innovation outcomes across countries. While their model encompasses a broader institutional scope and uses composite indices, their approach validates the premise that national-level institutional variation has measurable consequences for innovation performance.

In parallel, this study is informed by the Swedish innovation paradox literature, which highlights the disconnect between Sweden's high R&D intensity and its modest commercial returns. Previous research (Bitard, 2008; Ejermo & Kander, 2006) attributes this gap to structural and institutional features, including the dominance of large firms in R&D activity. These studies underscore the importance of focusing not only on innovation inputs, but also on how institutions affect the translation of those inputs into economically valuable outputs. The paradox also motivates the use of turnover from new-to-market products as a central output measure, given its direct relevance to commercialization rather than research intensity or patent counts.

To support interpretation, this thesis draws selectively on the Systems of Innovation (SI) framework (Edquist, 2011), not as a theory to be tested, but as a diagnostic structure that helps map institutional roles onto key system functions. The institutional variables used in this thesis can be related to SI functions such as knowledge creation (R&D investment), knowledge diffusion (UIC), market formation (high-tech exports), and institutional alignment (tax incentives, production structure). Although the SI framework is typically used in qualitative or policy evaluation contexts, it remains useful for interpreting how different institutions might affect commercialization performance functionally, even if the underlying relationships are not formally modeled through systems logic.

The decision to focus on DVA, tax incentives, and UIC is theoretically justified and empirically grounded. Each represents a distinct institutional mechanism relevant to the commercialization process. DVA reflects the structural capacity of a national economy to retain innovation-related value, especially in the context of global production fragmentation. It offers a way to assess whether innovation performance is masked by value leakage abroad. R&D-related tax incentives are a widely used policy instrument across OECD countries and provide a lens on how fiscal design affects the cost structure of private R&D investment and subsequent market activity. University–industry cooperation captures the extent and institutional quality of knowledge transfer between science and business. Weak collaboration structures have been repeatedly cited as a bottleneck to commercialization, particularly in sectors where product innovation depends on scientific research and human capital alignment. While these three variables are central to this analysis, they are not exhaustive. Other institutional factors such as intellectual property regimes, public procurement policies, or labor market flexibility, undoubtedly influence innovation outcomes. However, constraints in data availability, cross-country comparability, and empirical tractability necessitate a focused approach. The selection of DVA, tax incentives, and UIC is thus both theoretically relevant and pragmatically feasible within the empirical design of this thesis.

In addition to this structured institutional framework, it is important to recognize that innovation dynamics are often non-linear and path dependent. Some policy instruments, such as tax incentives, may have delayed effects, while others, such as funding allocations or regulatory adjustments, may trigger more immediate but transitory responses. Taalbi (2017) argues that innovation frequently arises not from stable institutional environments, but from creative responses to structural shocks or crises. While this thesis does not attempt to model such dynamics explicitly, the point remains analytically important: the effects of institutions on innovation are mediated by broader historical conditions and temporal asymmetries. These considerations inform the longitudinal scope of the study, which seeks to capture average tendencies over a 17-year period rather than short-term fluctuations.

Turnover from new-to-the-market products, as defined in the Community Innovation Survey (CIS), measures the share or value of sales derived from products introduced within the last three years that are novel not only to the firm but to its market. This indicator occupies a critical position in the innovation measurement framework because it captures the commercial realization of innovation, the point at which innovative ideas, R&D efforts, and development activities materialize into goods that generate market revenue. Unlike input indicators such as R&D expenditure or patents, which signal potential innovative capacity, turnover from new-to-the-market products reflects the tangible economic impact of innovation, providing a direct measure of how successfully a firm or sector has translated inventive activity into marketable outcomes.

The strength of this measure lies in its focus on market novelty and the associated commercial performance. In high- and medium-high-technology manufacturing, where product life cycles are often short and competitive dynamics are intense, the ability to generate a substantial share of turnover from new-to-the-market products signals an effective innovation system. At the same time, the indicator is sensitive to institutional and structural conditions: factors such as domestic value added in exports, the presence of R&D tax incentives, and the extent of university–industry collaboration can influence the capacity of firms to develop and commercialize market-creating innovations. As such, turnover from new-to-the-market products serves as a suitable dependent variable for assessing how national-level institutions enable or constrain the commercialization of innovation.

To clarify the analytical logic underpinning this thesis, the institutional variables under study (DVA, R&D-related tax incentives, and university–industry cooperation) are each linked to specific mechanisms that affect the translation of R&D inputs into commercial results. DVA operates through a value capture mechanism, reflecting the extent to which national economies retain the economic benefits of innovation rather than allowing them to leak through globally fragmented production structures. R&D tax incentives function via a cost-reduction mechanism, aiming to stimulate private R&D by improving its return on investment, though their effect on commercialization depends on firm responses and broader market conditions. University–industry cooperation works through a knowledge diffusion mechanism, influencing the degree to which scientific research is absorbed by firms and transformed into marketable products. These mechanisms align with key innovation system functions, such as institutional alignment, market formation, and knowledge transfer. Together they shape the conditions under which R&D activity results in increased turnover from new-to-market products, the core commercialization outcome analyzed in this thesis. By linking institutions to mechanisms and mechanisms to measurable outputs, this pathway provides a coherent framework for understanding how national-level institutional configurations influence innovation performance.

4 Data

The empirical analysis draws on harmonized panel data for Austria (AT), Denmark (DK), Poland (PL), and Sweden (SE) covering the period 2004–2020. The country selection reflects both the availability of comparable indicators across the three institutional dimensions of interest, university–industry collaboration (UIC), domestic value added in exports (DVA), and R&D tax incentive generosity. The sample includes both advanced innovation-intensive economies (SE, DK, AT) and a catching-up economy (PL), enabling comparative inference across different institutional contexts. The panel is balanced, with nine biennial observations per country, yielding 36 country–year pairs.

4.1 Source Material

Five main data sources are used. First, innovation output data are obtained from the Eurostat Community Innovation Survey (CIS), a harmonized biennial survey of enterprises' innovation activities. The dependent variable, turnover from products new to the market (NTM), is taken from the CIS structural indicators module, restricted to high- and medium-high-technology (HMHT) manufacturing sectors as defined by Eurostat and OECD technology intensity classifications. For earlier waves using NACE Rev. 1, sectors are mapped to NACE Rev. 2 codes C20, C21, C26–C30. The CIS provides aggregated turnover in thousands of euros, which is converted to millions of USD using Eurostat annual exchange rates and deflated to constant 2015 prices using US CPI data from the World Bank. This conversion facilitates comparability across countries and over time.

$$\text{ntm\_hmht\_usd\_2015}_{c,y} = \text{TURN\_NTM}_{c,y} \times \text{EXCHANGE\_RATE}_{c,y} \times \text{CPI\_adj}_{2015}$$

where:

- $\text{TURN\_NTM}_{c,y}$: Turnover from new-to-market products (CIS indicator, in THS_EUR).
- $\text{EXCHANGE\_RATE}_{c,y}$: EUR to USD exchange rate for year y.
- CPI_adj_{2015}: CPI adjustment to constant 2015 prices, $\text{CPI\_adj}_{2015} = \frac{\text{CPI}_{2015}}{\text{CPI}_{y}}$.

Second, university–industry collaboration is drawn from the CIS cooperation module. The UIC indicator measures the share of innovating enterprises in manufacturing that report collaboration with universities or other higher education institutions during the reference period. For most countries, the variable is available as a rate-type (RT) measure in percentage terms; where reported in proportion form, it is converted to percentages. Due to confidentiality restrictions, HMHT-specific cooperation rates are unavailable for all countries and years, and total manufacturing rates are therefore used as a proxy.

$$\text{uic\_rate}_{c,y} = \text{R}T_{c,y} * 100, \text{if} y \leq 2008$$

$$\text{uic\_rate}_{c,y} = \text{PC}_{c,y}, \text{if} y \geq 2010$$

where:

- $\text{uic\_rate}_{c,y}$: Percentage of enterprises with university-industry collaboration (0–100%).
- $\text{RT}_{c,y}$: Share of enterprises (rate, 0–1) from CIS data (2004–2008).
- $\text{PC}_{c,y}$: Percentage of enterprises (%, 0–100) from CIS data (2010–2020).

Third, domestic value added in exports is calculated from the OECD Trade in Value Added (TiVA) database, 2023 release. Sectoral DVA shares, defined as the percentage of gross exports accounted for by domestic value added, are extracted for each HMHT sector and weighted by the sector's gross export value in USD to obtain an aggregated HMHT-level share for each country–year. The weighting ensures that larger export sectors have proportionally greater influence on the composite measure.

$$\text{dva}_{c,y} = \frac{\sum_{a \in A} \left(\text{DVA\_EXPsh}_{c,y,a} \times \text{EXGR}_{c,y,a} \right)}{\sum_{a \in A} \text{EXGR}_{c,y,a}} \times 100$$

where:

- $\text{dva}_{c,y}$: Weighted average DVA share of gross exports (%) for country c, year y.
- $\text{DVA\_EXPsh}_{c,y,a}$: DVA share (%) for activity a.
- $\text{EXGR}_{c,y,a}$: Gross exports (USD millions) for activity a.
- A: High/medium-high tech activities (C20, C21, C26, C27, C28, C29, C30).

Fourth, R&D tax incentive generosity is compiled from the OECD R&D Tax Incentives database. The variable combines indirect public support for business R&D via tax relief (GTARD) with direct government-financed BERD, both expressed as a percentage of GDP. This combined measure reflects the total scale of fiscal support for business R&D. In cases where GTARD data are unavailable for a given country–year (e.g., Denmark 2006), the value is proxied using direct support alone.

$$\text{tax\_incentive}_{c,y} = \text{GTARD}_{c,y} + \text{BERD\_GOV}_{c,y}$$

Fifth, exchange rate and deflator series are sourced from Eurostat and the World Bank. Eurostat provides annual EUR/USD exchange rates, while the World Bank supplies the US CPI series (2015=100), which is used to convert nominal USD values to constant 2015 prices.

4.2 Data processing and harmonization

The dataset construction involved multiple stages of cleaning and harmonization to ensure comparability. For CIS variables, country and sector codes were aligned across NACE revisions, and missing values in sectoral breakdowns were cross-checked with national statistical offices where available. Innovation output values were transformed from thousands of euros to millions of constant 2015 USD. All institutional regressors, UIC rate, DVA share, and R&D tax incentive generosity were standardized as z-scores to remove the influence of differing units of measurement and enable direct comparison of coefficient magnitudes:

$$\text{std}_{c,y} = \frac{x_{c,y} - \mu}{\sigma}$$

Log-transform NTM:

$$\text{ntm\_hmht\_usd\_2015\_log}_{c,y} = \log\left(\max\left(1, \text{ntm\_hmht\_usd\_2015}_{c,y}\right)\right)$$

Where data were missing for a country–year and could not be recovered from primary sources, mean imputation was applied. This was done sparingly, affecting at most one observation per variable in the panel (e.g., GTARD missing for DK in 2006). While mean imputation reduces variance and may bias results if missingness is systematic, it avoids listwise deletion, which would reduce the already limited sample size.

4.3 Descriptive statistics

Table 3 (see p. 17) summarizes the overall distribution of the dependent and independent variables across all 36 country–year observations. Turnover from new-to-market (NTM) products in high- and medium-high-technology (HMHT) manufacturing averages 15,199 million USD (2015 prices), but the range is wide, from just 558 million to over 28 billion USD, reflecting substantial differences in commercialization capacity. Among the institutional variables, university–industry cooperation (UIC) averages 15.0%, with a low of 0.6% and a high of 28.1%; domestic value added (DVA) in exports averages 64.5%, ranging from 55.0% to 74.3%; and R&D tax incentive generosity averages 0.126% of GDP, with a minimum of 0.021% and a maximum of 0.37%. Standard deviations indicate that DVA is the most stable over time (≈ 6.1 pp), whereas UIC shows greater variability (≈ 7.1 pp), suggesting more frequent policy or structural shifts in collaboration intensity.

Table 3 – Short Descriptive Statistics (N=36)

VARIABLES	(1) mean	(2) sd	(3) min	(4) max
ntm_hmht_usd_2015	15,199,170	8,814,591	557,941	36,736,838
tax_incentive	0.13	0.09	0.02	0.37
dva	64.53	6.09	55.04	74.25
uic_rate	14.96	7.09	0.60	28.10

4.4 Limitations in data coverage

Several limitations in the dataset merit consideration. First, CIS confidentiality suppressions are more frequent in HMHT breakdowns, leading to the use of total manufacturing UIC rates as a proxy. Second, the DVA measure is constructed at the sectoral level from TiVA data, which are available only at ISIC Rev. 4 classifications and must be matched to NACE codes; while this mapping is precise for manufacturing, it is not immune to classification differences. Third, R&D tax incentive generosity is an aggregate measure that does not account for design differences in tax schemes (e.g., incremental vs. volume-based credits), which may affect their effectiveness. Fourth, while the panel is balanced in terms of coverage, the small N and long gaps between waves limit the capture of short-term dynamics. The university–industry collaboration (UIC) variable is measured at the level of total manufacturing, while the dependent variable reflects turnover from new-to-market products in the high- and medium-high-technology (HMHT) subsectors only. This mismatch may introduce aggregation bias, as the measured collaboration intensity may not reflect the actual collaboration patterns in HMHT sectors. If low-technology sectors have systematically higher or lower UIC rates, the aggregate measure could attenuate or inflate the estimated association with HMHT commercialization. Similarly, the domestic value-added (DVA) share in exports is an economy-wide indicator; in economies with large primary or low-tech sectors, this may not map cleanly to value capture in HMHT industries. More generally, national-level indicators may mask within-country heterogeneity in firm size, sectoral structure, and policy targeting. For example, tax incentives may disproportionately benefit large incumbents, while commercialization outcomes may depend more on smaller, more agile firms. These measurement constraints suggest that the estimated coefficients should be interpreted as broad structural associations rather than precise sector-specific effects. Despite these constraints, the assembled dataset offers a consistent, multi-dimensional view of institutional conditions and commercialization outcomes in R&D-intensive manufacturing across diverse national contexts. The harmonization procedures ensure comparability across countries and years, providing a suitable empirical foundation for the econometric analysis that follows.

5 Methodology

This study employs a quantitative panel data approach to examine how three institutional variables, university–industry collaboration (UIC), domestic value added in gross exports (DVA), and R&D tax incentive generosity, relate to commercialization performance in high- and medium-high-technology (HMHT) manufacturing sectors. Commercialization is proxied by turnover from products new to the market, measured in constant 2015 USD millions. The analysis covers Austria (AT), Denmark (DK), Poland (PL), and Sweden (SE) over nine waves of the Community Innovation Survey (CIS), corresponding to the years 2004, 2006, 2008, 2010, 2012, 2014, 2016, 2018, and 2020. The unit of analysis is the country–year. The selection of countries reflects both the availability of harmonized data and their diversity in institutional structures relevant to innovation systems. Sweden serves as the focal case, while Austria, Denmark, and Poland provide variation in innovation performance and institutional configurations. The sectoral scope is limited to HMHT manufacturing, defined according to NACE Rev. 2 classes C20, C21, C26, C27, C28, C29, and C30, with earlier waves mapped from NACE Rev. 1 equivalents. This focus aligns with the literature on the Swedish Innovation Paradox, which emphasizes the commercialization gap in R&D-intensive manufacturing dominated by high and medium high tech big firms.

The dependent variable is turnover from new-to-the-market products in HMHT manufacturing, drawn from CIS micro-aggregates. Values, originally reported in thousands of euros, are converted to USD using annual EUR/USD exchange rates from Eurostat, deflated to constant 2015 prices using US CPI data from the World Bank, and scaled to millions. The measure captures domestic and export sales of products introduced during the preceding three years that were new to the market, regardless of whether they were developed locally or abroad. Given its strong right skew (range 557.9 thousand – 36,7 million USD 2015, see Table 3 earlier), the variable is long–transformed to stabilize variance and facilitate interpretation of coefficients as approximate percentage changes. The institutional regressors are constructed as follows. First, the UIC rate is the percentage of product- or process-innovating enterprises in manufacturing that report cooperation with universities or other higher education institutions. This is extracted from CIS cooperation modules (C06 or UNIV) and harmonized across waves, with rate-type measures (RT) converted to percentages where required. Sector-specific HMHT data are unavailable for all countries and years; thus, total manufacturing values are used as a policy-relevant proxy. Second, DVA share is the weighted average domestic value-added content of gross exports in HMHT manufacturing, derived from the OECD TiVA database. It is calculated by weighing sectoral DVA shares by their respective gross export values (in USD millions) before aggregation to the HMHT level. This measure reflects the extent to which export value is generated domestically, thereby indicating the degree of domestic retention of value within global value chains. Third, tax incentive generosity is the sum of indirect public support for business R&D via tax relief (GTARD) and direct government-financed business R&D expenditure (government-financed BERD), both expressed as a percentage of GDP. The measure is compiled from the OECD R&D Tax Incentives database. For Denmark 2006, where GTARD data are missing, values are proxied using government-financed BERD alone.

To enable coefficient comparability, all three regressors are standardized as z-scores: the country–year value minus the sample mean, divided by the sample standard deviation. Standardization removes the influence of differing measurement scales (percentages vs. GDP shares) while preserving the linear structure of the model. The final balanced panel comprises 36 observations, with missing values imputed by variable-specific means to maximize coverage. While mean imputation reduces variance and may attenuate estimated effects, it is preferred here to maintain comparability across waves in a small-N context; robustness checks without imputation are discussed separately. The empirical strategy begins with pooled ordinary least squares (OLS) regression with heteroskedasticity-robust (HC1) standard errors, estimated as:

$$\text{ntm\_hmht\_usd\_2015\_log}_{c,y} = \alpha + \beta_1 \text{uic\_rate\_st}d_{c,y} + \beta_2 \text{dva\_st}d_{c,y} + \beta_3 \text{tax\_incentive\_st}d_{c,y} + \varepsilon_{c,y}$$

where indexes "c" country and "y" indexes year. Coefficients on standardized regressors can be interpreted as the expected change in log turnover from a one-standard-deviation change in the regressor, holding other factors constant. In percentage terms, the semi-elasticity is given by: $\left(e^{\beta} - 1\right) \times 100$. This pooled OLS model is motivated by the small sample size and the slow-moving nature of the institutional variables, which limits variation within-country over time. Nevertheless, robustness checks include specifications with country and year fixed effects to control for time-invariant unobservable and common shocks, as well as models with one-period-lagged regressors to account for delayed institutional impacts on commercialization outcomes. Multicollinearity is assessed via variance inflation factors (VIFs), and influence diagnostics (Cook's distance, leverage) are used to check for dominant observations. Heteroskedasticity is formally tested using the Breusch–Pagan test, with robust standard errors reported throughout.

Several limitations must be acknowledged. First, the small number of observations (N=36) constrains the number of parameters that can be reliably estimated and limits statistical power, especially for detecting modest effects. Second, the regressors may be endogenous: UIC intensity, DVA share, and R&D tax incentives can themselves be influenced by commercialization performance, raising concerns of reverse causality. Third, the UIC measure covers total manufacturing, not exclusively HMHT sectors, potentially attenuating estimated effects if institutional conditions differ across sectors. Fourth, mean imputation for missing data introduces potential bias if missingness is systematic. Finally, the dependent variable is based on self-reported CIS turnover data, which may be affected by confidentiality suppressions and reporting differences across countries.

Despite these limitations, the chosen methodology offers a transparent framework for quantifying the relationship between national-level institutional features and commercialization in R&D-intensive manufacturing. The emphasis on standardized regressors, robust inference, and multiple robustness checks ensures that results can be interpreted in a comparative, scale-independent manner while remaining grounded in the constraints of the available data.

6 Empirical Analysis

The sample covers Austria, Denmark, Poland, and Sweden over nine CIS waves (2004–2020), producing a balanced panel of 36 country–year observations. The dependent variable is the log of turnover from new-to-market products in high- and medium-high-technology manufacturing (constant 2015 USD). Institutional variables are standardized university–industry collaboration (UIC) rate, standardized domestic value added (DVA) share in exports, and standardized R&D tax incentive generosity. Preliminary inspection shows Sweden consistently leads in UIC intensity, Denmark has high tax incentive generosity, and Poland has experienced the largest increase in DVA share. New-to-market turnover exhibits high between-country variation but modest within-country change over time, suggesting that structural factors may dominate short-term policy shifts. Bivariate correlations show small to moderate associations: UIC and tax incentives correlate positively with turnover, while DVA correlates negatively. None of the correlations approach levels that would trigger multicollinearity concerns, confirmed by variance inflation factors (1.5–1.7).

Table 4, reported in Appendix A, shows clear cross-country contrasts. Sweden's UIC rate averages 17.8%, more than double Poland's 8.8%, consistent with Sweden's reputation for strong science–industry linkages. Denmark matches Sweden's commercialization levels despite lower UIC (14.7%), hinting that other institutional or structural advantages may compensate. Austria records the second-highest DVA share (66.9%), while Poland has the lowest (60.7%). Interestingly, Poland's DVA profile does not translate into high commercialization, reinforcing the notion that value capture in exports and frontier product turnover is not necessarily aligned. Tax incentives are highest in Poland (0.21% of GDP) and lowest in Sweden (0.045%), yet Sweden still records the highest average NTM turnover, which challenges the assumption that more generous fiscal support alone ensures stronger commercialization.

Looking across countries, Sweden leads in both commercialization and UIC, but lags on tax incentives; Denmark achieves comparable commercialization with moderate UIC and high tax support; Austria's mid-range values in all three institutional variables correspond to mid-range commercialization; and Poland combines high tax generosity and rising DVA with the lowest commercialization. These patterns hint at the correlations later tested in the regressions: UIC and tax incentives may have positive associations with commercialization, while high DVA could be negatively related, reflecting value-chain structures that prioritize intermediate goods over frontier product launches.

6.1 Regression Results

The pooled OLS model with heteroskedasticity-robust (HC1) standard errors is:

$$\log(\mathrm{NTM\_HMHT\_c,t}) = \alpha + \beta_1 \cdot \mathrm{UIC}_{c,t} + \beta_2 \cdot \mathrm{DVA}_{c,t} + \beta_3 \cdot \mathrm{Tax}_{c,t} + \epsilon_{c,t}$$

Model fit is modest ($R^2 = 0.17$, adjusted $R^2 = 0.094$), which is expected given the small sample size and the aggregate nature of the variables. In the pooled OLS specification with standardised regressors reported in Table 5 (column 1), university–industry cooperation (UIC) is positively but not statistically significantly associated with innovation output ($\beta = 0.026$, $p > 0.10$). R&D tax incentive generosity is likewise positively but insignificantly associated with innovation output in the pooled OLS model ($\beta = 0.162$, $p > 0.10$). By contrast, domestic value added (DVA) in exports exhibits a statistically significant negative association with innovation output in the pooled specification ($\beta = -0.273$, $p < 0.05$), indicating that countries with higher domestic value added in exports tend to exhibit lower turnover from new-to-market products in the pooled cross-country setting. In the lagged specification reported in Table 5 (column 3), the negative association between DVA and innovation output strengthens ($\beta = -0.350$, $p < 0.05$), while the lagged coefficients on UIC ($\beta = 0.087$) and tax incentives ($\beta = 0.014$) remain positive but statistically insignificant. This suggests that the negative association between DVA and innovation output is not purely contemporaneous but persists with a one-period delay.

Table 6 translates the pooled OLS estimates into economically interpretable semi-elasticities by expressing the coefficients in percentage terms. In this specification, a one-standard-deviation increase in university–industry cooperation (UIC) is associated with an implied increase in turnover from new-to-market high and medium-high-tech products of approximately 4.9% ($\beta = 0.049$), although the estimate is statistically indistinguishable from zero ($p = 0.751$). A one-standard-deviation increase in domestic value added (DVA) in exports is associated with an implied reduction in turnover of approximately 25.1% ($\beta = -0.289$), which is marginally significant at the 10% level ($p \approx 0.08$). R&D tax incentive generosity is associated with an implied increase in turnover of approximately 15.4% ($\beta = 0.143$), but this estimate is likewise not statistically significant ($p = 0.316$). These results provide an economically intuitive interpretation of the pooled OLS estimates and complement the coefficient-based results reported in Table 5. Finally, fixed-effects estimation, which isolates within-country variation over time, substantially reduces all coefficients in magnitude and eliminates statistical significance (see Table 7, Appendix A). This indicates that the explanatory power of the pooled OLS results is largely driven by persistent cross-country differences rather than short-run year-to-year changes within countries.

The negative DVA effect runs counter-intuitive expectation that retaining more domestic value in exports should enhance commercialization. Instead, it aligns with a global value chain (GVC) mechanism in which higher domestic value-added shares may reflect retention of lower-margin production stages, while high-margin commercialization takes place abroad. Sweden provides a clear illustration: despite high R&D intensity and strong value retention, large multinationals such as Ericsson and Volvo often keep design and development at home but produce and launch new products in foreign markets, suppressing domestic turnover from frontier products. A similar pattern is visible in Austria's high-value machinery exports, where domestic value capture is strong, yet novelty shares in turnover remain modest. This dynamic has been noted in prior research by Mion & Zhu (2013) and Baum et al. (2020), who find that offshoring can diminish domestic commercialization metrics without reducing overall innovation output. From a policy perspective, these findings suggest that DVA is not necessarily a proxy for successful innovation appropriation at home; unless complemented by domestic scale-up capacity and demand, high value capture in exports may coincide with weak domestic commercialization.

UIC shows a positive but statistically insignificant association with commercialization, in line with the theory that stronger science–industry linkages facilitate knowledge transfer and market application (Edquist, 2011). The lack of precision here is likely due to two factors: (i) measurement mismatch, UIC is measured for all manufacturing, whereas the dependent variable is HMHT-specific; and (ii) sectoral heterogeneity, collaborative innovation may be more effective in certain subfields (e.g., pharmaceuticals, electronics) than others. For example, Sweden's UIC rate is consistently among the highest in the OECD, yet its commercialization gap remains, suggesting that collaboration alone is insufficient without complementary market formation and scale-up mechanisms. This resonates with systemic innovation theory, where linkages are necessary but not sufficient for output gains unless embedded within a supportive institutional framework.

R&D tax incentives also display a positive but unstable coefficient across models. This pattern suggests that fiscal incentives may primarily influence innovation inputs, such as increasing business expenditure on R&D, rather than generating immediate effects on commercialization. Effects may be lagged, indirect, or geographically displaced if beneficiary firms commercialize abroad. Denmark, for instance, combines generous R&D tax incentives with strong commercialization performance, whereas Sweden's more limited tax support coexists with high commercialization in absolute terms. This mismatch points to the importance of incentive targeting: broad-based credits may encourage R&D, but without conditions or complementary policies to anchor later-stage production domestically, the impact on national commercialization can be muted.

Model diagnostics reinforce confidence in the results. Variance inflation factors (VIFs) are well below the conventional threshold of 5, indicating no problematic multicollinearity. Breusch–Pagan tests do not reject homoskedasticity, but robust (HC1) standard errors are used as a safeguard. Influence diagnostics (Cook's distance and leverage) show no observation or country disproportionately shaping the estimates.

Robustness checks strengthen the interpretation. Removing mean-imputed values, a potential source of bias, reduces sample size and increases standard errors but leaves coefficient signs unchanged. Adding country-specific linear trends to FE models preserves the substantive direction of effects, although the DVA coefficient loses significance, consistent with its role as a slow-moving structural characteristic. Leave-one-out tests confirm that no single country drives the overall pattern. The contrast between pooled OLS (stronger coefficients) and FE (weaker coefficients) further supports the view that results are shaped by long-standing structural differences rather than short-term policy changes.

6.2 Summary

Across the 2004–2020 panel, no consistent evidence emerges that UIC, or R&D tax incentives directly increase commercialization of high and medium-high new to the market tech products at the country-year level. The most robust finding is a negative association between DVA and commercialization, particularly in lagged models, supporting the view that value-chain positioning can limit domestic appropriation of innovation rents. Together, these results suggest that commercialization efficiency is shaped less by isolated institutional levers than by the interaction of these levers with structural conditions such as production geography, market formation, and firm size distribution. Policies aimed at closing the commercialization gap may therefore require sector-specific targeting, integration with scale-up support, and longer time horizons to shift entrenched structural dynamics.

7 Discussion

The regression evidence indicates that national institutional levers do not yield uniform, positive effects on commercialization outcomes in high- and medium-high-tech manufacturing. Using turnover from new-to-market products (log) as the dependent variable and standardized institutional predictors, the pooled OLS suggests modest explanatory power ($R^2 \approx 0.17$) for 36 observations (see Table 8 in Appendix A); University–industry collaboration (UIC) and R&D tax incentive generosity display positive but statistically indistinct associations with commercialization (see Table 9 in Appendix A: +5% and +15% per 1 SD), whereas domestic value added in exports (DVA) shows a negative, borderline association (see Table 9 Appendix A: −25% per 1 SD; $p \approx 0.11$). When introducing temporal structure, the lag model (see Table 11 in Appendix A) strengthens the DVA result to a statistically significant negative effect (≈ −35%, $p \approx 0.03$), while UIC and tax incentives remain imprecise. Fixed-effects estimates (see Table 10 in Appendix A) are uniformly imprecise, consistent with limited within-country variation and small T.

These patterns challenge mechanistic “more R&D = more innovation” policy narratives. From an institutional economics angle, formal incentives (e.g., tax generosity) can fail to move commercialization if complementary institutions and structures are misaligned: weak entrepreneurial capabilities, financing frictions, or demand-side bottlenecks can decouple inputs from market outcomes. From a systems-of-innovation perspective, structure matters: Sweden and peers are characterized by large-firm R&D intensity and internationalized production networks. If high-tech commercialization is realized through foreign production, domestic turnover from new-to-market products will under-record the value created by domestic R&D. The significantly negative lagged DVA coefficient fits an offshoring/composition mechanism: periods with higher domestic value-added shares may correlate with more domestically retained, lower-margin stages or with export-mix shifts unfavorable to HMHT new-product turnover. Conversely, when higher-margin or fast-growing commercialization is realized abroad, domestic DVA declines while domestic R&D remains high, an institutional-structural configuration at the heart of the Swedish innovation paradox.

The country-level descriptive patterns support this interpretation. Sweden and Denmark both exhibit high UIC and strong R&D intensity, yet their commercialization performance differs in ways consistent with their global value chain positioning. Denmark, despite smaller absolute turnover, may benefit from institutional agility and niche specialization, while Sweden’s high DVA share reflects the retention of manufacturing stages that are not necessarily linked to frontier product launches. Austria, with strong UIC and tax incentives, nonetheless shows moderate commercialization, suggesting that without demand-pull mechanisms or high-value chain niches, institutional levers alone have limited impact. Poland’s case is particularly interesting: low R&D intensity and modest UIC are paired with comparatively high turnover levels, due to integration into export-oriented production networks where product novelty is driven by foreign-linked firms operating domestically.

Beyond these descriptive contrasts, the regression results can be further unpacked by considering the interaction between institutional variables and national industrial structures. Sweden's combination of high R&D intensity, strong UIC, and moderate tax incentives occurs in the context of a manufacturing sector heavily concentrated in large, export-oriented firms. These firms excel in developing technologically advanced products but frequently commercialize them through foreign production facilities, which diminishes measured domestic turnover. Denmark, while also internationally integrated, has a more diversified industrial base and a policy environment that emphasizes green technologies and niche specialization; this may explain why negative DVA effects do not translate into equally pronounced commercialization gaps. Austria's strong fiscal incentives and UIC performance are offset by a sectoral profile skewed toward incremental innovation in medium-technology industries, where product turnover cycles are slower. Poland's higher-than-expected commercialization performance reflects its integration into European manufacturing networks, where domestic plants of foreign-owned firms produce goods that meet "new-to-market" criteria in export destinations, thereby boosting turnover without equivalent national R&D spending.

For UIC, the consistently positive but imprecise coefficients (see all three percent-effect tables) align with theory (knowledge transfer and absorptive capacity) yet fail to clear conventional significance thresholds. Two factors mute detectability. First, measurement mismatch: the UIC proxy aggregates manufacturing broadly, while the dependent variable focuses on HMHT sectors; if UIC benefits are heterogeneous and concentrated in specific niches, aggregation dilutes signal. Second, limited variation across countries and over time reduces statistical power. The small sample (4 countries, 9 years) compounds this, especially in FE models, where identification relies on within-country changes. It is also possible that UIC effects lag beyond the two-year intervals observed here, particularly in sectors where collaborative R&D cycles are long.

R&D tax incentives do not exhibit robust positive effects on commercialization in any specification. This does not imply they are ineffective; rather, their primary margin may be inputs (BERD) rather than immediate HMHT turnover, with lags, targeting, and firm-composition effects obscuring average output responses. If incentives are primarily utilized by large multinationals that subsequently scale production abroad, domestic commercialization metrics will weakly reflect realized value. This mechanism is compatible with the paradox literature: strong inputs and prolific patenting coexist with muted domestic commercialization when complementary production, scale-up finance, and home-market demand are insufficiently aligned. It also raises questions about the design of such incentives: volume-based credits may encourage more R&D expenditure without necessarily prioritizing commercial readiness or domestic scaling.

These results support an interpretation where institutional quality matters through interaction with structural conditions: export-value-chain positioning, the geography of production, firm size distribution, and the location of sales. The statistically stronger, negative lagged DVA effect increases the plausibility that domestic commercialization is sensitive to where in the chain value is captured, not just how much R&D is conducted. In this sense, the paradox is not necessarily about "too little commercialization effort" but about where commercialization happens and who captures the rents. This reframing aligns with the Gear B logic, institutions that bridge invention to innovation must also align with structures that enable market introduction at home.

Therefore, the policy problem is less about "insufficient R&D" and more about "insufficient domestic scaling and appropriation capacity." In practical terms, interventions that enhance domestic scale-up (procurement, mission-oriented demand, late-stage financing), strengthen entrepreneurial capabilities, and reduce frictions for HMHT production and early sales at home are likely to raise the measured turnover outcome more effectively than broad R&D tax generosity alone. Such measures should be complemented by strategies to reposition domestic industry segments toward higher-value, innovation-intensive nodes in global value chains.

Three limitations temper inference. First, sample size and aggregation: four countries over nine years restrict power and the ability to model heterogeneous effects by firm size or technology field. Second, measurement mismatch: UIC at the whole-manufacturing level may understate sector-specific complementarities relevant for HMHT commercialization; DVA aggregates the entire export basket and may obscure where in value chains the shifts occur. Third, identification: contemporaneous OLS cannot fully address endogeneity (reverse causality, omitted demand shocks); the stronger lagged DVA result is suggestive but not definitive. Sensitivity checks with alternative timing, inclusion of demand proxies (e.g., domestic HMHT final demand or procurement shocks), and instrumented strategies for DVA or UIC, as data permit, would strengthen causal claims.

The discussion anchored in model outputs points to a coherent mechanism: institutions that raise R&D inputs are not sufficient when value-chain geography and domestic scaling conditions divert commercialization abroad. The paradox is not input inefficiency but rather suggests a domestic capture inefficiency. Future work should integrate measures of scale-up finance, procurement intensity, and foreign production ratios by top R&D performers to separate input stimulation from domestic appropriation channels. Extending the analysis to a broader set of countries and incorporating firm-level data could also help disentangle the role of multinational strategies from purely national institutional effects.

7.1 Policy implications

Results show weak/insignificant effects for UIC and R&D tax incentives on HMHT commercialization, but a significant negative lagged effect of DVA. This pattern is consistent with a Swedish-paradox mechanism: strong inputs with commercialization realized abroad due to value-chain position and scale-up frictions at home. Policy should therefore shift emphasis from input subsidies to domestic appropriation levers. This includes mission-oriented demand, strategic procurement for HMHT sectors, investment in pilot and demonstration facilities, late-stage finance targeted at first-of-a-kind production, and tighter coupling between UIC initiatives and commercialization pipelines. Where tax incentives remain, they should reward milestones closer to market entry, prototype completion, initial sales, domestic scaling, to align institutional support with the commercialization stage your dependent variable measures. Moreover, policies aimed at improving DVA should be nuanced, rather than maximizing domestic content indiscriminately, they should target retention of high-margin, innovation-driven stages in production chains. In the case of UIC, developing sector-specific collaboration metrics and linking funding to downstream commercialization indicators could sharpen impact and improve measurability in future evaluations.

Policy implications extend beyond generic recommendations to the design of highly targeted interventions. For example, in the Swedish context, public procurement strategies could be tied to mission-oriented priorities in HMHT sectors such as advanced materials, precision instrumentation, and green propulsion systems, creating lead markets that incentivize domestic scale-up. Denmark's experience with renewable energy clusters suggests that consistent government demand, combined with targeted export promotion, can accelerate commercialization while maintaining high domestic value capture. For Austria, aligning generous tax incentives with measurable downstream milestones, such as prototype completion or first commercial sale, could help convert its strong R&D base into higher NTM turnover. In Poland, policies that embed local suppliers into high-value segments of global production chains could sustain its commercialization gains while gradually building indigenous innovation capacity. In all four cases, improving the granularity and sectoral specificity of institutional indicators, especially for UIC, would both sharpen policy targeting and enable more precise empirical evaluation in future research.

8 Conclusions

This thesis set out to examine how specific national-level institutional factors, domestic value added in exports, R&D-related tax incentives, and university–industry cooperation, influence the commercialization of innovation in high- and medium-high-technology manufacturing. This focus on commercialization outcomes addresses a recognized gap in the innovation literature, which has traditionally concentrated on input–output relationships (e.g., R&D–patents) rather than market-level realization. By centering on turnover from new-to-market products, the thesis operationalizes a measure that captures both technological novelty and its translation into economic value. This responds to calls in institutional economics for more outcome-oriented assessments of innovation systems. Using a balanced panel of four OECD economies from 2004 to 2020, the analysis contributes to a growing body of empirical research on the Swedish Paradox by moving beyond descriptive accounts toward quantitative assessment of institutional drivers.

The findings reveal a nuanced picture. While theory and prior literature suggest that UIC and tax incentives should facilitate the translation of R&D into marketable products, their effects in this study are positive but statistically indistinct, indicating that such levers may be insufficient in isolation or require longer time horizons to manifest in measurable outputs. By contrast, the consistent negative association between domestic value added and turnover from new-to-market products, statistically significant in lagged models, points to the role of global value-chain positioning in shaping domestic commercialization outcomes. This result suggests that innovation rents generated by domestic R&D may be captured abroad when production and scaling are offshored, a structural condition embedded in Sweden's economic model and shared to varying degrees by peers. These findings challenge linear policy assumptions that greater R&D inputs or stronger formal institutions automatically yield proportional commercial returns. They underscore the importance of complementary conditions, domestic scale-up capacity, entrepreneurial ecosystems, targeted demand-side measures, that determine whether innovation is commercialized at home or elsewhere. The Swedish case illustrates that high institutional quality and R&D intensity can coexist with persistent commercialization gaps when structural channels for domestic appropriation are weak. These results do not simply nuance the Swedish Innovation Paradox, they reframe it. The paradox is less about inefficiency in converting R&D into innovation and more about the structural geography of commercialization. In highly globalized production systems, the capacity to innovate domestically is necessary but insufficient; retaining value at home depends on the strategic alignment of institutions, industrial capabilities, and market opportunities.

Descriptive statistics reinforce these patterns. Sweden consistently records the highest UIC rates in the sample (≈17.8%), yet its commercialization output remains below what might be expected from its innovation inputs, an empirical reflection of the Swedish Innovation Paradox.

Austria combines high DVA with moderate commercialization, fitting the negative association observed in regressions. Denmark displays a more balanced institutional profile, with moderate DVA, high UIC, and relatively strong commercialization, while Poland, with low UIC and tax incentives, also exhibits the lowest commercialization rates.

From a policy perspective, this points toward recalibrating innovation strategies. Rather than relying primarily on broad-based tax incentives or generic collaboration schemes, governments should consider instruments that link R&D activity to domestic production and market entry, such as mission-oriented procurement, prototype-to-market financing, and policies that anchor high-value stages of production domestically. For Sweden, and for small, open economies more broadly, the challenge is not only to stimulate innovation but to ensure that the economic value it generates is retained and reinvested locally. More concrete; the results suggest that a one-size-fits-all approach is unlikely to close the commercialization gap. In Sweden and Austria, addressing the negative DVA-commercialization relationship may require policies that strengthen domestic scale-up capacity, incentivize domestic product launches, and integrate trade and industrial strategies to retain high-margin stages of the value chain. For Poland, improving UIC may yield greater benefits if paired with institutional reforms that lower barriers to private-sector innovation adoption. In Denmark, where institutional balances are already more favorable, the focus might shift toward sustaining agility in response to global market changes. Across all cases, aligning R&D tax incentives with downstream commercialization support, such as demonstration facilities, procurement programs, or export-readiness schemes, could increase the likelihood that innovation spending translates into domestic economic gains.

While this analysis relies on panel regression techniques, the results are interpreted with caution. Innovation systems are complex, and institutional effects are not always additive or linear. The findings should be understood as evidence of systematic associations, not definitive causal estimates. The scope is constrained by data limitations, small sample size, and sectoral aggregation. Further research using more granular firm-level data, longer time series, or mixed-methods approaches could better capture the interplay between institutional design, value-chain structures, and innovation outcomes, and move closer to identifying the causal pathways through which institutions enable or hinder the domestic capture of innovation's economic benefits. Methodologically, the limited within-country variation in institutional variables constrained the capacity of fixed-effects models to detect time-varying impacts, suggesting that much of the signal lies in slow-moving structural differences. Future work could apply non-linear or threshold models to capture potential tipping points in commercialization performance or employ system dynamics approaches to model feedback loops between institutional change, innovation input, and market outcomes. Extending the analysis to firm-level panel data would allow for the disentangling of sectoral heterogeneity and the identification of mechanisms, such as firm size, ownership structure, and export orientation, that mediate institutional effects on commercialization. Ultimately, this study reinforces the idea that innovation policy cannot be divorced from industrial and trade policy. For policymakers and scholars alike, the implication is clear: measuring and improving commercialization requires looking beyond input metrics and addressing the institutional and structural pathways through which innovation becomes, or fails to become, domestic economic value.

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Appendix A

Table 4 – Overall Statistics for Four Countries

geo	AT	DK	PL	SE
ntm_hmht_usd_2015_mean	17,992,590	9,438,570	16,851,244	16,514,276
ntm_hmht_usd_2015_min	3,379,625	3,172,112	2,517,226	557,940
ntm_hmht_usd_2015_max	25,688,135	15,199,170	26,204,804	36,736,838
ntm_hmht_usd_2015_median	20,424,677	10,316,468	18,544,241	14,149,498
ntm_hmht_usd_2015_sd	7,899,375	4,263,430	8,281,620	11,816,719
uic_rate_mean	18.55	14.66	8.84	17.79
uic_rate_min	5.8	3.8	0.6	14.96
uic_rate_max	28.1	23.26	13.1	22.8
uic_rate_median	20.83	14.5	11.6	17
uic_rate_sd	8.481	7.146	4.985	2.546
dva_mean	59.503	71.098	58.537	68.959
dva_min	55.754	65.748	55.044	67.165
dva_max	62.990	74.251	63.085	70.485
dva_median	58.623	71.573	58.485	69.091
dva_sd	2.683	2.881	2.495	1.071
tax_incentive_mean	0.25	0.065	0.062	0.126
tax_incentive_min	0.178	0.0403	0.0214	0.11
tax_incentive_max	0.37	0.1389	0.1453	0.1393
tax_incentive_median	0.25	0.06	0.0368	0.1256
tax_incentive_sd	0.06	0.029	0.049	0.0082

Table 5 – OLS Regression

	(1)	(2)	(3)
	OLS (robust)	FE (geo&year)	OLS lag (robust)
uic_rate_std	0.026107	0.487055	
	(0.081868)	(0.243574)	
dva_std	-0.273160**	0.103910	
	(0.133419)	(0.431661)	
tax_incentive_std	0.161664	0.189999	
	(0.115818)	(0.375831)	
2004.year		0.000000	
		(.)	
2006.year		0.534707	
		(0.479004)	
2008.year		1.656807**	
		(0.368381)	
2010.year		1.378914***	
		(0.230268)	
2012.year		1.173041***	
		(0.199847)	
2014.year		1.152494**	
		(0.204441)	
2016.year		0.311834	
		(1.020263)	
2018.year		2.216250**	
		(0.474555)	
2020.year		2.220123***	
		(0.168184)	
L1_uic_rate_std			0.087124
			(0.118264)
L1_dva_std			-0.349702**
			(0.158593)
L1_tax_incentive_std			0.013997
			(0.140760)
_cons	16.268620***	15.085934***	16.423673***
	(0.141445)	(0.128642)	(0.152638)
R-squared	0.170347	0.635176	0.182080
Observations	36	36	32

Standard errors in parentheses

="* p<0.10 ** p<0.05 *** p<0.01"

Table 6 – OLS Tidy Robust

	(Intercept)	uic_rate_std	dva_std	tax_incentive_std
estimate	9.36	0.05	-0.29	0.14
std.error	0.14	0.18	0.18	0.18
statistic	66.23	0.28	-1.62	0.78
p.value	0.00	0.78	0.11	0.44
conf.low	9.07	-0.31	-0.65	-0.23
conf.high	9.65	0.41	0.07	0.52
pct_effect	1162343.06	5.03	-25.13	15.39
pct_ci_low	871545.12	-26.69	-47.91	-20.72
pct_ci_high	1550156.90	50.47	7.62	67.93

Table 7 – Results: Fixed Effects

Dependent Var.:	log (NTM HMHT, 2015 USD)
UIC (std)	0.0736 (0.1882)
DVA (std)	-0.1142 (0.3372)
Tax incentive (std)	0.0645 (0.2949)
	Fixed-Effects
geo	Yes
year	Yes
S.E. type	Heteroskedasticity-rob.
Observations	36
R2	0.60336
Within R2	0.01442

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Table 8 – OLS Results at Glance

r.squared	0.172
adj.r.squared	0.094
sigma	0.848
statistic	2.209
p.value	0.106
df	3
logLik	-43.027
AIC	96.055
BIC	103.973
deviance	23.013
df.residual	32

Table 9 – Percent Effects OLS

Variable	UIC (std)	DVA (std)	Tax incentive (std)
Estimate	0.049	-0.289	0.143
Std. Error	0.177	0.178	0.184
p-value	0.783	0.114	0.443
Percent effect	5.026	-25.127	15.387
CI 95% low	-26.695	-47.911	-20.717
CI 95% high	50.472	7.623	67.933

Table 10 – Percent Effects FE

Variable	UIC (std)	DVA (std)	Tax incentive (std)
Estimate	0.07	-0.11	0.06
Std. Error	0.19	0.34	0.29
p-value	0.70	0.74	0.83
Percent effect	7.64	-10.79	6.67
CI 95% low	-27.21	-55.76	-42.24
CI 95% high	59.19	79.88	96.97

Table 11 – Percent Effect Lag

Variable	UIC (std)	DVA (std)	Tax incentive (std)
Estimate	0.182	-0.424	-0.049
Std. Error	0.175	0.181	0.191
p-value	0.305	0.026	0.799
Percent effect	20.015	-34.571	-4.815
CI 95% low	-16.093	-54.799	-35.697
CI 95% high	71.662	-5.290	40.900

9 AI contribution statement

Artificial Intelligence or AI was used in this work, particularly, ChatGPT and Grok. It was used to check for grammatical mistakes, refine phrasing without altering core meaning or loosing logical flow, do research on available data, sources. It was also used to optimize parts of coding where efficiency was important to reduce unnecessary usage of memory and cut the redundant code. In conversation with AI, it provided suggestions to investigate topics that helped to narrow down the research. AI was used to verify statements and numerical accuracy made from analysis. AI was not used to create whole parts of the paper.