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Does Trust Affect Innovation through Promoting Collaboration in OECD Countries? Cross-country Analysis and Case Studies in Sweden and Japan

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Abstract: Trust has attracted academic attention as the crucial social capital to foster economic development. Especially in analysing today's knowledge-based economy, the influential role of trust on innovation has been studied by many researchers due to the favourable feature of trust in accelerating knowledge exchange and collaboration in innovation networks. However, the quantitative relationship between the level of trust in a country, the degree of collaboration on innovative activity, and innovation performance at the country level is still ambiguous, because the previous studies have seldom analysed the relationship using the right measurement of innovation output while taking into account the effects of trust on innovation networks on a national scale. This study contributes the academic discussion in several ways through a combination of quantitative and qualitative methods. First, the current quantitative cross-section model analysis of OECD member countries from 2006 to 2014 provides further support for the idea that the degree of trust in countries, using data from the World Values Survey, has a positive influence on innovation, as measured the ratio of small and medium-sized enterprises (SMEs) which have experienced new or improved goods or services that differ significantly from the firm's previous goods or services and that have been introduced on the market. The qualitative analysis comparing Sweden and Japan also indicates that high-trust countries have an advantage over lower-trust countries in promoting innovation. Second, although the quantitative analysis indicates that participation in global innovation networks contributes to promoting innovation, both the quantitative and the qualitative analysis cannot fully support the idea that trust has a positive impact on facilitating collaboration for innovation, as measured the ratio of SMEs collaborating on innovation with other organisations.

Key words: Trust, Innovation, Collaboration, Global Innovation Networks, Sweden, Japan

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GINs : Global Innovation Networks

OECD : Organization for Economic Co-operation and Development

SMEs : Small and medium-sized enterprises

NIS : National Innovation System

WVS : World Values Survey

1 Introduction

Many authors suggest that institution plays a significant role in the development of countries (Acemoglu, Johnson & Robinson, 2005; Bardhan, 2005; North, 1991; North, Waillis & Weingast, 2006). There are many layers to institution, ranging from tangible features such as geography, political system, and economic law, such as property rights, to intangible features of culture such as customs, traditions, religions, and norms (Williamson, 2000). Among them, norms, values, and trust are viewed as kinds of social capital that complement traditional resources for economic development (like physical capital and human capital) and produce better outcomes (Akçomak, & Ter Weel, 2009).

Particularly trust, which is essentially defined as the propensity of people to believe other people whom they do not know personally, is regarded as one of the most important ingredients of social capital (Gur, 2015). It plays a fundamental role in transactions and collaborations among individuals, which form the basis of economy. According to Arrow (1972), 'Virtually every commercial transaction has within itself an element of trust, certainly any transaction conducted over a period of time. It can be plausibly argued that much of the economic backwardness in the world can be explained by the lack of mutual confidence'. In other words, in a high-trust society, people spend less time investigating others, thus reducing the cost of transactions (Dakhli & Clercq, 2004; Shirley, 2005; Zak & Knack, 2001). It is also argued that, in a knowledge-based economy, knowledge exchange and collaboration in innovation networks is crucial for promoting innovation, and trust is the basis for this (Giest, 2019). Since today's knowledge-based economy has relatively high uncertainty for promoting innovation due to unpredictable future conditions in areas such as technology and markets, it is not control that is needed, but rather trust (Nooteboom, 2013). Therefore, trust is considered to play a crucial role in promoting innovation in today's economy.

Many scholars have investigated a large number of cases and argued the role of trust in innovation. Some of them have focused on clusters of firms or innovation networks to illustrate how trust facilitates knowledge exchange within the innovation network (Giest, 2019; Klijn, Sierra, Ysa, Berman, Edelenbos & Chen, 2016). Others have argued that trust has a positive impact on not only microeconomics, but also macroeconomic topics such as economic growth (Knack & Keefer, 1997; Horvath, 2013), GDP per capita (Bjørnskov & Méon, 2013), investment per GDP (Zak & Knack, 2001), balancing the governmental budget deficit (Butzer, Jordan & Stracca, 2013), and entrepreneurial activity (Guiso, Sapienza & Zingales, 2006; Troilo, 2010). Those studies with cross-sectional analysis suggest some paths through which trust affects the macroeconomy, such as constructing favourable political or economic institutions (Bjørnskov & Méon, 2013; Troilo, 2010) or supporting entrepreneurial activity (Guiso, Sapienza & Zingales, 2006; Troilo, 2010).

However, I consider that the quantitative relationship between the level of trust in a country, the degree of collaboration on innovative activity, and innovation performance at the country

level is still ambiguous for several reasons. First, the relationship between trust and the innovation network is mainly studied using qualitative methods, i.e. case studies, but has not been studied on a national scale thus far. Second, some country-wide quantitative studies adopt variables that are too narrow or too wide to measure innovation performance. As is described in depth in the following section, some of the measurements are beyond the scope of innovation, such as GDP growth (Knack & Keefer, 1997; Horvath, 2013), productivity (GDP/working hours) (Kostis, Kafka & Petrakis, 2018), and macroeconomic imbalance (Butzer, Jordan & Stracca, 2013). Innovation is part of the answer to creating jobs and accomplishing sufficient economic growth to provide public goods, but it is not the only answer (Gault, 2013a, p. 3). Thus, I consider that those measurements in the prior literature cannot be classified into the effects of innovation and those of other factors, such as the influences of the financial market, trade conditions, demographic change, and so on. On the other hand, the measurements are sometimes restricted in the range of technological innovation like patents and share of high-tech exports (Chaminade, Lundvall & Haneef, 2018, p. 55); thus, they fail to contain other forms of innovation like creating new services. Innovation is a complex phenomenon and can be achieved not only through technological improvement but also by changing business practices, restructuring the organisation of the firms, and finding new methods of developing marketing strategies (Gault, 2013a, p. 3). In sum, few studies have investigated the relationship between trust and innovation output with an exact measurement of innovation while taking into account the effects of trust on innovation networks on a national scale.

This study contributes to the academic discussion by testing a general hypothesis, which I later elaborate on in the form of research questions, that the more deeply knowledge-intensive the economy becomes, the more significant a role trust plays in stimulating innovation through facilitating collaboration for innovation. This hypothesis is tested through a combination of quantitative and qualitative methods. In the quantitative analysis, I construct a cross-sectional dataset of Organization for Economic Co-operation and Development (OECD) member countries from 2006 to 2014. This dataset consists of the ratio of small and medium-sized enterprises (SMEs) with product or process innovation, the ratio of SMEs that engage in collaborating with other organisations, and the degree of trust in the country. The main finding is that the degree of trust in a society has a positive and statistically significant relationship with the innovation output. However, trust does not have a positive and statistically significant relationship with the degree of collaboration for innovation, though there are positive, strong, and statistically significant relationships between collaboration and innovation output.

To investigate the results of the quantitative analysis that do not fully support the general hypothesis, this study combines the qualitative method with the quantitative analysis. I analyse the up-to-date situation regarding the relationship between the level of trust and innovation and trust and collaboration for innovation in two of the OECD member countries. This methodology is adopted because quantitative methods with aggregated data sometimes miss the context behind the results of the quantitative analysis (Chaminade, Lundvall & Haneef, 2018, p. 61). This study compares Sweden and Japan, which have similar levels of innovative capability and industrial structure but different levels of trust, collaboration, and innovation, by reviewing governmental documents, previous literature, and other secondary data. Furthermore, to concretise the comparison in depth, this study focuses on cases in the

automobile industry. This industry is facing a paradigm shift that requires more collaboration with other industries to address new trends like electrification and autonomous driving (The Economist, 2019). In addition, the selected countries provide ideal cases for analysing this industry because both have internationally competitive firms. The qualitative analysis finds that in Sweden's high-trust society, trust is regarded as one of the strengths of promoting innovation in general. In addition, Sweden's government and a representative firm, Volvo cars, display a higher tendency to collaborate with others, especially with foreign firms, compared to the lower trust society, Japan, and a representative firm, Mazda. At glance, the findings from the qualitative analysis cast doubt on the finding from the quantitative analysis that denies the effects of trust on collaboration. However, due to the difference in the size of the countries' economies, it is not sufficient to fully support the general hypothesis. The main arguments from the quantitative and qualitative analysis require future research with more recent data or different pairs of countries to compare in depth.

This study is structured as follows. In the second section, I review the previous literature, then proceed to argue the present research question and methodology in the third section. In the fourth, I explore my quantitative analysis based on the cross-sectional data focusing on OECD member countries regarding the relationship between trust, collaboration, and innovation. In the fifth, I conduct a qualitative analysis that compares the case of Sweden and Japan. In the last section, I conclude the study and suggest future research.

2 Literature review

2.1 Studies regarding the effects of trust on economy on a national scale

Many studies have investigated the relationship between degree of trust in countries and economic performance (Bjørnskov & Méon, 2013; Dakhli & Clercq, 2004; Giest, 2019; Guiso, Sapienza & Zingales, 2006; Hauser, Tappeiner & Walde, 2007; Horvath, 2013; Knack & Keefer, 1997; Klijn et al., 2016; Kostis, Kafka & Petrakis, 2018; Troilo, 2010; Zak & Knack, 2001). Knack and Keefer (1997) discovered that the countries with higher social capital, such as norms and trust, demonstrated higher GDP growth than those with less social capital from 1980 to 1992 (N = 29). They measured the degree of trust in countries using data from the World Values Survey (WVS), which consisted of the ratio of respondents who answered, 'Most people can be trusted' to the question, 'Generally speaking, would you say that most people can be trusted, or that you cannot be too careful in dealing with people?'. They also illustrated the causal relationship between trust and GDP growth by adopting some instrumental variables like the percentage of ethnic majority and the percentage of law school students in all postsecondary education. They claimed that trust stimulates innovation because entrepreneurs can easily find partners and devote their time to promoting innovation in new products or processes, though they did not find any evidence for the relationship. However, as mentioned previously, GDP growth is not always the result of innovation; thus, it seems unfounded to assert that a high-trust society promotes innovation.

Their paper has triggered many follow-up studies that focus on the role of trust in economic development (Horvath, 2013). For example, Zak and Knack (2001) have demonstrated a positive relationship between trust and the rate of investment per GDP (averaged from 1970-1992) and between trust and economic growth (averaged over the same period) with a cross-country regression model (N = 41). They measured the level of trust using the first three WVSs, which were conducted in 1981, 1990-1991, and 1995-1996. They argue that high trust enables decreased transaction costs and stimulates investments. In the same line, Horvath (2013) used more than 40 regressors for nearly 50 countries to illustrate that trust was a robust determinant of long-term economic growth between 1960 and 2005. Bjørnskov and Méon (2013) have empirically demonstrated that high trust results in high GDP per capita (in 2007) through the improvement of education (measured by the ratio of the population over the age of 25 with some form of secondary education in 2005) and political institution (measured by the degree of corruption of governments by index in 2007-2008). In a similar vein, Kostis, Kafka and Petrakis (2018) indicate that some cultural elements like trust affect labour productivity growth per hour, which they measured by using GDP, in OECD countries between 1980 and 2010 (N = 34).

Other than GDP, some literature have adopted measurements related to innovation to analyse the effects of trust on economy. For example, Dakhli and Clercq (2004) have empirically demonstrated that trust has a positive impact on innovation activities such as the number of patents registered and the expenditures for R&D, using a multinational regression model (N = 59). They used trust data from the third WVS in 1995-1996 and regressed it to the data on innovation activity in 1998 to show causality. However, the positive relationship between trust and the types of technological output is not always supported by other studies. For instance, Hauser, Tappeiner and Walde (2007) tested whether social capital, including the degree of trust, affects innovative activity as measured by patent application in Europe on a regional level. They discovered that trust did not have a statistically significant impact on patent application from 1997 to 2001. Therefore, it seems that there is no consensus on whether trust influences innovation in terms of technological development.

Entrepreneurship is also raised as one of the indicators of innovation, and some studies have investigated the influence of trust on entrepreneurial activity (Guiso, Sapienza & Zingales, 2006; Troilo, 2010). For example, Guiso, Sapienza and Zingales (2006) argue that there is more entrepreneurship in high-trust countries than in low-trust countries. They verified causality using religion as an instrument variable because attitudes of trust are related to types of religion (Algan & Cahuc, 2010; Zak & Knack, 2001), which have mainly passed from generation to generation and seem unrelated to entrepreneurial activity. Troilo (2010) has also examined the relationship between trust level in countries and the ratio of creation of SMEs by comparing OECD countries and non-OECD countries. He argues that trust works as a kind of informal institution to safeguard against expropriation of property in developing countries. He demonstrated that the effect of trust on increasing the ratio of person who set up a new business was larger in non-OECD countries than OECD countries between 2001 and 2003 (N = 160). These studies support the general contention of many authors that trust affects innovation by fostering entrepreneurial activity (Knack and Keefer, 1997; Kostis, Kafka & Petrakis, 2018).

Although many empirical analyses have evaluated the international performance of innovation by taking into account the influence of the national level of trust, those do not support the present hypothesis that the more deeply knowledge-intensive an economy becomes, the more significant a role trust plays in stimulating innovation through facilitating collaboration for innovation. In other words, those studies do not take into account the possible role of trust in facilitating collaboration for innovation. Furthermore, those studies regard innovation as the performance related to science and technological issues or entrepreneurial activity. Other studies refer to innovation but actually adopt measurements that are beyond the realm of innovation, such as GDP growth. Thus, it is my belief that no prior study has investigated how trust affects innovation output through promoting collaboration using macro data.

2.2 Case studies regarding the role of trust on facilitating collaboration for innovation

Based on the case studies, some authors demonstrate how trust influences innovation in specific firms or innovation networks through facilitating collaboration (Giest, 2019; Klijn et al., 2016). For example, Klijn, Sierra, Ysa, Berman, Edelenbos, and Chen (2016) analysed the case of Taiwan, Spain, and the Netherlands using participant questionnaires in similar governmental projects (N = 678) and argue that there is a positive relationship between the level of trust on a national level and network performance. They explain that a high level of trust stimulates the exchange of information and knowledge by reducing transaction costs and increasing learning processes. That is, a high level of trust plays a role in increasing the effectiveness of networking. Though they could not prove how the effective network performance actually contributes to creating innovation output, their research suggest that trust has a positive influence on the quality of collaboration.

The tendency for trust to affect the quality of an innovation network has also been analysed in specific industries. For example, Giest (2019) has focused on the life-science industry in Chicago and found that high trust based on individual relationships evolved into one based on organisational relationships. He explains that the relationships are complementary to formal or contract-based relationships and help innovation networks work well. His analysis was based on a limited number of interviews (N = 6) with keypersons from academia, government, and industry, and there is room for discussion about causality, but it supports the idea that high trust is related to high-quality innovation networks, even when focusing on one industry.

The findings from the case studies are in line with innovation theory, which places an emphasis on innovation networks to access and acquire knowledge. To seek knowledge for innovation, networks become more crucial for accessing and clarifying tacit information (Powell & Grodal, 2005). For example, some scholars argue that the participating in global innovation networks (GINs) is crucial to promoting today's innovation, because the activity and motivation of firms to promote innovation has shifted from asset exploiting to asset seeking (Alvandi, Chaminande & Lv, 2014; Dunning, 2001). In other words, firms have begun to internationalise, not only because they want to exploit their goods or services in foreign countries, but also to acquire knowledge that reinforces their competitiveness. The role of trust therefore seems more significant in accessing such knowledge internationally than within countries through facilitating collaboration more smoothly.

The previously described studies suggest that there is a positive relationship between trust and quality of collaboration for promoting innovation. However, they do not empirically test whether the relationship is seen on a country-wide scale. In other words, the effect of trust on the quantity of the collaboration is unclear, even though trust has a positive impact on the quality of the collaboration. In addition, the studies do not illustrate the relationship between high-quality innovation networks and innovation output. I therefore hold that it still remains a question whether the high level of trust in countries results in high innovation outputs through promoting collaboration for innovation.

3 Research questions and methodology

3.1 Research questions

From the previous literature review, I argue that there are two gaps between previous studies and what I want to uncover regarding the relationship between trust, collaboration, and innovation output. First, many articles conclude that trust influences innovation, but the measurements of the innovation are not always equal to innovation output. For example, the majority of the studies have adopted GDP growth (Horvath, 2013; Knack and Keefer, 1997; Zak & Knack, 2001) and productivity growth (GDP/working hours) (Kostis, Kafka & Petrakis, 2018) as measurements of innovation. Since these measurements include the results of many factors other than innovation, it seems unsuitable to measure the degree of innovation activity. Of course, some papers have focused on innovation outputs such as the number or quality of patents (Chen, Podolski & Veeraraghavan, 2017; Dakhli & Clercq, 2004; Hauser, Tappeiner & Walde, 2007). Indeed, technology is still an important factor in promoting innovation, but it is too narrow to grasp all innovation, which includes process, organisational, and market innovation (Gault, 2013a, p.3). Therefore, the measurements related to scientific and technical matters seem to focus on issues that are too narrow to grasp innovation output.

Second, few studies have empirically demonstrated the influence of trust on innovation through promoting collaboration with others for innovation on a national level. Bukowski and Rudnicki (2019) contend that there is no specific theoretical model for the relationship between cultural elements and national economy because culture may influence national innovation in multiple ways. They therefore argue that examining the partial effects may cast some light on the question of whether culture operates, to some extent, independently of economic and policy factors. In fact, some factors are investigated as those through which trust influences innovation, such as fostering entrepreneurial activity (Guiso, Sapienza & Zingales, 2006; Troilo, 2010). As for the effect of trust on promoting collaboration, there are some studies that have focused on specific cases (Klijn et al, 2016; Giest, 2019), but they do not analyse the quantitative impacts of trust on innovation output through facilitating the innovation network.

Considering those gaps, the following research questions have been formulated:

A) Does trust affect innovation output on a national scale?

B) Does trust have a positive impact on promoting collaboration for innovation on a national scale?

3.2 Methodology

To address the research questions, which focus on the relationship between an institutional element, trust, and innovative activities in knowledge-based economy, this study combines quantitative and qualitative approaches. The combined approach is called 'mixed methods research' and offers 'a more complete understanding of a research problem than either approach alone' (Creswell, 2017, p. 32). This approach is regarded as a useful way to understand the National Innovation System (NIS) (Chaminade, Lundvall & Haneef, 2018, p. 67). The NIS is a concept that depicts the interplay of institutions and the interactive processes of creation, diffusion, and application of knowledge nationwide (Galindo-Rueda, 2013, p. 235). Lundvall, Vang, Joseph & Chaminade (2009) define NIS as 'an open, evolving and complex system that encompasses relationships within and between organizations, institutions and socio-economic structures which determine the rate and direction of innovation and competence-building emanating from process of science-based and experience-based learning'. Though the NIS is a complex form, the closed-ended data in the quantitative approach and the open-ended data in the qualitative approach enrich the research questions in depth (Creswell, 2017, p. 265).

3.2.1 Quantitative approach

I run a cross-sectional regression for the level of trust, the degree of collaboration, and innovation output among OECD member countries[1] between 2006 and 2014. I have selected OECD member countries for two reasons: first, these countries are regarded as advanced countries with similar economic structures in which knowledge-based economies have developed (Galindo-Rueda, 2013, p. 218, Troilo, 2010). As previously mentioned, the hypothesis is that the more deeply knowledge-intensive an economy becomes, the more significant a role trust plays in stimulating innovation through facilitating collaboration for innovation. Therefore, the OECD member countries that have knowledge-based economies comprise an ideal sample to test the hypothesis. Second, the data on innovation output comes

[1] There are 36 countries as OECD member as following: Australia, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, South Korea, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom, and United States

from subjective questionnaires distributed to firms, and firms in developing countries may regard some standard products as innovation output if the products have not been introduced into their markets (Janger, Schubert, Andries, Rammer & Hoskens, 2017). In sum, to analyse the effects of trust on collaboration and innovation in today's knowledge-based economy, as well as the utilised characteristics of the data regarding collaboration and innovation output, I focus on OECD member countries.

Data collection 1: Trust

As many prior studies have done, I use data from the WVS to measure the level of trust in each country (Algan & Cahuc, 2010; Bjørnskov & Méon, 2013; Dakhli & Clercq, 2004; Knack & Keefer, 1997; Wang & Gordon, 2011; Zak & Knack, 2001). The WVS is an international survey that investigates socio-cultural factors and consists of nationally representative surveys conducted in approximately 100 countries (World Values Survey, 2019). The WVS is regarded as the only database on social values with individual-level observations for many countries (Beugelsdijk & Klasing, 2016). The survey has been conducted six times since 1981; for the present study, I use data from the fourth (2000-2004), fifth (2005-2009), and sixth surveys (2010-2014). In other words, the current study uses data on the value of social trust from 2000 to 2014. The WVS includes face-to-face interviews with approximately 1,000 respondents per country. As many previous studies have done, I consider the level of trust in the country as the ratio of respondents who answered, 'Most people can be trusted' to the question, 'Generally speaking, would you say that most people can be trusted or that you need to be very careful in dealing with people?'. It is important to note that I obtain the average value of trust from the last three waves of the WVS for following reasons: first, social trust is considered stable over a long period of time (Bjørnskov & Méon, 2013). Second, since countries that participate in the surveys differ from time to time, taking an average enables researchers to maximise the sample size and reduce potential biases due to measurement error (Beugelsdijk & Klasing, 2016). Figure 1 displays the average value of trust in the OECD member countries as collected from the last three waves of the WVS. Due to data limitations, not all member countries are included.

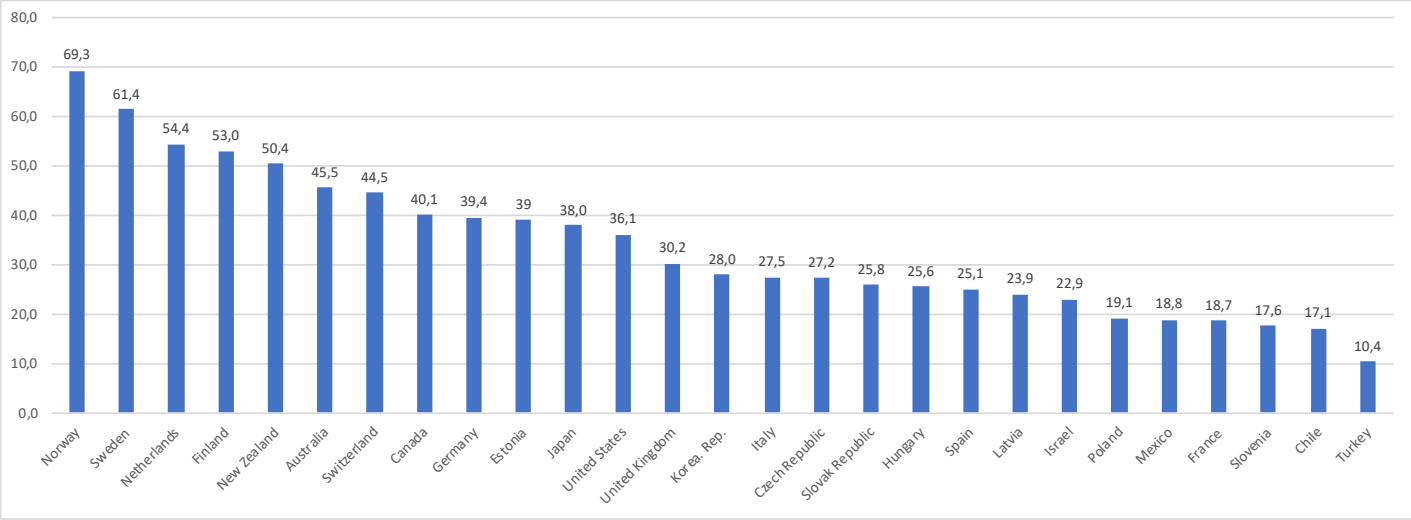

Figure 1 The average ratio (%) of respondents who answered, 'Most people can be trusted'
Note: WVS is source materials

It is plausible to adopt values from the WVS not only because many previous studies have already done so, but also because the cognitive data significantly correlates with actual and behavioural trust (Ahmed & Salas, 2009; Johnson & Mislin, 2012). For example, Knack and Keefer (1997) demonstrated that people have a greater chance of having their dropped wallets returned in countries with a higher WVS trust score. Johnson and Mislin (2012) have similarly discovered that trust as measured by the WVS is positively correlated with experimentally measured trust. It is also worth noting that many scholars support the value of trust from the WVS in terms of the measurement of willingness to collaborate with others. Hauser, Tappeiner and Walde (2007) explain that 'Trust is the most prominent indicator for empirical measurement of social capital and serves as the foundation of an open-minded interaction and mutual dialogue. (…) Trust relates to knowledge diffusion and acquisition in terms of willingness to engage in interaction and information exchange'. In sum, the WVS is an appropriate tool for testing the research questions that focus on the relationships between trust, collaboration, and innovation.

Although the WVS data are supported by a large number of previous studies, to conduct a robustness test, I use additional trust data from the appendix of Bjørnskov and Méon (2013). They list the trust value in each society using combined survey data from not only the WVS (between 1981 and 2005), but also from similar surveys (LatinoBarometro, between 2001 and 2004; Asian and East Asian Barometers, between 2001 and 2007; AfroBarometer, between 2002 and 2004; and the Danish Social Capital Project). In each survey, trust is measured using the standard question, 'In general, do you think most people can be trusted?'; thus, they are suitable to determine the robustness of the WVS findings. The alternative data are also helpful in determining the trust value in some countries that are not measured in the WVS.

Data collection 2: Innovation

I consider that there is no measurement to indicate innovation output that would not be criticised. It is common to use public surveys on innovation conducted by many organisations, such as 'Doing Business' and 'World Development Indicators' published by the World Bank (Chaminade, Lundvall & Haneef, 2018, p. 58). For instance, Bukowski and Rudnicki (2019) adopt the Innovation Output Sub-Index of the Global Innovation Index, published by Cornell University, INSEAD, and World Intellectual Property Organization, as proxies for overall results of innovative activities within the economy. Such innovation indexes are intuitive but are sometimes criticised because they are calculated by combing too many factors and do not clearly distinguish between innovation input and innovation output (Edquist and Zabala-Iturriagagoitia, 2015). For instance, the index regards a patent as an output, but others argue that the patent should not be treated as an innovation output because not all intellectual property becomes patented (Gault, 2013c, p. 445). Besides, Edquist and Zabala-Iturriagagoitia (2015) cast doubt on measurements relying on input indicators because they might overrate unproductive input. There are also many studies that use indicators related to technology such as patents and R&D expenditure, but it is well discussed that innovation activity is beyond the technological perspective (Hollanders & Janz, 2013, p. 294).

To overcome such inconveniencies in measuring innovation output, I use data from the 'OECD Science, Technology and Industry Scoreboard' (OECD Scoreboard), which has been published by OECD every two years since 1999. The main purpose of the OECD Scoreboard is to measure innovation performance of countries, and the performance is directly measured by innovation outputs, rather than inputs like R&D expenditure or intermediate outputs like patents (Hollanders & Janz, 2013, p. 294). In the survey, output is measured through subjective answers from the firms to the question of whether the firms have experienced new or improved goods or services that differ significantly from the firm's previous goods or services and that have been introduced on the market. The OECD member countries refer to a common manual, known as the Oslo Manual (OECD and Eurostat, 2005), to measure their performance in science, technology, and innovation with standard-setting methodology and analyse and compare their NIS with others (Galindo-Rueda, 2013, p. 218). It is important to note that the Oslo Manual provides guidelines for measuring innovation including non-technological forms of innovation and innovation practices in the service sector (Galindo-Rueda, 2013, p 227; Gault, 2013b, p. 48). Thanks to attempts by the OECD to harmonise the measurement, the innovation output data seem to be worth comparing across countries. Furthermore, counting the product or process innovation or the share of firms that have introduced the innovation is considered to be a typical measurement of innovation output (Janger et al., 2017).

To be concrete, I use 'the percentage of SMEs that introduced product innovation or process innovation'. The data are calculated for each government that refers to the Oslo Manual, and the manual defines product and process innovation as follows: 'product innovation: the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses. This includes changes in technical specifications, incorporated software or components, user friendliness or other functional characteristics'; 'process innovation: the implementation of a new or significantly improved production or delivery method. This includes changes in techniques, equipment and/or software'. It is noteworthy that the measurement covers not only technological innovation, but other types of innovation as well, such as service. The data have been gathered from the OECD Scoreboards published in 2011, 2013, 2015, and 2017, all of which are based on the Oslo Manual. The data are also used as one of the innovation activities in the European Innovation Scoreboard, as well as intellectual assets (European Commission, 2018); thus, it is plausible to adopt this measurement.

I also refer the ratio of 'firms with new-to-market product innovation by SMEs' as one of the variables of innovation output. Though the data can be collected from only the 2015 and 2017 OECD Scoreboards, they seem to be intuitive data that focus on product innovation and remove innovation regarding only the improvement of previous products. These data seem plausible to grasp the innovation output in today's knowledge-based economy, because they reflect the actual number of innovations introduced into the market, as well as contain more than just technological innovation.

Data collection 3: Collaboration

From the OECD Scoreboards, I calculate to what extent SMEs are collaborating with others to promote innovation. To be concrete, from the OECD Scoreboards of 2011, 2013, 2015, and 2017, I use the ratio of SMEs collaborating on innovation with 'foreign organisations', 'higher education or research institutions', and 'suppliers' and 'clients' as a percentage of product- and/or process-innovating SMEs. It is important to note that the denominators of the data in the OECD Scoreboards do not indicate the total population of SMEs. To compare with the data on innovation whose denominators are the total population of SMEs, I adjust the collaboration data by multiplying the ratio of SMEs with product or process innovation to calculate the ratio of SMEs collaborating on innovation with others as a percentage of all SMEs. I calculate the ratio respectively depending on the types with whom SMEs collaborate: 'foreign organisations', 'higher education or research institutions', and 'suppliers' and 'clients'. The collaboration data are also used in the European Innovation Scoreboard; thus, they seem plausible to adopt.

Although the data on innovation and collaboration discussed previously typically classify their value into large firms and SMEs, I focus on SMEs. This is because large firms promote innovation more easily than SMEs due to their abundance of resources; thus, it seems suitable to investigate SMEs due to more room for trust on innovation than large firms. Moreover, SMEs include small firms which are just starting their business, and trust is important to the entrepreneur in growing their business (Knack & Keefer, 1997). Furthermore, other innovation surveys like the European Innovation Scoreboard also use data from SMEs to measure the degree of collaboration in countries, because nearly all large firms are engaged in innovation co-operation (European Commision, 2018).

3.2.2 Qualitative approach

No study thus far has analysed the impacts of trust on innovation output on a national scale by comparing two countries. In other words, most previous studies do not extend their general findings about the positive influence of trust on innovation to how differences in trust affect innovative activity in different countries. I argue that, if researchers could select two countries that have similar conditions in terms of innovation capability and industrial structure but different levels of trust, collaboration, and innovation output, this would be useful in analysing how trust affects tendencies of collaboration and innovation.

Therefore, in addition to the discussed quantitative approach, to analyse the research questions from a different point of view, I analyse the case of Sweden and Japan for several reasons. First, since Scandinavia is regarded as one of the high-trust regions (Zak & Knack, 2001), they are ideal for benchmarking how trust affects society. Indeed, Algan and Cahuc (2010) have demonstrated the effects of trust on income per capita by comparing the impacts if the other countries would have the same trust level as that of Sweden. Second, Sweden and Japan are ideal to compare the effects of trust on collaboration and innovation due to their particular similarities and differences. Both countries are members of the OECD and have

similar industrial structures, which have international competitive manufacturing sectors such as automobile (Subrahmanya, Fujiwara & Suh, 2018; VINNOVA, 2017). Moreover, those countries are known for their high investment in R&D, and both countries have a high score of human capital, such as the educational attainment score of pupils; for example, their ratios of R&D expenditure per GDP in 2015 were 3.28% (Japan) and 3.26% (Sweden), the third and fourth largest ratios in the world (The World Bank, 2019a). Furthermore, the World Bank placed Japan as third and Sweden as eigth in its 'Human Capital Index' in 2018 (The World Bank, 2019b; The World Bank, 2019c). However, both countries display striking differences in their levels of trust, collaboration, and innovation output (see Table 1). Thus, both countries seem suitable to compare the effects of trust on innovation activity because they have similarities in industrial structure and conditions of promoting innovation, but they demonstrate differences in their levels of trust, collaboration, and innovation output.

Table.1 Descriptive statistics for Sweden, Japan, and the average of OECD members

		Sweden	Japan	Average of OECD
Trust	The ratio of respondents who answered "most people can be trusted" (WVS)	61.40	37.98	33.66
Innovation output	The percentage of SMEs that introduced product innovation or process innovation	44.58	26.97	36.70
	The percentage of SMEs with new-to-market product innovation	17.73	7.66	11.96
Collaboration	The ratio of SMEs collaborating on innovation with foreign organizations	9.87	1.72	6.16
	The ratio of SMEs collaborating on innovation with higher education or research institutions	6.78	4.62	4.76
	The ratio of SMEs collaborating on innovation with suppliers	12.01	7.48	7.66
	The ratio of SMEs collaborating on innovation with clients	11.17	7.06	6.61

Notes: All values other than trust are averaged from 2006 to 2014. Trust is the average value of the fourth to the sixth WVS. WVS and OECD Scoreboards are source materials

I conduct the qualitative analysis in two steps. First, I investigate general features of the effects of trust on innovation by reviewing government statements, previous literature, and discussion in business world. Second, to clarify the differences with a concrete example, and particularly to investigate the effects of trust on facilitating collaboration, I discuss the case of the automotive industry in depth. The automobile industry seems suitable for investigation, not only because both countries are famous for this industry, but also because the industry is facing great challenges such as electrification, autonomous driving, and the shift to service (The Economist, 2019). This paradigm shift requires the industry to collaborate with other industries like energy and IT (Krasniqi & Hajrizi, 2016). I examine both political and firms' attitudes regarding the relationship between trust, collaboration, and innovation through secondary data such as official documents, speech in a business conference, and annual reports. The reason I do not collect data from primary sources, such as interviews, is that the interviewee might hesitate to comment negatively on the role of trust because the negative comment could damage his or her reputation or transaction with others. Thus, to prevent a potential overstatement about the role of trust, I have elected to use secondary data as opposed to interviews. Regarding a governmental policy, I compare similar projects that intend to promote a certain future technology in the automobile industry: a self-driving system. Comparing the members in the project, I illustrate the differing attitudes between the two countries. Regarding the firms' features, I investigate the case of large firms that mainly produce passenger vehicles, Volvo cars and Mazda, which have many similarities in terms of

sales, the degree of reliance on the global market, and a common history. To examine their strategies to promote innovation with others, this study analyses the degree of collaboration for innovation.

4 Quantitative Analysis

To develop the research questions into the model for quantitative analysis, I assume the nexus in which trust affects innovation output through promoting collaboration with other organisations (see Figure 2).

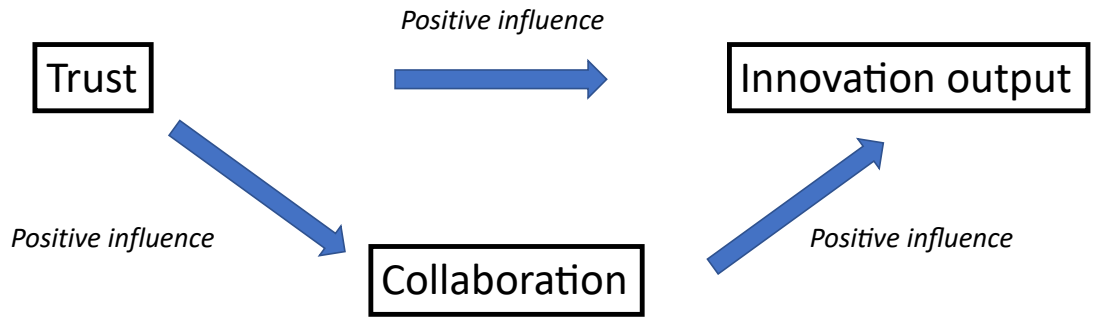

Figure 2 The predicted nexus for the relationship among the three factors

To be concrete, I test the following three hypotheses:

H_1: The degree of trust has a positive impact on innovation output

H_2: The degree of trust has a positive impact on collaboration

H_3: The degree of collaboration has a positive impact on innovation output

The econometrics strategy of the paper is as follows: first, I test simple OLS analysis without any control variables. Second, I add some control variables that seem to influence the relationships. Third, as for H_1 and H_2 in which the independent variable is the level of trust indicated in the WVS, I substitute the trust data from Bjørnskov and Méon (2013) for data from the WVS to test robustness.

Table 2 displays a list of the control variables with explanations and data sources.

Table.2 The description and sources of control variables

Control variables	Description	Sources
Log GDP	GDP (US million $ constant prices, 2010 PPPs)	The World Bank (2019d)
R&D per GDP (%)	Gross domestic spending on R&D per GDP (USD constant prices, 2010 PPPs)	OECD (2019)
Average total years of schooling	Average total yeas of schooling for population aged 25 and over.	Barro-Lee Educational Attainment Dataset (2019)
Military expenditure per GDP (%)	Including all current and capital expenditures on the armed forces, including peacekeeping forces; defense ministries and other government agencies engaged in defense projects; paramilitary forces, if these are judged to be trained and equipped for military operations; and military space activities.	The World Bank (2019e)
Trade per GDP (%)	Trade is the sum of exports and imports of goods and services measured as a share of GDP.	The World Bank (2019f)

For the following reasons, I consider that the control variables are needed to introduce all or part of the regression models:

- A large GDP means a large market, which allows an opportunity for firms to promote innovation due to the large potential consumer base to buy the firms' products or services (Bruland & Mowery, 2006). Moreover, a large GDP also means that the country has an abundance of economic resources, which better facilitates innovation processes than a small GDP (Bukowski & Rudnicki, 2019). Thus, I predict that the variable will indicate a positive coefficient in the regression model for testing H_1 and H_3 in which the dependent variables are innovation output. However, in the regression for H_2, I assume that the variable will show a negative coefficient because, in a large economy, firms do not seem to find their partner more eager than in a small one.
- R&D is argued as one of the resources of technological innovation and reflects the intensity of investments for innovation (Bukowski & Rudnicki, 2019). In addition, R&D alliance or partnership seems to be a common method of collaboration. Therefore, I place the variable in the regression models for testing H_1, H_2, and H_3 and expect they will show positive coefficients.
- It is widely recognised that human capital influences economic development, and education attainment is sometimes used to control the effects on innovation (Zak & Knack, 2001). Thus, I predict that the variable will show a positive coefficient in the regression models for testing H_1 and H_3 in which the dependent variables are innovation output.
- The investment in military stimulates innovation activity due to the high technological requirements of military products and the high spill-over effects (Bruland & Mowery, 2006; Bukowski & Rudnicki, 2019). Thus, I assume that the variable will show a positive coefficient in the regression models for testing H_1 and H_3 in which the dependent variables are innovation output.
- Trade is argued to promote innovation activity through learning the features of foreign markets (Ejermo & Bergman, 2014). In addition, high openness of trade is considered to provide firms with motivation for long-run innovation (Bukowski & Rudnicki, 2019). Thus, I predict that the variable will show a positive coefficient in the regression models for testing H_1 and H_3 in which the dependent variables are innovation output.

I construct a cross-sectional dataset that consists of the 36 OECD member countries and includes averaged data for collaboration and innovation (2006-2014) and trust (2000-2014). Regarding the data related to collaboration and innovation, there are two reasons I use averaged data, although the data come from four discrete periods from the OECD Scoreboard between 2006 and 2014. First, there are several OECD countries that do not measure their data through the whole period; thus, the strategy of averaging the value through the period increases the number of observations. Second, the goal is to reduce the volatility of values and the risk of error. Therefore, I calculate the average value from the four OECD Scoreboards (published in 2011, 2013, 2015, and 2017) to determine the value for collaboration and innovation. Regarding the data on trust, I take the average value of trust from the last three waves of the WVS because social trust is considered to be constant over a short period (Bjørnskov & Méon, 2013); moreover, this strategy increases the number of samples and reduces measurement errors. Regarding the control variables, this study uses averaged data (2006-2014) to be harmonised with the data for collaboration and innovation.

Table 3 illustrates the descriptive statistics on the level of trust, collaboration, innovation, as well as the control variables. It is also noteworthy that all variables are standardised to compare their magnitude when running regression models.

Table.3 Descriptive statistics

Variables	Mean	Standard Deviation	Min	Max	Observations
Trust (%)	33.66	14.90	10.38	69.25	27
The percentage of SMEs that introduced product innovation or process innovation	36.70	11.97	15.25	57.64	34
The percentage of SMEs with new-to-market product innovation	11.96	5.51	2.23	20.64	32
The ratio of SMEs collaborating on innovation with foreign organizations	6.16	4.00	0.40	14.24	32
The ratio of SMEs collaborating on innovation with higher education or research institutions	4.76	2.51	0.59	11.36	32
The ratio of SMEs collaborating on innovation with suppliers	7.66	3.72	1.41	16.63	33
The ratio of SMEs collaborating on innovation with clients	6.61	3.78	1.23	17.74	33
Log GDP	26.69	1.61	23.36	30.36	36
R&D per GDP (%)	1.85	0.99	0.35	4.13	36
Average years of total schooling	10.99	1.57	6.31	13.28	36
Military expenditure per GDP (%)	1.66	1.11	0.47	6.42	35
Trade per GDP (%)	98.13	57.07	28.79	332.18	36

4.1 Test for the effects of trust on innovation output (H_1)

Thus far, there is no established theoretical model to illustrate a causal relationship between economic/cultural factors and national innovativeness (Bukowski & Rudnicki, 2019). Therefore, following from similar previous research by Kostis, Kafka and Petrakis (2018), I use the following model to test H_1: 'The degree of trust has a positive impact on innovation output'.

$$Innovation\_output_i = \alpha\,\mathrm{Trust}_i + \beta\,Controls_i + \mathrm{Constant} + \mathrm{u}_i$$

The dependent variable, innovation output, is measured in two ways: the ratio of SMEs with product or process innovation, and the ratio of SMEs with new-to-market product innovation. Trust_i denotes the level of trust in country i. I also use control variables. $\mathrm{u}_i$denotes the error term. It is important to note that all variables (the dependent variable, the independent variable, and control variables) are standardised; thus, in terms of interpretation, α indicates the average effect of one standard deviation change in trust on innovation output.

The results of OLS regression are displayed in Table 4. Without introducing control variables, there is a positive and statistically significant relationship between trust and innovation output on a national scale (see equations [1] and [3] in Table 4). For example, one standard deviation increase in trust (a 14.90 percentage point increase in the ratio of people who answered 'most people can be trusted') would lead to a 60.3% standard deviation increase in the ratio of SMEs with product or process innovation (a 7.22 percentage point increase in this ratio). As the control variables are introduced, the coefficients of the dependent variables remain positive and statistically significant, though both cases (the ratio of SMEs with product or process innovation and the ratio of SMEs with new-to-market product innovation) do not satisfy the 1% significance level (see equations [2] and [4]). Regarding the issue of reverse causality, it seems far-fetched to contend that innovation output alone may affect the level of trust, rather than the other way around. In particular, it seems unnatural to assert that high innovation output should help people to trust others whom they do not know. Therefore, I argue that H_1 is supported.

There is another finding regarding the control variables. In the case of the equation in which the dependent variable is the ratio of SMEs with product or process innovation (see equation [2]), all control variables display positive coefficients, though none of them indicate statistical significance. However, in the case of the equation in which the dependent variable is the ratio of SMEs with new-to-market product innovation (see equation [4]), contrary to expectation, the variable regarding the average total years of schooling has a negative and statistically significant relationship with innovation output. The OECD member countries generally show longer years of schooling compared to developing countries, and there are small differences among the OECD member countries. Therefore, it may be concluded that marginal impacts of schooling years to promote new-to-market innovation diminish, however, the tendency does not mean that schooling or human capital is useless for promoting innovation in advanced economies.

Table.4 The relationship between trust (WVS) and innovation output

Dependent variable		**The ratio of SMEs that introduced product innovation or process innovation**		**The ratio of SMEs with new-to-market product innovation**	
Independent variables		[1]	[2]	[3]	[4]
	Trust (World Value Survey)	0.603***	0.479*	0.550**	0.613**
		(0.208)	(0.261)	(0.210)	(0.279)
Control variables					
	Log GDP		0.426		0.271
			(0.352)		(0.353)
	R&D per GDP		0.338		0.325
			(0.250)		(0.256)
	Average total years of schooling		0.020		-0.703*
			(0.326)		(0.345)
	Military expenditure per GDP		0.197		-0.044
			(0.373)		(0.370)
	Trade volume per GDP		0.168		0.942
			(0.656)		(0.718)
Observations		25	25	25	25
Adjusted R square		0.235	0.347	0.195	0.219

*Notes: ***, **, and * indicate significance at the 1%, 5%, and 10% level. Standard errors are displayed in brackets.*

4.2 Test for the effects of trust on collaboration (H_2)

To test H_2: 'The degree of trust has a positive impact on collaboration', I use the following model:

$$Collaboration_i = \text{a Trust}_i + \text{b } Controls_i + \text{Constant} + u_i'$$

The dependent variable is the degree to which SMEs are collaborating with other organisations in innovation activity. I collect four types of data regarding the degree of collaboration from the OECD Scoreboards, depending on the types of partners: international organisations, higher education or research institutions, suppliers, and clients.

The results are displayed in Table 5. The OLS analysis, without any control variable, reveals that there is a positive relationship between trust and the degree of collaboration with each type, and, other than the case of collaboration with foreign organisations, the positive coefficients indicate statistical significance. However, this statistical significance is not achieved after introducing the control variables, despite each type still suggesting a positive coefficient. Thus, the main finding is that H_2 is not supported.

Two results were found for the control variables. R&D per GDP shows positive and statistically significant relationships with each type of collaboration. It is also noteworthy that the size of the GDP has a negative relationship with the degree of international collaboration, with statistical significance at the 1% level (see equation [2]). These findings are in line with my assumption regarding the control variables.

Table.5 The relationship between trust (WVS) and collaboration

Dependent variable	**The ratio of SMEs collaborating on innovation with foreign organisations**		**The ratio of SMEs collaborating on innovation with higher organisations or research institutions**		**The ratio of SMEs collaborating on innovation with suppliers**		**The ratio of SMEs collaborating on innovation with clients**	
Independent variables	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Trust (World Value Survey)	0.355	0.216	0.378**	0.157	0.416**	0.256	0.372*	0.183
	(0.219)	(0.197)	(0.175)	(0.144)	(0.175)	(0.168)	(0.191)	(0.181)
Control variables								
Log GDP		-0.701***		-0.088		-0.240		-0.097
		(0.235)		(0.172)		(0.200)		(0.217)
R&D per GDP		0.470**		0.575***		0.445**		0.496**
		(0.191)		(0.140)		(0.163)		(0.176)
Observations	24	24	24	24	24	24	24	24
Adjusted R square	0.066	0.349	0.137	0.494	0.169	0.338	0.108	0.303

*Notes: ***, **, and * indicate significance at the 1%, 5%, and 10% level. Standard errors are displayed in brackets.*

4.3 Robustness test for the WVS trust level

To test whether the presented results are robust, I use the value of trust from the list by Bjørnskov and Méon (2013), rather than data from the WVS. This strategy enables an increased number of observations because the WVS lacks trust data from some OECD member countries. Regarding hypothesis H_1, after the introduction of the control variables, there is no statistically significant relationship between trust and innovation output as measured by the ratio of SMEs with new-to-market product innovation (see equation [4] in Table 6). However, the coefficient of the independent variable is still positive (p-value = 0.102), and the coefficient of the dependent variable, the ratio of SMEs with product or process innovation, shows positive statistical significance at the 10% level even after the introduction of the control variables (see equation [2]). Therefore, H_1 is still supported.

Table.6 The relationship between trust (list by Bjørnskov and Méon (2013)) and innovation output

Dependent variable		**The ratio of SMEs that introduced product innovation or process innovation**		**The ratio of SMEs with new-to-market product innovation**	
Independent variables		[1]	[2]	[3]	[4]
	Trust (list of Bjørnskov and Méon (2013))	0.518***	0.408*	0.412**	0.440
		(0.170)	(0.232)	(0.210)	(0.259)
Control variables					
	Log GDP		0.481*		0.155
			(0.278)		(0.292)
	R&D per GDP		0.317		0.261
			(0.226)		(0.248)
	Average total years of schooling		-0.235		-0.570**
			(0.225)		(0.251)
	Military expenditure per GDP		0.251		-0.159
			(0.333)		(0.345)
	Trade volume per GDP		0.579*		0.634*
			(0.322)		(0.359)
Observations		34	33	32	32
Adjusted R square		0.201	0.305	0.100	0.224

*Notes: ***, **, and * indicate significance at the 1%, 5%, and 10% level. Standard errors are displayed in brackets.*

Regarding the control variables, the average total years of schooling still shows a negative and statistically significant relationship with innovation output when the dependent variable is the ratio of SMEs with new-to-market product innovation (see equation [4]). Moreover, trade openness suggests a positive and statistically significant relationship with innovation at the 10% level.

Regarding hypothesis H_2, the trust data from Bjørnskov and Méon (2013) reveal results similar to the findings of the trust data from WVS. Table 7 illustrates that each type of collaboration shows a positive relationship with innovation, but there is no statistical significance after the introduction of control variables. I therefore argue that H_2 is not supported by the quantitative analysis. In addition, the control variables also demonstrate similar tendencies to the results in Table 5. That is, R&D per GDP shows positive and statistically significant relationships with each type of collaboration. Furthermore, there is a negative and statistically significant relationship between economy size (GDP) and the ratio of SMEs collaborating on innovation with foreign organisations. The robustness test reveals that the main findings from the previous sections are robust.

Table.7 The relationship between trust (list by Bjørnskov and Méon (2013)) and collaboration

Dependent variable	**The ratio of SMEs collaborating on innovation with foreign organisations**		**The ratio of SMEs collaborating on innovation with higher organisations or research institutions**		**The ratio of SMEs collaborating on innovation with suppliers**		**The ratio of SMEs collaborating on innovation with clients**	
Independent variables	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Trust (list of Bjørnskov and Méon (2013))	0.261	0.111	0.331**	0.064	0.385**	0.217	0.409***	0.192
	(0.196)	(0.203)	(0.151)	(0.149)	(0.154)	(0.171)	(0.143)	(0.151)
Control variables								
Log GDP		-0.584**		-0.079		-0.200		-0.130
		(0.225)		(0.165)		(0.186)		(0.164)
R&D per GDP		0.435**		0.552***		0.380**		0.455***
		(0.208)		(0.152)		(0.175)		(0.154)
Observations	32	32	32	32	33	33	33	33
Adjusted R square	0.025	0.212	0.110	0.353	0.141	0.217	0.183	0.329

*Notes: ***, **, and * indicate significance at the 1%, 5%, and 10% level. Standard errors are displayed in brackets.*

4.4 Test for the effects of collaboration on innovation output (H_3)

I test H_3: 'The degree of collaboration has a positive impact on innovation output' using the following model:

$$Innovation\_output_i = \text{A Collaboration}_i + \text{B } Controls_i + \text{Constant} + u_i''$$

The dependent variable is the same as that used in Section 4.1: the ratio of firms with product or process innovation (see Table 8) and the ratio of firms with new-to-market product innovation (see Table 9). Independent variables are the ratios of SMEs collaborating with others, just as in Section 4.2.

The results strikingly reveal that collaboration has a positive relationship with innovation output. Other than the relationship between collaboration with higher organisations and research institutions and the ratio of SMEs that introduced product innovation or process innovation (see equation [4] in Table 8), the relationships are positive and statistically significant even after introducing control variables. For example, according to equation [2] in Table 8, one standard deviation increase in the ratio of SMEs collaborating with foreign organisations (a 4.00 percentage point increase in this ratio) would result in an increase of approximately 0.45 standard deviations in the ratio of SMEs that introduced product or process innovation (a 5.33 percentage point increase in this ratio).

I argue that the positive and statistically significant relationships have causality, especially in the case of collaboration with foreign organisations. Indeed, there is a possibility that the aggressiveness of innovation output would foster collaboration with others. However, a large number of studies have already theorised that participation in GINs is crucial to promoting innovation today (Alvandi, Chaminande & Lv, 2014; Dunning, 2001; Saxenian & Sabel, 2008). For example, Saxenian and Sabel (2008) have illustrated how Taiwan has evolved into a more sophisticated economy by connecting its domestic industry with GINs. Therefore, I assert that H_3 is supported, especially in the case of collaboration with foreign organisations.

Other than the main presented finding, two other findings are derived from the results. First, the magnitudes of the coefficients of collaboration with others on the ratio of SMEs with new-to-market product innovation are generally larger than those of the ratio of SMEs with product or process innovation. In other words, it seems more important to collaborate with other organisations so that the firms are inclined towards new-to-market product innovation, rather than introducing product or process innovation. Second, contrary to the assumption that the control variables play a positive role in promoting innovation, the average total years of schooling and the military expenditure are negatively related to innovation output, though they do not always indicate statistical significance other than in equations [2], [6], and [8] in Table 9.

Table.8 The relationship between collaboration and innovation output as measured by the ratio of SMEs that introduced product or process innovation

Dependent variable	**The ratio of SMEs that introduced product innovation or process innovation**							
Independent variables	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
The ratio of SMEs collaborating on innovation with foreign organisations	0.417**	0.445**						
	(0.154)	(0.178)						
The ratio of SMEs collaborating on innovation with higher organisations or research institutions			0.665***	0.395				
			(0.175)	(0.248)				
The ratio of SMEs collaborating on innovation with suppliers					0.575***	0.391**		
					(0.174)	(0.185)		
The ratio of SMEs collaborating on innovation with clients							0.670***	0.419*
Control variables							(0.176)	(0.212)
Log GDP		0.530*		0.316		0.434		0.372
		(0.276)		(0.282)		(0.262)		(0.264)
R&D per GDP		0.346*		0.313		0.390*		0.373*
		(0.196)		(0.247)		(0.198)		(0.207)
Average total years of schooling		-0.208		-0.138		-0.213		-0.222
		(0.199)		(0.217)		(0.204)		(0.206)
Military expenditure per GDP		-0.122		-0.011		-0.058		-0.096
		(0.257)		(0.274)		(0.260)		(0.264)
Trade volume per GDP		0.191		0.295		0.392		0.389
		(0.297)		(0.312)		(0.287)		(0.290)
Observations	32	31	32	31	33	32	33	32
Adjusted R square	0.169	0.380	0.302	0.292	0.237	0.368	0.297	0.355

Table.9 The relationship between collaboration and innovation output as measured by the ratio of SMEs with new-to-market product innovation

Dependent variable	**The ratio of SMEs with new-to-market product innovation**							
Independent variables	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
The ratio of SMEs collaborating on innovation with foreign organisations	0.540***	0.720***						
	(0.158)	(0.183)						
The ratio of SMEs collaborating on innovation with higher organisations or research institutions			0.792***	0.860***				
			(0.179)	(0.252)				
The ratio of SMEs collaborating on innovation with suppliers					0.679***	0.711***		
					(0.177)	(0.190)		
The ratio of SMEs collaborating on innovation with clients							0.614***	0.662**
Control variables							(0.207)	(0.240)
Log GDP		0.564*		0.213		0.341		0.260
		(0.285)		(0.286)		(0.278)		(0.304)
R&D per GDP		0.090		-0.109		0.114		0.136
		(0.202)		(0.251)		(0.204)		(0.231)
Average total years of schooling		-0.382*		-0.233		-0.394*		-0.406*
		(0.205)		(0.220)		(0.209)		(0.229)
Military expenditure per GDP		-0.512*		-0.309		-0.450		-0.490
		(0.265)		(0.278)		(0.268)		(0.296)
Trade volume per GDP		0.094		0.185		0.372		0.396
		(0.306)		(0.317)		(0.296)		(0.325)
Observations	31	31	31	31	31	31	31	31
Adjusted R square	0.262	0.445	0.383	0.385	0.313	0.425	0.206	0.308

*Notes: ***, **, and * indicate significance at the 1%, 5%, and 10% level. Standard errors are displayed in brackets.*

4.5 Main findings from the quantitative analysis

Through the quantitative analysis, it becomes clear that trust is important in promoting innovation. Since H_1: 'The degree of trust has a positive impact on innovation output' is supported, a high-trust society is more likely to promote innovation than a low-trust society among OECD member countries. However, contrary to previous studies suggesting positive effects of trust on facilitating collaboration for innovation, H_2: 'The degree of trust has a positive impact on collaboration' is not supported. In other words, trust may influence the quality of an innovation network, as the previous studies suggest, but it does not affect the quantity of collaboration in the case of OECD member countries. Therefore, it seems that there is a path, other than fostering collaboration, through which trust has a positive influence on innovation output on a national scale.

The quantitative analysis supports the established theory on GINs, though it is not clarified how trust affects GINs. That is, the results supporting H_3: 'The degree of collaboration has a positive impact on innovation output' in the quantitative analysis are in line with a large number of studies arguing that collaboration with others on a global scale is crucial for promoting innovation today. Particularly in promoting new-to-market product innovation, the importance of collaboration becomes greater. However, as H_2 is not supported, it remains unclear that trust affects the positive relationship between collaboration and innovation output.

5 Qualitative analysis

To analyse the research questions from a different point of view, I compare two specific countries, among the OECD member countries, that are similar in terms of innovative capability and industrial structure but different in terms of trust, degree of collaboration, and innovation output. To verify the results from the quantitative analysis, it seems applicable to observe the concrete example (country). In addition, a comparison between two countries is sufficient to analyse to what extent innovation has occurred in each country (Chaminande, Zabala & Treccani, 2010).

5.1 Descriptive statistics between Sweden and Japan

This study compares Sweden and Japan because they exhibit striking differences in trust, the degree of collaboration, and innovation output (see Table 10). Regarding innovation output, Sweden shows a higher level than the average of the OECD countries, and this performance is in line with the general impression that Scandinavian countries are innovative (Solesvik, 2017). On the other hand, as Ijichi (2013, p. 208) has revealed, contrary to the general image of Japan as an innovative country, the facts demonstrate that the rates of SMEs in Japan with product or process innovation and SMEs with new-to-market product innovation are lower than in Sweden and the average of the OECD countries.

To compare the effects of trust on collaboration and innovation in two countries, it seems crucial to control other factors that may affect the relationships among the three elements of trust, collaboration, and innovation, as I have done in the quantitative analysis. Compared to other OECD member countries, both Sweden and Japan have similar status in terms of R&D per GDP, and there are no striking differences in the average total years of schooling and the military expenditure per GDP (see Table 10). There is a difference in trade volume per GDP, but the control variable does not affect statistical significance in the quantitative analysis with the WVS. It is important to note that, as mentioned in Section 4.2, R&D per GDP has a positive and statistically significant relationship with the degree of collaboration with others. Thus, to examine how a different level of trust affects the level of collaboration for innovation, pairing Sweden and Japan presents an ideal case because it rules out the effects of R&D expenditure.

However, there is one decisive difference: the size of the economy (log GDP). As verified in the quantitative analysis, the size of GDP is negatively related to collaboration with foreign organisations (see equation [2] in Table 5). It is plausible to consider that small countries need to seek partners abroad more often than large countries due to their limited market size (Davenport & Bibby, 1999). It is noteworthy that the GDP of Japan is the third largest in the world and approximately eight times greater than that of Sweden.

Table.10 Descriptive statistics on Sweden, Japan, and the average of the OECD members (WVS, OECD Scoreboards, and other sources shown in Table 2)

		Sweden	Japan	Average of OECD
Trust	The ratio of respondents who answered "most people can be trusted" (WVS)	61.40	37.98	33.66
Innovation output	The percentage of SMEs that introduced product innovation or process innovation	44.58	26.97	36.70
	The percentage of SMEs with new-to-market product innovation	17.73	7.66	11.96
Collaboration	The ratio of SMEs collaborating on innovation with foreign organizations	9.87	1.72	6.16
	The ratio of SMEs collaborating on innovation with higher education or research institutions	6.78	4.62	4.76
	The ratio of SMEs collaborating on innovation with suppliers	12.01	7.48	7.66
	The ratio of SMEs collaborating on innovation with clients	11.17	7.06	6.61
Control variables	Log GDP	26.92	29.38	26.69
	R&D per GDP (%)	3.31	3.26	1.85
	Average years of total schooling	11.99	11.35	10.99
	Military expenditure per GDP (%)	1.19	0.95	1.66
	Trade per GDP (%)	87.39	31.23	98.13

Notes: Values other than trust are averaged over the period from 2006 to 2014. Trust is averaged from the fourth to the sixth WVS.

5.2 The relationship between trust and innovation in both countries

To analyse H_1: 'The degree of trust has a positive impact on innovation output', I review official documents, analyses by a prominent economic magazine and an economic forum, and previous literature. The Swedish government acknowledges that the high trust in Sweden is one of the advantages to being a global frontrunner in promoting innovation; as the government says of the innovation strategy: 'Sweden's position in terms of institutional framework is also good, with a high level of trust, good political stability and effective laws and regulations' and 'in the global knowledge economy, the importance of proximity in relationships between different actors in innovation processes is increasing (…), the increased specialisation makes trustful relations ever more important' (Government offices of Sweden, 2012). It seems symbolic that the Swedish government emphasises the role of trust on innovation in the national innovation strategy.

The government's idea regarding how trust affects innovation in Sweden is also shared in the business world. The discussion in the World Economic Forum, which is a prestigious forum in which global leaders from government and business debate economic issues, also refers to the important role of trust in promoting innovation in Sweden. The discussion suggests that

there are high-trust relationships between employers and employees, big firms and start-ups, and among employees in Sweden, and that the high-trust relationships act as a kind of social safety net to promote entrepreneurship and innovation (World Economic Forum, 2017).

Contrary to the case of Sweden, it is argued that low trust acts as an obstacle for innovation in Japan. Regarding the low innovation activity in Japan, Kushida (2016) has argued that large firms in Japan were overwhelmingly engaged in 'close innovation' and seldom collaborated with new partners; moreover, entrepreneurship was not supported by Japan's social norms. Although he has also argued the unfavourable situation in Japan has been changing, Forbes (2015) has illustrated that the barrier to trust is still relatively high in Japan for entrepreneurs, putting a damper on innovation. Hierarchical ways regarding Japan's business is also regarded as a barrier for outsiders to participate in the business (The Economist, 2011). These unfavourable features for innovation seem to be partly stemmed from lower trust to others.

Moreover, Japanese government does not refer to the role of trust on innovation in the national strategy for innovation. The Japanese government has published the growth strategies every year since 2013, and those include basic outlook and key strategies, as well as many reform ideas, regarding promoting innovation (Dasher, Harada, Hoshi, Kushida & Okazaki, 2015). In the national strategies from 2013 to the latest 2018, trust is not mentioned as the role in promoting innovation. This is one of the facts that reveals the differences in governmental attitudes regarding trust in terms of promoting innovation. Since the trust level in Japan is lower than that in Sweden, the different features of the relationship between trust and innovation in both countries suggest that a high-trust society has a greater advantage in promoting innovation than a lower-trust society. This insight is in line with the quantitative analysis, which supports H_1.

5.3 The relationship between trust and collaboration in both countries

To analyse H_2: 'The degree of trust has a positive impact on collaboration' from a different point of view, this study investigates the degree of collaboration for innovation in both countries using previous literature and public information. It is noteworthy that there is a large difference between the two countries in the ratio of SMEs collaborating with foreign organisations on innovation (see Table 10). In addition, collaboration with foreign organisations demonstrates positive and statistically significant impacts on innovation (see Section 4.4). Thus, I focus on the effects of trust on collaboration with foreign organisations in the two countries.

On a macro scale, both countries demonstrate different levels of collaboration with foreign players. Chaminande, Zabala and Treccani (2010) depict today's Swedish NIS and provide evidence that Swedish firms tend to be more collaborative on a global scale. They point out that the firms have a clear view of connecting their business with GINs. Regarding the participation in GINs, they illustrate that not only large firms, but also SMEs, have engaged in some form of collaboration in innovation with emerging countries; about 20% of SMEs in Sweden have collaborated with partners in China and India. This fact is in line with the government interest to foster the link between innovation and globalisation (Government office of Sweden, 2017a). Based on the case study on the regional development in Gothenburg, which is the second largest city in Sweden, Forgelberg and Thorpenberg (2012) argue that the high-trust nature of Swedish society enables actors to easily rely on each other, which promotes collaboration among different actors like government, industry and academia. Therefore, it seems that the characteristics of a high-trust nature enable Sweden to collaborate with foreign players easily.

Contrary to the Swedish case, only 7% of Japanese firms, including large firms, collaborate with foreign organisations to promote innovation (National Institute of Science and Technology Policy, 2015). Compared to other countries, the Japanese innovation system is characterised as less internationally active (Ijichi, 2013, p. 207). This less-international tendency seems to be partly caused by the business strategy of Japanese firms. They are sometimes considered to rely on 'jimae-shugi' in Japanese, the in-house supply of technology (Lundin & Eriksson, 2016). In other words, they rely on their own competence, not often trusting the competence of others. This factor seems to prevent them from collaborating with foreign counterparts. Therefore, I argue that the high-trust society of Sweden exhibits a higher degree of collaboration with foreign organisations than the lower-trust society of Japan.

Focusing on the same particular industry in both countries seems helpful to vividly illustrate the differences, because the level of collaboration with others may differ from industry to industry. In particular, this study investigates the case of the automobile industry, which is a strategic industry for both countries and an industry in which both countries have a technological advantage (Edquist & Lundvall, 1993; Subrahmanya, Fujiwara & Suh, 2018; VINNOVA, 2017). Furthermore, the automobile industry today requires collaboration with others to cope with large industry changes such as electrification, autonomous vehicles, and mobility as a service (Krasniqi & Hajrizi, 2016; The Economist, 2019). Regarding this industry, this study compares the attitudes of governments and large firms towards

collaboration with foreign organisations using official information sources such as governmental homepages, companies' annual reports, and official remarks at public conferences.

5.3.1 Governmental attitude regarding collaborating with foreign organisations

Comparing similar national projects, this study has discovered that the Swedish government tends to involve the foreign firms in the project more eagerly than the Japanese government does. Both governments have an international competitive automotive industry and have implemented national research projects on the auto-driving system. Sweden's government has initiated the 'Drive Sweden' project, which was one of the 'Innovation Partnership Programmes' launched in June 2016 and consists of five projects (Government office of Sweden, 2017b). The official 'Drive Sweden' website states that 'over a third of our partners are headquartered outside of Sweden' (Drive Sweden, 2018).

Japan's government has also launched a similar national project, called the 'Cross-ministerial Strategic Innovation Promotion Program (SIP)', in 2013. 'Innovation of Automated Driving for Universal Services' is one of the 12 SIP projects (SIP, 2019). However, contrary to the case of Sweden, there are no data indicating that a foreign company has joined the national project. Moreover, all 26 members of the steering committee regarding the project come from Japanese organization. Through a comparison between the ongoing projects, which have the similar goal of realising a self-driving system, it seems obvious that the Swedish government is more eager to connect its domestic players with global ones than the Japanese government.

5.3.2 Big firms' attitude regarding collaborating with foreign organisations

There is a clear difference in terms of the collaboration strategies of large firms in both countries, though the automobile industry has already integrated globally (Spatz & Nunnenkamp, 2002). This study compares the case of Volvo cars from Sweden with Mazda from Japan for several reasons. First, both firms were under the control of the same parent firm, Ford Motors, prior to approximately two decades ago, and similar strategies were shared, such as platform sharing and co-operation in vehicle design, within the Ford family partners (Bordenave & Lung, 2003; Holweg & Pil, 2009). Thus, these samples seem relatively favourable to control culture of companies. Second, both firms have a relatively similar sales volume in comparison to other big carmakers like Toyota and Honda, which have more than five million global sales per year. The similar sales volume implies that both firms also have similar resources to promote innovation. Furthermore, the ratios of sales in the global market to the domestic market are also at a similar level (Table 11). Thus, it seems that

both firms are in a similar situation to promote innovation and maintain their existence in the global market.

Table.11 The comparison between Volvo cars and Mazda in terms of sales

Home country	Car makers	Sales in global market	Sales in the home country	Share of the sales other than the home country
Sweden	Volvo cars	666,586	69,943	89.5%
Japan	Mazda	1,560,789	197,314	87.4%

Notes: Sales indicate the total number in 2018. Database of Marklines is source materials.

However, there is a striking difference in collaboration strategies between the two firms. At the largest business conference in Nordic countries (Vehicle Electronics & Connected Services; VECS) in April 2018, the vice president of Volvo cars announced that collaboration and partnership were crucial for reacting to the new demand for autonomous driving and connected service (VECS, 2018). In fact, Volvo cars claims in its annual reports to 'establish smart collaborations to bring leading progressive products and services to market' to achieve one of the seven key initiatives (Volvo cars, 2017, p. 30) and states that creation and collaboration are part of its culture and competences (Volvo cars, 2018, p. 33). The official publication and the statement at the public conferences reveal the attitude of Volvo cars regarding collaborating with new partners all over the world. Furthermore, at its latest business conference in April 2019, Volvo cars introduced the 'Volvo cars tech fund' to audiences as the body for seeking start-ups all over the world to invest in new technologies and collaborate with the start-ups (VECS, 2019).

Contrary to the case of Volvo cars, Mazda referred, in its 2017 and 2018 annual reports, to its attitude regarding collaboration mainly in terms of its business and capital alliance with Toyota (Mazda, 2017; Mazda, 2018). Other than its alliance with large firms, there is no information available regarding the existence of the branch for collaborating with start-ups all over the world like the 'Volvo cars tech fund'. In sum, there is a remarkable difference in the tendency towards collaboration with others between the two firms, even in the same industry, which has already been internationalised and confronted large challenges such as electrification and autonomation, which require the industry to collaborate with others more often than ever.

Reflecting on the facts presented above, it seems that the high-trust society of Sweden exhibits more tendency towards collaboration with foreign organisations than the lower-trust society of Japan. However, it is not clear whether the tendency stems from the different trust levels or the differences in GDP size. In general, firms in small countries have difficulty finding business partners within those countries. Contrary to the general view, it may be argued that Sweden has many firms that engage in the automobile industry to collaborate within the country. In fact, VINNOVA (2017) reports that Sweden has kept a large share of employees in the automobile industry—around 100,000. However, there are around 862,000 employees in Japan who engage in automobile manufacturing (Japan Automobile Manufacturers Association, 2019). This difference implies differences in the opportunity to find counterparts in the domestic market. Therefore, H_2: 'The degree of trust has a positive impact on collaboration' is still not supported, though the presented findings indicate a

positive relationship between the level of trust and the degree of collaboration with foreign organisations on a macro scale.

5.4 Main findings from the qualitative analysis and relationships with the quantitative analysis

Regarding H_1: 'The degree of trust has a positive impact on innovation output', the qualitative and quantitative analyses suggest that a high-trust society is more likely to promote innovation than a lower-trust society. Regarding H_2: 'The degree of trust has a positive impact on collaboration', the qualitative analysis indicates that a high-trust society is more likely to collaborate with foreign organisations than a lower-trust society. However, as the results of the quantitative analysis indicate that the degree of collaboration with foreign partners is also affected by the country's size, the validity of H_2 is still ambiguous. Although Sweden and Japan seem to provide an ideal comparison to analyse the hypothesis because they have similar innovation capability, including the high investment in R&D, and industrial structure, another combination with similar economic size would enrich the analysis.

6 Conclusion and future research

It is well recognised that institutions matter for economic development, and trust has attracted academic attention as the crucial social capital to foster this development (Bjørnskov & Méon, 2013; Dakhli & Clercq, 2004; Giest, 2019; Guiso, Sapienza & Zingales, 2006; Hauser, Tappeiner & Walde, 2007; Horvath, 2013; Knack & Keefer, 1997; Klijn et al., 2016; Kostis, Kafka & Petrakis, 2018; Troilo, 2010; Zak & Knack, 2001). Especially in analysing today's knowledge-based economy, the influential role of trust on innovation has been studied by many researchers due to the favourable feature of trust in accelerating knowledge exchange and collaboration in innovation networks. This paper adds to the previous literature arguing the role of trust on innovation in several ways.

First, while the positive influence of trust on innovation has been widely discussed in academic debate and political documents without using the right measurement, the current quantitative cross-section model analysis of OECD member countries from 2006 to 2014 provides further support for this idea. The degree of trust in countries has a positive influence on the ratio of SMEs with product or process innovation, and SMEs with new-to-market product innovation. Furthermore, the qualitative analysis comparing Sweden and Japan also indicates that high-trust countries have an advantage over lower-trust countries in promoting innovation.

Second, although this study indicates that participation in GINs contributes to promoting innovation, as previous theories have suggested, the quantitative analysis with macro data cannot support the idea that trust has a positive impact on facilitating collaboration for innovation. Although previous case studies have argued that facilitating collaboration is one of the paths through which trust affects innovation, this study could not verify this through the cross-section regression models. On the other hand, the qualitative analysis implies that high-trust countries tend to collaborate with foreign organisations more often than lower-trust countries. Even in the same industry, which has already been internationalised and is facing large changes that necessitate collaboration with others, there is a striking difference in terms of the level of collaboration with foreign organisations between high-trust society, Sweden, and lower-trust society, Japan. However, the implication is not decisive, because the qualitative analysis could not disentangle the background of the difference into the effect of trust or of country size. To analyse the relationship between trust and collaboration in depth, it is necessary to study another pair of countries that are similar not only in innovative capability and industrial structure, but also in country size.

Future research should also investigate other potential ways through which trust affects innovation, such as the influence of trust on increasing productivity. In fact, many authors suggest that trust affects the productivity of workers in organisations by influencing the workplace environment (Brattström, Löfsten & Richtnér, 2012; Brattström, Löfsten & Richtnér, 2015; Godart, Görg & Hanley, 2017; Hauser, Perkmann, Puntscher, Walde &

Tappeiner, 2016). For instance, based on a survey of 1,244 employees of 116 firms in Italy, Hauser, Perkmann, Puntscher, Walde and Tappeiner (2016) concluded that high-trust individuals contribute to higher workplace productivity as measured by wage. Godart, Görg and Hanley (2017) have revealed the positive relationship between the adoption of trust-based working hours (self-management work) and the innovativeness of the firms by analysing cases of German firms in 2006 and 2008 (N = 2472). Brattström, Löfsten and Richtnér (2015) have discovered that trust within teams is a central performance driver for product innovation through their analysis of medium-sized tech firms in Sweden (N = 99). In contrast, low trust in the workplace, as displayed through, for example, tight monitoring and control mechanisms, reduces productivity by diminishing creative thinking (Dakhli & Clercq, 2004). Therefore, the influence of trust on productivity on a national scale seems worthy of analysing in depth, just as I have analysed the potential role of trust on fostering collaboration.

Indeed, the study does not support the idea that trust influences innovation through fostering collaboration on a national scale. However, the data for innovation output and collaboration, which I have used in the quantitative analysis, covers only the years prior to 2014. It is arguable that, if the role of trust has increased as the knowledge-based economy has deepened, the latest data would reveal different results. Besides, it seems to be worth taking into account the ability of SMEs depending on the knowledge source and organizational capability. For example, Ebersberger and Herstad (2013) have demonstrated that the participating in GINs has a positive impact on high-ability SMEs in Norway, but a negative influence on low-ability SMEs in the country. In similar manner, the quantitative analysis in this study using aggregate data on SMEs would indicate different results if the SMEs would be classified into groups depending on their ability. As Bukowski and Rudnicki (2019) argue, the relationships between cultural factors like trust, economic factors, and innovation output are multiple (individual level, organisational level, and national level), complex, and difficult to specify and track in a statistically exact manner. Therefore, researchers should be persistent in the effort to uncover these relationships by combining multiple lenses.

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