UNIVERSITY COLLEGE LONDON
School of Slavonic and East European Studies

UNIVERSITY OF HELSINKI
Faculty of Social Sciences

Yingna Zhang

DETERMINANTS OF FINNISH HIGH TECHNOLOGY EXPORTS: AN APPLICATION OF GRAVITY MODEL

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Supervisors: Professor Sakari Heikkinen (PhD)

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HELSINGIN YLIOPISTO
HELSINGFORS UNIVERSITET
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Tiivistelmä – Referat – Abstract

This paper places its focus on the largest 10 high-tech importers of Finland with the objective to investigate the determinants of Finnish high-tech exports during the period of 1996 and 2010. The Gravity Theory acts as the theoretical foundation of the study and panel data will be adopted to carry out OLS regression and fixed effects regression models. Six clusters of determinant have been introduced to the basic gravity empirical model respectively, seeking to identify categories which have the greatest effects on Finnish high-tech exports. The research finds that the variables related to information cost, labour market and high technological level are more impactful than other factors. An adjusted gravity empirical model with more than 70 per cent explanatory power is subsequently presented. The empirical results manifest that a 1 per cent increase in GDP of Finland's major trading partners contributes to 0.35 per cent growth in Finnish high-tech exports while a 1 per cent rise in bilateral distance between Finland and its exporting destinations leads to a decline of 0.8 per cent in Finnish high-tech exports. Other independent variables included in this empirical equation are estimated to be statistically significant as well.

A case study has been introduced to illustrate certain aspects of the paper as well. The adjusted gravity model together with the Reveal Comparative Advantage (RCA) index are employed to analyse the export potentials of high-tech commodities of China for Finland. The study shows that the high technology export potential is not great, and has the requisites for Finland to develop export potential of products that have comparative advantages over China's and explore new high-tech commodities.

Avainsanat – Nyckelord – Keywords: High Technology Exports, Determinants of Trade, Gravity Model, Export Potential

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INTRODUCTION

Historical Background

Finland, the country with a territory of 33.842 square kilometres and a population of only 5.34 million, has been frequently mentioned by the global media in the past two decades. International media coverage of Finnish issues is often accompanied with words like High Technology, Production Capacity, Competitive Force and Incorruptness.

Yet before World War II, Finland was an agricultural country with an emphasis on small-peasant economy. A weak industrial foundation with only a small-scale timer processing industry and elementary industry rendered Finland a position significantly lagging behind countries like Sweden, Germany and United Kingdom in economy, science and technology. It was not until World Word II that Finland followed the footsteps of Sweden and established its industrial base painstakingly. Global trade flows contracted at a brutal rate on the grounds that the 1970s oil crises ignited trade protectionism. Faced with the deteriorating international situation and an increasingly fierce competition, Finland came up against bottlenecks to develop its economy. In the early 1980s, the Finnish government was committed to implementing export-oriented and technology-driven policies, seeking to boost economic growth by improving its scientific and technological level. In pursuance of its technological commitments, the government augmented investments into research and development (R&D); and even set up The Technology Development Centre of Finland (TEKES) in 1982 to manage innovation funding and give impetus to the extension and application of technological findings. Consequently Finland achieved average annual economic growth of 3.5 per cent throughout the 1980s[1]. The economic malaise of most western countries combined with the collapse of the Soviet Union resulted in a severe recession in Finland in the early 1990s since Finnish economic growth heavily relied on international trade. Finland's Gross Domestic Products (GDP) fell to 97.06 billion euros in 1993, reaching its lowest in the preceding two decades, while unemployment rate climbed from 6.61

[1]Own calculation by applying GDP constant prices measured in national currency, which is provided on World Economic Outlook (WEO) Database (April 2013 version).

per cent in 1991 to 16.36 per cent in 1993[2]. However, Finland was still exerting great efforts to developing knowledge concentrated industries. Since becoming a member in the EU in 1995, Finland was given more business opportunities by the new common market however on another hand also confronted with stiffer challenges because of its heavy reliance on global trade.

Despite the fact that Finland suffered from a deep recession in the early 1990s, the economic downturn impelled Finland to transform its industrial structure from resource-intensive (like paper and pulp industry) to knowledge-intensive (like machinery and electronic industry). For example, as the collapse of the Soviet Union and the transformation of its trade regime, exports from Finland to Soviet Union sharply declined. Companies in traditional industries such as food, garment and other product processing industries that had the Soviet Union as their primary target market were forced to cut back on production and in some cases companies even switched their business areas to electronic and communications industries. Apart from the increase in export of some traditional sectors like paper and chemicals, which partially accounted for Finland's recovery, the successful and rapid recovery was more attributed to the export of information and telecommunication technological products. The contribution made by Nokia in the midst of crisis for Finland was considered to be a critical element in rescuing the economy. The existence and development of high-tech companies such as Nokia are ascribed to the encouraging Finnish science and technology policies. These policies have enabled more funds to be invested into R&D, innovation and education, creating a stimulating environment for the development of advanced technology. Ultimately, the advancement of technology facilitated the Finnish economy taking off.

Moreover, the lack of competitive advantages around the year of 1990, which hindered the export performance, was tackled by the currency floatation in autumn 1992 which led to Markka devaluation. The depreciation was crucial in developing Finland's trading advantages and achieving long term benefits. This had given Finland the competitive edge to boost its export. Currency devaluation is believed to lead to significantly more

[2]The terms of GDP in this case refer to GDP calculated by constant prices; unemployment rate measures the percentage of Finland's total labour force. Both data are collected from WEO Database (April 2013 version).

advantageous position. But the effects of the devaluation would not last forever. The cause was partially due to the temporary effect of the expanding money supply, which is seen in the revaluation of the currency in Finland during 1995 and 1996, prior to it being indexed to euro. The longer term stimulations to competitive advantages include narrowing wage differences and enhancement in production rate, both leading to a decrease of the cost per unit of labour since 1991. After 1995, controlling wage difference was accomplished by more instances of cooperation between government and labour union and tax reduction (Kiander, 2004).

The regional policy and technology policy have been the main focuses in Finland. The purpose of the regional policy was to develop the social welfare and improve equality. The technology policy on another hand has been the pillar of Finland's shift from an economy relying on traditional industry to one that depends greatly on advanced technology and knowledge for continual development. Finland's impressive economy towards the end of 1990s has drawn interests to the new type of economic model that is driven by technologies as a growing market. The example set by Finland as a fast growing economy and the reputation achieved by Nokia in the global market encouraged public sectors around the globe to promote technology policy. This trend, however, caused some conflicts between the aspiration of the government and that of the private sector. The endeavour to continually improve the image of the region in the last few years has further moved wider-scale technology programs into narrower regional ones. The process has been a combination of localisation in general and increasing concentration on regional level. (Häyrinen-Alestalo, M. and Pelkonen, et al. 2006).

Standing at a dominant position in the high-tech manufacturing industries, Finland has the latest and most sophisticated technology in various fields like information science, traditional and renewable energy, marine science and etc. The export of Finnish high-technology products and its proportion in total export have grown for years and reached its apex at 11524 million euro, equivalent to 23.3 per cent of the total export in 2000[3].

[3]Figures on Finnish high-tech exports and Finland's total exports of goods are collected from Finnish Customs Database (ULJAS) under Standard International Trade Classification (SITC). Please notice

However, the export of high-technological sector was hindered by the pressure of a global economic slowdown and the volume went down from approximately 9983 million euro in 2001 to around 8579 million euro in 2004. Afterwards Finland experienced sustained growth until the 2008 economic collapse, resulting in a swift decline in 2009, to almost 6323 million euro at only 14.0 per cent of total commodity exports. The condition deteriorated repeatedly over the next three years, Finland's high-technology export has yet to rebound.

Table1 The Global Overall Competitiveness Index for Top 10 Economies[4]

Rank	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1	USA	FI	USA	FI	FI	USA	CH	USA	USA	CH	CH	CH
2	SG	USA	FI	USA	USA	FI	FI	CH	CH	USA	SE	SG
3	NL	CA	TW	SE	SE	DK	SE	DK	DK	SG	SG	SE
4	IE	SG	SG	DK	TW	CH	DK	SE	SE	SE	USA	FI
5	FI	AU	SE	TW	DK	SG	SG	DE	SG	DK	DE	USA
6	CA	NO	CH	SG	NO	DE	USA	FI	FI	FI	JP	DE
7	HK	TW	AU	CH	SG	SE	JP	SG	DE	DE	FI	NL
8	UK	NL	CA	IS	CH	TW	DE	JP	NL	JP	NL	DK
9	CH	SE	NO	NO	JP	UK	NL	UK	JP	CA	DK	JP
10	TW	NZ	DK	AU	IS	JP	UK	NL	CA	NL	CA	UK

Source: Data collected from The Global Competitiveness Report (World Economic Forum) of each year.

Table 1 has displayed the global over competitiveness index of the 10 most outstanding regions during the period of 2000 and 2011. Finland has been rated as one of the top 10 most competitive countries by World Economic Forum for more than 12 years. Between year 2000 and 2006, Finland ranked at the first place for three times and the second place twice. Specifically, Finland came out at the top in terms of infrastructure, macroeconomic stability, health and primary education as well as innovation. In order to firmly establish itself in the progressively globalised and increasingly more competitive

that data from 2003 to 2006 are not available online; however data of these 4 years applied in this thesis are provided by Finnish Customs Officers.

[4]The abbreviation for the economies stands as: CA for Canada; CH for Switzerland; DE for Germany; DK Denmark; HK for Hong Kong, China; FI for Finland; IE for Ireland; IS for Iceland; JP for Japan; NO for Norway; NL for Netherlands; NZ for New Zealand; SE for Sweden; SG for Singapore; TW for Taiwan, China; UK for United Kingdom; USA for the United States.

marketplace, Finland has to enhance its level of scientific research constantly to strengthen its economic power and international competitiveness.

Research Questions

This study is attempting to present the historical performance and competitiveness of Finnish high technology[5] exports and its nine categories that classified by Organisation for Economic Co-operation and Development (OECD). Gravity Theory will then be introduced as the theoretical foundation to conduct pooled Ordinary Least Squares (OLS) regression and fixed effects regression with an aim to assess the determinants of Finnish high-tech exports. Following that, a case study is provided to estimate potentiality opportunities of high-tech products in Chinese market for Finland. Last but not the least, this dissertation seeks to fill a gap in literature of determinants of Finnish high-tech exports and its high-tech export potential to Chinese market since there are few literature studies on these two aspects.

The major research questions in this paper are “what factors determine Finnish high technology exports to its major trading partners” and “how is the export potentiality of high-tech goods provided by China for Finland” by carrying out a case study.

Structure

The structure of this study is as follows: Chapter 1 is a fifteen-year (1996-2010) retrospective study on Finland’s economy with focus on its high-tech industry. It firstly gives a general outline of Finnish economy in terms of real GDP growth rate, unemployment rate, inflation rate and GDP per capita and then provides a brief overview of Finland’s commodity trade. A detailed description of the Finnish high-tech industry is demonstrated soon afterwards. It mainly concentrates on the relationship between Finnish high-tech trade and Finland’s total trade, its main export destinations and its components. Chapter 2 introduces theories of determinants of trade and the Gravity Model. Literature reviews on high-tech exports and empirical review of gravity model will be presented as well. Chapter 3 is about the methodology of this paper. It presents the sample size and dataset that will be applied in the empirical research. In

[5]In this thesis, the definition of high-technology products bases on the SITC classification put forward by the OECD. Detailed explanation of High Technology Products please refers to Chapter 3.

addition, the data description, data processing and the seven analytical models are presented in this chapter. The empirical results and analysis together with an adjusted gravity model are shown in Chapter 4, evaluating the determinants of Finnish high-tech exports. The case study is conducted by adopting the adjusted gravity model and Reveal Comparative Advantage (RCA) index, which is also presented in the Chapter 4. These will be followed by the conclusion, limitation, bibliography and appendix.

CHAPTER 1THE FINNISH ECONOMY AND ITS HIGH-TECH INDUSTRY

An Overview of the Finnish Economy from 1996 to 2010

Figure 1 presents the historical real GDP growth of Finland between 1996 and 2010. The Finnish economy has witnessed a high growth rate from the mid-1990s to 2000; the real GDP growth rate of Finland remained above 3.2 per cent and even grew to 5.1 per cent in 2000, with GDP at constant price 132.195 billion euro. Meanwhile, there is an upward trend in the value of Finnish foreign trade in goods since it became a member of the EU, experiencing an increase from 55.2 billion euro in 1996 to 86.3 billion euro in 2000. At that time Finland was reckoned to be the most developed country in the world by The Human Development Report published. Finland then experienced a smooth ride in the following years, with the real GDP growth rate reaching 4 per cent and 4.9 per cent in 2006 and 2007 respectively. However, a slight drop occurred in Finnish foreign trade of goods due to the global economic downturn in 2001 and 2002; from that time onwards, Finland's foreign trade of goods continued to climb and peaked at 128 billion euro in 2008. The onset of the 2008 global economic crisis brought the first negative growth rate to Finland in the past decade, descending to -0.2 per cent. The situation continued to deteriorate and dragged the real GDP growth rate down rapidly to -9.0per cent; the GDP sank from 186 billion euro in 2008 to 172 billion euro in 2009[6]. Simultaneously, total international trade of commodities fell considerably, dropping to 88 billion euro in 2009[7]. However since then, Finland has slowly recovered at all aspects.

[6]Data of GDP calculated by constant prices in is provided on WEO Database (April 2013 version).
[7]Figure on Finnish foreign trade of goods is calculated by the author, employing data provided by Finnish Customs database (ULJAS)

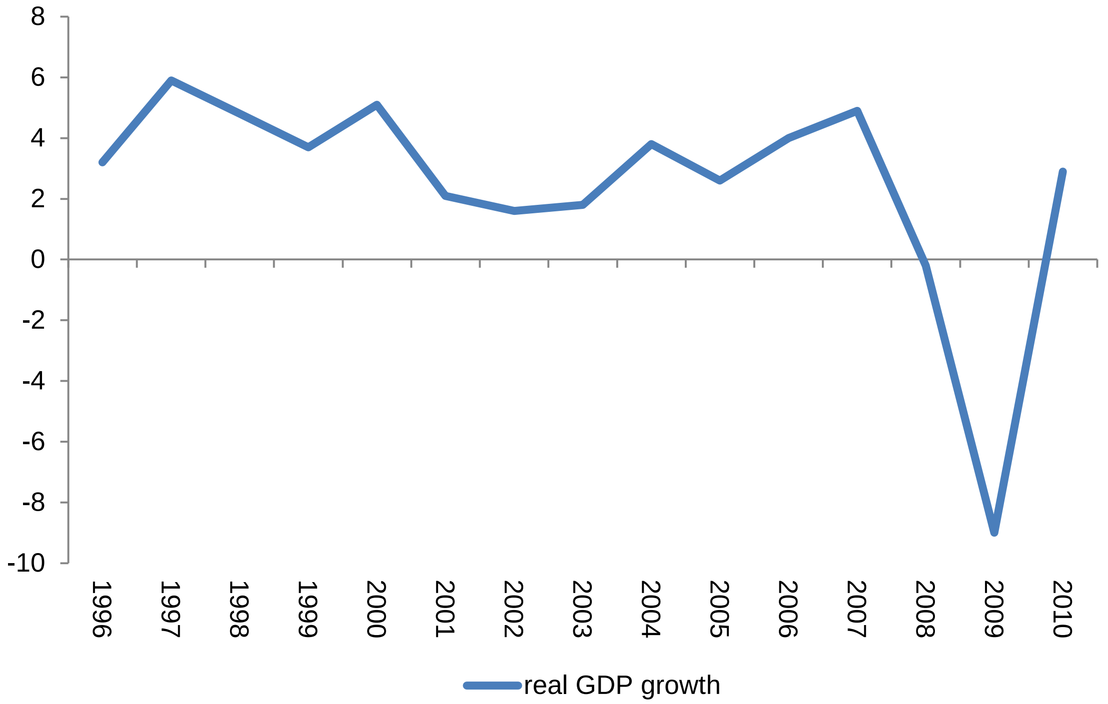


Figure 1 Finland's Real GDP Growth Rate (%)

Source : Data from Eurostat Database, available at
http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database

Table2 Finnish Recent Economic Performance from 1996 to 2010

Year	Unemployment Rate	Inflation Rate	GDP per capita (constant prices)
	(%)	(%)	(unit euro)
1996	14.60	0.97	21102.71
1997	12.70	1.89	22346.53
1998	11.40	0.82	23412.29
1999	10.20	2.03	24271.06
2000	9.80	3.02	25514.78
2001	9.10	1.78	26028.22
2002	9.10	1.65	26447.60
2003	9.00	0.60	26910.39
2004	8.80	0.43	27930.28
2005	8.40	0.59	28640.80
2006	7.70	2.20	29783.09
2007	6.90	2.64	31232.81
2008	6.40	3.43	31172.59
2009	8.20	-0.55	28434.29
2010	8.40	2.85	29364.45

Source: data of inflation rate is obtained from Eurostat Database; data of unemployment rate GDP per capita are collected from World Economic Outlook (WEO) database (April 2013 version).

Table 2 presents some key factors in relation to Finnish historic economic performance. The Finnish unemployment rate decreased progressively since it became a member of EU in 1995, from 14.6 per cent in 1996 to 10.2 per cent in 1999. However the first upturn in jobless rate was seen after the 2008 financial storm, it rocketed to 8.2 per cent in 2009 from 6.4 per cent in 2008, and did not fall back under 8.0per cent until 2011. Finland has maintained a slowly increasing inflation rate for years but as can be seen from Table 2, the inflation rate declined sharply to negative (-0.55 per cent) in 2009, signifying Finland was likely to face deflationary pressure. Nevertheless the inflation rate has been back to pre-crisis levels soon afterwards, standing at 2.85 per cent in 2010. Finland has perceived a significant improvement in GDP per capita over the past two decades; however the GDP per capita was impacted by the 2008 financial shock and the GDP per capita has bounced back to 30057 euro.

The integrating world economy has also accelerated business cooperation and consequently the foreign trade was placed more emphasis by almost all economic powerhouses. Finland, as a member of the EU, is no exception. Figure 2 has provided the data of proportion of Finnish total foreign trade of goods in GDP, which reflects the degree of Finland's reliance on international trade. The percentage remained steady above 50 per cent in the past 15 years and hit the ceiling at 70.4 per cent in 2006. It implies Finland has a relatively high degree of openness and dependence on international trade.

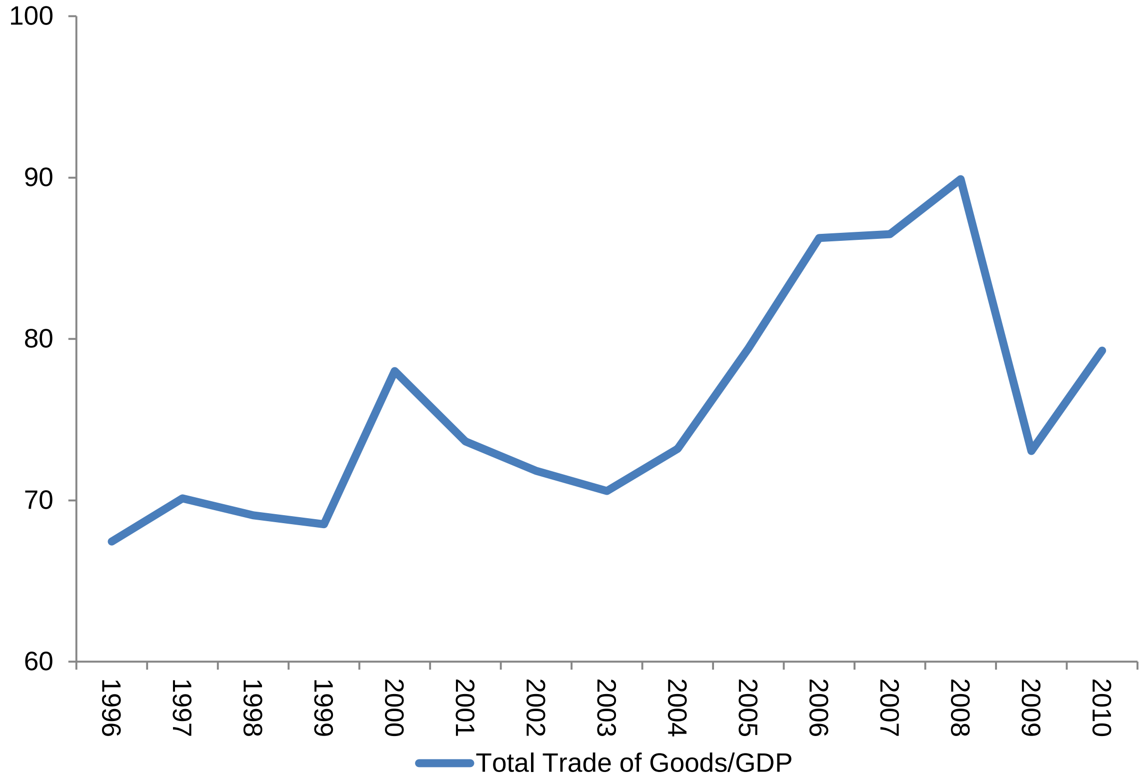


Figure 2 Finland's Total Trade in commodities as a Percentage of GDP (%)

Source: data is available at Eurostat Database.

Figure 3 displays Finland's historical trade balance of commodities from 1996 to 2010 measured in euro. Even if there was an economic downturn in 2003 and a severe global economic crisis in 2008, Finnish commodities exports still remain more robust than its imports. However, without a doubt the value of merchandise trade declined: the value of exports has dropped from its historic peak, 65721 million euro, in 2007 to 45164 million euros in 2009[8]. Both the imports and exports of goods have been immunised from the impact of the economic storm, experiencing a significant growth in 2010.

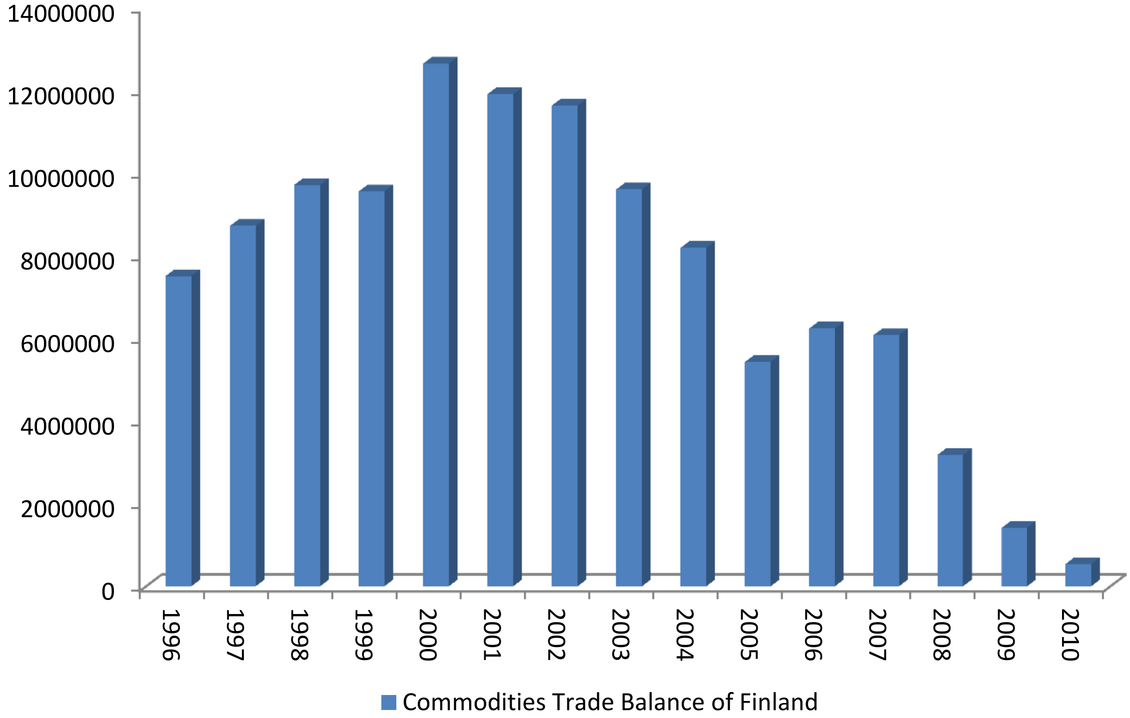


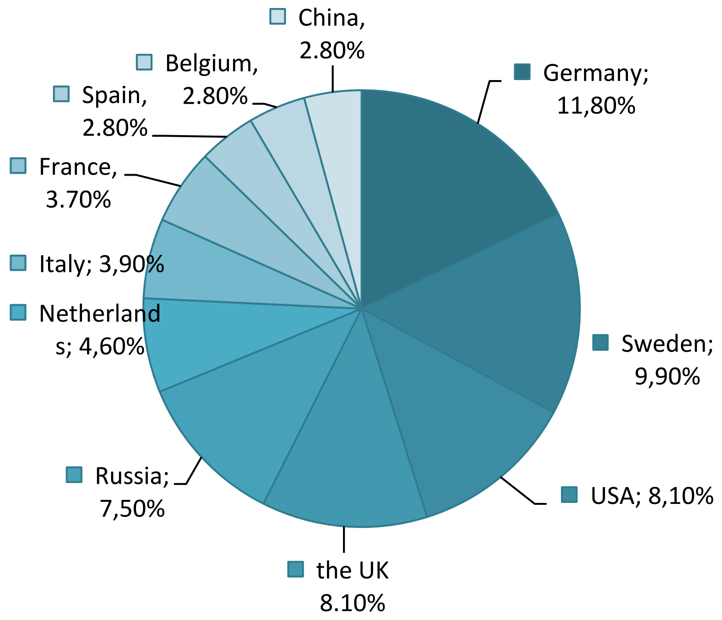
Figure 3 Merchandise Trade Balance of Finland 1996-2010 (euro)

Source: Own calculation by applying data provided by Finnish Customs Database (ULJAS) under SITC revision 3 and revision 4.

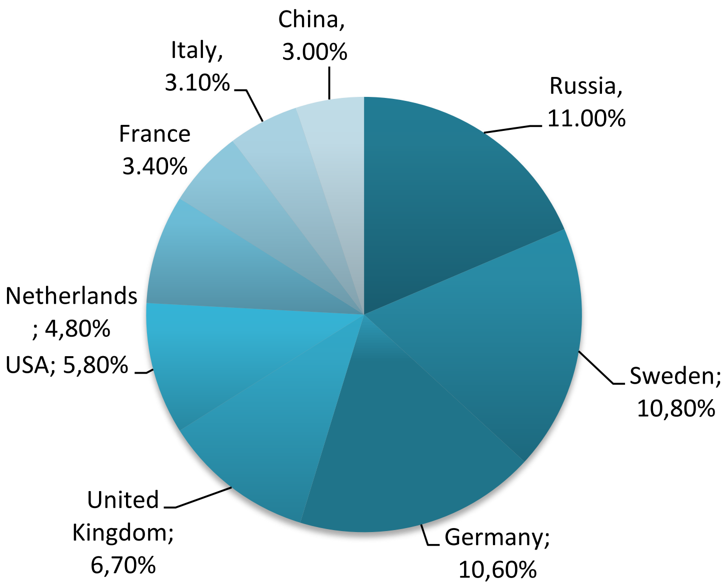
Finland's main export destinations in selected years are displayed in Figure 4. From the pie charts, apparently Germany, Russia and Sweden have long been the top exporting partners with Finland, having accounted for approximately 30 per cent of Finnish export sector. The U.S.A, United Kingdom and Netherlands have always been major export destinations for Finland. It is noteworthy that with Finland's growing emphasis on Asian market and the emergence of China, the share of exports to China in total export is climbing from 2.8 per cent in 2003 to 4.7 per cent in 2011.

[8]Data of total Finnish Exports of Commodity is collected from Finnish Customs database (ULJAS).

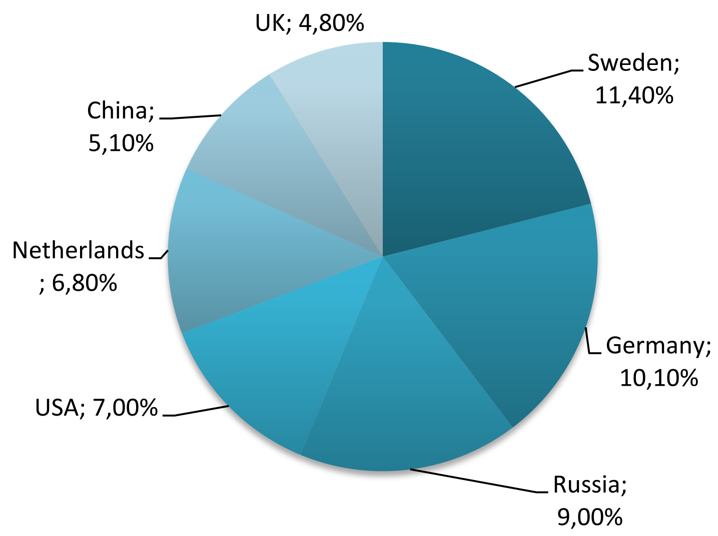
2003


China, 2.80%
Germany; 11,80%
Belgium, 2.80%
Spain, 2.80%
France, 3.70%
Italy; 3,90%
Netherland s; 4,60%
Sweden; 9,90%
Russia; 7,50%
USA; 8,10%
the UK 8.10%

2005


China, 3.00%
Italy, 3.10%
Russia, 11.00%
France 3.40%
Netherlands ; 4,80%
USA; 5,80%
Sweden; 10,80%
United Kingdom; 6,70%
Germany; 10,60%

2010



2011

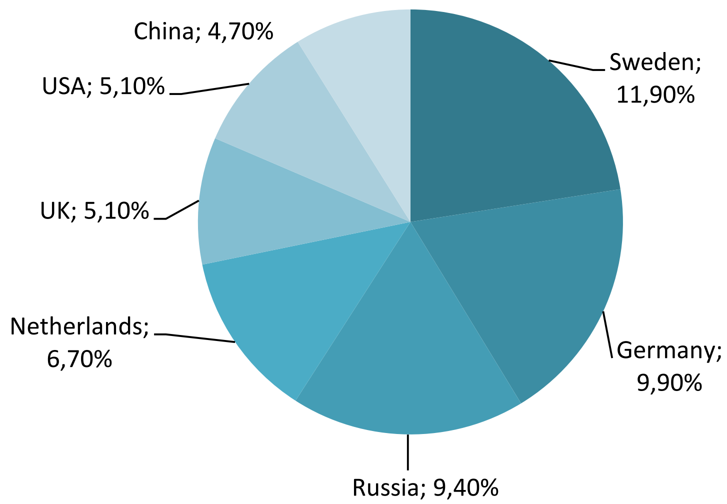


Figure 4 Finland's Total Export by Destinations in Selected Years

Source: Foreign Trade Pocket Statistics (Finnish Trade in Figures) in 2003, 2005, 2010 and 2011.

Introduction to Finnish High Technology Exports

When evaluating the factors that helped Finland out of economic regression in the early 1990s, institutional restructuring is considered to have played a very limited role in terms of unemployment recovery while modifications on conventional elements such as exchange rate, had a huge contribution, which was owing to the advancement in information and communication technologies (Autio and Yli-Renko, 1998). Positioning itself as one of the pioneers in information and communication technologies has enabled the Finnish economy to take off at the early 1990s. The increased productivity from 1990 was due to a shift from industries focused on resources to ones focused on knowledge with Information and Communication technology sector being the primary driving force. In early 1990s the domestic output and export overseas were focused on traditional fields with low technology elements such as paper, metal and equipment. 10 years later the economy is reliant on electronics as the primary export sector. This is largely owing to the fast development of mobile telecommunication. In 2000 Nokia Group – the Finnish producer of mobile devices - was the largest in the field, and the 7 per cent of the world’s telecoms equipment were manufactured in Finland (Kiander, 2004).

The knowledge and technology driven economy discourages a state subsidisation. At the beginning of 1990s, the government in Finland started a process to enhance the competitiveness in sectors, heavily investing in new technologies and privatising public sector companies. Support was given in favour of companies and entities with knowledge and technologies (Häyrinen-Alestalo, M. and Pelkonen, et al. 2006).

New Technology-Based Firms (NTBFs) have had dominating significance in economic development of Finland since the economic slump took place in the early 1990s. The number of NTBFs has grown much more quickly than corporations who manufacture goods with low technology. Businesses engaged in microchip technology, communication apparatus and information facilities have proved to be the fastest-growing domains among the NTBFs and contributed the most to Finnish recovery.

Functioning in an innovative environment and maximising the utilisation of scientific capitals, Finnish NTBFs play the part of supplying specialists and services for large and medium scale enterprises from various sectors and generated profits from the practice. The empirical study on Finnish data suggests that high-tech industries are not the single sector that NTBFs dedicate to; they are also energetic participants in traditional industries, for example, forestry and transport industries, supplying commodities and services. NTBFs introduce technologies to traditional sectors and enable firms from these industries to bring their skills into full play (Autio and Yli-Renko, 1998; Storey and Tether 1998).

As NTBFs in Finland, they shoulder the responsibility of interconnecting scientific information research and industries, applying the theoretical achievement into practice and in turn, providing inspiration for theoretical investigation through field experience. Most of the time, NTBFs from Finland are also regarded as a conduit for technology transfer to their clients, instead of assimilating technologies from their customers. Within a group enterprise, although under some circumstances subsidiaries deliver technology to its parent company, parent firms convey technologies to the sub-NTBFs much more often (Autio and Yli-Renko, 1998).

It is noteworthy that in Finland, the small scale NTBFs, say a staff team with fewer than ten employees, far outnumber those medium or large sized NTBFs and to one’s surprise, these tiny companies have gained high evaluation in appreciation of their excellent performance. Not only have they operated efficiently and contributed to employment, but the small NTBFs have also acted as powerful backbone for those large organisations. Professionalised technological supports originating from tiny NTBFs have been enhancing the efficiency of large firms and sharpening competitive force of corporations in different industries. Thanks to the positive contributions made by small NTBFs, Finland has attracted across its geographical space an increasing number of companies which require scientific and technological input to establish subcontracting plans. Autio and Yli-Renko (1998) suggest that in light of his empirical study on Finland, the better channel for most of Finnish NTBFs to become universally influential is being attractive to international technology-based enterprises since the demand from Finnish domestic market is weak.

Table 3 Historical Performance of Finnish High-Tech Trade from 1996 to 2010 (%)

Year	hi-tech trade /total trade	hi-tech exp /total trade	hi-tech imp /total trade	hi-tech exp /total exp	hi-tech imp /total imp
1996	14.3	7.77	6.58	13.7	15.2
1997	15.8	9.17	6.63	16.1	15.4
1998	18.0	10.80	7.24	18.9	16.9
1999	19.4	11.65	7.77	20.5	18.0
2000	21.4	13.36	8.06	23.3	18.9
2001	19.5	11.92	7.61	20.9	17.7
2002	18.7	11.78	6.89	20.6	16.1
2003	17.8	11.20	6.56	20.1	14.8
2004	16.0	9.57	6.43	17.5	14.2
2005	18.6	11.23	7.38	21.3	15.6
2006	16.3	9.59	6.67	18.2	14.1
2007	16.4	9.23	7.19	17.6	15.1
2008	15.5	8.94	6.60	17.5	13.5
2009	14.0	7.13	6.92	14.0	14.1
2010	10.7	5.10	5.65	10.1	11.4

Source: own calculation by collecting data from Finnish Customs Database (ULJAS).

According to Table 3, which displays the historical performance of Finland's high technology trade between 1996 and 2010, it can be perceived that the contribution of trade in high-technology productions to total commodity trade peaked in 2000 at 21.4 per cent while touched its bottom in 2010 at 10.7 per cent, even lower than the one of year 1996, with 14.3 per cent. When compared with the situation in high-technology imports, the high technology exports suffered more from the global financial shock, its share of total trade plunged dramatically from 9.23 per cent in 2007 to only 5.10 in 2010. It was not until the year 2010 that the share of high technology exports to total trade was lower than the one of high-tech imports. Prior to this, export of high technology consistently showed better performance than its imports. Specifically, as for the involvement of high technology export (import) in total export (import) from 1996 to 2010, both the share of high-tech export in total commodity export and the share of high-tech import in total commodity import hit the roof in 2000, with 23.3 per cent (11524 million euro for high-tech exports) and 18.0 per cent (6958 million euro for high-tech imports) respectively[9]. However they have been seriously affected by the global economic downturn.

The trend of Finnish high-tech trade balance is described in Figure 5. As can be seen from Figure 5, years of trade surplus in high-technology sector faded away for the first time in 2010 and an even worse trade deficit occurred in 2011. Finland's high-tech trade balance dropped from 4566 million euro in 2000 to -578 million euro in 2010 and worse, -1435 million euro in 2011[10].

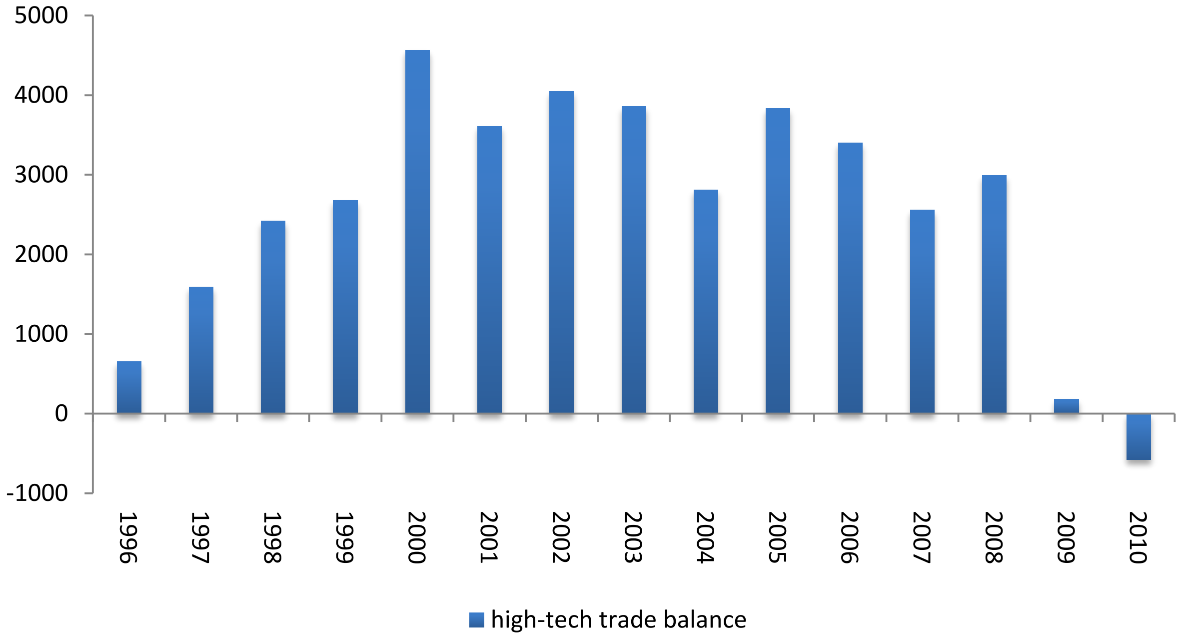


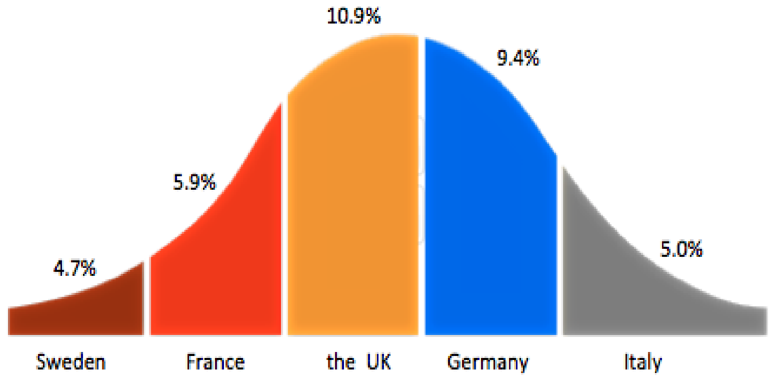
Figure 5 Historical Performance of Finnish High-Tech Trade Balance (1996– 2010)

Source: own calculation by using data provide on Finnish Customs Database (ULJAS) under SITCrevision 3 and revision 4.

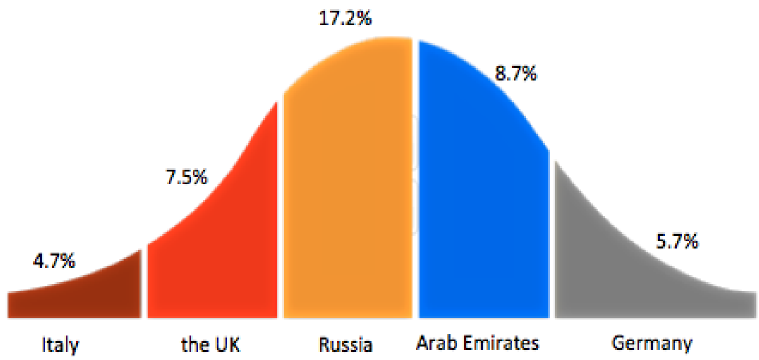
[9]The figure of Finnish high tech exports and imports are calculated by the author, using data provide on Finnish Customs database (ULJAS).

[10]The value of high-tech trade balance is calculated by the author, applying data provide on Finnish Customs database (ULJAS).

Figure 6 presents the Finland's major export destinations in terms of high-tech commodities in selected years. Finland mainly exported their hi-tech products to the UK, Germany, Sweden, Russia and Italy. Of these, Russia often accounted for the largest proportion, 17.2 per cent in 2005, 9.8 per cent in 2008, 11.0 per cent in 2010 and 13.8 per cent in 2011. China has developed to be one of Finnish the top five high technology exporting targets since 2009, constituting 5.9 per cent with roughly 373 million euro. And its significance to Finnish high-tech exports is increasing as China occupied 7.0 per cent of Finland's total export of high technology productions in 2010 and 7.3 per cent in 2011, reaching 371 million euro (ranked the second place) and 338 million euro (ranked the third largest) respectively[11].

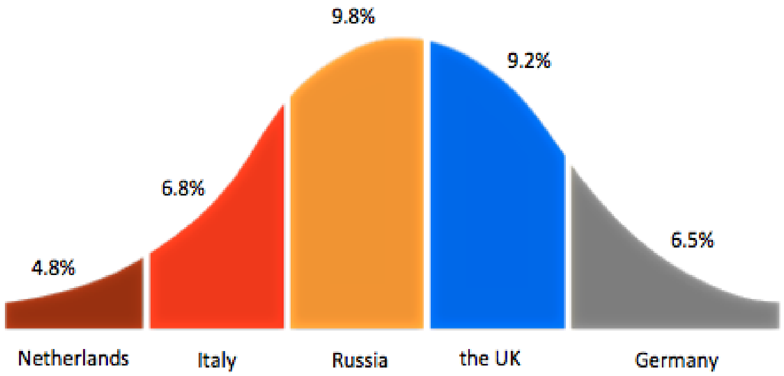


2000

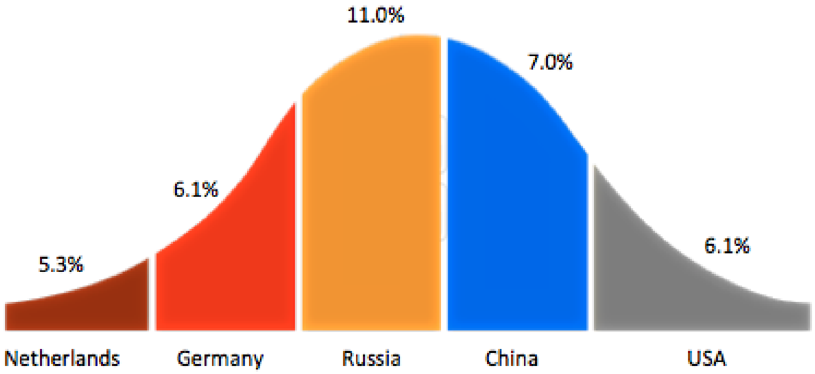


2005

[11]Figures on the percentage of high-tech exports to different regions are available at annual Foreign Trade Pocket Statistics (Finnish Trade in Figures).



2008



2010

Figure 6 Finland's High-tech Exports with Major Trading Partners in Selected Years

Source: Foreign Trade Pocket Statistics (Finnish Trade in Figures) of selected years.

Table 4 The Breakdown of Finnish High-Tech Exports by Categories (%)[12]

Year	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1996	0.26	0.49	0.96	17.27	1.05	66.29	2.53	0.43	10.73
1997	1.27	0.33	0.78	16.83	1.19	66.55	2.12	0.37	10.57
1998	0.81	0.42	0.64	12.47	1.52	73.05	1.87	0.35	8.87
1999	0.26	0.76	0.58	9.88	2.51	75.17	1.54	0.32	8.98
2000	0.82	0.35	0.51	3.75	1.93	83.72	1.31	0.27	7.34
2001	1.63	0.39	0.59	3.55	1.16	81.59	1.74	0.34	9.00
2002	0.50	0.70	0.64	3.04	0.67	82.92	1.93	0.77	8.83
2003	1.14	0.55	0.55	2.76	1.14	82.39	1.33	0.83	9.30
2004	0.43	0.60	0.64	3.80	1.24	80.40	1.76	1.07	10.06
2005	1.15	1.01	0.50	4.00	1.06	81.01	1.39	1.20	8.70
2006	0.65	0.47	0.50	5.11	1.07	79.39	2.11	1.43	9.28
2007	0.94	0.57	0.63	4.28	1.02	80.56	1.97	1.14	8.90
2008	1.28	0.97	0.70	3.49	0.98	80.46	1.91	1.06	9.16
2009	1.95	1.49	1.09	4.74	1.18	71.08	2.19	2.01	14.27
2010	6.37	1.43	1.55	5.78	1.54	58.23	2.50	3.71	18.89

Source: own calculation by applying data from Foreign Trade Pocket Statistics (Finnish Trade in Figures).

Table 4 has shown the share of Finland's high technology exports by categories in its high-tech total exports from 1996 to 2010. The percentage of 9 categories under high technology varies differently in share of Finland's high technology products exporting. The most obviously amount of fluctuation appears in the Electronics and telecommunications sector. Being Finnish most exported high-tech products, it has accounted for roughly 80 of Finnish high-tech exports for years; but it is greatly influenced by the 2008 global economic strike, its share dropped dramatically from 80.5 per cent(93.2 million euros) in 2007 to 58.2 per cent (31.0 million euros) in 2010. However, the greatest contribution to high technology exports is still from electronic and telecommunications group. It is noteworthy that although the export percentage of

[12]. The names of groups are replaced by number due to the space limited: (1) Aerospace; (2) Armament; (3) Chemistry (4) Computers-Office Machines; (5) Electrical Machinery; (6) Electronics-telecommunications; (7)Non-Electrical Machinery; (8)Pharmacy; (9) Scientific Instruments.

armament products in total high technology exports increased after the global crisis, in effect, its export value declined, from 11.0 million euros in 2008 to 0.7 million euros in 2010. This situation happens to the groups of computers-office Machines and non-electrical machinery as well. Nevertheless, exports of aerospace goods were not impacted by the economic shock taken place in 2008; it even surprisingly became the third largest contributor to Finnish high-tech exports in 2010, accounting for 6.37 per cent, with 33.9 million euros[13]. Other groups of high-tech commodity have slightly recovered from the attack of the global crisis. The export value of nine groups of high-tech product from 1996 to 2010 is provided in Appendix 4.

[13]The nine groups of high technology products is classified according to the definition provided by OECD based on SITC. The total export value of each group and the percentage of their exports in total high-tech exports are calculated by the author. Data are obtained from ULJAS database.

CHAPTER 2 THEORIES AND LITERATURE REVIEW

Theories on Determinants of Trade

It was the critique made by Adam Smith (1776) on Mercantilism in the middle of the 18th century that inspired the development of Classic International Trade Theory. Adam Smith insisted that bilateral trade is beneficial to both parties but disapproved of state intervention with trade, founding the Theory of Absolute Advantage. The social division conduces to boosting labour productivity for each worker and lowering the production costs and therefore, increasing the ultimate yields. And in the same way, Adam Smith advocated that if foreign firms provide goods or services at a lower price than the cost of domestic production, the nation should import this commodity instead of producing it. Furthermore, it is critical for countries to protect and develop their own competitive strengths and trade part of their outputs for products that they have no absolute advantage of. Apart from the natural endowments like mineral reserves or environment, acquired advantage like skills of labour or technological level is another element accounted for the emergence of absolute advantages. However, the assumptions that absolute advantage theory is based on are criticised as impracticable and more importantly, the interpretation of the theory is limited to a country with absolute advantage of a particular product over its trade partner, which signifies that trade will not happen between countries who have advantages over more than one commodity, while the reality is, the advantages of countries are always comparative instead of absolute.

The concept of comparative cost was first put forward by David Ricardo (1817) with the purpose of explicating the origin of comparative advantage. He pointed out that it was the cheaper price that motivates countries to import from their trading partners. Moreover, a country could profit if it specialises in producing a specific product that has a comparative advantage and yields it as efficient as possible, concurrently imports the products where the country is relatively disadvantaged at. Within a single factor (labour, in this case) economy, the discrepancy in productivity gives rise to the comparative advantages, and furthermore, it forms the country’s production mode. Yet despite the apparent success of comparative advantage theory, it is subject to a certain number of disapprovals. Firstly, the assumptions are very strict and are divorced from reality. For example, transferring factors of productions from location to location in the real world is much harder than Ricardo imagined; non-labour costs are not taken into account by the theory and transportation costs do exist in the reality; perfect competition is almost never found; the assumptions of constant costs and trading without any trade barriers are unrealistic; the role of technology and innovation in worldwide business should has been given emphasis but Ricardo neglects it (Fletcher, 2010). Secondly, some economists argue that we should evaluate the comparative advantages from a dynamic view rather than a static one. For instance, the comparative advantages are gained from the past technological advancement (Redding, 2002). Last but not the least, it is criticised that the comparative advantage theory is too simple to conduct empirical analysis (Leamer and Levinsohn, 1994).

As for the Neo-Classic International Trade Theory, the Factor Endowment Theory (H-O theory) was first construed by Bertil Ohlin in 1933. He indicated that the international trade and international division are provoked by the price differentiation in commodities, which is attributed to manufacturing cost; the distinction between production costs is due to the difference in prices of production factors, which results from the dissimilarity in production factor endowment between nations. Therefore Bertil Ohlin concludes that the difference in factor endowments is the fundamental cause of intercontinental business and global division of labour. The H-O theory inherits Ricardo's comparative advantage theory and departs from it in four aspects: 1. In terms of assumption, H-O theory (2*2*2 model) introduces capital as another factor endowment and presumes that capital and labour are the two factor endowments that differ from one country to another; there are two commodities to be yielded; 2.the country with abundant capital exports relatively more capital-intensive products and imports relatively more labour-intensive commodities and vice versa; 3.The comparative cost is utilised by Ricardo to demonstrate a general principle in which trade is mutually beneficial to trading parties while Ohlin explored the roots of comparative cost by an application of factor endowments; 4. The H-O theory reveals the impacts of transnational trade on a country's economic structure and income distribution. The H-O theory was assessed by Leontief in 1953 by applying a data set of 200 U.S industries for year 1947. He categorised the 200 sectors into 50 groups (with 38 departments export their commodities to international market directly) and built up an "output-input" table to conduct a series of calculations. In light of comparative advantage theory, the USA should export capital-intensive products while import labour-intensive commodities at that time. Nevertheless, Leontief discovered that what the U.S.A imported were capital-intensive goods and what it exported were labour-intensive products, which contradicts the comparative advantage theory. The share of import substitutes in capital is 6.0 per cent higher than the export products, and about 17.6 per cent higher if the capital substitute of the input-output ratio is taken into consideration. The H-O theory was proved by Arrow, Chenery, Minhas and Solow in 1961 to be fallacious. They argued that when the production function applies a constant elasticity substitution (CES) model, "factor intensity reversal" occurs if the elasticity of substitution of the two products is different. Therefore, when a certain commodity is defined as capital-intensive in country A while as labour-intensive in country B, there is always a country which runs in opposition to the H-O theory. Minhas (1962) supports this disagreement by directing an empirical study on paper industry and dairy industry.

Government Intervention is criticised by the traditional trade theory, however, Brander and Spencer (1980,1981,1985) argue that state interference, for instance in the forms of subsidy or custom duties, is expected to improve its welfare standard by transferring monopoly profits, even for a small nation. They further claim that government interference could be observed as an approach to achieving strategic purposes, preventing aggressive foreign competitors and transforming the market share as well as production costs. Another discordance comes from Krugman (1987), he disputes that government intervention enables infant industries to gain "learning effects" and "scale effects", by which one could increase its productivity and reduce its production costs. And that, in turn, sharpens the home country's edge and augments the international market share.

The traditional trade theories are built up on the basis of some firm theoretical hypotheses such as a perfectly competitive market, constant returns to scale, similarities in consumer preference for countries and there are only two countries as research targets.

These impractical assumptions generated a good deal of suspicion on the explanatory power of the traditional theory by those advocators of the new trade theory. Being different from the traditional trade theory, new international trade theory concentrates on the study of intra-industry trade under the circumstances of increasing returns to scale and an imperfect competition market.

The notion of increasing returns to scale (IRS) is brought forward by Krugman and Elhanan (1985) to illustrate the genesis of international trade: the cost of an IRS commodity decreases with the expansion of production scale and reaches a cost advantage, resulting in specialised production and export of this certain product. This theory takes two forms: internal and external. For the internal one, the average costs rely on the scale of the manufacturer and the firm is operating under an imperfectly competitive market. When the decline of corporation's long run average cost is driven by the enlargement of the firm itself, namely, an uptick in output, then it could be described as an internal economy of scale. To reach the internal economies of scale, the firm is required to bring various essential productive factors into full play, facilitate the labour division and professionalise production and raise the utilisation rate of machinery equipment. For the external one, the unit cost of commodities depends on the industrial scale and the industrial clustering; the firm is functioning under a perfectly competitive market. Thanks to the increasing number of companies in a particular industry, the industrial scale is expanding and leads to a drop in average costs in the long term. Such phenomenon, which is resulted from "aggregation effects", is labelled as external economies scale. It is associated with factors like knowledge spillover and technology diffusion. To achieve an external economy of scale, a firm is expected to fully utilise transportation, communication facilities and natural resources. It was proposed by Hufbauer in 1970 that more sizable countries manufacture and export to other states the items which are more effectively produced by plants of small scale. He notices there is a high correspondence between the country size and the usefulness of economy of scale; however, the correlation is not significant statistically.

The technological gap theory has been deemed as an extension of the H-O theory. Technology that contains time dimension is taken as a third factor endowment by

Posner (1961), being completely independent from labour and capital and attempting to assess the impacts of technological gap and change in international trade. The technological advancement or innovation allows an increase in output with invariable inputs of factor endowments. It has effects on the ratio of a country's factor endowments, and then the comparative advantage of countries, playing a role in the world trade pattern. The period of time between the invention of a brand-new product in innovation country and the moment imitation country starts to imitate is identified as "Foreign Reaction Lag" while the length of time required from replication to export, namely, ceasing imports of this product, is recognised as "Domestic Reaction Lag". The combination of foreign and domestic reaction lag is "Imitation Lag". Another important concept, "Demand Lag", represents the time period ranged from the presence of a novel commodity in innovation country to the acceptance by consumers from imitation state. The difference between "Imitation Lag" and "Demand Lag" is named as "Net Lag". The length of foreign reaction lag mainly depends on the tariff, transportation costs and the income level of residents while the domestic reaction lag relies on the ability to absorb new technology for imitation states; the length of demand lag is determined by the disparity of income and market capacity between the two countries: the smaller the gap is, the less time it takes. Despite the technological gap enables innovation country to obtain a comparative advantage with respect to technology, during the process of transferring innovative goods from revolution country to imitation country, this kind of comparative advantage fades away. Meanwhile, no more trade takes place between these two countries. However, by investigating the film industry in the USA, Gordon Douglas argues that once a country has a comparative advantage with a certain product, it could maintain its technological advantage on other relevant products. Even if technological gap theory discusses the dynamic transmission of comparative advantage and the disappearance of technological gap, it fails to illustrate the fluctuation in trade volume and the modification in trade structure (Yu and Liu, 2007).

Trade Gravity Model

Almost all of the traditional international trade theories, from the Theory of Comparative Advantage put forward by Adam Smith and David Ricardo to the Theory of Factor Endowment (H-O Model) presented by Eli Heckscher and Bertil Ohlin to New

Trade Theory, place particular emphasis on the origin of trade, the pattern of trade and the welfare effects of trade, regardless of the most practical problem: trade flows. Nevertheless even though the empirical study of trade flows became one of the most significant research tasks for international trade, hardly could empirical study on bilateral trade be found until the 1960s. The application of Gravity Model in trade is a novel milestone of the development of international trade theory.

The earliest contribution for the application of Trade Gravity Model was made by Tinbergen (1962) and Pöyhönen (1963), elaborating that the collaboration and links between smaller economic groups is weaker than greater ones and more trade opportunities are provided for neighbouring countries than distant ones. This is exactly the same as the application of Gravity Model in physics: the force of gravitation between two objects is always proportional to their masses while inversely related to their distance.

The primitive equation is as follows:

$$T_{ij} = \frac{Y_i * Y_j}{D_{ij}^{\theta}} = \frac{GDP_i^{\alpha} * GDP_j^{\beta}}{D_{ij}^{\theta}} \qquad (1)$$

where, T_{ij} refers to the bilateral trade between country i and j; Y_i $and Y_j$ indicate the economic size, while GDP_i and GDP_j are used as a measurement of the economic scale; $D_{i,j}$ signifies the geographic distance between country i and j; the coefficients α, β and θ are estimated when the model is reformulated to be a log-linear one. While this model is extremely simple, it has received frequent usage not only in the fields of bilateral trade and capital flows but also in other socio-economic activities like patient flows between different hospitals. In terms of bilateral trade flows, the Gravity Model provides a compelling explanation, 70 to 80per cent, of the variance (van Bergeijk and Brakman, 2010).

When considering the international trade, the traditional gravity model has frequently been expressed as follows (Bikker, 1982):

$$T_{ij}=\beta_0 Y_i^{\beta_1} N_i^{\beta_2} Y_j^{\beta_3} N_j^{\beta_4} D_{ij}^{\beta_5} P_{ij}^{\beta_6} \qquad (2)$$

where T_{ij} indicates the volume of trade between both countries i, j; GDP in country i and j are used to measure the size of economy as usual, representing byY_i *and* Y_j ; N_i and N_j are the scope of population of the two countries; D_{ij} refers to the bilateral distance while P_{ij} denotes "a possible special preference relationship" (J. A. Bikker, P.135); β_0 is deemed as a constant term while other 6 β are regarded as parameters.

Despite its popularity and strong interpretation power in applied research, the Gravity Model is still criticised for lacking sound micro-foundation, which weakens the reliability of the model considerably. According to Anderson (1979), a lack of identification in the nature of the model is perceived as a barrier for the utilisation of policies. For example, its theoretical rationality would be challenged when variables like tariff and border tax were introduced to a modification model. Berstrand (1985) considers the prediction for the potential trade flows is constrained to a great extent due to the absence of stable theoretic base. Although Leamer and Levinsohn recognise the importance of distance in explaining bilateral trade, still, "the Gravity models…lack a theoretical underpinning so that once the facts are out, it is not clear what to make of them" (Leamer and Levinsohn, 1994, p.1387). It is ironic that Deardorff (1998), Evemett and Keller (1998) and Feenstra et al. (2001) critique the model from the reverse side: It is because of too many micro-economic foundations, in other word, the model is able to derived from a large number of theories, instead of lacking micro-foundations, that lead the usage of the model to be problematical.

A growing number of variables have introduced and constantly improved the empirical model, yet the shortage of theoretical foundation is still a weak spot of the model. Being motivated by the empirical achievement of the Gravity Model, the pursuit of its theoretical basis has long been a subject of interest for economists.

Based on the Computable General Equilibrium Model (CGE), Anderson (1979), Bergstrand (1985,1989), Anderson and van Wincoop (2003,2004) have provided a solid theoretic foundation and perfected the Gravity Model. At first, Anderson(1979) rigorously deduces a simple Gravity Model by combining Cobb-Douglas function, Constant Elasticity of Substitution (CES) function with Expenditure System Model under two critical assumptions: 1) each country produces only one product and products of various regions are differentiated; 2) with CES preferences and with no tariff and transportation costs. The assumptions are obviously too strict. Anderson then builds up the trade-share-expenditure model and modifies the Cobb-Douglas' hypothesis. He postulates both importer and exporter produce two kinds of product: tradable and non-tradable goods; importers no longer have the same share of expenditures on tradable goods while the share of expenditures on exporting goods in its total tradable goods remains the same. Under the condition of trade equilibrium, the bilateral trade equation between countriesi and j is as follows:

$$T_{ij} = \frac{\alpha_i Y_i * \alpha_j Y_j}{\sum_i \sum_j T_{ij}} \qquad (3)$$

However Anderson's model explicates only balanced trade and even requires demand structure of countries is alike (Van Bergeijk and Brakman, 2010). To provide a solid theoretical foundation**,** Bergstrand (1985, 1989, and 1990) continues to utilise the CES preferences and takes the price terms as a new variable, introducing the Constant Elasticity of Transformation (CET) output function to create a partial equilibrium model, afterwards reaches a relatively complicated Gravity Model. In consequence of demand, Bergstrand includes income of importing countries while involves income of exporters to describe its deliverability. However, Bergstrand did not further explicate and deal with the intricate price index (Van Bergeijk and Brakman, 2010).

McCallum (1995) conducts a regression test in trade flows among domestic provinces in Canada and another test in trade volumes between a Canadian province and a state of the USA. A comparison of these two tests brings McCallum to a conclusion that "border effect" does exist since the trade volume in the first test is more than 22 times that of the latter, which is also called a "border puzzle". This finding inspired an impressive body of literature on "border effect", demonstrating the existence of "border effect". On the basis of the previous research and four hypotheses: 1) there is a distinction of goods by places where they originate; 2) countries concentrate their resources into making only one good; 3) consumers' preferences are the same in different countries 4) approximated by CES function; Anderson and Wincoop (2003,2004) made further efforts to re-derive and highlight the gravity equation. For best results, they applied an approach to digging deeper into price terms--separate out trade costs from item price and analyse the component factors of trade cost, for instance, the bilateral distance or free trade agreement. They drew a conclusion from the research that: 1) the "border coefficient" is not as high as what McCallum presented and that was because he took no account of the "multilateral resistance" variable; 2) Not only does the determinants associated to the country itself, but the factors linked to every other country worldwide exert influence on the trading activities between two countries.

However, the three approaches illustrated above are regarded as deficient in international trade theory, and therefore weaken the explanatory power of the model significantly. Deardorff (1995) derived the gravity equation from the H-O model. With regard to frictionless trade, since there is no trade cost and same consumer preferences among countries, the gravity equation is the same as the one adopted a Pure Expenditure System Model by Anderson (1979). As for trade with friction, it is impossible for trade costs to coexist with factor price equalisation. When the consumer preference is indicated by CES function, Deardorff was able to develop a gravity equation. He concludes that bilateral trade is relatively stronger if there are more similarities in the industrial structure and consumption pattern of the two countries (Deardorff, 1998). Ricardian Model, H-O model and Increasing Returns to Scale (IRS) model are counted as micro-foundations to bolster up the Gravity Model by Eaton and Kortum (1997) and Evenett and Keller (1998). This derivation relies on two assumptions: 1) same consumer preferences; 2) fully specialised production, to a certain extent, each country yields one product. Nevertheless the reasons for specialised production differ from theory to theory: production techniques are differentiated by regions (Ricadian Model); factor endowment varies in different countries (H-O Model); the increasing returns to scale in enterprises differs from country to country (IRS Model).

In the context of the Model of Firm Heterogeneity, scholars raise economic foundations to reinforce the Gravity Model. The geographic distance was initiated into the Gravity

Model for the purpose of assessing the conveyance costs and shipping time, more nearly, the trade costs. Grossman's investigation in 1998 elaborates that a higher transportation cost incurs more trading expenses and therefore greater reduction in trade volume. Taking it a step further, Grossman sets information cost down as a fraction of trade costs caused by distance. Owing to the presence of fixed cost, only when enterprises achieved a high degree of production efficiency could profit be generated from exporting. The fixed cost triggered by exports varies from one importer to another, and as a result, the number of trading partnership is different for export corporations. In empirical test, the "extensive margin" is measured by quantity of manufacturer combined with the number of trade partners while the "intensive margin" is calculated by the trade value of exporters (Helpman et al., 2008). The distance, in accordance with the New Trade Theory, has an influence not only on the trade volume, but also on the extensiveness and intensity of the trade.

Detailed analysis on the impacts of variable cost and fixed cost on trading scope and intensity was directed by Chaney (2008). The lower the degree of firm's heterogeneity is, the stronger the reaction of trade value to distance will be; and a higher product elasticity of substitution implies a weaker response of "extensive margin" but a more sensitive response of "intensive margin" to distance. This conclusion has already been proved by a great number of empirical studies, for example, the examination on French corporations based on layer data by Crozet and Koenig in 2010; the investigation on Swedish firms by Anderson (2007): a greater impact is produced on the "extensive margin" than its "intensive margin".

Literature Review on High-Tech Exports

Jim Bell (1997) has discussed in "A Comparative Study of the Export Problems of Small Computer Software Exporters in Finland, Ireland and Norway" the challenges faced by small companies in Finland, Ireland and Norway, which specialise in IT software. The paper investigated the financial issues surrounding the companies in this sector and the increasing financial pressure brought by higher exposure to foreign markets. It is also shown that the more involved a company is in exporting their products and services overseas, the more likely is the company affected by nonmarketing-related factors. The study finds that the public body that regulate the export policies should try to resolve the issues by offering training and support in export finance. An improved financial environment in favour of the smaller companies will also enhance these firms' capabilities overseas.

Besides the financial issues, there are a number of other challenges and obstacles that discourage the small technology firms from exporting their products and services. Bilkey (1978) proposes that among these factors, financial shortcoming is the most significant factor. However importing government's restriction, unawareness of the local sales practices, insufficient distribution channels, and absence of local market contacts are common hurdles for exporting.

Rabino (1980) further suggested that high technology firms believe the problems that affected their own decision whether to participate in exporting include the red-tape paperwork, existence of a reliable distribution partner, non-tax barriers, redemption of letter of credit, and ease of communication with suppliers. Regarding the reasons they think affecting their competitors' decision, the following were quoted: insufficient exposure or understanding of foreign cultures, mature and sizeable local market, limitation of manpower or resources, paperwork and formality as well as the difference in quality or health & Safety requirements.

Tebaldi (2011) made use of a panel data that consists of statistics from 1980 to 2008, to investigate the factors affecting the high tech exports. Among the factors, there is evidence to show that Human Capital, inward flow of foreign direct investment, and openness to international trade are the key areas which will affect the high-tech sector in a country in the international market. Institutions, on the other hand, do not seem to have a direct link to affect high-tech exports. The effects institutions have on the exports are diverted through the influence on human capital and foreign direct investment. Other factors such as gross capital formation, savings, and macroeconomic volatility are shown to have no noticeable impact on high-tech exports.The results of Tebaldi's study illustrated that the effects on high-tech exports per employee by human capital, openness to trading activities, and foreign direct investment are positive and significant statistically. This indicates that a high-tech exporter will gain from an open trading environment. This result is supported by findings of Zhu and Jeon (2007), who deduced global trading activities encourage knowledge transfer among countries and help to expand R&D activities which lead to increasing amount of high-tech exports.The positive and statistically significant coefficient of foreign direct investment indicates that high-tech exports are positively correlated to the foreign direct investment inflow. The result is supported by Zhang's (2007) findings but countered by Braunerhjelm and Thulin (2008).

The coefficients of exchange rate and inflation are statistically insignificant, indicating that the high-tech exports are not affected by exchange rate and inflation, which are macroeconomic indicators. This implies that high-tech exports are correlated to the economic environment set-up such as human capital, foreign direct investment and trade openness, instead of dynamic changes in the economy such as exchange rate and inflation (Tebaldi 2011).Also in the same paper, Tebaldi has discovered that the savings and capital formation, like exchange rate and inflation, are statistically insignificant. Combining this finding to the previous finding where human capital is shown to be a determinant, it can be concluded that high-tech exports are dependent and intensive on human capital but not capital. Barlevy (2004) has concurred in his findings.

On the topic of factors determining high-tech exports, to a certain extent, the literature still proves to be lacking. Zhang's (2007) study, although concluding that inward flow of foreign direct investments and economic infrastructure to be important variables in determining high-tech exports, is prone to issues such as specification and endogeneity, which may lead to inaccuracies or undesirable results from the OLS estimates. Srholec (2007) used a parsimonious model and derived that high-tech exports are determined by a country's technological capabilities, which are gauged by university enrolment, intellectual property copyrights, and use of computer. Srholec shows that there is a positive correlation between them and the scale of the economy has an important influence on high-tech exports. Somewhat contradictorily, Braunerhjelm and Thulin (2006) argue that the market size plays no part in determining high-tech exports and instead, the R&D investment is the main driving force that determines high-tech exports in OECD countries.

Eaton and Kortum (2001) took advantage of their series of separate work on connections among innovation, technology, trade and growth, and use technology as a medium to construct a parsimonious model of innovation, growth and trade. The impact of geographical barriers on research, as well as the impact of R&D productivity on relative incomes was investigated.Various streams of work have been conducted to examine the connection of research activity, patenting, technology diffusion and growth; and the connection of technology and trade.

Trade of high-tech products is considered by many to be an important indicator of the competitiveness of the economy in the international technology market. Falk (2009) comes to the conclusion that the proportion of high-tech exports greatly affects the growth rate of GDP. In Falk's article, he based his model on a panel data of 5-year averages for 22 OECD countries from 1980 to 2004. By GMM panel estimator, business R&D intensity and share of high-tech exports are found to be correlated to GDP per head at working age. The coefficients of these two variables imply that the R&D intensity is more influential than the share of high-tech exports in affecting the GDP per head, but share of high-tech exports is nevertheless statistically significant in determining the GDP growth.

Besides GDP growth, there are a number of other factors which will be brought about by high-tech exports. According to Spulber (2007), the market for technology in the global scope has been developing faster than the rate of international GDP growth. The model used to investigate the global technology market was focused on the topics of innovation and global trade where innovators auction their inventions both locally and internationally. Due to the nature of the products, there is differentiation between the products and they operate in a monopolistic competition market. The impacts of technology trade in the global market are economically significant and beneficial. The quality of invention result is enhanced due to the fact that the number of R&D activities is much more in the global scope than domestic, and the potential choices from which the final output is picked are more abundant. The speed at which innovation takes place also increases and number of people involved in the invention decreases. At the same time, trade in technology will bring about more trade of other products, improve product diversity and help increase total gains from trade for all participating countries.

Empirical Literature Review of Gravity Model

Being the dependent variable in the empirical gravity model, the value of bilateral trade flow is introduced more frequently in empirical study than the one expressed by quantity (UNCTAD, 2012). For example, Baldwin (1994) and Linneman (1996) use the value of trade flows between nations as the dependent variable, Rose (2000) selects the export value to analyse the common market effects on trade; Egger (2002) chooses the export value to estimate the gravity model; Chaney (2008) applies the monetary value of exports to explore the trade in differential products; Möhlmann et al. (2009) apply export value as the dependent variable to assess the impact of intangible barriers on bilateral trade.

Some economists prefer the application of geographic distance, distance calculated from capital to capital (McCallum, 1995; Paas, 2000; Antonucci and Manzocchi, 2005); Möhlmann et al. (2009) employ simple distances between cities with the largest population for trading parties while Bikker (2009) goes for distances between the largest cities of each pair of countries; Anderson and van Wincoop (2003), Head (2003) and some other authors also introduce the concept of "remoteness" to evaluate the weighted distance between a country and its trading partners. The coefficient of distance in these researches is always negative and significant.

In a sample of 12 EU members, Nitsch (2000) applied a panel dataset from 1976 to 1990 and finds that even EU is regarded as a highly integrated region, the border effects still exist. Trade costs between a pair of countries has a common border is regarded to be less than country pair that does not share a common border. A strong and positive correlation between border effects of a certain sector and the value to weight ratio of trade in that sector is perceived by Head and Mayer (2002) and Chen (2004). In empirical study, Feenstra et al. (2001), Glick and Rose (2002) and Kang and Fratianni (2006) include the common border as a dummy variable in their models.

By developing an econometric gravity model, Kepaptsoglou, Tsamboulas, Karlaftis, and Marzano (2009) analyse the impacts of free trade agreements on trade flows between EU and Mediterranean nations. The results conclude that free trade agreements occasionally produce negative effects on trade while transport cost constantly exerts principal influence on bilateral trade.

To examine the commodity trading flows across the USA, China and Brazil, Miranda, Ozaki, Mendoça Fonseca, and Moratti (2007) develop an augment model that includes trade policy factors from elementary gravity equation. A positive correlation between the trade flows and GDP and a significant but negative coefficients of those trade policy variables are presented by their analysis.

In a sample of three economic associations, EEC (European Economic Community), LAFTA (Lartin American Free Trade Association) and CMEA (Council of Mutual Economic Assistance), apart from the traditional variables, Endoh (1999) also includes variables such as population and dummy variable like members of the organisations to his empirical gravity model. He found the impacts of trade generation and diversion became smaller through the 20^{th} century. To analyse the trade flows of Eastern Asia, Filippini and Molini (2003) take the population as one of the explanatory variable as well.

Tzouvelekas and Mattas (1997) uses the gravity model to investigate how GDP per capita, remoteness of a country from its trading partner and the exchange rate volatility affect the wine trade flows across EU range from 1989 to 1997. Their empirical outcomes demonstrates a positive impacts of GDP per capita and remoteness (when exports to other destinations) on wine trade while a negative impact of remoteness (when imports from other countries) and currency depreciation on wine trade flows among the EU memberships.

Carrère (2006) and Kucera and Sama (2006) include the exchange rate to explore the impacts of regional trade agreement on trade and the influence of trade union rights on exports. Kandogan (2005) selects the real exchange rate element as one of the variables to conduct research on trade within EU memberships. The gravity model is applied by rose (2000) to exploit the impacts of exchange rate fluctuation and monetary union on intercontinental trade throughout 186 economies in 1970, 1975, 1980, 1985 and 1990. A significant positive correlation between monetary union and foreign trade is discovered from the results. However, the author concludes from the studies that the fluctuation of exchange rate has little e and adverse influences on international business.

Some authors such as Butter and Mosch (2003), Lindders et al. (2005), Egger (2012) and Novy (2013) include language as a dummy variable to describe the cultural distance with the purpose to reveal the costs generated during bilateral trade. Mélitz and Toubal (2012) discuss the impact of common official language (COL), common spoken language (CSL) and common native language (CNL) on bilateral trade and found that the correlation coefficient between COL and CSL is 0.56. They blame this on the fact that the diversity of language spoken at home is high while a wide range of residents does not speak official language(s).

CHAPTER 3 METHODOLOGY

An Overview of the Methodology

Both qualitative and quantitative approaches are included to conduct the research in this paper. On one hand, the qualitative method contains the introduction of theories and the literature reviews of high-tech exports together with the review of empirical trade gravity model. On the other hand, a list of literature has applied Gravity Model to explore the bilateral trade: scholars (for example, Kalirajan 1999; Endoh1999; Rose 2000; Nitsch 2000; Glick and Rose 2002; Egger 2004; Paas and Tafenau 2005 and Carrère 2006) use panel data while others prefer cross sectional data (for instance, Breuss and Egger, 1999; Feenstraer al. 2001; Porojan 2001; Kandogan 2005). As for the estimation technique, almost all the economists choose the Ordinary Least Squares (OLS) regression; there are also authors that conduct their empirical study by utilising OLS with fixed effects while a few studies focus on random effect. The estimation model adopted in this paper is employing OLS and fixed effects models to conduct linear regression under STATA 11.

All the empirical models that examine the determinants of high technology exports are run separately and independently without fixed effect (pooled OLS) and with various fixed effects, namely fixed time (dyear), fixed country pair (dpair), fixed both time and country pair (dyear and dpair). The reason for applying models with fixed effects is to prevent omitted variables bias generated from some absent elements; for instance, the common border factor varies across country pair but is continuous throughout time. The combination of both country pair and time fixed effects allow a deletion of omitted variable bias which is caused by not only unnoticed factors that stay unchanged over time but also omitted variables that remain the same across country pair.

This empirical study is grounded on the allocation of Finnish high technological products exports by destination countries during the period 1996 to 2010. The import countries (China, Germany, France, Italy, Japan, Netherlands, Russia Sweden, United Kingdom and United States) are the top 10 trading partners of Finland, accounting for approximately 60 per cent of Finnish total high technology exports[14]. There are seven countries from Europe, two countries from Asia plus United States. Finland became a member of EU in 1995 and its economic boom started since1996; during 1996 and 2010, Finland suffered from two major economic downturn including the ones in 2002 and global financial crisis in 2008, and the proportion of high technology exports in Finnish total exports was impacted as well. All figures used in the analysis are annual amount. In summary, there will be one dependent variable and 15 explanatory variables included in the research.

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[14] *Foreign Trade Pocket Statistics 2000-2011 (Finnish Trade in Figures).Available at: http://www.tulli.fi/en/finnish_customs/statistics/publications/pocket_statistics/index.jsp*

Empirical Gravity Model with Six Clusters of Determinants

This paper is applying an Original Gravity Model with 6 Augmented Gravity Models. Six groups of different factors, namely, Market Scale, Transport and Transaction Cost, Information Cost, Labour Market, Global Integration Level and Technology Level, are introduced to the original gravity equation respectively. A pooled OLS model and model with fixed time effects and fixed country pair effects and both time and pair fixed effects will be applied in the empirical study.

Model 1 The original gravity empirical equation could be yielded from equation (1) as followed:

$$lnhtexp = \alpha + \beta_1 lnimpgdp + \beta_2 lnfigdp + \beta_3 lndist \qquad (4)$$

where (the same as the following equations),
α refers to the constant;
β refers to the coefficient of the independent variables;
ε refers to the error term.

Model 2 When including market scale factor (population), which is also derived from equation (2):

$$lnhtexp = \alpha + \beta_1 lnimpgdp + \beta_2 lnfigdp + \beta_3 lndist + \beta_4 lnimppopu + \beta_5 lnfipopu + \varepsilon \qquad (5)$$

Model 3 When including transport and transaction cost factors (REER and common border as dummy variable):

$$lnhtexp = \alpha + \beta_1 lnimpgdp + \beta_2 lnfigdp + \beta_3 lndist + \beta_4 lnimpreer + \beta_5 lnfireer + \beta_6 Border + \varepsilon \qquad (6)$$

Model 4 When including information cost factors (language, EU member, OECD member):

$$lnhtexp = \alpha + \beta_1 lnimpgdp + \beta_2 lnfigdp + \beta_3 lndist + \beta_4 Language + \beta_5 EU + \beta_6 OECD + \varepsilon \quad (7)$$

Model 5 When including labour market factors (unemployment rate and GDP per capita):

$$lnhtexp = \alpha + \beta_1 lnimpgdp + \beta_2 lnfigdp + \beta_3 lndist + \beta_4 lnimpun + \beta_5 lnfiun + \beta_6 lnimpgdppc + \beta_7 lnfigdppc + \varepsilon \quad (8)$$

Model 6 When including factors measured global integration level (trade freedom and openness index):

$$lnhtexp = \alpha + \beta_1 lnimpgdp + \beta_2 lnfigdp + \beta_3 lndist + \beta_4 lnimpoi + \beta_5 lnfioi + \beta_6 lnimptrfr + \beta_7 lnfitrfr + \varepsilon \quad (9)$$

Model 7 When including factors measured technology level (percentage of R&D expenditure in GDP and number of total patents):

$$lnhtexp = \alpha + \beta_1 lnimpgdp + \beta_2 lnfigdp + \beta_3 lndist + \beta_4 lnimprdgdp + \beta_5 lnfirdgdp + \beta_6 lnimptpat + \beta_7 lnfitpat + \varepsilon \quad (10)$$

Data Description and Data Processing

Htexp --- (Export of High technology Products from Finland)***:*** The high-tech explosion has generated a flood of invention, resulting in a larger and larger proportion of high technological trade in the world merchandise trade. At present two approaches are popularised in defining and classifying high technology commodities, they are Advanced Technology Products (ATP) classification that represented by the USA and Standard International Trade Classification (SITC) that put forward by OECD and adopted by most of the European countries. This study adopts the SITC system since the catalog statistics are in relation to the analysis of its memberships and the foremost research targets are the members of OECD and European Union. Another primary reason for applying the OECD characterisation is that it itemises high technology merchandises by the intensity of Research and Development (R&D), achieving a more accurate category of the high technological industry (Wu, n.p.). The SITC Revision 3 was utilised by the Finnish Customs before year 2007 and the SITC Revision 4 is enabled since 2007. There are nine categories under high technology commodities, they are: Aerospace, Armament, Chemistry, Computers-Office Machines, Electrical Machinery, Electronics-telecommunications, Non-Electrical Machinery, Pharmacy and Scientific Instruments.

In this paper, the value of high technology goods exported from Finland to its chief trading partners serves as the dependent variable. The figure of the export value range from 1996 to 2002(based on SITC Rev.3), and from 2007 to 2010 (based on SITC Rev.4) measured in unit of euro is collected from the Finnish Customs Database (Uljas). As for the export values of Finnish high technology in year 2003,2004,2005 and 2006 that are not available online, I obtain it from the Finnish Customs personnel.

impgdp, figdp --- (Gross Domestic Product (GDP))***:***GDP of the 10 high-tech importers of Finland and Finland's GDP. GDP is considered as a proxy for the scale of the economies. The nominal GDP is usually selected by scholars (McCallum 1995; Rose 2007; Bikker 2009; Möhlmann et al. 2009). As nominal GDP better reflects a country's total output while real GDP is often utilised to describe a country's economic growth rate, this study selects the nominal GDP at current price measured in unit of US dollar. Data of GDP for both Finland and its trading companions from 1996 to 2010 is gained from the World Bank.

dist --- (Geographical Distance): the bilateral distance is regarded as another critical independent variable to weigh the trade costs in the empirical studies of gravity model. For the measurement of physical distance, the statistics of simple distance (from capital to capital) between Finland and its export countries applied in this paper is gathered from Great Circle Distances Between Capital Cities of World measured in kilometres.

imppopu, fipopu --- (population***):*** population of importers and Finland respectively. Population is another element that applied to measure the mass of bilateral countries. The estimation model in this paper will embrace the population as an element as well; data on total population is collected from the World Development Indicators (WDI).

border --- *(Common Border):* Sharing a common border with Finland is represented by "1", otherwise, with "0". In this paper, data on common border is acquired from CEPII.

impreer, fireer --- *(Real Effective Exchange Rate****):*** the REER of the ten importers and Finland. Exchange rate is taken as an explanatory variable by some scholars to investigate international trade between regions. In this paper, the REER will be included for the reason that this index is a weighted-average exchange rate that weights the proportion of external trade. Based on the World Bank definition, the inflation is eliminated when calculating the REER index. Depreciation in a country's REER signifies the fall range of its national currency is larger than that of the country's trading companions, which denotes an increase of the country's commodity in world competitiveness. That is, depreciation in a country's REER is advantageous to its export trade. The REER index applied in this paper is collected from the World Bank and takes 2005 as base value 100 and scale other years accordingly.

language --- (Common Spoken Language): Having the common spoken language as Finland is represented by "1", otherwise, by "0". In this research, common spoken language rather than common official language will be integrated to the model. With respect to CSL, as what Melitz (2008) has done, all languages are expected to be spoken by 4 per cent or more of all residents in Finland and its trading partners. The data are collected from Centre d'EtudesProspectivesetd'InformationsInternationales (CEPII).

EU --- (*European Union Membership)*: being a member of EU is represented by "1" otherwise is signified with "0". A lot of scholars have introduced EU membership as a dummy variable to the gravity model: Porojan (2001) utilises EU membership to evaluate the spatial effects on the gravity model; Antonucci and Manzocchi (2006) include EU-membership as one of the dependent variables to explore the trading relationship among Turkey and countries in European Union; EU membership plays as a critical explanatory variable to assist Sarkera and Jayasinghe (2007) measure the relationship of regional trade agreements and trade;. The EU membership variable will be considered in this paper as well; the data on EU membership is obtained from EU website.

OECD --- (*Organisation for Economic Co-operation and Development):* as a dummy variable, "1" represents the country is a member of OECD while "0" embodies the importer is not a member of OECD. Members of OECD work together to tackle the challenges brought by globalisation. Kang and Fratianni (2006) investigate the impacts of OECD member and religion on trade by involving the OECD variable. The data on OECD member countries included in this paper is collected from OECD website.

impun, fiun --- (*Unemployment Rate)*: the unemployment rate of Finland's exporting destinations and Finland. To measure the labour market, this paper is planning to involve the unemployment rate of Finland and its trading partners. Egger (2004) investigates the regional trading bloc effects by exploiting the ratio of high and low skilled labour to transport costs. Figures on unemployment rate of Finland and its exporting countries are achieved from the World Bank.

***impgdppc, figdppc* ---** (GDP per capita): it represents the average GDP per head of the population, and is an indicator of the average income of the same group of people. Figures on GDP per capita applied in this thesis are collected from the World Bank.

impoi, fioi --- (Openness Index): the openness index of Finland’s trading companions and Finland. The openness index is contained in the empirical model as an explanatory variable. It indicates the degree of opening up to the outside world and the level of market opening. The openness index is the indicator of the combination of total export and import over GDP. Sarkera and Jayasinghe (2007) and Park,I and Park, S (2008) introduce the openness index to their gravity empirical model. The data on overall export and import, and GDP that use to calculate openness index is gained from the World Bank.

imptrfr, fitrfi --- (*Trade Freedom)*: the trade freedom index of importers and Finland. Non-tariff barriers and trade-weighted average duty rate are taken into account during the formation of the trade freedom index. It exercises influence over trade between countries. The Heritage Index of trade freedom used in this paper is available on the Heritage Foundation Website.

imprdgdp, firdgdp* ---** (Research and Development Expenditure as a percentage of GDP):*** the percentage of R&D expenditure in GDP of importing countries and Finland. It based on the World Bank definition; expenses for research and development are costs on innovative work conducted to intentionally enhance knowledge, which comprises more than humanity, culture and society, as well as the ability to apply knowledge to new areas of use. R&D is relevant in basic research, practical research as well as experimental development. Data on the percentage of R&D expenditure in GDP is obtained from the World Bank measured in per cent.

imptpat, fitpat* ---** (Total Patents):*** the number of total patents of the ten high technology importers and Finland. Being a crucial measurement value of innovation productivity and the degree of technologies dispersion, patent is attached more and more importance.

To assess the technology output, this paper includes the total patents into the empirical model. Figures on total patents are collected from OECD measured in unit.

Variables listed above are categorised by the author into 6 clusters, which has been displayed in Table 5:

Table 5 Six Clusters of Determinants of Finnish High-Tech Exports

Categories	Variables
Market Scale	Population
Transport and Transaction Cost	Real Effective Exchange Rate (REER), Common Borders
Information Cost	Common Spoken Language, European Union Members, OECD Members
Labour Market	Unemployment Rate, GDP per capita
Global Integration Level	Openness Index, Trade Freedom Index
Technology Level	R&D Expenditure as a percentage of GDP, Total Number of Patents

In principle, variables are not required to be in normal distribution when conducting linear OLS regression; however, skew distribution in dependent variable is often a cause for the abnormal distribution of residuals (Stock and Watson, 2007). Moreover, it is simpler to conduct a log-linear OLS regression than non-linear one. With an aim to enhance the validity of the result, this paper analyses the issues by taking into account the normality. As far as dependent variable (htexp) is concerned, both numeric and graphic displays are presented below.

Table 6 Transformation of htexp (Displayed by Numeric Results)

Transformation	Formula	Chi2 (2)	P (chi2)
cubic	htexp^3	.	0.000
square	htexp^2	.	0.000
identity	htexp	42.40	0.000
square root	sqrt(htexp)	9.55	0.008
log	log(htexp)	7.17	0.028
1/(square root)	1/sqrt(htexp)	40.11	0.000
inverse	1/htexp	66.96	0.000
1/square	1/(htexp^2)	.	0.000
1/cubic	1/(htexp^3)	.	0.000

It has been illustrated from Table 6 that the log transformation of htexp has the smallest chi^2, say 7.17, signifying that the log transform of htexp is the closest approach to normal distribution. By applying histogram plot, Figure 7 and Figure 8 graphically illustrate the distribution of htexp and lnhtexp (log form of htexp) respectively. Evidently the log form of the dependent variable gets closer to normal distribution. Therefore, in the following empirical study, the dependent variable (htexp) adopts its log transform. With regard to the independent variables, for example the GDP of Finland's trading partners (impgdp); its log transform is similar to normal distribution as well. The log transform of all the independent variables (excluding the dummy variables) will be used. However neither the graphic nor the numeric results of its distribution testing will be presented here. Their log transform will be again used as well. One other thing worth mentioning is the panel data is strongly balanced in all the estimated models.

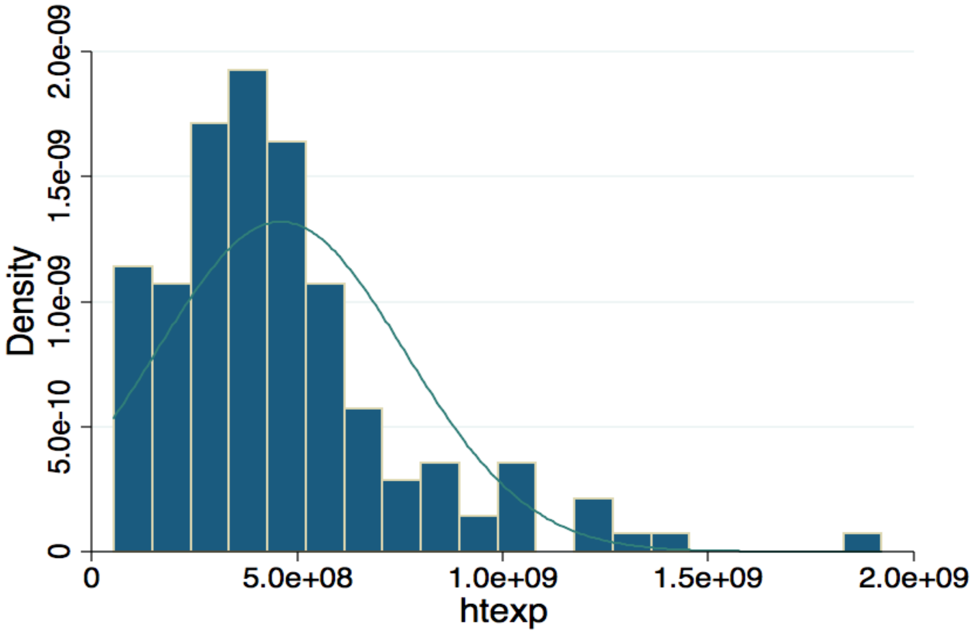


Figure 7 Graphic Display of the Distribution of htexp

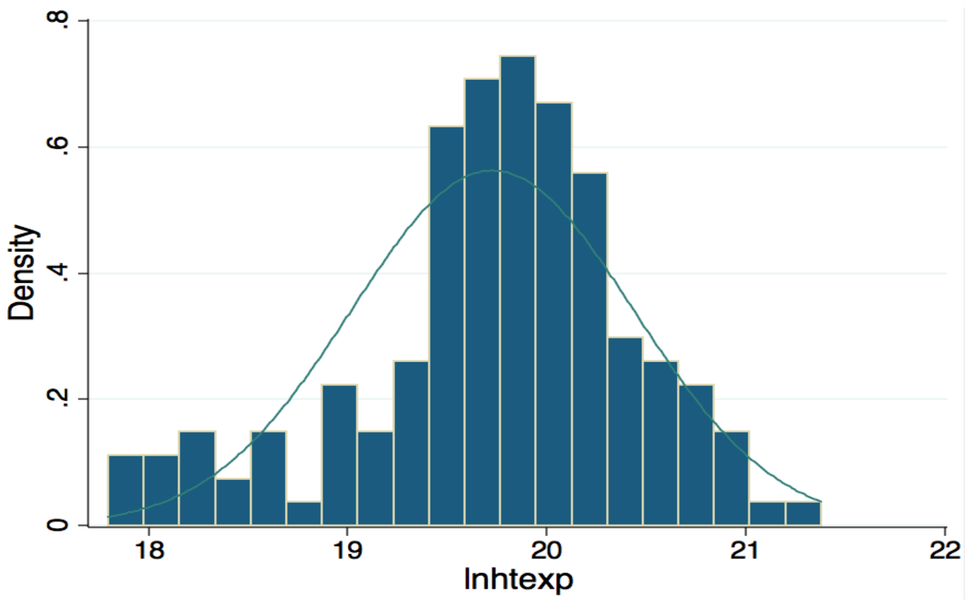


Figure 8 Graphic Display of the Distribution of lnhtexp

Figure 9 displays the variations in Finnish high technology exports to its 10 major trading partners from 1996 to 2010, which is conducted by STATA 11. The horizontal axis shows year ranged from 1996 to 2010 while the vertical axis represents the value of high technology exports from Finland measured in euro. From the graph it is evident that Finnish high-tech exports to its chief trading partners (except Japan) achieved a significant growth since it became a member of the EU. In relation to Japan, the precipitous drop in high-tech imports from Finland in 1997 was attributed to the explosion of Asian economic crisis. What is also worth noticing is that being an Asian country as well, China was just slightly affected, which was largely thanks to its "pegging to US Dollar" exchange rate regime. As can be seen from the Figure 9, Finnish high-tech exports to its trading destinations have been on a downward trend since the onset of crisis in 2008.

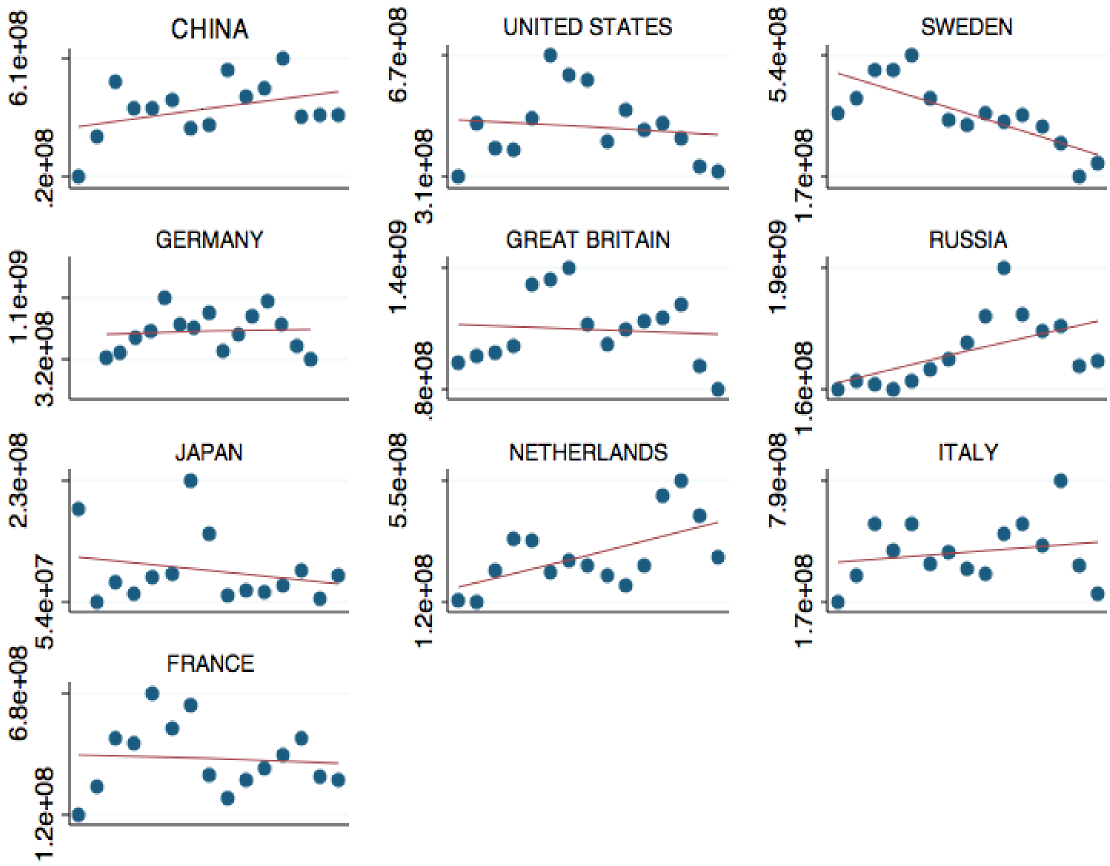


Figure 9 Finnish High Technology Exports by Destination Countries 1996-2010

Figure 10 presents the value of Finnish high-tech exports to its major exporting destinations varies with distance, conducting under STATA 11. One of the conclusions drawn from the Gravity Model is the inverse relation between bilateral trade flows and bilateral distance. As is shown in Figure 10, from overall perspective, the closer the proximity between Finland and its high technology export destinations, the greater is the amount of the trade between Finland and that importer; and vice versa. Still, the nearest country (Sweden) in the group does not the one import the most from Finland, but the furthest destination in the group (Japan), imports the least. Thus it follows that while distance might play a role on the bilateral high technology trade, it is by no means the only factor.

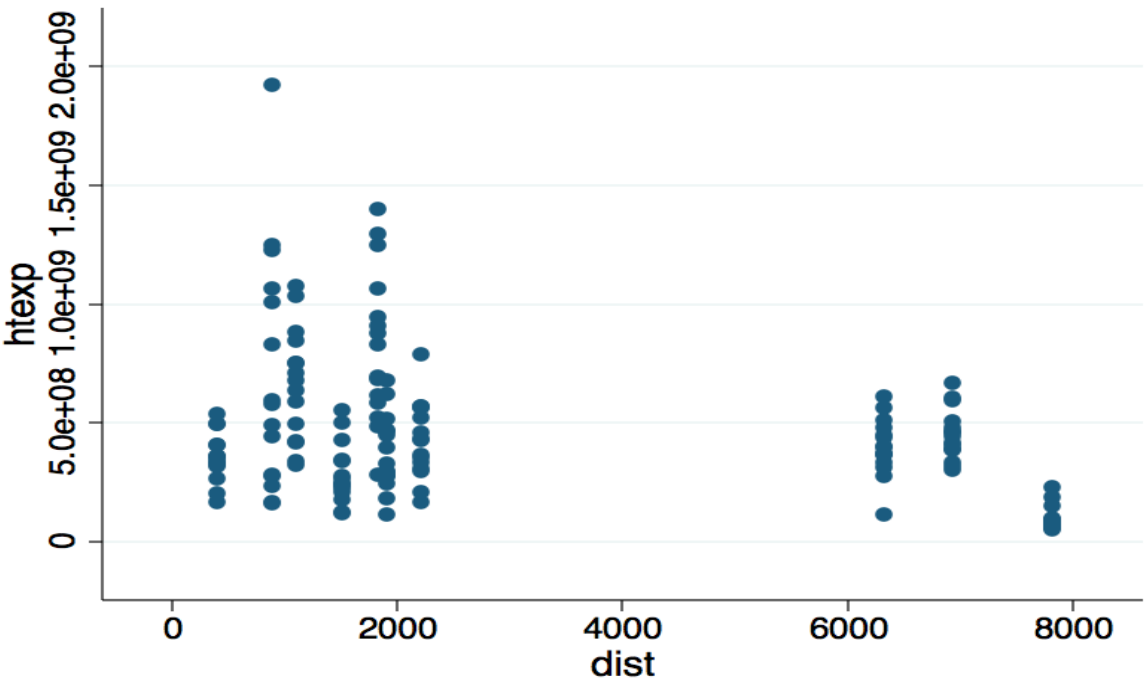


Figure 10 Finnish High Technology Exports by Distance

Table 7 Test of Multicollinearity and Heterokedasticity for Empirical Models

		1	2	3	4	5	6	7
VIF Test	Mean VIF	2.34	4.80	2.01	3.11	10.00	3.45	6.17
	Max VIF	3.01	7.55	3.36	4.54	32.32	5.84	11.69
White Test	Probability	0.000	0.001	0.000	0.400	0.000	0.011	0.002

With regard to the empirical investigation of the pooled OLS and various fixed effects models, it has been illustrated by the Table 7 that the mean of VIF are below 10 and the maximum VIF of most models are less than 10, indicating multicollinearity does not exist in the model. However the maximum VIF of Model 7 slightly exceeds 10 while Model 5 has a noticeably higher VIF, which signifies the existence of multicollinearity. Despite this, the VIF value is still acceptable for a small-size dataset. Conducting White Test enables us to diagnose if heteroskedasticityexists in the models. It is evident that the probability of homoscedasticity for all the models (except Model 4) is low, suggesting the existence of significant heteroskedasticityin the models. To deal with heteroskedasticity, this paper simply introduces the Robust approach, for both pooled OLS and fixed effects models.

Empirical Results and Analysis

Table 8 Empirical Results of Model 1

	Without Fixed Effect	With Fixed Effect		
	OLS	dyear*	dpair*	dyear*dpair*
lnimpgdp	0.395	0.404	0.682	0.781
	(0.000)	(0.000)	(0.001)	(0.000)
	(5.500)	(6.160)	(3.440)	(4.760)
lnfigdp	-0.262	-0.333	-0.560	-0.698
	(0.196)	-0.342	(0.018)	(0.005)
	(-1.320)	(-0.950)	(-2.400)	(-2.860)
lndist	-0.604	-0.613	-0.757	-0.879
	(0.000)	(0.000)	(0.003)	(0.000)
	(-5.99)	(-6.250)	(-3.070)	(-4.260)
Constants	22.768	23.370	23.117	24.227
	(0.000)	(0.000)	(0.000)	(0.000)
	(20.09)	(12.760)	(15.510)	(16.820)
Adjusted R-Squared	0.230	0.353	0.666	0.794
Number of Obs.	150	150	150	150

Dependent variable: log of high-tech exports; Significance level: 5%.

Table 9 Empirical Results of Model 2

	WithoutFixed Effects	With Fixed Effects		
	OLS	dyear*	dpair*	dyear*dpair*
lnimpgdp	0.384	0.393	0.639	0.721
	(0.000)	(0.000)	(0.002)	(0.000)
	(5.680)	(6.610)	(3.170)	(4.570)
lnfigdp	0.384	0.334	-0.493	-0.452
	(0.506)	(0.325)	(0.206)	(0.077)
	(-0.640)	(-0.990)	(-1.270)	(-1.780)
lndist	-0.930	-0.938	1.963	3.160
	(0.000)	(0.000)	(0.412)	(0.045)
	(-8.910)	(-9.640)	(0.820)	(2.030)
lnimppopu	0.318	0,317	-3.351	-4.778
	(0.000)	(0.000)	(0.205)	(0.006)
	(6.050)	(6.350)	(-1.270)	(-2.770)
lnfipopu	0.543	omitted	3,630	omitted
	(0.953)		(0.692)	
	(0.060)		(0.400)	
Constants	11.302	20.161	4.248	75.658
	(0.936)	(0.000)	(0.974)	(0.000)
	(0.080)	(11.470)	(0.030)	(4.200)
Adjusted R-Squared	0.393	0.5155	0.671	0,805
Number of Obs.	150	150	150	150

Dependent variable: log of high-tech exports; Significance level: 5%.

Table 10 Empirical Results of Model 3

	Without Fixed Effects	With Fixed Effects		
	OLS	dyear*	dpair*	dyear*dpair*
lnimpgdp	0.357	0.371	0.174	0.444
	(0.000)	(0.000)	(0.523)	(0.053)
	(5.120)	(5.540)	(0.640)	(1.950)
lnfigdp	-0.118	-0.322	0.052	-0.428
	(0.543)	(0.353)	(0.867)	(0.116)
	(-0.610)	(-0.930)	(0.170)	(-1.580)
lndist	-0.636	-0.648	-0.123	-0.459
	(0.000)	(0.000)	(0.719)	(0.107)
	(-6.050)	(-6.250)	(-0.360)	(-1.620)
common border	-0,.97	-0.191	omitted	omitted
	(0.260)	(0.257)		
	(-1.130)	(-1.140)		
lnimpreer	0,316	0.369	1.339	0.957
	(0,549)	(0.527)	(0.017)	(0.065)
	(0.6000)	(0.630)	(2.410)	(1.860)
lnfireer	-5.302	omitted	-5,738	omitted
	(0.004)		(0.000)	
	(-2.950)		(-3.920)	
Constants	45.586	22.177	39.383	17.862
	(0.000)	(0.000)	(0.000)	(0.000)
	(5.990)	(8.520)	(5.640)	(5.230)
Adjusted R-Squared	0.275	0.360	0.713	0.800
Number of Obs.	150	150	150	150

Dependent variable: log of high-tech exports; Significance level: 5%.

Table 11 Empirical Results of Model 4

	Without Fixed Effects	With Fixed Effects		
	OLS	dyear*	dpair*	dyear*dpair*
lnimpgdp	0.678	0.692	0.682	0.781
	(0.000)	(0.000)	(0.001)	(0.000)
	(8.650)	(10.670)	(3.440)	(4.760)
lnfigdp	-0.555	-0.612	-0.560	-0.698
	(0.000)	(0.015)	(0.018)	(0.005)
	(-3.450)	(-2.460)	(-2.400)	(-2.860)
lndist	-0.454	-0.466	-1.232	-1.415
	(0.000)	(0.000)	(0.001)	(0.000)
	(-4.750)	(-5.710)	(-3.300)	(-4.690)
language	0.468	0.464	0.282	0.360
	(0.000)	(0.000)	(0.186)	(0.043)
	(4.780)	(5.560)	(1.320)	(2.040)
EU	1.124	1.131	-0.343	-0.323
	(0.000)	(0.000)	(0.026)	(0.01)
	(7.380)	(8.090)	(-2.25)	(-2.560)
OECD	-1.842	-1.855	omitted	omitted
	(0.000)	(0.000)		
	(-11.110)	(-11.790)		
Constants	21.601	22.122	27.040	28.604
	(0.000)	(0.000)	(0.000)	(0.000)
	(23.240)	(15.720)	(11.240)	(14.110)
Adjusted R-Squared	0.573	0.701	0.666	0.794
Number of Obs.	150	150	150	150

Dependent variable: log of high-tech exports; Significance level: 5%.

Table 12 Empirical Results of Model 5

	Without Fixed Effects	With Fixed Effects		
	OLS	dyear*	dpair*	dyear*dpair*
lnimpgdp	0.778	0.781	0.799	0.801
	(0.000)	(0.000)	(0.006)	(0.004)
	(9.550)	(9.450)	(2.800)	(2.910)
lnfigdp	-1.221	-0.463	-1.250	omitted
	(0.009)	(0.172)	(0.001)	
	(-2.66)	(-1.370)	(-3.350)	
lndist	-1.064	-1.067	-0.884	-0.893
	(0.000)	(0.000)	(0.000)	(0.000)
	(-9.150)	(-9.020)	(-5.160)	(-5.470)
lnimpun	-0.241	-0.244	-0.305	-0.311
	(0.084)	(0.088)	(0.149)	(0.143)
	(-1.740)	(-1.720)	(-1.450)	(-1.480)
lnfiun	-2.455	omitted	-2.494	omitted
	(0.001)		(0.000)	
	(-3.410)		(-4.530)	
lnimpgdppc	-0.490	-0.490	-0.174	-0.133
	(0.000)	(0.000)	(0.717)	-0.779
	(-7.700)	(-7.530)	(-0.360)	(-0.280)
lnfigdppc	-0.878	omitted	-1.239	omitted
	(0.439)		(0.157)	
	(-0.780)		(-1.420)	
Constants	35.693	28.932	34.336	20.737
	(0.000)	(0.000)	(0.000)	(0.000)
	(4.390)	(14.750)	(5.810)	(5.270)
Adjusted R-Squared	0.502	0.527	0.787	0.800
Number of Obs.	150	150	150	150

Dependent variable: log of high-tech exports; Significance level: 5%.

Table 13 Empirical Results of Model 6

	Without Fixed Effects	With Fixed Effects		
	OLS	dyear*	dpair*	dyear*dpair*
lnimpgdp	0.815	0.843	0.665	0.872
	(0.000)	(0.000)	(0.004)	(0.000)
	(7.680)	(8.250)	(2.970)	(4.270)
lnfigdp	-0.570	omitted	-0.584	omitted
	(0.111)		-0.080	
	(-1.600)		(-1.770)	
lndist	-0.814	-0.846	-0.700	0.872
	(0.000)	(0.000)	(0.005)	(0.000)
	(-8.510)	(-9.240)	(-2.890)	(-4.190)
lnimpoi	0.624	0.613	0.101	0.157
	(0.000)	(0.000)	(0.798)	(0.689)
	(3.840)	(3.760)	(0.260)	(0.400)
lnfioi	1.451	omitted	1.789	omitted
	(0.007)		(0.000)	
	(2.740)		(4.570)	
lnimptrfr	-1.346	-1.481	0.221	-0.246
	(0.000)	(0.000)	(0.618)	(0.566)
	(-3.580)	(-4.750)	(0.500)	(-0.580)
lnfitrfr	-1.185	omitted	-1.300	omitted
	(0.455)		(0.278)	
	(-0.750)		(-1.090)	
Constants	35.089	26.692	28.666	21.197
	(0.000)	(0.000)	(0.000)	(0.000)
	(5.540)	(18.890)	(6.010)	(12.690)
AdjustedR-Squared	0.424	0.516	0.717	0.795
Number of Obs.	150	150	150	150

Dependent variable: log of high-tech exports; Significance level: 5%

Table 14 Empirical Results of Model 7

	Without Fixed Effects	With Fixed Effects		
	OLS	dyear*	dpair*	dyear*dpair*
lnimpgdp	0.540	0.585	0.780	0.870
	(0.000)	(0.000)	(0.001)	(0.000)
	(4.530)	(4.980)	(3.540)	(4.770)
lnfigdp	-0.877	-0.466	-1.090	-0.730
	(0.000)	(0.063)	(0.000)	(0.004)
	(-3.890)	(-1.880)	(-4.310)	(-2.960)
lndist	-0.893	-0.905	-0.956	-0.939
	(0.000)	(0.000)	(0.004)	(0.001)
	(-11.420)	(-12.130)	(-2.910)	(-3.570)
lnimprdgdp	-1.188	-1.132	-0.430	-0.172
	(0.000)	(0.000)	(0.456)	(0.757)
	(-5.570)	(-5.310)	(-0.750)	(-0.310)
lnfirdgdp	-0.022	omitted	-0.322	omitted
	(0.976)		(0.586)	
	(-0.030)		(-0.550)	
lnimptpat	0.177	0.135	0.032	-0.072
	(0.123)	(0.239)	(0.854)	(0.690)
	(1.550)	(1.180)	(0.180)	(-0.400)
lnfitpat	1.192	omitted	1.421	omitted
	(0.012)		(0.000)	
	(2.550)		(3.610)	
Constants	17.782	24.544	16.916	25.035
	(0.000)	(0.000)	(0.000)	(0.000)
	(6.290)	(17.140)	(5.100)	(14.600)
AdjustedR-Squared	0.565	0.627	0.730	0.797
Number of Obs.	150	150	150	150

Dependent variable: log of high-tech exports; Significance level: 5%.

The 7 models are conducted to evaluate the relationship of the dependent variable - the export of high technology products from Finland, and various parameters, including GDP of the 10 high-tech importers of Finland, Finland's GDP, geographical distance, population, existence of common border, real effective exchange rate, common spoken language, European Union membership, membership of OECD, unemployment rate, openness index, trade freedom, R&D expenditure as a percentage of GDP, and total number of patents. The significance level has been taken at 5 per cent for all models, and in the tabulated summary the first line is coefficient, second line is p value and third line is t statistics. Since the omitted variables bias arising by country pair effects in this dataset are considered to be severer, the analysis below mainly focuses on the examination and comparisons between pooled OLS model and models with country-pair fixed effects.

The results received largely corroborate with the derivations of gravity theory model. The GDP of 10 high-tech importers of Finland is shown to be positive in all models, and distance of the country to Finland is shown to be negative in almost all the models. Although Finnish GDP is negative in some models and positive in others, in many of the models it is shown to be statistically insignificant and cannot be considered as an explaining variable. However, in some models, Finnish GDP is negatively correlated. A potential explanation of this phenomenon is that Finland during the estimation period is a highly capable and efficient high tech producer. In the climate of a lower GDP - translating into a weaker domestic demand - a falling GDP encourages high tech service to shift from domestic market to overseas, thus a higher export volume.

In model 1 where only 3 basic independent variables are considered, namely GDP of importers, GDP of Finland, and bilateral distance between Finland and its trading partners. In this model, GDP of importers is consistently estimated to be positive in all 4 models, and shown to be statistically significant. With regards to the fixed time and country pair effects model, it indicates for the country pair fixed effects model, when controlling other two variables, a 10 per cent increase in importers' GDP leads to 6.8 per cent increase in Finnish high technology exports to the certain country. Similarly, the distance to Finland is shown to be statically significant and estimated to be negatively correlated to high-tech export volume with elasticity of negative 0.757: a 10 per cent reduction in distance contributes to an increase in Finnish high-tech exports of 8.79 per cent when other two variables are controlled. The GDP of Finland, on another hand, is estimated to be negative. However it is only statistically significant under the models with fixed effect of country pair, or both time and country pair. This shows that the explanatory power of the Finnish GDP is not always strong and to a certain extent negatively correlated to the high tech export volume. The coefficient of these three independent variables are much higher in country-pair fixed effects model than those in pooled OLS and it deserves to be mentioned that the Finland GDP variable is significant in the former model while insignificant in the pooled OLS model. The Adjusted R-squared is highest at 0.794 when the model is run with fixed effect in both time and country pair, and second highest with fixed effect in country pair only at 0.666.

In model 2, when extending the variables from simply the ones focused on by gravity model, to include parameters such as population in importing countries and of Finland, the Adjusted R-squared increased in all conditions, with highest 0.805 in the model with fixed effects of both time and country pair. In the estimation of these variables line-up, GDP of importing countries is again consistently estimated to be positive and statistically significant. Distance from Finland is estimated to be negative in condition without fixed effect and with fixed effects of only time; but positive under the other fixed effects conditions. However, in the latter cases the p value is significantly higher than the former two and the coefficient was statistically insignificant in one and marginally significant at 5 per cent in another, which GDP of Finland is statistically insignificant in all 4 estimations. Regarding the two newly introduced population variables, Finland's population was estimated to be statistically insignificant, and importing countries population is estimated to be positive without fixed effect and with fixed effects of time, and negative with fixed effects of both time and country pair.

In model 3, the effects of common border and exchange rate are assessed together with model 1's variables. The gravity model variables still follow the same trend, with GDP of importing countries positive and statistically significant, and distance to Finland negative and statistically significant, and GDP of Finland statistically insignificant in most cases. The introduced variables vary in their explanatory power, common border is shown to be statistically insignificant and real effective exchange rate of importing countries is statistically significant under fixed effects of country pair, and estimated to be positive. Real effective exchange rate (REER) of Finland is the most significant one statistically, and estimated as negative, shown to be inversely correlated to the high-tech export volume. This denotes that a 10 per cent depreciation of Finland's REER encourages a 5.3 per cent increase in its high technological exports. This model also has a relatively high Adjusted R-squared value, with the highest 0.80 in the estimation with fixed effects of both time and country pair.

In model 4, where information cost is considered, common spoken language, membership of EU and OECD respectively, has been introduced for estimation. The gravity model variables are following previous path and shown to be positive for importing country GDP, negative for Finland GDP, and negative for distance to Finland. The noticeable difference in this model though, regarding these 3 variables, are that they are all estimated under all conditions to be statistically significant. This again may reflect the role played by Finland GDP, where a weaker GDP encourages export overseas. The common spoken language, is estimated to be indeed positively correlated to the high-tech export volume, and shown to be statistically significant in all conditions other than fixed effects of country pair. Likewise for membership of EU and OECD, both are shown to be statistically significant. However for the EU membership, the coefficient is estimated to be positive under 2 conditions and negative under others. OECD membership is estimated to be negative. The Adjusted R-squared value is again rather high at 0.79 with fixed effects of time and country pair, and 0.57 without fixed effects.

In model 5, labour market variables are introduced. However unemployment rate in importing countries does not seem to be statistically significant in affecting the export volume. Unemployment rate in Finland, on the other hand, have a negative effects on the high-tech export, and shown to be statistically significant, implying an increase of 1 per cent in unemployment rate causes 2.46 per cent decrease in Finnish high-tech exports. GDP per capita in importing countries and Finland are shown to be insignificant statistically in most cases, however the GDP per capita does seem to negatively impact high-tech export sometimes. The Adjusted R-squared is in the range of 0.50 to 0.80 depending on whether fixed effects are considered.

In model 6, factors that measured global integration level are investigated. Openness index in importing countries, as well as in Finland, are estimated to have a positive impact on the high-tech export of Finland, and shown to be statistically significant in most estimation, reflecting an increase of 1 per cent in openness degree for Finland and its exporting destinations contributes to 1.45 per cent and 0.62 per cent to Finnish high technology exports respectively. However the trade freedom in importing countries is estimated to have a negative impact on the export volume in some instances, while the trade freedom in Finland does not seem to be significant factor. The Adjusted R-square is in the similar region as previous models between 0.42 and 0.80.

In model 7, the level of technology is considered. R&D expenditure in Finland does not seem to affect the export volume as it is shown to be statistically insignificant. However the R&D expenditure in importing countries is estimated under OLS regression to be negatively impacting the high-tech export from Finland. Implying those who spend more on their own R&D progress tend to import less from Finland. Interestingly, the number of patents in importing countries does not have an effect on the dependent variable, but the number of patents in Finland has a positive correlation to the export volume. The Adjusted R-squared is in the range of 0.57 to 0.80.

Overall, the gravity model is shown to be largely supported by the various models conducted, with the exception of the Finland GDP. However, as previously suggested, this might be due to the fact that high tech sector is a particularly strong part of the economy, where the supply is ample and quality is high. Therefore the export volume is boosted in a low GDP period instead due to the shift of domestic consumption to overseas. The various parameters introduced in different models have their strength and weaknesses in explaining the gravity model. However it is clearly displayed with the consideration of other economic and even cultural and demographic variables, gravity model is held up with solid evidence in terms of importing countries GDP and distance from Finland. After comparison, the introduction of information costs, labour market and high technological level improves the explanatory power of the basic gravity model. However, the explanation strengths and the significant degree are weaker and lower for models with market scale, transport cost and the global integration elements. But it is worth mentioning that the residuals of all the 7 OLS models are normal distributed.

Adjusted Gravity Model and Analysis

By applying a stepwise regression, this part is going to present an adjusted gravity model that has stronger explanatory power of analysing the determinants on Finnish high-tech exports. Pooled OLS regression and the same dataset are used, including the independent variables like population in importers, R&D as a percentage in GDP in import countries, the REER and trade freedom index of Finland's trading destinations and unemployment rate in Finland. Common spoken language is also considered as a dummy variable in this adjusted model. The expression of the empirical adjusted model is as followed:

$$lnhtexp = \alpha + \beta_1 lnimpgdp + \beta_2 lnfigdp + \beta_3 lndist + \beta_4 lnimppopu + \beta_5 lnimprdgdp + \beta_6 lnimpreer + \beta_7 lnimptrfr + \beta_8 lnfiun + \beta_9 language + \varepsilon \quad (11)$$

Table 15 Test of Multicollinearity and Heteroskedasticity for Adjusted Model

		VIF	1/VIF
VIF Test	lnimpgdp	8.83	0.11
	lnfigdp	3.35	0.29
	lndist	4.36	0.23
	lnimppopu	8.37	0.12
	lnimprdgdp	2.24	0.45
	lnimpreer	1.19	0.84
	lnimptrfr	5.45	0.18
	lnfiun	3.07	0.33
	language	1.69	0.59
	Mean VIF	4.28	
Heteroskedasticity White Test	Probability	0.0003	0.0003

It is demonstrated by Table 15 that the value of VIF for each variables are less than 10 and the 1/VIP are less than 1, indicating the non-existent of multicollinearityin this model. However when referring to the heteroskedasticityWhite Test, the null hypothesis (homoscedasticity exists in the model) is rejected, which requires the model to be revised. To avoid the influence resulted from heteroskedasticity, this paper adopts the robust regression.

Table 16 Pooled OLS Regression Result of Adjusted Gravity Model

	Coef.	Std. Err	t - stat	P>|t|	[95% conf. Interval]	
lnimpgdp	0.350	0.070	4.970	0.000	0.211	0.490
lnfigdp	-1.435	0.212	-6.750	0.000	-1.855	-1.015
lndist	-0.804	0.070	-11.530	0.000	-0.941	-0.666
lnimppopu	0.294	0.058	5.060	0.000	0.179	0.409
lnimprdgdp	-1.021	0.092	-11.090	0.000	-1.203	-0.839
language2	0.586	0.082	7.140	0.000	0.424	0.748
lnfiun	-1.987	0.320	-6.200	0.000	-2.620	-1.353
lnimpreer	0.901	0.427	2.110	0.037	0.056	1.746
lnimptrfr	0.919	0.209	4.400	0.000	0.506	1.333
constants	12.801	2.468	5.190	0.000	7.922	17.679
Adjusted R-squared		0.731	F(9,149) = 46.19			
Number of Obs.		150.000				

Dependent variable: log of high-tech exports; Significance level: 5%.

Table 16 has presented the empirical results of the adjusted gravity model by employing a pooled OLS regression approach. The panel data in this case is strongly balanced as well. On the whole the Adjusted R-squared accounts for 73.1 per cent of the Model, which means it has relatively high explanatory power. The F test is significant at 5 per cent significant level, indicating this gravity equation is expressive. P value for the independent variables are all significant at 5per cent significance level and apart from the REER in importing countries, other variables are even significant at 1 per cent significant level. Specifically, GDP of Finnish trading partners is estimated to be positive in this model and is in accordance with the assumption of empirical gravity model. It implies that when controlling the other variables, an increase of 10 per cent in importers' GDP leads to 3.5 per cent growth in Finnish high tech exports. The bilateral distance, as expected, is estimated to be negatively correlated to the Finnish high-tech exports. However, due to the same potential reasons suggested previously, the coefficient of Finland's GDP in this equation is still valued as negative as the previous 7 models. The population in import countries, which is applied to measure the demand of market, is positively and significantly correlated to Finnish high-tech exports, denoting a rise of 10 per cent in population of import countries brings 2.9 per cent increase for Finnish high-tech exports when other variables are controlled. The common spoken language, the REER and trade freedom of Finland's major trading associates have statistically significant contribution to Finnish high-tech exports. The percentage of R&D in GDP of import countries and the unemployment rate of Finland both have negative effects on the high-tech export, and shown to be statistically significant, which is in line with the economic principles.

Figure 11 and Figure 12 examine the normality of residuals for this model. Figure 11 provides an intuitive graph, showing the normal density of the residual. As can be seen from Figure 11, the residuals are not perfectly normally distributed. The above graph under Figure 12 is the pnorm command graph while the one at the bottom is a qnorm command graph, indicating there is a slight deviation from normal distribution. However, it is acceptable to consider the residuals as normally distributed.

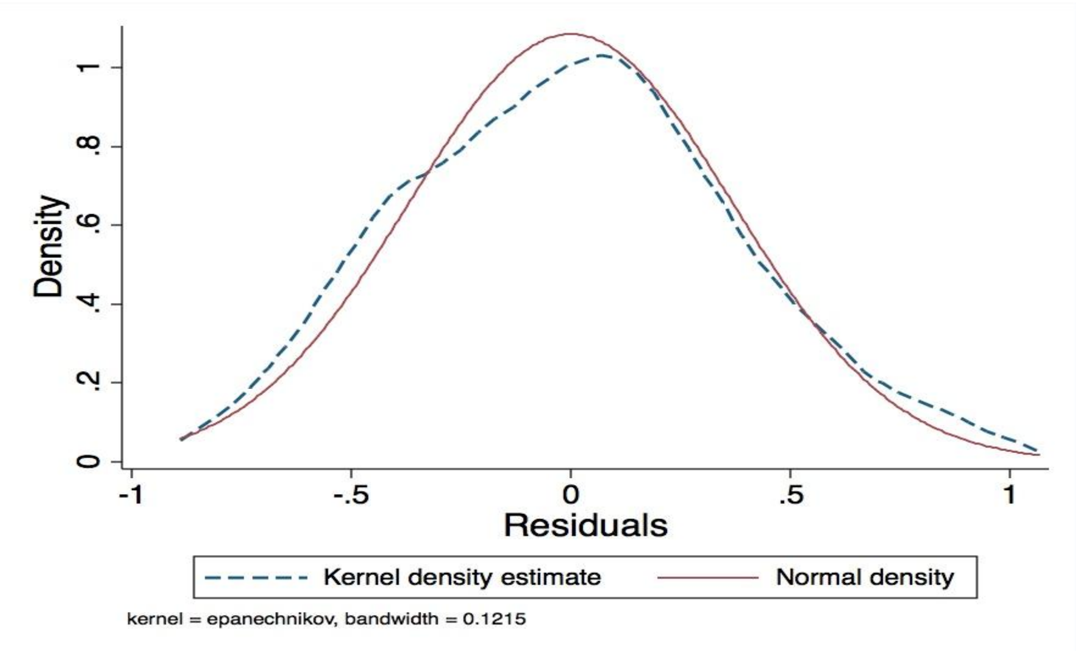
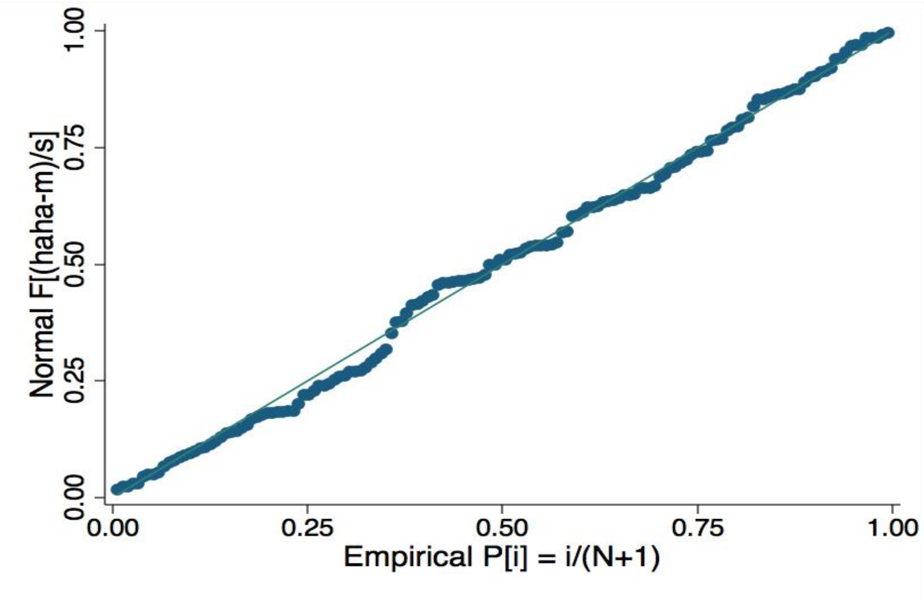
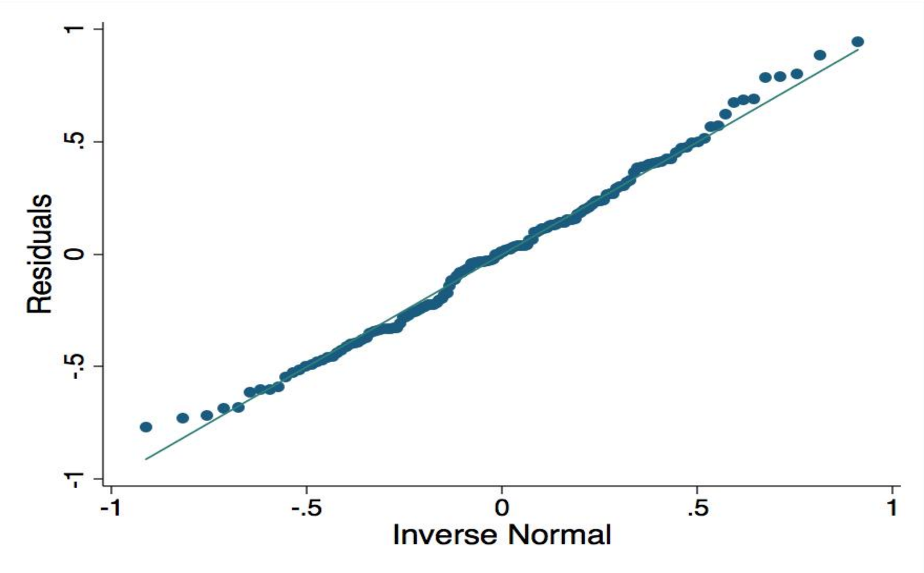


Figure11 Kernel Density Estimation of the Residual



pnorm



qnorm

Figure 12 Testing Residual Distribution with pnorm and qnorm Command

In summary, the Finnish high-tech exports corroborate with the Gravity Model to a large extent. The determinants included in this equation are all statistically significant, generating impacts on Finnish high technological exports to various degrees. This gravity equation will continue to be examined in next section, exploring the Finnish high-tech export potentials to Chinese Market.

Case Study

Being one of the most destitute countries in the world, China's constant GDP in 1978 was a mere 689.52 billion Yuan. In 1986 – eight years later -- its GDP passed one trillion Yuan for the first time and in the number doubled by 1985 and reached 4147.75 Billion Yuan in 1997. The Asian Financial Crisis which broke out in 1997 did not prevent China from developing at a dazzling pace; its GDP continued to grow strongly and made a historic breakthrough in 2007—surpassing 10693.20 billion Yuan. Despite the slowdown brought by the 2008 Global Financial Crisis to China's growth, its constant GDP still increased to 12803.68 billion Yuan in 2009 and was even over 15000 billion Yuan in 2011. China's real GDP has experienced an average annual growth at 9.4 per cent during year 2008 and 2011. Meanwhile, its share of world GDP skyrocketed from 1.8 per cent in 1978 to 10.0 per cent in 2011, ranked as the second largest in the world behind only the U.S.A[15].

The more than three decades' implementation of export-oriented development strategy has made a positive contribution to China's economic growth and social progress. The percentage of China's foreign trade in its GDP is presented in Figure 13.Overall, the proportion of the total volume of Foreign Trade in China's current GDP has seen a sharp increase from 1995 to 2006, growing from 38.66 per cent to a record high of 65.17 per cent respectively. It is noteworthy that after being a member of the World Trade Organisation (WTO) in 2001, the growth in foreign trade of China remained by 20 per cent annual for six consecutive years and the volume of foreign trade tripled (rose from 4.218 trillion Yuan in 2001 to 14.097 trillion Yuan in 2006). Influenced by the Global Financial Crisis, the contribution of foreign trade to China's GDP decreased to a certain extent (57.29 per cent in 2008, 44.19 per cent in 2009 respectively). However, it recovered quickly after 2009, contributing 50.24 per cent to China's economic growth.

[15]The terms of GDP in this sentence refer to GDP calculated by current prices. The information of the rank obtained from Wikipedia, available at: http://en.wikipedia.org/wiki/List_of_countries_by_GDP_(nominal).

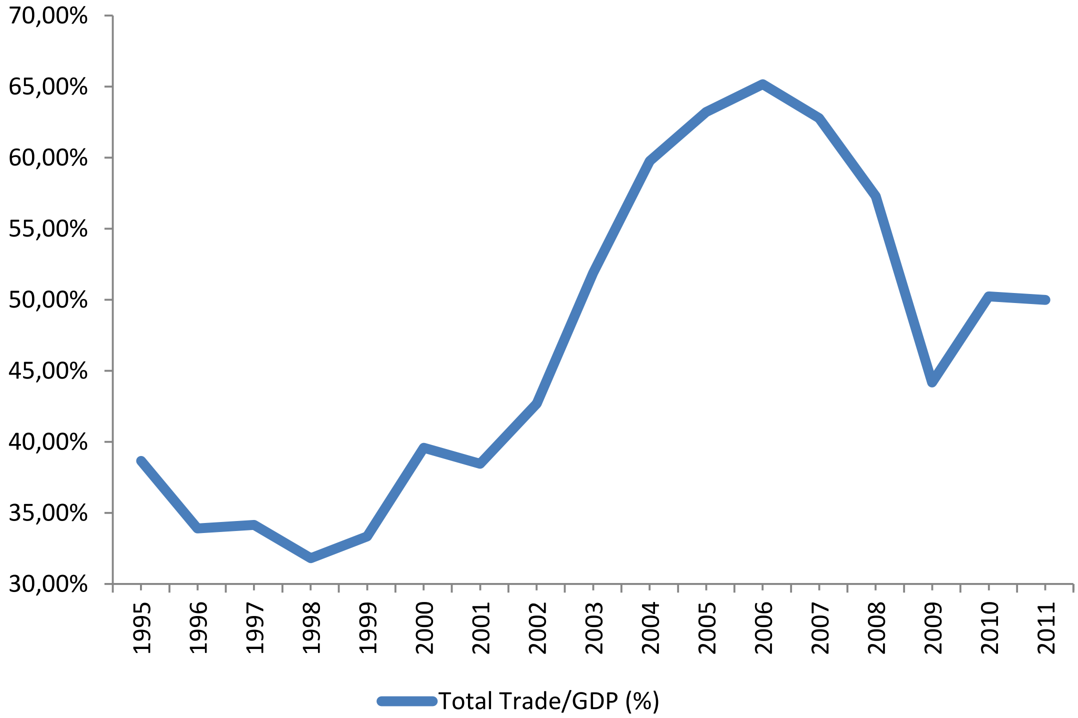


Figure 13 Contribution of Foreign Trade to China's GDP from 1995 to 2011(%)

Source: own calculation by collecting data from the Chinese Statistical Bureau.

China's mercantilist trade policies have long placed emphasis on exporting and in contrast to this, overlooked the importance of importing, which has brought China a series of problems: relying too heavily on overseas market demands; significantly expanding the scale of both trade surplus and foreign exchange reserves; becoming an anti-dumping object; worsening trade frictions with trade partners. Figure 14 shows the trade surplus/GDP ratio of China, which can representatively reflect China's balance of payments account to a certain extent. China's large amount of surplus began to emerge in 2005, rocketing from 320.9 hundred million dollars in 2004 to 1020.0 hundred million dollars in 2004[16]. It was in 2005 that China's trade surplus/GDP ratio sprinted through 4 per cent for the first time, reaching an astonishing 4.5 per cent. In 2007, this ratio peaked at a remarkable 7.5 per cent, with 2643.3 hundred million dollars surplus. The disequilibrium in trade has been exerting pressure on China to appreciate its currency. However, as can be seen from Figure 14, after 2007, the trade surplus/GDP

[16]Figures on GDP of China and its value of foreign trade are available at National Bureau of Statistics of China.

ratio is declining gradually year after year, hitting 3.1 per cent with 1815.1 hundred million dollars in 2010 and the ratio is still slipping downwards. The reduction in China's trade surplus /GDP ratio in the context of a sustained rise in GDP was attributed to not only the fading external demand but also a greater emphasis on imports. Among various imported products, China is seeking an expansion of high-tech imports to complete the process of "import-imitate-innovate". By keeping on enhancing imports, China is seeking to adjust its economic development structure to a more healthy level. However, the trade restrictions established by the USA and other developed European countries withhold Chinese imports in high-tech commodities.

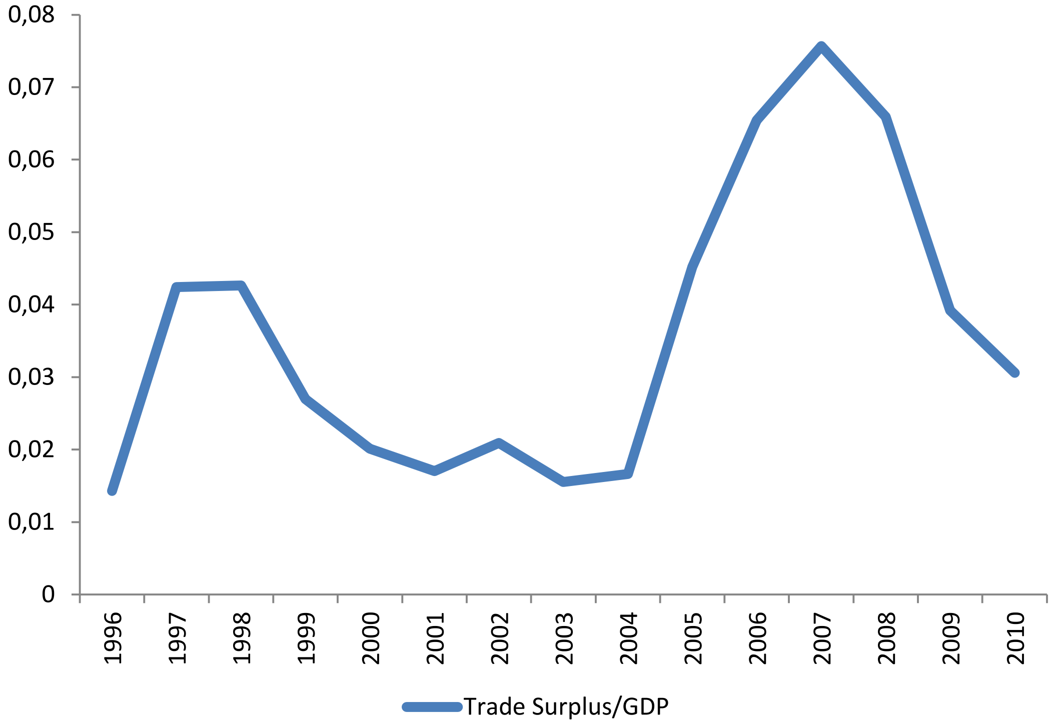


Figure14 The Trade Surplus/GDP Ratio of China

Source: Figures on trade balance and GDP are collected from National Bureau of Statistics of China; all the data are measured in US dollar at current prices.

On 28 October 1950 diplomatic relations between Finland and China were established and following that, the two countries initiated their bilateral trade. In the first few years, China imported some traditional products from Finland but did not export anything to Finland until the bilateral trade agreement was signed in 1953. On one hand, the clear trend of globalisation combined with the growing economic potential in Asian markets tempted Finland to increase its emphasis on Asia. On the other hand, the reform and implementation of opening-up policy have assisted China to achieve tremendous accomplishment in social development and economic growth, attracting attention from across the world. These two factors have led to a boost in economic and technological cooperation between Finland and China and their bilateral trade volumes. Sweden, Germany and Russia have historically been the three largest trading partners with Finland while China has grown to the fourth largest importer and the sixth largest exporter to Finland in recent years.

Figure 15 illustrates the development of commodity trade between Finland and China. Finland's total trade in goods with China was 806.5 million euro in 1996, equivalent to 1.46 per cent of the Finnish total trade. The total amount continued to climb year on year until the first drastic decline in 2009 after the financial crisis took effects from 643.1 million euro in 2008 to 533.2 million euro in 2009; however the percentage of trade with China in Finland's total trade increased, which is due to the decline in Finnish total exports[17].

In terms of high technological products trading, China has a better performance. Being under mounting pressure to appreciate Chinese Yuan after the global financial crisis, the government re-evaluated its trade policies and has begun to attach greater significance to imports, broadening its import scope, especially imports of high-tech products, by adopting a series of measures. And the fact is, acting as the largest high technological products importer from Finland for more than 4 years in succession; China also ranked at the second and third place as the high-tech products exporter to Finland in 2010 and 2011. Figure 16 has presented Chinese historical imports of high-tech commodities from Finland. The amount of Finnish high-tech exports to China was only 115 million euro in 1996 but rocketed to 610 million euro in 2007. The financial crisis decreased Chinese imports of high technology commodities from Finland, falling to 371 million euros in 2010.

[17]Figures on value of Finnish total trade in commodity measured in euro are collected from Finnish Customs database.

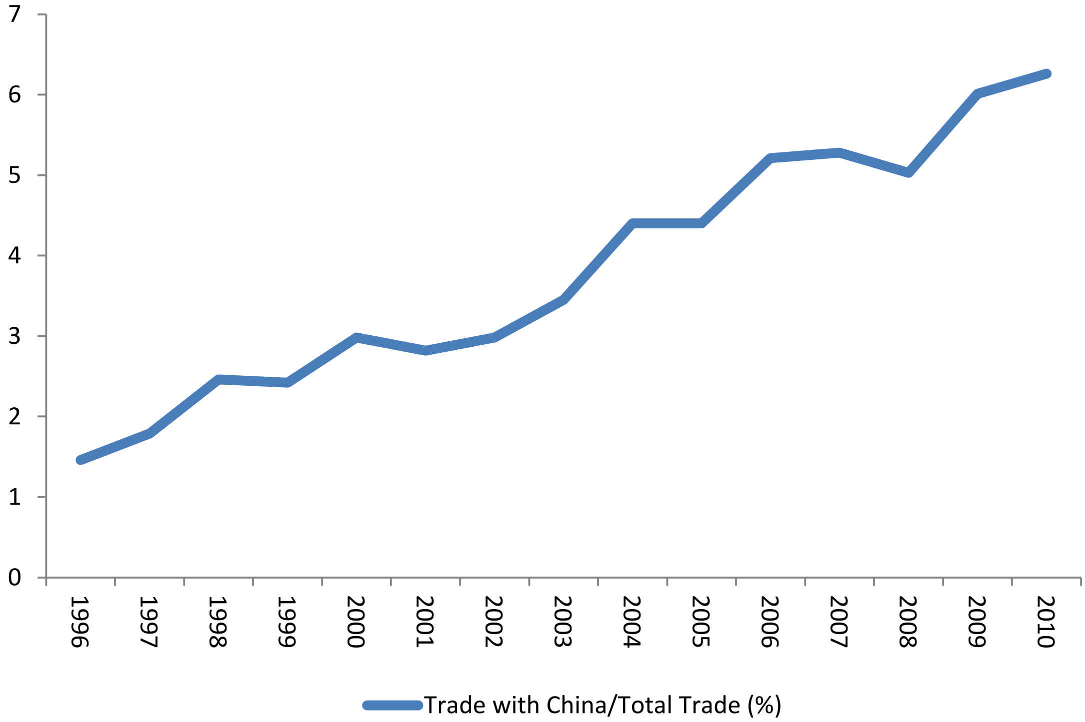


Figure 15 Finland's Commodity Trade with China

Source: Finnish Customs Database (ULJAS) under SITC revision 3 and revision 4.

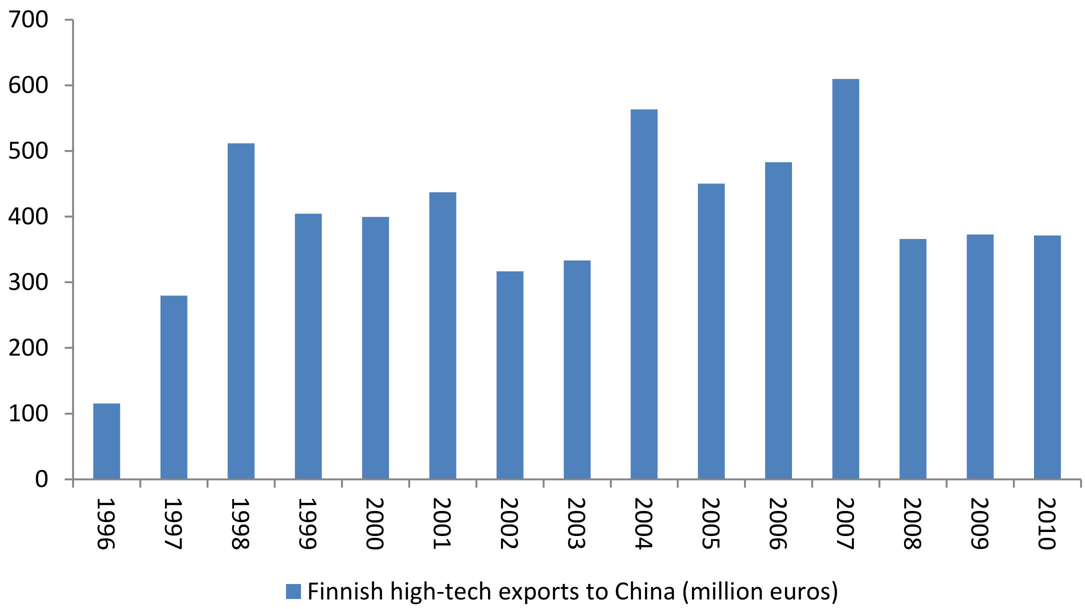


Figure 16 Finland's High -Tech Exports to China

Source: Finnish Customs Database (ULJAS) under SITC revision 3 and revision 4.

Table 17 Accumulated Finnish High-Tech Exports to China by Groups (euro)

Aerospace	6473428
Armament	1114931
Chemistry	16129536
Computers-office Machines	229016794
Electrical Machinery	108284965
Electronics-Telecommunications	4954184265
Non-electrical Machinery	91477238
Pharmacy	9699265
Scientific Instruments	596367726

Source: own calculation by collecting data from Finnish Customs database according to OECD definition based on SITC.

Table 17 lists the 15 years' (1996-2010) accumulated value measured in euro of Finnish high technology exports to China by classifications. Electronic-telecommunications goods accounted for the largest proportion of Chinese high-tech imports from Finland, reaching to 4954184 thousand euros while Armament products being the smallest component.

To assess the export opportunities of high-tech commodities to Chinese market, two approaches are adopted. One is the introduction of Reveal Comparative Advantage (RCA) with the purpose of analysing comparative advantage of selected products from Finland and China; the other one is an application of the Adjusted Gravity Model presented in the previous section.

The concept of RCA was put forward in 1965 by Balassa and has been extensively applied to evaluate the performance of specific commodities in different countries for decades. The measurement of RCA is presented below:

$$RCA_{c,x}=\frac{Exp_{c,x}}{Exp_{c,w}}*\frac{TExp_x}{TExp_w} \qquad (12)$$

where,

$RCA_{c,x}$ refers to the revealed comparative advantage index of commodity c for country x;

$Exp_{c,x}$ refers to the exports of commodity c of country x;

$Exp_{c,x}$ refers to the whole world's exports of commodity c;

$TExp_x$ indicates the total commodity exports of country x;

$TExp_w$ indicates the world's total exports of commodity.

The interpretation of RCA index is straightforward. The country is considered to have a revealed comparative advantage in a particular commodity if the corresponding RCA index is greater than 1. This suggests that the share of a certain product in a country is higher than the one in the world. The popularity of utilising RCA index is due to its reflection of a commodity's essential advantage and its consistency with the country or the world's production. However, not taking into account the policy factor is the greatest disadvantages in the application of RCA (Batra and Khan, 2005).

Table 18 RCA Index of Specific Commodities of Finland and China in Selected Years

Finland	2000	2005	2008	2009	2010	2011
Medical and Pharmaceutical Products	0.33	0.41	0.42	0.45	0.56	0.69
Chemical Materials and Products, n.e.s.	0.64	0.60	0.65	0.45	0.84	0.93
Telecommunication and Sound Recording Apparatus	4.42	3.53	3.15	1.91	1.16	0.96
Electrical Machinery, Apparatus and Appliances, n.e.s.	0.53	0.55	0.63	0.59	0.57	0.66
Office Machines and Automatic Data Processing Machines	0.15	0.19	0.19	0.18	0.16	0.19
Metal Working Machinery	0.65	0.63	0.81	0.80	0.80	0.83

China	2000	2005	2008	2009	2010	2011
Medicinal and Pharmaceutical Products	0.43	0.20	0.23	0.21	0.23	0.23
Chemical Materials and Products, n.e.s.	0.61	0.63	0.72	0.62	0.67	0.68
Telecommunication and Sound Recording Apparatus	1.69	2.82	3.01	2.98	2.88	3.01
Electrical Machinery, Apparatus and Appliances, n.e.s.	0.97	1.31	1.57	1.50	1.51	1.57
Office Machines and Automatic Data Processing Machines	1.28	3.33	3.65	3.55	3.56	3.60
Metal Working Machinery	0.43	0.46	0.75	0.79	0.69	0.64

Source: the value of total trade in commodity for Finland and China are collected from Word Bank; data of specific products exports is collected from "open data for morocco" website, available at: http://morocco.opendataforafrica.org/czlfbqf?tsId=1002680.

Table 18 has demonstrated the RCA index of selected high technological commodities in selected years of Finland and China. The categories listed in Table 18 are in the light of the SITC Rev.4 classification. It is evident that the RCA index for Finland's medical and pharmaceutical products is increasing while the ones of China is declining with years; this means that Finland is getting stronger comparative advantage in these products but China, conversely, does not process the comparative advantage in these products in the world market. The development of Chemical materials and products of Finland seem to make great process since 2010, the relevant RCA jumped from 0.45 in 2010 to 0.84 in 2010 and even 0.93 to 2011; there is a real possibility that these Finnish commodities have comparative advantages in the next year. When compared with the case in China, Finland is of clear advantage. It is interesting to see a converse trend between Finland and China in terms of the telecommunication and sound recording apparatus. In 2000 the RCA index of Finland was as high as 4.42, which is a very distinct advantage throughout the world; however, as the challenges faced with the strongest supporter of Finland's telecommunication industry, Nokia, are increasingly stark, the RCA index of this area dropped sharply to 1.91 in 2009 and 0.96 in 2011. Meanwhile, China's fast developing economy and technology together with the relatively lower labour cost have endowed China with a comparative advantages all over the world. For the rest of products listed in Table 18, when examining the market potential, Finland does not have a comparative advantage over China in relation to electrical machinery, apparatus and appliances nor office machines and automatic data processing machines but have a comparative advantage of metal working machinery over China. However, it should be noticed that the products shown below are just some selected high-tech products; this paper continues to evaluating the high-tech export opportunities of China for Finland.

The predicted regression equation could be derived from the results of the adjusted gravity model posted in Table 16, the equation is expressed as:

$$lnhtexp = 12.8 + 0.35lnimpgdp - 1.43\ lnfigdp - 8.75lndist + 0.29lnimppopu - 1.02lnimprdgdp + 0.90\ lnimpreer + 0.92\ lnimptrfr - 1.99lnfiun + 0.58\ language + \varepsilon \quad (13)$$

In this paper the predicted value of high-tech exports from Finland to China is observed by focusing on the parameters of the regression. The actual-to-potential export ratio is employed to estimate the export potential. In this case, the ratio of Finnish high technology exports to China in 2010 is equal to 1.05. Liu and Jiang (2002) classified the actual-to-potential export ratio into three levels. If the ratio is greater than 1.2, the export potential is very limited and approximate saturated while the export potential is regarded as huge if the ratio is lower than 0.8, in this case, the trading parties are suggested to break down the trade impediments to facilitate trading. As for the actual-to-potential ratio of Finnish high technology exports to China, which is 1.05, it indicates that the high technology export potentials to China is not huge but there is still scope for development. To expand the high technology exports, Finland and China are expected to overcome the high technology trade restrictions and improve coordination and cooperation in their efforts to achieve growth and bilateral benefits, and exploit the full potential.

CONCLUSION

Owing to the export-oriented and technology-driven policies carried out in Finland in the early 1980s, combined with the rapid rise of Finnish electronic and communications industries after the deep slump in the early 1990s, Finland's high-tech trade has been strengthened significantly. The high-tech trade has accounted for more than 10 per cent in Finland's total trade for years, even the poor economic performance during the economic crisis could not sway it. However the long lasting surplus in Finnish high-tech trade was first broken in 2010, when the unfavourable trade balance reached to a record of 578 million euros. Specifically, owing to the economic storm which took place in 2008, the share of electronics-telecommunications commodity exports in total high-tech exports fell dramatically from 80.56 per cent (92 million euros) in 2007 to 58.23 per cent (31 million euros) in 2010 while other groups of high-tech commodity have been on slight recovery in 2010.

This paper applies a gravity model approach to evaluate the determinants of Finnish high-tech exports from 1996 to 2010 by considering Finland's 10 largest high-tech export countries, which have been contributing to roughly 60per cent of Finnish high technology exports in total. Apart from the basic gravity model (Model 1 in this paper), the independent variables have also been categorised into 6 groups to generate 6 augmented gravity models, they are Market Scale (Model 2), Transportation and Transaction Cost (Model 3), Information Cost (Model 4), Labour Market (Model 5), Global Integration Level (Model 6) and Technology Level (Model 7). All the 7 models are conducted with a pooled OLS regression, regression with entity fixed effects, time fixed effects and both entity and time fixed effects. The empirical results largely testify to the derivations of gravity theory model: the GDP of importers is positively while the bilateral distance is negatively correlated to Finnish high-tech exports. However Finnish GDP in some cases is shown as insignificant or negatively significant. This might be interpreted as the declining demand at home motivates manufacturers in high-tech sectors to export their commodities overseas. Overall, variables of information costs, labour market and high technological level have stronger explanatory power and more statistically significant in explaining the determinants of Finnish high-tech exports among the 6 augmented gravity models.

This paper then develops an adjusted gravity model to estimate the determinants of Finnish high technology exports. GDP of importers, GDP of Finland, bilateral distance, population of import countries, percentage of R&D in GDP of Finland's exporting destinations, REER of importers, trade freedom degree of the 10 importers, unemployment rate of Finland are included as independent variables while common spoken language is introduced as dummy variable into the adjusted gravity model. This adjusted R-squared in this model is 0.73, explaining 73 per cent of the Finnish high-tech exports. The variables mentioned above are all statistically significant. The empirical study illustrates that a 10 per cent increase in GDP of Finland's major trading partners leads to 3.5 per cent growth in Finnish high technology exports while a rise in distance of 10 per cent causes 8 per cent decline in Finnish high-tech exports. The coefficients in population, trade freedom and RRER of importers and sharing a common spoken language are tested to be statistically significant while the coefficients of the rest variables are negative.

In the case study, this adjusted gravity model is employed to assess the potential opportunities of high-tech commodities in Chinese market for Finland by using the 2010 data. The actual-to-predict ratio of high-tech exports from Finland to China in 2010 is calculated to be 1.05. Taking the actual-to-predict ratio and the comparison in RCA index for high-tech goods into consideration, the author reaches the conclusion that Finland does not have great high-tech export potentials to Chinese market. Therefore, to extend the Finnish high-tech exports to China, Finland is suggested to excavate the potentialities of high-tech products that possess comparative advantages over China and, more importantly, to explore and identify new areas of growth opportunities than dwelling in traditional products.

LIMITATION

As for the time and data limitation, the panel variables in this paper are the 10 largest high-tech importers of Finland, which account for 60 per cent of Finland's high technology exports, while the time variable are from the year of 1996 to 2010. If the number of observations could be expanded to account for more than 90 per cent of its exports, the regression models are able to have stronger explanatory power. Since the value of Finnish high-tech for all the trading partners are collected from Finnish customs online database in accordance with the classification of SITC rev.3 and SITC rev.4. Some specific products have zero trade in some years, for example, there are no data available for Aerospace products exported from Finland to China during 1996 and 2001, or Armament (STIC code: 891) exports in 1998, 2002, 2010, or pharmacy products exported from Finland to China in 1996 either. There were Aerospace products exported from Finland to China in 2002, with 1489 thousand euros, it was assumed that the trade flows in the previous year exists based on background research and knowledge, however the customs officers explained that there was no exports data for these products. Although data for other countries are all available and it could be estimated that the value of lacked data is small, the regression results were still impacted by this to a small extent.

Specifically, with regard to the measurement of trade cost, this paper adopts the capital-to-capital distance. However, since the estimated observations include large countries like Russia, China, and the USA who have more than two major cities, the explanatory power of distance as a measurement of trade cost is lowered. For the Model 5 and Model 7, from the VIF value we know that multicollinearity exists. However, considering independent variables in these two models are not large in number, stepwise regression was not applied to take out the relevant variables that caused the multicollinearity.

When applying the RCA index to evaluate the comparative advantage in Finland and China, it would be ideal to list all the 9 groups which were classified by OECD according to SITC to better analyse the comparative advantages of the whole high-tech industry. However, the data in China is not available in Chinese statistical offices. This is because SITC is popular used across European countries while China applies the ATP classification more often.

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APPENDICES

Appendix 1 Classification of High-Tech Based on SITC Revision 3

1. Aerospace
792 = Aircraft and associated equipment, excluding 7928, 79295, 79297
714 = Aeroplanemotors, excluding 71489, 71499
87411= Othernavigationalinstruments
2. Computers – Office machines
75113 = Word-processingmachines
7513 = Photo-copyingapparatusexcluding 75133, 75135
752 = Computers: excluding 7529
75997 = Parts and accessories of group 752
3. Electronics – Telecommunications
76381 = Video apparatus
76383 = Other sound reproducingequipment
764 = Telecommunicationsequipmentexcluding 76493, 76499
7722 = Printedcircuits
77261 = Electrical boards and consoles 1000V
77318 = Optical fibrecables
77625 = Microwavetubes
77627 = Othervalves and tubes
7763 = Semi-conductordevices
7764 = Electronic integrated circuits and micro-assemblies
7768 = Piezo-electriccrystals
89879 = Numericrecordingstays
4. Pharmacy
5413 = Antibiotics
5415 = Hormones and theirderivatives
5416 = Glycosides, glands, antisera, vaccines
5421 = Medicaments containing antibiotics or derivatives thereof
5422 = Medicaments containing hormones or other products of heading 5415
5. Scientificinstruments
774 = Electro-diagnostic apparatuses for medicine or surgery and radiological apparatuses
871 = Optical instruments and apparatuses
87211 = Dentaldrillengines
874 = Measuring instruments and apparatuses excluding 87411, 8742
88111 = Photographiccameras
88121 = Cinematographiccameras
88411 = Contactlenses
88419 = Optical fibres other than those of heading 7731

8996 = Orthopaedicappliancesexcluding 89965, 89969

6. Electricalmachinery

7786 = Electrical capacitors, fixed, variable or adjustable excluding 77861, 77866, 77869

7787 = Electrical machines having individual functions

77884 = Electric sound or visual signalling apparatus

7. Non-electricalmachinery

71489 = Othergasturbines

71499 = Part of gasturbines

7187 = Nuclear reactors and parts thereof, fuel elements etc..

72847 = Machinery and apparatus for isotopic separation

7311 = Machine-tools working by laser or other light or photon beam, ultrasonic electro-discharge or
electro-chemicalprocess

7313 = Lathes for removing metal excluding 73137, 73139

73142 = Otherdrillingmachines, numericallycontrolled

73144 = Other boring-milling machines, numerically controlled

73151 = Milling machines, knee-type, numerically controlled

73153 = Other milling machines, numerically controlled

7316 = Machine-tools for deburring, sharpening, grinding, lapping etc; excluding 73162, 73166, 73167,73169

73312 = Bending, folding, straightening or flattening machines, numerically controlled

73314 = Shearingmachines, numericallycontrolled

73316 = Punchingmachines, numericallycontrolled

7359 = Parts and accessories of 731- and 733-

73733 = Machines and apparatuses for resistance welding of metal fully or partly automatic

73735 = Machines and apparatuses for arc, including plasma arc welding of metal; fully or partly automatic

8. Chemistry

52222 = Selenium, tellurium, phosphorus, arsenic and boron

52223 = Silicon

52229 = Calcium, Strontium and barium

52269 = Otherinorganicbases

525 = Radio activematerials

531 = Synthetic organic colouring matter and colour lakes

57433 = Polyetheleneterephthasase

591 = Insecticides, disinfectants

9. Armament

891 = Arms and ammunition

Available at:

http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/Annexes/htec_esms_an4.pdf

Appendix 2 Classification of High-Tech Based on SITC Revision 4

1. Aerospace

(714-714.89-714.99)+ = Aeroplanemotors, excluding 714.89 and 714.99

792.1+ = Helicopters

792.2+792.3+792.4+ = Aeroplanes and other aircraft, mechanically-propelled (other than helicopters)

792.5+ = Spacecraft (including satellites) and spacecraft launch vehicles

792.91+ = Propellers and rotors and parts thereof

792.93+ = Undercarriages and partsthereof

874,11 = Direction finding compasses; other navigational instruments and appliances

2. Computers officemachines

751.94+ = Multifunction office machines, capable of connecting to a computer or a network

751.95+ = Other office machines, capable of connecting to computer or a network

752+ = Computers

759,97 = Parts and accessories of group 752

3. Electronic telecommunications

763.31+ = Sound recording or reproducing apparatus operated by coins, bank cards, etc

763.8+ = Video apparatus

(764-764.93-764.99)+ = Telecommunicationsequipment, excluding 764.93 and 764.99

772.2+ = Printedcircuits

772.61+ = Electrical boards and consoles < 1000V

773.18+ = Optical fibrecables

776.25+ = Microwavetubes

776.27+ = Othervalves and tubes

776.3+ = Semiconductordevices

776.4+ = Electronic integratedcircuits

776.8+ = Piezoelectriccrystals

898.44+ = Optical media

898,46 = Semiconductor media

4. Pharmacy

541.3+ = Antibiotics

541.5+ = Hormones and theirderivatives

541.6+ = Glycosides, glands, antisera, vaccines

542.1+ = Medicaments containing antibiotics or derivatives thereof

542,2 = Medicaments containing hormones or other products of subgroup 541.5

5. Scientific Instruments

774+ = Electrodiagnostic apparatus for medicine or surgery and radiological apparatus

871+ = Optical instruments and apparatus

872.11+ = Dentaldrillengines

(874-874.11-874.2)+ = Measuring instruments and apparatus, excluding 874.11, 874.2

881.11+ = Photographiccameras

881.21+ = Cinematographiccameras

884.11+ = Contactlenses

884.19+ = Optical fibres other than those of heading 773.1

(899.6-899.65-899.69) = Orthopaedicappliances, excluding 899.65, 899.69

6. ElectricalMachinery

(778.6-778.61-778.66-778.69)+ = Electrical capacitors, fixed, variable or adjustable, excluding 778.61, 778.66, 778.69

778.7+ = Electrical machines, having individual functions

778,84 = Electric sound or visual signalling apparatus

7. Chemistry

522.22+ = Selenium, tellurium, phosphorus, arsenic and boron

522.23+ = Silicon

522.29+ = Calcium, strontium and barium

522.69+ = Otherinorganicbases

525+ = Radioactivematerials

531+ = Synthetic organic colouring matter and colour lakes

574.33+ = Polyethyleneterephthalate

591 = Insecticides, disinfectants

8. Non-electricalMachinery

714.89+ = Othergasturbines

714.99+ = Part of gasturbines

718.7+ = Nuclear reactors and parts thereof, fuel elements, etc

728.47+ = Machinery and apparatus for isotopic separation

731.1+ = Machine-tools working by laser or other light or photon beam, etc

731.31+ = Horizontallathes, numericallycontrolled

731.35+ = Otherlathes, numericallycontrolled

731.42+ = Other drilling machines, numerically controlled

731.44+ = Other boring-milling machines, numerically controlled

731.51+ = Milling machines, knee-type, numerically controlled

731.53+ = Other milling machines, numerically controlled

731.61+ = Flat-surface grinding machines, numerically controlled

731.63+ = Other grinding machines, numerically controlled

731.65+ = Sharpeningmachines, numericallycontrolled

733.12+ = Bending, folding, straightening or flattening machines, numerically controlled

733.14+ = Shearingmachines, numericallycontrolled

733.16+ = Punchingmachines, numericallycontrolled

735.9+ = Parts and accessories of 731 and 733

737.33+ = Machines and apparatus for resistance welding of metal, fully or partly automatic

737,35 = Machines and apparatus for arc welding of metal, fully or partly automatic

9. Armament

891 = Arms and ammunition

Available at: http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/Annexes/htec_esms_an5.pdf

Appendix 3 Description of Independent Variables

		Variable	Obs	Mean	Std.Dev.	Min	Max
Dependent Variable		htexp	150	4.60E+08	3.02E+08	5.36E+07	1.92E+09
Independent Variables							
	Basic Variables	impgdp	150	2794.45	3242.18	195.91	14526.55
		figdp	150	176.74	52.20	122.15	273.23
		dist	150	3090.53	2651.31	397.91	7816.59
	Market Scale	imppopu	150	2.13E+08	3.67E+08	8840998	1.34E+09
		fipopu	150	5227072	71681.09	5124573	5363352
	Trade Cost	common border	150	0.200	0.401	0.000	1.000
		impreer	150	100.11	9.59	60.38	126.13
		fireer	150	100.56	2.75	95.73	106.08
	Information Cost	language	150	0.500	0.502	0.000	1.000
		eu	150	0.600	0.492	0.000	1.000
		oecd	150	0.800	0.401	0.000	1.000
	Labour market	impun	150	0.07	0.02	0.03	0.13
		fiun	150	0.09	0.02	0.06	0.15
		impgdppc	150	25828.11	11001.17	1678.80	46900.91
		figdppc	150	27934.68	5468.11	18967.87	35996.94
	Global Integration	impoi	150	0.48	0.23	0.16	1.19
		fioi	150	0.61	0.05	0.51	0.70
		imptrfr	150	75.46	12.44	20.00	87.50
		fitrfr	150	80.49	4.37	73.20	87.50
	Technology Level	imprdgdp	150	2.12	0.86	0.57	4.13
		firdgdp	150	3.34	0.38	2.53	3.96
		imptpat	150	9567.35	12332.06	146.65	52433.92
		fitpat	150	1368.14	215.81	811.89	1644.96

Appendix 4 Figures on Finnish High-Tech Exports by Groups from 1996 to 2010

Year	Aerospace	Armament	chemistry	computers-office machines	electrical machinery	electronics-telecommunications	non-electrical machinery	pharmacy	scientific instruments
1996	11.19	20.78	41.04	739.87	45.18	2839.24	108.24	18.33	459.51
1997	73.07	18.77	44.62	967.63	68.54	3827.33	121.99	21.04	607.67
1998	59.32	31.11	47.02	915.60	111.75	5365.67	137.28	25.86	651.38
1999	21.00	61.26	46.27	793.47	201.40	6037.41	123.34	26.03	721.29
2000	94.93	40.38	59.03	431.66	222.21	9648.35	151.04	30.78	846.34
2001	162.95	38.86	59.34	354.77	115.36	8145.04	173.94	33.62	898.92
2002	48.79	68.36	62.21	296.72	65.01	8085.57	188.50	75.05	861.33
2003	106.41	51.44	50.82	257.09	106.43	7672.08	124.21	77.28	866.29
2004	37.29	51.80	54.73	325.69	106.53	6897.24	150.68	91.78	863.15
2005	128.39	112.48	55.32	446.39	118.32	9050.17	155.08	133.92	972.15
2006	72.37	52.74	55.72	571.66	119.14	8880.76	235.53	160.22	1038.16
2007	108.50	65.77	72.67	495.30	117.45	9317.72	228.09	132.24	1029.18
2008	146.49	110.46	79.75	399.42	112.07	9208.71	218.31	121.69	1048.76
2009	123.07	94.34	69.00	299.63	74.50	4494.17	138.23	127.39	902.29
2010	338.68	76.15	82.66	307.75	82.07	3098.18	133.10	197.26	1005.06

Source: own calculation by using data provided on Finnish Customs Database. Figures are measured in million euros.