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Econometric analysis of impacts of immigration on Finnish bilateral trade flows

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Abstract of master's thesis

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Abstract

Objectives

In this study the effects of immigration on Finnish bilateral import and export flows are studied using the gravity model of trade as a theoretical framework. Marginal effects of immigration on trade flows are found out by employing the traditional gravity equation partially and using data for 179 trading partners of Finland over a 17-year period 1995-2011. In addition, channels through which immigration could affect trade are discussed in this thesis and, finally, empirical estimation models employed in the estimation of the gravity equation are compared.

Theoretical background and methodology

The theoretical framework of this study relates to the literature on business and social networks. The networks can bring about, for example, informational advantages or improve contract enforcement. In addition, immigration's impacts on imports could also be characterized by immigrants' preferences for their home goods. On the other hand, vast literature on theoretical gravity equation is reviewed in the thesis too. The theory on gravity equation of trade is dealt with in detail to reflect the need for a correct theoretical equation including multilateral trade resistance. Henceforth, in some of the empirical estimations the traditional gravity equation with amendments is employed to reflect the qualities revealed by the theory. Ultimately, the estimation of the partial gravity equation in this thesis is done by using both ordinary least squares (OLS) and Poisson pseudo-maximum-likelihood (PPML) methods to obtain information on an adequate estimator in the context of trade data, known to contain a large number of zeros and very likely to possess heteroskedastic error terms.

Key findings

Based on the results obtained in the empirical estimations, a small positive effect of immigration on imports and exports was found using the PPML and OLS regressions. When comparing the PPML and OLS estimators, the PPML was concluded to be more adequate in the context of this partial gravity equation. All in all, no conclusions could be drawn from the channels through which immigration might have an impact on trade due to incomplete model considerations. Thus further studies on immigration's effects on trade using a complete theory-based gravity equation and, especially, more complete data should be conducted in order to be able to draw further conclusions on the impact channels of immigration on trade.

Keywords immigration, international trade, gravity equation, migrant networks, Finland

Table of contents

List of tables

List of figures

1 Introduction

Understanding the effects of international migration on economy will become an increasingly interesting topic in future as globalisation has resulted in ever increasing migration flows in the world during the recent decades. Migration is driven by several different factors, the economic factors, however, dominating the reasons for migration (OECD 2012). As a result of the economic downturn that began in 2008, labour migration to the OECD countries was significantly reduced in 2010 in comparison to the previous years but other types of migration, such as those depending on humanitarian crises or family reunification, were not as largely affected (OECD 2012).

Studying the impacts of immigration on economy have mainly concentrated on studying labour market and wage effects in the immigrant host country, including immigrants' earnings assimilation and employment displacement effects among other factors (e.g. Borjas 2003; Kerr and Kerr 2011 to cite few). Due to labour market effects of immigration dominating the public discussion, immigration has also widely evoked political debate on its consequences in the media in Finland and elsewhere in the early 2010s, yet impacts of immigration have often been criticised by relatively simple arguments by those for and against immigration.

In addition, the reigning tendency in immigration discussion has long seemed to be driven by various opinions especially on economic reasons for immigration or results of immigration. This clearly indicates increasing needs for explaining immigration's economic impacts, for instance, on labour markets, remittances or foreign trade. Consequently, this thesis takes the foreign trade under study using Finnish data, and hence, the impacts of immigration on trade flows are studied using Finnish trade and immigration data in this master's thesis.

The impacts of immigration on international trade have not been studied using Finnish data before, which makes the topic of the thesis even more interesting. However, earlier studies done in other countries on the relationship of immigration and international trade have shown that a larger immigrant stock may have a positive effect on export or import flows (e.g. Gould 1994; Co et al. 2004; Lee 2012 and many more). The majority of the studies on the effects of immigration on trade has concentrated on large economies, not on small open economies, like Finland in which international trade constitutes a large portion of the GDP; trade has accounted for approximately 80 % of the country's GDP in recent years (WTO 2014).

Although Finland can be counted as a small open economy, there is one significant difference in comparison to several other small open European economies – a smaller number of immigrants. Consequently, it would be interesting to know if even a small number of immigrants could have an effect on trade flows. Therefore the focus in this thesis will be on immigration's overall trade cost reducing effects, no matter what the size of the immigrant stock is. The trade cost reducing effects of immigration are assigned to the networks created by immigrants that might facilitate trade, for example, by improving contract enforcement (e.g. Rauch 2001).

On the whole, immigration's hypotheticals trade cost reducing effects are interesting since international economics often faces the question of why the countries trade so little and instead buy their own goods, much more than a world of costless trade would predict. For instance, Eaton and Kortum (2012) mention that the home share in manufacturing products is from 3 to 100 times greater than the country's GDP of world total GDP, although the latter should predict the home share according to the theory. This observation clearly suggests evidence of the existence of trade barriers. Ultimately, this shows how important a limiting factor the trade costs are and therefore anything that would reduce trade barriers, including formal and informal trade barriers, could possibly increase the trade.

1.1. Research questions and objectives

In this thesis the effects of migration on Finnish bilateral trade flows are studied using gravity equation, first introduced in international trade context by Tinbergen (1962) and later on theoretically derived by Eaton and Kortum (2002) and Anderson and van Wincoop (2003) among others.[1]

First, nonetheless, more precisely, the research question is whether immigration has any significant effect on Finnish bilateral import and export flows and what, if any, is the magnitude of this effect. Furthermore, channels through which immigration could affect trade are addressed shortly. The focus will be on merchandise trade instead of service trade although the latter has become globally more and more important lately. Furthermore, aggregate trade data is used since no consensus has been reached in empirical studies whether immigration's effects apply to all the goods or only some classes of goods.

The earlier studies on immigration's effects on trade flows explain the effects of immigration either by a preference for home goods, by improved contract enforcement brought by

[1] The gravity equation has been used in many different forms, and therefore due consideration is given to the representation of the theoretical background of the equation as well as its use in empirics.

immigrants, or by so called informational effects (Gould 1994; Rauch 2001). The preference for home goods relates the effects of inward migration to increased trade, and especially imports, due to the population preferences in the immigrant host country changing towards immigrants' home country goods. Therefore, these effects would be on the imports only because the host country immigrants demand more for their home country goods and possibly also affect the host country's original population's preferences.

The network (informational and contract enforcement) effects, on the other hand, have consequences for both exports and imports as they increase knowledge and reliability of the immigrants' home markets in the host country as well as host country market information in the immigrants' home country (Rauch 2001). In different empirical studies either the home bias or the informational effects have been observed to be more powerful in explaining effects of immigration on trade flows. In any case smaller trade barriers, or trade costs as per the terminology of Anderson and van Wincoop (2004), due to immigration networks that are proxied by immigrant stock in a country, are therefore assumed to lead to increased trade.

Essentially, in this study the assumptions on trade and trade costs follow the line that the trade between countries is limited by several different factors – there are the visible trade costs, such as tariffs and transport costs, and other factors that impede trade between countries, like the lack of knowledge of the destination market. Any factor that would decrease trade costs would consequently increase trade. This improvement could take place, for example, by increased opportunities for the entrepreneurs in a certain country to enter export markets due to networks. Moreover, it has been suggested in several studies that social networks over the country boundaries may have preferable effects on trade (Rauch 2001). The above mentioned factors exemplify why immigration might have beneficial effects on trade.

However, there are several limiting aspects related to the study that will be given an emphasis in the later sections. Still, it is worth mentioning here some of the limitations. First, the direction of causality from immigration to trade may be difficult to be determined. For example, on a micro level in a case when an educated employee moves to some host country it should also be studied what are the reasons for the immigration – it could be argued that an employee having a job in an exporting firm and migrating to another country to work in might as well mean that trade has created immigration, not on the contrary. On the other hand, immigration might still increase trade through always reducing trade costs, no matter by what induced. However, in that case it would be difficult to estimate the size of the effect of immigration resulting purely from immigration and excluding the effect of trade. Consequently, causality and related issues will be dealt with in more detail in section 2.4 as well as in section 4.4.2 when discussing the empirical specification of the model.

Additionally, another limitation not related to the technical issues in the study is the fact that, due to the topic limitations, no discussion on foreign trade's effects on the society or well-being on a larger scale can be made. In this study, therefore, there will not be made any suggestions for interpretation of the overall positive or negative effects of immigration or trade. The interest lies in the partial effects of immigration on trade.

Also, the type of data used has imposed some limitations to the study. For instance, no possibility of studying the effects of the educational level of the immigrants on trade could be carried out due to the immigration data being poorly constructed in Finland. On the other hand, it was also decided that trade by the type of goods traded was not to be studied, although, for example, some manufactured goods are more knowledge-intensive (e.g. ICT) and might therefore benefit from the more highly qualified sellers and buyers that can easily communicate with the other party. If knowledge intensive goods were studied separately, additional information could have been obtained about the hypothesis that informational effects explain immigration's effects on trade. However, additional issues related to data are discussed in section 5.1.

1.2. Motivation to the study

Before moving on to the important definitions used in the study, it is worth mentioning a couple of aspects why this study might be beneficial or bring some new insights into discussion.

First, the political debate on immigration in Finland has been relatively heated up during the last couple of years, which possibly makes the themes unfolded in this thesis interesting to the general public too. Consequently, this study is conducted in order to provide us with some more information on impacts of immigration on economy and offer a new angle to the immigration discussion. The study should act as widening the perspectives for discussion of possible effects of immigration in a yet another field. However, no position to immigration policies nor any suggestions for policy measures are considered, although it could be argued that immigration's trade effects could be taken into account in immigration policy considerations.

The study will also add up to the existing literature on immigration and its trade effects using Finnish data that has not been used before to study immigration's trade effects.[2] Albeit the effects of immigration on labour markets and employment might be of greater current interest, it would be interesting to find out if any relationship can be detected between immigration and international trade, possibly suggesting need for future research. Additionally, needs for further research in a small open economy context could arise.

1.3. Definitions

When studying the impacts of immigration on economy, as in this study, it is of crucial importance to define the concept of immigrant properly in order to be able to draw conclusions based on the immigration data used. Therefore an *ad hoc* definition for an immigrant is given: in this study, immigrants are defined as foreign born people living permanently in Finland at the end of any specific year.

The definition, of course, has its flaws as people of Finnish origin born abroad are also counted in the figure. Alternatively, immigrants could be defined as those who have a foreign nationality at the end of the year but this does not alleviate the problem since nationality does not automatically define the immigrant's source country or background and does not include those people who are foreign born but have obtained Finnish citizenship (Population Research Institute 2013). The problems with the definition are further discussed in section 5, in which the data used in the study is introduced.

Exports and imports in the study refer to merchandise exports and imports each year, and are treated as aggregates. What is included in these and what not is defined by the data used, but the purpose is to study the effects of immigration on overall merchandise trade (cf. limitations mentioned in section 1.1).

Finally, trade costs refer not only to the concrete trade costs like tariffs and transport costs but also to the other barriers for trade, such as lack of information or imperfect contract enforcement, following the definition by Anderson and van Wincoop (2004). From the theoretical point of view, the effects of contract enforcement and networks as well as preference for home goods are explained in section 2.3.1.

[2] This is probably due to the fact that immigration to Finland has not been very common and only has taken place for a short period in larger numbers.

1.4. Structure of the thesis

The first section of this study introduces the topic and the research questions as well as objectives of the study, providing at the same time motivation to the study. In chapter 2 background information on Finland's trade and immigration trends is given as well as the empirical studies on trade and immigration are reviewed; migrant networks and their potential trade facilitating effects are outlined and the causality of the immigration-trade relationship is discussed. In section 3, gravity equation is introduced from a theoretical perspective concentrating mostly in the two different models introduced by Anderson and van Wincoop (2003) and Eaton and Kortum (2002). This should provide a solid theoretical basis for the specification although the specification applied in the study departs from the theoretical models.

In section 4, thereafter, the specification used is outlined and the data is introduced briefly; additionally, the variables used in the empirical specification are presented as well as the estimation models are discussed. Then, section 5 describes data and presents the results obtained. The results obtained from the empirical specifications used are then discussed in detail in chapter 6 as well as limitations and improvements to the study are considered. Finally, in chapter 7, conclusions to the study are drawn and possible future research opportunities will be presented.

2 Immigration, trade and networks

In the following sections 2.1 and 2.2 of this study the immigration patterns and trade patterns in Finland are shortly discussed in order to attempt to better understand the immigration and trade in Finland from the point of view of the data needed for the study. By observing trade and immigration statistics, it can be seen that both immigration and trade have been moving towards the same direction (i.e. mostly increasing with increasing GDP) during the observation period. Of course, this is not to suggest any causal effect from immigration to trade or vice versa.

In section 2.3, in addition, empirical literature on immigration's effects on trade is reviewed as well as immigration's trade creating effects are discussed; for example, the question why network effects brought by immigration might increase exports and imports is dealt with. In section 2.4 endogeneity of trade and immigration is further questioned and the problems of the direction of causality are brought up; the issues related to causality are discussed later on also in section 4.4.2.

Although the interest of this study is first and foremost to find out if immigration impacts exports and imports it is worth noting that trade in general has been deemed by some authors economically beneficial for countries that participate in trade.[3] Albeit mentioning the potential results of trade in the footnote, I will not dig deep into what consequences increased trade might have to a country or its trade partners in this study.

2.1. Short overview of immigration in Finland

The immigration to Finland from abroad and by non-Finnish origin people has accelerated noticeably only from the beginning of the 1990s. Hence immigration in Finland is still a rather new phenomenon, although it is worth mentioning that the number of immigrants every year since 2000, except for the years immediately after the financial crisis, has been increasing (see figure 1 below for the total migration patterns; OSF 2013). Free movement of persons in the European Union is but one facilitating factor that has increased immigration to Finland during

[3] Frankel and Romer (1999), for example, instrument for trade by different countries' geographic factors that are likely to have no effect on other determinants of income. By doing this the authors create a natural experiment, for which the effects of trade on income can be studied due to trade variations by geographic factors, and hint at that trade could actually raise countries' income.

the observation period 1995-2011 since the immigration form outside of the EU has also increased markedly.

As mentioned before, immigration to Finland in significant amounts is a novel phenomenon and the number of immigrants has increased considerably from the beginning of the 1990s onwards and totals currently an inflow of approximately 30 000 yearly international immigrants (OSF 2013).[4] The immigrant population measured by the birth country at the end of 2013 formed approximately 5.5 % of the country's total population (Statistics Finland 2014); in comparison, the migrant population on average in Europe represented 10 % of the total population in 2013 (UN 2013).

The first modern immigrants to Finland were refugees from Chile and Vietnam at the beginning of the 1970s. After the World War II immigration to Finland had been very small due to reiging emigration and a relatively closed society (Salmio 2000; Koivukangas 2003). After the collapse of the Soviet Union immigration boomed, and immigrants from Russia and from the former Soviet state of Estonia have been the two largest groups, in addition to returning Finnish citizens (Statistics Finland 2010). With increasing immigration Finland has become a country with net immigration as summarised in figure 1 on Finnish migration patterns.

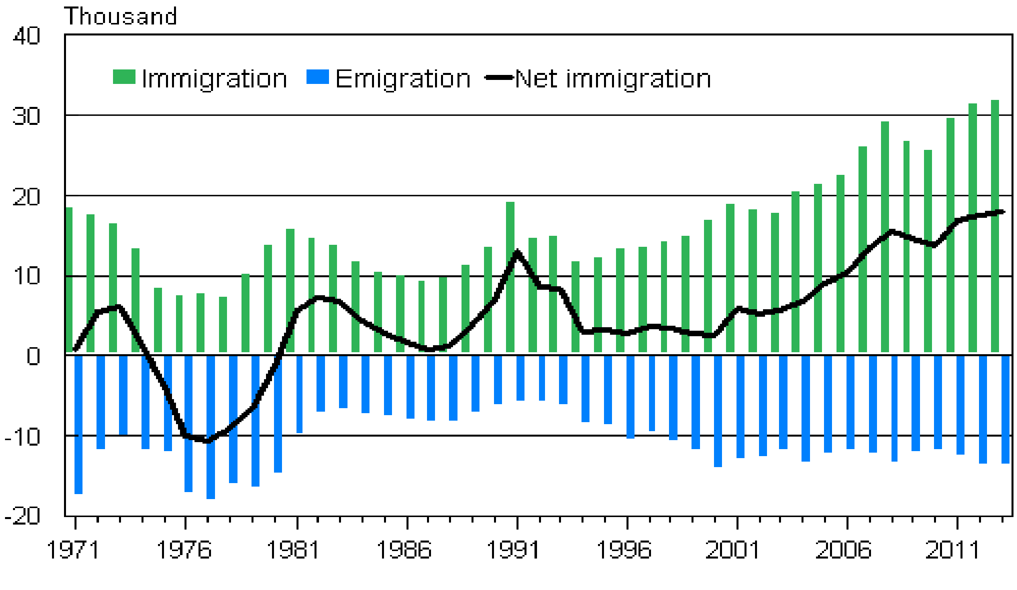

Figure 1: Immigration patterns of Finland 1971-2013
(Retrieved from: http://www.stat.fi/til/muutl/2013/muutl_2013_2014-04-29_kuv_001_en.html**).**

[4] Historically (which here refers to all the periods before World War II) there were some ethnic minorities present in Finland, though, and the country was not as homogeneous as often thought. These include according to Koivukangas (2003), for example, the Finnish Swedes, the Tatars etc. Also, immigration (refugees) was very significant from the Karelia region during the Second World War but mostly had to do with ethnic Finns.

As a result of increasing immigration, the Ministry of the Interior, for instance, has addressed the need for an updated immigration strategy that includes immigration employment opportunities, integration and fighting discrimination among others as its key objectives and mentions immigration an important factor for the country's competitiveness, showing increased interest and emphasis on immigration questions in Finland (Ministry of the Interior 2012). As a matter of fact the immigration inflow to Finland was the largest ever in 2013 (OSF 2013).

Furthermore, the composition of the yearly immigrant stock has changed markedly from the beginning of the 1990s – before that the majority of the immigrants were Finnish people returning from abroad whereas after this the number of foreign citizens has been the majority, around two thirds of the incoming immigrants (Myrskylä 2010).

The political and economic situation of the world self-evidently affects immigration and emigration patterns to and from Finland, and there are certain differences in the composition of the different immigrant groups according to their source country: Americans, other EU citizens and Indians move to Finland mostly because of a pre-scheduled job, whereas for other groups the reasons are various, including family reunification, job hunt and studying (Statistics Finland 2010). The predictability of migration to Finland is not easy due to fluctuations in it. Consequently, not knowing the accurate reasons for migration makes the study of its economic effects (for instance, on trade) more difficult, and several studies, for example, Borjas (1994) shows how crucial it would be to understand which are the factors that lead to immigration in order to understand economic effects of immigration. However, some reasons for immigration in the Finnish context have been detailed in the Ministry of Interior's (2013) report and those will be outlined shortly in section 2.4, where the direction of causality between immigration and trade is discussed.

As this study aims at finding out whether immigration has any effect on Finnish bilateral trade flows due to immigration's effects on information procurement, network creation or preference for home goods, it is crucial to define what is meant by an immigrant in a statistical sense in the context of this study. For example, immigrant's citizenship may change in course of the year or within the period under investigation, and using this as a measure for immigrant status might bias results to some direction – an immigrant might obtain the Finnish citizenship and still continue to keep in contact with people in her native country (i.e. keep up networks), in which case there might be an upward positive effect on the coefficient of immigration's effects for the people who remain with their native country citizenship.

On the one hand, obtaining citizenship might indicate assimilation to the host country society and therefore the changing citizenship might remove the bias that would be born if many of these assimilated citizens (no contact with home country) were to keep their home country citizenship. On the other hand, the immigrant's birth country does not necessarily give enough information on the immigrant's real ethnic background and the possibility that she would form contacts to her birth country; there are many immigrants who are ethnically Finnish but were born abroad (Statistics Finland 2010). Additionally, immigrants also have children in Finland that might have network creating effects (data on second generation immigrants exists), and Finnish people have children born abroad who might lack the network creating effect. Mother tongue of an immigrant, therefore, could be an alternative measure due to its unchanging nature and could act as a good indicator of the immigrant's ethnic background in many cases although it has many defects as well, the major defect being the presence of many languages in several countries. Hence the immigrant birth country was assumed to give the definition of an immigrant most closely.

The considerations for the definition of an immigrant were dealt with in section 1.3 and will be considered again when formulating the empirical specification in chapter 4. Although several alternatives in data are available for the variable, as we saw above, table 1 reports the different immigrant groups based on migrant's self-reported birth country used in the study.

Table 1: Finland's largest immigrant groups in the end of 2013 by source country

	Immigrant country	Total stock	% of population		Immigrant country	Total stock	% of population
1	Former SSSR	53740	0.99	11	Turkey	6053	0.11
2	Estonia	39488	0.72	12	Vietnam	5531	0.10
3	Sweden	31777	0.58	13	Iran	5333	0.10
4	Russia	11058	0.20	14	United Kingdom	5312	0.10
5	Somalia	9618	0.18	15	India	4925	0.09
6	Iraq	9275	0.17	16	USA	4481	0.08
7	China	8894	0.16	17	Poland	3797	0.07
8	Thailand	8699	0.16	18	Afghanistan	3704	0.07
9	Former Yugoslavia	6748	0.12	19	Philippines	2730	0.05
10	Germany	6350	0.12	20	Spain	2350	0.04

Source: Statistics Finland (2015), compiled by author

2.2. Trade trends in Finland

Before moving into the discussion on the possible interconnection between trade and immigration in the following section, it is worth considering briefly the trade patterns that Finland has had during the ultimate decades.

Following the World War II and during the Cold War Finland was heavily dependent on trade with the Soviet Union. Still today, foreign exchange of goods (and services) can be considered one of the cornerstones of the Finnish economy, although the composition of trade and the trading partners have changed following the collapse of the USSR. As a small open economy Finland's total trade to GDP ratio was 82.3 for the period of 2011-2013 (WTO 2014). In many similar countries this figure is higher though (Ministry for Foreign Affairs of Finland 2008). Still, the relatively heavy dependence on trade indicates that the importance of any means that would decrease trade costs[5], such as free trade agreements or immigrant networks, could theoretically increase trade of the country and might allow it to participate in the economic growth generated by countries outside of it.

The largest trade flows to Finland took place at the same time as increased immigration from 1990s on, being probably consequences of emerging globalisation and the collapse of the Soviet Union (as can be seen by observing the statistics on immigration and trade). The countries from which Finland has the most imports are Russia, Germany and Sweden; similarly, these countries dominate the export statistics in the opposite order (OECD 2015).

The main portion of trade in Finland is intra-EU-28 trade. As a member of the European Union, Finland's trade policy measures are dictated by the Union. The 28 Member States of the Union are part of a single market, they have a single external border and a single trade policy (European Comission 2013).

Being part of the EU consequently most likely increases trade between Finland and other member states due to free trade agreements' trade creating effects, as observed by Clausing (2001) in the context of Canada and USA with data on trade liberalisation.

As discussed above, taking together the trade creating effects of the European Union and free movement of people indicate that including the EU countries under study might bias the results because existing trade between the countries might have led to the creation of the

[5] Trade costs could be defined as any cost related to the trade and may include concrete costs, such as tariffs, quotas and costs related to transportation, but also costs of information acquirement about the foreign markets and contract enforcement related costs etc. (Anderson and van Wincoop 2004).

preferential multilateral agreement and because the common market already significantly might have reduced trade barriers. Therefore, not including the EU countries under study is discussed later on in context of the specification and data in chapters 4 and 5. Alternatively, including the EU countries and then studying the trade creating effects of the union are also considered using dummy variable for the EU.

The trade partners included in the study is not the only thing problematic since the composition of trade also needs to be discussed and the scope of whether aggregate trade flows or trade by goods group are considered. In other words, some goods traded might be, for instance, more information intensive and therefore their trade might increase more with immigration due to, for example, increased information in a new host country. This and other considerations related to the type of goods traded are discussed in the following sections. Still, in this study different traded good groups will not be studied separately but total merchandise trade data is used and service trade is left out of the study too.

As it has been noted previously the immigration and trade have moved to the same direction in the period studied but obviously not much can be said about the relationship based on the fact. However, several studies have indicated a positive relationship between increased immigration and trade. In the following sections these studies are discussed and later on the problems arising due to causality are referred to.

2.3. Networks and information – impacts on trade

In this section the immigrant networks and their potential effects on trade (2.3.1) are discussed as well as empirical evidence (2.3.2) for immigration-trade relation are outlined. In section 2.4 problems arising from the assumption of the direction of causality from immigration to trade are introduced in more detail as well as solutions to the problem are discussed.

In his article on social networks and international trade Rauch (2001) classifies informal trade barriers depending first and foremost on weak contract enforcement and inadequate information and mentions that networks existing over national borders may overcome these barriers. Therefore these phenomena are discussed in the following sections.

First, however, it is worth noting on a practical level how exporting and importing firms very often bump into obstacles in their trading activities. The exporting firms enter a market of which it has very little knowledge and prior to that it has to identify in the first place which market to enter, how to distribute merchandise to the market and so on. Importing firms instead face unknown suppliers and has to be able to resolve any problem with them among other things. These simple examples highlight the importance of information in trade and, on the other hand, give us a reason to study the effects that immigrants might have in facilitating information acquirement on the market.

However, other effects in addition to informational and network effects might also explain the increased trade. Simply, the preferences that the immigrants have and that they introduce to the "original population" may also increase trade. For example, this could be the case of Chinese shops in any big city with a large enough Chinese diaspora – the preferences of the Chinese immigrants directly supports the importation of their home country goods. From the immigrants' host country perspective the preferences only affect imports because the immigrants want to buy goods with which they are familiar and therefore import goods from their home country.

2.3.1. Channels through which immigration could affect trade

As mentioned above, the informal trade barriers can mainly be seen to depend on weak contract enforcement and inadequate information. In connection to this, Rauch (2001: 1178) brings forward an idea that institutions are improving and, as a result, there is less need for networks due to enhancing international contract enforcement and improving technology for information spreading. This would mean that the networks would not matter to trade so much in the future, and could possibly suggest that immigrations effect on trade through contract enforcement or information sharing would become smaller. However, the importance of networks in the future depends on what the economic efficiency of networks is and whether they are open to new members (Rauch 2001). It would be also important to study intermediaries who connect networks to domestic networks as, for instance, Co et al. (2004) mention that immigrants might act as middle men having no involvement in production, but possessing knowledge of local customs and laws.

Empirical studies have focused on either business networks or coethnic networks; the latter defined loosely as individuals or businesses that share some demographic attribute (Rauch 2001: 1178). More generally, Podolny and Page (1998: 59) in Rauch (2001) give a definition of economic networks as "a group of agents that pursue repeated, enduring exchange relations with one another". This relationship could result in increased trade if members of the network migrated to a country and continued their trading activities with the remaining members of the network in their home country. However, the relationship described by Podolny and Page (1998), as well as a weaker version of it by Granovetter (1973) in Rauch (2001), [6] might be too broadly defined because most of the trade by these definitions would depend on networks (and due to inexistence of organised exchanges for many goods, it could seem that trade is created mostly by networks); therefore using these definitions might lead to defining as coethnic networks also those networks that were born as a result of trade (Rauch 2001: 1179).

So, the focus should be on the networks that were domestically born and as a result of migration become transnational networks (Rauch 2001). These kinds of networks would be sustained by the trade they create but were not born because of trade. Still, observing whether the networks existed before migration took place might be impossible. Furthermore, for the study of networks, observability of networks would be important (Rauch 2001). In this study, anyhow, we will not take any position on these themes although it could be argued that networks might reduce trade barriers if its members have knowledge of culture, language and norms of countries where there are weak institutions and knowledge of markets is weak.

Furthermore, to explain the relatively small quantity of international trade Anderson and Marcouiller (2002) state that trade is constrained by inadequate institutions as much as by tariffs. The authors suggest that good institutional quality in high income countries makes the transaction costs in trade between these regions smaller and leads to higher trade, and trade necessarily needs not to be explained by the product differentiation models as has been done – in other words, factor endowment models could still explain trade (Anderson and Marcouiller 2002). The authors assume that insecurity raises the prices of the goods and the potential loss is estimated as a hidden tax for trade. Then they find that the omission of indices of institutional quality (hinting at the insecurity caused by the absence of proper institutions) gives biased gravity model estimates, making a negative relationship between per capita income and the share of total expenditure devoted to traded goods unclear (Anderson and Marcouiller 2002). This example shows how important it is to consider inadequate information as a factor increasing trade costs; at the same time, the example hints at networks' ability to increase trade in the absence of adequate institutional quality.

In addition to information acquiring, as suggested above as a reason for the networks' benefits, Rauch (2001) reviews articles that have studied uninstitutionalised environments in the past, argues that networks are a means for substituting trust in making contracts. Also Greif

[6] Granovetter (1973) defined networks as "a set of actors who know each other's' relevant characteristics or can learn them through referral."

(1993) shows that networks were maintained because trade coalitions alleviated problems of asymmetric information, enabled monitoring and coordinated responses; the threat of punishment acted as a substitute for trust in diasporas. A repeated game equilibrium in which cheating any dealer in the network leads to not dealing with the cheater in the future instead of only preventing deals between the cheated and the cheaters, so called collective punishment, highlights the functioning of the networks (Greif 1993).

Similarly, Rauch (2001) mentions moral community creation in order to deter cheating and suggests that study on international trade law and institutions should be added to the study of networks to find out how these affect the networks' functioning. By doing this, it would be easier to see if the benefits of networks accumulate through alleviating problems in contract enforcement or simply by bringing "positive" informational advantages (such as knowledge of language, culture and norms) to the trading partners.

This discussion continues as Rauch (2001) mentions that trade networks are likely not only to give information on the opportunistic behaviour but also on the future trade opportunities. For instance, information on how to adapt the product to consumers' preferences in some country (Rauch 2001). Immigrants know their home country sellers' and buyers' characteristics especially well and having moved to another country has brought this information available to others as well (Rauch 2001: 1185). Still, it is obvious that there is no easy solution to determine through which channels the ethnic networks might operate.

Moreover, Rauch (2001) mentions that demand for networks is changing due to institutional factors, such as better contract enforcement; at the same time, on the other hand, the supply of networks might increase as more migration takes place. In addition, Rauch (2001) mentions potential benefits of modern communications technology in maintaining networks. It could be concluded, therefore, that the network effects of immigration in the future are even more probably created by the informational advantages that are more easily spread because of the improved communications technology and a greater number of migrants. In contrast, the improved contract enforcement would make the use of networks redundant, reducing the network effects.

Rauch (1999) further introduces another idea and notes that manufactured goods are heterogeneous and their prices may be uninformative. Consequently, trading in organised exchanges is not likely as in the case of primary commodities, and the connection between the buyers and sellers requires a search process that is costly but can benefit from the pre-existence of ties between the buyer and the seller, leading to a trading network. According to Rauch

(1999) the informational demands for the differentiated goods are so high that no commodity arbitrage is possible, and as a result the buying and selling party engage in search to find the best match, indicating that anything, such as common language and contacts who know the market, will facilitate the search. In short, what Rauch (ibid.) also states is that the networks should play a bigger role in case of differentiated products and have a lesser impact when trade on homogenous or reference priced products is considered. The above would suggest that immigration, hypothesised to increase informational advantage and capture network effects, would be greater for the manufacturing or differentiated goods.

Moving ahead, Head and Ries (1998) suggest that the effects of the preference for home country goods are probably not visible in the context of homogenous goods, but trade in differentiated goods, in which the availability of ideal variety is important, would be affected more likely by immigration. As a result, the effect of immigration could be observed more easily when merchandise trade of different product classes is studied separately, i.e. studying manufactures and raw materials separately, for instance.

Furthermore, Poot and Strutt (2010) view several different reasons for migration's trade creating effects. First, migration as a process of creating higher income will expand demand for traded goods and services. Then, as mentioned by several authors, migrants throughout history have seen trade opportunities. Preferences for home goods is also mentioned as well as knowledge of practices, laws and markets, bilingual migrants facilitating communication and personal contacts in the home country.

Finally, it is suggested that as immigrants integrate into the society the effects are likely not to get indefinitely better – Epstein and Gang (2006) present a model of migrants' assimilation to the society, based on which the immigrant finds out profitable not to invest in assimilation activities at some point. In their study Epstein and Gang (2006) investigate self-employed migrants trading with their home country, but the empirical evidence also has suggested that the effect created by immigration of entrepreneurs is smaller than for any other group (Head and Ries 1998).

Ultimately, it is worth mentioning some other channels through which immigration might have an effect on trade. For instance, Poot and Strutt (2010) mention that remittances might have an indirect effect on trade by creating a chance for the developing countries to import more with the money they receive as remittances than would otherwise be possible. So, the relationship between remittances and trade could also be studied. On the other hand, it should be noted, notwithstanding, that large immigration populations in a certain country might lead this population to produce home goods itself instead of trading. Therefore immigration in significant amounts could also diminish trade.

Additionally, there are several other aspects of networks as well as other factors affecting trade that could be studied; for example, Duanmu and Guney (2013) suggest that culturally dependent stronger family ties could potentially lead to higher trade in networks. All things considered, taking into account cultural and behavioural factors of the immigrants could turn out to be an important explaining factor for possible changes in trading activity. Nonetheless, these considerations are left for future investigations.

2.3.2. Empirical evidence on immigration's effects on trade

In addition to theoretical considerations for the reasons behind the effects of immigration on international trade, several empirical studies have shown a relationship of immigration either with export or import flows or both. The results of a selected number of studies are summarised in table 2 at the end of this section. Before coming to that, some of the studies are discussed in more detail in this section.

Coughlin and Wall (2011) study effects of immigration on exports at both intensive and extensive margins; they hypothesise that information barriers are greater when the country is not present in the market and information would be beneficial when entering the market. On the other hand, the authors also mention that information might not be the most important barrier in gaining entry to the market at all. Coughlin and Wall (2011) study separately the extensive margin by using a fixed-effects logit and the intensive margin by using OLS. The results show that at intensive margin the immigration increases exports (statistically significant and positive), but at extensive margin not. So, this would mean that the immigrant networks are not beneficial for gaining access to new markets and the lack of information is not the strongest barrier for trade. On the other hand, the study by Coughlin and Wall (2011) suggests that informational advantages do increase the existing trade.

Moreover, Co et al. (2004), working with US state level data, find out that exports seem to be positively affected by immigration. Contrary to the discussion that the effects of networks for differentiated goods would be higher (see 2.3.1 based on Rauch (2001)), it is proposed in the study that there are only small differences in results between different goods groups, and even in the organised exchange trading (or trading of homogenous goods) the effects of immigrant links are still positive. So, countries trade more with each other in all goods as a result of larger immigrant stock.

On the contrary, by studying the effects of ethnic Chinese networks on trade, Rauch and Trindade (2002) find that the effect of immigration on differentiated goods was higher than on homogenous goods. The authors assign this difference for the importance of networks in trade because the differentiated goods benefit more from the existence of networks. Also Dunlevy and Hutchinson's working paper (1999: 1058-1059) observe similar phenomena in effect. Consequently, the debate on benefits of information sharing and its effects on trade is still ongoing.

Rauch and Trindade (2002) try to find out whether the effect of preventing opportunistic behaviour or improving information sharing is greater by studying separately reference priced and differentiated products. The hypothesis is that if the network has a greater impact on differentiated goods, the effect is through information transmission due to differentiated goods having more information requirements. Instead, if the effects accumulate to both goods, they have to do with opportunistic behaviour or lack of trust since sanctions, on the contrary, will affect all types of trade (Rauch 2001). Comparing results for different years separately they find diminished effect of networks later on and assign this either to better contract enforcement or to weaker bonds.

Gould (1994), additionally, using US data finds that immigrant skill level does not seem to have any effect by studying separately immigrants belonging to skilled and unskilled labour. Head and Ries (1998) in turn find smaller effects of immigration on trade than Gould by using Canadian data, representing different composition of exports and imports. On the other hand, the effects of immigrant entrepreneurship were not considered important by Epstein and Gang (2006).

Finally, it is worth noting that empirical evidence has not pointed out in detail to the problem of the direction of causality from immigration to trade and therefore the problems with causality will be discussed separately in section 2.4. Before that, the summarised results of some empirical studies and their scope is finally shown in table 2 on the following page. In the last column the findings of the studies are presented, and it is worth noting that although most of the studies show similar results (i.e. positive effects of immigration on trade) there is some variation in what type of goods and trade the effects apply, for instance.

Table 2: Review of empirical studies on the impacts of migration on international trade

Author (year)	Immigration data	Trade data source	Findings i.e. effect on trade
Gould (1994)	U.S. immigration data	U.S. trade data	Positive and significant effect on exports and (not as much) on imports
Head & Ries (1998)	Canadian Census information and arrival data	Canadian trade data	Positive effect on imports and exports (different professional categories studied separately)
Dunlevy & Hutchinson (1999)	U.S. migration data	U.S. historical trade data	Positive and significant effect on imports (greater effect on finished goods)
Girma & Yu (2000)	U.K censuses and data on immigration	IMF direction of trade statistics	Significant positive effect on exports*
Dunlevy & Hutchinson (2001)	U.S. data	U.S. commerce and navigation reports	Significant positive effect on exports
Rauch & Trindade (2002)	Ethnic Chinese population data for different countries	WTDB of Statistics Canada for bilateral trade	Greater impact on differentiated than homogeneous goods; statistically significant effect**
Co et al. (2004)	U.S. census data	U.S. state level export data	Strong immigration-trade link
White (2007)	U.S. immigration data and census	U.S. bilateral trade data	Significant positive effect on exports and imports (both preference and network effects found)
Murat & Pistoresi (2009)	Italian immigration and *emigration* data	Italian trade data (Statistics Italy)	Positive effect of emigration, no effect of immigration (or even a negative one)
Lee (2012)	23 OECD countries, cross-sectional (OECD statistics)	23 OECD countries (IMF, UN Comtrade and UN Service Trade)	Positive for manufactured goods***

* for non-Commonwealth countries
** studies also effects of colonial ties, language etc.
*** studies also the effect of the Internet (as a proxy for IT networks) and FDI (a proxy for business networks), immigration represents social networks

2.4. Immigration – cause or consequence of trade?

An important aspect of the relationship between immigration and trade is actually the direction of causality between the two. Albeit in this study (as well as in most of the empirical studies introduced above) immigrant stock is used as an independent, exogenously given, variable in the empirical analysis, the direction of correlation is not self-evident. Could it be actually so that an increase in trade might result in higher immigration? Therefore, in this section the direction of causality between immigration and trade is discussed by taking into consideration some factors that might affect the decisions to migrate, for instance. In this way, the solution for the direction of causality is tried to be solved by investigating migration decisions. Causality will also be examined in section 4.4.2 in which the use of instrumental variables is discussed as an alternative to solve for endogeneity as well as some examples of variables are listed; in the same section some technical methods are outlined as well.

To begin with, Borjas (1994) mentions that it is crucial to understand the factors that lead to immigration in order to understand economic effects of immigration. Understanding factors that lead to immigration could potentially also solve the problem of the direction of correlation if it could be shown that other factors but trade are the only reasons for a migration decision. However, it might be very difficult to show this hypothesis absolutely true since there are certainly at least some immigrants who have moved into a country as a result of trade (for example, it could be people who work in multinationals and are engaged in sales related activities).

Thus understanding decisions to migrate would also be crucial for the scope of this study, but no easy answer exists as the reasons to migrate are multifaceted and the explanations require thorough understanding of reasons from a duly multidisciplinary perspective. It is argued, for example, that decisions to emigrate come from the fact that moving to another country will make it possible to maximise the revenue or the salary of the employee; on the other hand, the existing diaspora could potentially also affect migration decisions. When asked, the immigrants respond that reasons to come to a country are: higher standard of living and existence of other immigrants in a country (OECD 2012). Furthermore, Lundborg (1991), for instance, noted that the migration from Finland to Sweden was mainly explained by real wage differences. The author hypothesised that as wage differences get smaller immigration to Sweden would slow down.

So, until this point none of the reasons seem to hint at the direction of causality directly from trade to immigration albeit it is worth noting that trade could have affected employment opportunities among other things in some country and hence could be regarded as a reason for immigration. Anyhow, considering the Finnish context it is worth scrutinising the Ministry of Interior's (2013: 5) report, in which reasons behind migration to and from Finland are outlined. According to the report, in 2011 the main reasons to move to Finland for the immigrants that need a residence permit are family ties and studies, employment only comes third with 27 % of those who were granted a residence permit having this reason. However, as more than 1/3 of the immigrants come from the EU countries and do not need a permit, no conclusion of the overall composition of reasons to immigrate can be done. If we assume that the immigration decisions follow the same pattern for all groups, yet less than 30 % of the immigration is directly caused by employment or entrepreneurship opportunities.[7] This would alleviate problems to do with causality if we expect only a small proportion of the 30 % (employment related immigration) to be caused by trade (i.e. only the jobs that were born as a result of existing trade).

Notwithstanding, this does not solve the causality problem totally since trade might indirectly be behind other reasons to immigrate as well. With a reasonable probability, however, it is safe to say that only a small proportion of immigration to Finland could be caused by trade (i.e. via the jobs that were born as a result of trade), giving stronger support for the direction of causality from immigration to trade.[8]

Moreover, Gould (1994) also outlines reasons why the direction of causality would run from immigration to trade, not vice versa. He argues that quotas for immigration make immigration flows exogenously determined, and that reasons for immigration come from wage differentials and existing immigrant community. Obviously, the first argument of quotas cannot be applied to the case of Finland since the European Union enables free movement of labour. However, ignoring data on the EU countries, some quota usually sets the limits to the immigration. Therefore, it could be useful to use data only on countries that are not members of the EU, or more specifically include data only on the immigrants that require a residence permit. The third justification for the direction of causality is found in Gould (1994) using Granger's causality test that will be discussed later in section 4.4.2.

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[7] However, it is likely that a greater proportion of EU citizens move to Finland as a result of employment opportunities, as the review by Finnish Immigration Service (2013) also suggests.

[8] Still variation between immigrant source countries remains, such as US work vs. Russia family (Finnish Immigration Service 2013).

Conversely, Poot and Strutt (2009) take a different, slightly dubious, position on immigration and trade introducing an idea that trade might potentially result in immigration through high tariffs – if a country induces high tariffs, demand for other countries' exports will be diminished and as a result the tariffs reduce demand for labour in export sector in a the trading partner of a high tariff country. This may lead to immigrant's decision to move to the high tariff country, in which the wages in protected industries might also be higher. However, considering Finland's low, approximately 2 % (World Bank 2012), aggregate tariff level the above mentioned effect seems unlikely; also, the country is a member of the EU and, additionally, due to its small size it would be impossible for it to impose tariffs that have that wide effects to its trading partners. Also, when the relationship between aggregate trade data and immigration is studied, no such effects would be expected since the effects would concern probably individual industries and have smaller effects on the aggregate trade.

Finally, although immigration was caused by trade (i.e. labour that has migrated due to its work in companies that trade), immigration might later on increase trade again even more through always reducing trade costs. For example, in the case of increasing exports the explanation could be that the host country would further benefit from migrant employees' knowledge of her home market, which would result in firms exporting even more, for instance. However, in that case it would be difficult to estimate the size of the effect due to two opposite effects prevailing and immigration and trade affecting each other in cycles.

By and large, the definition of immigrants to different groups is also linked to the problems of causality. If the immigrants are individuals who have, for example, higher education, it is more likely that they migrate as a result of finding a job in foreign trading firm. Anyhow, as mentioned earlier, the data on immigrants' education level is not available in Finland, and the immigrants will be treated as an aggregate group in the study.

Based on the facts presented above, an assumption on the direction of causality from trade to immigration should not bias the results obtained in the study remarkably; several other empirical studies have taken the direction of causality as given. Still, other aspects related to causality and the model used will be discussed in section 4.4.2.

2.5. Trade theories – towards the theoretical gravity equation

Having introduced briefly the situation of immigration and trade in Finland as well as potential reasons for the positive effects of immigration on trade, the basic ideas behind trade will be briefly discussed. Furthermore, understanding different theories of trade is crucial for understanding the derivation of a gravity equation from its different precursors. In this section, also, the theories in which factors of production movements can be complementary to trade are very briefly introduced, in contrast to the traditional Ricardian and Hecksher-Ohlin (H-O) type models in which the differences in factor endowments explain trade flows.

The very first "theory" of trade was constructed by Ricardo in 1817 when he alluded to the concept of comparative advantage. In other words, Ricardo's idea was that by specialising in doing things the country can do the best each country will be able to consume more and do relatively better.[9] Eaton and Kortum (2012) explain trade based on Ricardo's theory on comparative advantage, which in their model is a result from countries' differing technological advances, and also note that the theory, although very simple by its principles, can be expanded to be more realistic by having assumptions, for example, on preferences and taking into consideration the Samuelson's (1977) suggestion of trade costs.[10] The Ricardian model also lays the grounds for the gravity model developed by Eaton and Kortum (2002) which is introduced later in section 3.4.

This description shows how the driving factors for the trade are differences in countries' technologies as well as the resulting wage differences and prices for goods – taking into account also the trade costs that impede trade. No talk of relative factor endowments is included as the (purely) Ricardian model only considers one factor of production (in contrast to the H-O model with countries having different relative factor endowments in several factors of production).

However, even for a relatively long time, ideas have existed that something else but the differences in relative factor endowments act as a basis for trade: clearly, trade that is created by relative factor endowments would require that equalisation in factor endowments would lead to a reduction in trade between the countries; in other words, factors of production and trade would act as substitutes. Thus, for example, Mundell (1957), has resorted to the idea of substitutability between factors (capital) and trade, but approaches the topic from a different angle. He states how trade impediments stimulate factor movements and impediments to factor movements stimulate trade, and hence, factors and trade in his work are substitutes. On the contrary, as Markusen (1983) notes, in many cases increases in factor mobility have lead to increased

[9] Of course, this assumption of "doing better" as a result of free trade only refers mainly to more consumption opportunities in the Ricardian world, but the theme will not be developed further here.
[10] Details of this Ricardian type model can be found in in Eaton and Kortum (2012).

trade. This suggests that factor endowments and trade are not necessarily substitutes. Additionally, as it could be deduced from the empirical literature on immigration and trade flows, the situation is more likely to be described by trade and immigration, i.e. movement of factor *labour*, being complementary. This remark and Markusen's (1983) study could be taken as evidence for factor movements and trade being complements, and some other ingredient than relative factor endowments being the cause of trade.

Consequently, the above introduced approaches to trade by Eaton and Kortum (2012) and Markusen (1983) seem to hint at other causes but factor endowment differences as a basis for trade. The H-O model, in which country exports goods in which it has abundant factors seems to be a special case explaining trade, and therefore the "Ricardian" model explained by different technological advances, or the models that encompass, for example, imperfect competition or product differentiation might be more realistic to assume.

Hence as a starting point for the next section, this section lays the grounds for the assumptions used in the following chapter in which the derivation of the theoretical gravity equation from two different starting points is explained. The Eaton and Kortum's (2002) formulation evidently has its roots in the Ricardian world of differing technological advances whereas Anderson and van Wincoop's (2003) model departs from product differentiation between different countries of origin. However, both result in standard generalized gravity equation.

3 Theoretical background of gravity equation

Gravity equation provides us with a possibility to represent economic interactions easily in a many country world in contrast to the most of the theories of international trade that are limited to two country (or at best) three country cases; gravity equation therefore can be seen as enabling more realistic, yet complicated, representation of trade (Anderson 2011). As a result, gravity equation was chosen in this research to study the effects of immigration on export and import flows.

The major part of the studies on immigration and trade has used the traditional gravity equation, introduced in section 3.1, and the so called theory based gravity equation on estimating the effects of immigration on trade has been less frequently used.[11] Thus before discussing the theoretical equation the traditional gravity equation is presented.

3.1. Traditional gravity equation

The standard, ordinary or traditional gravity equation has been introduced in several studies and could be specified as follows:

$$X_{ijk} = \alpha_k Y_i^{\beta_k} Y_j^{\gamma_k} d_{ij}^{\mu_k} U_{ijk} \tag{1}$$

where X_{ijk} is the dollar value of the flow of good k from country i to country j, Y_i and Y_j are the GDPs of country i and j respectively, d_{ij} is the distance between the countries, and finally, U_{ijk} is the error term (Anderson 1979).[12] α, β, γ and μ are unknown parameters. The above shown standard gravity equation in logarithmic form has been used in several studies on immigration's effects on international trade due to the facileness of adding to the equation explanatory variables that can be seen as benefitting or hindering trade (Bergstrand 1985).

The log-linearised version of the equation that is employed in regression for an ease of obtaining results, is introduced, for instance, by Anderson and van Wincoop (2004: 706), and below a slightly modified version consistent with the above shown specification (1) is shown:

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[11] See, for example Gould (1994), Trinidade and Rauch (2001) etc.

[12] Anderson (1979) further includes a lognormally distributed error term to the model so that $E(lnU_{ijk}) = 0$. This assumption is more closely looked at in section 4.5 where the actual regressions (OLS and Poisson regression) are discussed.

$$x_{ij} = \alpha_1 y_i + \alpha_2 y_j + \sum_{m=1}^{M} \beta_m \ln(z_{ij}^m) + \varepsilon_{ij} \quad (2)$$

In the above equation (2) the dependent variable x_{ij} is the logarithm of trade flows between the countries *i* and *j*, y_i and y_j respectively are logarithms of the incomes of the countries and z_y captures a set of other factors (totalling to *m*) that are related to trade costs (including distance d_{ij} from above). ε_{ij} represents the error term lnU_{ij}. The specification is the same as above, except for its logarithmic form and the equation being valid only for one good or for total trade flow (not *k* different goods as before).

Concerning the traditional gravity equation, Anderson and van Wincoop (2003) mention that it is affected by omitted variable bias and, due to lacking theoretical foundations, it has not bases for comparative static analysis; the comparative static analysis is not possible due to the equation not representing full general equilibrium result (Anderson and van Wincoop 2004). To correct the omitted variable bias, a concept of multilateral resistance – the average trade barrier that the country encounters in trading with all the other countries – is introduced in Anderson and van Wincoop (2003). In the following section 3.2 the idea of multilateral resistance is developed more.

3.2. Theory based gravity equation – Anderson and van Wincoop

As there would be several starting points for a theoretically founded gravity equation, in this study the model by Anderson and van Wincoop (2003, 2004) and Anderson (2011) will be elaborated first in detail because it leads to a specification that closely resembles the traditional gravity equation introduced above. Later on we will introduce other ways to arrive in similar results.

The key idea in all of the theory based gravity equations is that trade is dependent on trade barriers – including distance, tariffs and many other concrete and abstract barriers – between the regions (Snorrason 2012). These trade barriers include not only bilateral barriers between the two trading partners, but also multilateral trade resistance i.e. the barriers that each country faces with all their (domestic and foreign) trading partners (Adam and Cobham 2007).

The bilateral frictions were not seen to be enough to explain frictions to trade flows from *i* to *j*, but the trade flows were seen to be also relative to country *i*’s trade with all the other trading partners as well as *j*'s trade with its partners (Anderson 2011). As a result, without any theoretical explanation, a so called remoteness index in which country's average effective distance, i.e. $\sum_i d_{ij}/Y_i$, was included to capture the remoteness in empirical work using the gravity equation (Anderson 2011: 135). This remoteness index, although frequently observed empirically significant, would require theoretical foundations. The theoretical gravity models hence enable us to consider the remoteness index (or more specifically, multilateral trade resistance) theoretically and take it into account when constructing the empirical specification. How to arrive in the gravity equation will be explained in the coming sections (starting in 3.2.1). Before that, some assumptions and background for the theory is offered.

The gravity equation explained in Anderson and van Wincoop (2004: 707) requires an equilibrium of within nation expenditure and production. The gravity equation is also developed under relatively similar conditions, for example, in Anderson (1979) and Bergstrand (1985), in all of which the gravity equation is derived from the general equilibrium world trade model. However, the general economic equilibrium would require that the set of bilateral factor and goods prices are such that the markets clear and all budget constraints are met, at both national level as well as at the level of individuals, and therefore Anderson (2011: 139) clearly states how some useful simplifications or restrictions are needed to obtain the "structural gravity equation". [13]

The first one deals with trade separability, or modularity (Anderson 2011: 139). For trade separability to hold, separable preferences and technology are assumed. Moreover, according to Anderson and van Wincoop (2004: 707) "each product class has a distinct natural aggregator of varieties of goods distinguished by country of origin". This leads to a two-stage budgeting, hence, trade separability means that the expenditure is first allocated for the product classes and then within a product class across countries of origin (Anderson and van Wincoop 2004: 707). According to Anderson (2011: 139) this property permits an analysis, in which it is not necessary to consider the total supplies of and demand for goods to all countries; it also enables inferring distribution costs from the pattern how the goods are actually distributed. This makes deducing costs easier and consistent from the point of view of general equilibrium models of production and consumption.

[13] The framework presented in this thesis resorts mostly to Anderson and van Wincoop (2004) and Anderson (2011). Anderson (2011) presents the derivation of the gravity equation from the demand side but mentions the possibility of obtaining the structural gravity model on the supply side as well, as in Eaton and Kortum (2002).

However, the assumption of modularity imposes some restrictions on trade costs, most importantly how the "national aggregate burden of trade costs within a goods class matters for allocation between classes" (Anderson 2011: 139). To conform to this, costs are often supposed to be so called iceberg costs in which the distribution costs of goods are proportional in the same way as the production of these goods uses resources (Anderson 2011). Nonetheless, other cost types can be considered and, for example, Bergstrand's (1985) CET (constant-elasticity-of-transformation) joint production surface, although consistent with the modularity assumption, does not follow the iceberg analogy. According to Bergstrand (ibid.), the resources can be allocated in a way that the elasticity of supply between home and foreign markets and the elasticity of supply among foreign markets can be different. As outlined in Anderson (2011) this model does not similarly assume that the trade costs are independent, but in the model the supplier makes a profit maximisation choice based on the destination (substitution effect in costs between destinations). Other cost functions are also possible in addition to the generally linear iceberg costs; the assumptions related to trade costs that are followed in this study are discussed in section 3.2.2 when further discussing the model.

Overall, a simplification of general equilibrium theory which allows trade to be analysed *separately* from the production and consumption decisions of the country acts as a basis for the theoretical gravity equation. This *conditional general equilibrium* obtained as a result of trade separability restriction is not sufficient for comparative static analyses, and two additional restrictions are needed to be included in trade separable models to yield gravity equation (Anderson and van Wincoop 2004: 707). These restrictions added to the trade separability are that 1) the aggregator of varieties is identical across countries and CES[14] and 2) that the tax equivalents of trade costs are independent of the quantity of trade (Anderson and van Wincoop 2004: 707).

3.2.1. Demand driven gravity

To start with, the effects on demand for the different classes of goods should be in accordance with modularity and depend only on aggregate price indices; therefore the usual assumption on demand is concerned with differing substitution elasticities between sectors based on their locations (Anderson 2011). The same products are differentiated based on a country of origin and hence imposing a tariff or other trade restrictions to one country, for instance, would not have too heavy effects on the demand from other countries. In other words, the changes in the total

[14] This implies homothetic preferences and for the intermediate input demand homogeneity. Consequently, these assumptions simplify both demand and market clearing equations (Anderson and van Wincoop 2004: 707).

demand for some goods class would not be very large if trade restrictions affect only one or few trading partners.

According to modularity, this demand-side structure works basically so that first, given the general price index, the consumer selects how much to consume composite good or aggregate, and the allocation is made between the composite goods (e.g. steel vs. chemical A). Then the consumer selects the between varieties consumption (e.g. steel from Belgium vs. from Sweden, chemical A from Belgium vs. from Sweden etc.) given the relative prices of the varieties. The amount to which the between-variety allocation changes in the relative price is determined by the Armington substitution elasticity[15] (Snorrason 2012). Thus the separability implies that the expenditure shares within chemical A class, for example, will not change when there are changes in prices of other products. Anderson (2011) also notes that identical preferences across countries are a usual assumption, and homotheticity implies that relative demands depend only on relative aggregate prices (i.e. the expenditure shares are invariant to income).

Anderson (1979 and 2011) and Anderson and van Wincoop (2003) start with the assumption of expenditure function derived from the utility function in equation (3). As mentioned earlier, the assumption of CES and identity for the aggregator of varieties across countries (for a product class) would be required as well as that the tax equivalent trade costs are independent of the trade quantity, meaning that the trade costs are not proportionally larger or smaller as the amount of trade increases (Anderson and van Wincoop 2004). However, Anderson and van Wincoop (2003: 174) further simplify the gravity equation by assuming that every country is only specialised in the production of only one good and that the substitution elasticity, σ, is common among all goods. (Later in this section an alternative version is shown in which different product classes, k, are permitted).

To begin with the formal presentation of the model, the consumer maximises the utility function in (3) with respect to the budget constraint in (4) assuming a CES utility function that approximates homothetic preferences:

$$U_j = \left(\sum_i \beta_i^{(1-\sigma)/\sigma} c_{ij}^{(\sigma-1)/\sigma} \right)^{\sigma/(\sigma-1)} \qquad (3)$$

[15] Armington elasticity refers to the products not being separated only by their kind but also by their origin (Armington 1969: 159-160).

$$\sum_i p_{ij} c_{ij} = Y_j \quad (4)$$

in which β is a positive distribution parameter that reflects the preference for goods produced in a certain country i, c_{ij} is the consumption of goods from country i in country j, p_{ij} stands for prices of country i to country j's consumers and Y_j is the nominal income in country j ($Y_j = E_j$, market clearing, assuming one sector economy), σ is the elasticity of substitution between goods (Anderson and van Wincoop 2003: 174; Snorrason 2012). Assuming proportionality of trade costs to trade indicates that the price for the exports from country i can be expressed as $p_{ij} = p_i t_{ij}$, in which t_{ij} represents (*1 + "tax equivalent of trade cost")*[16] and p_i is the price that the producers receive in country i (Anderson and van Wincoop 2003).[17]

Thus Anderson and van Wincoop (2003) also define the nominal value of exports from i to j as $X_{ij} = p_{ij} c_{ij}$; this nominal value tells us the value of the exports of any i in any importing country j since it also includes the trade costs (in p_{ij}). Finally, the sum of all X_{ij} (including $i = j$) is equal to the exporting country's nominal income Y_i.

In the case of CES, maximising the utility function given above taking into account the budget constraint in (4), leads to the following form for the expenditure share of country i's exports demanded in country j:

$$\frac{X_{ij}}{E_j} = \left(\frac{\beta_i p_i t_{ij}}{P_j} \right)^{1-\sigma} \quad (5)$$

where X_{ij} is the exports from i to j, E_j is the expenditure (and income) in j, p_i is the price "at the factory gate", t_{ij} is the factor of trade costs between i and j, σ is the elasticity of substitution amongst the products, P_j (shown in (6) is the CES price index (Anderson and van Wincoop 2003; Anderson 2011). The cost factor t_{ij} captures that the trade costs in the model are totally borne by the importer of the goods, country j in this equation. Additionally, CES price index is given by:

[16] E.g. a 44 % border-related barrier translates into (1 + 0.44) in 1+tax equivalent of trade cost.
[17] Following Anderson (2011), with frictionless trade t would be equal to 1, which would imply that the seller i's share of good in market j would be $(p_i/\Sigma p_i)^{1-\sigma}$, indicating equality with the seller's share of world sales Y_i/Y.

$$P_j = \left[\sum_i (\beta_i p_i t_{ij})^{1-\sigma} \right]^{1/(1-\sigma)} \qquad (6)$$

Furthermore, it is important to assume that the markets clear[18], $\sum_j X_{ij} = Y_i$ (Anderson and van Wincoop 2003). Using these, by first multiplying equation (5) by E_j and then summing over j, as market clearing indicates, yields (7) according to Anderson and van Wincoop (2003: 175):

$$Y_i = \sum_j X_{ij} = \sum_j \left(\frac{\beta_i p_i t_{ij}}{P_j} \right)^{1-\sigma} E_j = (\beta_i p_i)^{1-\sigma} \sum_j \left(\frac{t_{ij}}{P_j} \right)^{1-\sigma} E_j \qquad (7)$$

From above, the scaled prices $\beta_i p_i$ is solved and then substituted back to equation (5) multiplied by E_j to obtain the demand for the country i exports, and then to equation (6); the following results, when we also assume that the sum of expenditures over j must equal world total income, $\sum_j E_j = Y$ (Anderson and van Wincoop 2003; Snorrason 2012: 81-82).

$$X_{ij} = \frac{E_j Y_i}{Y} \left(\frac{t_{ij}}{P_j \Pi_i} \right)^{1-\sigma} \qquad (8)$$

$$\Pi_i = \left[\sum_j \left(\frac{t_{ij}}{P_j} \right)^{1-\sigma} \frac{E_j}{Y} \right]^{1/(1-\sigma)} \qquad (9)$$

$$P_j = \left[\sum_j \left(\frac{t_{ij}}{\Pi_i} \right)^{1-\sigma} \frac{Y_i}{Y} \right]^{1/(1-\sigma)} \qquad (10)$$

Pj and Π_i represent the indices of all the trade costs in the gravity equation model (gravity equation is (8)). It can be clearly seen that these indices, that Anderson and van Wincoop (2003) give the name of the “multilateral resistance”, are dependent on bilateral resistances and furthermore affect trade. On the other hand, the authors (2003: 176) mention that the interpretation

[18] There the assumption is that X_{ij} includes the case X_{ii}.

of these indices more generally as price indices is not proper since the “multilateral trade resistance variables” can also be interpreted when trade costs are in non-money based terms.

Anderson and van Wincoop (2004) note that the model presented above does not restrict production and expenditure models since E_j and Y_i can have any value, including zero. In the equation, t_{ij} represents bilateral trade resistance, trade costs or trade barriers. Π_i and Pj are defined as outward and inward multilateral resistance variables respectively. When either of the multilateral trade resistance variables is higher, the bilateral trade flows between *two countries i* and *j* will be higher. This can also be explained intuitively: increasing resistance between *j* and any other country decreases the relative prices of country *i*’s products, and similarly increase in general trade resistance for *i* increase trade due to relatively lower price (Anderson 2003: 176).

Furthermore, some modifications to the model are possible and by assuming symmetric trade costs (i.e. $t_{ij} = t_{ji}$) for the two countries and balanced trade, the insight from the model is that $\Pi_i = P_i$ (Snorrason 2012: 82). From (9) and (10) it can be derived then that

$$P_j^{1-\sigma} = \sum_i \Pi_i^{\sigma-1} \theta_i t_{ij}^{1-\sigma} \tag{11}$$

, in which θ represents the income share of country *i* or *j* (Anderson and van Wincoop 2004). Obviously, this model of gravity is a special case in which the trade costs are symmetric and where $P = \Pi$. In this aggregated (one sector) case the gravity equation simplifies to ($E_j = Y_j$ since one-sector economy):

$$X_{ij} = \frac{Y_j Y_i}{Y} \left(\frac{t_{ij}}{P_j P_i} \right)^{1-\sigma} \tag{12}$$

The gravity equation in which we arrived above requires, as we discussed in the beginning of the section, trade separability, the aggregator of varieties to be same across countries and CES, and also that the tax equivalent trade costs are independent of the trade volume (Snorrason 2012).

Nonetheless, before moving on, a slightly more general approach is discussed and its differences with the above presented are compared. As mentioned earlier, the model presented in Anderson and van Wincoop (2003) and Anderson (2011) is a mere simplification of a more realistic model in which several product classes would be allowed. When different product classes *k* are permitted and each country can produce more than one good, the model in (8)-(10) is obtained (Anderson and van Wincoop 2004).

$$X_{ij}^{\ k} = \frac{E_j^k Y_i^k}{Y}\left(\frac{t_{ij}^{\ k}}{P_j^{\ k}\Pi_i^k}\right)^{1-\sigma_k} \tag{8}$$

$$\left(\Pi_i^k\right)^{1-\sigma_k} = \sum_j\left(\frac{t_{ij}^{\ k}}{P_j^{\ k}}\right)^{1-\sigma_k}\frac{E_j^k}{Y^k} \text{ or } \Pi_i^k = \left[\sum_j\left(\frac{t_{ij}^{\ k}}{P_j^{\ k}}\right)^{1-\sigma_k}\frac{E_j^k}{Y^k}\right]^{1/(1-\sigma_k)} \tag{9}$$

$$\left(P_j^k\right)^{1-\sigma_k} = \sum_j\left(\frac{t_{ij}^{\ k}}{\Pi_i^{\ k}}\right)^{1-\sigma_k}\frac{Y_i^k}{Y^k} \tag{10}$$

The model presented above is more realistic than the simplified version. For instance, this version of the same model permits a multi-sector economy and different elasticities, σ_k, in the different goods classes (Anderson and van Wincoop 2004: 709).

Now, what is important, in both of the gravity models (*k* goods and not) that were presented above, it is clearly observable that inferring results from this kind of a gravity equation requires information on the elasticity of substitution, σ, and hence in section 3.5 we will further discuss its significance to the study. Before going to that, however, trade cost function present in the above equation is first briefly outlined.

3.2.2. Trade cost function

Anderson and van Wincoop (2004: 710) state that unobservable trade costs, such as, for example, those linked to information availability, can be either 1) linked to observable cost proxies or 2) an assumption might be made about “the error terms which link observable trade flows to theoretically predicted values”. The first alternative will be described below and is used to form the specification for the trade cost function that can be then be used in the gravity equation as in equation (12).

The trade cost function can be given as follows in a multiplicative form that becomes in log-linear form additive with all the trade costs:

$$t_{ij} = \prod_{m=1}^{M} (z_{ij}^{m})^{\gamma_m} \quad (13)$$

where $(z_{ij}^{m})^{\gamma}{}_{m}$ is the (*1 + tax equivalent*) trade cost of the variable that is associated with some variable *m* and can be any observable variable that is assumed to generate trade costs; the trade costs are normalised so that z_{ij}^{m} measures zero trade barriers (Anderson and van Wincoop 2004: 711).

The costs that are considered include basically all the other costs except for the marginal cost of production of the good itself (Anderson and van Wincoop 2004). Additionally, the authors introduce, but also criticise, the linking of observable variables to trade costs on an *ad hoc* basis; the variables mentioned include common language, better information and contract enforcement, among others – however, noting that exogeneity of the trade cost proxies should be considered rigorously to do this. The use of immigration as a proxy for either information costs or home bias can be justified as long as its exogeneity from trade can be explained rigorously.

What comes to the trade cost function, the importance of a correct functional form arises when drawing conclusions about the effects of trade costs and considering comparative statics (Anderson and van Wincoop 2004). Thus a correct functional form would guarantee that the estimate of the magnitude of the effect is consistent (or at least correct in the context of the functional form used). Nonetheless, a lot of questions arise in the context of more abstract trade barriers and how they should be presented as trade costs (Anderson and van Wincoop 2004: 711). For example, in the case of immigration, it should be considered how the immigration affects trade, whether this effect is linear or not and so on. Finally the authors (2004), however, mention that identifying trade costs as simple functional forms, like (13), is the easiest way to proceed.

3.3. Homogenous goods and gravity – Eaton and Kortum

As mentioned briefly in section 2.5 the model by Eaton and Kortum (2002) is a Ricardian trade model that is based on comparative advantage and takes into account geography (trade barriers) in general equilibrium context. In contrast to the model introduced above in section 3.2, there is no requirement for the goods to be unique but countries can trade in homogenous goods, which might be more realistic when considering general trade patterns (Eaton and Kortum 2002). In the previously discussed demand side model either Armington assumption (in e.g.

Anderson 2004) or monopolistic competition, in which firms in different countries produce differentiated goods (Bergsrand 1985), are assumed. In the Eaton and Kortum (2002) model the initial assumptions are very different due to the starting point in the supply side.

The model of Eaton and Kortum (2002) starts with the idea that each country varies as for access to technology, implying that efficiency in production over countries and goods varies. Therefore each country i can produce goods j with a different efficiency $z_i(j)$.[19] Initial assumption on the costs of inputs between the commodities in a country being the same – due to mobile inputs across activities and equal input shares of activities – also simplifies the model. Hence, denoting input costs/unit as c_i, the unit production of good j in country i costs $c_i/z_i(j)$ when constant returns to scale are assumed. Furthermore, assuming geographic barriers in the form of iceberg costs the price that is paid for country i goods in country n becomes $p_{ni} = [c_i/z_i(j)]d_{ni}$. Here $d_{ni} > 0$, $n \neq i$ simply measures how much good in country i is needed to be delivered in order for one unit to be received in country n. Naturally, buyers in country n choose to buy from any country that offers the lowest price for the good j and hence for a selection of source countries i the price that country n's buyers are willing to pay is: $p_n = min\{p_{ni}(j);\ i = 1, \ldots, N\}$. Purchasing goods $j \in [0,1]$ the buyer (or intermediate producer) will maximise its CES utility function subject to a budget constraint, facing the minimum price for each good, where country n's total expenditure is X_n. (Eaton and Kortum 2002: 1744-1746).

To contrast the first steps taken in this model to on presented earlier, the difference is evident. Eaton and Kortum (2002) make an assumption of the input costs of production being different between the countries whereas Anderson (2011) does not allow this because prices are taken as given, not taking into account input costs.

3.3.1. Efficiency

To move on, the efficiency of production of good j in country i is then drawn for each country i from a probability distribution, $F_i(z) = Pr[Z_i < z]$. It is assumed that Z_i is a random variable of which realisation determines country i's efficiency based on the distribution F_i. This also gives for country i the fraction of goods j for which the efficiency in production is below efficiency z (by the law of large numbers). The price of some good j that country n buys from country i depends on the realisation of $P_{ni} = [c_i/Z_i]d_{ni}$, a random variable, and consequently the lowest

[19] Note that the indices used here are different than in section 3.2. The index i still represents exporting country, but the j now represents goods and n importing countries. This annotation was chosen to comply with the original indices in Eaton and Kortum's (2002) article.

price is $P_n = min\{P_{ni}; i = 1, ..., N\}$ with highest efficiency. With a certain probability π_{ni} country i will have the lowest price and supply a particular good to country n. (Eaton and Kortum 2002).

To obtain π_{ni} and the distribution for the prices, an extreme value Fréchet distribution is assumed to represent country i's efficiency distribution. This is represented in equation (14) below

$$F_i(z) = e^{-T_i z^{-\theta}} \tag{14}$$

where $T_i > 0$ and $\theta > 1$, and T_i characterises country i's state of technology in this context and in Ricardian terms gives the absolute advantage of a country (i.e. tells us where the distribution is located). In turn, θ represents what is the comparative advantage and controls heterogeneity in relative efficiencies over goods (i.e. shows the variation in distribution). Higher θ implicates that there is less variability or heterogeneity in production costs, and this means that the probability of the efficiency being greater than z and that the production of the good takes place is smaller. Higher T, in turn, says that a chance for a draw for Zi greater than z is increased. (Eaton and Kortum 2002).

3.3.2. Prices

Then, the expression for prices P_{ni} that was obtained earlier is substituted for z in the efficiency distribution. The prices for which the country n will buy from i are the prices smaller than p (or efficiency higher than z) and this is represented by a distribution $G_{ni}(p) = Pr[P_{in} < p] = 1 - F_i(c_i d_{ni}/p)$ that can be shown as

$$G_{ni}(p) = 1 - e^{-\left[T_i (c_i d_{ni})^{-\theta}\right] p^{\theta}} \tag{15}$$

For a particular good the price that country n pays is less than p if the price from each source is not higher than p. For this to exist the distribution of prices in n must follow $G_n = Pr[P_n < p]$, for which country n buys when

$$G_n(p) = 1 - \prod_{i=1}^{N} \left[1 - G_{ni}(p)\right] \tag{16}$$

, where the term $\prod_{i=1}^{N}[1-G_{ni}(p)]$ represents the situation when all the sources' prices are greater than *p*. Furthermore, substituting equation (15) to (16), country *n*'s buying price distribution consequently becomes

$$G_n(p) = 1 - e^{-\Phi_n p^{\theta}} \tag{17}$$

, where price parameter Φ_n stands for $\sum_{i=1}^{N} T_i (c_i d_{ni})^{-\theta}$. The price parameter shows how the technology, input costs as well as geographic barriers control for prices in each country. (Eaton and Kortum 2002).

Moreover, the price distribution of the form above results in properties that are useful later on. First of all, the probability that country *n* buys from country *i,* or the probability that country *i* provides the lowest price, can be obtained as a ratio of parameters for $G_{ni}(p)$ and $G_n(p)$ and this also gives the proportion of goods *j* that *n* buys from *i*, namely shown by:

$$\pi_{ni} = \frac{T_i (c_i d_{ni})^{-\theta}}{\Phi_n} \tag{18}$$

Secondly, the price by which country *n* in reality buys from *i* also follows $G_n(p)$ and it is indicated that for the goods bought, the prices are not dependent on the source. The lower cost country therefore sells a wider range of goods, but the price distribution that the importer pays follows $G_n(p)$. Finally, also the CES price index is obtained, explaining the deviations from the purchasing power parity due to geographic barriers affecting the price parameter in the equations below. (Eaton and Kortum 2002).

$$p_n = \gamma \Phi_n^{-1/\theta} \tag{19}$$

$$\gamma = \left[\Gamma\left(\frac{\theta + 1 - \sigma}{\theta} \right) \right]^{1/(1-\sigma)}$$

As mentioned above in the second point introduced "country *n*'s average expenditure per good does not vary by source". Eaton and Kortum (2002) outline that this leads to the idea that the fraction of goods π_{ni} that country *n* buys from country *i* is the same as the fraction of expenditure of country *n* on country *i's* goods X_{ni} of its total expenditure X_n, which already resembles the traditional gravity equation where the bilateral trade is linked to geographic barriers and importer's total expenditure. Moreover, assuming that exporter's total sales are the sales of country *i* to all the countries *m* (*m = 1,2,…i,…,n*; thus exports from *i* to *i* included) and solving for $T_i c_i^{-\theta}$ for this and applying (19), gives an equation:

$$X_{ni} = \frac{\left(\frac{d_{ni}}{p_n}\right)^{-\theta} X_n}{\sum_{m=1}^{N} \left(\frac{d_{mi}}{p_m}\right)^{-\theta} X_m} Q_i \qquad (20)$$

where *Qi* is the exporter country's total sales, *Xn* importer *n*'s total purchases and the denominator represents total spending of all the importers (*m*), but adjusted for geographic barrier between *i* and any other importer *m* that is deflated by any importer's price level, indicating that increasing geographic barrier and decreasing price level have a similar effect (i.e. trade reducing effect for *i* to *m* trade). The denominator can therefore be dubbed the total effective world market from country *i*'s perspective. (Eaton and Kortum 2002).

Comparing to the models with Armington assumption and monopolistic competition (first of which is represented in section 3.2), Eaton and Kortum (2002) point out that their model assumes trade shares responding to geographic barriers and costs at *extensive margin*, thus leading to a lower range of goods exported in the case of increasing barriers or costs. On the contrary, greater costs in the other models would mean that the same range of goods is exported but less is spent on imports by all the importers or any good (*intensive margin*). Also, trade is more sensitive to costs or geographic barriers as the substitutability between the goods is higher in the Eaton and Kortum model.[20]

3.3.3. Input costs

The model of Eaton and Kortum (2002) further assumes, instead of treating input costs as given, that the production takes place as a result of combination of intermediate inputs and labour, labour share being β in it. Assuming CES for intermediate input demand and that the importer's price index will follow equation (19), the cost of inputs becomes $c_i = w_i^{\beta} p_i^{1-\beta}$. This means that

[20] Considerations on labour markets omitted here, see Eaton and Kortum (2002: 1757).

the cost of production depends through price index p_i on prices in exporting country i as well as the input costs and hence the prices in all the other countries (see equation (19) in the previous section). Mutually determining price levels (substituting c_i to Φ_n and considering (19)) gives a system of equations for the price level in any importing country:

$$p_n = \gamma \left[\sum_{i=1}^{N} T_i (d_{ni} w_i^{\beta} p_i^{1-\beta})^{-\theta} \right]^{-1/\theta} \tag{21}$$

Similarly in any importing country the trade shares as a function of wages and prices can be expressed by modifying the trade share equation. (Eaton and Kortum 2002: 1756).

$$\frac{X_{ni}}{X_n} = \pi_{ni} = T_i \left(\frac{\gamma d_{ni} w_i^{\beta} p_i^{1-\beta}}{p_n} \right)^{-\theta} \tag{22}$$

To proceed to estimation of the trade equation, Eaton and Kortum (2002: 1759) continue with the normalisation of the equation (22) by the importer's home sales (divide $\frac{X_{ni}}{X_n}$ by $\frac{X_{nn}}{X_n}$) to obtain[21]:

$$\frac{X_{ni}}{X_{nn}} = \frac{T_i}{T_n} \left(\frac{w_i}{w_n} \right)^{-\theta\beta} \left(\frac{p_i}{p_n} \right)^{-\theta(1-\beta)} d_{ni}^{-\theta} \tag{23}$$

and then using equation (22) for both country i and n the following equation is obtained for the price relation between i and n:

$$\frac{p_i}{p_n} = \frac{w_i}{w_n} \left(\frac{T_i}{T_n} \right)^{-1/\theta\beta} \left(\frac{X_i / X_{ii}}{X_n / X_{nn}} \right)^{-1/\theta\beta} \tag{24}$$

21 After this Eaton and Kortum (2002) present a labour market equilibrium and determine the wages; for the brevity of presentation these will be skipped here.

and finally inserting the above to the equation (23) and taking logarithms gives an estimable gravity equation (25):

$$\ln\frac{X'_{ni}}{X'_{nn}} = -\theta\ln d_{ni} + \frac{1}{\beta}\ln\frac{T_i}{T_n} - \theta\ln\frac{w_i}{w_n} \qquad (25)$$

where $\ln X'_{ni} = \ln X_{ni} - \left[(1-\beta)/\beta\right]\ln(X_i / X_{ii})$, and similarly for lnX'_{nn}

Based on the equation (25) above, the trade barriers, the relative technology of the country as well as the relative wages would explain the change in the proportion of country *n*'s imports of country *i*'s goods (corrected by country *i*'s total expenditure ratio to home sales) to the change in country *n*'s consumption on home goods (corrected by country *n*'s total expenditure ratio to home sales). The model can be further simplified by defining $S_i = (1/\beta)lnT_i - \theta lnw_i$; S_i, which measures country's competitiveness (i.e. its technology adjusted with wages), will be captured in the estimation by the coefficients on the source country dummies.[22] Furthermore, it is simply assumed that the trade barriers (i.e. the functional form of the trade cost function) follow $lnd_{ni} = d + b + m + \ldots + CONTROL$, where all the variables are expressed as dummies and are proxies for geographic barriers and assumed trade impediments (Eaton and Kortum 2002: 1760).

All the variables in the Eaton and Kortum model are binary but no further considerations are given here as our specification departs from this model. Thus the functional forms are discussed more in detail in section 4 and 5 in the context of the empirical specification used and the analysis of the results.

3.4. From theoretical gravity equation to the specification

Almost identical theoretically derived gravity equations are obtained in Anderson (2011) with Armington assumption[23] in section 3.2 and in Eaton and Kortum (2002) assuming different technological advances and competitiveness between countries in section 3.3. Moreover, both Eaton and Kortum (2002) and Anderson and van Wincoop (2004) use proxies for geographic

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[22] "Since prices of intermediates reflect imports from all sources, *Xn* includes imports from all countries in the world. In other respects this bilateral trade equation lets us ignore the rest of the world." (Eaton and Kortum 2002: 1760)

[23] As well as in Bergstrand (1985) assuming monopolistic competition.

and other trade barriers, instead of a direct measure with a reasonable similarity of the assumptions on the trade costs. However, although the theoretical foundations for the equation are clear, we face the problem about the most suitable specification to be used in studying the effects of immigration on trade since our data does not adapt to the requirements of the equations. In addition, choosing either of the theoretical approaches as a basis for the analysis of the results would give us similar results, for example, when it comes to determining the magnitude of the effect of immigration on trade.

Anderson and van Wincoop (2004) review how the trade barriers enter an estimable gravity equation in theoretical gravity models, either obtained in section 3.2. They observe that the theoretical gravity equation in which the multilateral resistance is included can be solved in three different ways: 1) solving the multilateral resistances implicitly, 2) using country fixed effects or 3) using information on price indices (Anderson and van Wincoop 2004). Baier and Bergstrand (2009) outline the problems with the first two methods shortly: fixed effects impede the use of comparative statics without using a structural system of equations whereas the implicit multilateral resistance indices -method is computationally demanding. However, all three methods and their benefits and disadvantages are shortly discussed below.

First, as shown in equation (11), $P_j^{1-\sigma} = \sum_i \prod_i^{\sigma-1} \theta_i t_{ij}^{1-\sigma}$, the multilateral trade resistance indices cannot be assumed as simple observable consumer price indices 1) due to multilateral resistances including non-pecuniary costs and 2) because the consumer price indices contain information on prices of non-tradables (Anderson and van Wincoop 2003: 179). Following the authors (2003: 179), it could be possible to solve the multilateral resistance equations as a function of distance and other barriers, which results in a usable specification and an implicit solution for P_i that could be used in the specification to estimate the gravity equation with non-linear least squares. However, this is not the method that is selected to be used in this study.

In contrast, the use of country specific dummies, S_i (measure of competitiveness), as suggested by Eaton and Kortum's model in section 3.3 could also give unbiased estimates for the multipliers of the trade cost function by replacing the multilateral resistance variables by region specific dummies as shown in the end of section 3.3.3 (Eaton and Kortum 2002). Also Anderson and van Wincoop (2003) suggest this is one of the possibilities. In this study, country-specific dummies as such are not employed, but country-pair fixed effects and year dummies are considered later on when the model is used, but their interpretation will slightly vary from above.

Third method, and probably the simplest one, is presented by Anderson and van Wincoop (2004: 712) that suggest the use of price indices and estimation with OLS. This method, according to the authors, requires information on the price level in cross section data or changes of the price level in time-series data (panel data would permit the use of the latter ones as well). The authors (2004) resort to Bergstrand's (1989 etc.) model of the use of price indices in which wholesale price indices are used in the context of time-series data. However, the use of price indices has its limitations, as mentioned earlier, due to these indices including domestic goods, taxes and other determinants that make the indices consistent for all prices in a country including non-tradable domestic goods' prices. Additionally, not all the factors that affect trade necessarily have an effect on prices, such as home bias in preferences (Anderson and van Wincoop 2004). By and large, what comes to the handling of price indices in Bergstrand's (1989) and Anderson and van Wincoop's (2003) papers, it is obvious that the latter one follows the theory more closely by using implicitly derived indices instead of explicit wholesale price indices. Nevertheless, the use of price indices as in Bergstrand (1989) is considered in this study to depict multilateral resistances because this alternative gives us a chance to use the OLS estimator instead of non-linear regression.

There are notwithstanding many limitations when using the country specific dummies. Capturing the country fixed effects means that the gravity equation can be used to estimate coefficients of the bilateral variable but not that of any country specific variable that experiences perfect collinearity with the country fixed effect. In other words, capturing the effect of immigration on trade by using country fixed effects would require information on every country's immigrant population in each country (as a matter of fact, all the data would be required for each country). Then it would be assumed that immigration reduces trade costs and, thus, by having the data and setting the country-specific dummy, the overall effect of immigration on trade could be detected but no country specific effects.[24]

Furthermore, it is worth noting that if we think about using panel data in the study and assume country specific dummies that are invariant over years, the model of Eaton and Kortum (2002) would not be suitable in the study as the fixed effects include *unobservable* country-specific technology etc. that can vary over the years; these are factors which might have a great effect on amounts of goods traded. So, the estimation would not give reliable results on the effects of trade barriers using panel date. Therefore the best results would be obtained probably

[24] In this study, only the Finnish data on immigration by each source country is used and therefore no fully defined gravity equation is obtained as the situation described above would require.

by setting the country specific effects invariant and studying trade costs in a short sample or a cross-section, or assuming country *and* time specific effects, or taking a different approach and adding a remoteness variable (or something similar) to capture the multilateral resistance, although this might be problematic as discussed earlier.

Thus the use of the country fixed effects in our specification would be problematic since only Finnish export and import data with all the countries are considered. What is problematic there is that not all the data is considered for the rest of the countries (i.e. all their exports and imports with other countries, distance from all the others, and the number of immigrants from every country to another[25] etc.); therefore all of the country specific effects, that translate into multilateral resistance, are not taken into account from the theoretical view point when analysing the coefficients and, consequently, the effects of immigration on trade.

However, before moving on to the model used in detail, additional factors affecting the specifications are discussed. First, it is important to consider the error term in the specification. Usually the error term is taken to reflect the measurement error, in which case its orthogonality to the regressors is clear; however, the error term might also reflect unobservable variables in the trade cost function (Anderson and van Wincoop 2004: 713). Non-orthogonality of the error term may arise, for instance, from a misspecified trade cost function due to wrong functional form or due to the trade cost function not including unobservable variables that are reflected in the error term (Anderson and van Wincoop 2004). More discussion on the specification problems are discussed in section 4.4.

Referring to section 3.2.1, where the model by Anderson and van Wincoop (2003) for the gravity equation and trade costs is presented, the elasticity of substitution parameter, σ, would need to be defined for us to be able to infer the effect of trade costs as can be observed based on equation (12). At the beginning of chapter 4 more details on how to infer costs are outlined. This also affects the interpretation of the magnitude of the tax equivalent of trade barriers (Anderson and van Wincoop 2004).

Additionally, although in this study the elasticity of substitution will not be solved for, it is important to understand how the elasticity could be solved. Thus the simplest way is to include to the estimation of the gravity specification information on the tariff rate, transport costs or both and assume for the trade costs a functional form (Anderson and van Wincoop 2004: 715). Several others suggest similar method to solve the elasticity, but an alternative

[25] The collection of this data turned out to be very laborious due to the inexistence of combined and reliable database of world immigration stocks or flows.

would be to estimate demand equations directly using data on prices (Anderson and van Wincoop 2004: 716). Alternatively, Eaton and Kortum (2002) solve the parameter σ-1 using information on observable trade quantities, income, logarithmic trade costs and information on logarithmic price differentials between countries. They show that $\sigma - 1 = \theta$[26] and therefore get a value for σ using this model as well. When thinking about the theoretical gravity equation in which multiple sectors are allowed, an assumption of different elasticities for different goods would be crucial

In general, the results obtained in various studies have shown that the value for σ is generally between 5 and 10 (Anderson and van Wincoop 2004: 716). Consequently, these values could be used when inferring trade costs from the results obtained, because the simple functional form is assumed for trade costs also in this study.[27]

All of the methods discussed above assume the use of theoretical gravity equation and, consequently, the need for multilateral resistance variables to be taken into account in some way to be able to infer reliable results. However, other methods have been suggested to solve for the problems related to multilateral resistance. Among others, Rose and van Wincoop (2001) suggest that the multilateral trade resistance variables could be captured by the so called remoteness index, briefly introduced in 3.1. Similarly, Head and Ries (1998) include a notion of country's openness to trade, which is similar to the remoteness variable – the openness being defined as country's total trade with all the others divided by its GDP; the openness aims at characterising the economy's integration to the world economy. Bergstrand (1995) also suggests the use of real exchange rate between Canada and its trading partners instead of GDP deflators as a measure of multilateral resistance. As this data is also readily available, we will use real exchange rate as an alternative for changes in price indices, as the changes in consumer price indices are not considered good proxy for the multilateral trade resistance.

Above, we have considered various aspects that need to be taken into account when empirical specification is constructed following closely the theoretical form. In this study, referring to the alternatives presented in the previous studies, the multilateral trade resistance will be tried to be solved either by using price indices, real exchange rates or country-pair dummies in fixed effects estimation. However, the various theories on gravity and their implications on empirical specification are not the only ways to proceed in general.

[26] Representing the comparative advantage.

[27] Alternatively, different assumptions on immigration's specific effects on trade, such as Gold's (1994) idea "that the foreign market information brought by immigrants decreases the transactions costs to trade at a decreasing rate", would give us a different starting point for the analysis.

4 Variables, specification and estimation models

After having developed in the previous section (3.4) an idea about how the theoretical gravity equation could be used in empirical work, this section now concentrates on explicitly presenting the specification that will be estimated with the data used. Furthermore, discussion on how to infer results based on the models used is contained in section 4.2 on marginal effects. Also, a brief introduction of the variables used in the study will be given in this chapter. Finally, threats to internal validity are discussed and different empirical estimation models are considered. The data on the variables will be presented in the following chapter 5 with the results.

It is worth noting how most of the studies on studying the of immigration on trade have used the traditional gravity equation with control variables added up to the equation assuming a functional form as in equation (2), section 3.1. That equation does not assume any special functional form for trade cost, as, for instance, Anderson and van Wincoop's (2003) suggestion in equation (13). Furthermore, the functional form of the traditional gravity equation differs significantly from the theoretical gravity equation's form, whether derived by Anderson and van Wincoop (2003) or by Eaton and Kortum (2002). In the estimation of traditional gravity equation there is no need for determining σ, the elasticity of substitution, as in Anderson and van Wincoop (2003), or θ (= σ-*1*), the parameter indicating comparative advantage, as in Eaton and Kortum (2002). Neither are included in the traditional gravity equation other additional elements generated by the theoretical gravity models, namely multilateral trade resistance, that can be estimated in various ways as discussed earlier.

Although the omitted variable bias generated in the estimation of the traditional equation is a fact that we are unable to bypass, we will estimate the equation without taking into account the implicitly derived multilateral resistance (MR) variables and hence ignore many factors that are present in the trade relations outside the bilateral Finnish trade relations studied that the MRs would capture. However, the data requirements for this equation in which only the above mentioned trade flows are considered are less rigorous since data of all the observations for variables of all the countries are not needed (like, for example, in Eaton and Kortum (2002)).

This means that the estimates for the factors that affect the between Finland and any foreign country trade are biased due to trade barriers only being considered between the two countries at any point and not these countries' barriers with all the other countries at the same time. This is tried to be corrected differently in different specifications (partially by the time fixed effects that could include Finnish MR at any point in time), by including proxies for MR (such as real exchange rate) or by the country-pair fixed effects that could absorb part of the MR.

Consequently, arriving to a specification that conforms to the theory and is easily estimable would require some additional assumptions on the above mentioned, already discussed in section 3.5. Thus in the following sections we will 1) show different ways to include multilateral resistance into the specification (4.3.3), 2) discuss the assumptions on a trade cost function that affects the inference of results of marginal effects (4.2) and 3) theoretically explore the need for the assumptions on σ or θ that also affects the magnitude of the effect of immigration on trade.

This section starts with the general overview of the specification, and then it is considered how the marginal effects of immigration on trade and immigration on trade costs could be derived (at least hypothetically). After that an overview of variables to be included in the specification is given. Then threats and limitations to the validity are discussed. Finally, different estimation models are introduced.

4.1. Towards the empirical specification

The starting point for the empirical specifications used in this study is the gravity equation derived in section (3.2.1) and presented in equation (12). The log linear form of the equation is assumed, as suggested in Anderson and van Wincoop (2004), and additionally the trade cost function is assumed to follow what is presented in in equation (13). Thus when the logarithmic form of the gravity equation is used, the equation simplifies to (26) below:

$$x_{ij} = y_j + y_i + (1-\sigma)\ln t_{ij} + (1-\sigma)\ln P_j + (1-\sigma)\ln P_i + \varepsilon \qquad (26)$$

, where x_{ij} is the natural logarithm of exports (or imports) from i to j, y_i and y_j are the logarithms of GDP in countries i and j and the rest of the terms represent the logarithm of trade cost function and logarithms of multilateral resistance and ε_{ij} gives the logarithm of error term, as in equation (2). In the specification estimated i represents Finland and therefore the model is very much simplified.

The trade cost function is assumed to have the form below:

$$t_{ij} = \prod_{m=1}^{M} (z_{ij}^{m})^{\gamma_m} \qquad (27)$$

Consequently, the logarithmic form of the gravity equation then becomes (with *m* different factors causing trade costs and $\lambda = (1\text{-}\sigma)*\gamma$):

$$x_{ij} = y_j + y_i + \sum_{m=1}^{M} \lambda_m \ln z_{ij} + (1-\sigma)\ln P_j + (1-\sigma)\ln P_i + \varepsilon \qquad (28)$$

By estimating equation (28) with or without MR, we get values for the parameters (coefficients) of the different variables.

At this point, before introducing the variables, it is useful to take a look at the marginal effects when it comes to the specification. In other words, in the next section an explanation on how the coefficients of immigration obtained in the estimation could be interpreted in the context of trade costs and exports and imports.

4.2. Marginal effects

The importance of understanding how the immigration affects trade costs and exports and imports is crucial for drawing any conclusions of its effects on trade. In sections 4.2.1 and 4.2.2 I will briefly outline how the coefficients obtained in the estimation could be interpreted. These interpretations of *partial* effects apply to pooled OLS (and more or less to fixed effects) but are not suitable for the random effects estimation nor for the interpretation of the Poisson regression coefficients of which details will be later introduced. Discussion on the error terms is also presented when the different regressions are introduced.

In general, it is worth noting how the interpretation differs for the traditional gravity equation and the theoretically derived equation. The former will be discussed first, the latter then in section 4.2.2.

An important factor when interpreting the estimation coefficients would be to take into account the elasticity of substitution in the context of theoretical gravity equation. However, to consider this, the estimated models should conform to the theory and properly depict multilateral trade resistance. Thus in the estimation of our specifications, the results obtained should be actually interpreted based on the traditional gravity equation. Anyhow, the theoretical alternative is also considered and hence the interpretation is briefly discussed in section 4.2.2.

4.2.1. Marginal effects in traditional gravity equation

As discussed before, in the case of traditional gravity equation the coefficients will automatically give us biased estimates of the effects of the variables due to omitted variables. Anyhow, it is important to understand how the coefficients can be interpreted, and thus the average marginal or partial effects of the independent variables on exports or imports will be discussed here. Additionally, it is worth mentioning that the interpretation in this part only applies to pooled OLS and (partially) to fixed effects estimates, and in the case of other estimation models, the interpretation of the results is discussed in the context of each regression model.

In the simplest form, the coefficient for immigration in the traditional logarithmic gravity equation ($\lambda = \gamma$ in equation (28) assuming no $1\text{-}\sigma$ due to traditional functional form as in (2)), gives us approximately the percentage change in trade that a certain percentage change in immigration causes. For example, a coefficient of 0.4 would imply that a 10 % increase in immigration causes a 4 % increase in trade. This is the method adopted also in many of the empirical studies of immigration's effects on trade introduced in table 2. For instance, Head and Ries (1998) estimate the effect of immigration like this.

Nothing much can be said about the effects of immigration on trade costs directly based on the model. By the earlier assumptions, it can be deduced that the larger trade flows are caused by the effects of smaller trade costs.

4.2.2. Theoretical gravity – marginal effects of immigration on trade and trade costs

As noted above, the marginal effects of immigration on trade costs and trade presented below is applicable to OLS and fixed effects estimation, also in the context of theoretical gravity.

In the equation (28) it is assumed that $\lambda_m = (1\text{-}\sigma)\ \gamma_m$. Furthermore, when the coefficient estimated in the equation are determined and the assumptions on elasticity of substitution, σ, is made as well as the trade cost function in (27) is used, the tax equivalent of trade barriers can be estimated, as suggested in Anderson and van Wincoop (2004):

$$(z_{ij}^{m})^{\lambda_m/(1-\sigma)} - 1 \approx \lambda_m (z_{ij}^{m} - 1)/(1-\sigma) \qquad (29)$$

To simplify this even more, the trade cost function is assumed to be log-linear, to allow for easily obtaining meaningful values for the parameters, as proposed in Anderson and van Wincoop (2003) among others. Thus an example of tax equivalent trade costs in Anderson and van Wincoop (2003: 178) takes the form $t_{ij} = b_{ij}d_{ij}^{\gamma}$, where b depicts a dummy variable related to border barrier (= 1, when trade in the same country, otherwise *1 + tax equivalent cost*) and d the distance between countries or regions. This form can be used in estimation of equation (26) or (28), and the estimation would give us some numerical value A for $(1\text{-}\sigma)lnb$ and B for $(1\text{-}\sigma)\gamma$.

Thus considering the first of the alternatives, the dummy variable of border, the *1+tax equivalent barrier* effect for b can be solved as $b = e^{A/(1-\sigma)}$ giving easily the tax equivalent of trade cost effect of a dummy variable. Anyhow, in contrast to this this study, the Anderson and van Wincoop (2003) study would require the consideration of the information on the intra-country trade, and therefore is not applicable directly here.

On the other hand, the effects of immigration on trade is probably more straightforward. As immigrant stock enters the equation taking a continuous form as trade costs, its coefficient divided by one minus the elasticity of substitution ($1\text{-}\sigma$) depicts the percentage change in trade taking place as a result of some percentage change in immigration. As illustrated in equation (29) where $\lambda_m = (1\text{-}\sigma)\ \gamma_m$ by dividing this by ($1\text{-}\sigma$) a value for γ_m is obtained. The basic interpretation of the coefficient is therefore (as in log-log model should be) that a 1 % increase in the value of a continuous variable causes a γ_m % increase in the dependent variable, either for exports or imports. The value for σ used could be taken from the estimates in previous studies that set it between 5 and 10 (Anderson and van Wincoop 2004).

4.3. Variables included in the specifications

The variables that are used in the specification are chosen to best follow the theoretical gravity equation, the earlier empirical work and to realistically reflect the possible trade costs. As the goal of the study is to find if immigration has any effect on Finnish exports or imports, the immigrant stock is assumed to capture the trade cost reducing effects that are obtained by the network effects and preference for home goods. The immigrant stock will be included as a continuous variable in the trade cost function, as represented by $\ln t_{ij}$ in equation (26). Self-evidently, the dependent variable in the specifications is the natural logarithm of either Finnish exports or imports when OLS estimation is considered. In general, the logarithmic transformation of the gravity equation is the most widely used specification and will be employed in this study as a first alternative.

The other independent variables in addition to the immigrant stock could include, for instance, GDPs of the trading partners, the distances between economic centres of the countries, membership in a trade or monetary union, common borders, historical and colonial linkages, common language and many more. Below, the variables used in the study will be introduced and it is discussed how the variables enter the specification. The sources of the data on the independent and dependent variables are described in section 5.1; the variables are also summarised in tables 1 and 2 in appendices 1 and 2.

4.3.1. Dependent variables

The dependent variables in the study are the bilateral import and export flows of Finland with its trade partners. More specifically, the OLS model requires logarithmic transformation of these, represented as *lnimp* and *lnexp*. As we consider only Finnish imports and exports, the model is a pure simplification of the theoretical and standard gravity models, in which between country trade data should be considered in a determined group of countries (this group could be, for example, randomly selected countries or include all the world). This is the standpoint in the theoretical gravity equation by Eaton and Kortum (2002), for instance, in which the relative import trade flows between 10 countries are investigated. In this study, on the contrary, only import flows to Finland from 179 countries and export flows from Finland to 179 countries are studied.

Although the starting point is different here, same problems exist. Using imports and exports as dependent variables poses some challenges to the study of effects of trade costs since import and export flows between pairs of countries can be zero and the gravity equation is estimated in logarithmic form. Evidently this implies further considerations of the estimation model and error terms, which are mostly presented in section 4.5.1. The treatment of zeros largely depends on what is the reason for flows.

However, two of the methods that are widely used refer to either leaving out the variable or creating a new variable and will therefore be introduced here. A common approach to zero trade flows is to add 1 to trade data in order to include all the observations into the data set (Linders and de Groot 2006). For instance, Eichengreen and Irwin (1995) adopt the latter alternative for not excluding small trade flows and therefore use *ln(1 + trade)* as the dependent variable.[28] This addition of 1 assumes that no true zeros are present in the trade data as most theories of gravity equation would suggest.

With regards to the statistical software Stata that is used in estimation, on the other hand, the observations containing zero trade flows will be automatically deleted from the estimation, which may result in biased results if zeros contain valuable information (Linders and de Groot 2006). Anyhow, the specifications in this study will also be estimated in most cases with the data removed (when *lnimp* and *lnexp* are the dependent variables), and in that case it is assumed that the missing values represent really missing observations and do not contain any additional information.

However, Santos Silva and Tenreyro (2006) mention that neither dropping out observations nor adding 1 to the values to deal with the problem of zero trade flows is the correct way to solve for the problem although widely used, but might lead to inconsistent parameter estimates. Additionally, as argued above, zeros may be missing observations not justifying removing from data; there would be a lot of small values and hence normal distribution of error term could be violated. Therefore, the authors suggest the use of Poisson distribution to capture error term correctly. More discussion on the treatment of zeros is included in section 4.4.1.

4.3.2. Independent variables

The independent variables that are assumed to explain trade are selected based on their presence in previous literature on factors that might affect trade and trade costs. For the definitions, table 1 in appendix 1 should be referred to.

The variable that is used to capture the trade cost reducing effects of immigration is the logarithm of number of immigrants by birth country and by year (in OLS estimation). However, the zeros in the data might cause some problems again in the basic gravity estimation. As the logarithm of birth country, *lnbirth*, enters as an explanatory variable in the estimation, the values for birth country should be greater than zero in order to enter the equation. If not, the observations will be dropped. Some countries excluded, due to assuming the trade cost function as introduced above, have positive trade flows with Finland and therefore the zero immigrant stock should be somehow captured in the model. Otherwise the model only captures those countries from which there are immigrants in Finland.

[28] In this study, dependent variables *lnimp1* and *lnexp1* are created by assuming that *lnimp1 = ln (imp+1)*, and this alternative specification is also tested, although the results are not analysed due to understanding the erroneous form of the regression.

If the data is truncated so that countries with no immigrants are not included, no information on all the countries can be obtained but only for those countries from which immigrants have come to Finland. Therefore, the inferences are made from a subpopulation.

Moreover, the immigrant stock and *lnbirth* variable only capture the effects of total immigrant population, which means that no effects of different groups of immigrants can be studied – alternatively, we could study only the working age population, for instance. This could result in larger effects since it could be assumed that working age population is more likely to engage in trading activities.

In addition to immigration, many commonly used variables in gravity equation are included. For instance: representing the economic mass, the logarithm of trading partner GDP, *lnGDPFOR*, which is assumed to have a positive coefficient; logarithm of distance between the countries, *lndist*, which should have a negative coefficient due to longer distance hampering trade; membership in the currency union or free trading arrangements, *eu* and *oecd* variables, should increase trade and have a positive coefficient (although solving for the endogeneity of variables would be required); sharing a border, *contig*, could also affect trade positively; colonial ties, *colony*, could increase trade; common language, *comlang_off*, could increase trade too.

There are several other variables that could potentially increase or decrease trade, but the above mentioned are the most commonly used in gravity literature. The rest of the variables used in this study are related to multilateral trade resistance and will be dealt with in a separate section below.

4.3.3. Multilateral trade resistance

Finally, some measures for the multilateral resistance are tested in the model although it does not fully comply with the theoretical gravity equation. These methods for dealing with the multilateral resistance variables were outlined above in section 3.4 and included the use of price indices, use of country dummies (as in Eaton and Kortum 2002) and the use of real exchange rates as suggested in Bergstrand (1995).

First, using the logarithms of price index changes in the trade partner countries, *lnCPIFOR*, are included to capture some of the multilateral trade resistance. Alternatively, then, the logarithms of relative real exchange rates, *lnreer*, are considered. Finally, the country pair fixed effects are included to test for the possible country pair fixed effects that could also capture part of the multilateral trade resistance of the trading partners.

The signs for the multilateral resistance terms are assumed to follow Anderson and van Wincoop (2003). Thus they are assumed to have a positive coefficient since increasing the trade resistance with other countries is likely to lead into increased bilateral trade. However, this is a simplistic assumption in this model because no data between *all* the trading partners is considered and therefore the multilateral trade resistance cannot be implicitly taken into account based on the trade costs between all these countries but approximate variables are included that probably have the same effect to bilateral trade as to the trade with other trading partners. In other words, the coefficient might be negative since higher the CPI and real exchange rate, the more expensive the trading partners goods' will be relatively.

Moreover, year-fixed dummies are introduced to capture the changing nature of the multilateral resistance and other effects, especially for Finland since otherwise it would be assumed that the effects remain fixed over time. In the context of only Finnish data considered, country-year fixed effects could not be included in addition to country-pair and time-fixed effects.

4.4. Threats to internal validity and some solutions to its problems

In this section some threats to the validity of the model and solutions to them are discussed briefly to better understand the limitations related to the empirical specification as well as more solidly be able to draw conclusions from the results obtained in the following chapter.

First, the discussion on zeros in the trade data is introduced. The zeros in trade data are quite common and they pose problems when the log-linearised specification is used. Anyhow, several solutions to taking the zeros into account are presented below. Another important threat to validity of the model is the omitted variable bias, discussed last. In addition, the direction of causality may also pose problems to the specification, and will be discussed in section 4.5.2.

4.4.1. Zeros in trade data and selection bias

Trade data is notorious for containing a relatively large number of zeros in it since there are many country pairs that do not trade or trade insignificant amounts of goods. In this study, the Finnish trade with 179 different countries or groups of countries is studied, but import and export data often contain zeros. However, under an assumption that the zeros only represent measurement error (too small to be recorded in trade data), then it would be safe to leave them out, as was suggested earlier. Otherwise, selection bias is present since the zero observations in trade data cause us to leave the observations for these years and countries out, which could cause correlation between the error term and the independent variable, and thus biased results.

So, many trade flows not active, fall below some threshold or data is just missing, and two main reasons explain this: 1) either the flows are insignificant and not reported and can be left out 2) or the fixed costs are so high that nobody wants to enter a particular market; in the latter case OLS would be biased (Anderson 2011)

Anderson (2011:) also emphasised that “the zeroes present two distinct issues for the analyst: appropriate specification of the economic model and appropriate specification of the error term on which to base econometric inference”; from the perspective of the economic model, the problems are present in both the CES model as well as Eaton and Kortum’s (2002) model that would both forecast no zero trade flows under reasonable trade costs. However, the modelling issues are not discussed here further, but the specification of the error term is considered.

Two solution alternatives to zeros were already discussed earlier, omitting observations and adding a small positive number (i.e. 1) to observations, both of which possess many problems. The first alternative, omitting observations, might lead to losing information and sample selection bias due to not randomly distributed zero trade flows as, for example, Head and Ries (1998) emphasise. The second, adding a small positive number, anyhow, makes the results sensitive to the units in which trade is measured and therefore biases them. In other words, choosing 1 or 100 might be the same or different thing depending on the units in which trade is measured.

Another alternative that Head and Ries (1998: 52) suggest is the use of a latent variable that includes undermeasurement and which equals bilateral trade when it is positive and zero when negative. This is a Tobit formulation and could be solved by using Tobit estimation instead of OLS. However, Santos Silva and Tenreyro (2006) suggest that using Tobit estimation would also be inconsistent, and suggest the use of Poisson regression that will be discussed later.

Also Helpman et al. (2008) mention that important information may be lost when zero trade flows are disregarded in the study and consequently biased estimates may result, although the authors approach the zero trade flows from a theoretical perspective and consider extensive as well as intensive margin. The model presented is two-stage – it uses first the Probit model to find out the probability that the country will engage in trade and in the second part the gravity equation is estimated in a log-linear form (Helpman et al. 2008). The sample selection bias could be corrected by this method, the two-stage estimation instead of OLS (Helpman et al. 2008). However, theoretically this approach would need to be explained so that there is a barrier that must be overcome (e.g. by the firms) to enter the market and then the trade costs would have a different effect when already in a trade relationship. This relates to the considerations of intensive vs. extensive margins of trade so that the firms' or countries' existence in the export or import market is conditional on trade barriers.

4.4.2. Endogeneity of trade and immigration: Granger causality and other solutions

The zero trade flows are by far not the only problems related to internal validity but there are several others. In this section some solutions to endogeneity of trade and immigration are briefly discussed and a formal solution for testing the direction of causality of trade and immigration is presented.

As it was clearly emphasised in section 2.4 no indication in the literature has been made so far that there would be any effect of trade on immigration. The extensive literature review on immigration, trade and networks that was included in chapter 2 of this study has not hinted at the direction of causality running from trade to immigration, but more likely suggests that the effects actually run in opposite direction. However, in the event of reverse causation being considered a major issue, solutions to it have to be suggested.

First, the problem of the direction of causality could be solved by instrumental variables. The variable in question should be such that it is correlated with immigration (or factors causing immigration) but not caused by either imports or exports. Of course, it is not an easy job finding this kind of a variable, but there are some good alternatives for this kind of instruments. For example, wars and conflicts happened in the past might be reasonably good instruments for immigration since these might have resulted in refugees leaving their home country and are often totally independent of trade patterns of the country. However, at the same time conflicts might not be the best instrument since they often also have an effect on trade; thus the effect of conflicts to trade is not likely to run only through immigration. Of course, if old conflicts and refugees are considered *a posteriori*, and then trade to these countries is studied only afterwards, the problem is alleviated.[29]

For a group of countries, also the collapse of the Soviet Union and the following opening of the borders could be used as an instrument. The trade did not cause the collapse but was caused by other factors and thus collapse could work as an instrument for migration. Nonetheless, in this study this is not possible due to all the soviet countries grouped to one aggregate entity. Other possible instrument could be, for example, immigrant's personal relations to Finland since it is not a far-fetched idea that marriages and relationships act as a common reason to move into the country. However, in a wider setting where several countries are studied, it would be unlikely that the data for this kind of information was available as it is not in the Finnish case. By and large, the data availability for the potential instrumental variables might turn out to be difficult.

The other possibility to account for the possible endogeneity of trade and immigration is to study the likely direction of causality using the Granger causality test. As it was mentioned earlier, the direction of causality from immigration to trade and whether any causal relationship occurs, as earlier discussed, is not straightforward, although likely. Therefore a Granger causality test for panel data will be employed. The Granger causality test at its simplest tests linear causality.

Anyhow, the basic idea that Granger (1969) introduces about causality is that if, in the presence of all the available information, some *X* can help to predict better *Y* in comparison to the prediction of *Y* without *X*, then *X* is causing *Y*. Mathematically, at its simplest form for two time-series variables the model can be defined as

$$\begin{aligned} X_t &= \sum_{j=1}^{m} a_j X_{t-j} + \sum_{j=1}^{m} b_j Y_{t-j} + \varepsilon_t \\ Y_t &= \sum_{j=1}^{m} c_j Y_{t-j} + \sum_{j=1}^{m} d_j X_{t-j} + \eta_t \end{aligned} \qquad (30)$$

, where ε_t and η_t are taken as two uncorrelated error series, and *m* represents (here) some finite time period (shorter the length of the given time series); the given definition implies that *Y* is causing *X* if some b_j is not zero, and similarly *X* is causing *Y* if some c_j is not zero (Granger 1969: 431). No more theoretical details of the test are supplied here, but a practical approach is taken to the test for the purpose of our data. Basically, the Granger causality test tests a null

[29] This would imply the use of lags of immigrant stock in the estimated egression equation.

hypothesis H_0: $b_1 = b_2 = ... = b_m = 0$, against the alternative *Ha*:not H_0, and if the null hypothesis cannot be rejected *X* does not Granger cause *Y*.

With panel data the test involves testing for homogeneous causality and heterogeneous causality; the heterogeneous causality may be temporal or cross-country dependent (Chen et al. 2012). From the first concept, homogeneous non-causality, refers to the test that no causal relationship, whatsoever, exists from *X* to *Y*. Under heterogeneous non-causality at least one non-causal relationship exists, but there are subgroups for which the *X* does not cause *Y* (Chen et al. 2012).

The Granger causality test can be tested with lags of several different years; in this study the lags for five years are used. Furthermore, to fully study the causality effects in in the case of panel data, the cross-sectional dimension would need to be inserted into the model. However, in this study the checking of Granger causality only involves considering the homogenous causality, i.e. whether the lag coefficients can all be assigned a value of zero for all the groups aggregately. The test is conducted in the context of OLS estimations only.

4.4.3. Omitted variable bias

As the starting point in the estimation is the traditional gravity-like equation, the omitted variable bias really may cause problems since the multilateral resistance is left out in the form it would be needed – thus the problem is that the omitted terms are correlated with the trade-cost term, since the trade costs directly enter the multilateral resistance terms, as seen in equations (9) and (10). This correlation biases the estimate of trade costs and all its determinants, such as immigration, and testing the gravity without the multilateral resistance is likely to give only partial effects of the estimated variables on trade. The problem is tried to be solved by adding proxies for the multilateral resistance, *lnCPI* and *lnreer*, but these are unlikely to solve the problem totally, and therefore after the pooled OLS regression this must be taken into account when analysing the results.

On the other hand, the bias caused by time-constant omitted variables can be removed by including fixed effects estimation. In this study, country-pair fixed effects are assumed and these should remove at least partially the omitted variable bias expected. Also, the inclusion of time dummies takes into account some time variant qualities and corrects for the false correlations between some variables over time (e.g. changes of CPI in which common inflation trends are seen). The year fixed effects absorb at least relatively well the time variant effects related to Finland. Furthermore, in a fully potent gravity equation in addition to time fixed effects and country-pair fixed effects, country-time dummies should also be included. However, in the context of this study, including these is not possible due to perfect collinearity; only a single country trade with several others is studied, and this means that assigning country-time fixed effects makes the estimation of the equation impossible when year fixed and country-pair fixed effects are already included.

Moreover, the multilateral resistance terms are not the only variables of which absence might cause omitted variable bias. The biased estimates on immigration could be solved, again, with instrumental variables related to immigration. Instrumental variables could be used as well to solve omitted variable bias related to other trade cost causing factors, although it is worth noting that there will be several more variables that explain trade costs and it is very likely that there are also several variables that might explain these trade cost reducing or increasing effects, thus causing omitted variable bias that is not taken into account in this study.

4.5. The estimation models

In the following sections regression models for the specification are suggested and the estimable gravity equations are shown. First we consider pooled OLS regression, then the fixed effect and random effect models and, finally, the Poisson regression.

4.5.1. Pooled OLS

The first specification introduced here, and also most widely used in the context of literature on gravity as well as gravity and immigration, is based on the OLS model. In the context of panel data, the OLS model gets additional attributes due to the repetitive cross sectional observations over time and therefore it is often called pooled OLS. This name reflects the idea that there are by assumption no unique attributes of individuals within the measurement set, and no universal effects across time, although the latter effects will also be controlled in our OLS estimation. After the simple OLS model is conducted, a test for time fixed effects as well as a test for normality and heteroskedasticity of error terms will be conducted to see if clustered, heteroskedasticity robust standard errors are needed to be used in the study. The specification tests include, for example, Breusch-Pagan LM test for the heteroskedasticity of error terms and Shapiro Wilks W test for autocorrelation of the errors.[30]

First, the specification presented here is based on standard gravity equation in the log-linear form.[31] The log-linear form of gravity model is used under the assumption of trade costs taking a form that the logarithm of distance as well as logarithm of immigrants affect trade, other trade costs, such as language, majorly presented by dummies. The model also takes the home country GDP (Finnish GDP) invariant across trade partners, included in the year dummy in pooled OLS regression. The partner country's GDP, in turn, is included in logarithmic form in regression. Santos-Silva and Tenreyro (2006: 642) emphasise that the estimation of the log-linearised equation by OLS is only valid when the error term is statistically independent of the regressors. Hence, as introduced in section 3.1 the error term should follow $E(\varepsilon_{ijt} \mid Y, Z...) = E(lnU_{ijk} \mid Y, Z...) = 0$.[32] This, however, can be easily violated since the logarithm of a random variable depends on its mean and its higher moments; i.e. if the variance of error term U_{ijk}, for instance, depends on other regressor(s), then the logarithm of this error term is also dependent of the variance and the condition of $E(lnU_{ijk} \mid Y, Z...) = 0$ of OLS might be violated (Santos-Silva and Tenreyro 2006). This leads us to the consideration of another estimation model (in section 4.5.3), however, before that considerations of OLS regression are continued.

Results obtained from the OLS regression using data on Finnish immigration are shown in section 5.2. Moreover, to check the robustness a different regression without the EU countries and without the former SSSR could be included in the study. Furthermore, exclusion of the EU from the study from a theoretical perspective would be probably suitable. Since no tariffs exist in the EU and tariffs probably affect trade between countries, tariff data should be included as an independent variable, which is not the case here. Hence, to exclude the invisible effects of tariffs may show up as a favourable outcome for the EU trade, from which there are also a lot of immigrants, and therefore the EU is excluded to count for the possible upward bias that the

[30] However, these tests do not solve the problem that heteroskedastic error terms might cause to the model. Santos-Silva and Tenreyro (2006) indicate that the pattern of heteroskedasticity and the higher moments of the conditional distribution of the error term actually might affect the consistency of the estimator, for which the solution would be not to use OLS estimator. The use of heteroskedasticity robust error terms in the OLS estimation and in the fixed effects estimation therefore does not solve the problems that the pattern of errors might cause to the estimation model since the error term is likely to affect the parameter estimates. Thus the Poisson estimation with heteroskedasticity robust error terms is introduced in section 4.5.3.
[31] For instance, White's (2007) approaches the estimation using a similar specification.
[32] Here *Y, Z, ...* denotes regressors, i.e. GDP, distance and so on.

immigrant stock coefficient might have due to not counting for the tariff barriers or other formal trade barriers.

The specification (either with or without the EU and the SSSR) excludes data on negative trade flows and zero trade flows and can be presented as below.

(i) $ln(trade_{FINjt}) = \beta_o + \beta_1 lngdp_{jt} + \beta_2 lndist_{FINj} + \beta_3 lnbirth_{jt} + \beta_4 CONTROL_{jt} + \beta_5 YEAR + \varepsilon_{ijt}$

Above, β_o is the constant, $trade_{FINjt}$ refers to the logarithm of Finnish import or export flows (which are studied separately) from country *j*, $lngdp_{jt}$ refers to partner country GDP reflecting the economic mass at time *t*, $lndist_{FINj}$ is the logarithm of distance of country *j* from Finland, $lnbirth_{jt}$ alludes to the immigrant stock from a trade partner country *j* at time *t*, and the $CONTROL_{jt}$ variables include dummies for colony, EU membership and other variables introduced in section 4.3.2; basically these variables get a value 1 if they share a common feature with Finland. Finally, $\beta_5 YEAR$ includes year dummies.[33]

Finally, the proxies for multilateral resistance can be included in the specification, which changes the functional form slightly.

(ii) $ln(trade_{FINjt}) = \beta_o + \beta_1 lngdp_{jt} + \beta_2 lndist_{FINj} + \beta_3 lnbirth_{jt} + \beta_4 CONTROL_{jt} + \beta_5 MR_{jt} + \beta_6 YEAR + \varepsilon_{ijt}$

In the above, MR_{jt} refers to multilateral resistance of each country *j* at time *t*, and is captured either by the logarithm of real effective exchange rate, *lnreer*, or the logarithm in the change of price index, *lnCPIfor*. It is assumed that the year dummy partially absorbs the Finnish MR.

Different empirical specifications have been used in studying the effects of immigration on bilateral trade, based on either theoretical assumptions or intuition on whether data on all the trading countries are studied instead of concentrating only on bilateral data. As the theory suggests, to draw reliable conclusions from the use of gravity equation the model would require considering all the countries although only a single country's trade relation with its partners would be under interest – this would be the only way to take into account properly the multilateral resistance that exists between the trading country and all the other countries except for its trading partner. As introduced earlier, the country pair fixed effects and year dummies in

[33] A modified version is the one presented below to count for zeros in trade data.
$ln(1+trade_{FINjt}) = \beta_o + \beta_1 lngdp_{jt} + \beta_2 lndist_{FINj} + \beta_3 lnbirth_{jt} + \beta_4 CONTROL_{jt} + \beta_5 YEAR + \varepsilon_{ijt}$
The only difference with the previous specification is the change in the dependent variable to *lnimp1* or *lnexp1* (see section 4.3.1), which indicates that omitted values are transformed to zeros.

this kind of a model would depict these effects as well as some other measures. However, constructing a purely theory-based specification with this data is not possible due to the omission of country-year dummies.

4.5.2. Fixed effects and random effects

The fixed effect regression relates to the estimation of the equation by assuming that panel units might have time-invariable effects that are do not possibly change over the years; it enables us to estimate variables that change over time only. Additionally, the requirements for the fixed effects regression is that the effects should not be correlated with other panel units.

In this study the fixed effects would refer to the country pair fixed effects, or the effects that are invariable between the country pairs. Since the other trading partner is always Finland, each country gets a country specific dummy. Thus running a fixed effects regression will give us information on the coefficients for the variables that can be time-variable. These include, for example, the number of immigrants and GDP. On the other hand, fixed effects regression assumes that there are country pair specific effects that do not change over time. These could include some political factors, or even the multilateral resistance, if it is assumed that its effect on country-pair bilateral trade is reflected in the fixed effects.

More formally, the fixed effects regression estimation can be shown at its simplest as below:

$$Y_{it} = \beta_1 X_{it} + \alpha_i + \varepsilon_{it} \qquad (31)$$

Above, *i* represents in our setting each country *j* and *t* time, *Y* represents the dependent variable, α is the country-pair time-invariable (fixed) effect, *X* represents one independent variable and ε the error term. In our setting the regression equation could be as follows:

(iii) $ln(trade_{FINjt}) = \beta_o + \beta_1 lngdp_{jt} + \beta_2 lnbirth_{jt} + \beta_3 CONTROL_{jt} + \beta_4 YEAR + \alpha_j + \varepsilon_{ijt}$

Above, α_j contains all the time-invariable fixed effects for each country *j* and all the other coefficients can be interpreted as per earlier in section 4.5.1. The idea is that a common slope for each β is given but the fixed effects capture the different intercepts for each country pair that are due to the country pair specific effects. Moreover, most of the control variables are not included in the fixed effects, but there are some that actually vary with time and for which a coefficient estimate can be given.

The fixed effect regression suffers from a fundamental assumption that the coefficients over time for each cross-sectional unit are a constant. This could be justified for a short time period but for longer time periods not likely to work since the country pair specific effects might change over time. In addition, Adam and Cobham (2007) mention that using country fixed effects in context of panel data does not solve the problem of multilateral trade resistance since in panel data the average country effect over time is only taken into account although the factors affecting multilateral trade resistance can be (and are likely) to vary with time. In this study, furthermore, it must be taken into account that the fixed effects only capture the country pair specific effects, not purely each country-specific effect since in each country pair the other partner is always Finland. However, the regression is run with fixed effects as well for purposes of comparison and, also, since the country pair specific fixed effects might include some information on the multilateral resistance as well.

Additionally, the fixed effects regression usually always requires a test whether the fixed effects or the error terms are correlated with the others. This test called Hausman test implicates whether fixed effects or random effects would better describe the process in question, having the null hypothesis that the preferred model is a random effects regression. In the random effects regression the individual specific effects are not being with the independent variables, like it was assumed in the case of fixed effects. In the fixed effects regression the coefficient simply implies how much the dependent variable will change if the independent variable's value is changed by some amount.

Finally, to decide between OLS and random effects, a Breusch-Pagan Lagrange multiplier test is executed in Stata. Some other post-estimation tests are also conducted in order to approve on the validity of the model. These are outlined in the results section.

Additionally, evidence of a heteroskedastic error term in the pooled OLS regression is in general not evidence of a heteroskedastic error term in the fixed effects regression and therefore the tests for heteroskedasticity and normality of the error terms are conducted also in the case of fixed effects regression.

4.5.3. Poisson pseudo-maximum-likelihood

Although the OLS is the most used method for the estimation of the gravity model, there are several shortcomings that have been addressed in empirical literature. Santos Silva and Tenreyro (2006: 641) put the major problem into words: "under heteroskedasticity, the parameters of loglinearized models estimated by OLS lead to biased estimates of the true elasticities". [34] As mentioned briefly in section 4.5.1, the OLS may lead to biased estimates if the error terms violate the assumptions needed for OLS. So, the problem boils down to the error terms and the assumptions on their form, and how they affect the interpretation of the regression coefficients as elasticities. Therefore, the authors (ibid.) propose the estimation of the gravity model in its multiplicative form with the pseudo-maximum-likelihood (PML) estimation technique that could solve the problem. Additionally, as discussed earlier, the zeros are also problematic for trade data and Santos-Silva and Tenreyro (2006) also solve this problem by suggesting estimation of the gravity equation in a multiplicative form.[35]

The model that Santos-Silva and Tenreyro (2006) propose to be used in the estimation is called Poisson pseudo-maximum-likelihood (PPML) estimation, in which it is assumed that the conditional variance of the dependent variable is proportional to the conditional mean of it (an assumption of the form for heteroskedasticity). Using this kind of assumption of heteroskedasticity, the model only needs additionally an assumption of the conditional mean of the dependent variable of the form $E[y_i \mid x] = e^{(x_i \beta)}$, that the correct explanatory variables are used, and the model can be then estimated (Santos Silva and Tenreyro 2006: 645).[36] Additionally, the model could be estimated using the fixed effects.

Thus the regression that is estimated using the PPML takes the following form:

(iv) $trade_{FINjt} = \beta_o + \beta_1 lngdp_{jt} + \beta_2 lndist_{FINj} + \beta_3 lnbirth_{jt} + \beta_4 CONTROL_{jt} + \beta_5 YEAR + \varepsilon_{ijt}$

The only difference to the earlier regression estimators presented is that the dependent variable (either exports or imports) is now included in the estimation in levels, without taking the logarithm. The right hand side of the regression is therefore unchanged to (i). The marginal effects can be interpreted in the same way as when the log-linearised OLS is estimated.

[34] This is explicitly explained in Santos-Silva and Tenreyro (2006: 644).
[35] The solutions presented earlier in this study are likely to lead to inconsistent estimates.
[36] The authors have also developed a special *ppml* command that is directly available in Stata and automatically uses robust option in estimation.

5 Data and results

In this chapter, data on immigration, trade and other variables used in the study are described. The data used in the study composes mainly of Finnish import, export and immigration data spanning a seventeen-year period from 1995 to 2011. The data is reported for every country and year, and therefore the data takes a panel form.

In addition to the variables mentioned above, data on other variables is shortly discussed in this section too. Finally, results derived from the different empirical specifications (introduced in sections 4.5) are reported and discussed in section 5.2.

5.1. Data description

The period under observation was chosen to be the period between 1995 and 2011 because the data is readily available for most of the variables in this time span. The data used covers Finnish export and import flows and the number of immigrants in Finland from several source countries. The immigration and trade data as well as the data for other variables were retrieved from different sources and compiled for the purpose of this study.

The Statistics Finland population statistics section gives immigration related information on nationality, mother tongue, background country and birth country of the population in Finland at the end of each reporting year, collected by the Population Register Centre starting in year 1990. The data on imports and exports in the United Nations Commission for Trade and Development (UNCTAD) statistics department is available for 213 entities (countries or dependencies); also the GDP data is available from the same source for the same entities.

However, in this study the countries, former countries or other entities, of which trade flows with Finland are studied, are 179 due to reorganising some countries into aggregate entities to represent former countries since the immigrant source countries are often reported as countries that do not exist anymore. Using the aggregate entities the data availability is ensured for all the other variables used in the specification as well. In other words, the Finnish immigration data, for example, reports as its biggest immigrant group those born in the former Soviet Union, and hence the decision was made to combine the data for all the variables to correspond to this aggregate entity.

The above mentioned aggregation relates to summing up all the data on every variable, in addition to the case of the Former Soviet Union, for Former Yugoslavia, Former Czech Republic, Former Netherland Antilles and China as a total. The reason for this is the immigration data that is based on people's self-reported birth country which for many might be, for instance, the Former Soviet Union instead of Estonia. Additionally, for every variable the Chinese data does not exist separately for Hong Kong and Macao, and therefore the aggregation is needed in that case as well. The aggregation will, of course, lead to the difficulty of defining the economic centre of the region, especially in the case of the Former Soviet Union where new countries also have significant trade flows with Finland. Additionally, data for British Overseas Territories, French Overseas departments and independent entities of New Zealand and United States were not either available for all years or at all and these regions are not included in the study. Countries included are shown in appendix 3.

In the following sections the data on immigration, trade and other variables used in the specification are discussed more in detail.

5.1.1. Data on immigration

The Finnish immigration data used reports the country of birth according to age and sex between 1990 and 2011 for 211 immigrant birth countries. The data includes also countries that are not official members in the United Nations that has currently 193 sovereign nations as members. The country of birth data is available freely from Statistics Finland population statistics and is based on Finnish Population Register Centre's data (Statistics Finland 2014).

The immigrant stock could also be estimated using data on people's mother tongue. This could reflect the ability of people to communicate with people from similar ethnic backgrounds and the ability to learn about the culture, and consequently, through that, form networks and affect trade flows. However, mother tongue is problematic due to the same language spoken in several different regions. On the other hand, the nationality reported by the Statistics Finland could also be used as a proxy for immigrant stock and a factor that creates network effects. However, the nationality might change over the years and therefore no realistic picture of the number of immigrants might be obtained. Therefore, the birth country gives probably the best picture of the immigrant stock – though, it is worth mentioning that children of immigrants who share a mother tongue with their parents and could have an ability to form networks with their progenitors' home country are not included in the immigrant stock when birth country is used as a measure.

Still, referring to the effects of informational advantages that migrants might generate on trade would hint at the effect of first generation migrants to be greater than that of the second generation migrants. However, even the second generation immigrants might have conserved tastes for their parents' home country products, hinting at the import effect not being affected. However, as Epstein and Gang (2006) note, the integration to the society by second generation would mean that immigration's effects should be smaller for this group. Due to data limitations, second generation immigration's effects will not be studied.

As mentioned earlier, the data for the birth country, mother tongue and nationality are available for the years 1990-2011. However, as discussed above, the birth country best depicts the immigrant stock and will be chosen as an explanatory variable in the model. What comes to the time span of the study, due to complete data availability, the period of interest in the study will be 1995-2011. The immigration data used will be an aggregate for all of Finland although it is available separately for regions as well. Additionally, no age groups nor division in genders are studied separately here.

Moreover, what is problematic in the data is the immigrants from the Former Soviet Union, i.e. people who have reported the Former Soviet Union as their birth country instead of their ethnic or national origin. This is the biggest group and includes among others Russians and Estonians, immigrants from countries with which Finland also heavily trades. As a result of this "reporting bias", these countries' immigration data as well as other data will be aggregated to represent the whole region of the former SSSR. Furthermore, aggregation of data of the modern countries into historic entities (i.e. Estonia, Russia, Ukraine etc. into Soviet Union) implies that almost a third of the immigrants now come from a single source "country". Therefore, the specifications will also be tested with data without the Former SSSR.

5.1.2. Data on trade

The trade data used in the study is available from UNCTAD statistics database for the period 1995-2011. This data is recollected from the UN Comtrade database and includes data corrected by some estimates drawn from other sources. The data is available on the aggregate level and also up till three digit level SITC. The data is based on UN's SITC, Rev.3 commodity classification. Anyhow, the empirical specifications in this study will be estimated using the aggregate merchandise trade data and no different goods groups will be studied separately. Neither service trade will be included under study.

The biggest problem with the trade data is zeros when using a specification that requires the logarithmic transformation of the trade flows. These problems are alluded to already in section 4.4.1 and 4.5.

With the trade data there are some considerations to be taken into account. For example, imports reported by one country do not coincide with exports reported by its trading partner. Differences are due to various factors including valuation (imports are valued at CIF, exports at FOB) or due to differences in inclusion and exclusion of particular commodities, timing of transactions and so forth. Additionally, it is worth noting that the data available in UNCTAD are different from the data offered by the Finnish Customs, for example. This might be explained by the fact that the data is based on UNCTAD secretariat calculations which thereafter are based on "UN DESA Statistics Division, *UN COMTRADE*; IMF, *Direction of Trade Statistics*; UNCTAD, UNCTADstat Merchandise Trade Indices; and UNCTAD, *UNCTADstat* Total Merchandise Trade" (UNCTAD 2015).

When it comes to trueness of the data it could be suggested, for example, that imports reported by another country also as a source for some country *i*'s exports could be used to obtain more true figures about the export data. Anyhow, the use of data on imports compiled by the importing country itself is not assumed to create that large deviations to the data used as long as the data collected with same method for all countries is used.

Furthermore, data may include rounding errors due to trade flows measured in thousands of dollars as well as missing observations, where probability of rounding down increases for small countries (Santos Silva and Tenreyro 2006). However, I tried to keep also the smallest countries in the data but due to the lack of data for some variables a number of countries were left out because consistent data in comparison to other countries' data was not easily obtainable. In total, nevertheless, the countries that were left out of the analysis consisted mainly of small autonomous regions of New Zealand, UK, USA and France.

Ultimately, the trade data used is contained in only one database in which the data format should be the same for any observed unit and therefore it was chosen to be used, despite the discrepancies with the original Finnish import and export data. Also, the export and import data used was aggregated similarly as the immigration data for the overall entities, such as the former SSSR.

5.1.3. Data on other variables

In the previous chapter the normally used variables and other explanatory variables, or control variables, inherent to gravity equation were explained and this section describes the sources of the data for them.

Similarly to the trade data, the data on GDP is obtained from the UNCTAD database for the countries included in the study. The nominal and real GDP data reported in US dollars is available for the years 1970-2014. The data is derived from UNCTAD secretariat calculations, based on UN DESA Statistics Division, National Accounts Main Aggregates Database (UNCTAD 2015). The nominal GDP for each country was selected as an independent variable for the purpose of this study because the rest of the variables are also reported in nominal values. The nominal GDP for Finland as well as all the trading partners is included in the data, although the former is not required in the estimation of the traditional gravity equation of bilateral trade since the pooled OLS with year fixed effects as well as fixed effects model takes into account the trade between country pairs, which makes the Finnish GDP data redundant in the model. Thus the fixed effects regression automatically takes into account the country pair specific fixed effects and the Finnish GDP will always be the same in observations with any country. The GDP data on the aggregate entities (i.e. former SSSR and so on) is combined from the same data source.

Other than the trading partners' GDPs that are usually included in the gravity equation, the data on distance is one of the explaining factors in describing trade. The data for distance between Finland and its trading partners is obtained from the information provided by the GeoDistance database of CEPII, which reports the distance between the capital cities and main cities for 225 countries and their trading partners as well as the population weighted distance between the most populous cities in each country (CEP 2015). Thus the dataset reports the above mentioned bilateral information for all the possible country pairs. In this study, the distance between capitals is used. However, what comes to the distance data, for the aggregate entities, former Yugoslavia, former SSSR and China, the distance to the biggest cities is used so that the biggest city of the biggest country of the aggregate group is considered, i.e. Belgrade, Moscow and Beijing.[37]

[37] This assumption might not be realistic since the economic centre of each of the aggregate regions is likely to be different from the current capitals. In the case of Indonesia and Netherland Antilles the difference is not that large due to Indonesia presenting major part of the trade and Netherland Antilles located very close to each other.

The CEPII also reports information on other country specific factors between the country pairs, such as contiguity, several measures for colonial ties and common official languages between the country pairs; these reported as dummies. These dummies get a value of 1 when the countries share common features and 0 otherwise. These variables are also used commonly in the empirical estimation of gravity equation, for example.

Furthermore, in a complete gravity model in which all the bilateral trade relations were considered, country-pair-specific dummy variables could be used to control for a country-pair's a membership in multilateral organisations or participation in free trade agreements. Using the Finnish data only, data on OECD membership as well as EU membership is collected and used as explanatory variables. The EU membership variable also include the countries in EEA and Switzerland since these countries are also in free trade agreement with the EU and Finland. Dummy variable 1 indicates membership in the organisation and 0 designs non-members. In several earlier empirical studies (e.g. Santos Silva and Tenreyro (2006)), membership in free trade agreements or areas are also used as explanatory variables.

Additionally, since in this study the multilateral resistance is intended to be captured somehow, data on price indices and real exchange rates is needed. Thus the data on price indices is obtained from UNCTAD database and contains information on the changes of the consumer price indices in each country (UNCTAD 2015). Although this is not the best measure for the multilateral resistance since it contains changes in countries' internal prices as well, the specification is tested with these changes included. Additionally, Bergstrand (1995) suggests the use of real exchange rates depicting multilateral resistance and consequently the data on real exchange rates are obtained from Bruegel Think Tank's calculations for the real effective exchange rate for 178 countries. The data comprises real effective exchange rate for almost all of the countries under study in this investigation and represents the real value of country's currency against the basket of its trading partners.

The appendix 1 summarizes all the variables used in the study and describes them. In total 3043 observations on Finnish imports, exports, trading partner GDPs and other variables except for the relative real exchange rates and price index changes are observed over the 17 year period and 179 trading partners. The data available forms a balanced panel, although some of the specifications used imply that all of the observations are not taken into account in the estimation.

5.2. Estimation results for Finnish imports

In this section results for the effects of immigration on Finnish imports from the different specifications used are explained as well as alternative solutions to the problems encountered in the specifications are outlined. First, following a traditional gravity model, pooled OLS regression models for Finnish import flows were estimated using several commonly used independent variables, such as the gross domestic product of the trading partner, distance between the countries and the immigrant stock from the partner country, as explained earlier in chapter 4. As mentioned earlier, the Finnish GDP is not included since it gets the same value for each country pair and differs only every year and hence is included in the year effects. All of the estimation were run using Stata 13.

After each regression we check for collinearity with variance inflation factors command in Stata. For the pooled OLS specification of imports, no evidence of multicollinearity was found.

Additionally, heteroskedastic standard errors were assumed in the pooled OLS regression after conducting the Breusch-Pagan test and White's general test for heteroskedasticity that suggest that the error variances are not equal for all the variables and heteroskedasticity is present. Heteroskedasticity robust standard errors are very likely due to larger countries likely to have greater errors, i.e. between groups heteroskedasticity is present. Hence the pooled OLS is run with heteroskedasticity robust standard errors.

Although the heteroskedasticity observed most likely is also related to the misspecification of the model, we will run the estimation to compare results to those found in earlier literature; the heteroskedastic robust standard errors are assumed, but as discussed in the context of OLS and PPML regressions, this is not enough to correct for the effects that the heteroskedastic errors cause to the estimators. Therefore PPML regression is also run later. The heteroskedasticity was also studied in the context of fixed and random effects estimation; results are reported in section 5.2.3.

Also, the normality of the error residuals is studied by using graphical methods (depicting the predicted residuals distribution with Kernel distribution against normal distribution) and Shapiro-Wilk W test for normality that can be used for OLS estimation (Razali and Wah 2011). The hypothesis that the error term is normally distributed can be rejected. The results show that non-normally distributed error terms are assumed and therefore cluster option that also includes heteroskedasticity robust standard errors in Stata is assumed to correct for this. The clustering is done by the trading partner (correlation within countries might occur). This clustering option has impact on standard errors of the regression coefficients.

As a general note on the results obtained, it can be concluded that by pooled OLS, immigration has a significant and positive effect on imports over the time period of 1995-2011 and that the results obtained in the model closely resemble those obtained in other studies either what comes to immigration or to the effect of other variables on trade. The effects on exports remain unclear. Also the PPML estimator run hints at similar results.

Finally, to facilitate the interpretation, the coefficient estimates of the independent variables as well as the estimates of the standard errors (in parentheses) are presented first in the tables. The statistical significance of the coefficients are shown with ** for the 1 percent, * for the 5 percent and # for the 10 % significance levels. The results showing the goodness of fit of each model are shown at the bottom of the table.

5.2.1. Pooled OLS without the multilateral resistance, traditional gravity equation

Considering a very simple pooled OLS estimation that includes the year fixed effects (not shown in the table below) to capture the effect of immigrant source country factors (GDP, distance, birth country etc.) on trade, results presented in table 3 were obtained. The first five specifications, (1)-(5), have *lnimp*, natural logarithm of imports, as the dependent variable and each of the specifications adds up some control variables to see their effect on trade; the sixth specification in table 4 tries to correct for the zeros in trade data by the method suggested in gravity literature (e.g. Head and Ries 1998) – the dependent variable *lnimp1* is constructed by adding 1 to all the import observations to be able to calculate a logarithm of them and the results are shown for comparison. No paramount differences were observed in the coefficients when using either *lnimp* or *lnimp1* as a dependent variable and therefore the variable *lnimp* is chosen to be used in the rest of the specifications (the fixed effects regression and Poisson regression). Additionally, as discussed earlier, adding some positive number to zero trade observations cannot be considered a good choice for treating the zeros.

The results of the effects of immigration on trade will be interpreted based on the traditional gravity equation (no assumption for σ will be made). The coefficient estimates for *lnbirth* (the natural logarithm of the number of immigrant) obtained are between 0.461 and 0.564 and in both specifications and the coefficients are significant at 1 % significance level. The coefficient of immigration on imports therefore translates as follows: a 10 % increase in immigration would lead to an approximately 5 % increase in imports. The magnitude of the effect of immigration on imports is close to the results obtained in earlier studies, such as Head and Ries (1998) and White (2007), in which the former finds a coefficient of 0.31 and the latter 0.46 for low income trading partners.

However, there are some shortcomings in the model, as well. According to the standard gravity equation the coefficient for the logarithm of trading partner GDP, *lngdpFOR*, is close to 1 as expected based on the OLS – regarding this, Santos Silva and Tenreyro (2006) note that the PPML model gives a lower more reliable estimate. Additionally, the coefficient for distance changes as more control variables are added. The coefficient in specifications (3), (4) and (5) are positive for distance, which would mean that Finland trade more with countries that are farther away. This is against the results of a standard and theoretical gravity equation and probably implies problems with the OLS regression. [38] As a rule of thumb based on the theory, the coefficient on distance should be negative, but as we consider further specifications below, still the same variables as in regression (4) are included in them due to significant coefficients of other variables that have been included in earlier research as well. Thus it could be assumed that although other specifications with the OLS are tested, it does not give adequate estimates. By and large, the most surprising result from this OLS regression is probably the positive coefficient for distance.

The coefficients on the dummy variables also closely follow the earlier studies. The effects of common language, contiguity and membership in either a free trade agreement or OECD all bear a positive effect, but a very large one. This underlines the problems with the OLS estimation. The magnitude of the effect of contiguity, for instance, in specification (4) is unbelievable 1283 %[39]. Additionally, the *colony* variable has a positive effect, although insignificant, always but when the contiguity variable representing contiguous countries only is included. The two are highly collinear and the *contiguity* variable is assumed in further specifications.

Finally, short discussion on why year fixed effects are included will clarify the model here. The year fixed effects are included in the regression because there may be variation in the overall world economic situation yearly, and also because the Finnish or trading partner specific

[38] The specification is also tested with interaction terms on *oecd x lndist* and *eu x lndist*, and it is found out that for these country groups distance affects negatively for imports. Therefore, we could deduce that there are some countries not members of the OECD far away from which the Finnish imports form a significant portion. More likelier still, the OLS regression is not adequate for estimation.

[39] $(e^{2.627}-1)*100$

factors are not constant over years. The presence of year fixed effects is also tested, if the year fixed effects should be included in the specification. The F-statistics (with 16 numerator and 2385 denominator degrees of freedom) gives us a value of 3.52 which automatically rejects the null hypothesis that all of the year fixed effects would be zero. Thus the year fixed effects are assumed to be present in all of the import OLS specifications estimated in this study from this on. Anyhow, the year fixed effects are not explicitly shown in table 3 for the purpose of clarity of presentation. The tables of results also report some model statistics.

Table 3: The results of pooled OLS estimation on Finnish imports with year fixed effects

Independent variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
lngdpFOR	1.036	1.035	0.897	0.812	0.818
	(0.167)**	(0.167)**	(0.168)**	(0.181)**	(0.183)**
lndist	-0.236	-0.165	0.731	0.769	0.797
	(0.247)	(0.257)	(0.338)*	(0.323)*	(0.331)*
lnbirth	0.461	0.463	0.548	0.564	0.562
	(0.172)**	(0.172)**	(0.167)**	(0.166)**	(0.167)**
colony	1.032	-1.031			
	(0.787)	(0.567)			
contig		2.231	2.802	2.627	2.264
		(0.512)**	(0.953)**	(0.869)**	(0.840)**
eu			2.979	2.295	2.406
			(0.522)**	(0.505)**	(0.549)**
oecd				1.166	1.086
				(0.496)*	(0.525)*
comlang_off					1.289
					(0.927)
_cons	-9.239	-9.864	-15.949	-15.050	-15.387
	(3.056)**	(3.122)**	(3.231)**	(3.245)**	(3.391)**
N	2,410	2,410	2,410	2,410	2,410
R2	0.64	0.64	0.67	0.68	0.68
Root MSE	2.5526	2.5466	2.4288	2.4138	2.6352
F	63.89	-[40]	53.03	52.97	-[41]
Prob > F	0.0000	-	0.0000	0.0000	-

* *p*<0.05; ** *p*<0.01

The specifications (1)-(5) have the *lnimp* as a dependent variable. Various control variables are added to study their effect on the dependent variable and to make a decision on their inclusion in the model. In the further estimations (FE and RE etc.) I resort to the specification (4) and the variables presented in it.

[40] Collinearity of the *contig* with *colony* results in the clustered regression to insufficient rank of VCE to estimate the F-statistics. However, this is not considered to render the model non-usable as all the standard errors are consistently estimated.
[41] Just as above, but this time with *comlang_off* and *contig* variables.

Ultimately, after the estimation results for the different OLS regressions were obtained, a simple test for homogenous Granger non-causality was also introduced. As it was noted in section 4.4.2 on endogeneity, s complete Granger causality test with panel data would require several different considerations, but here the homogeneous causality is tested. At 10 % significance level no causal relationship was observed from imports to immigration; conversely the null hypothesis that the causal effect does not exist could not be rejected when the causality from immigration to imports was studied. This result, however, is sufficient to reject the idea that trade might cause immigration. The causality test was run also for exports, but was not considered in the context of other regression models.

After having tested the model with *lnimp* as a dependent variable, also the problem with zeros in trade data is tried to be solved with the specification in which the dependent variable is *lnimp1* (natural logarithm of imports + 1)). The results obtained are fairly similar to the estimation above and are therefore not discussed further here. The results, nonetheless, are shown in table 4.

Table 4: The result of pooled OLS estimation with *ln(imports+1)* as a dependent variable

Independent variable	**(6)**
lngdpFOR	0.899
	(0.182)**
lndist	0.909
	(0.351)*
lnbirth	0.588
	(0.178)**
contig	2.798
	(0.951)**
eu	2.504
	(0.560)**
oecd	1.111
	(0.517)*
_cons	-18.124
	(3.566)**
N	2,647
R2	0.70
Root MSE	2.504
F	60.87
Prob > F	0.0000

* p<0.05; ** p<0.01

Finally, we test the pooled OLS model when not taking into account the former SSSR (7), since it represents over a third of overall immigrant stock and the results could be biased by that. Then we also test the model without the EU, EEA and Switzerland (8) as all of them belong to the same free trading agreement, in which the movement of people is also free (or at least very flexible) and might depend on existing trade relations between the countries resulting in endogeneity of immigration and trade. The estimation results are represented in table 5.

Table 5: The results of pooled OLS estimation on Finnish imports without former SSSR (7) and the EU (8)

Independent variable	(7)	(8)
lngdpFOR	0.808	0.821
	(0.182)**	(0.199)**
lndist	0.769	1.854
	(0.323)*	(0.398)**
lnbirth	0.562	0.602
	(0.166)**	(0.174)**
contig	2.356	5.127
	(0.989)*	(0.942)**
eu	2.290	
	(0.503)**	
oecd	1.212	0.564
	(0.517)*	(0.619)
_cons	-14.979	-25.025
	(3.253)**	(4.240)**
N	2,393	1,985
R2	0.67	0.58
Root MSE	2.4247	2.5203
F	51.44	31.78
Prob > F	0.0000	0.0000

* *p*<0.05; ** *p*<0.01

No large changes in the coefficient values are seen, but excluding the EU countries reduces the overall explicative power of the model. In addition, the distance coefficient gets a large positive value, showing how the Finnish imports would increase with larger distance again. Because of perfect collinearity, *colony* variable is automatically left out of the estimation (7) due to collinearity with contiguity since the only country with colonial ties is contiguous to Finland, i.e. Sweden in the data when the former SSSR is already left out. By and large, it seems that the model would not require leaving out the former SSSR since the coefficient estimates are consistent when this aggregate entity is included in the model. On the other hand, including the EU seems reasonable for the explicative power of the model, although this should not be taken as an indication of a better specification. Therefore, in further estimations of the model specification all of the 179 countries are taken into consideration.

5.2.2. Pooled OLS with multilateral resistance included

Next, we will consider the results obtained when we include logarithms of changes in CPI and relative real exchange rates (REER) to capture the effect of multilateral resistance. These are measures that do not comply with the theoretical background presented and therefore the results do not enable us to draw conclusions based on the theoretical gravity equation – however, it is assumed that both of the variables to some extent capture the effect of overall trade resisting effects by each country as a result of trade costs with third parties outside the bilateral trade relation.

Similarly to the section 5.2.1 above, the regression estimates assume heteroskedasticity robust clustered standard errors and time fixed effects to comply with the realistic assumptions on the observations and the specification tests run. Results are shown in table 6.

Anderson (2003) suggests that the effect of multilateral resistance on bilateral trade is positive; in other words, when the total multilateral resistance of a country *j* increases, its relative price to *i* is likely to be lower and trade between *j* and *i* will be higher. In this estimation, however, when the multilateral resistance is not implicitly solved from the trade costs experienced by all the countries, the results might be somewhat misleading. First of all, the proxies for the multilateral resistance, change in CPI and REER, capture country specific effects that also affect bilateral trade of the countries with Finland. The REER has been calculated so as to include information on all the trading partners for each country (collinear with trade costs) and CPI includes changes in non-traded goods as well. Thus the coefficient estimates will be biased by assumption and not really reflect the theoretical multilateral resistance. Nevertheless, we will try to see how the results are changed when these measures of "multilateral resistance" are included.

When (natural logarithms of) changes in CPI are used, the coefficient estimates for other variables remain relatively stable in comparison to the pooled OLS estimation presented earlier. In the first column, named CPI (i), the results are reported when multilateral resistance is depicted by changes in trading country consumer price indices. The variable *lnCPIFOR* is negative and would imply that increasing multilateral resistance in any country would decrease trade, but the more appropriate interpretation would be that when trading country price increase accelerates, less imports are expected to be bought from this country. The results show that the coefficient are not significant at 5 % significance level.

When the *lnreer* is added as an independent variable, a small positive effect of it on Finnish imports can be observed. Theoretically this could be interpreted that the multilateral trade resistance of each trade partner increases the bilateral trade to Finland, other things equal. However, in practice the REER also affects the bilateral trade of each partner country with Finland. Moreover, adding the Finnish REER does not give any extra value to the model because it is repeatedly same in every country pair. Thus it is not possible to draw any further conclusions or give any general notion on the effect of multilateral resistance based on these.

Table 6: Pooled OLS estimation results for Finnish imports with proxies for MR

Independent variable	CPI (i)	REER (i)
lngdpFOR	0.821	0.694
	(0.200)**	(0.165)**
lndist	0.704	0.941
	(0.314)*	(0.333)**
lnbirth	0.563	0.703
	(0.182)**	(0.148)**
lnCPIFOR	-0.118	
	(0.113)	
contig	2.581	2.541
	(0.794)**	(0.851)**
eu	2.177	2.426
	(0.492)**	(0.527)**
oecd	0.961	1.294
	(0.486)*	(0.521)*
lnreer		0.249
		(0.801)
_cons	-14.324	-16.299
	(3.233)**	(4.767)**
N	2,159	2,299
R2	0.68	0.69
Root MSE	2.3801	2.3446
F	49.24	51.62
Prob > F	0.000	0.000

* *p*<0.05; ** *p*<0.01

5.2.3. Fixed effects and random effects estimation

Next, we attempt to see if fixed effects or random effects estimation could better model the relationship between immigration and trade. The summary statistics in appendix 2 show the overall, between and within variation for the variables. The relatively small within standard deviation of the variables *eu* and *oecd* might indicate that they are maybe not as well identified as other variables. The fixed effects (FE) and random effects (RE) regressions are run including the same variables as in the pooled OLS specification (4) earlier. In both FE and RE a comparative estimation is considered by including *reer* to depict the multilateral resistance of each trading country. This is included due to the assumption that the country pair fixed effects included in the models do not, however, take into account all the trading country specific multilateral resistance that changes with time, which could additionally be depicted in the model by including REER in it.

Some tests for the consistency of the model are conducted. First, the test for heteroskedasticity must be conducted also in the context of fixed effects regression and what was found with the modified Wald test was heteroskedasticity between different groups (countries) as expected. Therefore, the heteroskedasticity robust standard errors were also used in the fixed and random effects estimation with Stata. Finally, the autocorrelation in the error terms was dealt with the Wooldridge panel data test for serial correlation in Stata. The null hypothesis that there is no autocorrelation could not be rejected, so no need for clustered standard errors was expected and only heteroskedastic robust standard errors were used.

In the fixed effects estimation also the inclusion of time fixed effects was studied. The time effects turned out to be jointly significant and therefore the year dummies were included in the regression. The rho-values reported suggest that a lot of variation is related to differences between country pairs in imports.

After the fixed and random effects regressions, some tests regarding the efficiency of the estimators are run. First, running the Breusch-Pagan Lagrangian multiplier (LM) test for random effects implies that the random effects are appropriate and there are significant differences across the countries, which would bias the OLS estimator. Then, a Hausman test[42] between the FE and RE estimators is conducted – the rejection of the hypothesis that there are no systematic differences in the coefficients and that the RE is consistent implies that the fixed effects regression should give a more consistent estimator.

[42] Amended to conform to the robust standard errors in Stata (overidentification).

Thus, the results obtained from the RE estimation show how the effects of immigration on trade obtain a similar magnitude as in the OLS estimation, but the interpretation of the coefficient is slightly different. It could be described as the average effect of the independent variable over the dependent variable when the independent variable changes across time and between country pairs by one unit (units in this case are percentage changes).

The coefficients for *eu* and *oecd* in the RE estimation a lot lower in comparison to pooled OLS. However, the coefficient for distance is still positive and at the same time is not significant. Furthermore, adding the suggested multilateral resistance by *reer* does not changes the results remarkably.

Table 7: Estimation results for the FE and RE models for imports

Independent variable	**FE (i)**	**FE (ii)**	**RE (i)**	**RE (ii)**
lngdpFOR	1.027	1.004	1.052	0.981
	(0.330)**	(0.415)*	(0.147)**	(0.155)**
lnbirth	-0.010	0.083	0.302	0.417
	(0.146)	(0.187)	(0.122)*	(0.134)**
eu	0.295	0.396	0.601	0.690
	(0.165)	(0.165)*	(0.165)**	(0.167)**
oecd	0.272	0.343	1.236	1.174
	(0.182)	(0.177)	(0.353)**	(0.350)**
lnreer		-0.345		-0.356
		(0.463)		(0.371)
lndist			0.102	0.203
			(0.308)	(0.288)
contig			2.396	2.130
			(0.669)**	(0.617)**
_cons	-9.504	-7.852	-12.507	-10.884
	(5.405)	(5.850)	(3.473)**	(3.556)**
N	2,410	2,299	2,410	2,299
R2 (within)	0.09	0.09	0.09	0.09
F	14.57	13.99	-	-
Prob > F	0.000	0.000	-	-
Wald chi2	-	-	1446.22	1848.49
Prob > chi2	-	-	0.000	0.000
Rho	.800440	.771169	.655419	.657792

* p<0.05; ** p<0.01

In the case of fixed effects model, on the other hand, immigration gets a very small positive, but insignificant coefficient. This would suggest a minor (0.8 %) increase in imports when immigration increases by 10 %. The difference between the coefficients of FE and OLS suggest that there are unobserved country effects that are correlated with the explanatory variables. The coefficient for the logarithm of foreign GDP remains unchanged and the coefficients for *eu* and *oecd* seem more reasonable in this estimation. The rest of the variables did not vary in time and are therefore not reported in the fixed effects estimation results in table 7.

5.2.4. PPML estimation

Finally, as Santos Silva (2006) suggested that the OLS by log-linearising the gravity equation does not give adequate estimates for the elasticities of the coefficients, the PPML estimator suggested by them is used to run the regression. The standard errors by assumption are heteroskedasticity robust and also clustered standard errors (by trade partner) were assumed. Similarly, as in OLS the year fixed effects are included in the regression. In the second regression with PPML, labelled PPML (ii) in the table, also dummies for each trade partner wear added. The results are shown in table 8.

As the results show, the coefficient for *lngdpFOR* and *lndist* are significant at 1 % level and consistent with the theoretical model. The coefficient of GDP is still lower than in the case of using OLS. A similar result was found by Santos Silva and Tenreyro (2006). The coefficient estimate of *lnbirth* in the PPML(i) estimation in which country dummies are not included is smaller than in the OLS estimation. A 10% increase in immigration would lead to a 1.7 % increase in trade. On the other hand, when the country dummies are included the effect is larger, but not significant anymore (in PPML (ii)).

When it comes to the other control variables, the value that are obtained in PPML(i) are smaller than in the OLS estimation for imports. The effect of belonging to the EU is positive and significant. On the other hand, when the effects of contiguity in the two regressions ae compared, the results are ambiguous. When country dummies are not added, the overall effects of contiguity is positive, but in the estimation (ii) negative. This might be due to some unobserved country specific effects.

Table 8: Estimation results of PPML regression for imports

Independent variable	PPML (i)	PPML (ii)
lngdpFOR	0.833	0.669
	(0.085)**	(0.118)**
lndist	-0.696	-0.669
	(0.198)**	(0.198)**
lnbirth	0.173	0.318
	(0.085)*	(0.246)
comlang_off	0.450	
	(0.376)	
contig	0.565	-0.417
	(0.283)*	(0.117)**
eu	0.583	0.316
	(0.273)*	(0.048)**
oecd	-0.341	-0.061
	(0.300)	(0.136)
_cons	0.835	3.570
	(2.066)	(1.453)*
R2	0.91	0.98
N	2,647	2,645

*p<0.05; ** p<0.01

5.3. Estimation results for Finnish exports

Above, the results from the various regressions related to immigration's effects on imports were presented. In that section, we saw how the coefficient for distance for the imports did not conform to the standard gravity estimates in OLS and how both the fixed effects and PPML estimation generated different results from the pooled OLS.

When it comes to Finnish exports, the results show that the impact of immigration on exports would be smaller than the effect on imports. Using OLS, a 10 % increase in immigration would generate approximately 1.5-2 % increase in exports. The pooled OLS, however, does not deem this effect significant. Further considering the fixed and random effects models, the results indicate that the coefficient for the natural logarithm of immigrant birth country could be indeed negative. The interpretation of the results is contained in the following sections.

As in the case of earlier specifications, the tests for heteroskedasticity and normality of the error terms as well as for including the time fixed effects are conducted. Finally, it could be note already here that the Granger causality test for homogeneous causality run after the OLS estimation for exports implies that at 1 % significance level no causal relationship was observed between exports and immigration.

5.3.1. Pooled OLS without the multilateral resistance, traditional gravity equation

First of all, before introducing the results, some notes on the specification are presented. After conducting the Breusch-Pagan and Shapiro-Wilks tests, the heteroskedasticity robust clustered standard errors were assumed. Also the year fixed effects were included in the pooled OLS estimation of exports since the F-statistics indicated the rejection of null hypothesis that all year fixed effects would be zero.

The results obtained in the OLS estimation of the gravity equation with exports hint at a positive relationship between immigration and exports. Furthermore, the estimation results conform well to the theoretical gravity and standard gravity estimates. The coefficient for the *lngdpFOR* is of similar magnitude as in the case of imports, coinciding with the standard gravity. However, the coefficient for distance is more negative, and the most importantly, *always* negative, hinting at smaller exports to faraway countries. The distance coefficient is also always significant at 1 % significance level.

Additionally, the coefficient for colony is not significant in these estimations either and will be dropped out in further estimations. In contrast, the *contig* gets a value of 0.69-0.85 indicating that sharing a border has an effect of approximately 110 % of increased exports to neighbouring countries. Finally, *eu* also has a positive coefficient, indicating beneficiality of free trading agreements for exports as well.

Most importantly, the value of coefficient at 0.157-0.175 for *lnbirth* would indicate that a 10 % increase in the immigrant stock would lead to an increase of approximately 1.5 to 1.7 % increase in exports. The coefficient estimate, however, is not significant at 5 % significance level. The results for the estimation are shown in table 9.

Table 9: The results of pooled OLS estimation on Finnish exports with year fixed effects

Independent variable	(1)	(2)	(3)	(4)	(5)
lngdpFOR	0.997	0.997	0.970	0.960	0.962
	(0.124)**	(0.124)**	(0.127)**	(0.140)**	(0.142)**
lndist	-0.702	-0.680	-0.504	-0.500	-0.490
	(0.123)**	(0.127)**	(0.159)**	(0.160)**	(0.162)**
lnbirth	0.157	0.157	0.173	0.175	0.174
	(0.119)	(0.119)	(0.121)	(0.122)	(0.123)
colony	0.512	-0.123			
	(0.421)	(0.345)			
contig		0.685	0.850	0.827	0.689
		(0.204)**	(0.357)*	(0.361)*	(0.282)*
eu			0.607	0.524	0.565
			(0.237)*	(0.221)*	(0.239)*
oecd				0.140	0.109
				(0.280)	(0.299)
comlang_off					0.489
					(0.393)
_cons	-2.002	-2.189	-3.390	-3.284	-3.407
	(2.030)	(2.059)	(1.979)	(2.064)	(2.143)
N	2,591	2,591	2,591	2,591	2,591
R2	0.79	0.79	0.79	0.79	0.79
Root MSE	1.5031	1.5025	1.495	1.4949	1.4949
F	184.55	-	122.17	125.62	-
Prob > F	0.000	-	0.000	0.000	-

* *p*<0.05; ** *p*<0.01

To test for the importance of leaving out observations due to export value reported as 0 is then studied by changing the dependent variable into lnexp1. The results obtained due not change dramatically, but the coefficient estimate for *lnbirth* becomes significant at 10 % significance level. The effect of immigration on exports would therefore conform to earlier research results, and an increase in immigration by 10 % would increase exports by 2 %.

Based on the model statistics included in the table, changing the dependent variable seems to explain equally well the effects of different independent variables on exports. The results are shown in table 10.

Table 10: The result of pooled OLS estimation with *ln(exports+1)* as a dependent variable

Independent variable	(6)
lngdpFOR	0.997
	(0.140)**
lndist	-0.513
	(0.184)**
lnbirth	0.208
	(0.127)#
contig	0.665
	(0.386)
eu	0.543
	(0.248)*
oecd	0.006
	(0.293)
_cons	-3.993
	(2.158)
N	2,647
R2	0.78
Root MSE	1.6246
F	124.41
Prob > F	0.000

# *p<0.1*; * *p*<0.05; ** *p*<0.01

Moreover, excluding Russian data from the model, (7) in table 11, does not change the estimation results a lot, when compared to the estimation that included all the countries. In contrast, when estimated without the former SSSR and the EU, the model statistics implicate clearly weaker fit reflected by a smaller R^2 and higher root MSE, for example. It can be concluded therefore, as in the case of imports, that there would be no need to remove the observations for the former SSSR or the EU in order to obtain consistent results. Therefore, in the rest of the specifications all of the 179 countries are included. The results of the above mentioned specification are shown in table 11.

Table 11: The results of pooled OLS estimation on Finnish exports without former SSSR (7) and the EU (8)

Independent variable	(7)	(8)
lngdpFOR	0.960	0.986
	(0.141)**	(0.153)**
lndist	-0.500	-0.317
	(0.160)**	(0.211)
lnbirth	0.175	0.173
	(0.122)	(0.128)
contig	0.812	1.139
	(0.411)*	(0.475)*
eu	0.523	
	(0.222)*	
oecd	0.142	-0.154
	(0.291)	(0.407)
_cons	-3.281	-5.310
	(2.072)	(2.775)
N	2,574	2,166
R2	0.79	0.71
Root MSE	1.4997	1.6106
F	107.81	56.05
Prob > F	0.000	0.000

* p<0.05; ** p<0.01

5.3.2. Pooled OLS with multilateral resistance included

Next, we will consider the results obtained when we include changes in CPI and relative real exchange rates (REER) to capture the effect of multilateral resistance. As above, the regression estimates assume heteroskedasticity robust clustered standard errors and time fixed effects based on the specification tests run. Results are shown in table 12 in which the name CPI refers to the use of *lnCPI* as an independent variable and REER to the use of *lnreer*.

As in the case of imports, the coefficient signs of the “multilateral resistance proxies” are different for different proxies. The change in CPI gets a negative value whereas the relative real exchange rate obtains positive value. However, coefficients of both are not significant at 5 % significance level. The assessment of the qualities of the proxies are presented already in the context of the imports and the same facts prevail here. It could be further mentioned that the proxies are probably not suitable for representing the multilateral trade resistance here, first of all, because bilateral trade relations are studied only and no total picture of all the trade relations can be obtained thereafter. Thus the results might be somewhat misleading.

However, adding these variables seem to increase the goodness of fit of the model as it could be expected for any variable that potentially could be an explanatory variable of trade. Therefore the efficiency of the estimator is probably not any better. The partial effect of *lnreer* seems to be in accordance with the theory; the effect of multilateral trade resistance is positive due to increasing pressures to increase bilateral trade when trade is seen hampered with all the other countries. In addition there are not large changes in the coefficients of all the other coefficient estimates and partial effects, and the model fit seems to be slightly better. Therefore, *lnreer* is used as a representative proxy of multilateral resistance in the fixed effects estimation too.

Table 12: Pooled OLS estimation results for Finnish exports with proxies for MR

Independent variable	CPI	REER
lngdpFOR	0.955	0.918
	(0.156)**	(0.134)**
lndist	-0.544	-0.551
	(0.152)**	(0.132)**
lnbirth	0.182	0.216
	(0.137)	(0.112)
lnCPIFOR	-0.093	
	(0.057)	
contig	0.685	0.581
	(0.336)*	(0.311)
eu	0.330	0.431
	(0.208)	(0.194)*
oecd	0.120	0.089
	(0.271)	(0.284)
lnreer		0.014
		(0.438)
_cons	-2.535	-2.261
	(2.108)	(2.373)
N	2,312	2,466
R2	0.81	0.82
Root MSE	1.4344	1.3638
F	217.24	162.65
Prob > F	0.000	0.000

* p<0.05; ** p<0.01

When natural logarithms of changes in CPI are used, the coefficient estimates for other variables remain relatively stable as well. In the first column, named CPI, the results are reported when multilateral resistance is depicted by changes in trading country consumer price indices. The coefficient would imply that increasing multilateral resistance in any country would decrease also the bilateral trade. However, as noted earlier in the context of imports, no further conclusions can be drawn from the multilateral resistance by these estimates as they are not consistent with the theory.

5.3.3. Fixed effects and random effects estimation

Similarly as in the case of imports, the results for fixed and random effects estimations are conducted. The results of the regression are given in table 13.

The fixed effects estimations were tested for autocorrelation with Wooldridge test in panel data and heteroskedasticity with modified Wald test for panel data. Both were observed, and thus clustered heteroskedasticity robust standard errors were used in the estimation. As specified earlier, the tests for time-fixed effects were conducted as well. At 5 % significance level we reject the hypothesis that all time fixed effects are 0.

After the regression, a modified Hausman test of overidentifying restrictions indicates that random effects better estimates the results since the *p*-value obtained, 0.5795, does not enable us to reject the null hypothesis that there are no systematic differences in the coefficients and that the RE is consistent. Additionally, the Breusch-Pagan Lagrangian multiplier (LM) test for random effects is run based on which the null hypothesis that random effects are not relevant can be rejected. Thus, the random effects instead of pooled OLS is favoured.

The estimates of the FE and RE are relatively similar in the case of exports, and the results from the most consistent estimator, here RE, hints at the direction that immigration's effects on exports are positive. The coefficient of immigration gets a value of 0.175 or 0.192, depending on whether the variable *lnreer* is included to depict multilateral resistance. The coefficient estimates are significant at 5 % significance level and. Based on the RE regression, the result could be described as the average effect of the independent variable over the dependent variable when the independent variable changes across time and between country pairs by one unit (units in this case are percentage changes).

The results obtained from the RE estimation show how the effects of immigration on trade obtain a similar magnitude as in the OLS estimation, but now the coefficient estimates are statistically significant. It could be argued that based on the regressions immigration is likely to have a positive effect on exports as well. Looking at the results more closely also shows how the estimation results are not greatly changed between the different models. Additionally, the coefficients of other independent variables in the RE estimation and FE are not far away from each other. The sign of the most commonly used gravity variable, GDP and distance, follow closely the theoretical values and therefore, it could be argued, that the model quite accurately describes the partial effects of the different independent variables on exports.

Finally, *rho* values reported in the model statistics indicate how the fraction of variance in exports due to differences between country pairs is less than in the fixed effects model, and a lot less than in the case of imports. Also, the rest of the model statistics suggest a better fit of the model for exports than for the imports.

Table 13: Estimation results for the FE and RE models for exports

Independent variable	**FE (i)**	**FE (ii)**	**RE (i)**	**RE (ii)**
lngdpFOR	0.776	0.844	0.928	0.945
	(0.168)**	(0.197)**	(0.094)**	(0.105)**
lnbirth	0.108	0.138	0.175	0.192
	(0.126)	(0.128)	(0.086)*	(0.087)*
eu	0.003	0.030	0.085	0.115
	(0.212)	(0.228)	(0.198)	(0.198)
oecd	-0.015	-0.001	0.323	0.129
	(0.130)	(0.132)	(0.190)	(0.202)
lnreer		-0.102		-0.147
		(0.432)		(0.396)
lndist			-0.649	-0.678
			(0.177)**	(0.139)**
contig			0.646	0.416
			(0.318)*	(0.292)
_cons	-4.251	-4.929	-1.533	-0.829
	(2.801)	(2.660)	(2.015)	(2.276)
N	2,591	2,466	2,591	2,466
R2 (within)	0.22	0.22	0.22	0.22
F	15.84	18.27	-	-
Prob > F	0.000	0.000	-	-
Wald chi2	-	-	4406.20	5129.64
Prob > chi2	-	-	0.000	0.000
Rho	.7395	.6720	.5600	.4746

* $p<0.05$; ** $p<0.01$

5.3.4. PPML estimation

The alternative method of estimating the partial gravity equation with PPML is also conducted in the context of exports. The PPML should more adequately estimate the coefficients and gives us a possibility to interpret the coefficients actually as marginal effects. In the estimation, the standard errors by assumption are heteroskedasticity robust (since the PPML command programmed in Stata by Santos Silva and Tenreyro (2006) is used. Also clustered standard errors by trade partner were assumed. Similarly, as in OLS the year fixed effects are included in the second regression with PPML, labelled PPML (ii) in the table. The results are shown in table 14.

As the results show, the coefficient for *lngdpFOR* and *lndist* are significant at 1 % level and consistent with the theoretical model so that the coefficient of GDP is positive and of distance is negative. Again, the GDP coefficient is lower than in the case of OLS. The coefficient estimate of *lnbirth* in the PPML(i) estimation in which country dummies are not included is about the same size, or slightly smaller, that the OLS estimator predicts; a 10% increase in immigration would lead to an approximately 1.3 % increase in trade. When the country dummies are not included the result is significant at 10 % level. However, when the country dummies are introduced, the sign of the coefficient changes and the result is not statistically significant for *lnbirth* anymore. The result shows how the overall effects of immigration might be positive when it comes to exports, but that there are some unobserved country specific effects that are correlated with the explanatory variables and after estimating these with country dummies, the effect to exports is not significant.

What comes to the control variables, the value that are obtained in PPML(i) are again smaller than in the OLS estimation for export. The effect of belonging to the EU is positive and significant. Also the contiguity gets a positive coefficient. This would translate to a 54.9 % increase in exports due to countries being contiguous. By and large, it could be said that the PPML estimation gives more realistic estimates for the coefficients than the OLS or the other regressions considered. However, to formally test the adequacy of the models, the next section introduces a way to do that.

Table 14: Estimation results of PPML regression for exports

Independent variable	PPML (i)	PPML (ii)
lngdpFOR	0.762	0.566
	(0.066)**	(0.051)**
lndist	-0.693	-0.505
	(0.124)**	(0.047)**
lnbirth	0.128	-0.102
	(0.077)#	(0.133)
comlang_off	0.365	
	(0.196)	
contig	0.438	0.105
	(0.184)*	(0.053)*
eu	0.371	0.160
	(0.123)**	(0.130)
oecd	-0.211	0.174
	(0.197)	(0.078)*
_cons	2.677	6.987
	(0.979)**	(1.205)**
R2	0.94	0.98
N	2,647	2,647

#<0.10; * p<0.05; ** p<0.01

5.4. Comparison of adequacy of OLS and PPML

It can be clearly seen from the results that the coefficient estimates for the different models are different. Especially, the OLS estimates and the PPML estimates that use same variables can be compared, and it can be observed how the latter estimation consistently gives lower values for the *lnGDP* as well as for *lnbirth* variables when imports is the dependent variable. The *distance* variable also gets more realistic (theoretical) coefficient estimates in the PPML model as the coefficient sign in the OLS for imports, for instance is opposite to the sign that the theory and vast majority of empirical studies have found. Similar effects can be seen in the context of exports, however, the coefficient for *lnbirth* not changing that drastically.

To formally compare the adequacy of the different models, Santos Silva and Tenreyro (2006) suggest in their study, a comparison between the OLS, PPML and other estimations that can be easily executed by using a heteroskedasticity-robust Ramsey's RESET test. This involves testing for the conditional expectation of the correct specification. To check this, an additional regressor, $(x'\beta)^2$ where β denotes the estimated parameters, is used (Santos Silva and

Tenreyro 2006: 651). The null hypothesis of the test is that the regressor introduced is zero and the model is specified correctly. If this is rejected, the model used in the estimation is inappropriate.

In this study, the RESET test implies that the null hypothesis in the OLS estimation of exports and imports can be rejected, the *p*-values obtained in the test for all the OLS specifications is 0.000. Conversely, the PPML *p*-value in the case of exports is 0.6777 and 0.8119 in the case of imports, and the null hypothesis in either case can be rejected. This is indication for the use of PPML estimator in the context of this partial gravity equation similarly as Santos Silva and Tenreyro (2006) suggest for a correctly specified gravity equation.

As a result of the RESET test, it can be concluded how the assumptions on the distribution of error terms clearly have effects on the model suitability when a gravity type model is estimated. The log-linearisation might lead to erroneous assumptions on error terms when heteroskedasticity is present and as a result the OLS coefficient estimates translated as marginal effects could be biased. Here, in the case of imports, for instance, the positive estimate of the coefficient of distance obtained in the OLS is likely to be a biased result caused by the misspecified estimator error pattern.

6 Discussion

Although the methodological limitations in the model estimated based on a gravity approach in this study are evident, there are some aspects that can be discussed regarding immigration's impacts on trade. The partial gravity equation that has been estimated using only Finnish trade and immigration data in this study hints at similar results that have been obtained in the earlier literature on trade and immigration (e.g. the Dunlevy & Hutchinson (2001), Rauch & Trindade (2002) and Co et al. (2004)).

The effects that have been estimated show that a positive change in immigrant population has a positive effect on imports and a positive (but not unambiguous) effect on exports. Furthermore, based on the considerations of causality as well as the preliminary Granger causality test in the context of OLS, the results indicate that the direction of this relationship is most likely not to run from trade to immigration. The positive impact of immigration on imports and exports could be explained by the network effects or, only additionally in the case of imports, the immigrant preferences for their home goods, as discussed in chapter 2.

Thus the following section discusses what, if anything, can be said about the motives for impacts of immigration on trade. Finally, in section 6.2 limitations related to the study will be outlined and improvements will be suggested.

6.1. What can be said about the impacts of immigration on trade?

Based on this study it seems that immigration's impact on imports is slightly larger than on exports when PPML estimates that turned out to be more adequate than OLS estimates are compared[43]; this could be explained by the imports, in addition to network effects, also increasing due to the preference for home goods that the immigrants have. Anyhow, as the results obtained do not point directly to a larger effect for imports (neither that the effects on exports in the first place are significant) it is not possible to say anything specific regarding why the immigration might cause an increase in either exports or imports. As Rauch (2001: 1177) mentions, determining the relative importance of the effects through which immigration might have an effect on trade should be "especially important since they point to quite different areas of

[43] The PPML(i) estimators for both imports and exports of sections 5.2.4 and 5.3.4 are considered here.

concern for policymakers." Hence, although the impacts of immigration were generally positive, no conclusions could be made on how to take into account these impacts, for example, in policy considerations as the reasons behind them is unclear.

Additionally, the results of the PPML(i) regressions, that are considered the baseline in the study, show that the coefficient of immigration when exports are studied is not significant at 5 % significance level, and in general, the results for exports do not seem to allude to an increase in trade due to increased number of immigration as unambiguously as in the case of imports. This might be a consequence of very different import and export structures of Finland; approximately 50 % of the Finnish exports are raw materials, figure remarkably less when imports are observed.

Furthermore, as this study only considered the immigrants as a homogenous group and did not make any difference between the goods traded either, the study of the reasons behind the immigration's effects is impossible. For example, Gould's (1994) comment that immigrant skill level has no impact over the effect or Rauch's (2001) idea that there might be different effects in different goods groups cannot be discussed here as the data used consisted of aggregate trade and immigration data only. Similarly, it impossible to comment Head and Ries' (1998) suggestion that the effects of the preference for home country goods are probably not visible in the context of homogenous goods, but that the effects are more visible when observing trade in differentiated goods, in which the availability of ideal variety is important.

Moreover, due to not adding a full plethora of control variables that have turned out to be important in earlier studies, the model might suffer further biases. For example, Anderson and Marcouiller (2002) hint at that the omission of indices of institutional quality gives a biased gravity model since insecurity raises the prices of the goods and the potential loss is estimated as a hidden tax for trade. To make the model more complete, further considerations should be given to potential variables that are assumed to create significant impediments to trade.

Moving ahead, as from the point of view of causality, the reasons behind immigration cannot be completely verified and therefore, it could be possible that the causality runs from trade to immigration, at least partially. However, based on literature the direction of causality is likely to follow the direction assumed in this study. Still, for instance, the changing pattern of immigration towards more educated workforce could support the idea that trade actually is a cause of immigration. For example, expatriates that are sent to work around the world in multinational companies are likely to be sent to their new host country due to existing trade relations.

Although the estimations done in this study cannot be generalised (due to the reduced form of the use of gravity model that would require bilateral data for all the countries studied), something about the adequacy of the estimation techniques can be said though. It seems that due to the zeros that trade data usually contains and the error term structure that trade data has, the OLS is not a consistent estimation method. The RESET test that was carried out in section 5.4 indicates that also when a reduced form of gravity equation is used, the Poisson pseudo-maximum-likelihood estimation gives estimates of less biased coefficients. The base line of the comparisons that are drawn based on this study, as well, should follow the PPML as suggested by Santos Silva and Tenreyro (2006).

So one of the outcomes of this study is also that a partial gravity equation can be estimated using the PPML and the results seem to conform with the results obtained in earlier studies as well as provide reasonably unbiased estimates for the regression coefficients. This is important to the gravity literature on trade and immigration, where OLS has been by far the most widely used methodology. The proper consideration of the model from the theoretical perspective can be seen to have very important implications also in applied empirical work to be able to predict unbiased coefficient estimates.

However, from a theoretical perspective, the gravity equation also needs some further considerations since the dilemma that why some countries trade and others do not still seems to exist when trade data is observed. It would be important to understand, therefore, that the increase in trade can be explained by intensive or extensive margin. In this study the intensive margin was under interest, therefore, the question was if immigration could increase the trade between countries that already trade. However, the problem might also lie in the extensive margin: if migrants are able to, for instance, expand trade to some geographical areas that do not trade between each other. Hence the question of extensive margin would also be interesting. As Coughlin and Wall (2011) suggested, the information barriers might be greater when the country is not present in the market and information, and networks, would be needed when a country enters this kind of a market. Therefore, it would be interesting to study the extensive margin of immigration as well.

Rauch (2001), additionally, has noted that existing domestic networks could affect trade as well, for instance, by restriction of international suppliers. Although this theme is not directly related to immigration, this would be a further way to understand the mechanisms of networks and, for instance, if foreign suppliers enter these networks.

Before entering the conclusions, some further considerations on the limitations of the study and suggestions for improvements are presented in the next section.

6.2. Limitations and suggestions for improvements

As mentioned at the beginning of this chapter the study contains several limitations that prevent us from drawing solid conclusions on the impacts of immigration on foreign trade. The obvious improvement for the study of immigration and trade would be to use complete bilateral data for all the countries studied in order to be able to take as a starting point the theoretical gravity equation and include the multilateral trade resistance correctly into the model. However, the biggest limitation for this is the availability of immigration data – depending on the number of countries used, the data should be probably collected from several different sources, which would imply a rigorous data collection process in order to obtain comparable data.

There are, however, some other concerns with the data that are not solely related to immigration data. When deciding on the number of countries included in the study, it should be considered if certain countries can be included under study in the first place; it is likely that countries in a conflict are likely to have a large number of people moving away from them to any country, but at the same time these same countries might trade very little. Thus when studying the links between immigration and trade, for instance, the use of gravity equation would probably not give accurate results under this kind data.

Then, if the complete immigration and trade data between all the countries studied was available and the selection of countries that were studied was made, it would be interesting to study also how different immigrant groups (for example, entrepreneurs vs. workers, old vs. young) affect the exports or imports.

Further considerations arise in the context of networks. It would be of utmost importance to understand how to model the existing networks and how the migrant members of the networks affect the functioning of them, i.e. how the information is shared between the members and how this could translate into increased trade between countries where members of the networks live.

On the other hand, to better answer the question of whether the effects are caused by information sharing, contract enforcement or solely by preference for home goods, different goods groups could be studied separately using the gravity model. For example, knowledge-intensive goods could be studied separately to get an insight if the trade in them benefit more from immigration. Also, it could be argued, for instance, that some basic food commodities are such that a large immigrant population in some country could affect the demand for a special home country good, increasing imports to their new host country, and implying home bias. This would mean that trade should be studied using product group or product level trade data.

Consequently, the empirical estimation in this study too could have been constructed so as to separately investigate the effects of immigration on aggregate trade and then, for instance, on different manufactures and commodities groups' trade. The consideration of the Finnish export and import structures that are clearly different should have been probably taken into account when thinking about using the aggregate trade data.

Ultimately, the assimilation of immigrants or different groups of immigrants and its effects as well as the many different channels through which immigration could affect the economy should be studied in further detail also in the context of the Finnish economy. Assimilation, for example, could affect preferences but may also cut the connection with the existing network in the previous home country or hamper the creation of new networks. Alternatively, if the assimilated individuals keep in contact with their ethnic network, increased interchange of goods might result between the two countries that the immigrant represents. Co et al. 2004 suggest that the immigrants could act as middlemen and consequently affect trade.

Furthermore, as Rauch (2001), for example, has argued, better institutional quality, and stronger legal environment that enables more effective contract enforcement could have led to lessened network and informational effects on trade. In order to see if this holds, some measure for institutional quality, for instance, could be included in gravity model of trade that could be estimated. By and large, the limitations and suggestions mentioned above are only a handful of the most important considerations that should be taken into account in the future studies.

7 Conclusions

The objective of this study was to find out whether immigration has impacts on the Finnish exports and imports. Based on the results obtained in the empirical estimations, a small positive effect for imports and exports was found using the PPML regression. However, when country dummies were added the effects were not significant that might be due to unobserved effects that are correlated with the explanatory variables. However, these preliminary results point at a direction that it would be interesting to study the impacts of immigration on trade by using more complete data that could be used to estimate the theoretically derived gravity equation in its full form including multilateral trade resistance. This would require bilateral trade and immigration data between all the countries studied. Moreover, the results obtained in this study also show that the estimation of the gravity equation with PPML is more adequate than the estimation by OLS, the method most widely employed in the literature related to gravity equation.

Furthermore, although the effects of immigration on trade were observed to be slightly positive in this study, nothing can be said about the channels through which the impacts of immigration on imports or exports accumulate. In the gravity literature on immigration and trade, the effects are either assigned to network effects or preference for home goods, home bias; the network effects further include informational and contract enforcement effects among others. A coefficient for imports that was clearly larger than for exports would have hinted at both network effects and preference for home goods acting simultaneously since the latter is likely to affect only imports. The results of PPML regressions for exports and imports shows that the difference between the coefficients in this study is not remarkable, only slightly larger for imports, and therefore probably cannot be assumed to strongly indicate that both home bias and network effects are the causes for that.

To be able to draw more accurate conclusions on how immigration impacts trade, different types of goods traded, for example differentiated vs. homogeneous goods, should be considered separately to obtain information on through which channels the effects might accumulate. For future research, data on immigrant characteristics, education level, age and so forth should be obtained too in order to draw more solid conclusions on how and why different immigrant groups might have an effect on trade.

Additionally, when the Finnish context is considered, there would probably be a need for micro-level research to be carried out, for instance, on migrant entrepreneurs and their supplier networks. This would offer more insight into the study of links between immigration and trade. More general research on immigrant networks could also be considered, in order to understand how immigrants in Finland are linked to their home country or to coethnic networks abroad.

Ultimately, there are several aspects that could possibly be linked to the impacts that immigration has on trade. Consequently, studies on immigrant assimilation, on reasons behind migration decisions as well as on ethnic networks could further shed light on how and why immigration might possibly affect trade.

Bibliography

Literature

Adam C. and Cobham D., 2007. Modelling multilateral trade resistance in a gravity model with exchange rate regimes. *Centre for Dynamic Macroeconomic Analysis Conference Papers*, Working Paper 07/02.

Anderson, J., 2011. The Gravity Model. *The Annual Review of Economics,* 3(1), pp. 133-160.

Anderson, J. and Marcouiller, D., 2002. Insecurity and the Pattern of Trade: An Empirical Investigation. *Review of Economics and Statistics,* 84(2), pp.342-352.

Anderson, J. and van Wincoop , E., 2003. Gravity with Gravitas: A Solution to the Border Puzzle. *The American Economic Review,* 93(1), pp. 170-192.

Anderson, J. and van Wincoop, E., 2004. Trade Costs. *Journal of Economic Literature,* 42(3), pp. 691-751.

Armington, P., 1969. A Theory of Demand for Products Distinguished by Place of Production. *International Monetary Fund Staff Papers,* XVI, pp. 159-178.

Bai, Z., Wing K. W., and Bingzhi Z., 2010. Multivariate linear and nonlinear causality tests. *Mathematics and Computers in Simulation,* 81(1), pp. 5-17.

Baier S. L. and Bergstrand J. H., 2009. *Bonus vetus* OLS: A simple method for approximating international trade-costs effects using the gravity equation. *Journal of International Economics*, 77 (1), pp. 77-85.

Bergstrand, J. H., 1985. The Gravity Equation in International Trade: Some Microeconomic Foundations and Empirical Evidence. *The Review of Economics and Statistics,* 67(3), pp. 474-481.

Bergstrand, J. H., 1989. The Generalized Gravity Equation, Monopolistic Competition, and the Factor-Proportions Theory in International Trade. *The Review of Economics and Statistics*, 71(1), pp. 143-153.

Bloningen B. A. and Wilson W. W., 1999. Explaining Armington: What Determines Substitutability between Home and Foreign Goods? *The Canadian Journal of Economics / Revue canadienne d'Economique*, 32(1), pp. 1-21.

Borjas, G. J., 1994. The Economics of Immigration. *Journal of Economic Literature*, 32(4), pp. 1667-1717.

Borjas, G.J., 2003. The labor demand curve is downward sloping: re-examining the impact of immigration on the labor market. *Quarterly Journal of Economics*, 118 (4), pp. 1335-1374.

Chen, W., Clarke, J.A. and Roy, N., 2012. Health and Wealth: Short Panel Granger Causality Tests for Developing Countries. *Econometrics Working Papers*, number 1204. Department of Economics, University of Victoria

Clausing, K. A., 2001. Trade Creation and Trade Diversion in the Canada - United States Free Trade Agreement. *The Canadian Journal of Economics / Revue canadienne d'Economique*, 34 (3), pp. 677-696.

Co, C., Euzent, P. and Martinez, T., 2004. The export effect of immigration into the USA. *Applied Economics*, 36(6), pp. 573-583.

Coughlin C .C. and Wall H. J., 2011. Ethnic networks and trade: Intensive versus extensive margins. *Economics Letters*, 113 (1), pp. 73-75.

Duanmu, J-L. and Guney Y., 2013. Heterogeneous effect of ethnic networks on international trade of Thailand: The role of family ties and ethnic diversity. *International Business Review*, 22 (1), pp. 126-139.

Dunlevy, J. A. and Hutchinson, W. K., 1999. The Impact of Immigration on American Import Trade in the Late Nineteenth and Early Twentieth Centuries. *The Journal of Economic History*, 59 (4), pp. 1043-1062.

Dunlevy, J. A. and Hutchinson, W. K., 2001: The Pro-Trade Effect of Immigration on American Exports during the Late Nineteenth and Early Twentieth Centuries. *IZA Discussion paper series*, Working Paper No. 375.

Eaton, J. and Kortum, S., 2002. Technology, Geography, and Trade. *Econometrica*, 70(5), pp. 1741-1779.

Eaton, J. and Kortum, S., 2012. Putting Ricardo to Work. *The Journal of Economic Perspectives*, 26(2), pp. 65-89.

Eichengreen, B. and Douglas A. I., 1995. Trade Blocs, Currency Blocs and the Reorientation of World Trade in the 1930s. *Journal of International Economics*, 38, pp. 1-24.

Epstein, G. and Gang, I. S., 2006. Ethnic Networks and International Trade. In: Foders, F and Langhammer, R. J. (eds.) *Labor Mobility and the World Economy*. Berlin, Heidelberg, Springer, pp. 85-103.

Frankel, J.A. and Romer, D.H., 1999. Does Trade Cause Growth? *American Economic Review*, 89(3), pp. 379-399.

Girma, S. and Yu, Z., 2002. The link between immigration and trade: evidence from the U.K., *Weltwirtschaftliches Archive*, 138, pp. 115-30.

Gould, D. M., 1994. Immigrant Links to the Home Country: Empirical Implications for U.S. Bilateral Trade Flows. *The Review of Economics and Statistics*, 76(2), pp. 302-316.

Greif, A., 1993. Contract Enforceability and Economic Institutions in Early Trade: The Maghribi Traders' Coalition. *The American Economic Review*, 83(3), pp. 525-548.

Granger, C. W. J., 1969. Investigating Causal Relations by Econometric Models and Cross-spectral Methods. *Econometrica,* 37 (3), pp. 424-438.

Head, K. and Ries, J., 1998. Immigration and trade creation: econometric evidence from Canada. *The Canadian Journal of Economics*, 31(1), pp. 47-62.

Helpman, E, Melitz, M, and Rubinstein, Y., 2008. Estimating trade flows: trading partners and trading volumes. *Quarterly Journal of Economics*, 123, 2, pp. 441-487

Kerr, S, and Kerr, W., 2011. Economic impacts of immigration: a survey. *Finnish Economic Papers*, 24, 1, pp. 1-32

Klausing, K. A., 2001. Trade creation and trade diversion in the Canada- United States Free Trade Agreement. *The Canadian Journal of Economics,* 34(3), pp.677-696.

Koivukangas, O., 2003. European Immigration and Integration: Finland. National Europe Centre Paper No. 63. Paper presented to conference entitled *The Challenges of Immigration and Integration in the European Union and Australia*, 18-20 February 2003, University of Sydney.

Lee, J., 2012. Network effects on international trade. *Economics Letters*, 116(2), pp. 199-201.

Lindersa, G-J. M. and de Groot, H.L.F., 2006. Estimation of the gravity equation in the presence of zero flows. *Tinbergen Institute Discussion Paper*

Lundborg, P., 1991, Determinants of Migration in the Nordic Labour Market. *The Scandinavian Journal of Economics,* 93(3), pp. 363-375.

Markusen, J. R., 1983. Factor movements and commodity trade as complements. *Journal of International Economics*, 14(3-4), pp. 341-356.

Mundell, R., 1957. International Trade and Factor Mobility. *The American Economic Review*, 47, pp. 321-335.

Murat, M. and Pistoresi, P., 2009. Migrant Networks: Empirical Implications for the Italian Bilateral Trade. *International Economic Journal,* 23(3), pp. 371-390.

Podolny, J.M. and Page K.L., 1998. Network Forms of Organization. *Annual Review of Sociology,* 24(1), pp. 57-76.

Poot, J. and Strutt, A., 2010. International Trade Agreements and International Migration, *World Economy*, 33(12) pp. 1923-1954.

Razali, N. and Wah, Y. B., 2011. Power comparisons of Shapiro–Wilk, Kolmogorov–Smirnov, Lilliefors and Anderson–Darling tests. *Journal of Statistical Modeling and Analytics*, 2 (1), pp. 21–33.

Rauch, J.E., 1999. Networks Versus Markets in International Trade. *Journal of International Economics*, 48(1), pp. 7-35.

Rauch, J. E., 2001. Business and Social Networks in International Trade. *Journal of Economic Literature*, 39(4), pp. 1177-1203.

Rauch, J. E. and Trindade V., 2002. Ethnic Chinese Networks in International Trade. *The Review of Economics and Statistics*, 84(1), pp. 116-130.

Rose, A.K., 2004. Do We Really Know That the WTO Increases Trade? *The American Economic Review*, 94, pp. 98-114.

Rose, A. and van Wincoop, E., 2001. National Money as a Barrier to International Trade: the Real Case for Currency Union. *American Economic Review Papers and Proceedings*, 91(2), pp. 386-390.

Salmio, T., 2000. Kylmän sodan loppuminen ja EU-jäsenyys muuttivat Suomen maahanmuuttopolitiikkaa. *Siirtolaisuus-Migration*, pp. 21-26.

Samuelson, P., 1952. The Transfer Problem and Transport Costs. The Terms of Trade when Impediments are Absent. *The Economic Journal,* Volume 62, pp. 278-304.

Santos Silva J. M. C. and Tenreyro, S., 2006. The Log of Gravity. *The Review of Economics and Statistics*, 88(4), pp. 641-658.

White, R., 2007. Immigrant-trade links, transplanted home bias and network effects. *Applied Economics,* 39(), pp. 839-852

Wong, K.-y., 1986. Are International Trade and Factor Mobility Substitutes?. *Journal of International Economics*, 21(1-2), pp. 25-43.

Online sources

European Comission, 2013. *Trade: Policy making*. [Online]. Available from: http://ec.europa.eu/trade/about/policy-making/ [Accessed 31st March 2015].

Finnish Customs, 2014. *Foreign Trade 2013: Finnish Trade in Figures.* [Online]. Available from: http://www.tulli.fi/fi/tiedotteet/ulkomaankauppatilastot/katsaukset/tiedotteet/taskutilasto2013/liitteet/pocket2013.pdf [Accessed 10 September 2015].

Finnish Immigration Service, 2013. *Maahanmuuton tunnusluvut 2013*. [Online]. Available from: http://www.migri.fi/download/54460_EMN_Maahanmuuton_tunnusluvut_2013_final.pdf?1fc1fa3cf334d288 [Accessed 14th April 2015].

Ministry for Foreign Affairs of Finland, 2008. [Online]. *Finland in the world economy*. Available from: http://formin.finland.fi/public/default.aspx?contentid=70745&nodeid=15263&contentlan=2&culture=en-US [Accessed 26th November 2012].

Ministry of the Interior, Finland, 2012. *Future of Migration 2020*. [Online]. Available from: http://www.intermin.fi/en/development_projects/future_of_migration_2020 [Accessed 26th November 2012].

Official Statistics of Finland (OSF), 2013: *Migration* [Online], Helsinki: Statistics Finland. Available from: http://tilastokeskus.fi/til/muutl/2013/muutl_2013_2014-04-29_tie_001_en.html [Accessed 26th March 2015].

Official Statistics of Finland (OSF), 2013. *Migration* [Online]. Appendix figure 1. Immigration, emigration and net immigration in 1971–2013. Helsinki: Statistics Finland. Available from: http://www.stat.fi/til/muutl/2013/muutl_2013_2014-04-29_kuv_001_en.html [Accessed 26th March 2015].

OECD, 2012. *International Migration Outlook 2012*. [Online]. Available from: http://www.oecd-ilibrary.org/social-issues-migration-health/international-migration-outlook-2012_migr_outlook-2012-en [Accessed 28 April 2015].

OECD, 2014. *International Migration Outlook 2014*. [Online]. Available from: http://www.oecd.org/migration/international-migration-outlook-1999124x.htm [Accessed 28 April 2015].

Population Research Institute, 2013. *Migration in Finland.* [Online]. http://www.vaestoliitto.fi/in_english/population_research_institute/facts-and-figures/migration-in-finland/ [Accessed 25th March 2015].

Snorrason, S. T., 2012. *Asymmetric Economic Integration: Size Characteristics of Economies, Trade Costs and Welfare*. Berlin, Heidelberg, Springer Verlag. Available from: http://dx.doi.org/10.1007/978-3-7908-2861-0 [Accessed 10th January 2013].

Statistics Finland, 2010. *Maahanmuutossa suuria vuosivaihteluita*. [Online]. Available from: http://www.stat.fi/artikkelit/2010/art_2010-07-09_001.html?s=0 [Accessed 26th March 2015].

United Nations (UN), 2013. *Population Facts.* [Online]. Available from: http://esa.un.org/un-migration/documents/The_number_of_international_migrants.pdf [Accessed 26th March 2015].

World Trade Organization (WTO), 2014. *Trade profiles: Finland.* [Online]. Available from: http://stat.wto.org/CountryProfile/WSDBCountryPFView.aspx?Language=E&Country=FI [Accessed 2nd April 2015].

Data sources

Bruegel, 2012. *Real effective exchange rates for 178 countries: a new database.* http://www.bruegel.org/publications/publication-detail/publication/716-real-effective-exchange-rates-for-178-countries-a-new-database/ Available online [Accessed 28 April 2015].

Centre d'Etudes Prospectives et d'Informations Internationales (CEPII), 2015. *GeoDist.* http://www.cepii.fr/CEPII/fr/bdd_modele/presentation.asp?id=6 [Accessed 28 April 2015].

Statistics Finland, 2014. *Country of birth according to age and sex by region 1990 – 2014.* Available from: http://pxnet2.stat.fi/PXWeb/pxweb/en/StatFin/StatFin__vrm__vaerak/040_vaerak_tau_103_en.px/?rxid=24b20d20-d40f-4f61-869d-44ca33ba80c1 [Accessed 28 April 2015].

UNCTAD, 2015. *Consumer price indices, annual, 1980-2014.* Available from: http://unctadstat.unctad.org/wds/TableViewer/summary.aspx [Accessed 28 April 2015].

UNCTAD, 2015. *Gross domestic product: Total and per capita, current and constant (2005) prices, annual, 1970-2014.* Available from: http://unctadstat.unctad.org/wds/ReportFolders/reportFolders.aspx [Accessed 28 April 2015].

UNCTAD, 2015. *Merchandise trade matrix - product groups, exports in thousands of dollars, annual, 1995-2013.* Available from: http://unctadstat.unctad.org/wds/ReportFolders/reportFolders.aspx [Accessed 28 April 2015].

UNCTAD, 2015. *Merchandise trade matrix - product groups, imports in thousands of dollars, annual, 1995-2013.* Available from: http://unctadstat.unctad.org/wds/ReportFolders/reportFolders.aspx [Accessed 28 April 2015].

Appendix 1: Summary statistics of variables in OLS estimation

Variable	Definition	N	Mean	Std. Dev.	Min	Max
imp	Finnish imports from any source country in thousands	3043	279444	1161776	0	1.90E+07
exp	Finnish exports to any source country in thousands	3043	318103.9	1101168	0	1.70E+07
lnimp	Natural logarithm of Finnish imports from any source country in thousands	2615	7.716741	4.353785	-5.29832	16.75995
lnexp	Natural logarithm of Finnish exports to any source country in thousands	2888	8.947251	3.47231	-1.62455	16.64872
year	Observation year	3043	2003	4.899785	1995	2011
id	Finnish id (data retrieved from a larger data set that included GDP, trade and distance data for all the countries)	3043	56	0	56	56
partner	Country id	3043	90.69274	52.05001	1	180
gdp_fin_in~s	Finnish GDP in thousands	3043	1.79E+08	5.56E+07	1.20E+08	2.70E+08
lngdpFIN	Natural logarithm of Finnish GDP	3043	18.95795	0.3059224	18.603	19.41393
gdp_for_in~s	Trading partner GDP in thousands	3043	240000000	1.03E+09	0	1.5E+10
lngdpFOR	Natural logarithm of trading partner GDP	3025	16.34786	2.598001	9.372672	23.43132
birth_coun~y	Number of people born in each source country or aggregated entity	3043	920.6704	4962.681	0	92986
lnbirth	Natural logarithm of number of people born in each source country or aggregated entity	2654	4.272388	2.51182	0	11.4402
dist	Simple distance between the most populous cities	3043	7034.944	3590.129	397.892	17362.6
lndist	Natural logarithm of simple distance between the most populous cities	3043	8.676843	0.6832441	5.986181	9.762074
distcap	Simple distance between capitals	3043	7021.718	3585.226	397.892	17362.6
distw	Population weighted distance between the most populous cities	3026	7066.026	3518.503	604.911	16838.8
contig	Dummy variable for contiguous countries, 1 if the two countries are contiguous	3043	0.0167598	0.1283912	0	1
comlang_off	Dummy variable for common official language, 1 if the country pair shares common official primary language	3043	0.0055866	0.0745467	0	1
comlang_et~o	Dummy variable for common official language, 1 if the language is spoken by at least 9 % in the countries that form a pair	3043	0	0	0	0
colony	Dummy variable indicating colonial ties, 1 if colonial ties existed for the country pair	3043	0.0111732	0.1051284	0	1
eu	Dummy variable if in EU, EEA or Switzerland, 1 if member	3043	0.0834703	0.2766372	0	1
p_index_ch~e	Average annual growth rate in each country's consumer price index measured in %	2924	12.96426	130.8149	-33.1262	5399.53
pindex_cha~d	Average annual growth rate in the Finnish consumer price index measured in %	3043	1.576419	1.123178	2.50E-06	4.06595
oecd	Dummy variable indicating OECD membership, 1 if member	3043	0.1501807	0.3573072	0	1
reer	Relative real exchange rate measured against a basket of each country's trading partners	2642	102.1904	26.43768	10.8	446.9
reer_fin	Finland's relative real exchange rate measured against a basket of its trading partners	3043	100.5412	3.871199	93.6	110.8

Appendix 2: Summary statistics of variables (in FE and RE) [44]

Variable		Mean	Std. Dev.	Min	Max	Observations
imp	overall	279444	1161776	0	19000000	N = 3043
	between		1022438	0	8500000	n = 179
	within		556633.7	-5620556	10800000	T = 17
exp	overall	318103.9	1101168	0	17000000	N = 3043
	between		1025795	0	7641176	n = 179
	within		407247.3	-3923073	9676927	T = 17
lnimp	overall	7.716741	4.353785	-5.298317	16.75995	N = 2615
	between		4.441201	-1.857899	15.71882	n = 178
	within		1.476854	0.4440159	14.80404	T-bar = 14.691
lnexp	overall	8.947251	3.47231	-1.624552	16.64872	N = 2888
	between		3.444379	1.316206	15.72019	n = 178
	within		1.178009	1.402622	14.90965	T-bar = 16.2247
year	overall	2003	4.899785	1995	2011	N = 3043
	between		0	2003	2003	n = 179
	within		4.899785	1995	2011	T = 17
id	overall	56	0	56	56	N = 3043
	between		0	56	56	n = 179
	within		0	56	56	T = 17
partner	overall	90.69274	52.05001	1	180	N = 3043
	between		52.18744	1	180	n = 179
	within		0	90.69274	90.69274	T = 17
gdp_fin_in~s	overall	179000000	55600000	120000000	270000000	N = 3043
	between		0	179000000	179000000	n = 179
	within		55600000	120000000	270000000	T = 17
lngdpFIN	overall	18.95795	0.3059224	18.603	19.41393	N = 3043
	between		0	18.95795	18.95795	n = 179
	within		0.3059224	18.603	19.41393	T = 17
gdp_for_in~s	overall	240000000	1030000000	0	15000000000	N = 3043
	between		994000000	20081.64	11400000000	n = 179
	within		273000000	-3750000000	4950000000	T = 17

[44] The definitions of the variables are introduced in the table in appendix 1.

lnCPIFOR	overall	1.615462	1.167855	-5.500679	8.594068	N = 2680
	between		0.8275422	-0.5190948	4.506654	n = 178
	within		0.848908	-4.686975	7.674516	T-bar = 15.0562
birth_coun~y	overall	920.6704	4962.681	0	92986	N = 3043
	between		4766.949	0	56144.47	n = 179
	within		1422.648	-24517.8	37762.2	T = 17
lnbirth	overall	4.272388	2.51182	0	11.4402	N = 2654
	between		2.555494	0	10.88269	n = 166
	within		0.5111904	1.533076	6.576011	T-bar = 15.988
dist	overall	7034.944	3590.129	397.892	17362.6	N = 3043
	between		3599.608	397.892	17362.6	n = 179
	within		0	7034.944	7034.944	T = 17
lndist	overall	8.676843	0.6832441	5.986181	9.762074	N = 3043
	between		0.685048	5.986181	9.762074	n = 179
	within		0	8.676843	8.676843	T = 17
distcap	overall	7021.718	3585.226	397.892	17362.6	N = 3043
	between		3594.692	397.892	17362.6	n = 179
	within		0	7021.718	7021.718	T = 17
distw	overall	7066.026	3518.503	604.911	16838.8	N = 3026
	between		3527.845	604.911	16838.8	n = 178
	within		0	7066.026	7066.026	T = 17
contig	overall	0.0167598	0.1283912	0	1	N = 3043
	between		0.1287302	0	1	n = 179
	within		0	0.0167598	0.0167598	T = 17
comlan~f	overall	0.0055866	0.0745467	0	1	N = 3043
	between		0.0747435	0	1	n = 179
	within		0	0.0055866	0.0055866	T = 17
comlang_et~o	overall	0	0	0	0	N = 3043
	between		0	0	0	n = 179
	within		0	0	0	T = 17
colony	overall	0.0111732	0.1051284	0	1	N = 3043
	between		0.1054059	0	1	n = 179
	within		0	0.0111732	0.0111732	T = 17
eu	overall	0.10023	0.3003558	0	1	N = 3043

	between		0.2852363	0	1	n = 179
	within		0.0963422	-0.3703582	0.8061124	T = 17
p_index_ch~e	overall	12.96426	130.8149	-33.1262	5399.53	N = 2924
	between		44.29057	-1.302133	522.6009	n = 178
	within		122.8651	-517.0555	4889.893	T-bar = 16.427
pindex_cha~d	overall	1.576419	1.123178	0.0000025	4.06595	N = 3043
	between		2.23E-16	1.576419	1.576419	n = 179
	within		1.123178	0.0000025	4.06595	T = 17
oecd	overall	0.1501807	0.3573072	0	1	N = 3043
	between		0.3557458	0	1	n = 179
	within		0.0421784	-0.7321722	1.091357	T = 17
reer	overall	102.1904	26.43768	10.8	446.9	N = 2642
	between		16.75655	46.70588	231.5294	n = 156
	within		20.46511	-29.73899	317.561	T-bar = 16.9359
reer_fin	overall	100.5412	3.871199	93.6	110.8	N = 3043
	between		0	100.5412	100.5412	n = 179
	within		3.871199	93.6	110.8	T = 17

Appendix 3: Trade partners of Finland used in the estimation

1	Afghanistan	32	Cape Verde	63	Greece	94	Madagascar	125	Papua New Guinea	156	Togo
2	Albania	33	Cayman Islands	64	Greenland	95	Malawi	126	Paraguay	157	Tonga
3	Algeria	34	Central African Republic	65	Grenada	96	Malaysia	127	Peru	158	Trinidad and Tobago
4	Andorra	35	Chad	66	Guatemala	97	Maldives	128	Philippines	159	Tunisia
5	Angola	36	Chile	67	Guinea	98	Mali	129	Poland	160	Turkey
6	Anguilla	37	Colombia	68	Guinea-Bissau	99	Malta	130	Portugal	161	Turks and Caicos Islands
7	Antigua and Barbuda	38	Comoros	69	Guyana	100	Marshall Islands	131	Qatar	162	Tuvalu
8	Argentina	39	Congo	70	Haiti	101	Mauritania	132	Romania	163	Uganda
9	Aruba	40	Costa Rica	71	Honduras	102	Mauritius	133	Rwanda	164	United Arab Emirates
10	Australia	41	Côte d'Ivoire	72	Hungary	103	Mexico	134	Saint Kitts and Nevis	165	United Kingdom
11	Austria	42	Cuba	73	Iceland	104	Micronesia (Federated States of)	135	Saint Lucia	166	United Republic of Tanzania
12	Bahamas	43	Cyprus	74	India	105	Mongolia	136	St. Vincent and the Grenadines	167	United States
13	Bahrain	44	Dem. Rep. of the Congo	75	Iran (Islamic Republic of)	106	Montserrat	137	Samoa	168	Uruguay
14	Bangladesh	45	Denmark	76	Iraq	107	Morocco	138	Sao Tome and Principe	169	Vanuatu
15	Barbados	46	Djibouti	77	Ireland	108	Mozambique	139	Saudi Arabia	170	Venezuela (Bolivarian Republic of)
16	Belgium	47	Dominica	78	Israel	109	Myanmar	140	Senegal	171	Viet Nam
17	Belize	48	Dominican Republic	79	Italy	110	Namibia	141	Seychelles	172	Yemen
18	Benin	49	Ecuador	80	Jamaica	111	Nauru	142	Sierra Leone	173	Zambia
19	Bermuda	50	Egypt	81	Japan	112	Nepal	143	Singapore	174	Zimbabwe
20	Bhutan	51	El Salvador	82	Jordan	113	Netherlands	144	Solomon Islands	175	Former SSSR
21	Bolivia (Plurinational State of)	52	Equatorial Guinea	83	Kenya	114	New Caledonia	145	Somalia	176	Former Yugoslavia
22	Botswana	53	Eritrea	84	Kiribati	115	New Zealand	146	South Africa	177	Former Indonesia
23	Brazil	54	Ethiopia	85	Korea, Dem. People's Rep. of	116	Nicaragua	147	Spain	178	Former Czechoslovakia
24	British Virgin Islands	55	Fiji	86	Korea, Republic of	117	Niger	148	Sri Lanka	179	Former Neth.Ant
25	Brunei Darussalam	56	Finland	87	Kuwait	118	Nigeria	149	Sudan (...2011)	180	China (total)
26	Bulgaria	57	France	88	Lao People's Dem. Rep.	119	Norway	150	Suriname		
27	Burkina Faso	58	French Polynesia	89	Lebanon	120	Occupied Palestinian territory	151	Swaziland		
28	Burundi	59	Gabon	90	Lesotho	121	Oman	152	Sweden		
29	Cambodia	60	Gambia	91	Liberia	122	Pakistan	153	Switzerland		
30	Cameroon	61	Germany	92	Libya	123	Palau	154	Syrian Arab Republic		
31	Canada	62	Ghana	93	Luxembourg	124	Panama	155	Thailand		

Former SSSR: Armenia, Azerbaijan, Belorussia (now Belarus), Estonia, Georgia, Kazakhstan, Kirgiziya (now Kyrgyzstan), Latvia, Lithuania, Moldavia (now Moldova), Russia, Tajikistan, Turkmenistan, Ukraine, Uzbekistan and Former Soviet Union.
Former Yugoslavia: Bosnia and Herzegovina, Croatia, Macedonia, Montenegro, Serbia, Former Serbia and Montenegro, Slovenia and Former Yugoslavia
Former Indonesia: Indonesia and Timor Leste
Czechoslovakia: Czech Republic and Slovakia and China (total): China, Hong Kong, Macau and Taiwan