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DETERMINANTS OF THE HORIZONTAL AND VERTICAL INTRA-INDUSTRY TRADE BETWEEN NORWAY AND THE EUROPEAN UNION

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Abstract

This study investigates determinants of the bilateral intra-industry trade (IIT) types between Norway and the European Union trading partners over the period 2000-2013. In the study there is applied comprehensive approach by analysing determinants of the IIT types in terms of country- and industry-characteristics. Intra-industry trade is decomposed into horizontal (HIIT) and vertical (VIIT) parts based on products' unit values *per kilogram* for two different values of dispersion factors. Trade pattern between Norway and the EU in analysed period suggests that only around 16% of trade occurs under IIT with greater domination of VIIT. In our empirical research we use fit panel-data models by employing feasible generalized least square method. Apart from traditional country-characteristics like difference in relative factor endowments, economic size and geographical proximity, there is also examined the impact of integration schemes, FDI inflows and endowments in specific natural resources. Furthermore, the study analyses the effect of increase in net migration flows on IIT and shows that it significantly promotes all types of IIT. In cross-industry analysis, the study argues that horizontal and vertical product differentiation are needed in considering determinants of IIT and confirms that intensification of the scale economies, market structure, market concentration and multinational character of the market have significant and positive impact on both HIIT and VIIT.

Keywords: Intra-industry trade, product differentiation, panel data, Norway.

JEL Classification: F12, F14

Resumo

O presente estudo analisa os determinantes do comércio intra-ramo (CIR) bilateral entre a Noruega e os países membros da União Europeia no período 2000-2013. O estudo desenvolve uma análise abrangente focando os determinantes dos vários tipos de CIR tanto em termos de características dos países como dos setores. O comércio intra-ramo é decomposto em comércio intra-ramo horizontal e vertical com base na utilização de fatores de dispersão para os valores unitários. O padrão de comércio entre a Noruega e a UE no período analisado sugere que apenas 16% corresponde a CIR e que este respeita fundamentalmente a CIR vertical. No estudo empírico, usamos modelos com dados de painel, nomeadamente o FGLS. No que concerne às características dos países, consideramos aspetos tradicionalmente incluídos como a diferença nas dotações fatoriais, dimensão económica ou proximidade geográfica mas também o impacto da integração económica, fluxos de IDE e dotações em recursos naturais específicos. Adicionalmente, o estudo coloca grande ênfase na análise do impacto dos fluxos migratórios, fator que se revela potenciador de todos os tipos de CIR. No quadro da análise cross-industry, o estudo confirma a relevância da diferenciação horizontal e vertical e confirma que fatores como economias de escala, estrutura de mercado, concentração e natureza multinacional do mercado têm um impacto positivo e significativo tanto no comércio intra-ramo horizontal como vertical.

Palavras-chave: comércio intra-ramo, diferenciação do produto, dados de painel, Noruega.

JEL Classificação: F12, F14

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1 Introduction

In the 1960s and the 1970s there appeared first studies, which started to investigate trade flows within industries rather than in industries. Since that time this phenomenon has been observed to be constantly growing in the global trade, especially among developed countries. The trade, which occurs in simultaneous export and import by a country of products within a particular industry grouping has been called intra-industry trade (IIT) or two-way trade. Today, a considerable share of global trade is occurring within intra-industry trade. Nevertheless, intra-industry trade should be investigated only on low levels of products aggregation (e.g. 6-digit level), because according to Grubel and Lloyd (1975) the amount intra-industry trade declines as the level of disaggregation in industries increases.

At the beginning, this kind of trade was difficult to explain within the framework of traditional trade theories since the standard Ricardo and Hecksher-Ohlin models were inadequate to reconcile the phenomenon. Therefore it resulted in emerging new developments in international trade theories[1]. In parallel with the new theories, there appeared also empirical studies, which began to receive global attention after Grubel and Lloyd in 1975 introduced an index that provided an operational measure of two-way trade. Next significant step in explaining intra-industry trade was made with the works by Abd-el-Rahman (1991) and Greenaway *et al. (*1994), who empirically proved that intra-industry trade should be examined solely by horizontal IIT (HIIT) and vertical IIT (VIIT) and they provided a method for disentangling them. In particular, the former arises when different varieties of a product are of a similar quality, whereas the latter when different varieties are of different qualities (Greenaway *et al.,* 1995). As a result, there could be assumed that vertical intra-industry trade is more related to the traditional theory of comparative advantage (e.g. the Heckscher-Ohlin model) and its modified version, whereas horizontal intra-industry trade could be rather classified into the new theories of international trade that allows for horizontal product differentiation.

[1] This area was called New Trade Theory and the main contribution within it had the models of the Krugman (1979), Lancaster (1980), Helpman (1981), Eaton and Kierzkowski (1984) and Helpman and Krugman (1985).

The principle purpose of this dissertation is to explain what determinants cause intra-industry trade between Norway and all members of the European Union for the time span of 2000-2013. Nowadays, in the literature there is a plethora of models and theories about IIT, which cause sometimes a problem in choosing the most appropriate model to explain observed trade patterns. Nevertheless, the majority of empirical studies explain only partially the factors determining intra-industry trade. In particular, they have considered the relevance for intra-industry trade either of industry characteristics to the neglect of country characteristics or of country characteristics to the neglect of industry characteristics. Consequently in this study we combine these two approaches by examining simultaneously two sets of determinants of intra-industry specialization, namely from industry and country sides. In the literature there already exist studies with this approach such as Balassa and Bauwens (1987), Hansson (1991), Blanes and Martin (2000) or Crespo and Fontoura (2004), which applied multi-country and mutli-industry framework. However, our study presents even more comprehensive approach by including some relevant factors that have not been investigated before. Apart from traditional country-characteristics like difference in relative factor endowments, economic size and geographical proximity, there is also examined the impact of integration schemes, FDI inflows and endowments in specific natural resources. In addition to, one of the biggest contributions of this work is to investigate the impact of increase in migration flows on all of the IIT types. This is the phenomenon that has been intensifying much in recent years in Norway and thanks to this study we will be able to investigate its effect in the context of IIT. Initially, we follow the research hypothesis that large increase in migrant inflows is accompanied with the increase in intra-industry trade types.

As far as reporter country is concerned, in the literature there is a lack of studies that investigate intra-industry trade for particular countries, because researchers focused merely on explaining the phenomenon of intra-industry trade. Therefore, the vast majority of researches are done for a group of countries like the EU and OECD and big countries like the US or UK, rather omitting smaller countries. Thus it was one of the reasons why Norway, as reporter country, was chosen. The other aspects that influence on our choice were as follows: firstly, the availability of data, secondly the fact that Norway and the EU operate on common market (European Economic Area) so that problem of trade barriers can be left out of consideration and thirdly Norway has a huge trade potential and its relationship with the EU has been growing in recent years.

Since the literature about Norway's intra-industry trade is scarce, we refer to the contribution of this subject that was made for all of the Nordic countries (Denmark, Finland, Norway and Sweden). Firstly, Andersson (1987) examines determinants of the share of IIT in total trade between all of the Nordic countries and all of their trading partners for three particular years: 1965, 1973 and 1980. These years were chosen to reflect the period during which the Nordic union, EFTA and the EEC were completed, so that the effect of economic integration was analyzed as well. However, the results show that integration plays a minor role in explaining the increase in the share of intra-industry trade. Instead, the author argues that the main cause of the observed increase in intra-industry trade was made by global economic growth and a tendency towards reducing international economic differences. In turn, Petersson (1984) shows in his study for Sweden that the growth in the average intra-industry trade has been provoked by the growth in the share of intra-industry trade for individual commodity groups rather than to change in trade composition towards commodity groups with a higher share of intra-industry trade, though the latter has been important in some periods.

Later on, Fagerberg (1987) examines the difference in intra-industry trade of the Nordic countries with the OECD and non-OECD countries and concludes that the IIT with the OECD countries was much higher than that with the non-OECD. Moreover, he gives insights that in order to understand intra-industry patterns and trends it is essential to consider different explanations for different sectors and product groups. He argues also that increase in intra-industry trade is caused by increasing in technology diffusion which allows countries to produce a wide range of products with decreasing specialization during that time. The seminal work in the case of Sweden is provided by Hansson (1991). In short, author confirms that product differentiation is a necessary condition for intra-industry trade to arise and comparative costs between countries significantly affect IIT. Additionally, he shows that IIT is higher in trade with countries that have similar factor endowments, there is lower transaction costs between trading countries and if countries have a common border. Similar conclusions were reached also by Sørensen et al. (1991), whose study refers to Denmark and Ireland[2].

On the basis of the above-mentioned motivations, in our empirical part we use fit panel-data models by employing feasible generalized least square method for two different groups

[2] See also more recent papers about IIT in the Norid countires by Lundberg (1990), Greenaway and Torstensson (1997) and Andersson (2004).

of explanatory variables, namely, country- and industry-characteristics. We use the UN Comtrade database as the source for detailed trade data, whereas the sources for explanatory variables are mainly the World Bank (World Development Indicators databank) and the Norwegian Statistical Office (Statistisk sentralbyrå).

The structure of this paper is as follows: Section 2 presents theoretical foundations of the subject and provides empirical background; Section 3 specifies the methodology that was used; Section 4 describes general patterns of trade between Norway and the EU; exact model specification is presented in Section 5; next, the results are presented in Section 6 and finally Section 7 is devoted for conclusions and policy implications.

2 Literature review

2.1 Theoretical background

In this section we discuss the theoretical foundations concerning determinants that may explain horizontal IIT, vertical IIT and total IIT. First studies about IIT began to appear in the 1960s with works of Verdoorn (1960) and Balassa (1966). These two authors by observing trade patterns between partner countries in the emerging European Economic Community noticed that certain developed countries exported and imported products that are from the same product categories. Nevertheless, this phenomenon had not been studied intensively until the seminal work of Grubel and Lloyd (1975), who introduced an index that provided an operational measure of two-way trade[3]. When the phenomenon of intra-industry trade was confirmed, any of existing at that time models (mainly based on Heckscher-Ohlin's theory) could not explain it. However, from the earliest work on IIT, researchers believed that product differentiation is one of the most important factors in explaining IIT[4]. This led to the emergence of the New Trade Theory, which explains the pattern of global trade by highlighting the importance of economies of scale and product differentiation (Cieślik, 2005).

Significant contribution was made by Dixit and Stiglitz (1977) and Lancaster (1979), who explicitly modelled product differentiation in formal analyses of IIT. They introduced

[3] Grubel and Lloyd (1975) defined IIT index as the ratio of difference between trade balance of industry i to the total trade of the same industry:

$$GL_i = \frac{(X_i+M_i)-|X_i-M_i|}{(X_i+M_i)} = 1 - \frac{|X_i-M_i|}{(X_i+M_i)}.$$

[4] See Linder (1961), Balassa (1967), Grubel and Lloyd (1975).

two approaches towards horizontal differentiation, viz. "love of variety" approach[5] and "favourite variety" or "ideal variety" approach[6]. Then, the former one was followed among others by Krugman (1979, 1980), Dixit and Norman (1980), Helpman and Krugman (1985) and the latter one was followed by Lancaster (1980) and Helpman (1981). All of these theoretical models were pioneering in explaining IIT. They were able to explain the Linder's (1961) hypothesis about negative correlation between the share of intra-industry trade and the differences in countries' per capita income by assuming per capita income differences as capital-labour endowment ratio differences[7]. Nevertheless, they were mainly concentrated on horizontal differentiation (HIIT), which highlighted the importance of monopolistic competition that identified increasing returns to scale along with the consumers demand for varieties of (horizontally) differentiated products as key drivers of IIT (Thorpe, Leitão 2013).

To be more specific, let us consider the simple 2 x 2 x 2 model framework proposed by Helpman and Krugman (1985) for explaining horizontal IIT. In this model there are two factors of production (capital – *K*, labour – *L*) used to produce two goods (the capital intensive *x* and the labour-intensive good *y*) in two different countries in terms of relative factor endowments (the capital-abundant country *A* and the labour-abundant country *B*). In addition, production functions (supply side) and consumer preferences (demand side) are assumed to be the same in both countries[8]. The capital-intensive good *x* is a differentiated product manufactured under economies of scale and monopolistic competition while the labour-intensive good *y* is a homogeneous product manufactured under constant returns to scale and perfect competition. On top of that, we assume that each country spends the same shares of consumers income on goods *x* and *y*. Then, we can notice that without introducing product differentiation for good *x*, this model follows the traditional Hecksher-Ohlin-Samuelson

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[5] The consumers' preferences in Dixit and Stiglitz (1977) can be visualised as the ulity function of the representative consumer:

$$U = \sum_{i=1}^{n} v(c_i),$$

where, $v(c_i)$ utility from consuming $c_i > 0$ units of variety *i* ($v(c_i) > 0$; $v'(c_i) > 0$; $v''(c_i) < 0$). In equilibrium (with a given budget constraint) everyone is buying the same amount of every variety.

[6] In Lancaster's (1979) "ideal variety" approach all consumers' optimal varieties are uniformly distributed among the possible varieties and the utility function can be visualised as:

$$U(x, y, v) = u\left[\frac{x(v)}{h(v)}; y\right],$$

where $h(v) \geq 1$ - compensation function, *v* - distance between the avaiable variaety and ideal one, *x* – quantity of differentiated good consumed, *y* – quantity of homogenous product.

[7] Alternatively, Pagoulatos and Sorensen (I975), Loertscher and Wolter (1980), Toh (1982), Lundberg (1982) and Havrylyshyn and Civan (I983) interpret the inequality between two countries' per capita incomes as taste differences (Bergstrand, 1990).

[8] Preferences for the differentiated product are specified assuming that every consumer wishes to purchase all available varieties so that variety has a value in its own right (Dixit and Stiglitz (1977) "love of variety" approach).

explanation for trade, where the capital-abundant country exports the capital-intensive good, while the labour-abundant country is an exporter of the labour-intensive product. Nevertheless, by applying together the varieties for one good and economies of scale assumption in the capital-intensive sector, it implies that the labour-abundant country can export also some varieties of the capital-intensive product. Therefore, based on this framework, Helpman and Krugman suggest that apart from the inter-industry trade, there will emerge intra-industry trade in varieties of the capital-intensive differentiated product *x*. As it is shown in Cieślik (2005) if we assume that total trade is balanced, Helpman and Krugman (1985) prove that the volume of (horizontal) intra-industry trade equals twice the exports of differentiated good by the net importer - country B:

$$IIT = 2s^A pX^B, \tag{1}$$

where, s^A is the share of country *A* in combined *GDP* of countries *A* and *B*, *p* is the relative price of good *x*, and X^B is the volume of output of good *x* in country *B*. Similarly, they show that the volume of total trade can be calculated as the twice the export of the differentiated good *x* by the net exporter – country A:

$$TOT = 2s^B pX^A, \tag{2}$$

where, s^B is the share of country *B* in combined *GDP* of countries *A* and *B*, *p* is the relative price of good *x*, and X^A is the volume of output of good *x* in country *A*. Thus, if we divide above equations we will get the share of intra-industry trade in total trade:

$$s_{IIT} = \frac{IIT}{TOT} = \frac{2s^A pX^B}{2s^B pX^A} = \frac{s^A X^B}{s^B X^A}\,. \tag{3}$$

Therefore, this equation posits that the larger is the share of intra-industry trade in total trade between two countries, the smaller the difference in their relative factor endowments ($\frac{X^B}{X^A}$), given the constant relative country size ($\frac{s^A}{s^B}$). It is more evident by considering the proportional rate of growth of the share of intra-industry trade in total trade:

$$\hat{s}_{IIT} = \left(\frac{1}{s^B}\right)\hat{s}^A - (1 + \frac{X^A}{X^B})\hat{X}^A. \tag{4}$$

Then, this mechanism works as follows: if country *A*'s share of world GDP is kept constant (e.g. $\hat{s}^A = 0$), and differences in factor proportions between countries increase making country A relatively more capital abundant (and at the same time B relatively more labour –

abundant), then this leads to an increase (decrease) in country A's (B's) output of good x, e.g. $\hat{X}^A > 0$ ($\hat{X}^B > 0$). Consequently, the share of intra-industry trade in total trade decreases[9], $\hat{s}_{IIT} < 0$.

On the other hand, we also have to take into consideration economic size of both countries following the concept of scale economies that the greater size of the markets, the more industries and varieties will exist. Thus, we can check it by keeping differences in relative factor endowment constant and assume that the relative country size can vary. In this case, if the differences in factor proportions in equation (4) are kept constant (e.g. $\hat{X}^A = 0$) and for example country A's share of world GDP increases ($\hat{s}^A > 0$), then it results in increase of the share of intra-industry trade in total trade ($\hat{s}_{IIT} > 0$). Likewise, the most econometric studies have explained the positive relationship between the share of intra-industry trade and average level of per capita income using Linder (1961) hypothesis. In particular, higher average per capita income represents higher level of economic development, which by raising the extent of demand for differentiated products causes increasing in the share of intra-industry trade. It is shown in theoretical models of Loertscher and Wolter (1980), Havrylyshyn and Civan (1983), Balassa (1986*a*, *b*), and Balassa and Bauwens (1987). Nevertheless, as Helpman and Krugman (1985) points out we cannot take this relationships for granted, because of the other factors that are not included into consideration can interpose it and as a result there is need to employ some other variables to balance the effect.

Later on, Eaton and Kierzkowski (1984) raised horizontal differentiation into a context of oligopoly. They assume that there exists two identical economies and in each of them two groups of consumers with a different "ideal variety" preferences. Then, international trade leads to the existence of only one producer for each of the ideal varieties in each market, which give rise to IIT. In all aforementioned models, each variety is produced under decreasing costs and when countries open up to trade, the similarity of the demands leads to intra-industry trade. Therefore, HIIT is more likely to occur between countries with similar factor endowments, so that it cannot be explained by traditional trade theories.

The main contributions for vertical differentiation (VIIT), which is that different varieties are of different qualities, are works by Falvey (1981), Shaked and Sutton (1984),

[9] Details about relationships between the share of intra-industry trade and differences and sums of capital – labour ratios are provided in appendix in Cieślik's (2005) paper and Cieślik (2009). In short, it is shown that taking the first – order Taylor expansion of the $\hat{s}_{IIT}$ function around some constant values of ($DIFF^*$, SUM^*), we have such approximation:

$$IIT \approx \beta_0 - \beta_1 DIFF + \beta_2 SUM$$

Falvey and Kierzkowski (1987) and Flam and Helpman (1987). Regarding Falvey and Kierzkowski (1987) model, the supply side is based on the comparative advantage theory, where product quality being linked to capital intensity in production. Thus, it is assumed that high- (low-) quality varieties are relatively capital (labour) intensive[10]. In turn, countries with relatively higher capital to labour ratios (capital-abundant) are considered to have comparative advantage in capital intensive products (higher quality set of varieties) and export them. On the other hand, countries that are labour-abundant will have comparative advantage in labour intensive products (low-quality varieties) and export them. On the demand side, although all consumers have the same preferences, each individual demands only one variety of the differentiated product, which is determined by their income (Crespo and Fontoura, 2004). This is still consistent with Linder (1961) hypothesis that "a significant element in explaining vertical product differentiation will be unequal incomes" (Falvey, Kierzkowski, 1987: 144). Furthermore, higher-income consumers acquire higher-quality varieties, while different income levels in each economy guarantee that there is a demand for every variety produced. Therefore, intra-industry trade arises because each variety of a differentiated good is produced in only one country, but is consumed in all countries. To sum up, taking two-country world model, IIT will be greater, the greater the differences of factor endowments between them (Faustino, Leitão, 2007). Especially, based on Helpman (1987), we can use income differences as a proxy for factor-endowment differences, because there is a positive correlation between the capital-labour ratio and per-capita income.

The framework of the Flam and Helpman (1987) model is similar, but this model contains the differences in technology (particularly labour productivity) that explain VIIT. Nonetheless, the conclusion is similar: the more productive country, which has higher wages, exports the higher-quality varieties. The aforementioned models that focus on explaining the VIIT are known as the Neo-Hecksher-Ohlin theory and overall they show that VIIT takes place between countries with different factor endowments (supply-side differences) and with differences in per-capita income (demand-side differences). Nevertheless, Falvey (1981) explains existence of the VIIT and inter-industry trade simultaneously. In his model, the capital-abundant (labour-abundant) country specializes in, and exports high-quality (low-

[10] Specifically, their average cost function (AC) is described as follows:

$$AC_i = w_i + \rho r_i,$$

where, i – country in which a differentiated good is produced, w_i – wage rate in country i (they assume that only one unit labour is used per one unit of product, regardless of its quality), r_i – capital rate in country i, ρ - amount of capital used in production of the chosen variety (quality index).

quality) products. In general, these authors assume that the differences in factor intensity determine the difference in the quality of the products and it leads to emerge of VIIT (Faustino and Leitão, 2007).

In addition, Shaked and Sutton (1984) provided alternative approach to explain VIIT. Their model put much more attention on the role of market structure (especially in oligopoly case) with IIT being supported by scale economies that are more significant relatively to the total market (Greenaway, Hine and Milner 1995). In particular, they assume that the quality of the product is determined by R&D, which refers to the fixed costs, and that is why the model explains better the high-technology sectors. Demand side is the same as in previous model, namely, consumers who have a higher income will demand goods of a higher quality. Then, when trade occurs, average cost decreases due to scale economies and R&D profitability increases, hence there is an extensive increase in the quality of the traded varieties in firms that become competitive located in different markets. In the extreme case, when the average variable costs increase moderately with quality improvement, the natural oligopoly will emerge (Crespo and Fontoura, 2004).

Nowadays, there is generally accepted that VIIT can be explained by traditional theories of comparative advantage. Therefore, the relatively labour-abundant countries will export the labour-intensive varieties and the relatively capital-intensive countries will export the capital-intensive varieties. In the context of factor endowments in the Heckscher-Ohlin theorem for *n* goods and factors, the capital ratio of the net exporters of the relatively capital-abundant country will be higher in relation to the net exporters of the other country (Vanek, 1968). As Davis (1995, p. 205) points out "goods are distinguished on the demand side according to perceived quality, and on the production side by the fact that high-quality goods are produced under conditions of greater capital intensity." Thus, there is needed to exclude from vertical IIT varieties that are produced under the same factor proportions. Otherwise, horizontal IIT may assume identical factor intensity. All things considered, Table 1 sets major aspects concerning the differences in organisation of trade in the horizontally and vertically differentiated products:

Table 1. Organisation of trade in horizontally and vertically differentiated products.

	Product differentiation	
	Horizontal	Vertical
Preferences	"Love of variety"	"Favourite variety"
Market structure	Monopoly/Oligopoly	Perfect Competition/Oligopoly
Key-driver factor	Similarity in factor endowments	Difference in factor endowments
Economies of scale	Positive relation	Positive relation

2.2 Theory implications

On the basis of theoretical foundations, there should be also highlighted some relevant implications for our empirical work. Firstly, as it was mentioned before, IIT should be analysed in terms of different market structures, since the relationships between IIT types and market structures are ambiguous. It is usually viewed that the both large numbers models and those for high degree of market concentration are dominant for explaining HIIT, whereas the relationship between VIIT and market structure is less clearly defined in the existing literature. For instance, when the Neo-Heckscher-Ohlin-Samuelson (HOS) settings are valid it is consistent with competitive market, but additionally the natural oligopoly model can support this type of trade as well (Faustino and Leitão, 2007).

Secondly, the aforementioned theories focus mainly on variations across industries in bilateral trade. However, Crespo and Fontoura (2004) points out that in most empirical cases researchers analyse the IIT either across countries, i.e. bilateral IIT between one country and its partner for the whole economy-level, or alternatively the IIT of one country with the previously specified partner group, i.e. taking multilateral trade into consideration for disaggregated sectoral-level. Thus, in the former model, the determinants of differences in IIT between countries are taken as an aggregation of the industry characteristics considered in the theory, but according to Havrylyshyn and Civan (1983) this can have ambiguous effects. Particularly, on the one hand, Loertscher and Wolter (1980) argue that the larger economy, there are the greater opportunities for scale effects and hence the higher value of IIT. On the other hand, Havrylyshyn and Civan (1983) find that by using aggregation on the whole economy-level, the expected impact of determinants can be difficult to grasp, because bilateral imports and exports may be affected asymmetrically. As for the sectoral-level of disaggregation, the characteristics of the sectors are implicitly assumed to be taken as an average for both analysed country and partner group[11].

Thirdly, theories reckon that the major factors for occurring IIT trade are the nature of the products, the size of the total market and minimum efficient scale of production (Greenaway and Milner, 1986). In particular, by considering firms that produce a number of varieties of a particular commodity, then thanks to economies of scale the presence of significant fixed overhead costs may result in emerging new varieties produced by new firms that enter or this cost can be spread over the number of varieties and results in gaining greater domestic market power by incumbent firms. For the reference, there is paper by Takahashi (2006), who investigates the influence of entry policy and intra-industry trade. There, author shows that implementation of national entry policy by one country makes both countries better off comparing to the market equilibrium if a certain conditions are met.

2.3 Migration and intra-industry trade

In this subsection, we will briefly present the theoretical foundations concerning the link of migration and intra-industry trade, but first of all it is needed to introduce the concept of the migrant networks. According to the new economics of migration, migrant network can be described as a larger unit of related people resembling a kind of a national family connected through the ties of kindness, often friendship, but the most of all – origin. Members of such network share a common language, culture and traditions what makes them exceptionally valuable in the foreign dissimilar environment. Simultaneously, in accordance with neoclassical theory, such networks still behave as rational market players, who minimize various costs and risks connected with transnational movement on several grounds. Provided with information about the foreign employment, living conditions and even transportation possibilities the members of the migrant network gain easier access to the foreign labour markets and what follows, they are more likely to move.

The undoubtedly crucial discovery for the research on international migration was revising its relation with the multilateral trade, raised by Rybczynski (1955), Mundell (1957) and later Markusen (1983). The first theories on factor mobility and factor-price equalization focused on wages disparities as intuitive search for the reasons why efficient arbitrage would

[11] See, for example, Aturupane, Djankov and Hekman (1997), Caetano and Galego (2007), Gabrisch (2006) and Dautovic, Orszaghova, Schudel (2014).

fail in reaching equilibrium under properties of a standard neoclassical model of trade. The blame for the arbitrage inefficiency was found in incomplete information. Then, thanks to migration networks the information-sharing increases and stimulates trade.

The seminal work of that relationship was made by Krugman (1992). The author considers two regions' model (North and South) and allows for mobility between them so that it can be understood as the phenomenon of migration. In general, the idea behind this model is that transaction costs and geographical distance contribute to a decrease in IIT, whereas immigration flows usually leads to an increase in IIT. The information carried by migrants, reducing the transaction costs in the foreign market, was perceived by Gould (1994) as one of the major factors decreasing the psychological distance between two countries.

The next large contributions on that subject were works by Girma and Yu (2002) and Blanes (2005). According to them, immigrants are thought to enhance host-home country trade via two channels, namely, the channel of preferences, where the immigrants have preferences for products from country of origin and the channel of reduced transaction costs due to immigrants' networks or information asymmetry[12]. However, throughout the years it was confirmed that these specified channels can be found in reality. Instinctively, it is understandable that migrants tend rather to have strong preferences towards goods produced in their home countries, but let us consider it in more a theoretical way. In particular, Ethier (1995) considers the impact of migration network on trade between countries in terms of different varieties and market structure. Therefore, assuming the principle of the "love of variety" preferences, there could be expected that variety of goods flowing from immigrants' home country may influence not only native but also foreign population from other countries. Eventually, the demand for more varieties of differentiated goods may result in exceeding the supply of home country's varieties by foreign country's varieties.

2.4 FDI and intra-industry trade

In following subsection we raise the theoretical issue of relationship between intra-industry trade and flows of foreign income or investment. The most common way for measuring this is to analyse how foreign direct investment (FDI) influence on intra-industry trade. In general, there could be distinguished two approaches that FDI might influence on IIT. The first one says that the majority of goods produced by multinational enterprises (MNEs), which are

[12] This channel was explained in details in works of Granovetter (1973, 1983, 2005).

responsible for FDI, are differentiated. In particular, those firms engage in trade producing horizontally or vertically differentiated goods as a result of different incomes and tastes between countries. The second approach says that the most intra-industry trade goes under intra-firm trade from MNEs, who locate different stages of the production process in different countries (Chen, 2000).

However, we have to take into account two structurally different types of FDI, namely horizontal and vertical, which account for the way that MNE organizes its foreign activity. In particular, horizontal FDI refers to bilateral flows of investment between developed countries and characterize that MNE replicates the whole process of production in foreign country. In turn, vertical FDI means that MNE fragments the production process in different countries with regards to comparative advantages under intra-firm trade and hence MNE reduces cost by increasing efficiency. Today, the vertical FDI mostly predominates in the flows from developed to less developed countries.

In the models of Helpman (1984), and Grossman and Helpman (1991), authors explain the trade occurrence and MNEs formation by the same determinants, namely difference in factor endowments, intensities and specialization and posit that there is complementarity between trade and vertical FDI. Furthermore, Markusen (1984) shows that even if the countries are characterized by the same endowments, preferences and technology there is a complementary relationship between trade and FDI, which appears in terms of multi-plant economies of scale. The mechanism of this is as follows: the headquarter characterize in activities such as R&D, distribution, marketing and administration, which generate fixed cost, whereas foreign branch is responsible for production process and also generate fixed cost. Therefore, when bilateral trade emerge, the headquarter services are exchange for final goods from abroad.

Substitution between FDI and trade is rather associated with horizontal FDI, where MNE produces the same goods and services in foreign country. That type of trade is most common for the investments between developed countries. The models that explain that linkage are for example, Hortsman and Markusen (1992), Brainard (1993) and Markusen and Venables (1998) and generally they assume similarity in size, endowments, technology and economies of scale at the firm and foreign plant as well. Thus, export or investment occurs, because of the reduction in trade costs and concentration of production, which account for economies of scale. However, in works of the Markusen and Venables (1998, 2000), Egger and Pfarffermayr (2002), there are highlighted that the convergence in economic size, endowment and income cause increase in foreign activity of MNEs. Particularly, the foreign enterprises displace home enterprises and as a result the volume of trade decreases. In other words, we can say that the FDI substitute trade. Later on, in trade models by Markusen (1997, 2000) and Carr et al. (2001), there are shown that FDI can be both complement and substitute to trade.

Nevertheless, one of the most important researchers in the context of FDI analysis is John Dunning (1977, 1980, 1988 and 1993). In his seminal work from 1993, he considers economic theories of FDI and the foreign activities of MNEs. His most known theory is an 'eclectic' approach, which is also so-called the OLI paradigm[13]. This approach explains the geography and industrial composition of foreign market on which MNEs operate by three interdependent conditions that are made out of three sub-paradigms. The first one is the competitive advantage over local firms, which the MNE gains from possessing certain ownership advantages (O) in a foreign market. In this sub-paradigm, the greater the competitive advantage of the investing enterprises, there is more likely to increase their foreign production (Dunning, 2000). Second condition is related to localization advantages (L), which is generated by value added activities of MNEs in the country of investment. This advantage arises from ownership advantage (O) and can be gained by access to immobile raw materials, relatively cheap labour or some kind of trade liberalization advantages. The third sub-paradigm is an internationalization advantage (I), which is also linked to the previous ones, but it is gained by own production in foreign country rather than producing through a partnership arrangement such as licensing or joint-venture (Dunning, 2000). On the whole, there could be four key factors that drive MNE for foreign activity, namely, *market seeking*, *resource seeking*, *efficiency seeking* and *strategic asset seeking.*

According to Greenaway and Milner (1986) in each three of these sub-paradigms, there is linkage to IIT. Assuming that goods produced by multinational enterprises are differentiated then the ownership advantage can be express in the form of a brand image. The advantage from location can be seen in difference in relative factor endowments or factor prices. By internationalisation advantage the home company can reduce its uncertainty and have advantage from economies of scale.

[13] The OLI abbreviation stands for: Ownership, Location and Internalization.

2.5 Empirical evidence

Up to now, there appeared a number of studies that have been investigating country- and industry-specific determinants that influence on IIT types. In majority of the empirical works authors show that country-specific determinants dominate over industry-specific factors. In general, there is common knowledge that in both horizontally and vertically differentiated goods the production process and market characteristics of industries play important role. In this study we present two approaches concerning both determinants of cross-country and cross-industry characteristics. Determinants that we chose are based on theoretical foundations about IIT, but there should be also considered strong empirical bases that confirm our choice. Thus, in this subsection, there are provided empirical evidences for theoretical background, according to which we can formulate our research hypotheses.

First of all, based on theoretical foundations, we can say that the major factor that account for occurring intra-industry trade is the difference in relative factor endowments. However, this characteristic has different impact on different IIT components. According to models with horizontal differentiated products there is expected negative correlation between the share of intra-industry trade and the differences in capital-labour ratio endowment, whereas in vertical differentiated models, authors assume positive correlation. It is common that for difference in capital-labour endowments, researchers take difference in per capita income and investigate its effect separately on horizontal IIT and vertical IIT. Such approach can be found among others in Bergstrand (1990), Hansson (1991), Blanes and Martin (2000), Crespo and Fontoura (2004), Gabrisch (2006) Jensen and Lüthje (2009), Zhang and Clark (2009) or Thorpe and Leitão (2013). In addition, some authors such as Blanes and Martin (2000), Martin-Montaner and Rios (2002) or Crespo and Fontoura (2004) consider difference in factor endowments in terms of difference in physical capital, technology and human capital, what we also apply in our work. In general, we can introduce our first hypothesis:

H1: The share of horizontal (vertical) intra-industry trade in total trade between two countries is larger, the smaller (greater) the differences in their relative factor endowments.

Nevertheless, in some empirical studies there are not so clear relationship between difference in factor endowments and horizontal and vertical IIT. According to Cieślik (2005) it could be the effect of the lack of control for the variation in the sum of capital-labour ratios. The results without such control variable can give biased estimates of the coefficients in factor endowments across country pairs. Therefore, to avoid these biased estimations we employ in our econometric model variable accounting for sum in capital-labour ratio.

Secondly, in the theoretical literature there is assumed that economic size of the market, especially in bilateral trade between pair of countries, has positive impact on all types of IIT. The proxy that is most often used for that is the sum of the Gross National Product that both countries generate. We can find positive relation between this proxy and all types of IIT in many empirical studies such as Bergstrand (1990), Crespo and Fontoura (2004), Jones and Kierzkowski (2004), Grossman and Helpman (2005), Jensen and Lüthje (2009) or Thorpe and Leitão (2013), to name but a few. Thus, we can introduce our second hypothesis:

H2: The share of horizontal, vertical and total intra-industry trade in total trade between two countries is larger, the larger the economic size of both countries.

In our study, we take into account the transportation costs that emerge between two trading partners. The most common proxy for that is the geographical distance between countries. It was not presented in the theoretical part, but it emerges strictly from gravity model equation that was introduced by Tinbergen (1962) and Pöyhönen (1963)[14]. Then, that factor was also successfully inputted in the theoretical models about IIT such as Balassa and Bauwens (1987) or Krugman (1979, 1980). Their conclusion was that the closer geographically distance between countries, the greater IIT. Afterwards, this variable has become extensively used in the empirical works confirming negative impact on the share of IIT (e.g. Balassa and Bauwens, 1987; Hansson, 1991; Crespo and Fontoura, 2004; Bergstrand and Egger, 2006; Gabrisch, 2006; Jensen and Lüthje, 2009 or Thorpe and Leitão, 2013). Nevertheless, there are some empirical works such as Gray and Martin (1980) or Zhang, van Witteloostuijn and Zhou (2005), which show that this negative impact affects to a larger extent HIIT rather than VIIT. Based on above-mentioned empirical examples, we can formulate our third hypothesis:

H3: The share of horizontal, vertical and total intra-industry trade in total trade between two countries is smaller, especially for HIIT, the greater the geographical distance between countries.

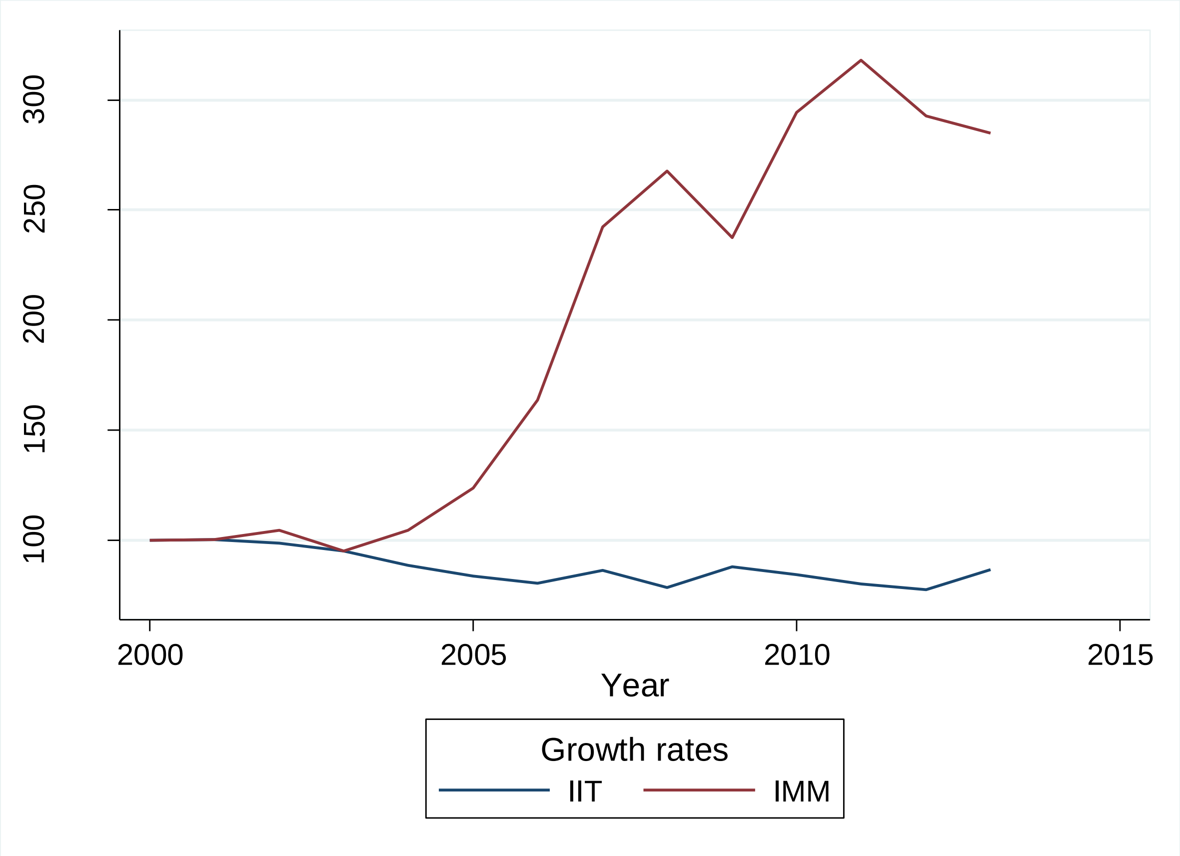
[14] The most basic gravity equation postulates that the amount of trade between two countries is positively related to their economic size and negatively to distance between them, which refers to a simple analogy with physics.

Next, we presented theoretical context of the link between migration flows and IIT types. From this theoretical part we can infer that there is a positive relation between migration flows and intra-industry trade mainly due to existence of migrant networks. This area of IIT has only been studied in the recent years, when immigration has become important issue in the economics theories. Firstly, as it was showed by Girma and Yu (2002) and Dunlevy (2006), the influence of immigrants on trade is connected with the institutional dissimilarities between host and home country. It is usually investigated by employing per capita income as a proxy for that and this approach is also applied in our study. Secondly, it has been proved by works of Rauch and Watson (2004), Rauch and Trindade (2002) and Rauch (1999, 2001) that the effect of immigration on trade will be greater for differentiated products, since transaction costs (e.g. gaining information about products or varieties characteristics) are more relevant for differentiated than for homogenous products. Following the Blanes (2005) and Blanes and Martin-Montaner (2006) and their evidence for Spain, since trade transaction costs affect more intra-industry trade than inter-industry trade, we should expect that increased flow of immigrants will increase share of the IIT in total trade. Last but not least, it is suggested by Rauch (2001) that based on immigrants' preferences assumption, we should rather expect greater impact of host country import than export. We can summarize all of above in the fourth hypothesis:

H4: There is a positive relationship between migration flows and all types of the IIT.

For that hypothesis there is a strong support in recent phenomenon of immigration in Norway. Particularly, in the recent years Norway has experienced massive inflow of immigrants (mainly from Central and Eastern Europe) and at the same time their economy has been constantly growing. Thus, we think that it is proper to consider also this factor as a driving force in Norwegian IIT. Figure 1 below provides graph of the growth rate of IIT and the stock of immigration between Norway and all members of the European Union, treating 2000 year as the baseline (2000 year = 100).

Figure 1. Growth rates of intra-industry trade and immigration stock between Norway and the European Union (in percent and 2000 year=100)



Note: IIT stands for intra-industry trade, while IMM stands for immigration inflow

Source: The Statistics Norway (Statistisk sentralbyrå).

At first glance, we can notice that Norway since 2000 year has experienced huge inflow of migrants from the EU. Nevertheless it seems that it did not have any significant impact on the growth rate of IIT, since in analysed period (2000-2013) the share of Norway's intra-industry trade in total trade with the EU decreased slightly. That is inconsistent with the aforementioned theories, but it could be the effect of other factors that prevailed over a positive impact of immigration. Thus, we will try to determine it in our empirical study. Apart from that, we will still take the view that immigration has positive impact on intra-industry trade. To investigate it, in our research, we will add a variable that measure the annual migration flows (immigration – emigration) between Norway and the trading partner. We believe that usage of this variable seems to be more proper, because IIT accounts for bilateral trade and that is why both immigrants and emigrants can influence on that process. Even so, since in the recent years Norway has experienced huge inflow of immigrants and negligible outflow of emigrants, the net migration can be treaten as an approximation of immigration flow.

Another thing refers the relationship between foreign direct investment and intra-industry trade. Based on so-far empirical developments there is no consensus on the trade effects of FDI as positive and negative relationships have been found in different studies. Goh, Wong and Tham (2013) argue that it is possible to have either a substitutionary or complementary relationship depending on the nature of investment. In the early literature, Mundell (1957) used a theoretical model to demonstrate that FDI and exports are substitutes for each other. Then it was also confirmed in the works by Markusen (1984) and Markusen and Venables (1995), which showed that horizontal FDI (market-seeking) lead to substationary relationship with trade[15]. On the other hand, Helpman (1984) and Helpman and Krugman (1985) showed the possibility of a complementary relationship when vertical FDIs (cross-border factor cost differences) are involved due to the fragmentation of the production process geographically[16]. Besides, there are also studies by Norman and Dunning (1984), Goldberg and Klein (1999) and Blonigen (2001) showing that FDI can have both substitution and complementary effects on trade. On the above-mentioned basis, we assumed that foreign investment is also an important factor that we cannot neglect. According to Thorpe and Leitão (2013), we can formulate next hypothesis as follows:

H5: There is a positive impact of FDI on VIIT, nevertheless its impact on HIIT and total IIT is ambiguous.

Following the empirical works of Balassa (1966, 1979) Balassa and Bauwens (1987), Crespo and Fontoura (2004) and Veeramani (2009), we also decided to consider IIT types in context of integration schemes. These works show that the value of IIT and its types is higher in the framework of regional integration spaces (e.g. European Union). In addition, Hansson (1991) show that cultural similarities between particular countries (in this case Nordic one) and common border as well, positively influence IIT trade. As a result, we assume that our next hypothesis is as follows:

[15] Other papers supporting substationary relationship between FDI and trade: Horst (1972), Svensson (1996), Bayoumi and Lipworth (1997), Ma et al. (2000), Lim and Moon (2001).

[16] Other papers supporting complementary relationship between FDI and trade: Agmon (1979), MacCharles (1987), Lipsey and Weiss (1984), Blomström et al. (1988), Brainard (1993, 1997), Lin (1995), Graham (1996), Pffafermayr (1996), Clausing (2000), Head and Ries (2001), Hejazi and Safarian (2001), Lee et al. (2009).

H6: Integration schemes and common borders positively influence on all types of IIT.

Apart from that, we decided also to consider influence of specific factor endowments such as forest area, arable land area or natural resources, on IIT. We did not find any empirical works, which can justify and support applied procedure, but knowing that Norway is endowed to relatively great extent with natural resources in comparison to other EU countries, we decided to employ such features. In this case, we follow the particular hypothesis:

H7: The larger (smaller) difference in natural resources endowments, the larger share of VIIT (HIIT) in total trade.

As far as cross-industry characteristics are concerned, we follow the empirical works of Greenaway and Milner (1986), Balassa and Bauwens (1987), Greenaway et al. (1995), Blanes and Martin (2000), Crespo and Fontoura (2004) and Faustino and Leitão (2007). All of these authors used similar proxies that investigate impact of particular industry structure on IIT, but their results are not unambiguous. Nevertheless, they proved that product differentiation, number of firms in the industry, concentration rate in the industry and existence of multinational enterprises have strong and significant influence on IIT. Therefore, we can generalize it in following hypothesis:

H8: Industry-characteristics have significant role in explaining IIT types, but theirs impacts on IIT are various.

3 Methodology

3.1 Measurement of intra-industry trade index

There has been presented many theoretical ways of measuring intra-industry trade in the literature so far. Nevertheless, the vast majority of them are based on simple the Grubel-Lloyd index, which is calculated as follows:

$$IIT_{ijK} = 1 - \frac{\left|\sum_{k=1}^{K} X_{ijk} - \sum_{k=1}^{K} M_{ijk}\right|}{\sum_{k=1}^{K} X_{ijk} + \sum_{k=1}^{K} M_{ijk}}, \quad (5)$$

where, *i* refers to reporter country, *j* refers to partner country, *k* refers to particular product in industry *K*. The index can have values between 0 and 1. In particular, if it is equal to 1 then all trade is considered to be intra-industry, while if it is equal to 0 then all trade is inter-industry.

The most common problem in measuring IIT by the Grubel-Lloyd index is due to the fact that it is taken on too aggregated level in terms of products (e.g. CN2 nomenclature level) and groups of partners (e.g. taking multilateral trade with the complete EU). This leads to sectoral or geographical bias. Sectoral bias stems from insufficient disaggregation in the trade classifications: the less detailed nomenclature used (e.g. the more products are lumped together into a single "industry"), the more trade becomes of an intra-industry nature. This is a well known problem that deserves further developments. In turn, geographical bias arises when different partner countries are put together before doing the calculations, and then in the extreme case, only a country's trade relations with "the rest of the world" are examined. For example, in a given industry, country *A*'s trade with partners *B* and *C* considered as a single trade bloc may be qualified as intra-industry trade, since exports and imports of 100 show up a perfect overlap. In contrast, a strict bilateral analysis reveals that A's trade is one-way with either partner, as *A* exports to *B* and imports from *C* (Fontagné and Freudenberg, 1997).

To overcome all of these problems IIT (i.e. two-way trade) needs to be analysed at the product level. Only simultaneous exports and imports of products having the same principle, technical characteristics can be considered as being "two-way trade". In particular, trade of motors for motors (of a certain cylinder capacity) represents two-way trade in intermediate goods (in the automobile industry), likewise, trade of cars for cars (of a certain cylinder capacity) can be considered two-way trade in final goods (in the same industry). Thus, it seems that the more disaggregated products are, the better. However, if the products are too much disaggregated it can cause problems in differentiating them (Aquino 1978). According to Durkin and Krygier (2000), different prices may partialy reflect differences in the product mix in addition to differences in quality, and as a result some horizontally differentiated trade will be misclassified as vertically differentiated. Therefore, in most empirical works authors use aggregation on 6-digit level of the Harmonized System (HS) nomenclature and it is assumed to be the best aggregation level to analyze IIT[17]. In this study the same aggregation level is taken and the Grubel-Lloyd indexes are calculated according to the formula:

[17] See, for example Gullstrand (2002), Mora (2002) and Crespo and Fontoura (2004).

$$IIT_{R,P,j,t} = 1 - \frac{\sum_R \sum_P \sum_{i \in j} |X_{RPit} - M_{RPit}|}{\sum_R \sum_P \sum_{i \in j} X_{RPit} + M_{RPit}}, \tag{6}$$

where *R* represents reporter country (which is Norway), *P* stands for partner country (28 members of the EU), *i* represents product which belongs to section *j* from HS6 nomenclature and t represents the particular year from time span 2000-2013.

3.2 Decomposition of the vertical and horizontal IIT

In the literature, there has been proposed several methods to disentangle horizontal from vertical intra-industry trade. Nevertheless, the most common approaches were introduced by Greenaway, Hine and Milner (1994) and Fontagné and Freudenberg (1997)[18]. The former authors decompose the Grubel-Lloyd index, while the latter categorise trade flows and computes the share of each category in total trade. However, as Černoša (2007) points out, the Fontagné and Freudenberg (1997) methodology cannot be used for measurement of multilateral trade, because it is useful only for the observation of the bilateral trade. Therefore, we follow methodology proposed by Greenaway, Hine and Milner (1994)[19].

This concept supposes decomposing of total IIT (B_i) into horizontal (HB_i) and vertical (VB_i) IIT:

$$B_j = HB_j + VB_j. \tag{7}$$

Then, in order to disentangle different types of intra-industry trade, one has to use the *product similarity criterion*, which is based on the ratio between the unit value of exports (UV_{ij}^X) and the unit value of imports (UV_{ij}^M). It is therefore a matter of calculating $\gamma = \frac{UV_{ij}^X}{UV_{ij}^M}$, then IIT type will be horizontal if satisfies following condition[20]:

$$\frac{1}{(1+\alpha)} \leq \frac{UV_{ij}^X}{UV_{ij}^M} \leq 1 + \alpha, \tag{8}$$

whereas vertical if it does not belong to that interval. In turn, we can divide vertical IIT into vertical superior and vertical inferior. Particularly, vertical superior is when:

$$1 + \alpha \leq \frac{UV_{ij}^X}{UV_{ij}^M} \leq +\infty, \tag{9}$$

[18] Second approach was also used by Abd-el-Rahman (1991), Fontagné, Freudenberg and Gaulier (2006).
[19] Nielsen and Lüthje (2002) also shows that the methodology introduced by Greenaway, Hine and Milner (1994) is more appropriate for the measurement of horizontal and vertical intra-industry trade than the alternative methodology mentioned above.
[20] The following range was also used by Fontagné and Freudenberg (1997) and Crespo and Fontoura (2004).

and vertical inferior if:

$$0 \leq \frac{UV_{ij}^{X}}{UV_{ij}^{M}} \leq \frac{1}{1+\alpha}. \quad (10)$$

The parameter α is an arbitrarily fixed dispersion factor, which usually equals to 15 percent. This means that, in case of the HIIT, transport and freight costs alone are unlikely to account for a difference of any more than 15 percent in the export and import unit values. However, if it is the case then quality differentiation will predominate and intra-industry trade will be of a vertical type. According to Greenaway et al. (1994) and Crespo and Fontoura (2004) the value of 0.15 for α can be considered as too low value for the case of imperfect information[21]. For this reason, we calculate also vertical and horizontal components for the alternative value of 0.25 for α, thus it gives a useful basis for evaluating the robustness of the estimated results.

The basic assumption of the above-mentioned criterion is that prices (unit values) are considered as quality indicators of goods. The relationship between price and quality is supported by the idea that in a perfect information framework a certain variety of a good can only be sold at a higher price if its quality is higher. However, it can be criticized because in the short run consumers may buy a more expensive product for reasons other than quality. Another critical aspect refers to the unit value proxy. Unit values may be computed in several ways e.g. per tonne or per item, and each of them is associated with some problems. In particular, if we consider the example of one small car (Smart) and one big car (Mercedes), we notice that small car has lower price and hence lower unit value than big car. Nonetheless, it does not mean that small car is of poor quality, but that only means that it is small. Therefore, in spite of scarce availability of product characteristics, applying weights of product seems to be more adequate. Unit value per tonne is also commonly used in the literature, e.g. by Oulton (1991) in an extensive survey of quality in UK trade 1978-87 and Abd-el-Rahman (1991) in study of the French trade. Consequently, we apply these changes in calculating our unit values.

The next criticism of product similarity criterion based on the G-L index is the fact that it is associated with the concept of "trade overlap"[22]. This concept can be understood as the proportion of the overlapping of exports and imports in total trade. Then, there is a dividing line within the majority flow (of either exports or imports) that can be explained by two

[21] Since the difference between CIF (cost, insurance, freight) for imports and FOB (freight on board) for exports is estimated to be 5 to 10 per cent on average.
[22] In particular, the G-L index is the ratio of twice the minimum flow over total trade.

different theories. In short, the part of the majority flow that exceeds the "overlap" refers to inter-industry trade that can be explained by comparative advantage theories, in turn, the other part refers to IIT theories. To overcome this problems, in the literature some researchers apply CEPII index[23]. In particular, this index rejects aforementioned dividing line by applying a minimum pre-defined overlap between two flows, usually on 10 percent level, and considers the both part in their totality as being the intra-industry trade type. Otherwise, there is inter-industry trade. Therefore, both exports and imports of a product group will always belong to the same trade type. However, the 10 percent criterion of the CEPII index for separating inter- from intra-industry trade is questionable and this index is not commonly used in literature, that is way we decided not to use it in our research.

3.3 Description of databases

We divided our study into two parts and in each we apply separate models to analyse impact of determinants of country- and industry-characteristics on horizontal, vertical and total IIT. Therefore, there are created two different databases for each of these particular models. As far as *cross-country* database is concerned, the empirical analysis of the IIT levels is developed at the 6-digit level of the Harmonized System 1996 (HS). Thus, we consider all disaggregated products at the 6-digit level of the HS nomenclature, which belong to the 97 sub-sections that are grouped in the 21 main sections. These particular sections cover products from all industries[24]. In this study, reporter country is Norway and we consider Norwegian trade with 28 European Union partners for the time span of 2000-2013. As for the fact that our analysed period includes also the 2013 year, we decided to Croatia into the study as a new member of the EU. Therefore, in our research, there are taken all actual members of the EU as the trading partners of Norway[25]. The source for the disaggregated trade data is the UN COMTRADE database.

In the *cross-country* model, there is analysed bilateral trade between Norway and each particular trading partner for each year. Norway has been trading with each mentioned partner, however the number of traded products varies across the different partners. For instance, Norway's trade with its major trading partners such as United Kingdom, Germany,

[23] See, for instance, European Commission (1996), Fontagné et al. (1998), Crespo and Fontoura (2004).
[24] The HS 1996 nomenclature is provided by the EUROTSTAT in its RAMON platform.
[25] In particular: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovak Republic, Slovenia, Spain, Sweden, United Kingdom.

Sweden, Denmark and Netherlands accounts for around 4000 products, whereas for less important trading partners like Malta, Cyprus or Luxemburg the number of traded products is only around 200. Moreover, in the database there are excluded data that have values equal to 0 either in export or in import and data without any information of weights. The second case mainly refers to the products from section V (mineral products), section XIV (jewellery, precious stones and metals) and section XVIII (optical, photographic, cinematographic, clocks)[26]. Nevertheless, these missing products do not account for large share of trade and they refer to mostly the categories which there are rather not expected to occur intra-industry trade.

The Grubel-Lloyd indices are calculated for the particular trading partner, disentangled by *product similarity criterion* (with two dispersion factors: 0.15 and 0.25) and then aggregated to each particular year. Consequently, database is categorized according to the partner, year, vertical superior IIT, vertical inferior IIT, horizontal IIT and total IIT. Such categorization constitutes panel data with 392 observations (28 partner countries x 14 years = 392)[27].

For the *cross-industry* analysis, the methodology to create database is much more complicated way. Due to the fact that the Norwegian Statistical Office (Statistisk sentralbyrå) shares the data on industry characteristics only on nomenclature of the Standard Industrial Classification (SIC 2007) on 2-digit categories and at the same time trade data on largely disaggregated products are provided on different nomenclature without giving any transition tables[28]. Therefore, we assumed to calculate G-L indices on 6-digit level of the HS 1996 categories (as previously) and aggregate these products to 2-digit level of the HS 1996. Likewise in previous case, the G-L indices were calculated on both 15 and 25 percent level of α parameter. Therefore, we were able to combine the 2-digit HS 1996 nomenclature and sectors from the SIC 2007 nomenclature by creating 14 industries to analyse. Below, in Table 2 we put the transition table of the both nomenclatures. Unfortunately, due to the scarcity of industry determinants data and that the SIC nomenclature was provided in different methods before and after 2007 year, we had to cut the research sample to years of 2008-2012[29].

[26] The sections are provided in the HS 1996 nomenclature and they refer mainly to the chapters of: 27, 28, 71, 90 and 91.
[27] This main database does not include many observations, but it is common in studies about IIT.
[28] They are able to provide more disaggregated data on industry characteristics, but they charge money for that.
[29] Particularly, they provided industry-characteristics data on the SIC 2002 nomenclature until the year 2007 and after such data are provided in the SIC 2007 nomenclature. Unfortunately these nomenclatures are not comparable.

Therefore, this database includes only 70 observations (14 industries x 5 years = 70), but it is also a standard in the literature of the IIT.

Table 2. Transition table of the nomenclature HS 1996 and the SIC 2007

	HS 1996		SIC 2007	
Industry	Section	Chapter	Section	Name
1	I	1-3	A01-A03	Agriculture
2	V, XV	25-27, 72-83	B05-B09	Mining and petroleum
3	I, II, IV	4-14, 16-23	C10-C11	Food products and beverages
4	XI	50-63	C13	Textiles
5	VIII	41-43	C14-C15	Leather and its articles
6	IX, X	44-49	C16-C18	Wood and its products
7	VI	28-38	C19-C21	Chemicals and pharmaceuticals
8	VII	39-40	C22	Rubber and plastic products
9	XIII	68-70	C23	Other non-metal mineral products
10	XV	72-83	C24-C25	Basic metals and its products
11	XVIII	90-92	C26	Electronic and optical products
12	XVI	84-85	C27-C28, C33	Electrical and machinery equipment
13	XVII	86-89	C29-C30	Vehicles, ships and other transport articles
14	XIV, XX	71, 94-96	C31-C32	Other manufacturing

Note: Details about the HS 1996 nomenclature is provided by EUROSTAT and its RAMON platform, whereas the SIC 2007 nomenclature is provided in the UK Statistical Office.

4 Pattern of the Norwegian intra-industry trade by types

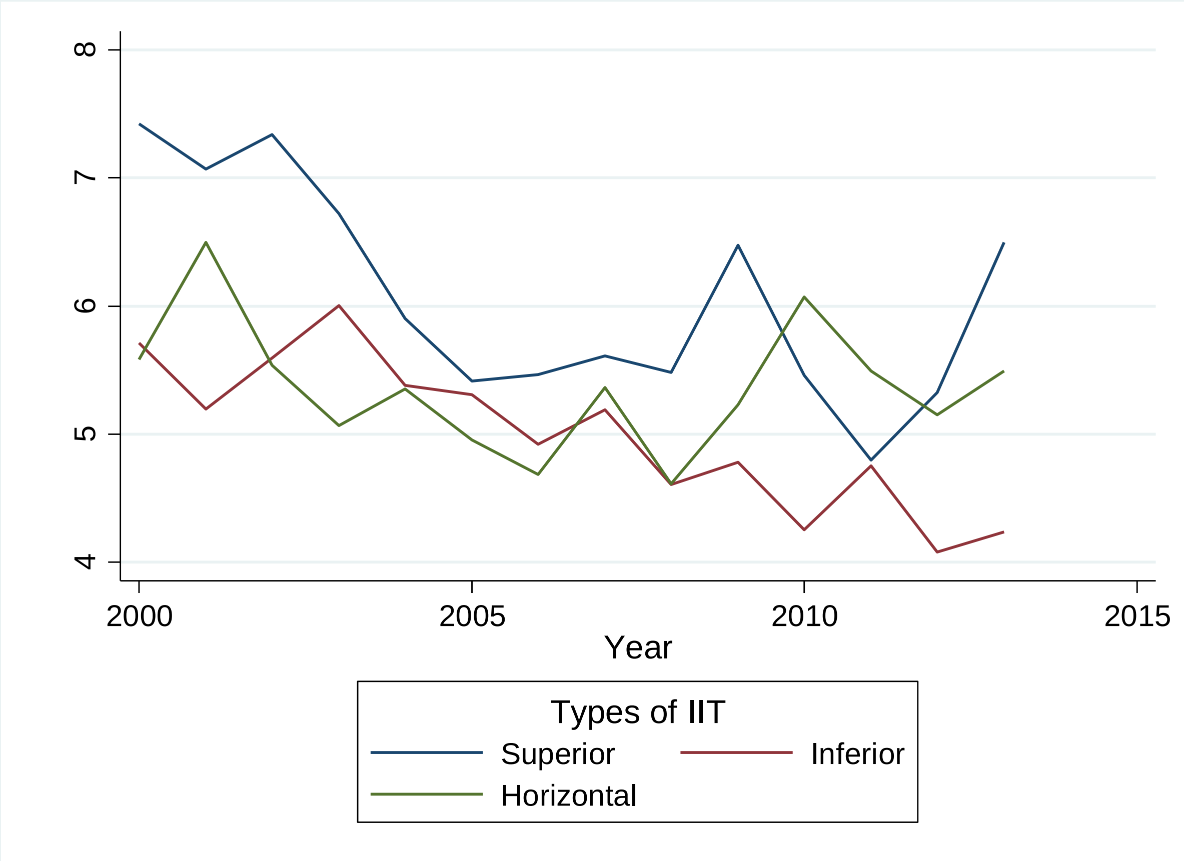
At the beginning, it is worth to analyse the changes in pattern of the Norwegian trade with the European Union. Thus, Table 3 shows the main results concerning IIT for Norwegian multilateral trade with all 28 members of the EU in terms of two parameters: 15 and 25 percent of *product similarity criterion*.

Table 3. Types of trade between Norway and the European Union (percent of total trade)

	Vertical			Horizontal	IIT	Inter
	superior	inferior	total			
2000						
(0.15)	7.4	5.7	13.1	5.6	18.7	81.3
(0.25)	6.3	4.9	11.2	7.5	18.7	81.3
2004						
(0.15)	5.9	5.4	11.3	5.4	16.6	83.4
(0.25)	5.2	4.8	10.0	6.6	16.6	83.4
2008						
(0.15)	5.5	4.6	10.1	4.6	14.7	85.3
(0.25)	5.1	3.8	9.0	5.8	14.7	85.3
2012						
(0.15)	5.3	4.1	9.4	5.2	14.6	85.4
(0.25)	4.9	3.7	8.5	6.0	14.6	85.4

From the analysed time span of 2000-2013, in Table 3 there are presented 4 particular years at regular time intervals. The first aspect to be noted is that the share of the intra-industry trade between Norway and the EU is far less than inter-industry. Its value is around 15%, whereas for inter-industry trade it is around 85%. Thus, the results could seem to be surprising, because the EU is the major trading partner for Norway. In addition, the share of IIT is constantly decreasing across the analysed period. This can suggest that Norwegian trade could be not so much diversified, since commonly the IIT trade accounts for above 50% of total trade for the most developed economies like the United States, United Kingdom, Germany or Japan. Secondly, we can notice that the values of G-L indices for two different parameters α are not so different from each other. In general, we can infer that the increased value of the parameter α chosen to distinguish IIT between vertical and horizontal one causes decrease of the share of VIIT in favour of the share of HIIT. Thirdly, we notice that VIIT shows itself to be the most relevant type of Norwegian IIT. Throughout the analysed period its value is equal to around 10%, whereas horizontal IIT represents around half of that. Moreover, among VIIT components we can notice that superior part dominates. Specifically, in Figure 2 there are presented line graphs of the vertical superior, vertical inferior and horizontal IIT between Norway and the EU. From these graphs, we can notice that all of the IIT types follow rather decreasing trend for the period from 2000 to 2013 and the financial crisis that emerged in 2007 could rather not be a explanation for that, because we can notice even slightly increase in IIT after that year. Apart from that, we can notice bounce back from decreasing trend only for vertical superior in the 2011 year.

Figure 2. Graph of Norwegian intra-industry trade with the EU by types (percent of total trade)



Note: Superior and inferior lines are the components of vertical IIT.

Following this analysis, Table 4 shows IIT between Norway and its major EU's trading partners according to the largest values of IIT for the years: 2000, 2004, 2008 and 2012. In this table there are provided values of G-L indices only for the 15% of α parameter.

Table 4. Types of trade between Norway and its main trading partners from the EU *(percent of total trade)*

	Vertical			Horizontal	IIT	Inter
	superior	inferior	total			
2000						
Sweden	10.5	11.1	21.5	6.8	28.3	71.7
Denmark	9.5	9.4	18.9	5.4	24.4	75.6
Lithuania	2.8	10.0	12.9	0.9	13.7	86.3
Finland	4.9	4.2	9.0	4.4	13.5	86.5
2004						
Sweden	7.1	11.5	18.5	11.2	29.7	70.3
Latvia	2.7	8.5	11.2	13.8	25.0	75.0
Denmark	6.3	8.4	14.7	9.6	24.4	75.6
Lithuania	2.4	7.0	9.4	3.2	12.7	87.3

Table 4. Continued

2008							
	Denmark	8.3	6.1	14.4	13.1	27.6	72.4
	Sweden	5.1	17.0	22.1	4.6	26.7	73.3
	Latvia	2.8	13.9	16.7	4.0	20.7	79.3
	Estonia	3.3	4.8	8.1	6.5	14.6	85.4
2012							
	Denmark	5.6	6.2	11.8	13.5	25.2	74.8
	Sweden	4.8	11.0	15.8	6.4	22.1	77.9
	Lithuania	3.2	5.3	8.4	1.5	10.0	90.0
	Poland	6.8	1.7	8.5	0.9	9.4	90.6

In each particular year there are taken four countries from the EU that has the highest share of the intra-industry trade in total trade with Norway. Therefore, we can highlight 7 countries that could be considered as the major Norwegian intra-industry trade partner, namely, Sweden, Denmark, Lithuania, Finland, Latvia, Estonia and Poland. As it would be expected there are two Norwegian partners, viz. Sweden and Denmark, that have the one of the highest share of IIT in each particular year. In 2000 and 2004 year, Sweden had the share of IIT with Norway nearly 30% with the significant predominance of vertical IIT. The countries traded vertically mainly with the products from sub-sections: 89, 85, 87 and 44 of the HS 1996 nomenclature. These particular sub-sections account respectively for ships, boat and floating structures; electrical machinery and equipments; vehicles other than railway or tramway rolling-stock with parts and accessories; wood and articles of wood. In turn, they traded horizontally with products mainly from 84 and 27 sub-sections. These are nuclear reactors, machinery and mechanical appliances; mineral fuels, mineral oils and products of their distillation, respectively.

As far as Denmark is concerned, in 2008 and 2012 horizontal IIT with Norway occurred mainly with products from oil sector (27-subsection) and vertically with pharmaceutical products (30-subsection), machinery sector (84-subsection) and furniture sector (94-subsection). Finland is noted only once in 2000 year. It had high horizontal IIT with Norway with products from oil sector (27-subsection) and rubber and plastic articles sectors (39-subsection). Horizontally they trade with electrical machinery products (85-subsection) and pharmaceutical products (30-subsection).

It is worth to mention about high position in intra-industry trade with Norway of countries such as Lithuania, Latvia and Poland. In particular, they are the countries, whose residents immigrated to Norway in the largest proportion. Especially, Lithuania traded mainly vertically with electrical machinery products (85-subsection), steel and iron articles (73-

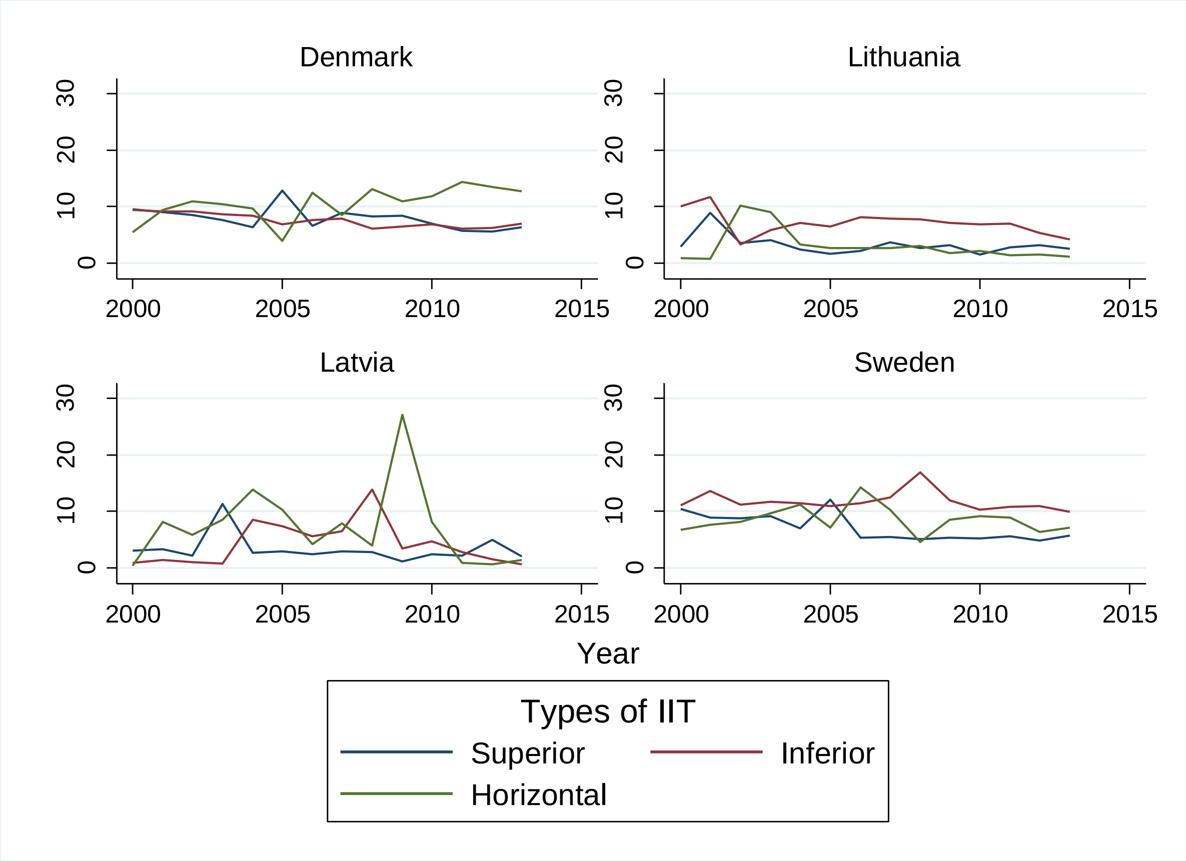
subsection), furniture (94-subsection) and textiles material (56-subsection). In turn, Latvia traded mainly vertically with aluminium and its products (76-subsection) and steel and iron products (73-subsection) as well. These pairs of countries traded also horizontally with petrol products (27-subsection) and copper and its articles (74-subsection). In case of Poland intra-industry trade with Norway occurred mainly under the vertical differentiation and countries traded with products from machinery and mechanical appliances (84-subsection), vehicles and their parts (87-subsection) and iron and steel articles (73-subsection).

Thus, Figure 3 below presents line graphs of vertical (superior and inferior) and horizontal IIT between Norway and four countries above-mentioned, namely, Sweden, Denmark, Lithuania and Latvia. These are countries with the highest share of IIT with Norway in our analysed period. According to these graphs, we can say that throughout the years of 2000-2013 the horizontal IIT dominated over vertical ones in case of Denmark and Latvia, whereas for Sweden and Lithuania dominated vertical inferior trade.

For all of these countries types of IIT seem to be stable throughout the years, however we can notice that in 2009 year there was a huge increase of horizontal IIT (around 25 p.p. comparing to previous year) for Norwegian trade with Latvia. Based on data it was largely caused by the increase in the trade of products from oil and gas sector (27-subsection).

All things considered, Table A1 in the Appendices sets together all results of the G-L indices for Norwegian intra-industry trade with the all 28 EU partners in three particular years: 2000, 2007 and 2013. There, G-L indices are provided for both α parameters: 15% and 25%.

Figure 3. Combined graph of vertical (superior and inferior) and horizontal IIT between Norway and its major intra-industry partners in the EU (percent of total trade).



Note: Superior and inferior lines are the components of vertical IIT.

5 Econometric model

Based on theoretical references relating to IIT and the regularities shown in *ad hoc* empirical studies, we formulated research hypotheses of the impact of country- and industry-determinants on the all types of IIT by using two distinct models. As it was shown in theoretical part, there is no clear-cut IIT model that combines all of the relevant factors to IIT. Therefore, we assumed to take an eclectic approach by gathering different theories in the same regression equation. One of the limitations of this approach is the usage of the adequate proxy variables for particular determinant, but we were choosing variables that have been previously used in other studies. Another limitation of this approach is the fact that various determinants based on different theories can have adverse effect on each other and the results from that approach can be difficult to interpret. Nevertheless, our study is based on intensive empirical research and other studies that applied also the same methodology such as Crespo and Fontoura (2004), Faustino and Leitão (2007), Thorpe and Leitão (2013).

Alternatively, there are some studies such as Balassa and Bauwens (1987, 1988) or Blanes and Martin (2000) that introduce both country- and industry-characteristics into the same regression equation. Nevertheless, this approach is not widely used in the empirical works and its advantages are highly ambiguous (Crespo and Fontoura, 2004).

In addition, in this study there are two different objects of analysing IIT, separately for countries and industries. Particularly, in cross-country analysis there is investigated bilateral trade between Norway and the trading partner from the EU, whereas in cross-industry analysis we analyse multilateral trade between Norway and the complete EU for particular industry. Thus in the former case the objects are pairs of countries, whereas in the latter case the objects are industries.

5.1 Explanatory variables and expected signs

In the cross-country analysis there are considered intra-trade between Norway and its 28 EU partners calculated on the 6-digit level products from the HS 1996 nomenclature. The explanatory variables in this model are following:

- *Average GNP (current $) of Norway and the trading partner (DIM).* This variable account for capturing the average size of the markets. There is expected a positive coefficient for both vertical and horizontal IIT (hypothesis H2). On the supply side: according to Lancaster (1980) Loertscher and Wolter (1980), Heplman (1981), Balassa (1986) the larger economy, the greater the opportunities for scale effects and the greater the equilibrium number of differentiated products. On the demand side: a larger market suggests that a wider range of qualities will be demanded (Jones and Kierzkowski, 2004; Grossman and Helpman, 2005).
- *Absolute difference between per capita income (current $) of Norway and the trading partner (DGDP).* Commonly used variable, which is responsible for the difference in relative factor endowments, but its expected effects on IIT are countervailing. Taking the assumption that the relative capital abundance is reflected in relative per capita income, then the greater the difference in per capita incomes the greater will be the opportunity for vertical integration of production across economies and hence greater VIIT, what is in line with the model developed

by Falvey and Kierzkowski (1987)[30]. However, in the horizontal IIT model a negative relationship is expected based on the importance of similarity in factory endowments for the ability to produce similar, differentiated goods[31]. Therefore, we leave the coefficient for the IIT to be empirically determined (hypothesis H1). According to Cieślik (2005), we add also variable measuring sum of GDP per capita between two countries (*SUM_GDP)* as a control variable for *DGDP* variation.

- *Absolute difference in public spending on education (as percent of government expenses) between Norway and the trading partner (EDU).* This variable is considered to be an indicator of the differential in development. It is used as an extension to the assumption that IIT is strongly correlated with the degree of economic development and industrialization. This is a commonly used measure of human capital in subsequent exemplary studies by Barro and Lee (1993), Mora (2002), Gullstrand (2002), Crespo and Fontoura (2004) and Jensen and Lüthje (2009). According to previous theories that IIT is less likely to occur in countries with big differences in development, so that there is expected negative impact of this variable on both of the two IIT types.
- *Absolute difference in electric power consumption (kWh per capita) between Norway and the trading partner (EPC).* This is a proxy used for difference in physical capital endowments between countries. It is one of the proxies that could capture the difference between capital and labour ratio between two countries. According to Cieślik (2005), it can be expected also negative impact on both vertical and horizontal IIT.
- *Straight line distance (in km) between the capital of Norway and the capital of the trading partner (DIST).* This variable is widely used as a proxy for transaction costs of trade, which increases with geographical distance. It brings the model closer to the gravity models of trade. The expected sign is negative in all specifications, for the relevance of transaction costs in trade with differentiated goods is higher compared to inter-industry trade with homogenous goods (hypothesis H3)[32].

[30] It also follows the theories of: Falvey (1981), Shaked and Sutton (1984), Helpman (1987), Flam and Helpman (1987) and Greenaway *et al.* (1995).
[31] See, for example, Helpman and Krugman (1985) and Eaton and Kierzkowski (1984).
[32] This variable was used in empirical works, for example by Balassa and Bauwens (1987), Crespo and Fontoura (2004), Gabrisch (2006) and Jensen and Lüthje (2009).

- *Net migration flows between Norway and the trading partner (MIG).* This proxy is used in line with the hypothesis immigration reduces the transaction costs (hypothesis H4). According to the literature, the immigration can reduce transaction costs between foreign and host countries through ethnic networks and asymmetric information or through specific preferences of migrants. The empirical studies such as Blanes (2005), Faustino and Leitão (2007) and White (2009) found a positive relationship between immigration and intra-industry trade.
- *Country dummies/Integration space.* In this study, there are included a three dummy variables which account for some kind of liberalization and cultural characteristics. First one is the dummy variable, which assumes the value one if the partner country belongs to the European Union (*EU*)[33]. Second is the dummy responsible for taking value one if the partner country belongs to Eurozone (*EUZ*). The empirical evidence shows that the level of IIT tends to be higher in integration spaces and as a result there is expected that these variables will have positive sign for both vertical and horizontal IIT[34]. Third dummy refers to the intra-industry trade with the Nordic countries (*CT*). It assumes value one if the partner country is Sweden, Denmark or Finland. Based on Hansson (1991), it tests the effect of border trade on IIT and cultural similarities. Therefore, it is expected to be positively correlated with all IIT types (hypothesis H6).
- *Specific factor endowments.* In the case of Norway, which is rich in natural resources, it could be relevant to consider also these aspects in relation to IIT. Particularly, there are included absolute differences between Norway and the trading partner in terms off: forest area in square km (*FOR*), total natural resources rents as a percent of GDP (*NAT*)[35] and arable land as a percent of land area (*LAND*). This is more or less in line with the empirical work of Cabral, Falvey and Milner (2008), nevertheless theoretical inferences in this respect are not unequivocal. As for the expected sign we believe that it the larger difference in those endowments will have positive impact on both IIT types according to our hypothesis H7.

[33] This variable seems to be relevant since in the analysed period there were three accession stages for entering new countries, namely, 2004, 2007 and 2013 year.
[34] See, for example empirical works of: Balassa (1966, 1979), Balassa and Bauwens (1987), Crespo and Fontoura (2004) and Veeramani (2009).
[35] According to the World Bank definition: the total natural resources rents are the sum of oil rents, natural gas rents, coal rents (hard and soft), mineral rents, and forest rents.

- *Absolute difference of net inflows of FDI (BoP, current $) between Norway and the trading partner (FDI)*[36]. We follow the methodology by Helpman (1987) and Markusen (1994), who empirically proved that all types of IIT are positively correlated to a trading partner's FDI inflows. As it was presented in the theory part, theory majority of the empirical works suggest that FDI flows have complementary effect to intra-industry trade and especially for VIIT case (hypothesis H5)[37].

To sum up, the predicted signs of coefficient of above-mentioned variables are presented in Table 5:

Table 5. Expected coefficients of country-characteristics' determinants of IIT

	Vertical			Horizontal	IIT
	superior	inferior	total		
DIM	+	+	+	+	+
DGDP	+	+	+	-	+/-
EDU	-	-	-	-	-
EPC	-	-	-	-	-
DIST	-	-	-	-	-
MIG	+	+	+	+	+
EU	+	+	+	+	+
EUZ	+	+	+	+	+
CT	+	+	+	+	+
FOR	+/-	+/-	+/-	+/-	+/-
NAT	+/-	+/-	+/-	+/-	+/-
LAND	+/-	+/-	+/-	+/-	+/-
FDI	+	+	+	+/-	+/-

In the cross-industry analysis, the G-L indices are calculated on 6-digit level of the HS 1996 nomenclature and then aggregated to 2-digit level of HS 1996 and then combined with 14 different industries from SIC (Standard Industrial Classification). In accordance with the works of Greenaway *et al.* (1995), Faustino and Leitão (2007) and Crespo and Fontoura (2004), there are taken into account following variables concerning the characteristics of the industries:

[36] Definition of this variable in the World Bank is as follows: Foreign direct investment refers to direct investment equity flows in the reporting economy. It is the sum of equity capital, reinvestment of earnings, and other capital. Direct investment is a category of cross-border investment associated with a resident in one economy having control or a significant degree of influence on the management of an enterprise that is resident in another economy. Ownership of 10 percent or more of the ordinary shares of voting stock is the criterion for determining the existence of a direct investment relationship.

[37] See, for example: Norman and Dunning (1984) Helpman (1984), Goldberg and Klein (1999) and Blonigen (2001).

- *Horizontal product differentiation (PD).* This variable is measured as the number of 6-digit products from the HS in each 2-digit level of the HS nomenclature. The same method of product differentiation was used by Greenaway *et al.* (1995) and Faustino and Leitão (2007). The expected sign is ambiguous, because the data does not distinguish between HIIT and VIIT. Nevertheless, based on the empirical works the horizontal product differentiation is positively related to HIIT and rather conversely for vertical VIIT[38].
- *Vertical product differentiation (VPD)*[39]. This proxy is created on the basis of the work of Greenaway *et al.* (1995) and Blanes and Martin (2000). It is measured as the number of the R&D units in each specified industries from the SIC nomenclature. There is assumed explanation that product quality is systematically related to skill intensity. This variable can be only used in the regression with endogenous VIIT. Thus, it is expected that this variable will have a highly positive sign in VIIT.
- *Share of the number of workers in firms with more than 100 workers in the total number of workers in the sector (SE).* This proxy is usually used as a measure to evaluate the effect of scale economies. This variable was used in Crespo and Fontoura (2004), who argue that expected sign for HIIT is unclear, despite the fact that most studies suggest positive sign. For VIIT, there is explanation in the Neo-HOS model, which assumes the perfect competition and excludes scale economies, hence positive impact on VIIT.
- *Number of enterprises in each sector (MS).* According to Greenaway *et al.* (1995) this proxy is used to capture market structure in the industries. The expected sign for this variable is ambiguous. The dominant paradigm considers the hypothesis of a large number of firms, and as such, the expected sign will be negative. As far as hypothesis of a small number of firms is concerned the expected sign is positive.
- *Share of the turnover of the firms with more than 250 employees in the total turnover of the sector (CONC).* This proxy is used as to express the level of concentration of the market. Depending on the market structure, both signs can be

[38] Especially, Gray (1988), Greenaway and Milner (1986) considered a positive relation of this variable with IIT, while Ethier (1982) considered the existence of a negative relation.
[39] According to Greenaway et al. (1995), this variable should be only used in the regression with VIIT as a dependent variable instead of PD, because previous result show inconsistent result what may be reflected that vertical and horizontal IIT differ in their relative importance across different samples.

expected. In short, with the hypothesis of a large number of firms, the expected sign is negative, whereas with the hypothesis of a small number of firms the expected sign is positive[40].

- *Share of the total industry turnover accounted for by foreign enterprises (MNE).* This proxy is often included because many multi-product firms are also multinational firms, and in accordance with the Heplman and Krugman (1985) model, there are a number of models where multinational firms are an important deterministic factor in analysing horizontally and vertically differentiated products. Thus, the expected sign on MNE is positive for both HIIT and VIIT.

As previously, to summarize described variables, we present their expected coefficients in Table 6 below:

Table 6. Expected coefficients of industry-characteristics' determinants of IIT

	Vertical			Horizontal	IIT
	superior	inferior	total		
PD	-	-	-	+	+/-
VPD	+	+	+		
SE	+	+	+	+/-	+/-
MS	+/-	+/-	+/-	+	+/-
CONC	+/-	+/-	+/-	+/-	+/-
MNE	+	+	+	+	+

After presentation of every variable used in the study, we provide the data sources for them in the Table 7.

Table 7. Sources for the proxies used in the models

Variables	Sources
IIT, V_SUP, V_INF, V_TOT, HOR, PD	UN Comtrade database
DIM, DGDP, EDU, EPC, FOR, NAT, LAND, FDI, SUM_GDP	The World Bank, WDI database
DIST	Google Maps
MIG, VPD, SE, MS, CONC, MNE	The Statistics Norway (Statistisk sentralbyrå)
EU, EUZ, CT	Own elaboration

[40] In previous works, authors usually used share of the sales of the 4 or 5 largest firms in the total sales of the sector, nevertheless due to unavailability of data we did not apply this variable.

5.2 Model specification

The purpose of our empirical studies is to explain the share of intra-industry trade and its different types between Norway and its trading partners. Therefore, in study the dependent variable is the Grubel and Lloyd's index (IIT_{it}) presented in equation (6), which is decomposed into vertical superior, vertical inferior and horizontal IIT according to the two fixed dispersion factors α (15% and 25%). Thus, in this study, we have five different dependent variables, namely, vertical superior, vertical inferior, total vertical IIT, horizontal IIT and total IIT. Each of these dependent variables is bounded within the interval $0 \leq IIT_{it} \leq 1$ and linear model (based on augmented gravity model) does not guarantee expected values between these limits. In order to handle with that, we use a logistic functional form:

$$\mathrm{IIT_{it}} = \frac{1}{1+e^{-\beta x_{it}}}\ , \tag{11}$$

where x_{it} is the vector of independent variables (with constant) and β is the corresponding vector of coefficients. Then the function can be linearized and estimated by following formula:

$$\ln\left(\frac{IIT_{it}}{1-IIT_{it}}\right) = x_{it}, \tag{12}$$

Likewise, all independent variables except time-invariant ones (DIST, EU, EUZ, CT) are taken in logarithmic form and hence coefficients in our estimations will be considered as elasticises. This methodology is often applied in the empirical works and it is in accordance with works of Balassa (1986), Balassa and Bauwens (1987), Bergrstrand (1990), Hansson (1991), Gabrisch (2006), Faustino, Leitão (2007), Jensen, Lüthje (2009) and Thorpe and Leitão (2013). In particular, we present all of the employed variables with their basic descriptive statistics in Table 8 below:

Table 8. Descriptive statistics of the sample

Variable	Obs.	Mean value	Standard deviation	Minimum value	Maximum value
Cross-country					
Dependent					
LIIT	392	-2.81	0.95	-7.22	-0.77
LV_SUP	392	-3.66	0.87	-8.55	-1.76
LV_INF	392	-4.13	1.15	-8.02	-1.59
LV_TOT	392	-3.03	0.87	-7.23	-1.20
LHOR	385	-5.13	1.66	-12.48	-0.99
Independent					
LDIM	392	27.19	1.09	25.86	42.43
LDGDP	392	9.98	0.56	7.84	10.81
LEDU	269	1.20	0.84	-3.38	2.29
LEPC	336	9.77	0.26	8.82	10.10
DIST	392	1460.94	674.27	416.24	2738.41
LMIG	333	18.95	1.90	6.50	23.32
EU	392	0.83	0.38	0	1
EUZ	392	0.57	0.50	0	1
CT	392	0.11	0.31	0	1
LFOR	364	11.03	0.77	7.79	12.13
LNAT	364	2.71	0.22	2.14	3.09
LLAND	364	2.95	0.67	1.29	4.03
LFDI	391	22.85	1.44	17.83	26.21
LSUM_GDP	392	11.44	0.38	10.57	12.27
Cross-industry					
Dependent					
LIIT	70	-5.34	1.58	-8.41	-2.86
LV_SUP	70	-6.63	1.84	-10.92	-3.32
LV_INF	70	-6.29	1.45	-9.24	-3.50
LV_TOT	70	-5.66	1.55	-8.72	-3.03
LHOR	70	-6.91	1.68	-10.29	-3.31
Independent					
LPD	70	5.35	0.77	3.74	6.52
LVPD	70	5.54	0.95	3.26	6.80
LSE	65	-0.78	0.52	-2.05	-0.11
LMS	70	7.28	1.36	5.66	11.20
LCONC	46	-0.80	0.33	-1.86	-0.33
LMNE	63	-6.20	1.77	-10.90	-3.03

In this study, hypotheses are drawn from a wide body of theoretical work using gravity model that has proved successful for explaining bilateral international trade flows in such circumstances. The vast majority of empirical studies about intra-industry trade is based on gravity model and we can see examples of this methodology in works of Bergrstrand (1990), Hummels and Levinsohn (1995), Anderson and van Wincoop (2004) Crespo and Fontoura (2004) and more recent Thorpe and Leitão (2013). The gravity model has long been recognized for its robustness in explaining many types of international flows, including, among others, trade, migration and FDI flows. However sometimes when dealing with models of, for example, imperfect competition and differentiated goods this approach can be problematic. Nevertheless, McCloskey (1988) provides support for this methodological approach in including explanatory variables from across a number of trade theories.

The analysis of the determinants of IIT as well as its components (HIIT and VIIT) is undertaken using a panel data approach. This approach is also very common in the literature on that subject, due partly to the availability of such data[41]. Otherwise, there are alternative techniques used by other authors such as the OLS, Probit or Tobit methods[42]. Nevertheless the major advantage of the panel estimation is that it permits to control for unobservable country- and industry-specific effects, which could result in omitted variable bias in cross sectional regressions. In addition, time specific dummy variables can control for unobservable time-related omitted variables. To be more specific, the usual panel data models take the following form:

$$Y_{it} = \beta_{1i}X_{1it} + \beta_2 X_{2i} + \alpha_i + \varepsilon_{it}, \tag{13}$$

where, i is an index of country pair and t is an index of time. X_1 is a row vector of the time dependent variables, and X_2 is a row vector of the time independent variables (including a constant to capture an intercept), α_i captures country pair-specific effects (omitted time-invariant explanatory variable) and ε is a stochastic residual. Therefore, the biggest problem with such kind of models is the possible correlation between α*'s* and the explanatory variables[43]. If we apply generalized least squares (GLS) method and treating α as a random variable, then it can results in biased and inconsistent estimates of regression coefficients. One of the solutions to overcome such problem is to use so-called 'within' estimates of regression coefficients where α's are treated as fixed constants that enter the model in the form of dummy variables. These 'within' estimators are unbiased and consistent even in the presence of the correlation between α's and the explanatory variables. However, using this method we

[41] For panel data approach, see for example: Hansson (1991); Kim, Taegi, Keun-Yeob Oh (2001); Gabrisch (2006); Faustino, Leitão (2007); Jensen, Lüthje (2009), Veeramani or Thorpe and Leitão (2013).

[42] See, for example: Balassa and Bauwens (1988), Lee and Lee (1993), Greenaway et al. (1995) or Crespo and Fontoura (2004).

[43] See, more detailed explanation in, for example, Hausman and Taylor (1981).

are unable to estimate effects of the time-invariant explanatory variables. Thus, if in our sample we have problem of correlation between α's and the explanatory variables, then we have to employ a robust estimation procedure. Moreover, another problem with panel data models of type (13) is that the possibility of heteroscedasticity of the residual ε as well as correlations of some form among country pair residuals (Jensen and Lüthje, 2009). To overcome such problems, we employ feasible generalized square procedure. This method allows estimation in the presence of AR(1) autocorrelation within panels and cross-sectional correlation and deals with the problem of heteroscedasticity across panels[44]. Here in Table 9, there are provided the Woodridge tests for autocorrelation and Wald tests for heteroscedasticity. These tests clearly indicate that in our model we have problem with autocorrelation and heteroscedasticity, what justify the usage of GLS method.

Table 9. Tests for detecting heteroscedasticity and autocorrelation

	Econometric tests					
	(1)	(2)	(3)	(4)	(5)	(6)
	VIIT	*VIIT*	*HIIT*	*HIIT*	*IIT*	*IIT*
	α = 0.15	α = 0.25	α = 0.15	α = 0.25	α = 0.15	α = 0.25
Wooldridge test for autocorrelation	15.408***	4.314**	10.432**	11.964***	10.394**	10.394**
H_0: no first-order autocorrelation	(0.0006)	(0.0487)	(0.0036)	(0.0020)	(0.0036)	(0.0036)
Wald test for groupwise heteroskedasticity	21907.90***	6821.20***	19599.16***	11554.84***	19017.40***	19017.73***
H_0: homoscedasticity	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)

*, **, *** statistically significant at the 10, 5, 1 percent level, respectively.

Note: In parentheses are provided p-values.

All in all, in our study we will consider two main models, namely, cross-country and cross-industry. In each model we will analyse impact of particular determinants on IIT as well as its components (VIIT and HIIT). Therefore the equations used in our first model have the following form:

[44] More information about this procedure can be found in Judge et al. (1985), Davidson and MacKinnon (1993), Maddala and Lahiri (2006) and Greene (2012).

Model [1]

$$\text{Ln}\left(\frac{IIT_{it}}{1-IIT_{it}}\right) = \beta_0 + \beta_1 LDIM_{it} + \beta_2 LDGDP_{it} + \beta_3 LEDU_{it} + \beta_4 LEPC_{it} + \beta_5 DIST_{it} + \beta_6 LMIG_{it} + \beta_7 EU_{it} + \beta_8 EUZ_{it} + \beta_9 CT_{it} + \beta_{10} LFOR_{it} + \beta_{11} LNAT_{it} + \beta_{12} LLAND_{it} + \beta_{13} LINC_{it} + \delta_t + \eta_i + \varepsilon_{it}, \quad (14)$$

where, η_i is unobserved time-invariant specific effects, δ_t captures a common deterministic trend and ε_{it} is a random disturbance assumed to be normally distributed with $(\varepsilon_{it}) = 0$ and $Var(\varepsilon_{it}) = \sigma^2$. Dependent variable, in this case IIT, is changing into vertical superior IIT, vertical inferior IIT, total vertical IIT and horizontal IIT. In general, all of them are used in logarithmic transformation form as in formula (12).

As far as cross-industry analysis is concerned, the equations in this model have the following form:

Model [2]

$$\text{Ln}\left(\frac{IIT_{it}}{1-IIT_{it}}\right) = \beta_0 + \beta_1 LPD_{it} + \beta_2 LSE_{it} + \beta_3 LMS_{it} + \beta_4 LCONC_{it} + \beta_5 MNE_{it} + \delta_t + \eta_i + \varepsilon_{it}, \quad (15)$$

likewise in above-mentioned formula, η_i, δ_t and ε_{it} have the same meaning. Dependent variable (IIT) is also changing into IIT components, which are expressed in logarithmic transformation form. Nevertheless, the variable $LVPD_{it}$ is not included in equation, because it can be only analysed with VIIT as dependent variable.

6 Empirical results

6.1 Country-level determinants

To begin with, let us consider the estimated coefficients for specified countries' determinants. The estimated coefficients for the impact of these determinants on IIT, VIIT and HIIT are provided in the Table 10 below:

Table 10. Estimated coefficients for country-characteristics' determinants of IIT

	FGLS regressions					
	(1)	(2)	(3)	(4)	(5)	(6)
	VIIT	*VIIT*	*HIIT*	*HIIT*	*IIT*	*IIT*
	α = 0.15	α = 0.25	α = 0.15	α = 0.25	α = 0.15	α = 0.25
Constant	13.08	8.90	-5.38	10.1767	6.48	3.87
	(4.34)***	(3.52)***	(-0.83)	(2.10)**	(1.99)**	(1.46)
LDIM	-0.35	-0.24	0.47	0.40	-0.22	-0.22
	(-3.32)***	(-2.43)**	(2.16)**	(1.84)**	(-1.96)**	(-1.96)**
LDGDP	-0.47	-0.32	-0.07	-0.27	-0.33	-0.33
	(-4.42)***	(-3.07)***	(-0.39)	(-1.47)	(-3.09)***	(-3.09)***
LEDU	-0.10	-0.13	-0.26	-0.28	-0.16	-0.16
	(-2.05)**	(-2.59)***	(-2.24)**	(-2.46)**	(-2.51)**	(-2.51)**
LEPC	-0.69	-0.76	0.21	-0.25	-0.27	-0.27
	(-3.16)***	(-3.32)***	(0.43)	(-0.55)	(-1.18)	(-1.18)
DIST	-0.0002	-0.0002	-0.0012	-0.0011	-0.0004	-0.0004
	(-2.26)**	(-2.29)**	(-8.12)***	(-7.50)***	(-4.31)***	(-4.31)***
LMIG	0.15	0.17	0.14	0.15	0.15	0.15
	(5.73)***	(6.17)***	(2.74)***	(3.10)***	(5.31)***	(5.31)***
EU	0.30	0.34	0.34	0.09	0.23	0.23
	(3.18)***	(3.53)***	(1.65)*	(0.51)	(2.25)**	(2.25)**
EUZ	0.15	0.04	0.05	0.30	0.09	0.09
	(2.25)**	(0.63)	(0.42)	(2.65)***	(1.33)	(1.33)
CT	0.05	0.18	-0.13	-0.44	0.09	0.09
	(0.40)	(1.58)	(-0.44)	(-1.71)*	(0.67)	(0.67)
LFOR	-0.26	-0.21	-0.03	-0.13	-0.17	-0.17
	(-5.41)***	(-4.19)***	(-0.30)	(-1.54)	(-3.27)***	(-3.27)***
LNAT	0.07	0.09	-0.16	0.08	0.01	0.01
	(0.52)	(0.69)	(-0.57)	(0.34)	(0.09)	(0.09)
LLAND	-0.16	-0.13	-0.72	-0.62	-0.29	-0.29
	(-2.52)**	(-1.95)**	(-4.77)***	(-4.72)***	(-3.91)***	(-3.91)***
LFDI	0.06	0.05	0.02	-0.01	0.04	0.04
	(2.29)**	(1.98)**	(0.42)	(-0.25)	(1.69)**	(1.69)**
LSUM_GDP	0.38	0.09	-1.08	-0.69	0.23	0.23
	(1.72)*	(0.43)	(-2.66)***	(-1.74)*	(0.99)	(0.99)
N	223	223	221	221	223	223
Wald Chi^2	330.01***	283.45***	403.43***	751.08***	346.83***	346.83***

*, **, *** statistically significant at the 10, 5, 1 percent level, respectively.
Note: In parentheses are the t-statistics (heteroscedasticity corrected).

There are presented six regressions since vertical, horizontal and total IIT are examined in terms of two different criteria for α parameter. In general, we can say that estimated results show differences in significance, impact and signs between vertical, horizontal and total IIT.

Thus it suggests that disentangling IIT by its components is justified, what is in accordance with the theory. Furthermore, the vast majority of the estimates obtained are significant and the signs for coefficients are the same regardless to the values of α parameters. Of particular interest are the results of the proxies for economic size and difference in factor endowments, which differ in signs for VIIT and HIIT, but that was expected by the theory.

The coefficients of the variable *LDIM*, which measures the difference in the average size of the markets turned out to have strong significant impact on all types of IIT. The hypothesis for this variable was saying that the larger economy size, the greater the opportunities for scale effects and the greater the equilibrium number of differentiated products both horizontally and vertically. The above findings show that this hypothesis is confirmed only in the case of HIIT, whereas, for VIIT the results are opposite to the theory. Thus, we decompose the vertical IIT into superior and inferior types and provide the results in Table 11 below. Then, we can notice that still coefficients are highly significant and negative coefficient with regards to vertical superior and inferior case. It can be the consequence that Norway trades in vertically differentiated goods in larger extent with the Baltic area countries, which are not the biggest one in terms of GDP. On the other hand, it seems that trade with horizontally differentiated products are much more diversified across other countries in the EU and hence the coefficients are positive as theory indicates.

Table 11. Decomposition of the vertical intra-industry trade for cross-country analysis

	FGLS regressions					
	(1)	(2)	(3)	(4)	(5)	(6)
	V_SUP	*V_SUP*	*V_INF*	*V_INF*	*V_TOT*	*V_TOT*
	α = 0.15	α = 0.25	α = 0.15	α = 0.25	α = 0.15	α = 0.25
Constant	7.29	5.35	13.02	8.11	13.08	8.90
	(2.58)***	(2.14)**	(3.08)***	(2.28)**	(4.34)***	(3.52)***
LDIM	-0.12	-0.24	-0.26	-0.14	-0.35	-0.24
	(-1.10)	(-2.66)***	(-2.06)**	(-0.99)	(-3.32)***	(-2.43)**
LDGDP	-0.08	-0.05	-0.66	-0.54	-0.47	-0.32
	(-0.76)	(-0.50)	(-4.99)***	(-3.75)***	(-4.42)***	(-3.07)***
LEDU	-0.04	-0.02	-0.10	-0.15	-0.10	-0.13
	(-0.79)	(-0.35)	(-1.46)	(-1.80)*	(-2.05)**	(-2.59)***
LEPC	-0.12	-0.14	-1.20	-1.12	-0.69	-0.76
	(-0.56)	(-0.61)	(-3.90)***	(-3.51)***	(-3.16)***	(-3.32)***
DIST	-0.0004	-0.0005	-0.0004	-0.0004	-0.0002	-0.0002
	(-5.05)***	(-5.86)***	(-4.62)***	(-3.91)***	(-2.26)**	(-2.29)**
LMIG	0.09	0.11	0.11	0.10	0.15	0.17
	(3.76)***	(3.93)***	(3.16)***	(2.54)**	(5.73)***	(6.17)***
EU	0.21	0.22	0.26	0.32	0.30	0.34

Table 11. Continued

	(2.34)**	(2.25)**	(1.93)*	(2.12)**	(3.18)***	(3.53)***
EUZ	-0.21	-0.15	0.45	0.24	0.15	0.04
	(-2.95)***	(-1.89)*	(5.46)***	(2.36)**	(2.25)**	(0.63)
CT	0.24	0.38	-0.14	0.19	0.05	0.18
	(1.93)**	(3.44)***	(-1.04)	(1.07)	(0.40)	(1.58)
LFOR	-0.34	-0.31	-0.16	-0.13	-0.26	-0.21
	(-7.52)***	(-6.05)***	(-2.52)**	(-1.79)*	(-5.41)***	(-4.19)***
LNAT	-0.04	-0.15	0.11	0.03	0.07	0.09
	(-0.28)	(-1.06)	(0.63)	(0.17)	(0.52)	(0.69)
LLAND	-0.26	-0.18	-0.08	-0.07	-0.16	-0.13
	(-3.52)***	(-2.33)**	(-0.91)	(-0.66)	(-2.52)**	(-1.95)**
LFDI	0.02	0.01	0.02	0.05	0.06	0.05
	(0.96)	(0.33)	(0.66)	(1.24)	(2.29)**	(1.98)**
LSUM_GDP	-0.23	-0.12	0.75	0.49	0.38	0.09
	(-1.03)	(-0.60)	(2.92)***	(1.76)*	(1.72)*	(0.43)
N	223	223	223	223	223	223
Wald Chi^2	328.76***	295.88***	960.11***	414.72***	330.01***	283.45**

*, **, *** statistically significant at the 10, 5, 1 percent level, respectively.
Note: In parentheses are the t-statistics (heteroscedasticity corrected).

In the similar way the signs of coefficients for *LDGD* differ. As theory indicates, this variable is very important in explaining the patterns of all types of IIT. It confirms also in our findings that this variable is key factor with the strongest impact on the Norway IIT with the EU. Particularly, in the case of VIIT and IIT the signs are negative, in turn, for HIIT the coefficients are insignificant. Therefore, the estimates are inconsistent to the theory of Falvey and Kierzkowski (1987), who show that the greater difference in per capita income should create greater opportunity for vertical integration of production and hence the sign for VIIT should be positive. Nevertheless, the coefficients for HIIT turn to be insignificant and theories of positive impact of similarity in capital-labour endowments on HIIT (e.g. Helpman and Krugman, 1985; Eaton and Kierzkowski (1984)), are also not confirmed.

From the decomposition of VIIT (see Table 11), we can notice that inferior goods account for this negative sign (regressions (3) and (4)). Likewise, it could be the effect that Norway's VIIT is occurring in larger extent with the countries like Sweden, Denmark or Finland where the absolute difference in share of the GPD *per capita* with Norway is not so big comparing to the other EU countries. Another explanation refers to the fact that our model is strictly empirical and is based on various theories that explain different phenomena and as a result there could be lack of some control variables or one effect can predominate over another. Nevertheless, in our research we use also the sum of GDP *per capita* (*LSUM_GDP*), which according to the Cieślik (2005) propositions should be used as a control variable to difference in GDP. In addition, we employ also another variable for difference in physical capital endowments between countries instead of GDP *per capita*. It is calculated as the ratio of total electricity production (in kWh) to total population[45]. This variable (*LCAPITAL*) is taken as absolute difference between Norway and the trading partner. The estimated models are provided in Appendices (see Table A2). Findings show that the signs for this variable are positive for VIIT as theory suggests, but all of them are not significant and cannot be interpreted.

Next, there are two proxies responsible for human capital endowments and physical capital endowments, namely, *LEDU and LEPC*, respectively. According to the expectations both of these variables should have negative impact on all IIT types based on theories that the higher the difference in economic development and capital-labour endowments, the lower share of intra-industry trade in total trade is. Empirical results suggest that these variables are statistically significant and consistent with the theoretical backgrounds, except the variable *LEPC*, which is not significant in the case of horizontal IIT and total IIT (estimations (3)-(6)).

The variable referring to distance between countries – *DIST* in all regressions turns out to be highly significant and negatively correlated to IIT types. This is consistent with the interpretation of gravity model of trade, where geographical distance is used as a proxy for transaction costs. Nevertheless, its impact on IIT types is not so strong in comparison to other variables.

As far as integration schemes are concerned, the dummy variable capturing participation of the particular trading partner to the EU displays a strong and positive influence on all types of IIT, especially for VIIT. Therefore, it is empirically proved that Norway trade with the EU is important and its trade under European Economic Area (EEA) is significant. As for the dummy concerning to be a member of the Eurozone (*EUZ*), that the results indicate that such membership is positively correlated to all types of IIT, but in larger extent for vertical inferior differentiated goods (estimations (3) and (4) in Table 11). In general, it is rather confirmed that regional integration schemes (particularly EU) have positive impact on IIT types. Moreover, the coefficients for cultural similarities with Nordic countries turn out to have

[45] Electricity production (kWh) data are taken from the World Bank database and its definition is as follows: Electricity production is measured at the terminals of all alternator sets in a station. In addition to hydropower, coal, oil, gas, and nuclear power generation, it covers generation by geothermal, solar, wind, and tide and wave energy, as well as that from combustible renewables and waste. Production includes the output of electricity plants that are designed to produce electricity only as well as that of combined heat and power plants.

significant and positive impact, but only in the case of vertical superior differentiated goods. This finding reinforces above-mentioned explanation that Norwegian VIIT occurs mainly among Baltic and Nordic countries.

One of the biggest contributions of this study is the analysis of the impact of migration flows on IIT types. According to the literature, the immigration flows account for reduction in transaction costs between countries, mainly thanks to existence of migrants networks. All of the presented empirical evidences posit that there should be expected positive impact. We employed net migration flows in our model, bearing in mind that both immigration and emigration can promote trade flows between countries. Consequently, it turns out that it is the only one variable that is strongly significant and with positive impact on both vertical IIT and horizontal IIT. By these results our study can be attributed to the empirical works that are in line with the hypothesis that migrants significantly and positively influence on bilateral trade.

Regarding to the impact of specific factor endowments, which include differences in forest area (FOR), land area (LAND) and overall natural resources (*NAT*), it turns out that among these three determinants, only the endowment in arable land area is the most important one. That variable is almost significant for all types of IIT on which it affects negatively with the strongest impact on HIIT. Endowment in forest area has the significant impact on decrease of Norwegian IIT types, especially for vertical superior IIT case. This means that the more similar countries are in terms of endowment in forest area, there is a higher trade in vertical differentiated products. Unexpectedly it turns out that difference in natural resources endowment (*NAT*) does not have any significant effect on IIT types. That variable takes into consideration endowments in oil, gas, coal, mineral and forest as a whole, but on the other hand these are the sectors in which we should not rather expect IIT.

Last but not least, we consider also the impact of difference in net inflows of FDI between Norway and the trading partner. Thus coefficients of this variable are strongly significant and with moderate positive impact, especially in terms of VIIT. These results are consistent with the theories of complementarity between IIT types and FDI and support still scarce empirical evidences of this relation.

6.2 Industry-level determinants

The second model in our research refers to the analysis of the cross-industry characteristics. Likewise, the previous analysis there are also reported six equations for vertical, horizontal and total IIT with regard to two values for α criterion, however there are two additional equations due to the fact that vertical product differentiation variable (*LVPD*) can be only applied in a model with vertical IIT. All of these estimations are set out in Table 12.

Table 12. Estimated coefficients for industry-characteristics' determinants of IIT

	FGLS regressions							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	VIIT	*VIIT*	*VIIT*	*VIIT*	*HIIT*	*HIIT*	*IIT*	*IIT*
	α = 0.15	α = 0.25	α = 0.15	α = 0.25	α = 0.15	α = 0.25	α = 0.15	α = 0.25
Constant	-8.73	-9.32	-3.58	-4.64	-14.26	-13.10	-11.15	-12.08
	(-6.09)***	(-7.21)***	(-3.95)***	(-4.34)***	(-10.01)***	(-9.61)***	(-7.99)***	(-10.14)***
LPD	1.06	0.85			1.02	0.54	1.09	0.75
	(4.49)***	(3.61)***			(4.34)***	(2.64)***	(4.66)***	(3.60)***
LVPD			-0.56	-0.32				
			(-1.78)*	(-0.74)				
LSE	0.005	-0.78	0.95	0.09	3.87	2.73	1.94	1.83
	(0.01)	(-1.75)*	(1.35)	(0.12)	(5.44)***	(4.31)***	(3.53)***	(3.72)***
LMS	-0.10	-0.007	0.69	0.45	0.74	0.90	0.37	0.68
	(-0.66)	(-0.06)	(2.22)**	(1.06)	(3.89)***	(5.27)***	(2.34)**	(5.05)***
LCONC	1.73	0.19	2.23	0.82	1.59	0.18	1.35	-0.17
	(3.83)***	(0.69)	(6.67)***	(4.53)***	(4.26)***	(0.64)	(3.53)***	(-0.68)
LMNE	0.06	0.10	0.13	0.13	0.005	0.10	0.07	0.11
	(1.20)	(2.57)***	(2.79)***	(2.18)**	(0.08)	(1.61)	(1.16)	(2.20)**
N	44	44	44	44	44	44	44	44
Wald Chi^2	75.68***	48.41***	79.33***	34.71***	164.22***	147.07***	158.06***	182.77***

*, **, *** statistically significant at the 10, 5, 1 percent level, respectively.
Note: In parentheses are the t-statistics (heteroscedasticity corrected).

As far as coefficients of horizontal product differentiation (*LPD*) are concerned, the estimated results show that this factor is strongly significant and has positive impact on all types of IIT, despite the fact that other studies on this subject have shown that the sign should be negative for vertical IIT. Nevertheless, we can confirm that product differentiation is the major determinant factor of total IIT with an expected positive sign, owing to prevailing idea that IIT should be associated with the horizontal type of monopolistic competition models. In addition, when we apply the proxy for vertical product differentiation (*LVPD*) instead of horizontal one, then this variable has negative effect on VIIT, but on very low significance level (see equation (3)). That is contradictory to the expectations that indicate positive impact. In the decomposition of VIIT (see Table 13), we can see that the variable has the highest significance and the strongest negative impact for superior component of VIIT (equations (1), (2)).

Table 13. Decomposition of the vertical intra-industry trade for cross-industry analysis

	FGLS regressions					
	(1)	(2)	(3)	(4)	(5)	(6)
	V_SUP	*V_SUP*	*V_INF*	*V_INF*	*V_TOT*	*V_TOT*
	α = 0.15	α = 0.25	α = 0.15	α = 0.25	α = 0.15	α = 0.25
Constant	-6.24	-8.23	-3.48	-4.90	-3.58	-4.64
	(-5.35)***	(-7.52)***	(-3.20)***	(-4.14)***	(-3.95)***	(-4.34)***
LVPD	-1.59	-1.05	-0.44	-0.88	-0.56	-0.32
	(-2.96)***	(-2.67)***	(-1.00)	(-1.97)**	(-1.78)*	(-0.74)
LSE	2.42	1.54	1.04	1.03	0.95	0.09
	(2.04)**	(1.89)*	(1.06)	1.59	(1.35)	(0.12)
LMS	1.92	1.53	0.51	0.91	0.69	0.45
	(3.32)***	(3.67)***	(1.19)	(2.58)***	(2.22)**	(1.06)
LCONC	2.75	1.14	2.37	1.11	2.23	0.82
	(6.13)	(5.05)***	(6.34)***	(4.25)***	(6.67)***	(4.53)***
LMNE	0.12	0.11	0.12	0.06	0.13	0.13
	(1.61)	(1.90)*	(1.87)*	(0.23)	(2.79)***	(2.18)**
N	44	44	44	44	44	44
Wald Chi^2	93.85***	72.20***	59.52***	500.05***	79.33***	34.71***

*, **, *** statistically significant at the 10, 5, 1 percent level, respectively.
Note: In parentheses are the t-statistics (heteroscedasticity corrected).

Next, the proxy for scale economics in the market (*LSE*) turns out to be highly significant and with very strong positive effect on HIIT and with slightly smaller positive effect on total IIT. That can be found in the theory. Moreover, the similar results can be noticed in the case of the market structure variable (*LMS*), but with slightly smaller positive impact on HIIT and total IIT. This variable tells us that the more enterprises operate in the industries then the larger is the share of VIIT and IIT in total trade. That is consistent to the logic and supports the theory concerning small number case.

Regarding to the proxy for concentration of the market (*LCONC*), we can infer from our results that this determinant is very important in analysing the Norwegian industry market in the context of IIT types. It seems that big companies promote intra-industry trade between Norway and the EU. Finally, the proxy concerning multinational aspect of the industries (*LMNE*) is significant for VIIT and total IIT with having positive impact on them what is in accordance with theory. This variable could refer to our cross-country analysis of FDI inflow. We concluded there, that FDI stimulates mainly VIIT and current findings concerning industries confirm previous results.

7 Conclusion

The aim of this study is the analysis of the determinants of the intra-industry trade types between Norway and the European Union trading partners over the period 2000-2013. In the study there is applied comprehensive approach by analysing determinants of IIT in terms of country- and industry-characteristics. Nevertheless, this approach is strictly empirical by gathering the various theories about IIT determinants. The measurement of IIT was based on the standard Grubel-Lloyd (1975) indices and IIT was decomposed into vertical and horizontal IIT by using two different values of factor dispersion parameters. As theory suggests disentangling IIT between VIIT and HIIT plays important role in analysing determinants of IIT and our study confirms it. It turned out that particular determinants have different impact on VIIT and HIIT, whereas the usage of two different values of fixed dispersion factor is not so important. In particular, all of the signs of determinants for these two parameters are the same.

The general evidence from analysing trade between Norway and the EU suggests that only around 16% of trade occurs under IIT and it is mainly dominated by VIIT. As it could be expected Norway has the largest share of IIT with countries from the Baltic region such as Sweden, Denmark, Latvia, Lithuania and Poland and the industries that account for that are mainly machinery and mining.

Our econometric models are based on augmented gravity model using panel data for country- and industry-determinants. For both models we used fit panel-data methods by using feasible generalized least square since we had problems of autocorrelation and heteroscedasticity across panels. As for the country analysis, our empirical results indicate that standard determinants of IIT such as difference in capital, human and technology endowments, economic size and geographical proximity are still important driving forces for explaining IIT types. Nevertheless, the results for VIIT in case of economic size and income per capita are inconsistent to the theory expectations. Particularly, there is smaller share of VIIT for larger economy size and the larger difference in GDP per capita between Norway and the trading partner. This could be the effect that Norway’s IIT occur mainly with the Baltic region countries or lack of other not used control variables. Apart from that we checked also the positive influence of integration schemes and cultural similarities on IIT types. We find that membership of the EU has positive impact on both HIIT and VIIT, whereas the Eurozone countries promote only VIIT in inferior goods. Surprisingly, it turns out that trade with Nordic countries, which account for cultural similarities, is only positively correlated with superior VIIT. We checked also impact of difference in specific factor endowments such as forest area, land area and natural resources. In short, we find that difference in natural resources endowments is not significant, whereas the dissimilarity in land and forest area have negative impact on VIIT, HIIT and superior VIIT, respectively.

The biggest contribution of this work refers to the hypothesis of positive impact of immigration and FDI flows on IIT types. These are the aspects that are not usually used in the empirical works of IIT and that still need to be investigated. Besides, the phenomenon of immigration has gained great importance in recent year in Norway and as a result it is worth to check its consequences on trade. The results from our empirical study confirm the main research hypothesis that migration flows positively influence all types of IIT. In addition to, we find that the dissimilarities in FDI inflows have complementary character on VIIT, what is also consistent with our research hypothesis.

As far as cross-industry analysis is concerned, we find that product differentiation between horizontal and vertical is needed. In particular, horizontal product differentiation promotes HIIT and aggravates VIIT, whereas vertical product differentiation, unexpectedly, has negative impact on VIIT. The rest determinants of the industry analysis, namely, scale economies, market structure, market concentration and multinational character of the market show that theirs intensification have significant and positive impact on both HIIT and VIIT.

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Appendices:

Table A1. Norwegian intra-industry trade types by country

		Vertical						Horizontal		IIT		Inter	
		superior		inferior		total							
Partner	Year	(0.15)	(0.25)	(0.15)	(0.25)	(0.15)	(0.25)	(0.15)	(0.25)	(0.15)	(0.25)	(0.15)	(0.25)
AUT	2000	5.0	4.9	4.6	4.1	9.6	9.0	1.3	2.0	11.0	11.0	89.0	89.0
	2007	4.0	3.8	3.9	3.1	7.8	6.8	1.2	2.2	9.0	9.0	91.0	91.0
	2013	4.0	3.5	5.4	5.3	9.5	8.9	0.9	1.5	10.4	10.4	89.6	89.6
BEL	2000	1.7	1.6	1.6	1.6	3.3	3.1	0.8	1.0	4.1	4.1	95.9	95.9
	2007	1.8	1.6	7.3	7.2	9.1	8.8	0.4	0.7	9.5	9.5	90.5	90.5
	2013	0.9	0.8	3.8	3.7	4.6	4.5	0.2	0.3	4.8	4.8	95.2	95.2
BGR	2000	2.0	2.0	0.5	0.5	2.5	2.5	0.2	0.2	2.6	2.6	97.4	97.4
	2007	3.1	3.1	0.6	0.5	3.7	3.7	0.1	0.1	3.8	3.8	96.2	96.2
	2013	1.3	1.1	2.0	2.0	3.3	3.1	0.1	0.3	3.4	3.4	96.6	96.6
CYP	2000	0.8	0.6	0.1	0.1	0.9	0.7	0.0	0.2	0.9	0.9	99.1	99.1
	2007	0.6	0.6	0.9	0.9	1.5	1.5	0.0	0.0	1.5	1.5	98.5	98.5
	2013	0.7	0.7	3.4	3.3	4.1	4.0	0.3	0.4	4.5	4.5	95.5	95.5
CZE	2000	1.8	1.8	0.6	0.6	2.5	2.5	1.4	1.4	3.9	3.9	96.1	96.1
	2007	2.2	2.2	0.6	0.6	2.8	2.8	0.3	0.3	3.1	3.1	96.9	96.9
	2013	5.5	5.5	4.1	4.1	9.6	9.6	1.1	1.1	10.7	10.7	89.3	89.3
DEU	2000	4.6	4.4	2.9	2.9	7.5	7.3	1.7	2.0	9.2	9.2	90.8	90.8
	2007	4.0	4.0	2.8	2.8	6.8	6.8	0.9	0.9	7.7	7.7	92.3	92.3
	2013	2.4	2.4	2.4	2.4	4.8	4.8	1.2	1.2	6.0	6.0	94.0	94.0
DNK	2000	9.5	9.5	9.4	9.4	18.9	18.9	5.4	5.4	24.4	24.4	75.6	75.6
	2007	8.9	8.2	7.9	6.7	16.8	14.9	8.5	10.4	25.3	25.3	74.7	74.7
	2013	6.4	6.1	7.0	6.4	13.4	12.5	12.6	13.5	26.0	26.0	74.0	74.0
ESP	2000	3.5	3.2	1.1	1.1	4.6	4.3	0.6	0.9	5.3	5.3	94.7	94.7
	2007	3.0	2.8	1.1	1.0	4.1	3.9	0.5	0.7	4.5	4.5	95.5	95.5
	2013	3.7	3.6	1.9	1.9	5.6	5.5	0.5	0.5	6.0	6.0	94.0	94.0
EST	2000	4.6	4.1	3.1	3.1	7.7	7.1	1.8	2.4	9.5	9.5	90.5	90.5
	2007	5.1	4.0	3.4	3.0	8.5	7.0	4.4	5.8	12.9	12.9	87.1	87.1
	2013	5.0	4.9	3.1	3.0	8.1	7.9	2.4	2.6	10.5	10.5	89.5	89.5
FIN	2000	4.9	4.1	4.2	3.9	9.0	8.0	4.4	5.5	13.5	13.5	86.5	86.5
	2007	4.1	3.0	5.4	4.8	9.5	7.8	1.7	3.4	11.2	11.2	88.8	88.8
	2013	4.0	3.7	3.9	3.6	7.9	7.3	4.5	5.2	12.4	12.4	87.6	87.6
FRA	2000	2.1	2.0	1.6	1.3	3.6	3.2	0.6	1.0	4.3	4.3	95.7	95.7
	2007	2.6	2.4	1.3	0.7	3.9	3.1	0.3	1.1	4.2	4.2	95.8	95.8
	2013	2.3	2.2	1.5	1.5	3.8	3.7	0.1	0.2	3.9	3.9	96.1	96.1
GBR	2000	2.3	4.1	3.2	2.1	5.5	6.2	3.3	2.6	8.8	8.8	91.2	91.2
	2007	4.8	3.9	1.2	4.6	6.0	8.6	3.6	1.0	9.6	9.6	90.4	90.4
	2013	4.4	4.8	1.6	4.3	6.0	9.1	4.4	1.3	10.4	10.4	89.6	89.6
GRE	2000	1.2	1.2	1.3	1.3	2.5	2.5	0.1	0.1	2.6	2.6	97.4	97.4
	2007	1.1	1.1	1.7	1.7	2.9	2.9	0.1	0.2	3.0	3.0	97.0	97.0
	2013	1.1	1.0	2.5	2.5	3.6	3.5	0.6	0.7	4.2	4.2	95.8	95.8

Table A1. Continued

HRV	2000	0.5	0.5	0.2	0.1	0.6	0.6	0.0	0.0	0.6	0.6	99.4	99.4
	2007	3.0	2.9	1.4	1.4	4.4	4.3	0.5	0.5	4.8	4.8	95.2	95.2
	2013	6.0	5.9	1.1	1.0	7.0	6.9	1.7	1.8	8.7	8.7	91.3	91.3
HUN	2000	2.7	2.6	0.8	0.8	3.5	3.4	0.6	0.7	4.1	4.1	95.9	95.9
	2007	5.4	5.4	1.4	1.4	6.8	6.7	0.5	0.5	7.3	7.3	92.7	92.7
	2013	3.0	3.0	2.4	1.1	5.4	4.1	0.3	1.6	5.8	5.8	94.2	94.2
IRL	2000	2.5	2.5	0.8	0.6	3.3	3.1	0.2	0.4	3.5	3.5	96.5	96.5
	2007	1.5	1.5	0.2	0.2	1.8	1.8	0.2	0.2	2.0	2.0	98.0	98.0
	2013	1.0	0.9	0.7	0.7	1.7	1.7	0.1	0.1	1.8	1.8	98.2	98.2
ITA	2000	4.4	1.6	1.3	4.1	5.7	5.7	1.1	1.2	6.8	6.8	93.2	93.2
	2007	3.5	3.4	1.5	1.1	4.9	4.4	0.6	1.1	5.5	5.5	94.5	94.5
	2013	4.3	4.0	1.6	1.4	5.9	5.4	1.2	1.7	7.1	7.1	92.9	92.9
LTU	2000	2.8	2.6	10.0	10.0	12.9	12.6	0.9	1.1	13.7	13.7	86.3	86.3
	2007	3.7	3.2	7.9	7.6	11.5	10.9	2.7	3.3	14.2	14.2	85.8	85.8
	2013	2.6	2.4	4.2	4.1	6.8	6.4	1.1	1.4	7.9	7.9	92.1	92.1
LUX	2000	1.9	1.7	0.7	0.6	2.6	2.3	0.3	0.6	2.9	2.9	97.1	97.1
	2007	2.8	2.7	0.9	0.5	3.7	3.2	0.1	0.6	3.9	3.9	96.1	96.1
	2013	1.1	1.1	1.2	1.1	2.2	2.1	0.2	0.3	2.4	2.4	97.6	97.6
LVA	2000	3.1	3.0	0.9	0.9	4.0	4.0	0.3	0.3	4.3	4.3	95.7	95.7
	2007	2.9	2.9	6.5	1.2	9.4	4.1	7.9	13.2	17.3	17.3	82.7	82.7
	2013	2.1	1.8	0.7	0.7	2.8	2.5	1.4	1.7	4.2	4.2	95.8	95.8
MLT	2000	0.2	0.2	0.1	0.0	0.3	0.3	0.0	0.1	0.3	0.3	99.7	99.7
	2007	1.2	1.2	1.4	1.3	2.7	2.5	0.0	0.2	2.7	2.7	97.3	97.3
	2013	0.3	0.3	0.2	0.2	0.5	0.5	0.0	0.0	0.5	0.5	99.5	99.5
NLD	2000	3.2	3.1	2.0	1.5	5.2	4.6	0.6	1.2	5.8	5.8	94.2	94.2
	2007	2.7	2.4	2.6	2.5	5.3	5.0	0.7	1.1	6.0	6.0	94.0	94.0
	2013	3.7	3.2	1.3	1.1	5.0	4.3	5.0	5.7	10.0	10.0	90.0	90.0
POL	2000	4.5	4.1	1.7	1.3	6.1	5.4	1.3	2.0	7.4	7.4	92.6	92.6
	2007	7.5	7.3	2.3	2.3	9.9	9.6	1.4	1.7	11.3	11.3	88.7	88.7
	2013	7.5	7.2	1.6	1.4	9.1	8.6	0.6	1.1	9.7	9.7	90.3	90.3
PRT	2000	0.7	0.6	0.3	0.3	1.0	0.9	0.5	0.6	1.5	1.5	98.5	98.5
	2007	0.5	0.4	0.9	0.9	1.4	1.3	0.1	0.2	1.5	1.5	98.5	98.5
	2013	0.9	0.9	0.4	0.4	1.3	1.3	0.2	0.2	1.5	1.5	98.5	98.5
ROM	2000	0.7	0.7	0.2	0.2	0.9	0.9	0.0	0.0	0.9	0.9	99.1	99.1
	2007	3.3	3.3	1.0	0.9	4.3	4.2	0.2	0.3	4.5	4.5	95.5	95.5
	2013	7.7	7.7	1.5	1.5	9.2	9.1	1.1	1.1	10.3	10.3	89.7	89.7
SVK	2000	6.7	6.7	0.1	0.1	6.8	6.8	0.0	0.1	6.8	6.8	93.2	93.2
	2007	9.8	9.8	2.4	2.3	12.3	12.2	0.3	0.4	12.6	12.6	87.4	87.4
	2013	1.3	1.3	0.6	0.6	1.9	1.8	0.2	0.3	2.1	2.1	97.9	97.9
SVN	2000	1.9	1.9	1.1	1.1	3.0	2.9	1.2	1.2	4.2	4.2	95.8	95.8
	2007	5.2	5.1	0.9	0.8	6.0	5.9	0.2	0.3	6.2	6.2	93.8	93.8
	2013	5.4	5.4	0.5	0.5	5.9	5.8	0.1	0.2	6.0	6.0	94.0	94.0
SWE	2000	10.5	9.3	11.1	9.5	21.5	18.8	6.8	9.5	28.3	28.3	71.7	71.7
	2007	5.5	4.6	12.5	9.6	18.0	14.2	10.3	14.0	28.3	28.3	71.7	71.7
	2013	5.7	4.9	9.9	9.0	15.6	13.8	7.1	8.9	22.7	22.7	77.3	77.3

Note: Partner's names are provided according to the ISO3 Countries Codes.

Table A2. Additional sensitivity tests with *LCAPITAL* variable

	FGLS regressions					
	(1)	(2)	(3)	(4)	(5)	(6)
	VIIT	*VIIT*	*HIIT*	*HIIT*	*IIT*	*IIT*
	α = 0.15	α = 0.25	α = 0.15	α = 0.25	α = 0.15	α = 0.25
Constant	11.46	9.23	-3.69	5.33	6.97	5.57
	(3.46)***	(3.58)***	(-0.55)	(1.13)	(1.98)**	(2.15)**
LDIM	-0.15	-0.16	0.08	0.13	-0.13	-0.13
	(-2.14)**	(-2.42)**	(0.52)	(0.92)	(-1.72)*	(-1.72)*
LCAPITAL	0.17	0.33	0.52	0.03	0.24	0.24
	(0.72)	(1.30)	(1.06)	(0.07)	(0.91)	(0.91)
LEDU	-0.09	-0.14	-0.24	-0.24	-0.15	-0.15
	(-1.74)*	(-2.59)***	(-2.03)**	(-2.03)**	(-2.50)**	(-2.50)**
LEPC	-1.20	-1.35	-0.34	-0.48	-0.81	-0.81
	(-4.21)***	(-4.54)***	(-0.55)	(-0.83)	(-2.57)**	(-2.57)**
DIST	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
	(-4.79)***	(-3.99)***	(-8.39)***	(-8.55)***	(-6.05)***	(-6.05)***
LMIG	0.08	0.10	0.08	0.07	0.09	0.09
	(3.32)***	(4.03)***	(1.67)*	(1.71)*	(3.51)***	(3.51)***
EU	0.14	0.20	0.11	-0.12	0.15	0.15
	(1.50)	(2.17)**	(0.55)	(-0.67)	(1.50)	(1.50)
EUZ	0.09	0.02	0.08	0.27	0.06	0.06
	(1.29)	(0.33)	(0.59)	(2.21)**	(0.82)	(0.82)
CT	-0.01	0.23	0.46	-0.00	0.10	0.10
	(-0.13)	(2.31)**	(1.93)*	(-0.02)	(0.95)	(0.95)
LFOR	-0.21	-0.20	-0.15	-0.21	-0.18	-0.18
	(-5.49)***	(-4.75)***	(-1.75)*	(-2.72)***	(-3.96)***	(-3.96)***
LNAT	-0.02	-0.07	-0.47	-0.12	-0.08	-0.08
	(-0.17)	(-0.45)	(-1.49)	(-0.45)	(-0.48)	(-0.48)
LLAND	-0.09	-0.04	-0.58	-0.55	-0.23	-0.23
	(-1.44)	(-0.59)	(-3.77)***	(-4.05)***	(-3.28)***	(-3.28)***
LFDI	0.06	0.05	-0.01	-0.03	0.06	0.06
	(2.38)**	(1.96)**	(-0.26)	(-0.66)	(2.24)**	(2.24)**
N	223	223	221	221	223	223
Wald Chi^2	275.63***	240.03***	328.58***	587.29***	296.35***	296.35***

*, **, *** statistically significant at the 10, 5, 1 percent level, respectively.

Note: In parentheses are the t-statistics (heteroscedasticity corrected).