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the gravity model approach

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Evaluation of Icelandic Trade Flows, the Gravity Model Approach[1]

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Abstract

In this paper the objective is to explain the driving export forces of a resource based economy. This is done by applying a gravity model to exports in Iceland. Results indicate that exports can be measured by some of the conventional gravity measures. For the period 1971-1997, EFTA membership of trading partners is estimated to have positive impacts on exports. However, for the period 1988-1997, NAFTA and EU membership of trading partners is estimated to be have positive effects on exports.
Moreover, closer European integration effects on the distant, resource based country are also analyzed. As to do this effectively, recent gravity model estimation on the Nordic countries is applied to Iceland as to determine potential exports from Iceland, if its trading pattern was similar to the other Nordic countries. The comparison covers 1993 and 1994 and indicates that in most cases Iceland would be exporting considerable more if its trade pattern was identical to the exports of the Nordic countries.

Keywords: Export, Gravity Model.
JEL Classifications Codes: F1, F15

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1. Introduction.

In recent years regional trading blocs have received considerable attention within the field of international trade. An intensive discussion has taken place on preferable extension of trading regions for participating countries to optimise their welfare from trade. Potential expansion of trading blocs like EU and NAFTA has received special attention and the development of EFTA has also been of some concerns, especially in Northern Europe. The main objective of this thesis is to analyse Icelandic trade with its main trading countries, while measuring the impact of membership to different trading blocs. For this purpose, the gravity model has proven to have a sound theoretical basis and to be an effective tool in finding the main determinants of trade flows. Hence, the gravity model approach will be used in this research. Early versions of the gravity model were put forward by Tinbergen (1962) and Pöyhönen (1963), and later Bergstrand (1985) laid out microfoundations of the model.

The set up of the paper is twofold. First, to determine whether the trade pattern of Iceland as a small open economy can be explained by a traditional gravity model. The gravity model is favourable in this respect because in addition to a basic estimation of trade flows, it combines different determinants of trade flows such as distances between trading partners as proxies for transportation cost, Iceland's GDP, the exporting countries GDPs, trade agreements, cultural ties etc. It turns out that for the period 1971-1997 exports are determined by Iceland's GDP, the importing country's GDP and the importing country's population. It also has significant positive effects on trade if the importing countries have EFTA membership. However for a shorter period, in 1988-1998, EU and NAFTA membership of importing countries is estimated to be significant, not EFTA.

Secondly, a recent gravity model estimation for the other Nordic[3] countries performed by Byers, Iscan and Lesser (2000) is applied to Iceland, as to determine potential effects on Iceland from closer European integration. Thus predicted trade flows are obtained, which potentially could be Iceland's exports, if Iceland had identical export pattern as the other

[3] Denmark, Finland, Norway and Sweden.

Nordic countries. Then predicted trade flows are compared to the actual trade flows of Iceland, and it turns out that the predicted trade flows are generally much higher than actual flows.

The structure of the paper is as follows: In section 2 the development of Iceland's trade is presented and in section 3 trading blocs Iceland trades with are introduced. In section 4, the gravity model is introduced, its methodological basis and empirical validity. In section 5 and 6, the gravity model is applied to Iceland and different specifications tested as to analyse which are the main determinants of Iceland's export.

In section 7 a recent gravity model estimation for the other Nordic countries is introduced and estimates received from the Nordic countries then applied to Iceland. Conclusions are presented in section 8.

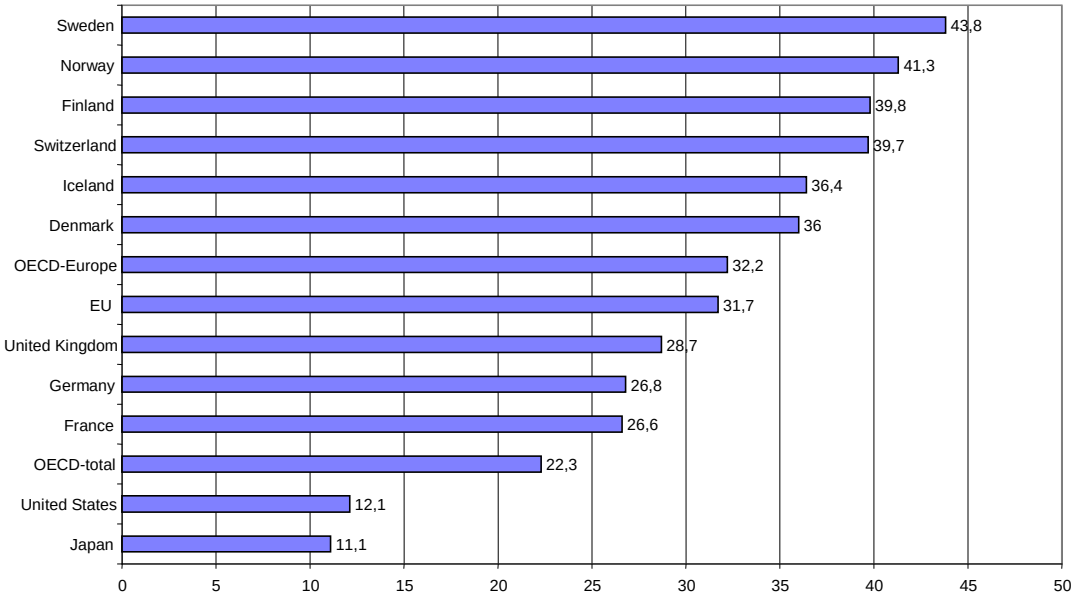
2. Trends in Iceland's Trade.

2.1 Iceland's Export Characteristics.

Iceland has typical characteristics of a small open economy, by having a high export to GDP ratio, as well as having high concentration on few export commodities. Because of the smallness of the economy, the home market for industry commodities is small which makes it generally difficult to obtain economies of scale in production.

As explained by Figure 1 below, Iceland was exporting 36,4%[4] of its GDP in 1997. This puts Iceland in group with some other small open economies with high export ratios, while economies like the United States and Japan were only exporting about 11-12% of their GDPs.

Figure 1. ***Export to GDP ratio (%) of Several Countries and Country Groups in 1997.***



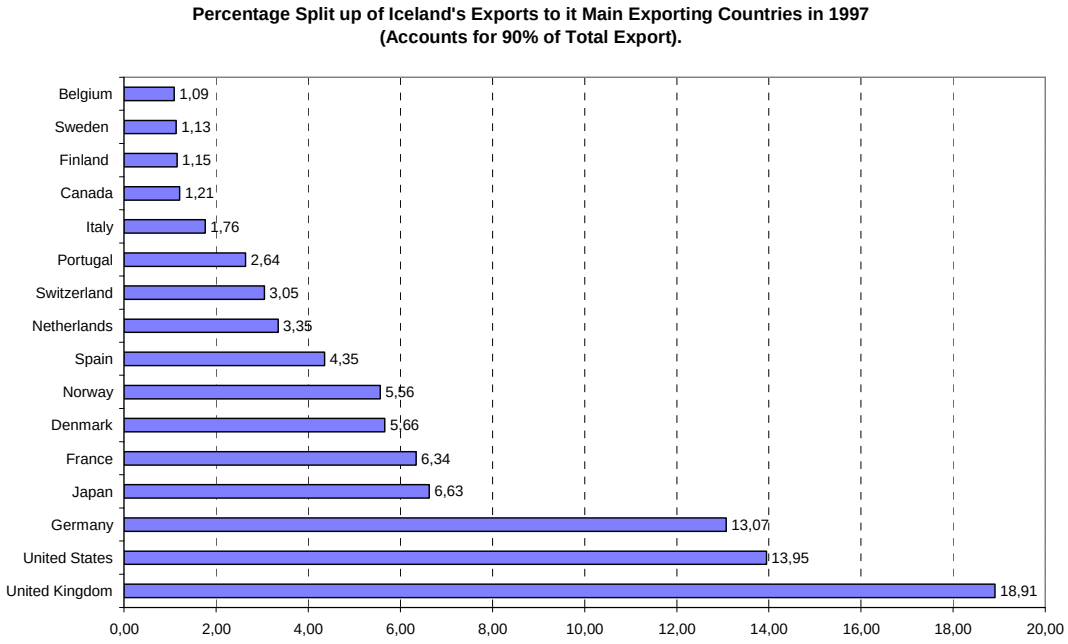
Source: The National Economic Institute of Iceland.

Large economies are less dependent on trade than small economies. In general overall world's exports have been increasing and the ratio of world's export to world's output was 21% in 1994, compared to 14% in 1970 as explained by Gylfason (1999).

[4] The export referred to is the overall merchandise exports, that is the sum of goods and services export.

Figure 2 shows the split up of Iceland's exports to its main exporting countries in 1997. The following research is based on information about these 16 trading partners. As can be seen from the figure, the United Kingdom was the biggest exporting country of Iceland in 1997, the United States was the second biggest, Germany the third, and Japan the fourth biggest.

Figure 2. ***Iceland's Main Trading Partners in 1997.***[5]



Source: The National Economic Institute of Iceland.

2.2 Trends in Icelandic Trade Since 1970.

2.2.1 Historical Overview of Iceland's Trade.

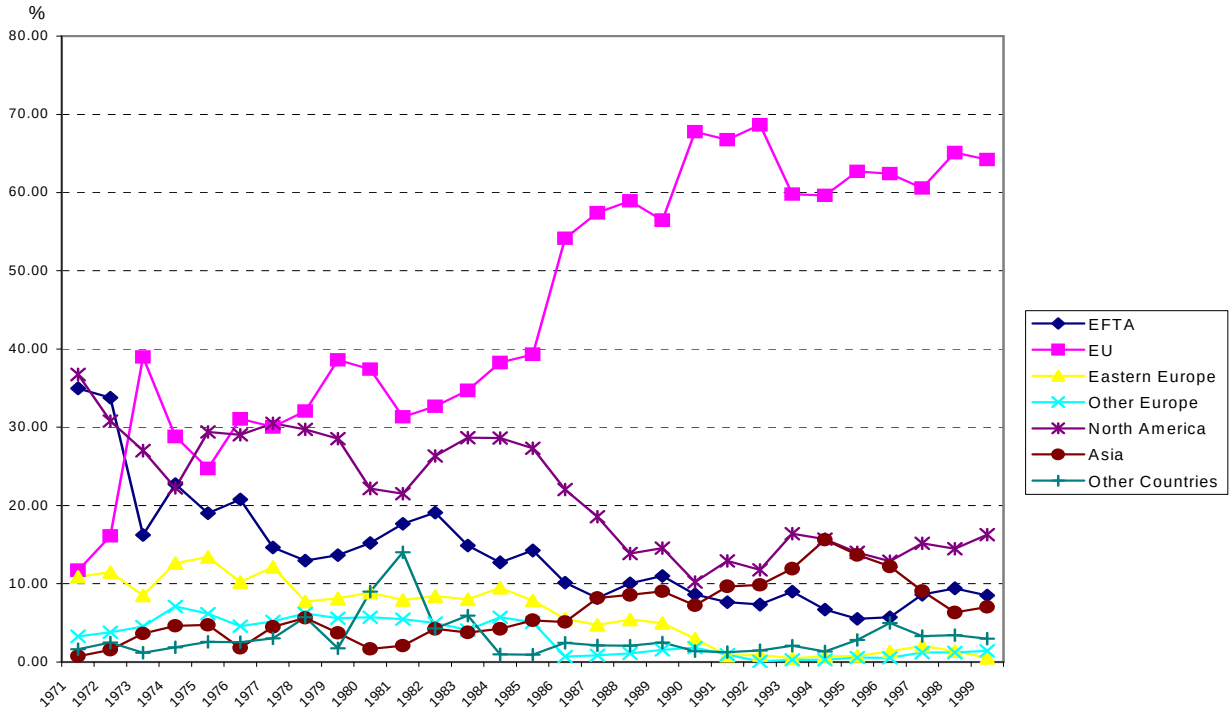
Figure 3 shows exports from Iceland to different trade regions[6] that is EFTA, EU, Eastern Europe, Other Europe, North America, Asia, and others. Overall this accounts for 88% to 99% of the total exports from Iceland during the period from 1971 to 1999.

[5] Percentage split up of exports from Iceland to its main trading countries in 1997, accounts for 90% of total exports.

[6] During the period 1971-1997, or for a part of the period, countries can be categorised in the following way. Eastern Europe: former East Germany before union, Bulgaria, Poland, Romania, Russia, former Soviet Union, former Czechoslovakia and Hungary. Other Europe: Faeroe Islands, Greece, Ireland, Yugoslavia, Spain and Turkey, before some of them joined EU. North America is the United States and Canada.

Figure 3 and 4 explain the evolution of Iceland's trade pattern over time. Trade with the EFTA countries has diminished most of the period since 1970, while trade with EU has increased. This is reflected in both Iceland's imports and exports.

Figure 3. ***Historical Overview of Iceland's Exports.***



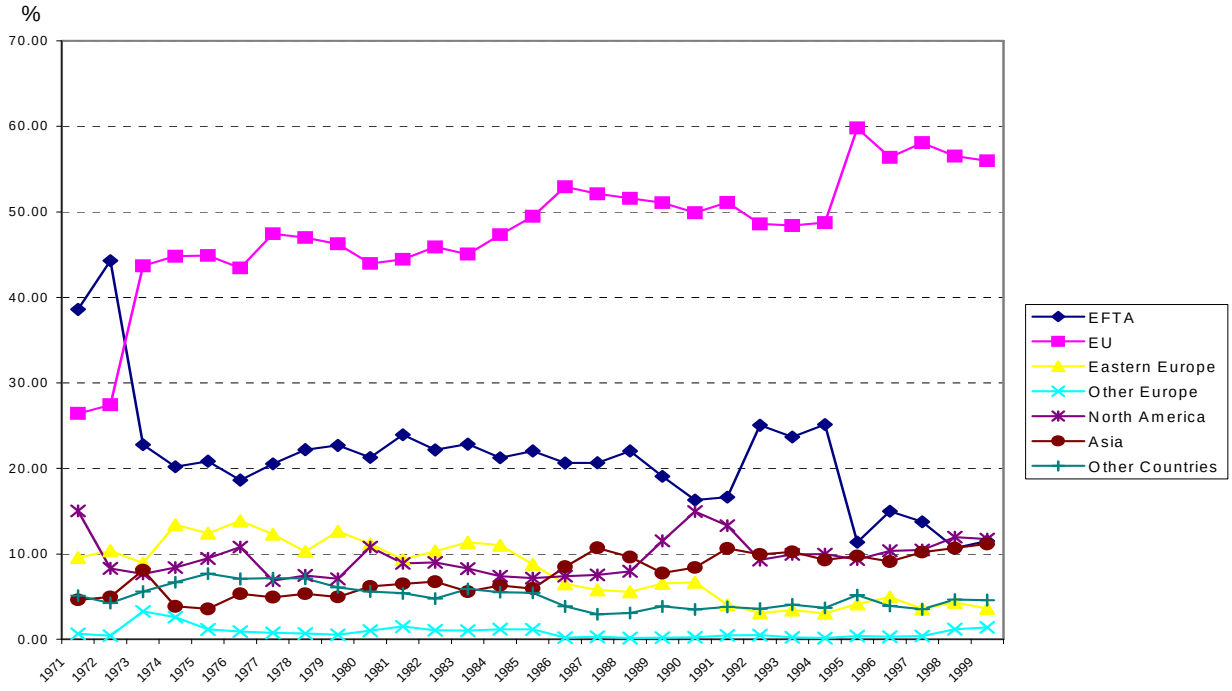
Source: The National Economic Institute of Iceland.

Iceland is trading much less with EFTA but more with EU than before.

This is primarily because Iceland has kept the trading relationship with its main trading countries, although some of these countries have left EFTA to join EU. The research part of this thesis takes into account that the membership of Iceland's trading partners to different trade blocs has not been time invariant, but changing over time. The former EFTA countries, the UK and Denmark joined EU in 1973. Portugal joined EU in 1986, and Sweden, Austria and Finland in 1995. Thus the remaining countries in EFTA are Iceland, Liechtenstein, Norway and Switzerland.

Figure 4 shows the split up of Iceland's imports from its main trading regions in 1997. Together these trading regions account for 92.3% to 97% of total imports for the time period included.

Figure 4. ***Historical Overview of Iceland's Imports.***



Source: The National Economic Institute of Iceland.

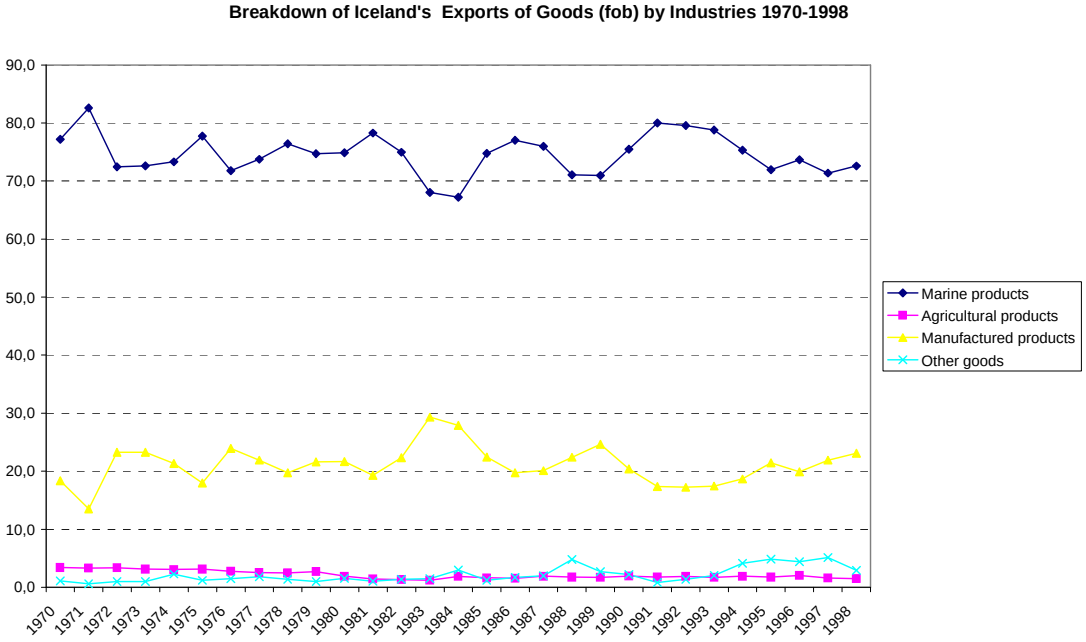
2.2.2 Composition of Exports.

Iceland's exports are primarily based on natural resources[7] and therefore the economy has probably experienced more fluctuations in export income than would be the general case for a country with more balanced exports.

[7] That is export of marine products.

It is clear from Figure 5 that marine products have traditionally had the heaviest weight and accounted for 77,2% in 1970 and 71,4% in 1997 of goods exported[8].

Figure 5. ***Composition of Iceland's Exports 1970-1999.***



Source: The National Economic Institute of Iceland.

[8] These ratios do not refer to overall merchandise exports.

3. Trade with Different Trade Blocs.

3.1. EFTA[9], EU and NAFTA.

EFTA, the European Free Trade Agreement was founded in 1960 as a response to the foundation of the EEC in 1952. Throughout the years Iceland has primarily been concerned with EU policy regarding member countries rights to control their own natural resources, particularly the fishing resources. When Iceland joined EFTA in 1970, EFTA had the following member countries: Austria, Finland, Norway, Portugal, Switzerland, Sweden, the United Kingdom and Denmark.

EFTA is a free trade agreement, originally established to stimulate trade between member countries. Before entering EFTA in 1970, Iceland had experienced economic slowdown since 1967. EFTA membership was meant to act against the slowdown and stimulate manufacturing industry, increase competition as well as allowing for lower importing prices to industries[10]. Also, an important reason why Iceland joined EFTA was to increase exports to EFTA member countries, as only 38% of Iceland's export went to EFTA at the time and 45% of Iceland's import came from the EFTA countries. However, when the UK and Denmark joined EU in 1973, Iceland's trade was increasingly directed towards EU, because in 1970 together these countries accounted for about 21% of Iceland's exports and 29% of imports. Thus it was not a change in the trade pattern that occurred but continuing of existing trading relationship to certain countries.

NAFTA, the North American Free Trade Agreement was founded in 1992[11]. Historically a large proportion of Iceland's exports has gone to the NAFTA countries. In 1970 about 30% of Iceland's exports went to the United States and Canada, but the share of exports to these countries has decreased gradually for most of the period and was down to 15,16% in 1997. The United States was the second biggest exporting country of Iceland in 1997 as could be seen in Figure 2 in section 2.1.

[9] EFTA is a free trade agreement and its member countries don't have joint tariffs against countries outside EFTA.
[10] Snævarr (1993), Íslensk haglýsing, pp. 226-230.
[11] NAFTA member countries are the United States, Mexico and Canada.

4. The Gravity Model.

4.1 Introduction to the Gravity Equation.

The gravity equation is originated in physics by Newton, who used it to estimate the gravity force between objects based on their mass and the distance between them. The gravity force increases positively with the mass of the objects, but decreases with the distance between them.

The model has been applied to economists by using the economic centres in countries as a mass, and the distance between them, as to determine the "gravity force". The gravity force obtained by this type of equation is an estimation of trade flows between economical centres. The gravity model has not only proven to be effective in estimating trade flows between countries, but also in estimating migration flows, commuting, tourism, and commodity shipping.

The model was used by Tinbergen in 1962 and Pöyhönen in 1963 for empirical analysis, and has been used since then by many researchers to explain trade flows.

The most commonly used gravity model specification was presented by Bergstrand (1985):

$$\mathrm{PX}_{\mathrm{ij}} = \beta_0 (Y_i)^{\beta 1} (Y_j)^{\beta 2} (D_{ij})^{\beta 3} (A_{ij})^{\beta 4} \varepsilon_{ij} \qquad (1.1)$$

Where $PX_{ij,t}$ is the value of exports from country i to country j in USD, at time t,

$Y_{i,t}$ is the GDP of country i in USD at time t,

$Y_{j,t}$ is the GDP of country j in USD at time t,

D_{ij} is the distance in kilometres between economical centres of country i and country j,

A_{ij} is factor(s) that either aid or restrict trade between country i and j,

ε_{ij} is a log-normally distributed error term, with $E(\ln \varepsilon_{ij}) = 0$.

When explaining exports, the size of the exporting and the importing countries are basic determinants. There are two relevant ways of measuring size, population and GDP. Therefore, researchers often start by inserting population into the variable A as an

additional determinant of trade. Then variable A_{ij} becomes P_{ij}, where P_{ij} is the population of the exporting country at time t. In order to apply the definition of the equation given in the first paragraph of this section to the log-linear form of the equation here below, the story of the gravity force can be continued: Trade flows (gravity force), originated in country i with destination in country j, are explained by the weight of the economic centre where the flow is originated (GDP_i), weight of the economical centre (GDP_j) of destination, in addition to economic forces (here P_{ij}) which stimulate or slow down flows between place of origin and destination.

Trade flows are expected to increase with an increase in GDPs. The expected effects of an increase in different factors added depend on their nature, here an increase in population can be expected to have positive effects on trade. The distance between economic centres[12] is of particular interest here, because it reflects transportation costs. A decrease in distance is expected to decrease transport costs[13] which normally leads to increased trade. Another way of looking at this is that the more distant countries are, the more likely it is that they will produce different products. More trade can thus be expected to take place. Therefore, it is hard to predict the sign of the distance coefficient between country i and country j. It can be either positive or negative. If the sign is estimated to be positive, the market can be regarded to be dominated by a home market effect as explained by Helpman and Krugman (1989) and in numbers of other models such as the geographical model of Krugman (1991a).

4.2 Methodological Basis of the Gravity Model and its Empirical Validity.

A considerable amount of literature has been published on the gravity model and its methodological premises. As explained by Abraham, Buyst and Geyssens (1997), the gravity model has been applied empirically in various ways; to evaluate main

[12] In most cases the distances between the countries capitals is used, see detailed discussion in the section 5.2 about data.

[13] "But as transportation costs fall, the incentive to impose tariffs falls and the benefits to cooperation rise. Thus, in a repeated game in which cooperation is limited by a self-enforcement constraint, a reduction in transport costs facilitates free trade…Virtually all preferential trade agreements (FTAs) are between geographically contiguous countries… Those that are not are typically based on former imperial relationships, which have been diminishing in importance. An exception is the US-Israel FTA. Also, Norway and Switzerland are members of EFTA but are not contiguous. "(Ludema, 1999)

determinants of international trade, as a forecasting and sensitivity analysis tool, and to examine the impact of different policy measures and the establishment of trade blocs.

Anderson (1979) was the first to apply product differentiation to the gravity model. He assumes Cobb-Douglas preferences and that products are differentiated by the country of origin, referred to as the Armington Assumption. By assuming that each country is fully specialised in production of one particular good, like the Keynesian version of a trade model, only one particular good is produced in each country. This model specification ignores tariffs and transport cost. There are identical Cobb-Douglas preferences everywhere, so the fraction of income spent on the product of country i, denoted b_i, is the same in all countries. Thus the basic equation becomes $\mathrm{M_{ij}} = b_i Y_j$, where $\mathrm{M_{ij}}$ is the import of good i by country j and Y_j is the income in country j. Then Anderson continues to add assumptions to the basics of the equation and comes up with more complicated specifications. He concludes that his application of the gravity model is an alternative to cross-section budget studies. But the main limitations of the model are that it only holds for countries with identical structure in terms of trade tax and transport, and identical preferences for traded goods. Anderson then also extends the model and assumes CES preferences instead of Cobb-Douglas preferences.

Bergstrand (1985) shows that although the gravity model has proven to be a successful tool empirically to explain trade flows, the model has lacked strong theoretical foundations. Bergstrand argues that the most commonly used version of the gravity equation (1.1) has been derived assuming perfect international product substitutability.

$$\mathrm{PX_{ij}} = \beta_0 (Y_i)^{\beta 1} (Y_j)^{\beta 2} (D_{ij})^{\beta 3} (A_{ij})^{\beta 4} \varepsilon_{ij} \qquad (1.1)$$

By differentiating trade flows by origin, he finds that the common version of the gravity equation is misspecified because some price variables are omitted. Bergstrand criticises that the specification of the gravity equation used previously by Tinbergen (1962), Pöyhönen (1963), Pulliainen (1963), Geraci and Prewo (1977) where prices were excluded, made their approach too “loose” and lacked explanation of a multiplicative

functional form of the model. Like Anderson (1979), Bergstrand assumes CES preferences and applies the Armington assumption. He derives an equation of a reduced form for bilateral trade where price indexes are involved.

As Bergstrand tests his assumption for product differentiation, his conclusion is that empirically price and exchange rate variables have plausible and significant effects on aggregate trade flows. His estimates indicate that goods are not perfect substitutes and that imported goods are more closer to being substitutes for each other than being substitutes for domestic goods. Bergstrand thus provides empirical evidence for the gravity equation being a reduced form of a partial subsystem of a general equilibrium model with nationally differential products.

Later Bergstrand (1990) distances himself from the Heckscher-Ohlin model by assuming, within a framework of Dixit-Stiglitz monopolistic competition, product differentiation between firms rather than between countries. Bergstrand assumes a two sector economy with monopolistically competitive sectors, and different factor proportions within each sector. By this set-up, Bergstrand seeks to connect the methodology of the Armington assumption to the framework of monopolistic competition and uses this framework to analyse bilateral intra-industry trade.

Deardorff (1995) rejects statements implying that the Heckscher-Ohlin model is incapable of providing sufficient foundation for the gravity equation. He points out that authors claiming the gravity equation was lacking theoretical basis had went on with providing empirical evidence for the equation. Deardorff extends the specification of the gravity equation made by Anderson (1979) and presumes that the same preferences hold, not only for traded goods like Anderson, but for all goods. He thus simplifies the specification made by Anderson.

5. Application of the Gravity Equation to Iceland's Exports.

5.1 The Gravity Model Specification for Iceland.

When an appropriate gravity equation specification was searched for, equation (1.1) in section 4.1 was used as bases.

The specification first tested was the following log-linear form:

$$\log(\text{Exp})_{ij,t} = \beta_0 + \beta_1 \log(GDP_{i,t}) + \beta_2 \log(GDP_{j,t}) + u_{ij,t} \qquad (1.2)$$

This was chosen as a basic specification where exports are determined by GDPs. The GDP of the importing country is believed to correspond to demand for exports, that is as the importing country's GDP increases, the country's consumption increases and so does demand. Therefore, export to that country will increase and β_1 is positive. Also, β_2 is expected to be positive, because an increase in the GDP of the exporting country will increase exports. The exporting country's GDP is believed to reflect capacity to supply.

A number of modifications is then made to improve the specification above. First, distance is added to the model as to account for transport costs to different countries. The population variables are added, as proxies for size in addition to GDPs. Also, several other modifications are made. A dummy is added to account for the implementation of the quota system in the Icelandic fishing industry in 1984. Dummies are also added to estimate if EFTA, EU or NAFTA membership of the importing countries had significant impact on trade.

Moreover, a dummy is included taking into account whether the exporting country is Nordic country or not in order to assess whether similarities in culture have significant trade impacts. Finally, country dummies are added to the basic equation as to capture country specific impacts. All distances are in levels and are represented in kilometers. All dummies in this paper take either the value of 1 or 0.

5.2 Data.

The objective is to explain exports from Iceland to its main trading partners in 1997, as determined by the National Economic Institute of Iceland (2000). In total 16 exporting countries are included: Belgium, Canada, Denmark, Finland, France, Germany, Italy,

Japan, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom and the United States. Data for Germany from 1991 refer to Germany after unification, but prior unification data on Germany are the sum of Eastern and Western Germany.

Together these countries accounted for 89,84% of Iceland's total merchandise exports in 1997[14]. Annual data on exports represent split-up of total merchandise exports as reported by the National Economic Institute of Iceland, but quarterly data represent split-up of exported goods as reported by the Statistical Bureau of Iceland.

In all cases, exchange rates and consumer price indexes were obtained from the IMF database on mid-year exchange rates IMF (1999). Thus all the data in national currencies were deflated by consumer prices and then converted to USD by current exchange rates.

Because exports to different countries are estimated simultaneously as evolution of trade over time, this is a panel data set, and the model is two-dimensional. By choosing to use panel data, rather than time series or cross sectional data, it is possible to substantially increase the number of observations. Therefore panel data can be considered to provide better estimates.

In the remaining of the paper OLS, fixed effects and random effects estimators are all presented. Both the fixed effects and the random estimator is looked at as to choose appropriate variables in the model.[15] The fixed effects estimator is included, because it takes country specific estimates into account.

5.2.1 Data on Exports.

Annual Data: Data on the overall merchandise[16] export from Iceland was taken from the IMF (1999) International Financial Statistics (IFS) database. Then the proportion of export to different countries was computed based on a percentage split-up available from the Statistical Bureau of Iceland (2000). The data are on annual basis from 1971 to 1997, yielding 27 observations per country. In order to put exports in constant prices of 1995, an index was used which accounts for traded goods in Iceland on average annual basis.

[14] For the time period 1971 to 1997 the 16 countries accounted for 74,46% or more of Iceland's total merchandise export.
[15] The fixed effects estimator takes country specific factors into account that are time invariant, such as geography, historical and cultural factors etc. The intercept is thus time-series invariant but cross-section specific.
[16] Accounting for goods and services.

The index takes weighted average of Iceland's imports and exports into account. This measure was provided by the Central Bank of Iceland. Data on exports are originally in Icelandic Krona (ISK), but then changed to USD by the current exchange rate. Export is thus expressed in 1995 prices [17] in USD.

Quarterly Data: Quarterly data on exports from Iceland cover the 10 year period 1988-1997. The data are from the database of the Statistical Bureau of Iceland. The data were provided on monthly basis, but then put on quarterly basis by summing up the monthly data.

5.2.2 Data on Gross Domestic Product.

Annual as well as quarterly data on GDPs were taken from the IMF (IFS) database. All quarterly data on GDPs are presented as seasonally adjusted data. Quarterly data for Iceland and Belgium was missing in the IFS[18] database. Belgium quarterly GDP data was obtained from the National Bank of Belgium (2000) quarterly data on Iceland's GDP was calculated by Guðmundsson (1999) at the Central Bank of Iceland by integrating a smooth flow, fitted to the annual observed values.

5.2.3 Data on Distances.

In order to capture the distance from Iceland to different countries, distance between Iceland's capital (Reykjavík) and the capital of the exporting country is used. An exception is Canada, where the average distance between Quebec and Montreal was believed to represent better the economic centre of Canada than the capital city Ottawa. Also, for the United States, New York was chosen instead of Washington. All distances are presented in levels. Data on distances was collected from Bali Online (2000).

5.2.4 Other Data.

Annual data on population are from the IMF database, quarterly data on population where however, not available. Data on trade agreements used dummy values which are from Tore and Kelly (1993). Data on the Icelandic quota system were obtained from the Icelandic Ministry of Fisheries (2000). All dummies are presented in levels. Data on the fish imports and exports were obtained from the OECD (1996) database.

[17] But as stated by Baldwin (1994) "Trade is not a nominal phenomenon, so the gravity model should be regressed on real values of the data."

6. Empirical Results of the Icelandic Gravity Model.

6.1 Results for Estimates Based on Long Term Annual Data.

First a basic version of the gravity model is estimated. The GDP of the exporting country and GDP of the importing country are used to explain export flows. The regression results are shown in the table 2.1.[19]

$$\log(\text{Exp})_{ij,t} = \beta_0 + \beta_1 \log(GDP_{i,t}) + \beta_2 \log(GDP_{j,t}) + u_{ij,t} \qquad (2.1)$$

Table. *2.1*

Variables	TOTAL (plain OLS)	WITHIN (fixed effects)	Variance Components (random effects)
Country i's Income	.641839*	.652929*	.651006*
	(19.6287)	(37.0403)	(37.1820)
Country j's Income	.455070*	.625459*	.595908*
	(11.8844)	(8.02160)	(8.34980)
Constant	-8.55195*		-12.5445*
	(-6.38228)		(-6.04813)
Adjusted R^2	.532961	.874795	.869746
F(15,414)		79.084	
F critical value		6.4737	
CHISQ(1)			.88545
Hausman critical value			3.84
Number of observations	432		

p values from a t distribution are in parentheses.
* denotes significance at 5% level two tailed test.[20]
** denotes significance at 10% level two tailed test.

The adjusted R^2 estimate for this regression is 0.53. For all the remaining regressions in this paper the adjusted R^2 ranges between 0.33 and 0.89. Here the results for the OLS, fixed and random effects estimators are presented. As for country j's income the OLS estimate is 0.64 and about 0.65 for the fixed and random effects estimators. Estimates obatined for country j's income are 0.45 by the OLS estimator, 0.62 by the fixed effects estimator and 0.59 by the random effects estimator. All the estimates are significant. The signs of the coefficients are all as could be expected, exports are positively affected both by increase in country's i and country's j income. That is, the GDP of the exporting country represents its capacity to supply and the GDP of the importing country reflects its

[18] IFS quarterly data that needed not to be seasonally adjusted for were the following: Canada, France, Germany, Italy, Japan, the Netherlands, Spain, Switzerland, the UK and the US. "Ratio to moving average-multiplicative" filter was used to seasonally adjust data.
[19] All results from the panel data estimation were obtained by running TSP version 4.3
[20] Two tailed tests are used because it is not known in advance if the coefficient value should be higher or lower.

need to demand. The estimates for the constants are –8.55 for the OLS estimator and –12.54 for the random estimator[21]. A Hausman test is applied to check whether the coefficients of the variables of the fixed and random effects estimators are significantly different.

6.1.1 Distance and Population added to the Basic Equation.

The most common version of the gravity model equation (1.1) in section 4.1 includes distances as one of its main determinants, therefore distance is now added the regression equation in (2.1). It is of particular interest to see the results of adding distance to the variables explaining Iceland's exports, because Iceland is fairly distant from all its major trading partners. When the distance variable was added to the model as to test the impacts of transportation costs on exports, the following gravity equation is obtained:

$$\log(\text{Exp})_{\text{ij,t}} = \beta_0 + \beta_1 \log(GDP_{i,t}) + \beta_2 \log(GDP_{j,t}) + \beta_3 D_{ij} + u_{ij,t} \qquad (2.2)$$

Table *2.2*

Variables	TOTAL (plain OLS)	Variance Components (random effects)
Country i's Income	.649373* (20.3940)	.652427* (37.1896)
Country j's Income	.570825* (13.0463)	.617746* (8.48227)
Distance	-.163979E-03* (-5.04170)	-.182281E-03 (-1.44784)
Constant	-11.4284* (-8.03248)	-12.7133* (-6.14874)
Adjusted R^2	0.558114	.869666
F(15,413)		
F critical value		
CHISQ(2)		0.60653
Hausman critical value		5.99
Number of observations	432	

Because distance doesn't change over time, the fixed effects estimator is not included in Table 2.2. Country i's income is estimated to be similar as in the first equation, with positive significant values of 0.64 by the OLS estimator and 0.65 by the random effects estimator. Estimates received for country j's income are 0.57 by the OLS estimator and

[21] Constant terms could have been obtained by TSP, but they are not shown here.

0.62 by the random effects estimator, both significant like before. However, estimates obtained for distance by the OLS estimator and the random effects estimators are both about –0.00017, which is a very low coefficient. The sign of the distance coefficient is as could be expected. Distance is estimated to have significant negative impacts on exports by the OLS estimator, but is not estimated to be significant by the random effects estimator. Because the random effects estimator is considered to be more reliable in this respect, these results can be interpreted such that distance is not an important factor in determining exports from Iceland. A possible explanation is that because how distant Iceland is from all its major trading partners, transport costs are always high and thus not important in determining exports.

Next it is analysed how important population is in determining exports. Thus variables representing domestic as well as foreign population are introduced in equation 2.3:

$$\log(\text{Exp})_{\text{ij,t}} = \beta_0 + \beta_1 \log(GDP_{i,t}) + \beta_2 \log(GDP_{j,t}) + \beta_3 \log(P_{i,t}) + \beta_4 \log(P_{j,t}) + u_{ij,t} \quad (2.3)$$

Table *2.3*

Variables	TOTAL (plain OLS)	WITHIN (fixed effects)	Variance Components (random effects)
Country i's Income	.742956*	.691949*	.701203*
	(7.00944)	(12.2262)	(12.4240)
Country j's Income	.396157*	.550473*	.562117*
	(2.89114)	(5.98762)	(6.15824)
Country i's Population	1.91159	.042571	.971772
	(1.00629)	(.038567)	(.943546)
Country j's Population	.056343	1.55107*	-.702281E-02
	(.413286)	(2.20438)	(-.036946)
Constant	-34.0374		-24.7657**
	(-1.33738)		(-1.81246)
Adjusted R^2	.531887	.875827	.869461
F(15,412)		79.848	
F critical value		6.4424	
CHISQ(2)			5.5023
Hausman critical value			5.99
Number of observations	432		

The estimates obtained for country i's income are positively significant like before and range between 0.69 and 0.74, estimates for country j's income are also similar to the last

regression and range between 0.39 to 0.56. Although positive, the coefficient value for the domestic population is not estimated to be significant by any of the estimators. The estimates for the importing country's population are only estimated to be significant for the fixed effects estimator with a coefficient value of 1.55. The signs of the coefficients are as could be expected. This can be translated such that an increase in the foreign population increases demand for export products, while the capacity to supply the products is not determined by the size of the domestic population. This is consistent with previous studies, although the domestic population is often estimated to have significant impact on exports. A potential explanation for why the Icelandic population is not significant could be because how small it is, but only about 280.000 people live in Iceland.

6.1.2 Quota System added to the Model.

As Figure 5 in section 2.2.2 indicates, marine products are a high ratio of Icelandic exports. In 1984 a quota system was implemented in Iceland, as to control the amount of fish cached in Icelandic waters. This government-set quota system was set as a response to declining fish stocks. The government has used the quota system since 1984 as to tighten the fish catch.

As to determine potential effects from the quota system, a dummy variable, that accounts for its implementation, is added to the model. The dummy variable takes the value 0 before 1984, but 1 in 1984 and thereafter.

Results indicate that the quota system is not estimated to be significant by any of the estimators, and therefore the results are not presented here.

6.1.3 Trade Blocs added to the Model.

Dummies are often added to the gravity equation as to determine whether membership of trading partners to trade blocs has significant impacts on trade. In the following regression we extend the gravity equation as to include dummies for EFTA, EU and NAFTA. The dummies take the value 1 during the years which the countries have membership one of the blocs, but 0 otherwise. Japan is the only trading partner of Iceland that cannot be categorised into one of these trade blocs. Japan is therefore used as a base country to avoid a dummy variable trap. Thus coefficients estimates obtained for the EFTA, EU and NAFTA trade blocs dummies, indicate if they are significantly different from exports to Japan.

$$\log(\text{Exp})_{ij,t} = \beta_0 + \beta_1 \log(GDP_{i,t}) + \beta_2 \log(GDP_{j,t}) + \beta_3 \log(P_{j,t}) + \beta_4 EFTA_{j,t} + \beta_5 EU_{j,t} + \beta_6 NAFTA_{j,t} + u_{ij,t} \quad (2.4)$$

Table *2.4*

Variables	TOTAL (plain OLS)	WITHIN (fixed effects)	Variance Components (random effects)
Country i's Income	.637643*	.675634*	.643011*
	(20.7835)	(27.3023)	(34.1993)
Country j's Income	.329150*	.508255*	.556689*
	(2.74989)	(5.93230)	(6.80659)
Country j's Population	.493016*	1.63038*	.109545
	(3.74352)	(2.20627)	(.622140)
EFTA	1.77962*	.488607*	.669270*
	(9.93747)	(2.12321)	(3.05318)
EU	1.06960*	.096144	.257520
	(8.41819)	(.485800)	(1.38519)
NAFTA	-.108665	-.046474	.108001
	(-.395686)	(-.251394)	(.646777)
Constant	-14.4359*		-13.4712*
	(-8.30316)		(-4.77458)
Adjusted R^2	.625577	.877957	.870882
F(15,410)		59.592	
F critical value		6.4111	
CHISQ(5)			9.2711
Hausman critical value			11.07
Number of observations	432		

The coefficients obtained for country i's income are somewhat lower than before, although estimated to be positively significant for all the estimators. The estimates go from 0.63 to 0.67. Country j's income is also significant with coefficients ranging from 0.32 to 0.55. Country j's population is not estimated to be significant by the random estimator like before, but continues to be positively significant for the two other estimators, with a value of 0.49 for the OLS estimator and 1.63 for the fixed effects estimator.

EFTA is estimated to have significant positive effects on exports by all the estimators, the coefficient estimates range from 0.48 to 1.80, EU however is only estimated to be significant by the OLS estimator with a value of 1.07. NAFTA is not estimated to be significant by any of the estimators. This is as could be expected since EFTA membership of the trading countries stimulates exports of Iceland, the indication of the positive coefficient estimates for the EU dummy are the same. But because EU membership is not estimated to be significant by the random or fixed effects estimators, it cannot be concluded to be relevant for exports. Therefore neither EU or NAFTA membership of the trading countries is estimated to have significant impacts on exports.

6.1.4 Testing for Cultural Ties with the Nordic Countries.

The gravity model has also proven to be able to test whether identical cultural characteristics have an impact on trade. Here it is tested whether it has significant impact on trade if the trading partner is Nordic. A dummy is added that takes the value 1 for the Nordic trading partners[22], but 0 for all other countries. Thus the estimated equation becomes (2.5):

$$\log(\text{Exp})_{ij,t} = \beta_0 + \beta_1 \log(GDP_{i,t}) + \beta_2 \log(GDP_{j,t}) + \beta_3 \log(P_{j,t}) + \beta_4 EFTA_{j,t} + \beta_5 Nordic_j + u_{ij,t} \qquad (2.5)$$

[22] Norway, Finland, Sweden and Denmark.

Table *2.5*

Variables	TOTAL (plain OLS)	Variance Components (random effects)
Country i's Income	.611967*	.637930*
	(18.8121)	(34.7220)
Country j's Income	.174971	.542546*
	(1.29052)	(6.62101)
Country j's Population	.483802*	.210012
	(3.05997)	(.897835)
EFTA	.681692*	.421903*
	(4.87175)	(3.23710)
Nordic	.244610	.453447
	(1.62141)	(.745141)
Constant	-8.75762*	-14.5805*
	(-5.02326)	(-3.84346)
Adjusted R^2	.560104	.871943
F(15,411)		
F critical value		
CHISQ(3)		6.5399
Hausman critical value		7.81
Number of observations	432	

Here only results for the OLS and the random effects estimators are reported. The fixed effects estimator is not included because "being a Nordic country" can be considered to be country specific effects.

Estimates obtained for country i's income are similar as before, they are significant and ranging between 0.61 and 0.64, country j's income estimates by the random effects estimator are 0.54 but the OLS estimate is insignificant. Country j's population is only estimated to be significant by OLS with a value of 0.48. EFTA is estimated to be significant, with an OLS estimate of 0.68 and random effects estimate of 0.42.

Although coefficients for the Nordic dummy have positive values as could be expected from cultural ties, they are not estimated to be significant. Therefore the results indicate that it does not have significant impacts on export flows from Iceland whether the trading countries are Nordic or not.

6.1.5 Choosing the Best Model.

After estimating the different model specifications, it appears that only a dummy variable for EFTA should only be included in the most favourable specification of the model. Therefore the model is re-estimated with EFTA as the only dummy variable and the following equation is obtained:

$$\log(\text{Exp})_{\text{ij,t}} = \beta_0 + \beta_1 \log(GDP_{i,t}) + \beta_2 \log(GDP_{j,t}) + \beta_3 \log(P_{j,t}) + \beta_4 EFTA_{j,t} + u_{ij,t} \quad (2.6)$$

Table *2.6*

Variables	TOTAL (plain OLS)	WITHIN (fixed effects)	Variance Components (random effects)
Country i's Income	.612051*	.672837*	.635336*
	(18.7789)	(27.9017)	(35.2665)
Country j's Income	.242294**	.507609*	.548323*
	(1.87370)	(6.02613)	(6.72926)
Country j's Population	.370264*	1.56077*	.106575
	(2.60704)	(2.35881)	(.567177)
EFTA	.716384*	.395440*	.427334*
	(5.17074)	(2.98568)	(3.28765)
Constant	-8.59308*		-12.8134*
	(-4.92786)		(-4.33892)
Adjusted R^2	.558426	.878456	.872131
F(15,412)		75.954	
F critical value		6.4424	
CHISQ(3)			6.4355
Hausman critical value			7.81
Number of observations	432		

Country i's income is significantly positive for all the estimators, with a coefficient value ranging from 0.61 to 0.67. Country j's income is estimated to be significant for the fixed effects and random effects estimators with a value about 0.5, and 0.24 by the OLS at a 10% significance level. Country's j population is estimated to be significant for the OLS estimator with a value of 0.37 and the fixed effects estimators with a value of 1.56. EFTA is estimated to be significant by all the estimators, with a value of 0.72 by the OLS estimator, 0.40 by the fixed effects estimator and 0.43 by the random estimator.

6.2.2 Country Specific Effects Estimation.

To estimate country specific effects, an OLS regression is run on the following equation:

$$\log(\text{Exp})_{\text{ij,t}} = \beta_0 + \beta_1 \log(GDP_{i,t}) + \beta_2 \log(GDP_{j,t}) + \beta_3 \log(P_{j,t}) + \sum_{k=1}^{15} (\alpha_k C_{kj}) + u_{ij,t} \quad (2.7)$$

Table *2.7*

Variables		TOTAL (plain OLS)
Country i's Income		.689967* (29.1797)
Country j's Income		.551931* (6.59361)
Country j's Population		1.55950* (2.33463)
C1	(Belgium)	3.97984* (1.96006)
C2	(Canada)	.755026 (.526727)
C3	(Denmark)	6.42018* (2.61066)
C4	(Finland)	5.59543* (2.24912)
C5	(France)	1.24367 (1.32299)
C6	(Germany)	2.12457* (2.62630)
C7	(Italy)	1.15000 (1.24525)
C8	(Japan)	-.024999 (-.054907)
C9	(Netherlands)	3.51524* (1.96645)
C10	(Norway)	6.13726* (2.36319)
C11	(Portugal)	5.66709* (2.78179)
C12	(Spain)	2.44239* (2.07868)
C13	(Sweden)	4.52194* (2.10751)
C14	(Switzerland)	5.70373* (2.47898)
C15	(UK)	2.97784* (3.24976)
Constant	(US)	-41.9152* (-3.33379)
Adjusted R^2		.881300
Number of observations		432

Because the fixed effects estimator includes country specific characteristics, an attempt is made as to estimate these fixed effects. This is done by running a regression (2.7) including the basic variables in addition to dummies estimating the country effects for the 16 trading partners included. The dummy variable representing the countries is C_{kj}, which takes the value 1 if j = k, but 0 otherwise, and α_K is country's k coefficient.

The dummy variables go from 1 to 15 as to account for all the main trading partners. The constant represents the 16th country (the United States), this is done to avoid the dummy variable trap. All the country dummies are estimated to be significant except for Canada, France, Italy and Japan. The coefficient estimates received for the other variables are all estimated to be significant, with an estimate of 0.68 for the domestic country's income, 0.55 for country's j income and 1.56 for country's j population.

Then the estimates obtained are put into a linear regression model where the fixed effects are regressed on the country specific characteristics, the distance between the countries and the ratio of fish trade to total trade.

This is done as to determine the composition of the fixed effects estimator. Because distances between the countries are fixed, they are likely to explain a part of the fixed effects obtained. Also, it is tested whether the EFTA dummy explains part of the fixed effects. In addition a variable is added that takes the proportion of fish trade to total trade. This last variable is added, because presumably the countries can be characterised by the amount of fish they consume, and thereby to the share of fish trade in their total trade. Fish trade is chosen because truly fish trade has been a high proportion of Iceland's exports in the period 1971-1997. More specifically the fish ratio can be defined as:

$$Fish_{j,71-97} = \frac{\left(\sum_{1971}^{1997} Country'\ j's\ Fish\ X + \sum_{1971}^{1997} Country'\ j's\ Fish\ M\right)}{\left(\sum_{1971}^{1997} Country'\ j's\ Total\ X + \sum_{1971}^{1997} Country'\ j's\ Total\ M\right)} \qquad (2.8)$$

Where the accumulative fish exports in 1971-1997 are added to accumulative fish imports in the same period and then the sum is devided with the sum of accumulative total exports and total imports.

Thus the linear regression estimated with the OLS estimator becomes:

$$Fixed\ Effects_j = \beta_0 + \beta_1 D_{ij} + \beta_2 EFTA_{j,71-97} + \beta_3 Fish_{j,71-97} + u_{ij} \quad (2.9)$$

Table *2.9*

Variables	OLS
Distance between country i and j	-5.07E-04* (-2.58231)
EFTA membership some time during 1971-97	2.68934* (3.98644)
Ratio of Fish Trade to Total Trade	0.341678 (1.18004)
Constant	-38.989* (-54.2403)
Adjusted R^2	.742811
F-statistic (zero slopes)	15.4409
Number of observations	16

The fixed effects are estimated to be significantly affected by distance and EFTA membership of the importing countries. The coefficient estimate for the EFTA dummy is 2.69, and the estimate for distance is –0.0005. However the fish ratio added is not estimated to be a significant part of the fixed effects. Thus it can be concluded that the fixed effects are explained by distance and EFTA membership, but not the weight of fish trade in total trade of the countries.

6.3 Results for Estimates Based on Short Term Annual Data.

As Figure 3 in section 2.2.1 indicates, exports from Iceland to EU have increased substantially over the period 1971-1997. However, exports to EFTA have decreased over the period. Because of this change in exports it is interesting to see if estimates for a shorter time period yield the same results for the trade blocs. Therefore the last 10 years are estimated specifically, that is the period 1988-1997.

Equation 2.6 which provided the best estimates for the long-term data before is applied here again, now as equation 3.0:

$$\log(\text{Exp})_{ij,t} = \beta_0 + \beta_1 \log(GDP_{i,t}) + \beta_2 \log(GDP_{j,t}) + \beta_3 \log(P_{j,t}) + \beta_4 EFTA_{j,t} + u_{ij,t} \quad (3.0)$$

Table *3.0*

Variables	TOTAL (plain OLS)	WITHIN (fixed effects)	Variance Components (random effects)
Country i's Income	.541210 (.964514)	.907784* (3.61206)	.558217* (2.53046)
Country j's Income	.371238 (1.58632)	.751313* (2.97736)	.771590* (3.30600)
Country j's Population	.133506 (.512664)	3.09759* (2.58498)	-.190585 (-.668339)
EFTA	.139327E-02 (.607500E-02)	.105257 (.642478)	.036427 (.229550)
Constant	-6.29069 (-.483925)		-1.19998 (-1.88299)
Adjusted R^2	.347016	.899853	.882471
F(15,140)		58.042	
F critical value			
CHISQ(3)			9.0348
Hausman critical value			
Number of observations	160		

The results obtained for country i's income are similar to the ones obtained for the long term data, and the variation between estimators is higher ranging from 0.54 to 0.91. The fixed effects estimate obtained for country j's income is 0.75 and 0.77 by the random effects estimate, the OLS estimate for country j's income is not significant. Country j's population is only estimated to be significant by fixed effects estimator with a value of 3.09.

Clearly, EFTA is not estimated to have significant effect on exports like before. Apparently it makes difference how far back one goes when estimating impacts from membership to trade agreements. When re-estimating if EU or NAFTA membership of trading partners matters for this ten year period, NAFTA and EU membership of trading countries is estimated to have significant positive effects on exports. A possible explanation for the difference between the long term annual estimates and the 10 year data estimates are that the short term estimates cover the period from 1988 to 1997 during which EFTA member countries are Iceland, Switzerland, Liechtenstein and Norway. However, the longer period covers the years from 1971 to 1997, a period when EFTA had

up to 8 member countries and higher share of Iceland's exports went to EFTA. All the countries that have left EFTA entered EU, resulting in increasing exports to EU[23], and therefore it is not surprising that EU becomes significant in the short-term period. Also, NAFTA[24] was more likely to be significant for this period than for the long-term period, because it was founded in 1992 and therefore has much more relevance in the short-term period.

6.3 Results for Estimates Based on Quarterly Data.

Because results obtained for the short-term period 1988-1997 yielded different results from the long-term period, it is of interest to estimate whether quarterly data for an identical short-term period provides similar results.

Therefore several regressions are run on quarterly data from 1988-1998, as to determine whether the estimates are consistent with the short-term annual data estimates.

By estimating quarterly data rather than annual data, it is now possible to determine quarterly effects on trade. First a regression is run on the equation which provided the best fit for the annual data. However, population variable is not included because quarterly population data is not available. Therefore the regression equation becomes:

$$\log(\text{Exp})_{ij,t} = \beta_0 + \beta_1 \log(GDP_{i,t}) + \beta_2 \log(GDP_{j,t}) + u_{ij,t} \qquad (3.1)$$

Table *3.1*

Variables	TOTAL (plain OLS)	WITHIN (fixed effects)	Variance Components (random effects)
Country i's Income	.654941* (2.44209)	.666835* (4.94882)	.661672* (4.91199)
Country j's Income	.495205* (18.4237)	0.812703* (6.01808)	.674882* (6.61792)
Constant	-1.0591 (-.49644)		-5.71227* (-2.0148)
Adjusted R^2	.327956	.830587	.826066
(15,686)		139.65	
F critical value		6.8570	
CHISQ(1)			2.4236
Hausman critical value			3.84
Number of observations	704		

[23] See Figure 3 with historical overview on Iceland's exports in section 2.2.1

[24] NAFTA was founded in 1992 and the dummy controls for the membership of US and Canada from 1992.

The estimates received are similar to the estimates received for the long term annual data for the period 1971-1997, as represented by equation (2.1). Here the estimates for country i's income range between 0.65 and 0.67, estimates for country j's income range between 0.49 and 0.81 and the constant is negative. From this it can be concluded that the basic determinants are the same for exports in 1988-1997, as in 1971-1997.

Because results for the 10 year period indicated that only EU and NAFTA membership of trading countries had significant impacts on exports in 1988-1997, a regression was run as to see if the quarterly data for the period 1988-1998 would give the same results. This turned out to be the case.

6.3.1 Estimation of Quarterly Effects.

Iceland's exports are highly dependent on natural resources as indicated by Figure 5 in section 2.2.2. As to determine whether Iceland's exports are subject to quarterly fluctuations, quarterly dummies for each quarter are added to the model. Each quarter's dummy takes the value 1 for that quarter, but 0 otherwise. Thus the model becomes:

$$\log(\text{Exp})_{ij,t} = \beta_0 + \beta_1 \log(GDP_{i,t}) + \beta_2 \log(GDP_{j,t}) + \beta_3 q_1 + \beta_4 q_2 + \beta_5 q_3 + u_{j,t} \qquad (3.3)$$

Table *3.3*

Variables	TOTAL (plain OLS)	WITHIN (fixed effects)	Variance Components (random effects)
Country i's Income	.665316*	.677549*	.672322*
	(2.47926)	(5.08133)	(5.04367)
Country j's Income	.495244*	.817181*	.679625*
	(18.4512)	(6.12191)	(6.7028)
Quarter 1	-.13019	-.12779*	-.12882*
	(-1.35188)	(-2.67179)	(-2.69352)
Quarter 2	.072134	.076653	.074722
	(.749522)	(1.60286)	(1.56299)
Quarter 3	-.07249	-.06851	-.07021
	(-.75295)	(-1.43233)	(-1.46825)
Constant	-1.10547		-5.88278*
	(-.51785)		(-2.08714)
Adjusted R^2	.329865	.834782	.830350
F(15,683)		143.21	
F critical value		6.8270	
CHISQ(1)			2.5104
Hausman critical value			3.84
Number of observations	704		

Estimates for country i's income are 0.67 by the fixed and random effects estimators, and 0.66 by the OLS estimator. Country j's income coefficients range between 0.49 and 0.81, all estimates received for the countries income are significant.

As for the quarterly estimates, quarter 4 is used as a base. The 1st quarter is estimated by the fixed and random effects estimators to have significantly lower exports than the 4th quarter, more specifically the coefficient value obtained range between –0.12 and –0.13. The estimate received for quarter 2 is about 0.07 for all the estimators and about –0.07 for quarter 3, however quarter 2 and 3 are not estimated to be significantly different from the 4th quarter.

As mentioned earlier, exports are highly dependent on marine exports. Therefore, fluctuations in exports are most likely to be explained by fluctuations in marine exports. The reason why exports in the 1st quarter are lower than in the 4th quarter could be because the 1st quarter is the coldest season in Iceland when not much fishing takes place. Also, the first quarter is the period when one of the major fish type, cod, is harder to catch, because it locates itself deeper in the sea.

The quota season starts at the 1st of September and normally trawlers start catching some of the more valuable fish stock. The second and the third quarter also represent the last two quarters of the fishing season, but then various fish derivatives from earlier seasons are ready to be exported. This could explain why exports in the second and the third quarters were not estimated to be significantly different from exports in the fourth quarter.

7. Application of a Nordic Gravity Model.

7.1 Application of Gravity Models to Determine Trade Bloc Effects.

In recent years, several authors have tried to estimate what would have been the current scenarios had trade regions developed differently, for example in Europe.

Sanz (2000) uses the gravity model to determine trade impact, that is the effects of economic integration between trading partners. In his research, Sanz estimates potential trade flows of Spanish manufactures in 1986-1992 had Spain not joined EEC in 1986. Sanz specification mainly differs from previous research models in that he uses a Kalman Filter-Gravity Equation in his approach. Sanz main conclusion is that the impacts on manufactures trade from Spain's entry to the EEC, can primarily be determined by trade creation, both in the case of imports and exports.

Baldwin (1994) uses the gravity model to predict potential trade flows in Eastern and Western Europe, had they not been subject to the old communist regimes. Baldwin's analysis consists of two parts. First, in the medium run, he predicts the trade flows of the CEECs, if they were as integrated in European trade as the average Western European country in the 1980's (using the average for the EU and EFTA countries). Secondly, in the long run, Baldwin estimates the potential outcome had the CEECs cached up with the Western European countries in income *per capita*. The conclusion from the analysis is that for almost all the countries included, predicted trade flows are estimated to be considerable higher than actual trade flows.

Byers, Iscan and Lesser (2000) use the gravity model to determine how trade flows of Baltic Countries would have developed had they not been affected by the Soviet Union. This is done by estimating the size and direction of trade flows of the Nordic countries[25] in 1993 and 1994, and apply the estimates to the Baltic countries. Their results indicate

[25] All the Nordic countries are included in the research except for Iceland, but Iceland is a Nordic country by definition.

that the Baltic foreign trade was not only reduced significantly due to distortions from the Soviet Union, but also diverted towards its member countries.

In their estimate authors base their empirical foundations on analysis made by Deardorff and use a gravity model to determine trade flows. After obtaining parameter estimates for the Nordic countries, they apply the estimates to the Baltic countries to get the difference between actual and predicted trade flows of the Baltics. The main conclusions are that the Baltic trade flows were affected considerable by the Soviet Union and that future trade flows are expected to turn increasingly to the EU countries.

7.2 A Nordic Gravity Model applied to Iceland.

Here the objective is to determine potential impact from closer European integration on Icelandic trade flows. This is done by predicting potential exports of Iceland, if Iceland's trade pattern was more identical to the other Nordic countries. But all the other Nordic countries are members of EU, except for Norway[26].

As discussed earlier, the gravity model has proven to be useful in this respect. Here the approach used by Byers, Iscan and Lesser (2000) is applied to estimate potential trade flows of Iceland.

In their procedure, Byers, Iscan and Lesser estimate the parameters of the gravity model based on 1993-1994 trade data for Denmark, Finland, Norway and Sweden. Then they apply these estimates to the Baltics to predict their trade flows, had they experienced similar trade regime as the Nordics since 1940. In this research the same procedure will be followed. The gravity model estimates obtained by Byers, Iscan and Lesser will be used and applied to Iceland.

More specifically this is done by applying the following log-linear version of the gravity equation applied by Byers, Iscan and Lesser (2000) and Baldwin (1994):

$$\log(\text{Exp})_{\text{ij,t}} = \beta_0 + \beta_1 \log(Y_{i,t}) + \beta_2 \log(Y_{j,t}) + \beta_3 P_{i,t} + \beta_4 P_{j,t} + \beta_5 D_{ij} + \beta_6 B_{ij} + \beta_7 TA_{ij} + u_{ij,t} \qquad (4.1)$$

[26] Norway only accounts for 20% of the size of the other Nordic countries combined, see table 5.1 appendix for GDPs.

Where $X_{ij,t}$ denotes export from i to j at time t. Parameter estimates are obtained on income of the exporting country $Y_{i,t}$, the income of the importing country $Y_{j,t}$, population of the exporting country $P_{i,t}$, population of the importing country $P_{j,t}$ and distance D_{ij}. Furthermore $B_{i,j}$ is a dummy which is 2 if countries i and j have common borders between them and 1 otherwise, and TA_{ij} is a dummy which is 2 if countries i and j have trade agreements between them but 1 otherwise. The dummies take the value of 2 if countries share a border or have trade agreements between them, and 1 otherwise. Finally the error term is presented as $u_{ij,t}$.

7.3 The Data Base of the Model.

Because the model estimates obtained by Byers, Iscan and Lesser (2000) are used, the data they use for their estimates are also the background of this research. Data on GDP, population and exchange rates are taken from the International Financial Statistics (IFS) of IMF. GDPs where converted into USD by using the mid-year exchange rate given by IFS, the end-year rates were used in the cases that mid-year rates where lacking[27]. Byers, Iscan and Lesser choose to use export data because they where more readily available than data on imports. Also the gravity model has been considered to give better estimates with export data (Fitzpatrick 1984) because export is reported in FOB (Free on Board), while import data normally account for insurance and freight as well. The authors use data from Bali Online (1997) to get the distance between the biggest cities of the countries chosen, as they regarded them to account better for the economical centres of the countries, than the countries capitals.

Two dummies are chosen to estimate the impact of borders between countries and if they have trade agreements with each other. Estimated impacts of different trade agreements are from an IMF report on regional trade agreements (de la Torre and Kelly, 1993).

[27] Mid-year exchange rates were only lacking for Jordan.

Byers, Iscan and Lesser choose to use annual estimates for 1993 and 1994, because these were the latest years with complete data for most of the countries.[28] Trade flows from the Nordic countries to all other countries are covered in the database, except for trade flows to the Ivory Cost and Oman due to lack of data. Exports to China, Cuba and North Korea were also excluded from the data, since those exports where not considered to be determined by market forces. Overall, 490 observations on bilateral trade flows where included in the database, after taking out zero trade flows to eliminate distortions.

For the two years under investigation, data on exports covered 83-95% of the total exports for all the countries, which should adequately reflect the geographical distribution of each countries exports. The ratio of export used each year is shown in table 4.1

Table 4.1 ***The Proportion of Each Country's Exports Included in the Data.***

Country	1993	1994
Denmark	89%	87%
Finland	86%	83%
Norway	93%	95%
Sweden	92%	92%

Source: The International Monetary Fund.

7.4 Main Results on Estimated Versus Actual Data.

The table below presents the coefficient estimates obtained by Byers, Iscan and Lesser on the logarithms values for the Nordic countries variables. This was the most preferred specification, after testing both levels and logarithms specifications and testing for specifications where some coefficients were restricted to be zero. Both population and income per capita were included in the model, based on F value estimates. The results below indicate that the parameters all have expected signs and most of them are significant at the 5% confidence level.

[28] More recent data could only be found on the developed countries.

Table 4.2 Gravity Model Coefficient Estimates[29] for the Nordic Countries.

Variable	Parameter	Coefficient	T value	Confidence level
Per capita foreign income	Y_j / P_j	0.857	30.01	5%
Per capita domestic income	Y_i / P_i	0.251	1.13	10%
Foreign population	P_j	1.533	9.91	5%
Domestic population	P_i	0.646	25.2	5%
Distance	D_{ij}	-0.739	-13.02	5%
Common boundary	B_{i,t_t}	0.854	2.30	5%
Trade agreement	TA_{ij}	0.121	1.28	10%

Byers, Iscan and Lesser use *per capita* foreign income and foreign population as proxies for GDP of the importing country and *per capita* domestic income and domestic population as a proxy for GDP of the exporting country. This is done because data on GDPs where not available for the Baltics.

Table 4.3 shows the results after applying the model to Iceland. The values in the rows represent the predicted flows obtained after applying the estimated, actual trade flows from Iceland, and the difference between these two. Finally the ration between the actual and predicted trade flows is presented.

[29]a) In 1993 and 1994 the member countries of EFTA were the following: Austria, Finland, Iceland, Norway, Sweden and Switzerland.

Table 4.3 ***Actual Versus Predicted Exports of Iceland in 1993 and 1994[30].***

	Year	Predicted Trade Flows	Actual Trade Flows	Difference (Predicted – Actual)	Actual / Predicted
Belgium	1993	70.255.377	30.004.922	40.250.455	43%
	1994	72.692.781	39.827.030	32.865.751	55%
Canada	1993	165.380.196	10.602.446	154.777.750	6%
	1994	166.553.805	30.114.533	136.439.272	18%
Denmark	1993	41.594.811	112.937.255	-71.342.444	272%
	1994	43.182.476	144.958.160	-101.775.684	336%
Finland	1993	45.037.439	14.270.892	30.766.547	32%
	1994	47.767.479	21.297.161	26.470.318	45%
France	1993	236.064.738	165.313.339	70.751.399	70%
	1994	242.843.515	161.326.145	81.517.370	66%
Germany	1993	268.888.812	221.591.122	47.297.689	82%
	1994	277.177.291	287.782.409	-10.605.118	104%
Italy	1993	230.818.076	41.020.864	189.797.212	18%
	1994	234.521.852	52.376.750	182.145.102	22%
Japan	1993	688.210.444	186.115.338	502.095.106	27%
	1994	715.435.462	314.436.328	400.999.133	44%
Netherlands	1993	88.462.725	44.169.790	44.292.935	50%
	1994	91.272.697	36.837.955	54.434.743	40%
Norway	1993	32.835.178	67.579.991	-34.744.814	206%
	1994	33.682.737	63.316.046	-29.633.309	188%
Portugal	1993	57.692.413	32.840.016	24.852.396	57%
	1994	59.031.235	28.390.221	30.641.015	48%
Spain	1993	164.329.930	97.922.071	66.407.858	60%
	1994	165.613.419	105.352.914	60.260.506	64%
Sweden	1993	44.187.115	23.410.201	20.776.914	53%
	1994	45.535.494	23.566.940	21.968.554	52%
Switzerland	1993	68.737.057	73.474.951	-4.737.894	107%
	1994	71.722.588	39.559.292	32.163.296	55%
United Kingdom	1993	208.280.667	434.021.731	-225.741.065	208%
	1994	215.431.656	461.256.667	-245.825.011	214%
United States	1993	824.848.809	318.730.733	506.118.076	39%
	1994	848.922.221	323.355.601	525.566.620	38%

As can be seen from Table 4.3 predicted trade flows are generally much higher than actual trade flows. This indicates that Iceland would export much more if it had trade pattern similar to the other Nordic countries. However, actual trade flows to Denmark, Germany, Norway, Switzerland and the UK are for higher than predicted trade flows for one or both of the years. A potential explanation for higher actual export values for Denmark could be that exports from Iceland to the Faeroe Islands are included in exports to Denmark in the actual value, but not in the predicted value. The reason why actual

b) The Asian countries included are China, India, Indonesia, South Korea, Malaysia, Pakistan, Philippines, Singapore, Sri Lanka and Thailand.

[30] All values are in USD, 1993 and 1994 current prices.

trade flows to Norway are higher than predicted could be because of the EFTA membership, stimulating trade between Iceland and Norway. The same reason could explain why Switzerland has higher actual values in 1993. The reason why actual trade flows to the United Kingdom and Germany are higher than the predicted could be due to a high tradition for fish consumption the these countries.

Thus overall a closer European integration can be regarded to have considerable positive impacts on the exports of Iceland.

8. Conclusions.

The objective of this research was to capture the main determinants of Iceland's exports, as to find out if a small open economy like Iceland had export determinants identical to other countries. This turned out to be the case.

As to estimate the determinants of Iceland's exports, a gravity model is used. After trying different specifications of the gravity model for the time period 1971 to 1997, it can be concluded that significant determinants of exports are Iceland's GDP, the importing country's GDP and the importing country's population. Moreover exports are estimated to be significantly effected by trading countries membership to EFTA.

As to determine whether exports have the same determinants in the short run, identical regression was also run on a shorter time period, from 1988 to 1997. Exports in this period were estimated to have the same determinants, except that EFTA membership of trading partners was not estimated have impact on exports like before, but EU or NAFTA membership.

Identical regression is also run on quarterly data from 1988-1998, to see if it would yield the same results. The results were the same. A potential explanation for the difference in the short term and the long term, is that the short term period only covers the time period from 1988 to 1998, whereas the long time period covers the period from 1971 to 1997. Therefore, the EFTA countries are much more relevant in the annual data sample that goes further back. For the quarterly data only two member countries of EFTA were included in the sample, but up to 7 member countries are included in the annual data. Also because exports to EU member countries is much higher in the short term period it is not surprising that it is estimated to be significant, moreover because NAFTA was founded in 1992 it is more relevant in the shot-term period.

Moreover it was tested if Icelandic exports where subject to fluctuations on quarterly basis. This turned out to be the case. The first quarter was estimated to be less important for exports that other quarters of the year. This is probably best explained by the fact that less fish products are exported in the first quarter than later during the year.

Finally, estimation of export pattern of the other Nordic countries was compared to Iceland. This was to see how the trade pattern of Iceland would be like if it were identical to trade pattern of the Nordic countries.

The results indicate that closer European integration could be expected to have substantial positive effect Iceland's exports to its 16 main trading partners. However, exports to the EFTA countries could be expected to decrease.

Appendix.

The weight of each country's GDP in the overall GDPs of the countries included in the research about the Baltic countries.

Table 5.1 ***The Ratio of Each Country's GDP Included in the Data.***

Ratio of GDPs	Denmark	Finland	Norway	Sweden
1993	26%	16%	22%	36%
1994	26%	17%	22%	35%

Source: The International Monetary Fund.

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