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# Determinants of Foreign Direct Investment in Iceland

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## Abstract

This paper investigates whether the low foreign direct investment in Iceland can be explained by its geographical location together with market size measures. The effects of these factors on inward FDI are analyzed by means of the gravity model. The model is also applied to analyze sector, trade bloc and country specific effects. The research is based on panel data, running over countries, sectors and years. Results indicate that distance negatively affects FDI and that FDI appears to be more driven by wealth effects than market size effects.

Keywords: Foreign Direct Investment, Gravity Model.
JEL Classifications Codes: F21, F23

# 1 Introduction

Foreign direct investment (FDI) has received increased attention in recent years. In some recent literature economists have been analyzing the driving forces of FDI, and why FDI tends to take place between wealthy countries, rather than flowing from the rich to the poor countries (Markusen, 2002).

One of the interesting features of inbound Icelandic FDI is that until fairly recently, there was none. As with the small level of exports, this might be due to the small market size of Iceland and its location. Gravity models of trade leads us to believe that this is because of market size and distance. Therefore, in this paper I choose to test this by using the gravity model of FDI which specifically accounts for these effects.

Gravity models have been increasingly popular in trade literature for analyzing the driving forces of foreign direct investment. In an interesting paper, Brainard (1997) applies a gravity model to multinational activities. Brainard analyses multinational enterprises (MNEs) and seeks to capture the trade-off between MNE affiliate sales and trade. She applies data on MNEs in the U.S. and its trading countries. In her paper, Brainard uses affiliate sales to proxy FDI rather than applying actual FDI, which is a reasonable way to capture actual MNE activity, because it measures the value of this activity.

Brainard estimates the incentive multinationals have for exporting rather than undertaking FDI, when corrected for several factors such as trade and investment costs as well as economies of scale. Brainard uses the share of exports in total sales as her dependent variable, which is meant to be an inverse indicator for foreign affiliate sales in total sales (that is FDI). She finds that MNEs have more incentive to undertake overseas production (FDI) rather than exporting to the foreign market as transport costs and trade barriers increase, and as investment barriers as well as relative weight of plant to firm scale economics decrease.

Several other papers apply gravity models to FDI flows and FDI stock data. Jeon and Stone (1999) analyze FDI flows with an emphasis on the Asia-Pacific
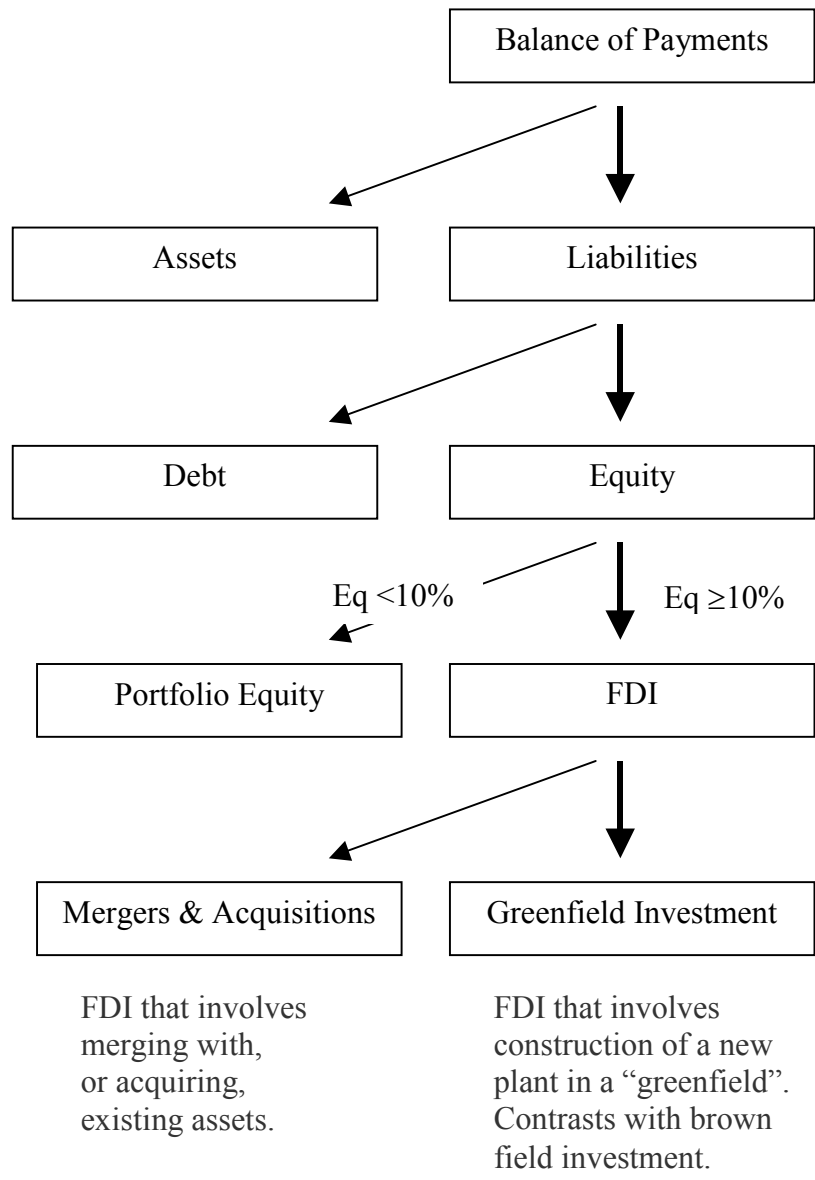
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region. They estimate sector and country fixed effects. They run separate regressions for individual years in 1987-93 and find that in most cases FDI is positively affected by home country GDP and negatively affected by home country population. However, their estimates indicate that for most years FDI is not impacted by host country population or GDPs, nor distance. Jeon and Stone also use dummies to account for the difference in investment made by various trade blocs. Di Mauro (2000) provides an interesting study where she analysis two issues: Whether FDI in the Central and Eastern European Countries (CEEC) region can be regarded to be substitute for exports from the European Union (EU), which would have a negative impact on employment in the EU, and secondly whether FDI in the CEEC region can be considered as replacing investment in regions such as Portugal and Spain. Econometrically, the research by Di Mauro is interesting, since she disaggregates FDI by both countries and sectors over time. The data dimensions are therefore comparable to the ones used in this research, although different questions are asked here, using different regressions.

An additional study on CEEC's is the gravity model approach by Bevan and Estrin (2000), where they analyze the determinants of foreign direct investment flows in transition economies.

In de Mello Sampayo (2000), a gravity model is applied to analyze determinants of US originated FDI. Finally, an even more recent paper by Mody, Razin and Sadka (2003), extends the gravity model to an information-based model of FDI flows.

More related to my data are the studies that have been carried out in order to analyze the determinants of FDI in Iceland (e.g. Thorsteinsson, 1995; Sighvatsson, 1996; Gylfason, 2000; and Sigurdsson, 2001). However, none of these use the gravity model approach.

**Figure 1. Balance of Payments and FDI.**

```
                    ┌──────────────────────┐
                    │  Balance of Payments │
                    └──────────────────────┘
                        ↙            ↓
   ┌──────────────┐          ┌──────────────┐
   │    Assets    │          │  Liabilities │
   └──────────────┘          └──────────────┘
                        ↙            ↓
   ┌──────────────┐          ┌──────────────┐
   │     Debt     │          │    Equity    │
   └──────────────┘          └──────────────┘
          Eq <10%   ↙            ↓   Eq ≥10%
   ┌────────────────────┐    ┌──────────────┐
   │  Portfolio Equity  │    │     FDI      │
   └────────────────────┘    └──────────────┘
                        ↙            ↓
┌──────────────────────────┐ ┌────────────────────────┐
│  Mergers & Acquisitions  │ │  Greenfield Investment │
└──────────────────────────┘ └────────────────────────┘

   FDI that involves          FDI that involves
   merging with,              construction of a new
   or acquiring,              plant in a "greenfield".
   existing assets.           Contrasts with brown
                              field investment.
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*Sources:* Deardorff (2003), Calderon, Norman and Serven (2002), Lane and Milesi-Ferretti (2003).

Figure 1 shows an overview of the balance of payments on the macro economic level. Foreign direct investment falls within the category of liabilities, since it represents the foreign ownership of controlling firm stock in a particular country. When compared to foreign bank loans or foreign portfolio investment, FDI is gen-

erally considered more stable, which is particularly important in volatile economic environment (Grosse, 1997).

The analysis provided in the following sections seeks to investigate whether FDI is driven by gravity model features such as market size and distance. This paper also analyses fixed source country effects and sector specific effects. The research is based on unique data on FDI in Iceland, covering both source countries and sectors of allocation over time. The data dimensions also allow for simultaneous estimates for sectors and trade blocs.

I test the gravity model and find that consistent with previous literature, distance seems to matter for FDI. Unlike earlier findings, wealth may be more important than market size. Here population size and GDP size is believed to give an indication of market size. If FDI increasing in market size then both population and GDP could be expected to have positive signs. Both source and host country GDP is always estimated to be positive. However, source and host country population is almost always estimated to be negative. If the signs of the market size variables (GDP and population) are close to being equal and opposite (GDP per capita), then it is possible to say that FDI is affected by wealth effects, rather than market size effects.

The paper is organized as follows. Section 2 gives an overview of how FDI has developed in Iceland. In Section 3 the foundations of the gravity model are laid out. Section 4 lists the data used in these research, and Section 5 exhibits regression results for the basic gravity model specification. Section 6 provides results for simultaneous analysis of sources and allocation of FDI, while Section 7 considers FDI allocation specifically. Section 8 provides results form running the gravity model for FDI stock. Finally, Section 9 includes summary and conclusions.

# 2 Development of Foreign Direct Investment in Iceland

Foreign direct investment (FDI) is often formed when multinationals expand their operations from one country to another. Although foreign investors have been increasingly interested in investing in Iceland, the inward FDI stock in Iceland has been low compared to the other Nordic countries. As can be seen in Figure 2, in Iceland FDI inflows were marginal until 1996 when a Swiss multinational started investing in the aluminum sector.

**Figure 2: Foreign Direct Investment Stock in Iceland, Million $ (1995).**
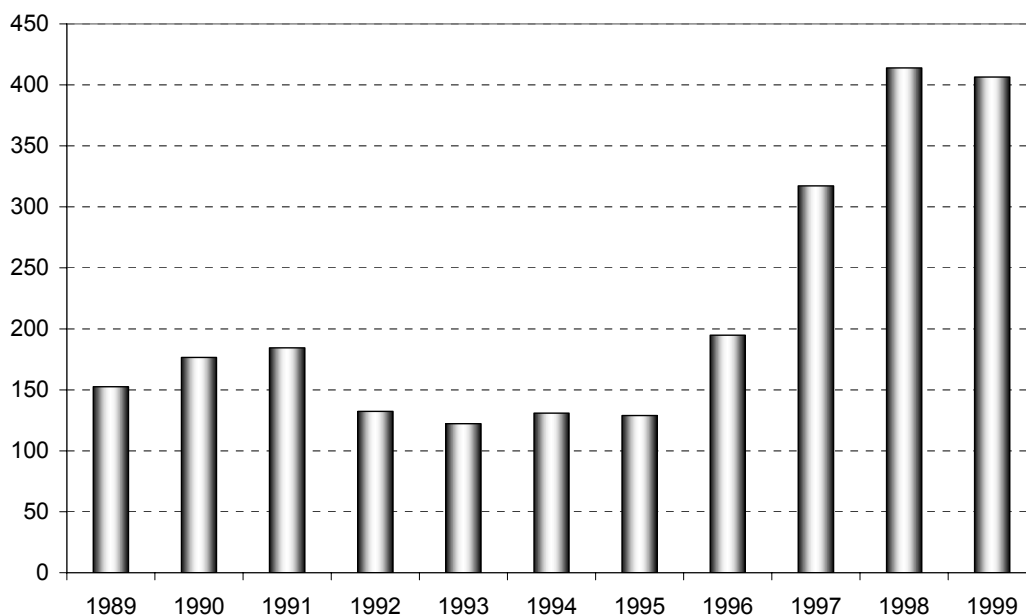


*Source:* The Central Bank of Iceland (2001).

Figure 2 shows the development of foreign direct investment (FDI) stock in Iceland, with Iceland being the host country of investment. In Figure 2 FDI is presented as the FDI stock at the end of period.[1] The stock of FDI equals accumulated FDI inflows. As Figure 2 exhibits, total FDI stock has grown substantially from 1995 to 2000, or about four-fold.

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[1] All stock values in the figures are the end of period values.

# 3 The Gravity Model

## 3.1 Theoretical Foundations of the Model

Several authors have made a contributions to the foundations of the gravity model. Valuable contribution to literature have been made by Anderson, Bergstrand and Deardorff. Anderson (1979) assumes product differentiation and Cobb-Douglas preferences. Anderson puts forward the so-called Armington Assumption on the basis that products are differentiated by the country of origin. However, tariffs and transport costs are not accounted for in this gravity model specification.

Later, Bergstrand (1985) presumes that the Armington assumption holds as well as CES preferences. Bergstrand's conclusion is that price and exchange rate variation have significant effects on aggregate trade flows. He also finds the gravity equation is a reduced form of a partial subsystem of a general equilibrium model with nationally differential products.

Deardorff (1995) derives a gravity model in the framework of a Heckscher-Ohlin model. Bergstrand presumes that the same preferences hold for all goods and thus simplifies the setup of Anderson (1979), who assumed this only for traded goods. Deardorff rejects the hypothesis that the Heckscher-Ohlin model is not a sufficient framework for the gravity equation, and points out that empirical evidence for the equation has been provided by those who complained about lack of theoretical basis for the equation. Later, Deardorff (1998) finds the gravity model to be consistent with several variants of the Ricardian and Heckschser-Ohlin models.

## 3.2 The Model Specification

The most commonly used version of the gravity model specified by Bergstrand (1985) is presented in Equation (1).

$$X_{ij,t} = \alpha_0 (Y_{i,t})^{\alpha_1} (Y_{j,t})^{\alpha_2} (D_{ij})^{\alpha_3} (A_{ij})^{\alpha_4} \zeta_{ij,t} \tag{1}$$

In the Bergstrand (1985) gravity model paper, Equation (1) explains the volume of trade between countries i and j by their GDPs, distance and factors that either

aid or restrict trade. The variable $X_{ij,t}$ accounts for export from country (i) to country (j), at time (t). The variable $Y_{i,t}$ is the GDP of country (i) at time (t), $Y_{j,t}$ is the GDP of country (j) at time (t) and $D_{ij}$ is the distance between the economic centers of country (i) and country (j). The variable $A_{ij}$ accounts for factors that either stimulate or reduce trade between country (i) and (j), and finally $\zeta_{ij,t}$ is a log-normally distributed error term, with $E(\ln(\zeta_{ij,t}))= 0$ (Greene, 1997).

In this paper, like in the paper di Mauro (2000a, 2000b), the gravity model predicts the volume of FDI stock. FDI is expected to increase with an increase in the GDPs of the host and source economies, but to decrease as distance increases. The gravity model specification used in this research can be presented as shown in Equation (2). The dependent variable is now specified as inward FDI in Iceland, varying over source countries, sectors and time. However, the variables representing the host country on the right hand side do not vary by country. Therefore the host country notation is simplified as to only vary by time, not various host countries. The (j) notation is therefore not needed, but only the (i) notation for source countries as exhibited in Equation (2):

$$FDI_{i,s,t} = e^{\beta_0}(Y_{i,t})^{\beta_1}(Y_t)^{\beta_2}(N_{i,t})^{\beta_3}(N_t)^{\beta_4}(D_i)^{\beta_6}\zeta_{i,t} \qquad (2)$$

This basic equation specification is presented in a logarithm format. The logarithms are all natural logarithms. Therefore, the interaction between the variables in the equation and the dependent variable is presented in percentages, i.e. how much a percentage change in one of the variables affects the dependent variable. The explanatory variables in Equation (2) are somewhat identical to Equation (1), but now $N_{i,t}$ and $N_t$ have been added to the basic equation as to account for the size of the economies, where as the GDPs account for the economies' total wealth. Then in model specifications introduced later in this paper, dummies are added to account for the source countries membership to trade blocs and the allocation of FDI to several investment sectors. In similar papers for other countries, people have tended to add dummies for a common borders between trading partner countries, or an identical languages. However, this is not done here since Iceland does not

share a border or language with any country.

<div align="center">

**Table 1.  Variable Definition**

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| Variable | | Predicted signs |
|---|---|:---:|
| $\ln(FDI_{i,s,t})$ | Foreign Direct Investment transformed by the Natural Logarithm Function, running over source countries (i) and sectors (s), over time (t). | |
| $\sinh^{-1}(FDI_{i,s,t})$ | Foreign Direct Investment transformed by the Inverse Hyperbolic Sine Function, running over source countries (i) and sectors (s), over time (t). | |
| $\ln(Y_t)$  *Host Country GDP* | Logarithm (ln) of Host country Gross Domestic Product (GDP), over time (t). | $+$ |
| $\ln(Y_{i,t})$  *Source Country GDP* | Logarithm (ln) of Source country (i) Gross Domestic Product (GDP), over time (t). | $+$ |
| $\ln(N_t)$  *Host Country Pop* | Logarithm (ln) of Host country population (Pop), over time (t). | $+$ |
| $\ln(N_{i,t})$  *Source Country Pop* | Logarithm (ln) of Source country population (Pop), over time (t). | $+$ |
| $\ln(D_i)$  *Distance* | Logarithm (ln) of distance between the source and the host country. | $-$ |
| $Sector_1$  *Power Intensive Ind* | Dummy variable accounting for the Power Intensive Industries. | $+/-$ |
| $Sector_2$  *Comm. and Fin. Ind* | Dummy variable accounting for the Commerce and Finance Industries. | $+/-$ |
| $Sector_3$  *Telecom & Transp. Ind* | Dummy variable accounting for the Telecom and Transport Industries. | $+/-$ |
| $Sector_4$  *Other Industries* | Dummy variable accounting for the Agriculture, Fishing and remaining Industries. | $+/-$ |
| $Bloc_1$  *EFTA* | Dummy variable accounting for country membership to the EFTA trade bloc. | $+/-$ |
| $Bloc_2$  *EU* | Dummy variable accounting for country membership to the EU trade bloc. | $+/-$ |
| $Bloc_3$  *NAFTA* | Dummy variable accounting for country membership to the NAFTA trade bloc. | $+/-$ |
| $Bloc_4$  *NON Bloc Members* | Dummy variable accounting for country non-membership to any trade bloc. | $+/-$ |

All regressions presented here are obtained from using STATA version 7.0.

# 4    Data Sources and Statistics

Data on Foreign Direct Investment (FDI) applied in this research were kindly provided by the Central Bank of Iceland. These data run over 4 investment sectors and an 11 year period, from 1989 to 1999. The data account for annual data on FDI undertaken in Iceland in the estimated period.

**Table 2.   Summary Statistics**

| VARIABLE | UNITS | OBS | MEAN | STD. | MIN | MAX |
|---|---|---|---|---|---|---|
| $FDI_{i,s,t}$ | Million USD (1995 base) | 748 | 3.155 | 13.887 | -0.953 | 157.934 |
| $\ln(FDI_{i,s,t})$ | Natural Logarithm | 240 | 0.366 | 2.514 | -6.830 | 5.062 |
| $\sinh^{-1}(FDI_{i,s,t})$ | | 748 | 0.559 | 1.165 | -0.847 | 5.755 |
| $Y_t$ | Trillion USD (1995 base) | 748 | 0.007 | 0.001 | 0.007 | 0.009 |
| $\ln(Y_t)$ | Natural Logarithm | 748 | -4.934 | 0.083 | -5.016 | -4.765 |
| $Y_{i,t}$ | Trillion USD (1995 base) | 740 | 1.219 | 1.957 | 0.014 | 8.582 |
| $\ln(Y_{i,t})$ | Natural Logarithm | 740 | -0.788 | 1.425 | -4.289 | 2.149 |
| $N_t$ | Million | 748 | 0.265 | 0.008 | 0.253 | 0.278 |
| $\ln(N_t)$ | Natural Logarithm | 748 | -1.327 | 0.029 | -1.376 | -1.282 |
| $N_{i,t}$ | Million | 748 | 43.179 | 63.843 | 0.378 | 278.230 |
| $\ln(N_{i,t})$ | Natural Logarithm | 748 | 2.817 | 1.509 | -0.974 | 5.628 |
| $D_i$ | Million | 748 | 0.004 | 0.004 | 0.002 | 0.0167 |
| $\ln(D_i)$ | Natural Logarithm | 748 | -5.827 | 0.571 | -6.349 | -4.098 |
| $Sector_k$ | $Sector_k \in \{1, 2, 3, 4\}$ | 748 | | | 0 | 1 |
| $Bloc_n$ | $Bloc_n \in \{1, 2, 3, 4\}$ | 748 | | | 0 | 1 |

*Sources:* Central Bank of Iceland, Bali-Online Webside, Economic Institute of Iceland, International Labor Organization, World Bank, World Competitiveness Report, Kyoto Protocol.

The data cover the inward FDI stock in Iceland, obtained from 17 different source countries: Australia, Austria, Belgium, Canada Denmark, Finland, France, Germany, Japan, Luxembourg, Netherlands, Norway, Spain, Sweden, Switzerland, United Kingdom and the United States. The number of observations could therefore be expected to be 17 times 4 times 11, equal to 748. However, the number of

observations is 740 since data on Germany in 1989 and 1990 is not included in the data, because these are the years before unification of Germany.

The countries trade bloc membership is also included in the research. The trade blocs included are Bloc 1 for the European Free Trade Association (EFTA), Bloc 2 for the European Union, Bloc 3 is the North American Free Trade Agreement (NAFTA), and finally Bloc 4 includes NON Bloc countries (non member countries).

Data on FDI are divided into four main investment sectors: Sector 1 represents the Power Intensive Industries, Sector 2 Finance & Commerce Industries, and Sector 3 Telecom & Transport. Finally Sector 4 represents the Fishing Industry, the Agricultural Industry, and remaining industries.

The original FDI data were obtained in Icelandic Krona, and then converted to dollar values by using World Bank dollar exchange rates, and finally put on 1995 base using the World Bank GDP deflator. By doing so, the FDI values become comparable to the variable values on the right hand of the equation, since values for foreign GDP are obtained in USD 1995 values. GDP (Gross Domestic Product) values used are defined by the World Bank (2001) CD-Rom as "constant 1995 US$", that is real values GDPs on a 1995 year base[2]. These are presented as trillion[3] dollar values on a 1995 base. Finally, the FDI data used in the last column in Table 8 are added up across sectors. Therefore, in those regressions the number of observations is 185.

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[2]The GDP World Bank deflator used is on a 1995 year base.

[3]Trillion is defined in the US and Canada as 10^12, and in Britain, France and Germany as million cubed or 10^18 (Hyper Dictionary, 2004).

# 5 The Basic Gravity Model Specification

Here the error term relationship previously described in Equations (1) and (2), in Section 3.2, can be presented in Equation (3) as follows, where the $(\zeta)$ is replaced by $(\varepsilon)$, so that: $E(\ln \zeta_{i,s,t}) = E(\varepsilon_{i,s,t}) = 0$.

$$
\begin{aligned}
\ln(FDI_{i,s,t}) &= \beta_0 + \beta_1 \ln(Y_t) + \beta_2 \ln(Y_{i,t}) + \beta_3 \ln(N_t) \\
&\quad + \beta_4 \ln(N_{i,t}) + \beta_5 \ln(D_i) + \varepsilon_{i,s,t}
\end{aligned} \tag{3}
$$

A different functional form of the gravity equation is shown in Equation (4), after applying the so-called "Inverse Hyperbolic Sine Function" to the dependent variable, rather than applying the natural logarithm function[4]. The procedure is preferred because of the need for transformation that does not truncate or eliminate low values of the dependent variable. This way of imposing the inverse hyperbolic sine (IHS) function to the dependent variable while imposing natural logarithm on the dependent variables, has been used in studies on household wealth. The procedure was proposed by Johnston (1949) and suggested as a suitable transformation for household wealth data by Burbidge, Magee and Robb (1988), since some households hold zero or negative net worth (Carroll, Dynan and Krane[5], 1999). Figure 3 provides a graphical description of the natural logarithm function $\ln(x)$ (thick line) and the inverse hyperbolic sine function[6] $\sinh^{-1}(x)$ (thin line).

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[4]A gravity equation in a natural logarithm format cannot operate on zero or negative values.

[5]In their 1999 paper, Carroll Dynan and Spencer make special thanks to Martin Browing at the University of Copenhagen for suggesting this transformation, see page 4.

[6]More specifically, the Inverse Hyperbolic Sine Function can be presented as $\sinh^{-1}(x) = \ln(x + (1 + x\char`^2)\char`^0.5)$

**Figure 3: Inverse Hyperbolic Sine and Natural Logarithm Functions**
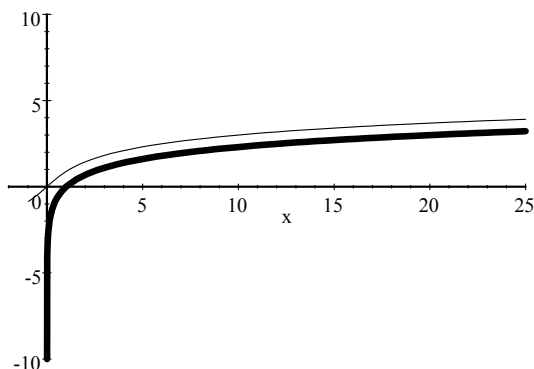


*Source:* Author's computations.

While other methods for dealing with zeros exist, they are all ad hoc in some fashion, therefore this approach seems as reasonable as any.

The variable notation has been simplified as to better reflect the nature of the data, since the data only covers one way investment[7], not bilateral investment.

$$
\begin{aligned}
\sinh^{-1}(FDI_{i,s,t}) \; = \;\; & \beta_0 + \beta_1 \ln(Y_t) + \beta_2 \ln(Y_{i,t}) + \beta_3 \ln(N_t) \\
& + \beta_4 \ln(N_{i,t}) + \beta_5 \ln(D_i) + \varepsilon_{i,s,t}
\end{aligned}
\tag{4}
$$

The regression results for Equation (4) are presented in Table 3. All the variables in Table 3 are estimated to be significant except for the domestic population variable.

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[7]By this notation (i) refers to the source countries of investment, running from 1 to 17. By doing so, the paper follows the notation applied in other thesis papers, this notation is well presented in the CMM (2001) paper.

## Table 3.   The Basic Model Specification

| Regressors | IHS ROBUST |
|---|---|
| $\ln(Y_t)$  *Host Country GDP* | 2.085** |
| | (2.23) |
| $\ln(Y_{i,t})$  *Source Country GDP* | 1.143*** |
| | (7.00) |
| $\ln(N_t)$  *Host Country Population* | −2.975 |
| | (−1.14) |
| $\ln(N_{i,t})$  *Source Country Population* | −0.976*** |
| | (−6.29) |
| $\ln(D_i)$  *Distance* | −0.235*** |
| | (−4.67) |
| *Constant* | 9.166*** |
| | (3.32) |
| OBSERVATIONS | 740 |
| LOG-LIKELIHOOD | -1125.1015 |
| DEGREES OF FREEDOM | 5 |
| R-SQUARED | 0.1028 |

Note: Robust t-statistics are in parentheses below the coefficients. ***,
** and * denote significance levels of 1%, 5% and 10%, respectively.

One of the major questions asked in the beginning of this chapter is whether it is possible to explain FDI in Iceland by distance, together with some other economic variables represented in the gravity model.

Table 3 shows robust[8] regression estimates for the gravity model based on Equation (4). The results indicate that the host and source countries GDPs are estimated to be positively significant.

Thus 1% increase in source GDP (equivalent to \$12.19 billions[9] at the sample mean) implies an 1.143% increase in FDI, equivalent to \$36,062 at the sample means[10]. The fact that the GDPs are estimated to have positive significant effects on FDI can be interpreted such that FDI increases with an increase in the economic

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[8]All robust t-statistics are calculated using White's (1980) heteroskedaticity correction. Note that all of these t-statistics assume normality which need not be true in the data. Since the trade literature typically ignores this difficulty, I do as well but note this potential problem.

[9]Here billion dollars are in American terms, so that \$ 1 billion are eqialent to \$1,000,000,000.

[10]Sample means are listed in Table 2. Note that the means are very low, because of all the zeros in the data.

size of the host and source country, which is as theory would predict. Similarly, theory would predict the population variables of both the host and source countries to have positive effects on FDI. This is however not the case, since both of these variables are estimated to be negative, although only the source country population coefficient is significant.

The significant negative estimate for the source country population indicates that FDI is negatively driven by this measure of market size, indicating that economies can be expected to invest more as their market size becomes smaller. Taken together, it seems as FDI is positively affected by countries total wealth but negatively by their market size, which is somewhat as could be expected based on the knowledge that a considerable investment is made by small economies like Switzerland, and the EFTA member countries are generally small in population[11].

Another way of interpreting the results for the host and source country sizes is to consider their combination as *per capita* wealth effects on investment. Thus the hypothesis would be that GDP and population are equal and opposite in sign. When considering the confidence intervals for the two variables, both intervals overlap one indicating an elasticity of one. This is because when the standard deviations are considered, the source country GDP is found overlaps 1, whereas source population is found to overlap -1[12]. Therefore, the coefficient ratio is estimated to overlap one[13]. This exercise gives a reason to believe that GDP *per capita* drives FDI rather than the country total wealth. More specifically it indicates that it is average wealth of country that matters, rather than total wealth.

Finally, the negative distance coefficient obtained indicates that FDI decreases in distance, more specifically FDI decreases as distance increases. In Table 3 I choose to report both R squared and the log-likelihood values, as an indication of the regression fit. Since Table 3 includes the first regression obtained in this

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[11]In the power intensive industry.

[12]The standard deviation for source country GDP is 0.1633 and the coefficient is estimated to be 1.143, so the confidence interval runs from 0.98 to 1.31. However, the standard dev. for source country pop. is 0.1552, and coefficient -0.976, resulting in confidence interval between -1.13 and -0.82.

[13]It would provide the same results if the coefficients would overlap 4 and -4, etc.

research, these measures on the R squared and the log-likelihood are for comparison with latter tables, rather than telling a story on their own.

# 6  Allocation of Foreign Direct Investment

## 6.1  Decomposition by Sectors of Allocation

Next I want to look more closely at FDI allocation, and therefore disaggregate FDI by sectors. This will be done now since it allows analysis of whether FDI is driven into individual sectors of allocation by the gravity model variables. I seek to gain some information on sector allocation by measuring whether there is fixed difference between individual sectors. Equation (5) offers a sectorial decomposition of FDI by incorporating dummies for sectors.

$$
\begin{aligned}
\sinh^{-1}(FDI_{i,s,t}) &= \beta_0 + \beta_1 \ln(Y_t) + \beta_2 \ln(Y_{i,t}) + \beta_3 \ln(N_t) \\
&\quad + \beta_4 \ln(N_{i,t}) + \beta_5 \ln(D_i) + \gamma_k Sector_k + \varepsilon_{i,s,t}
\end{aligned}
\tag{5}
$$

The regression results for Equation (5) are presented in Table 4, the where the variable coefficient $\gamma_k$ reflects on the sector specific effects[14]. Here the 3rd sector Telecom & Transport (T&T) is held fixed. When the estimates presented in Table 4 are considered, distance is estimated to be equally as restrictive as in the non-sector specific case in Table 3, indicating that it is not capturing sector specific constants. As before, both domestic and foreign GDPs are estimated to have significant positive effects on FDI, but source and host countries population to negatively affects FDI. Taken together these estimates indicate that investment incentives are positively affected by both host and source total wealth in that higher *per capita* GDP increases FDI negatively affected by market size (population). The estimates obtained for the source country have higher significance than those of the host country, indicating that FDI is more impacted by source country market size measures than those of the host country.

In Table 4 the third sector "Telecom and Transport" (T&T) is held fixed to avoid the dummy variable trap. Estimates for sector one, two and four indicate that these are all estimated to be significantly positive from the T&T sector. Interestingly

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[14]This is done to avoid the omitted variable bias.

enough, the commerce and finance (C&F) sector is estimated to account for even more FDI than the power intensive industries. However, these sector specific estimates are obtained after correcting for economic sizes of the host and source as well as distance, which may explain why C&F is higher than the power intensive industry, when compared to telecom and transport. Also could potentially be due to the small time series variation of the Icelandic variables, which impact the research as a whole.

### Table 4. Fixed Sector Effects

| Regressors | IHS ROBUST |
|---|---|
| $\ln(Y_t)$  Host Country GDP | 2.085** |
| | (2.29) |
| $\ln(Y_{i,t})$  Source Country GDP | 1.143*** |
| | (7.22) |
| $\ln(N_t)$  Host Country Population | −2.975 |
| | (−1.17) |
| $\ln(N_{i,t})$  Source Country Population | −0.976*** |
| | (−6.50) |
| $\ln(D_i)$  Distance | −0.235*** |
| | (−4.62) |
| $Sector_1$  Power Intensive Ind. | 0.575*** |
| | (5.07) |
| $Sector_2$  Comm. and Fin. Ind. | 0.649*** |
| | (6.79) |
| $Sector_4$  Other Industries | 0.435*** |
| | (5.43) |
| Constant | 8.751*** |
| | (3.26) |
| OBSERVATIONS | 740 |
| LOG-LIKELIHOOD | -1105.4495 |
| DEGREES OF FREEDOM | 8 |
| R-SQUARED | 0.1492 |

Note: Robust t-statistics are in parentheses below the coefficients. ***, ** and * denote significance levels of 1%, 5% and 10%, respectively.

The regression results are based on a sample of data with 740 observations. The log-likelihood values are presented here, since they can be used to compare

different specifications. By following the standard procedure for log-likelihoods[15], the difference between the two log-likelihood values is multiplied by 2 yielding a value of 4.6. And since the value 4.6 is higher than the critical value 3.841 (based on of one degree of freedom), the restricted model version in Table 3 is not preferred[16] to the unrestricted version in Table 4.

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[15]"Let $\theta$ be a vector of parameters to be estimated, and let $H_0$ specify some sort of restriction on these parameters. Let $\widehat{\theta}_U$ be the maximum likelihood estimate of $\theta$ obtained without regard to constraints, and let $\widehat{\theta}_R$ be the constrained maximum likelihood estimator." Greene (1997, pp. 161).

"If the restriction $c(\theta) = 0$ is valid, imposing it should not lead to a large reduction in the log-liklelihood function. Therefore, we base the test on the difference, $\ln L - \ln L_R$, where $L$ is the value of the likelihood function at the unconstraint value of $\theta$ and $L_R$ is the value of the likelihood value function at the restricted estimate" Greene (1997, pp. 160).

[16]The objective is to determine whether the restricted version can be rejected when compared to the non-restricted version. This is possible if the difference is high enough.

# 7   Sources of FDI

In order to analyze the country and trade bloc effects on FDI, I next estimate country and bloc specific fixed effects.

## 7.1   Decomposition by Trade Bloc Membership

This subsection deals with the decomposition of FDI by trade blocs. The disaggregation by trade bloc membership is reflected in the variable in Equation (6). The coefficient $\pi_n$ accounts for specific trade bloc effects, running from one to four, bloc=1,2,...4. More specifically bloc 1 represents the European Free Trade Association(EFTA), bloc 2 the European Union (EU), bloc 3 the North American Free Trade Association (NAFTA) and finally bloc 4 non bloc member countries.

$$
\begin{aligned}
\sinh^{-1}(FDI_{i,s,t}) \;=\;& \beta_0 + \beta_1 \ln(Y_t) + \beta_2 \ln(Y_{i,t}) + \beta_3 \ln(N_t) \\
& + \beta_4 \ln(N_{i,t}) + \beta_5 \ln(D_i) + \pi_n Bloc_n + \varepsilon_{i,s,t}
\end{aligned}
\tag{6}
$$

As can be seen in Table 5, estimates for variables of the basic regression are analogous to the ones obtained in Table 3, except that here distance is insignificant. These results for distance may indicate that countries grouped in various trade blocs tend to be geographically close to one another, the geographical fixed difference is captured primarily by these trade blocs so the distance variable is left insignificant. Along these lines the insignificance of the non-bloc countries may be due to that these are more geographically spread than others and therefore are not estimated to be significantly different from the EU bloc.

Moreover, the fixed effects estimates indicate that EFTA and NAFTA[17] are estimated to have significantly higher investment in host than EU, but not the fourth trade bloc (non-bloc members).

In general the fixed bloc effects may be related to predictions on investment costs

---

[17]The member countries of NAFTA are the US and Canada and they are presumed to be in NAFTA from 1989, although NAFTA was not formed until in 1992. However, it is taken into account whether other countries move between EFTA and EU etc.

or openness by trade blocs. That is the reason why EFTA countries are estimated to invest more in Iceland when compared to EU, could be because there is less trade costs involved for them. However, based on the EEA (European Economic Area) agreement EU countries have full permission to invest in EFTA countries like Iceland. This freedom to invest must overcome some threshold investment cost, and increase dual openness, but apparently there is some fixed difference left. Another possibility is that Switzerland which is in the EFTA group has substantial investment in the power intensive industry.

## Table 5. Fixed Trade Bloc Effects

| Regressors | IHS ROBUST |
|---|---|
| $\ln(Y_t)$ *Host Country GDP* | 2.189**<br>(2.37) |
| $\ln(Y_{i,t})$ *Source Country GDP* | 1.053***<br>(5.36) |
| $\ln(N_t)$ *Host Country Population* | −2.127<br>(−0.82) |
| $\ln(N_{i,t})$ *Source Country Population* | −0.892***<br>(−4.96) |
| $\ln(D_i)$ *Distance* | −0.068<br>(−0.23) |
| $Bloc_1$ *EFTA* | 0.484***<br>(3.41) |
| $Bloc_3$ *NAFTA* | 0.357**<br>(1.97) |
| $Bloc_4$ *NON Bloc Members* | −0.236<br>(−0.43) |
| *Constant* | 11.364***<br>(3.35) |
| OBSERVATIONS | 740 |
| LOG-LIKELIHOOD | -1111.6027 |
| DEGREES OF FREEDOM | 8 |
| R-SQUARED | 0.1349 |

Note: Robust t-statistics are in parentheses below the coefficients. ***, ** and * denote significance levels of 1%, 5% and 10%, respectively.

The log-likelihood measure presented in Table 5 has a value of -1111.6027 which

is not significantly better than that found in Table 3[18].

## 7.2 FDI Decomposition by Countries of Origin

In order to continue along the same lines, my next regression focuses more specifically on the sources of FDI, by analyzing country decomposition. Thus, the next step is to estimate whether a fixed difference is identifiable between source countries of investment. Equation (7) therefore includes countries of origin, rather than focusing on trade bloc membership like in Equation (6) before.

$$
\begin{aligned}
\sinh^{-1}(FDI_{i,s,t}) & = \beta_0 + \beta_1 \ln(Y_t) + \beta_2 \ln(Y_{i,t}) + \beta_3 \ln(N_t) \qquad (7) \\
& \quad + \beta_4 \ln(N_{i,t}) + \theta_i Country_i + \varepsilon_{i,s,t}
\end{aligned}
$$

Now the fixed country is Denmark. Here the dummy variable is presented as $\theta_i$, and i runs by the source countries of investment, from $\theta_1$ to $\theta_{17}$. The regression results are presented in Table 6. Estimates for distance cannot be included in the equation, because it is fixed over time.

Overall the estimates for market size and wealth are somewhat different from the basic gravity model specification presented in Table 3, however it is not fully comparable to Table 3 since it does not include distance as one of its variables. For the same reason it cannot be regarded as a constrained version of the specification in Table 6, since Table 6 does not include distance.

As before, the wealth and market size effects obtained for GDPs and population in Table 6 indicate that the wealth tends to have positive effects on FDI. Now however, the estimates indicate that FDI is more driven by the wealth of the host country than the wealth of the source country, since only host is estimated to be significant although both are estimated to be positive. And now source country population is estimated to have positive effects on FDI, implying that when correcting for individual countries FDI is positively impacted by their market size, however

---

[18]Like before, the log-likelihood difference doubled is compared to a critical value from the chi-squared distribution. And if the critical value is lower than the double difference, then hypothesis imposing restriction is rejected as being more favourable than the unrestricted one.

not significantly.

As can be seen in Table 6, investment made by most of the 17 countries in the Table is estimated to have a non-different investment amount from the fixed country, Denmark. Three countries are estimated to invest significantly less than Denmark however, and these are Austria, Belgium and Finland.

The log-likelihood value obtained for Table 6 has a value of -1050.27 which is considerable less negative than the log-likelihood value obtained for the restricted specification presented in Table 3. However, Table 6 regressions results cannot be compared to other tables in the remaining of the paper, and hardly to Table 3, since distance is not included in Table 6. Overall, therefore, the results seem to vary somewhat depending on whether corrected for country or trade bloc effects.

## Table 6.  Fixed Country Effects

| Regressors | IHS ROBUST |
|---|---|
| $\ln(Y_t)$  Host Country GDP | 2.416** |
| | (2.16) |
| $\ln(Y_{i,t})$  Source Country GDP | 0.210 |
| | (0.13) |
| $\ln(N_t)$  Host Country Population | −5.581* |
| | (−1.68) |
| $\ln(N_{i,t})$  Source Country Population | 5.381 |
| | (1.08) |
| $Country_1$  Austria | −3.763** |
| | (−2.08) |
| $Country_2$  Australia | −8.154 |
| | (−1.53) |
| $Country_3$  United States | −21.527 |
| | (−1.38) |
| $Country_4$  Belgium | −4.914* |
| | (−1.75) |
| $Country_5$  United Kingdom | −13.851 |
| | (−1.38) |
| $Country_7$  Finland | −1.012** |
| | (−2.33) |
| $Country_8$  France | −14.829 |
| | (−1.54) |
| $Country_9$  Netherlands | −7.316 |
| | (−1.64) |
| $Country_{10}$  Japan | −18.625 |
| | (−1.51) |
| $Country_{11}$  Canada | −10.921 |
| | (−1.50) |
| $Country_{12}$  Luxembourg | 13.122 |
| | (1.27) |
| $Country_{13}$  Norway | 0.654 |
| | (0.84) |
| $Country_{14}$  Spain | −12.531 |
| | (−1.44) |
| $Country_{15}$  Switzerland | −1.601 |
| | (−1.53) |
| $Country_{16}$  Sweden | −3.606 |
| | (−1.61) |
| $Country_{17}$  Germany | −16.071 |
| | (−1.47) |
| Constant | −2.571 |
| | (−0.26) |
| OBSERVATIONS | 740 |
| LOG-LIKELIHOOD | -1050.27 |
| DEGREES OF FREEDOM | 20 |
| R-SQUARED | 0.2671 |

Note: Robust t-statistics are in parentheses below the coefficients.  ***, ** and * denote significance levels of 1%, 5% and 10%, respectively.

# 8 Sources and Allocation of FDI

## 8.1 Fixed Sector and Trade Bloc Effects Determined

I now proceed by simultaneously taking into account sources and allocation of FDI. The analysis will start by providing decomposition of investment into the main investment sectors and country membership into various trade blocs. This is done for the purpose of determining whether it is possible to determine fixed difference between individual sectors on one hand, and individual trade blocs on the other hand. These effects will be estimated simultaneously. I start by looking at the least restricted version of the equation, after looking at the basic specification including the variables most commonly used in the gravity model. The results for estimating Equation (8) are presented in Table 7.

$$\sinh^{-1}(FDI_{i,s,t}) \;=\; \beta_0 + \beta_1 \ln(Y_t) + \beta_2 \ln(Y_{i,t}) + \beta_3 \ln(N_t) + \beta_4 \ln(N_{i,t}) \quad (8)$$
$$+\beta_5 \ln(D_i) + \gamma_k Sector_k + \pi_n Bloc_n + \varepsilon_{i,s,t}$$

In Equation (8) the fixed effects technique is applied once more. The sector dummy $Sector_k$ runs over sectors where $k = 1, 2, ...4$. However, the bloc dummy $Bloc_n$, runs over trade blocs where $n$=1,2,...4. The fixed term can therefore be presented as being $\beta_0 + \gamma_k + \pi_n$ and the error term as being $\varepsilon_{i,s,t}$. Here $\pi_n$ is a constant, accounting for trade bloc specific effects as before, $Sector_k$ is a constant accounting for sector specific effects, and $\varepsilon_{i,s,t}$ randomly distributed. There are three possibilities available when the results for Equation (8) are analyzed. First it is possible to set $\beta_0 = 0$ and $\pi_n = 0$, and second to set $\beta_0 = 0$ and $\gamma_k = 0$. Thirdly, it is possible to set $\pi_n = 0$ and $\gamma_k = 0$. Here it is presumed that $\gamma_3 = 0$ (coefficient for T&T sector) and $\pi_2 = 0$ (EU bloc). Therefore the regression results obtained for the dummy variables combined can be interpreted as the "deviation" from the T&T sector and the EU bloc.

Taken together, the results in Table 7 indicate that both the host and source countries total wealth (measured as GDPs) are estimated to have significant and

positive effects on FDI. However, the population variables continue to have signs different from what is typically found, with the source country population having a significant value.

When both sector and bloc fixed effects are included simultaneously, the sector dummy captures difference between that sector and T&T regardless of bloc. Similarly, the bloc coefficient indicates the average of FDI from a bloc across all sectors. The sector effects estimates indicate that all the sectors are estimated to have a significantly higher share of FDI than the Telecom & Transport sector. Moreover, when keeping the EU trade bloc fixed, the EFTA and NAFTA blocs are estimated to be positively and significantly different from the EU.

## Table 7. Fixed Sector and Trade Bloc Effects

| Regressors | IHS ROBUST |
|---|---|
| $\ln(Y_t)$  *Host Country GDP* | 2.189**<br>(2.44) |
| $\ln(Y_{i,t})$  *Source Country GDP* | 1.053***<br>(5.54) |
| $\ln(N_t)$  *Host Country Population* | −2.127<br>(−0.84) |
| $\ln(N_{i,t})$  *Source Country Population* | −0.892***<br>(−5.13) |
| $\ln(D_i)$  *Distance* | −0.068<br>(−0.24) |
| *Sector$_1$  Power Intensive Ind.* | 0.575***<br>(5.29) |
| *Sector$_2$  Comm. and Fin. Ind.* | 0.649***<br>(6.58) |
| *Sector$_4$  Other Industries* | 0.435***<br>(5.32) |
| *Bloc$_1$  EFTA* | 0.484***<br>(3.57) |
| *Bloc$_3$  NAFTA* | 0.357**<br>(1.99) |
| *Bloc$_4$  NON Bloc Members* | −0.236<br>(−0.45) |
| *Constant* | 10.949***<br>(3.34) |
| Observations | 740 |
| Log-Likelihood | -1091.20 |
| Degrees of Freedom | 11 |
| R-Squared | 0.1814 |

Note: Robust t-statistics are in parentheses below the coefficients. ***,
** and * denote significance levels of 1%, 5% and 10%, respectively.

One of the interesting things about the results in Table 7 is that the distance variable is estimated to be insignificant, although negative as in all previous regressions except for the Table 5 estimates. What is common with the regression in Tables 5 and 7 is that both of these incorporate sector specific effects. Taken together the results for Tables 5 and 7 therefore indicate that the distance to member countries of individual trade blocs are similar within each bloc and therefore

accounted largely for by fixed trade bloc effects.

A comparison of the R-squared value in Table 7 to that in Table 3 indicates that the regression applied in Table 3 does marginally better in explaining the data. Comparisons of log-likelihoods yields a similar story. However, as before, the log-likelihood ratio tests finds that this difference is not statistically significant.

# 9 Conclusion

The main objective of this paper is to analyze whether the low foreign direct investment FDI can be explained by the gravity model, by means of market sizes and distance. The results indicate that FDI is negatively affected by distance, and generally negatively affected population of the host and source country, but positively affected by their gross domestic products (GDPs). Taken together, these opposite signs estimates for GDPs and population indicate that FDI is possibly affected by distance and wealth, rather than market size.

Estimation of sector specific effects indicates that when corrected for distance, as well as wealth and market size, multinationals have higher incentive to invest in the "power intensive" sector, the "commerce and finance" sector and the "other industries" sector relative to the "Telecom and transport" sector. Furthermore, when compared to the EU trade bloc member countries, member countries of EFTA and NAFTA are estimated to be more interested in investing in Iceland. However, countries outside of trade blocs (non member countries) are estimated to have less incentive for investing in Iceland than the EU member countries. Finally, overall country effects estimates indicate that in most cases countries do not invest significantly less or more than the fixed country Denmark. However out of the 17 source countries, 3 countries (Austria, Belgium and Finland) are estimated to invest significantly less than Denmark, when corrected for market sizes.

An interesting topic for future research would be to analyze how foreign direct investment in Iceland is affected by factor endowments such knowledge capital, in order to better explain the driving forces of FDI and more closely determine whether FDI tends to be vertical rather than horizontal in nature.

# Appendix A.

This appendix exhibits several variants of the gravity model specification, based on whether the dependent variable is presented in natural logarithms, or as subject to the hyperbolic sine function. Moreover, the results from taking clustering observations are also taken into account. The clusters are formed based on sectors.

The regression results in the fifth column in Table 8 are derived from (time series) data running over countries and years, not sectors like before. When these are estimated they provide results consistent with the ihs results in column three. Therefore, these results back up results for the basic ihs regression.

**Table 8.  Various Regressions of the Basic Specification**

| Regressors | (1) Cluster ihs robust | (2) ihs robust | (3) ihs | (4) ln | (5) New Data ihs |
|---|---|---|---|---|---|
| $\ln(Y_t)$ | 2.085*** (3.20) | 2.085** (2.23) | 2.085** (2.21) | 5.375 (1.47) | 3.579 (1.51) |
| $\ln(Y_{i,t})$ | 1.143** (2.25) | 1.143*** (7.00) | 1.143*** (7.44) | 4.561*** (6.27) | 3.581*** (10.69) |
| $\ln(N_t)$ | −2.975* (−1.84) | −2.975 (−1.14) | −2.975 (−1.09) | −28.821** (−2.41) | −7.579 (−1.13) |
| $\ln(N_{i,t})$ | −0.976** (−2.00) | −0.976*** (−6.29) | −0.976*** (−6.74) | −4.060*** (−6.14) | −3.171*** (−9.72) |
| $\ln(D_i)$ | −0.235 (−1.55) | −0.235*** (−4.67) | −0.235*** (−3.09) | −1.273*** (−2.74) | −0.609*** (−4.08) |
| $Const.$ | 9.166*** (3.20) | 9.166*** (3.32) | 9.166*** (3.67) | −4.309 (−0.50) | 17.471*** (2.61) |
| Obs | 740 | 740 | 740 | 239 | 185 |
| R-Sq | 0.1028 | 0.1028 | 0.1028 | 0.1373 | 0.3710 |
| Clust | 68 | | | | |
| LL | | -1125.1015 | -1125.1015 | -539.22888 | -320.5548 |
| DoF | | 5 | 5 | 5 | 5 |

Note: Robust t-statistics are in parentheses below the coefficients. ***, ** and * denote significance levels of 1%, 5% and 10%, respectively.

# 10 Appendix B. Investment Definitions.

Here are some investment definitions by the World Bank, IMF and the OECD.

"**Foreign direct investment (FDI)** is net direct investment that is made to acquire a lasting management interest (usually 10 percent of voting stock) in an enterprise operating in a country other than that of the investor (defined according to residency). The investor's purpose is to be an effective voice in the management of the enterprise. FDI is the sum of net equity capital, net reinvestment of earnings, net other long-term capital, and net short-term capital as shown in the balance of payments" (World Bank, 2001, CD-ROM).

"**Direct investment** is the category of international investment that reflects the objective of a resident entity in one economy (direct investor) of establishing a lasting interest in an enterprise (the direct investment enterprise) resident in another economy. "Lasting interest" implies the existence of a long-term relationship and a significant degree of influence by the direct investor on the management of the direct investment enterprise. Direct investment involves both the initial transaction between the two entities and all subsequent capital transactions between them and among affiliated enterprises, both incorporated and unincorporated" (Falizoni, 2000, p. 4).

"**A direct investor** is defined as an individual, an incorporated or unincorporated public or private enterprise, a government, a group of related individuals, or a group of related incorporated and/or incorporated enterprises which have a direct investment enterprise that is, a subsidiary, associate or a branch, operating in a country other than the country or countries of residence of the direct investor(s)" (Falizoni, 2000, p. 4).

"**A direct investment enterprise** is defined as an incorporated or unincorporated enterprise in which a foreign investor owns 10% or more of the ordinary shares or voting power of an incorporated enterprise or the equivalent of an unin-

corporated enterprise. Ownership of 10 percent or more of the ordinary shares or voting stock is the guideline for determining the existence of a direct investment relationship. An "effective voice in the management", as evidenced by at least 10 percent ownership, implies that a direct investor is able to influence, or participate in, the management of an enterprise; absolute control by a foreign investor is not required. Direct investment enterprises may be subsidiaries, associates and branches" (Falizoni, 2000, p. 4).

"**Foreign direct investment flows** are made of three basic components:

- equity capital: comprising equity in branches, all shares in subsidiaries and associates (except non-participating, preferred shares that are treated as debt securities and are included under other direct investment capital) and other capital contributions such as provisions of machinery etc...

- reinvested earnings: consisting of the direct investors's share (in proportion to direct equity participation) of earnings not distributed, as dividends by subsidiaries or associates and earnings of branches not remitted to the direct investor.

-other direct investment capital (or inter company debt transactions): covering the borrowing and lending of funds, including debt securities and trade credits, between direct investors and direct investment enterprises and between two direct investment enterprises that share the same direct investor" (Falizoni, 2000, p. 4-5).

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