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The Knowledge-Capital Model and Small Countries

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The Knowledge-Capital Model and Small Countries*

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Abstract

In this paper, Knowledge-Capital model estimates for a small country are compared to estimates obtained for larger economies. The model is based on unique panel data on foreign direct investment in Iceland. Estimates obtained for the Knowledge-Capital model differ considerable from what has been obtained in earlier research, indicating that the driving forces behind foreign direct investment in small countries appear to be different from those in large countries.

Keywords: Foreign Direct Investment, Knowledge-Capital
JEL Classifications Codes: F21, F23

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1 Introduction

With increased data availability, empirical research on foreign direct investment (FDI) has grown as well. Among the approaches used by researches, the knowledge capital model presented by Carr, Markusen and Maskus(CMM, 2001) has moved to the forefront. The main advantage of this framework is that it is based on the theory of the multinational enterprise as discussed by Markusen (2002). In particular, this specification adds information on endowments of skilled labor to the traditional set of explanatory variables such as country size and trade costs. I apply the CMM specification to a unique panel of Icelandic FDI data and find estimates to differ considerably from those found by CMM and other researchers. In particular, my results for the skill labor measures run contrary to earlier findings. These results may be due to differences between the large country data used by other researchers, or that the CMM specification encounters data difficulties when the there is a lot of difference in source and host country gross domestic products.

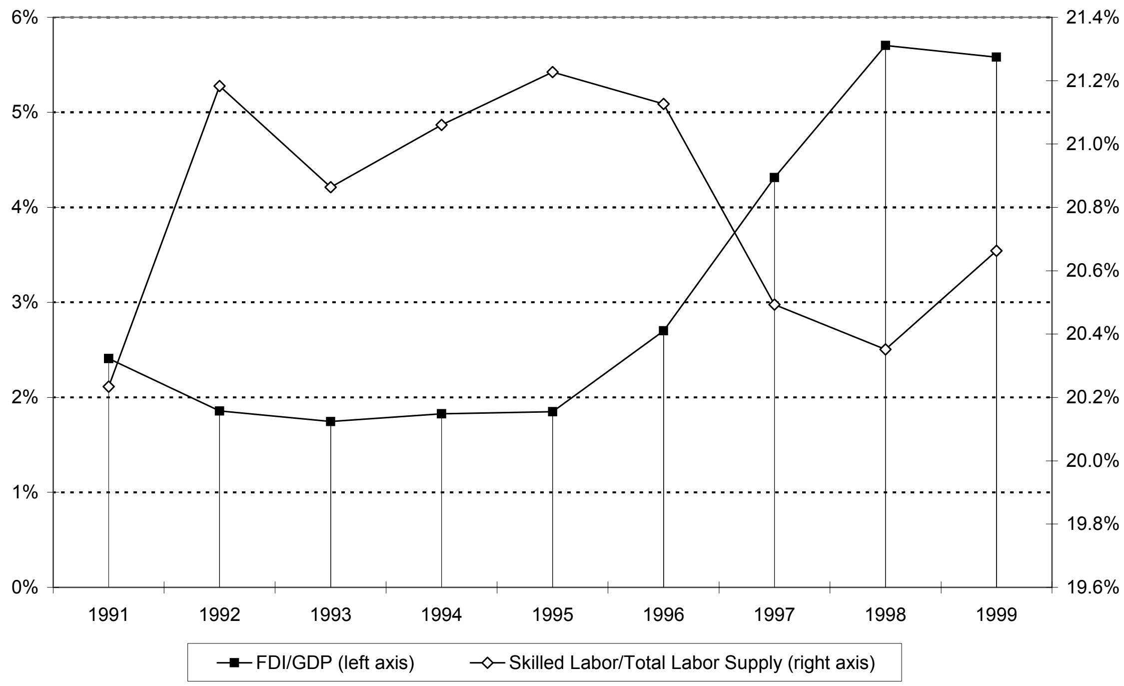
Multinational enterprises are firms that engage in activities transnationally, either by establishing subsidiaries or directly investing in foreign firms. The functionality of directly investing in foreign firms has been referred to as foreign direct investment in those cases where MNEs have a controlling stock in firms. Normally, a controlling stock refers to the interest in acquiring a lasting management interest ownership of 10% or more in a firm. This type of international capital investment has often been referred to as greenfield investment, or mergers and acquisitions. In this paper, the issue of concern is FDI stock in Iceland. This is measured as gross FDI and is equal to the total amount of FDI coming into Iceland, without subtracting outward FDI.

The general belief is that the flow of foreign direct investment is primarily from North to South, in other words, from the industrialized countries of the 'North' to the less developed world in the 'South'. This is however not the case since most of FDI takes place between the more developed countries and therefore the flow of FDI is primarily between the East and West, rather than from North to South. In

1999, the developed countries accounted for 74% of world FDI inflows and 91% of outflows, whereas the developing countries accounted for 24% of world inflows and 8% of outflows. The Central and the Eastern European countries accounted for only 1% of world FDI inflows (Markusen, 2002, pp. 9).

Figure 1 shows the development of two ratios in Iceland: the FDI/GDP ratio and skilled labor as a ratio of total labor supply. More specifically, the skilled labor is measured as "professional, technical, kindred, and administrative workers" classified as the sum of occupational categories 0/1 and 2 by the International Labor Organization (ILO). The relationship between the two ratios appears to be inverse, however the observations for skilled labor supply on the right side axis only vary over a narrow range. Since skilled labor is a key variable in other FDI studies, one of the main objectives of this paper is to analyze the relationship between skilled labor and FDI in Iceland. This will be done in order to determine how FDI is affected by skilled labor in small countries like Iceland, relative to other countries.

Figure 1: Development of FDI Stock and Skilled Labor in Iceland.



Source: World Bank, Central Bank of Iceland and the ILO.

Foreign direct investment is said to be horizontal when multinationals operate analogous corporate activities in different countries. A typical example of that would be a company like McDonald's. Generally, horizontal FDI is likely to take place between the developed countries of similar size and relative endowments. FDI is said to be vertical when multinationals place corporate facilities in different countries; this is often done to exploit differences in factor prices by gaining access to cheap raw materials.

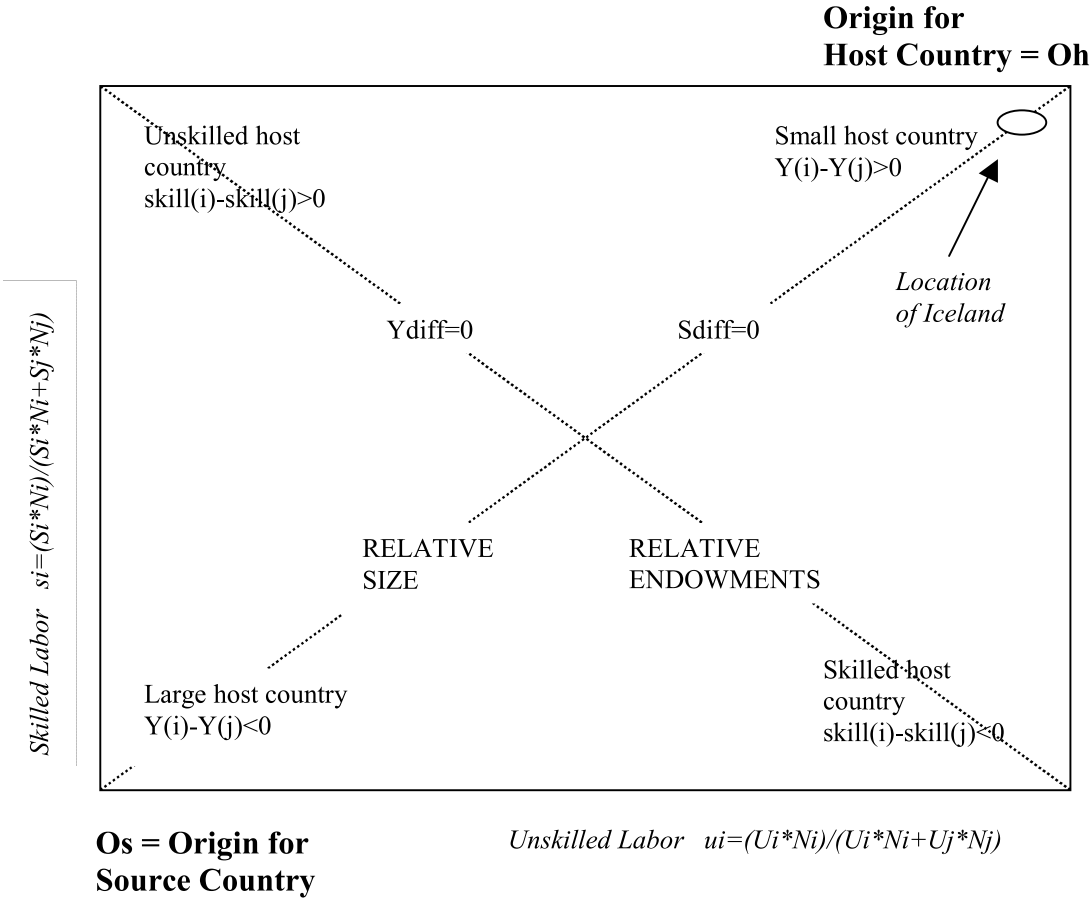
The literature on multinational enterprises and foreign direct investment is relatively recent. The models on horizontal FDI by Markusen (1984) and vertical FDI by Helpman (1984) have been widely used when explaining FDI. In a paper combining the main features of the vertical and horizontal models, Markusen, Venables, Konan, and Zhang (1996) laid the basis for the Knowledge-Capital (KK) model. The KK model draws its name from the fact that intangible assets such as human capital are sometimes referred to as knowledge-capital. One of the main features of the KK model is that it explains how investment decisions of multinationals are affected by the difference of skilled-labor in the source and host country. Further research by Carr, Markusen, and Maskus (CMM, 2001) presented an empirical specification of the model, hereafter referred to as the CMM specification. CMM (2001) tested their econometric specification on a sample representing bilateral activities of US multinationals in a range of countries. However, the KK model has not yet been tested for small economies such as Iceland. Iceland is not only an interesting case because of its small size and how distant it is from other countries, but also because it is generally believed to be relatively skilled-labor abundant.

CMM (2001) observe FDI to be strictly increasing in the skill differences between the source and the host country. However, more recent estimates obtained by Blonigen, Davies, and Head (2002) indicate that FDI is increasing in negative skill differences, but decreasing in positive skill differences. Blonigen et al. estimates indicate that a relative increase in source skillness compared to host will increase FDI in cases when source is more skilled than host, but decrease FDI in cases when host is more skilled than source. They therefore conclude that the Markusen

(1984) model on horizontal MNEs cannot be rejected in favor of the KK model. In a more recent paper, Davies (2002) estimation results indicate that FDI is increasing in negative skill differences, decreasing in slightly positive skill differences, and increasing again as skill differences become more highly positive. According to the Davies (2002) specification, the KK model cannot be rejected in favor of the horizontal model. Finally, Braconier, Norbäck, and Urban (2003) report that they find support for the KK model, basing their estimates on a much richer database on factor prices than used in comparable studies. They conclude that in previous studies, the mapping from theory to empirics has suffered from a poor data coverage.

Figure 2 exhibits an Edgeworth Box based on the theory behind the Knowledge-Capital model. The idea behind this box is to relate the countries' size to their relative endowments. Being a small host country, Iceland is expected to be positioned in the northeast corner of the Edgeworth Box. In the northeast corner, the difference between the source and the host countries GDPs is positive given that the host country is much smaller than the source country.

Figure 2: World Edgeworth Box



Moreover, since Iceland is generally believed to be well endowed with skilled labor, it is presumed to be in the northeast corner on the SW-NE diagonal in the Edgeworth Box. This is due to the fact that on the east side of the diagonal, the host country is better endowed with skilled labor relative to the source country. However, actual data on job categories indicate that Iceland is not necessarily more skill abundant relative to the source countries. Therefore, Iceland appears to be located farther to the northeast than host countries used in empirical studies generally are, and on both sides of the SW-NE diagonal. The location of Iceland as a host country is better exhibited in Figures 3 and 4 in Appendix A.

This paper is based on unilateral data of inward FDI stock in Iceland. The approach to the use of unilateral data on FDI is somewhat similar to a paper by Markusen and Maskus (1999) on outward FDI. Another analogous example would be Brainard (1997), in which she estimated separately inward and outward FDI proxies by shares of total foreign sales. The data in this paper cover foreign direct investment in Iceland from 1989 to 1999. The data are unique in that they have not been used before, and so is the approach in the sense that it has never before been applied to such a small country. Therefore, it is of particular interest to analyze how the CMM specification of the KK model applies to Iceland, and to consider the theoretical intuition behind the results. Several variations of the CMM specification are also estimated, including the Davies (2002) specification.

This paper is organized as follows. Section 2 includes a literature review and the model specification. Data are presented in Section 3. Section 4 provides estimation results for some specification restrictions. Section 5 gives an overview of the impacts from removing large outliers from the sample. Section 6 shows the results from increasing the number of observations, whereas Section 7 examines the effects of changing the skilled-labor abundance proxy. In Section 8, the results from applying the Davies (2002) empirical specification are reported. Finally, conclusions are presented in Section 9.

2 The KK Model

2.1 Related Literature

In the beginning of the 1980s, the so-called "New Trade Theory" was added to the conventional international economic literature. Models of the New Trade Theory incorporate imperfect competition, increasing returns to scale, and product differentiation in both general and partial equilibrium models of trade (CMM, 2001, pp.693). An important contribution to the literature was made by Paul Krugman in 1979. Later, the literature on Economic Geography developed, beginning again with Krugman (1991) explaining industry agglomeration within regions and countries.

There has been a growing literature on foreign direct investment made by multinational enterprises. Until recently, foreign direct investment has mainly been incorporated into two general-equilibrium models. These are the model on vertical FDI presented by Helpman (1984) and the model on horizontal FDI by Markusen (1984). FDI is said to be vertical when MNEs choose to facilitate their operations in different geographic locations depending on the stage of production. However, horizontal FDI takes place when MNEs locate analogous activities in different countries[1]. In Helpman's (1984) model, the incentive for vertical FDI is the difference in relative factor endowments. On the other hand, Markusen (1984) assumes that FDI is dominated by horizontal MNEs when countries are similar in size as well as in relative endowments, and trade costs are moderate to high[2]. The main features of the horizontal and vertical models are combined in the Knowledge-Capital (KK) model of the multinational in the paper by Markusen, Venables, Konan, and Zhang (1996). In addition, an econometric specification of the KK model was introduced by Carr, Markusen, and Maskus (CMM, 2001). Different empirical specifications of the KK model have been developed by Bloningen, Davies, and Head (BDH, 2002)

[1] More related literature on multinational firms can be found in Markusen (2002).

[2] Aggregate data has shown the developed countries to be the main source as well the main recipient countries of foreign direct investment (Markusen, 2002).

as well as Davies (2002).

By using an empirical specification slightly different from that of CMM and running regressions on subsamples of the data, BDH find evidence for a decrease in FDI when skill differences are positive and increasing. Therefore, BDH conclude that the horizontal model by Markusen (1984) cannot be rejected in favor of the KK model[3]. An alternative empirical specification of the KK model is put forward by Davies (2002)[4]. The specification applied by Davies finds FDI not to be strictly decreasing in positive skill differences, but that the relationship is non-monotonic. Davies therefore finds evidence supporting the KK model. Finally, Braconier, Norbäck, and Urban (BNU, 2003) test the CMM specification with a much richer dataset than has been used in earlier research. The results they observe from using the CMM specification are found to yield results much like the simulations in the CMM paper. BNU therefore conclude that strong support is found for the KK model. More specifically, by using data on factor prices instead of endowments, they find support for the CMM specification of the KK model. The findings obtained earlier give a motivation to analyze how the CMM specification of the KK model predicts for small countries.

[3] Estimates obtained for the horizontal model indicate that FDI is decreasing in positive skill differences.

[4] In his paper, Davies (2002) finds that while horizontal FDI is decreasing in positive skill differences, vertical FDI is increasing.

2.2 Theoretical Framework of the KK Model

The idea behind the CMM (2001) paper on the KK model is to translate trade theories into simulations[5] relating foreign direct investment to economic size and relative endowments. The paper is referred to by authors as the knowledge-capital model of the multinational enterprise. In the paper the authors apply industrial organization approach to international trade allowing for determination of how industry characteristics interact with country characteristics.

The knowledge-capital model specification estimated here is primarily based on three assumptions[6]. The first assumption implies that it is possible to geographically separate services referred to as knowledge-based and knowledge-generating activities from production. These would be services like research and development. Moreover, this first assumption implies that it is cheap to supply these services to production facilities. The second assumption is that knowledge-demanding activities require relatively a lot of skilled labor. Together, the first and second assumption allow[7] for vertical activities, implying that R&D are located where skilled labor is available at low cost, but production location favored close to cheap unskilled labor. Production is also drawn to locations where firms can exploit economies of scale in production plants. The third main assumption implies that the type of services defined in the first assumption can be used simultaneously in various locations. The third assumption allows for scale economies at firm level and gives an incentive for horizontal multinational activity, implying production in different geographical locations.

The model is based on a world with two countries, two factors and two goods. The countries are here referred to as source and host[8]. The two factors are internationally immobile factors, skilled and unskilled labor. The two goods in the

[5] The numerical simulation procedure applied in the CMM (2001) paper is better demonstrated in Markusen et al. (1996) and Markusen (1997).

[6] See more on the KK model in (CMM, 2001, pp. 694) and in (CMM, 2003).

[7] "allow" rather than "induce" is used for "create a motive for"...

[8] The countries are either referred to as source and host or as home and foreign, the latter labelling is applied in the CMM (2001) paper.

model are labelled x and y, and are different in nature. The characteristics of good x are such that x is skilled-labor intensive and enjoys increasing returns to scale (IRS) under the conditions of Cournot competition, with the possibility of having individual plants geographically separated from headquarters. However, the second good y, is subject to constant returns to scale (CRS) and is labor-intensive.

In this model structure there are six firm types and the model allows for free entry and exit in and out of firm types. Firms are either horizontal, vertical or national. The horizontal multinationals H_h (H_f) are firms producing in the source and host country, with headquarters in the source country. The national firms N_h (N_f), are firms with headquarters and production in the source (host) country only, which may export to the other country. Vertical multinationals V_h (V_f), are those with single plant in the host and headquarters in the source country, with export possible to the source country.

The assumptions presented in the knowledge-capital model drawn from Markusen and Venables (1986) paper and Markusen (1987) are that horizontal multinationals H_h will be dominant in the source country if source and host are similarly endowed and similar in size, and trade costs are moderate or high. However, vertical multinationals V_h will be dominant in the source country in cases when source is small, relatively skilled labor abundant and trade costs are not extreme. Finally, national firms N_h will be dominant under conditions where source is large and skilled labor abundant, source and host are of similar size and similarly endowed and trade costs are low, or in cases where barriers to foreign direct investment are high in the host country.

The simulation results obtained for the KK model allow for development of predictions about volume of production of various firm types. In the empirical regressions estimated in the following sections, the two countries are labelled as source and host, referring to the citizenship of a particular multinational.

2.3 The Basic Empirical Specification Applied

The KK model is primarily based on the assumptions of Economic Geography, since the model balances closeness to consumer markets with market size to achieve economies of scale (Krugman, 1983; Horstman and Markusen, 1992; Brainard, 1993). In the model, closeness to consumers is proxied by distance, and market size is proxied by GDP. The KK model is also based on the foundations of the Heckscher-Ohlin theorem[9] by applying the *factor proportions hypothesis* when using skill differences as a proxy for differences in relative factor endowments.

$$\begin{aligned} \mathrm{FDI}_{ij,t} &= \beta_0 + \beta_1 \mathrm{YSUM}_{ij,t} + \beta_2 \mathrm{YDIFF}^2_{ij,t} + \beta_3 \mathrm{SDIFF}_{ij,t} \\ &\quad + \beta_4 \mathrm{YDIFF}_{ij,t} * \mathrm{SDIFF}_{ij,t} + \beta_5 \mathrm{INVC}_{j,t} + \beta_6 \mathrm{TC}_{j,t} \\ &\quad + \beta_7 \mathrm{TC}_{j,t} * \mathrm{SDIFF}^2_{ij,t} + \beta_8 \mathrm{TC}_{i,t} + \beta_9 \mathrm{DIS}_{ij} + \varepsilon_{ij,t} \end{aligned} \tag{1}$$

The basic model specification estimated in this paper is introduced in Equation (1). In the equation above, the following relationship holds: $E[\varepsilon_{i,t} \mid x_{i,t}] = 0$ which means that the error term ($\varepsilon_{i,t}$) is independent of the explanatory variables ($x_{ij,t}$). A more careful description of the variables in the model is provided in Table 1 below.

In this paper, a Tobit procedure is also used, and here this procedure implies a threshold with a lower limit of zero, so that[10]

$$\begin{aligned} FDI^{TOBIT}_{ij.t} &= FDI_{ij.t} \quad if \quad FDI_{ij.t} > 0 \\ FDI^{TOBIT}_{ij.t} &= 0 \quad if \quad FDI_{ij.t} \leq 0 \end{aligned} \tag{2}$$

The dependent variable $\mathrm{FDI}_{ij,t}$ is defined as foreign direct investment going from country (i) to country (j) at time (t). More specifically, FDI is measured as stock of

[9] The proposition of the Heckscher-Ohlin Model implies that countries will export goods that use relatively intensively their relatively abundant factors.

[10] James Tobin (1959).

investment[11]. This variable measures the FDI made in the host country by various source countries over time. The subscript (i) denotes the source country, running from 1 to 23, the subscript (j) refers to the host country Iceland, and time is denoted by (t). The first two explanatory variables, $\text{YSUM}_{ij,t}$ and $\text{YDIFF}^2_{ij,t}$ are inserted to represent economic size and size differences. The first variable, $\text{YSUM}_{ij,t}$, accounts for the joint market size of host and source countries, proxied by the sum of the countries' GDP. Here $\text{YSUM}_{ij,t}$ is used to represent the aggregate economic size of the source and host country, since investment is expected to increase with the size of the host and source countries. More FDI is expected to take place between large economies, and therefore the variable coefficient is expected to have a positive sign. The second explanatory variable, $\text{YDIFF}^2_{ij,t}$ is defined as the GDP of the source country minus the GDP of the host country, squared. The squared economic size difference is used here rather than plain difference to reflect the absolute difference in the size of the countries. $\text{FDI}_{ij,t}$ is expected to decrease with an increase in squared size differences, and therefore the $\text{YDIFF}^2_{ij,t}$ coefficient is expected to be negative. This is true because FDI is expected to be increasingly trending downward as a function of $\text{YDIFF}_{ij,t}$. More specifically, the $\text{YDIFF}^2_{ij,t}$ term is symmetric around zero. From there it follows that $\text{FDI}_{ij,t}$ is biggest around the zero point, but decreases on either side of zero. This term is included to capture horizontal FDI, since horizontal FDI is believed to decrease as the source and host country become dissimilar in size.

The $\text{SDIFF}_{ij,t}$ variable is included in the model specification to capture differences in skilled labor endowments between the source and host country. $\text{FDI}_{ij,t}$ is expected to increase as skill differences increase, that is when the source country becomes more skilled than the host country. Therefore the $\text{SDIFF}_{ij,t}$ variable is expected to have a positive sign. Horizontal investment is expected to be the greatest between equally skilled countries; that is, when skill differences between the source and the host country are zero.

[11] The Central Bank of Iceland defines foreign direct investment (FDI) as solely investment in business activities, not including investment in real estate.

Table 1. Variable Definition for the Basic Sample

Variable		Predicted signs
$\text{FDI}_{ij,t}$	Foreign direct investment made by the source country (i) in the host country (j), over time (t).	
$\text{YSUM}_{ij,t}$	The sum of the Gross Domestic Product (GDP) of the source country (i) and the GDP of the host country (j), over time (t).	+
$\text{YDIFF}^2_{ij,t}$	The GDP of the source country (i) minus the GDP of the host country (j), squared over time (t).	−
$\text{SDIFF}_{ij,t}$	Skilled labor in the source country (i) minus skilled labor in the host country (j), over time (t).	+
$\text{YDIFF}_{ij,t}*\text{SDIFF}_{ij,t}$	Interation term, capturing the interaction between the GDP difference of the source and host countries and the skill difference variable, over time (t).	−
$\text{INVC}_{j,t}$	The investment cost foreign investors are faced with when investing in the host country (j), over time (t).	−
$\text{TC}_{j,t}$	Trade costs in the host country (j), over time (t).	+
$\text{TC}_{j,t}*\text{SDIFF}^2_{ij,t}$	Interaction term, capturing interaction between trade costs in the host country and squared skill differences, over time (t).	+
$\text{TC}_{i,t}$	Trade cost in the source country (i), over time (t).	−
DIS_{ij}	Geographical distance between the source country (i) and the host country (j).	−

The interaction term $\text{YDIFF}_{ij,t}*\text{SDIFF}_{ij,t}$ is included in the model to account for interaction between $\text{YDIFF}_{ij,t}$ and the differences in skilled labor endowments, $\text{SDIFF}_{ij,t}$. The interaction term is intended to reflect how much skill differences $\text{SDIFF}_{ij,t}$ matter, depending on where countries are located in the Edgeworth box. In other words, the idea is that the interaction term captures the importance of differences in the level of skilled labor in the source and host country, depending on how much they differ in size. Skill differences between similarly sized countries are not expected to weigh as much as those between dissimilarly sized countries. Therefore, FDI is expected to decrease with an increase in $\text{YDIFF}_{ij,t}$, yielding a negative expected coefficient.

The variable $\text{INVC}_{j,t}$ capturing investment costs, is used as a proxy for investment barriers facing investors entering the host country. The $\text{INVC}_{j,t}$ variable is an index calculated from a range of other indices. The investment cost index runs from zero to 100 with higher numbers indicating higher investment costs. An increase in the investment costs variable in the host country is expected to reduce inward FDI and therefore the investment cost has a negative predicted coefficient.

The two indices for trade costs are intended to reflect the protectionist stance of each country's trade policy. More specifically, trade costs are defined as national protectionism accounting for whether foreign products and services are prevented from being imported. Therefore, as the value of the variable representing trade costs $\text{TC}_{j,t}$ increases, the host country (Iceland) is more prone to prevent foreign products and services from being imported. This also applies to the trade costs index calculated for source countries, the $\text{TC}_{i,t}$ index. Higher trade barriers in the host country are expected to aid $\text{FDI}_{ij,t}$, since MNEs in the source countries have more incentives to invest in, rather than export to, a host country with high trade barriers. Higher trade barriers in the source country, $\text{TC}_{i,t}$, are expected to reduce FDI. This is because higher trade barriers in the source country are believed to reduce the source country's incentives to invest in the host country in order to export back home. Therefore, the coefficient of the latter trade variable is expected to be negative.

Moreover, the interaction between trade and skill differences is captured by an interaction term, $\text{TC}_{j,t} * \text{SDIFF}^2_{ij,t}$, which is expected to have a positive coefficient sign. The coefficient sign is expected to be positive since it represents the effects of skill differences changes on the marginal effect of host trade costs on FDI. As mentioned before, FDI is expected to increase with an increase in trade cost in the host, since the MNEs have more incentive to invest in the host rather than export to the host. The interaction term indicates that the squared skill term magnifies the effects of the host's trade cost, which increase its marginal effects. Furthermore, a geographical distance variable, denoted as DIS_{ij}, is included to reflect proximity to customers. The distance variable is expected to have a negative coefficient. The use of distance as a proxy for transport costs is well established in the gravity model by Bergstrand (1985).

3 Data

The data used in this paper cover overall foreign direct investment (FDI) in Iceland over the 1989-1999 period. The following countries are the source countries of foreign direct investment: Austria, Australia, Belgium, Canada, Chile, Denmark, Faeroe Islands, Finland, France, Germany, Gibraltar, Israel, Japan, the Netherlands, Norway, Latvia, Luxembourg, Russian Federation, Spain, Sweden, Switzerland, the United Kingdom and the United States. The data on FDI are obtained from the Central Bank of Iceland.

Foreign direct investment, $\text{FDI}_{ij,t}$, is measured as inward FDI, in millions of US dollars at 1995 prices. Here the accumulated stock of FDI is used rather than flows, since FDI stocks are generally believed to carry information about investment incentives from the past to the present, i.e. accumulated changes in investment up to the current year. In their paper, CMM use affiliate sales. However, FDI stock is used here since it is believed to better reflect long-term strategies of MNEs. Similar to FDI flows, affiliate sales are subject to short-term, rather than long-term objectives of MNEs operations. Advantages of using FDI stock, rather than affiliate sales, are well explained in a paper by Davies (2002).

The FDI stock data used are obtained in millions of Icelandic Kronur and converted to US dollars using the World Bank dollar exchange rate, and then put on a 1995 level by a World Bank GDP deflator. Thus, the FDI values become comparable to the variable values on the right-hand side of the model, since the host and the source country GDP values are obtained in 1995 US dollars.

Data for the first two explanatory variables, $\text{YSUM}_{ij,t}$ and $\text{YDIFF}^2_{ij,t}$, are based on the host and source countries' GDP, taken from the World Bank data base[12]. These GDP data are obtained from the World Bank in constant 1995 USD values, but the variables are presented in trillions[13] of USD. Data on GDP in Germany in 1989

[12] With the exception of data on GDP in the Faeroe Islands being obtained from the National Economic Institute of Faeroe Islands (Hagstova Føroya). The GDP data is obtained in Danish kronur and then converted into 1995 US dollars, using IMF exchange rate and a World Bank GDP deflator.

[13] Trillion is defined as a million million.

and 1990 are not included here because these are the years before the unification of Germany.

The data used for the skilled labor endowments, $\text{SDIFF}_{ij,t}$, are identical to those used by CMM[14]. These data are obtained from the International Labor Organization (ILO)[15] as the sum of occupational categories 0/1 and 2; where category 0/1 accounts for professional, technical, and kindred workers, and category 2 for administrative workers. Moreover, the skilled labor ratio is calculated as the sum of categories 0/1 and 2, divided by the sum of all occupational categories. The skilled labor ratio is used as a proxy for relative skilled labor abundance. The ILO data on skilled-labor in Iceland are available for the nine-year period, 1991-1999.

The indices for trade and investment costs and calculated in the same way as in the CMM paper[16]. The data used for the $\text{INVC}_{j,t}$ index here are also analogous to the data used in the CMM paper[17]. The index for investment costs is calculated using the following indices: restrictions on the ability to acquire control in a domestic company, limitations on the ability to employ skilled labor, restraints on negotiating joint ventures, strict controls on hiring and firing practices, the absence of a fair administration of justice, difficulties in acquiring local bank credit, restrictions on access to local and foreign capital markets, and inadequate protection of intellectual property. The resulting investment index runs on a scale from zero to 100, with a higher number indicating higher investment costs. The trade costs variable of the host country is presented as $\text{TC}_{j,t}$, while the source country trade

[14] I greatly appreciate that David Carr and Keith Maskus provided me with the data used in the (CMM, 2001) paper on the KK model.

[15] As in the case of CMM, data on skilled labor are taken from the ILO, *Yearbook of Labor Statistics*.

[16] The data on investment are obtained from a survey made by the World Competitiveness Report (WCR) on internationalization of countries. The values used are obtained by subtracting the original values in the report from 10 and then multiplying them by 100. This is done to make the values consistent with the investment cost index, with higher values representing higher barriers. As mentioned earlier, the investment cost is composed of a simple average of 9 individual indices. The simple average is then multiplied by 10 and subtracted from 100 as in the case of the trade cost index. Both of the cost indices run from 0 to 100, with 100 the highest possible barrier.

[17] The only exception is that the index accounting for "market dominance" is not included in the investment index due to lack of data.

costs are represented as $\textsc{Tc}_{i,t}$.

As Table 2 shows, the number of observations for the investment cost $\textsc{Invc}_{j,t}$ and the trade cost $\textsc{Tc}_{j,t}$ in the host country are limited to 115, since the data are only available from the World Competitiveness Report from the period 1995 - 1999. However, for most of the source countries trade cost data are obtainable for a longer period.

Table 2. Summary Statistics for the Basic Sample

Variable	Units	Obs	Mean	Std. Dev.	Min	Max
$\textsc{Fdi}_{ij,t}$	Million USD	253	9.39	24.82	-0.33	159.52
$\textsc{Ysum}_{ij,t}$	Trillion USD	240	0.97	1.78	0.01	8.59
$\textsc{Ydiff}_{ij,t}$	Trillion USD	240	0.96	1.78	-0.008	8.57
$\textsc{Ydiff}^2_{ij,t}$	Trillion USD	240	4.09	12.32	7.43e-7	73.51
$\textsc{Sdiff}_{ij,t}$	Index [-1,1]	155	0.03	0.06	-0.08	0.14
$\textsc{Sdiff}^2_{ij,t}$		155	0.004	0.005	9.57e-10	0.02
$\textsc{Ydiff}_{ij,t}*\textsc{Sdiff}_{ij,t}$		155	0.04	0.21	-0.27	1.11
$\textsc{Invc}_{j,t}$	Index [0,100]	115	33.01	1.92	29.92	35.28
$\textsc{Tc}_{j,t}$	Index [0,100]	115	48.18	3.81	43.70	52.50
$\textsc{Tc}_{j,t}*\textsc{Sdiff}^2_{ij,t}$		83	0.16	0.23	2.0e-5	0.85
$\textsc{Tc}_{i,t}$	Index [0,100]	215	28.61	11.66	5.30	64.80
$\textsc{Dis}_{ij}$	Kilometers	253	3,899	3,600	450	16,609

Sources: World Bank, IMF, ILO, World Competitiveness Report, Central Bank of Iceland, National Economic Institute of Faeroe Islands, Distance Calculator, David Carr and Keith Maskus.

Table 2 provides summary statistics for the basic sample. As shown, the dependent variable $\textsc{Fdi}_{ij,t}$ is measured in millions of USD, rather than trillions of USD, like the $\textsc{Ysum}_{ij,t}$ and $\textsc{Ydiff}^2_{ij,t}$ variables. This was done since the amount of FDI is considerably lower than the economic size of the source countries. What is also noteworthy in Table 2 is that $\textsc{Fdi}_{ij,t}$ has a negative minimum value of USD -0.33 million, which represents the FDI made by France in Iceland in 1989. A total of five observations were found to be negative[18], but FDI stock can become negative if

[18] In the case of France and the Faeroe Islands.

FDI flows become negative within that year. This might be the case if, for example, a dividend payment from the host country to the source country is higher than the investments made in a particular year.

As can be seen in Table 2, the number of observations is highest for FDI, with a total of 253 observations. The data provide full information on FDI, and the data are almost balanced for other variables. As explained earlier, the investment and trade cost samples are the most limited in size, including data running over five years from 1995 to 1999. As a result, the number of observations for the interaction term, $\text{TC}_{j,t}{*}\text{SDIFF}^2_{ij,t}$ is low, i.e. a total of 83 observations. The reason for the low number of observations for the interaction term is because the $\text{TC}_{j,t}$ and $\text{SDIFF}^2_{ij,t}$ variables do not overlap in all years. Furthermore, there is a balanced database on distance. Distance, DIS_{ij}, is measured in kilometers[19] between the capitals of the host and the source countries. FDI is expected to decrease as the source countries become more distant and the coefficient sign is therefore expected to be negative.

Finally, the new skill proxy in Section 9, measuring education, or "School enrollment, secondary (% gross)" is obtained from the World Bank indicators.

The regressions presented in following sections are estimated by the OLS or the Tobit estimators (Greene, 1997), and all regressions are obtained using STATA version 7.0.

[19] The data on distance were obtained from the Distance Calculator (2000).

4 Estimation Results

4.1 The Econometric Specification Estimated

The basic CMM empirical specification is first estimated with two different estimation procedures, OLS and Tobit. The main differences between these two procedures is that Tobit accumulates all negative observations around zero[20], while OLS includes all observations regardless of their value. More specifically, Tobit is a censoring procedure that allows us to set upper and lower limits on the regression data. Here the lower limit is zero. Therefore, the Tobit procedure can be regarded to act as a robustness check for OLS.

The OLS regression results for the KK model are shown in Table 3 along with Tobit estimates[21]. Although the coefficients vary in size, the estimates obtained are analogous for both regressions, having coefficients with the same signs. However, as shown in Table 3, most of the time the signs for both regressions are opposite of what is predicted by the CMM empirical specification. Even though the coefficient signs often differ from what is expected by CMM, it appears the results are in line with what could be expected for a small country like Iceland. That is, it should not be surprising that the CMM empirical specification predicts differently for small countries than larger ones. Being a small host country, Iceland is likely to be positioned in the northeast corner when considering the Edgeworth Box in Section One, Figure 2.[22]

[20] Thus, values lower than zero are set as zero and used as such for the regression estimates.

[21] For the Tobit estimates to be consistent, the error terms need to be normally distibuted. However, even if the Tobit estimates do not provide as reliable results as the OLS estimates, they tell the same story since the coefficients are analogous in signs and magnitude.

[22] The Figure 2 surface chart in the (CMM, 2001) paper gives a clearer indication of the landscape with which a small host country is faced, being in the northeast corner of the box.

Table 3. The Basic CMM Specification

Regressors	OLS	Are signs as predicted by the CMM specification?	Tobit	Are signs as predicted by the CMM specification?
$\text{YSUM}_{ij,t}$	-20.426^{***} (-2.77)	No	-19.177 (-1.45)	No
$\text{YDIFF}^2_{ij,t}$	3.193^{***} (2.65)	No	3.293 (1.37)	No
$\text{SDIFF}_{ij,t}$	61.994 (0.57)	Yes	39.596 (0.21)	Yes
$\text{YDIFF}_{ij,t}{*}\text{SDIFF}_{ij,t}$	28.173 (0.82)	No	13.476 (0.22)	No
$\text{INVC}_{j,t}$	-0.274 (-0.07)	Yes	-0.794 (-0.21)	Yes
$\text{TC}_{j,t}$	-0.731 (-0.38)	No	-1.353 (-0.69)	No
$\text{TC}_{j,t}{*}\text{SDIFF}^2_{ij,t}$	-45.758^{*} (-1.72)	No	-32.718 (-0.75)	No
$\text{TC}_{i,t}$	0.798 (1.36)	No	0.845^{*} (1.81)	No
DIS_{ij}	-0.003^{***} (-2.99)	Yes	-0.004^{*} (-2.92)	Yes
CONSTANT	62.421 (0.94)		107.114 (1.39)	
TOTAL OBS.	78		78	
LEFT CEN. OBS.			15	
UNCEN. OBS.			63	
PSEUDO R-SQ.[23]			0.044	
R-SQUARED	0.32			
LOG-LIKELIHOOD			-323.30	

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

The first two variables have coefficient signs opposite to what is predicted by the CMM empirical specification of the KK model. The interpretation of countries' interactions in the Edgeworth Box[24] is that as countries i and j become dissimilar

[23]It is not possible to calculate R squared for a non-linear model like the Tobit model, because R squared is designed for linear models. Therefore the so-called "Pseudo R squared " is calculated for the Tobit model. Pseudo R squared indicates how the model fits the data, but is not an R squared in the general sense.

[24]For example, see Figure 1 and Figure 2 in the CMM paper.

in size, $\text{FDI}_{ij,t}$ decreases. This happens as we move towards either the SW or the NE corner of the box. In our case, it can be thought of as if we are moving towards the NE corner over time. This occurs when the sum of GDPs ($\text{YSUM}_{ij,t}$) increases, which occurs mainly due to an increase in the GDP size of the source country (i).[25] As the source country becomes increasingly larger than the host, it corresponds to a movement along the diagonal towards the NE corner.

This needs not to be surprising, since along with an increase in the country size differences, we can expect overall FDI to decrease.[26] This is also in line with the coefficient of the $\text{YSUM}_{ij,t}$ variable being negative, whereas it was expected to be positive in the CMM paper.

A similar story holds for the second variable in the KK model, $\text{YDIFF}^2_{ij,t}$, which captures squared GDP differences. However, this variable estimates simultaneous movements to either the SW or the NE corner, since it is squared. Here it appears that within the Edgeworth box, the movement towards the SW corner outweighs the movement towards the NE corner, resulting in a positive coefficient.

The variable measuring skill differences, $\text{SDIFF}_{ij,t}$, is estimated to have a positive coefficient. This was also predicted by the CMM emprical specification of the KK model. This is logical, since we expect FDI to increase as we move towards the SW corner of the Edgeworth Box.[27] The $\text{SDIFF}_{ij,t}$ coefficient sign obtained in Table 3 is positive but far from being significant. Therefore we do not find clear evidence for the CMM empirical specification on the basis of results from Table 3.

The sign of the interaction term, $\text{YDIFF}_{ij,t}*\text{SDIFF}_{ij,t}$, is estimated to be negative. The sign of the investment cost variable $\text{INVC}_{j,t}$ is as could be expected. That is, FDI decreases as the investment cost in the host country increases. The variable $\text{TC}_{j,t}$ has a negative coefficient, however the test is inconclusive since the coefficient is insignificant. However, in the CMM paper, the substitutional effects

[25] An analogous case where the data mainly reflect variations in the host country's GDP can be found in a paper by Markusen and Maskus (1999). In that case the source of data is outward FDI from the US.

[26] See Figure 2 in the CMM (2001) paper.

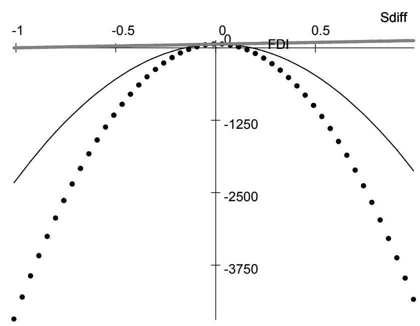
[27] More specifically, the relationship between FDI and skill differences is shown in the first graph, identified as CMM (2001) in Figures 3 and 4 in Section 10.

between trade and FDI seem to outweigh the complementary effects, indicating a predominance of horizontal FDI, since the $\text{TC}_{j,t}$ variable has a positive rather than a negative sign. The term $\text{TC}_{j,t}{*}\text{SDIFF}^2_{ij,t}$, which captures the interaction between skill difference and trade costs, has a negative sign, indicating FDI to be vertical rather than horizontal. On the contrary the trade cost coefficient in the source country $\text{TC}_{i,t}$, is positive, implying that higher trade barriers in the source country. Finally, the distance variable, DIS_{ij}, is estimated to have significantly negative impacts on FDI, as could be expected. This means that FDI decreases as distance increases. More specifically, the marginal relationship can be described such that a positive marginal change (in the mean value) of distance would have negative marginal effects on foreign direct investment.

4.1.1 Interpretation of Coefficient Estimates

When determining the interpretation of the coefficient signs and magnitude of individual variables, it is possible to explain the relationship by looking at the graphical relationship between the dependent variable and the explanatory variables.

Sketch 1



Let us start by looking at the relationship between $\text{FDI}_{ij,t}$ and $\text{SDIFF}_{ij,t}$ as described in Sketch 1. In Sketch 1, three possible scenarios of the relationship between $\text{FDI}_{ij,t}$ and $\text{SDIFF}_{ij,t}$ is exhibited. These are the following:

	$\text{YDIFF}_{ij,t}$	$\text{TC}_{j,t}$	MODEL SPECIFICATION	
Case 1	1	100	$62.421 + 90.167\text{SDIFF}_{ij,t} - 4,575.8\text{SDIFF}^2_{ij,t}$	(2)
Case 2	0	50	$62.421 + 61.994\text{SDIFF}_{ij,t} - 2,287.9\text{SDIFF}^2_{ij,t}$	(3)
Case 3	0	0	$62.421 + 61.994\text{SDIFF}_{ij,t}$	(4)[28]

In Sketch 1, Case 1 is represented by the *pointed line*, Case 2 with a *thin line*, and the Case 3 with a *gray thick line.*

The results shown in Sketch 1 are in line with the results of the BDH empirical specification, that support the horizontal model. That is, FDI is the highest when skill differences are close to zero. This is in line with the model on horizontal FDI, in that it predicts that FDI is the highest when skill differences ($\text{SDIFF}_{ij,t}$) are close to zero, trade costs ($\text{TC}_{j,t}$) are low, and the source and host countries are similar in size ($\text{YDIFF}_{ij,t}$ is close to zero).

Another way of interpreting the estimation results is to explain the marginal effects of change in the $\text{YDIFF}_{ij,t}$ variable as the following:

$\frac{\partial \text{FDI}_{ij,t}}{\partial \text{SDIFF}_{ij,t}} = 61.99 + 28.17\text{YDIFF}_{ij,t} + 2(-45.76)\text{TC}_{j,t} = 61.99 + 28.17\text{YDIFF}_{ij,t} - 91.52\text{TC}_{j,t}$ (5)

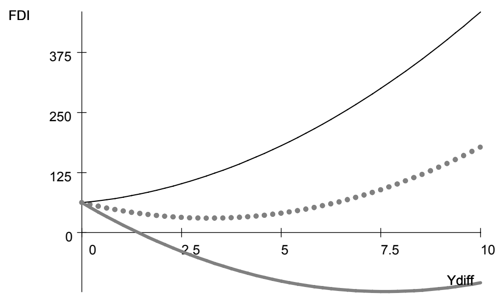
When the mean value for the $\text{YDIFF}_{ij,t}$ variable (USD 0.96 trillion[29]) is inserted into Equation (5), and $\text{TC}_{j,t} = 0$, FDI gets a value of USD 89.04 million. However, if $\text{YDIFF}_{ij,t}$ increases to USD 1 trillion, FDI gets a value of USD 90.17 million.

Now let us look at how the coefficients of the first two variables in Table 3 can be interpreted. Since most of the source countries are far larger than the host country (Iceland), much of the variation in $\text{YDIFF}_{ij,t}$ is due to variation in the size of the source country (i). Therefore, the asymtotic relationship between the two variables ($\text{YSUM}_{ij,t}$ and $\text{YDIFF}^2_{ij,t}$) and $\text{FDI}_{ij,t}$ can be shown in the equations below, and exhibited in Sketch 2.

[28] The trade cost variable $\text{TC}_{i,t}$ takes the lowest value of zero, since it is an index running from 0 to 100. Moreover, the $\text{YDIFF}_{ij,t}$ variable is represented with the lowest value of zero, because it is not so realistic to talk of a negative value, since it would only take a negative value if the GDP of Iceland was bigger than the GDP of other countries, wich is rarely the case.

[29] As shown in Table 3, in Section 3.

Sketch 2



Sketch 2 exhibits three possible scenarios of the relationship between $\text{FDI}_{ij,t}$ and GDP of the source country ($Y_{i,t}$). These are the following:

	$\text{SDIFF}_{ij,t}$	MODEL SPECIFICATION	
Case 1	1	$62.421 - 20.426\text{YDIFF}_{ij,t} + 3.193\text{YDIFF}^2_{ij,t}$	(6)
Case 2	0	$62.421 + 7.747\text{YDIFF}_{ij,t} + 3.193\text{YDIFF}^2_{ij,t}$	(7)
Case 3	-1	$62.421 - 48.599\text{YDIFF}_{ij,t} + 3.193\text{YDIFF}^2_{ij,t}$	(8)

In Sketch 2, Case 1 is represented by the *pointed line*, Case 2 with a *thin line*, and the Case 3 with a *gray thick line.* However, when the marginal relationship between the $\text{YDIFF}_{ij,t}$ variable and is looked at more specifically, the effects of marginal change in $\text{YDIFF}_{ij,t}$ on $\text{FDI}_{ij,t}$ can be represented in the following way: $\frac{\partial \text{FDI}_{ij,t}}{\partial \text{YDIFF}_{ij,t}} = 6.39\text{YDIFF}_{ij,t}$[30] $+ 28.17\text{SDIFF}_{ij,t}$.

So, for example when the mean value of the $\text{YDIFF}_{ij,t}$ variable (USD 0.96 trillion) is inserted into the equation and skill differences ($\text{SDIFF}_{ij,t}$) are equal to zero, then FDI has a value of USD 6.13 million. However, if $\text{YDIFF}_{ij,t}$ has a value of USD 1 trillion, FDI has a value of USD 6.39 million.

Overall, the estimates obtained in Table 3 indicate that, for other than the market size measures and distance, the specification does not perform very well. Nevertheless, it is possible that some restrictions on the specification perform better than the initial one. Therefore, the next section continues by estimating some restrictions of the initial empirical specification.

[30] Since $2 * 3.193\text{YDIFF}_{ij,t} = 6.386\text{YDIFF}_{ij,t}$.

4.2 Specification Restrictions

Since the signs for some of the coefficients in Table 3 turned out to be different from what was anticipated, we now analyze whether restricting the model by eliminating the first two potentially correlated variables from the model has an effect on estimates for the remaining variables.

Table 4. Some Specification Restrictions

Regressors	(a)	(b)	(c)
$\text{YSUM}_{ij,t}$	−20.426*** (−2.77)		−3.251 (−1.26)
$\text{YDIFF}^2_{ij,t}$	3.193*** (2.65)	−0.396 (−0.88)	
$\text{SDIFF}_{ij,t}$	61.994 (0.57)	−62.610 (−0.69)	−67.630 (−0.74)
$\text{YDIFF}_{ij,t}*\text{SDIFF}_{ij,t}$	28.173 (0.82)	102.196*** (3.39)	100.297*** (4.25)
$\text{INVC}_{j,t}$	−0.274 (−0.07)	−0.287 (−0.07)	−0.257 (−0.07)
$\text{TC}_{j,t}$	−0.731 (−0.38)	−0.922 (−0.47)	−0.921 (−0.47)
$\text{TC}_{j,t}*\text{SDIFF}^2_{ij,t}$	−45.758* (−1.72)	−13.217 (−0.65)	−12.456 (−0.60)
$\text{TC}_{i,t}$	0.798 (1.36)	0.978 (1.61)	1.022* (1.75)
DIS_{ij}	−0.003*** (−2.99)	−0.002*** (−2.63)	−0.002** (−2.47)
CONSTANT	62.421 (0.94)	53.045 (0.79)	52.630 (0.80)
OBSERVATIONS	78	78	78
R-SQUARED	0.32	0.30	0.30

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

The regression is split up to find out whether it alters the estimation results for the first two variables. The regression results for the basic CMM empirical specification are shown in column (a). Two restricted versions of the specification are introduced in columns (b) and (c), where the size variables are omitted separately in order to analyze whether some restricted specifications provide better estimates than the basic specification.

Omitting $\text{Ysum}_{ij,t}$ in column (b) leads to a sign change and insignificance of the second variable, $\text{Ydiff}^2_{ij,t}$. Moreover, when the $\text{Ydiff}^2_{ij,t}$ variable is omitted in column (c), the sum variable $\text{Ysum}_{ij,t}$ also loses significance. In both cases the $\text{Sdiff}_{ij,t}$ skill difference variable changes sign but remains insignificant. Finally, the variable omission affects the interaction term $\text{Ydiff}_{ij,t}*\text{Sdiff}_{ij,t}$ such that it becomes significant and positive. A possible reason for that could be that size difference matters only in interaction with skill differences. A potential reason for why only few of the variable terms are estimated to be significant could be because the error terms of the regression are not a perfectly normal distribution.[31] As mentioned earlier in Section 2.3, in the variables of Equation (1) it holds that $E[\varepsilon_{ij,t} \mid x_{ij,t}] = 0$. These are the typical assumptions for OLS to give consistent estimates. Furthermore, the application of robust t statistics corrects for heterogeneity in the sample by estimating correct standard errors. Potential non-normality of errors is a severe difficulty. However, since the goal of this paper is to show how the CMM model fits Icelandic data (which is a poor fit of best) rather than develop precise estimates for inference, I will ignore this issue in line with the rest of the literature.

It appears that the first specification represented in column (a) is the most preferred, because when either of the first two variables are dropped in columns (b) and (c), the remaining variables lose significance. Moreover, the higher R squared value for the first equation also indicates that the first regression has a better fit to the data than the other two.

Overall, estimating a restricted form of the specification indicates that when either of the two first variables in the regression ($\text{Ysum}_{ij,t}$ or $\text{Ydiff}^2_{ij,t}$) are left out, the interaction term ($\text{Ydiff}_{ij,t}*\text{Sdiff}_{ij,t}$) seems to be picking up the variation in the data. Otherwise the results do not seem to shed further light on the results obtained earlier. We will therefore continue by testing some alternatives of the

[31] The distribution of the error terms is exhibited in Figure 3 and 4 in Appendix A, Section 10.

CMM specification.[32]

[32] The original CMM empirical specificaiton may not be the best suitable one for this set of data.

5 Outliers Omitted

As Figure 5 in Appendix B exhibits, it appears that the long right tail of the distribution could be due to the existence of very few very large outliers in the sample. This could also be the reason why the distribution of the error terms in Figure 5 has a longer tail to the right. The existence of large outliers could be because some of the source countries of investment are considerably larger than others.[33]

Table 5. Sample Estimated by GDP Size.

Regressors	All Countries	3 Biggest Countries	Rest
$\text{YSUM}_{ij,t}$	-20.426^{***} (-2.77)	-266.197^{**} (-2.34)	-50.575^{*} (-1.84)
$\text{YDIFF}^2_{ij,t}$	3.193^{***} (2.65)	26.043^{**} (2.26)	40.142^{**} (1.97)
$\text{SDIFF}_{ij,t}$	61.994 (0.57)	1,660.536 (0.80)	331.185 (1.54)
$\text{YDIFF}_{ij,t} * \text{SDIFF}_{ij,t}$	28.173 (0.82)	-362.534 (-0.88)	-506.340 (-1.27)
$\text{INVC}_{j,t}$	-0.274 (-0.07)	2.967 (0.81)	0.014 (0.01)
$\text{TC}_{j,t}$	-0.731 (-0.38)	-2.580 (-0.88)	-0.082 (-0.04)
$\text{TC}_{j,t} * \text{SDIFF}^2_{ij,t}$	-45.758^{*} (-1.72)	176.533 (1.15)	-78.857^{**} (-2.02)
$\text{TC}_{i,t}$	0.798 (1.36)	-0.749 (-0.86)	1.101 (1.54)
DIS_{ij}	-0.003^{***} (-2.99)	0.024 (1.30)	-0.003^{***} (-2.60)
CONSTANT	62.421 (0.94)	513.665^{**} (2.45)	22.975 (0.30)
OBSERVATIONS	78	15	63
R-SQUARED	0.32	0.97	0.21

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

To correct for this potential effects of outliers, the data is now divided into two subsamples based on economic size. The second column represents estimates based

[33] Source countries of FDI are listed in Section 2.

on FDI made by the three biggest source countries only. These countries are the US, Japan, and Germany, respectively.[34] The third column represents estimates for the remaining 20 countries. Overall, the results for the two subsamples presented in Table 5 indicate that economic size does not alter the preceding results. Thus the results from dividing the sample into two subsamples further supports the results obtained earlier.

[34] In 1999, the GDP of the US and Japan, was substantially higher than the GDP of the third largest country, Germany. GDP in the US was 3.30 times higher than that of Germany, and Japan's GDP was 2.06 times that of Germany.

6 The Number of Observations Increased

In Table 6, the results are introduced from increasing the sample size by using different proxies for trade and investment costss. The results from enlarging the sample by almost half are shown in Table 6.

Table 6. Different Proxies for Trade Cost and Investment Cost

Regressors	(a)	(b)	(c)	(d)
$\text{YSUM}_{ij,t}$	-20.426^{***} (−2.77)	-15.978^{***} (−4.15)	-16.022^{***} (−4.18)	-15.449^{***} (−4.00)
$\text{YDIFF}^2_{ij,t}$	3.193^{***} (2.65)	2.254^{***} (3.66)	2.262^{***} (3.70)	2.140^{***} (3.43)
$\text{SDIFF}_{ij,t}$	61.994 (0.57)	-146.165^{***} (−3.60)	-147.111^{***} (−3.62)	-141.911^{***} (−3.48)
$\text{YDIFF}_{ij,t}*\text{SDIFF}_{ij,t}$	28.173 (0.82)	45.446^{***} (2.81)	45.314^{***} (2.80)	48.104^{***} (2.92)
$\text{INVC}_{j,t}$	−0.274 (−0.07)			
$\text{TC}_{j,t}$	−0.731 (−0.38)			
$\text{TC}_{j,t}*\text{SDIFF}^2_{ij,t}$	-45.758^{*} (−1.72)			
$\text{TC}_{i,t}$	0.798 (1.36)	0.621^{**} (2.16)	0.621^{**} (2.15)	0.673^{**} (2.29)
DIS_{ij}	-0.003^{***} (−2.99)	-0.002^{***} (−4.97)	-0.002^{***} (−4.98)	-0.001^{***} (−5.10)
CONSTANT	62.421 (0.94)	85.653 (1.35)	73.398 (1.54)	−0.728 (−0.06)
$\text{INVC}^0_{j,t}$		−2.163 (−1.15)		
$\text{DUMMY\_INVC}^0_{j,t}$		−76.889 (−1.22)		
$\text{TC}^0_{j,t}$			−1.228 (−1.30)	
$\text{DUMMY\_TC}^0_{j,t}$			−64.585 (−1.39)	
TIME_TREND_t				1.549 (1.54)
OBSERVATIONS	78	150	150	150
R-SQUARED	0.32	0.30	0.30	0.30

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

In order to see whether increasing the number of observations will possibly affect the previous results, we now analyze an enlarged sample. The number of observations is increased by adding dummies for trade or investment costs, and by inserting a time trend.

Column (b) represents the inclusion of host investment costs, where $\text{INVC}_{j,t}$ is replaced by an adjusted investment cost variable, $\text{INVC}^0_{j,t}$, together with a dummy variable,[35] $\text{DUMMY\_INVC}^0_{j,t}$. The number of observations has increased from 78 to 150, i.e. they almost double. The $\text{DUMMY\_INVC}^0_{j,t}$ takes a value of zero in 1989-1994, but the sample value otherwise.[36] Also in column (c), the trade variable is replaced by $\text{TC}^0_{j,t}$ together with a dummy variable, $\text{DUMMY\_TC}^0_{j,t}$. Finally in column (d), both investment and trade costs are replaced with a linear time trend[37]. The approaches applied in columns (a) through (d) are meant to show the effects of enlarged sample size on the size and skill variables. The estimates obtained for the dummies and the time trend are not interpreted specifically, since they are not important for the overall regression results.[38]

The results are similar for all three regressions. The first two size variables continue to have the same signs as the basic regression. However, the skill labor variable, $\text{SDIFF}_{ij,t}$, is estimated to be negative and significant in columns (b) through (d). In summary, application of dummies or a time trend[39] backs up previous results except in the case of the skill difference variable. The negative sign of the skill difference variable can be interpreted such that FDI is decreasing in positive skill differences, and thereby increasing in negative skill differences. In other words, when skills are measured by occupational categories of the labor force, FDI is estimated to increase as the host country (Iceland) becomes more skilled compared to the source country. Multinationals with headquarters in the source

[35] An explanation of the dummy approach can be found in Greene (1997, pp. 431).

[36] The dummy $\text{DUMMY\_INVC}^0_{j,t}$ takes a zero value in 1989-1994, for the years when data on investment cost could not be obtained from the World Competitiveness Report.

[37] The time trend runs from 1 to 11 to cover all years included in the sample.

[38] One additional regression was also run, including $\text{TC}^0_{j,t}$, $\text{INVC}^0_{j,t}$ and a dummy. However, this regression yielded results analogous to those in columns (b) and (c).

[39] An example of a time trend can be found in Heckman and Walker (1990). Another recent paper on FDI using a time trend is Braunstein and Epstein (2002, pp. 16, 20).

country can thereby be said to be attracted to more skilled labor when choosing Iceland as a host country.

7 Application of the Davies (2002) Specification

In a recent paper, BDH (2002) find evidence indicating that the model on horizontal MNEs presented by Markusen (1984) cannot be rejected in favor of the KK model. They base their results on findings that indicate that FDI is increasing in negative skill differences, but decreasing in positive skill differences. However, in a more recent paper, Davies (2002) finds it possible to reject the horizontal model in favor of the KK model. The model presented here by Davies will be referred to as "The Augmented KK model" and applied as a final specification tested.

In summary, all variations of the skill labor abundance variable in Part A are estimated to be positive although insignificant in most cases. This indicates that in our case, FDI is estimated to be increasing in skill differences. The regression part referred to as PART A in Table 7.

When squared skill differences are added to the regression in column two, the regression is estimated to be positively significant, providing some support for the model on horizontal MNEs by Markusen. However, adding a cubed term to the regression in column three suggests a rejection of the horizontal model in favor of the KK model. The positive significant coefficient of the cubed term indicates that the horizontal model can be rejected in favor of the KK model.

Table 7. Davies Empirical Specification of the KK model.

Regressors	Part A: Plain skill diff.	Part A: Squared skill diff.	Part A: Cubed skill diff.	Part B: Negative skill diff.	Part B: Positive skill diff.
$\text{YSUM}_{ij,t}$	-20.426^{***} (−2.77)	-19.423^{***} (−2.74)	-17.782^{***} (−2.75)	-21.639^{*} (−1.75)	-48.351^{***} (−4.20)
$\text{YDIFF}^2_{ij,t}$	3.193^{***} (2.65)	3.018^{***} (2.60)	3.037^{***} (2.71)	5.881^{*} (1.68)	−2.173 (−0.60)
$\text{SDIFF}_{ij,t}$	61.994 (0.57)	76.334 (0.69)	46.940 (0.51)	−905.237 (−0.65)	$-2,704.41^{***}$ (−3.27)
$\text{SDIFF}^2_{ij,t}$		$13,593.83^{*}$ (1.69)	1,573.932 (0.16)	−87,703.05 (−0.72)	−2,817.94 (−0.47)
$\text{SDIFF}^3_{ij,t}$			$65,074.47^{**}$ (2.43)		
$\text{YDIFF}_{ij,t}$* $\text{SDIFF}_{ij,t}$	28.173 (0.82)	28.563 (0.88)	17.142 (0.56)	102.669 (0.35)	670.550^{***} (3.55)
$\text{INVC}_{j,t}$	−0.274 (−0.07)	−0.164 (−0.04)	0.747 (0.19)	0.284 (0.10)	2.015 (0.43)
$\text{TC}_{j,t}$	−0.731 (−0.38)	0.264 (0.12)	0.488 (0.23)	1.169 (0.46)	-3.940^{**} (−2.42)
$\text{TC}_{j,t}$* $\text{SDIFF}^2_{ij,t}$	-45.758^{*} (−1.72)	-332.925^{**} (−1.99)	−254.299 (−1.51)	1,121.862 (0.54)	314.795^{*} (1.92)
$\text{TC}_{i,t}$	0.798 (1.36)	0.847 (1.46)	0.822 (1.44)	2.480^{***} (2.65)	-2.169^{**} (−2.42)
DIS_{ij}	-0.003^{***} (−2.99)	-0.003^{***} (−3.00)	-0.002^{***} (−3.22)	-0.017^{***} (−4.26)	-0.004^{**} (−2.43)
CONS.	62.421 (0.94)	10.268 (0.13)	−22.413 (−0.30)	−50.352 (−0.45)	314.777^{**} (2.47)
OBS.	78	78	78	39	39
R-SQ.	0.32	0.34	0.38	0.59	0.74

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

Another way of determining between horizontal and vertical FDI is to estimate the KK model based on subsamples. This is done in Table 7, Part B. The first subsample includes observations when the skill difference is positive, and the second subsample includes negative skill differences. Analogous subsample division was used by BDH (2002), and Davies (2002). Observations are separated into those with positive skill differences and those with negative skill differences. They obtained the coefficient estimates for skill differences to be positive for the negative subsample, but negative for the positive subsample. As in Davies, I find that splitting the sample signficantly raises my R squared. Furthermore, the positive skill difference tends to show greater significance for source trade costs. However, unlike Davies, my skill estimates still cannot reject the horizontal model.

It is possible that these results may be explained by a small variation in $\textsc{Sdiff}_{ij,t}$, since it runs only from -0.08 to 0.14. In comparison, the $\textsc{Sdiff}_{ij,t}$ variable runs within a much wider range in the CMM paper, running from -0.277 to 0.277. A potential reason for limited variation in skill differences in this paper could be due to a low number of observations. This gives an indication on how important variation is and how serious the lack of data can be for small countries.

8 Replacing the Proxy for Skilled Labor

We now turn to an alternative proxy for skilled labor over the same period to analyze if it alters previous results. Hence, the CMM specification of the KK model is now estimated after replacing the proxy for skilled labor with two different variables. First I replace the skilled labor proxy with *per capita* GDP, and then I use secondary school education as a new proxy for skilled labor. I begin by analyzing the effects of including *per capita* GDP. For clarification, the summary statistics for *per capita* GDP[40] are shown in Table 8.[41]

Table 8. Summary Statistics for the New Variables

Variable	Units	Obs	Mean	Std. Dev.	Min	Max
$\text{YPCDIFF}_{ij,t}$	USD	240	-2,860.91	11,635.93	-28,487.45	21,976.91
$\text{YDIFF}_{ij,t}*\text{YPCDIFF}_{ij,t}$		240	2,354.48	15,489.56	-12,608.37	84,004.77
$\text{TC}_{j,t}*\text{YPCDIFF}^2_{ij,t}$	USD	110	7.50e+09	1.05e+10	405,288.30	3.55e+10
$\widetilde{\text{SDIFF}}_{ij,t}$	% gross	192	1.71	18.80	-35.56	50.69
$\text{YDIFF}_{ij,t}*\widetilde{\text{SDIFF}}_{ij,t}$		191	-2.13	18.89	-122.84	55.41
$\text{TC}_{j,t}*\widetilde{\text{SDIFF}}^2_{ij,t}$	% gross	82	21,362.20	26,832.2	0.38	112,547.50

Source: Authors Computations.

The first new variable $\text{YPCDIFF}_{ij,t}$ presented in Table 8 measures the *per capita* GDP[42] difference between countries. The *per capita* GDP difference variable is defined as the following: $\text{YPCDIFF}_{ij,t} \equiv GDP_{i,t}/N_{i,t} - GDP_{j,t}/N_{j,t}$, where GDP is measured in trillions of dollars. The regression results obtained for this new variable are presented in PART A in Table 9. This new variable is somewhat similar to a variable used by Brainard (1997). Brainard used *per worker* GDP[43],

[40] The summary statistics for the $\text{YPCDIFF}_{ij,t}$ refer to sample estimates for the "Enlarged Sample" as referred to in Part A in Table 9.

[41] As a comparison to the variable definition in Table 2.

[42] Another example of a similar proxy is the one used by Slaughter (2000, pp. 461). He proxies skilled labor with what he refers to as the share of the nonproducation wages bill when divided by the total wage bill of production and nonproduction workers.

[43] Brainard (1997) included a *per worker* income differential to control for differences in factor proportions.

but I prefer to use *per capita* GDP in order to reflect the relative differences in wealth of countries.

The second new variable measures the educational[44] difference of the source and the host country. This is a new proxy for skilled labor, valuing skills based on *secondary school enrollment.*[45] This variable has been widely used in growth literature, an example that can be seen in *Economic Growth*[46] by Barro and Sala-I-Martin (1998). In order to stress the change in the proxy for skilled labor, it is denoted with tilda, as $\widetilde{\text{SDIFF}}_{ij,t}$ in Table 8 and Table 9.

To simplify the comparison between the two new variables, the first regression results presented in PART A in Table 9 (same sample) are based on the same sample size as the basic CMM regression presented previously in Table 3. However, estimates shown in the second column in PART A are obtained from an enlarged sample based on an increased number of observations for the new variable. The regression results for both columns in PART A indicate that replacing the original skill differences variable with *per capita* GDP backs up the results obtained for the size and skill differences in the basic regression in Table 3. In other words, the results in PART A indicate that source countries make more foreign direct investment as they become richer relative to Iceland.

Moreover, the regression results presented in PART B provide analogous results for size effects and skill differences, although the proxy for skill differences is estimated to be insignificant. This can be interpreted such that the level of FDI is not affected by a relative increase in education in the source country, compared to the host country. Put another way, it does not seem to affect investment incentives how well educated the domestic labor is compared to the labor in the source coun-

[44]"Education improves the labor force and thus enables workers to use existing capital more efficiently" (Gylfason, 2002).

[45]The World Bank defines the serie for secondary scholl enrollment, or *School enrollment, secondary (% gross)* in the following way: "Gross enrollment ratio is the ratio of total enrollment, regardless of age, to the population of the age group that officially corresponds to the level of education shown. Secondary education completes the provision of basic education that began at the primary level, and aims at laying the foundations for lifelong learning and human development, by offering more subject- or skill-oriented instruction using more specialized teachers."

[46]Chapter 12.

tries of investment, although a positive coefficient indicates that it might increase as source country labor is better educated. Also, distance looses significance under these circumstances.

Together, the results in PART A and PART B therefore back up the results obtained for the basic model specification presented in Table 3.

Table 9. Replacing Proxy for Skill Labor Abundance

	Part A		Part B
	$\text{YPCDIFF}_{ij,t} \equiv Y_{i,t}/N_{i,t} - Y_{j,t}/N_{j,t}$		$\widetilde{\text{SDIFF}}_{ij,t} \equiv E_{i,t} - E_{j,t}$
Regressors	Same Sample	Enl. Sample	
$\text{YSUM}_{ij,t}$	-2.647 (-0.67)	-9.916^{***} (-2.83)	-19.214^{***} (-2.82)
$\text{YDIFF}^2_{ij,t}$	1.423^{***} (2.67)	2.155^{***} (4.24)	2.621^{***} (2.77)
$\text{YPCDIFF}_{ij,t}$	0.004^{***} (5.87)	0.002^{***} (3.33)	
$\text{YDIFF}_{ij,t}{*}\text{YPCDIFF}_{ij,t}$	-0.002^{***} (-5.75)	-0.001^{***} (-3.69)	
$\widetilde{\text{SDIFF}}_{ij,t}$			0.039 (0.20)
$\text{YDIFF}_{ij,t}{*}\widetilde{\text{SDIFF}}_{ij,t}$			-0.231 (-1.21)
$\text{INVC}_{j,t}$	-0.998 (-0.47)	-0.556 (-0.21)	-2.459 (-0.45)
$\text{TC}_{j,t}$	-1.418 (-1.32)	-1.201 (-0.89)	-1.027 (-0.49)
$\text{TC}_{j,t}{*}\text{YPCDIFF}^2_{ij,t}$	$2.74e-9^{***}$ (4.73)	$5.2e-10$ (1.14)	
$\text{TC}_{j,t}{*}\widetilde{\text{SDIFF}}^2_{ij,t}$			$2e-5$ (0.19)
$\text{TC}_{i,t}$	0.459^{*} (1.85)	1.021^{***} (2.46)	0.832 (1.57)
DIS_{ij}	0.001^{**} (2.25)	0.001 (1.22)	-0.002^{**} (-1.96)
Constant	95.201^{**} (2.17)	64.367 (1.47)	141.192 (1.27)
Observations	78	100	74
R-squared	0.74	0.49	0.26

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

9 Concluding Remarks

This paper offers a refinement and explores a resolution of the Knowledge Capital model for small countries like Iceland, since better understanding the desire of multinationals when making foreign direct investments in small countries is economically meaningful.

The main conclusion is that when the empirical specification presented by Carr, Markusen, and Maskus (2001) is applied to Iceland, the estimates obtained differ from the general case. The overall results indicate that the driving forces behind foreign direct investment in small countries like Iceland appear to be different from the forces driving FDI in larger economies or that the CMM specification encounters data difficulties when GDP's are highly mismatched. More specifically, the size effects appear to be reverse, indicating that investment incentives decrease with dissimilarity in size, and that FDI is likely to increase as the source countries decrease in size. An important result is that I obtain mixed evidence for the role of skilled labor, although in most cases investment is estimated to increase as the source country becomes more skilled than the host country. More specifically, estimates indicate that when skill is measured by occupational categories, FDI increases as the source country becomes more skilled in comparison to the host country (Iceland). Consequently, multinationals will be attracted by less skilled labor when choosing Iceland as a host country, or that multinationals tend to come from highly skilled countries. Secondly, when skills are measured as *secondary school education*, rather than by occupational categories like before, more education in the source countries is estimated to have positive, however insignificant impact on FDI. That is, it does not seem to affect investment incentives how well educated source country labor is compared to host country labor. Taken together the these two different skill measures indicate somewhat conflicting effects of skills on FDI, and therefore the research continues by investigating whether source country firms seek host countries with skilled labor or unskilled labor, when measured by its cost, i.e. expensive or cheap labor. The third skillness proxy applied, is measured as per capita GDP, estimates indicate that an increase in skill differences increases FDI. Therefore, more foreign direct investment is made by source countries that are rich relative to Iceland.

A potential explanation for the results obtained for Iceland is that foreign direct investment is driven largely by one dominating industry, the power intensive industry. To dig deeper into this topic, further research into the forces behind sector specific FDI in Iceland may prove quite insightful.

10 Appendix A The Edgeworth Box

Figure 3: Scaled Relationship Between Skilled and Unskilled Labor.

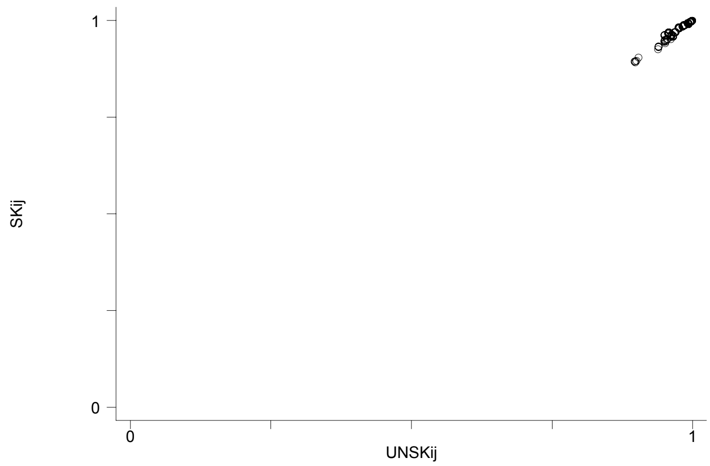
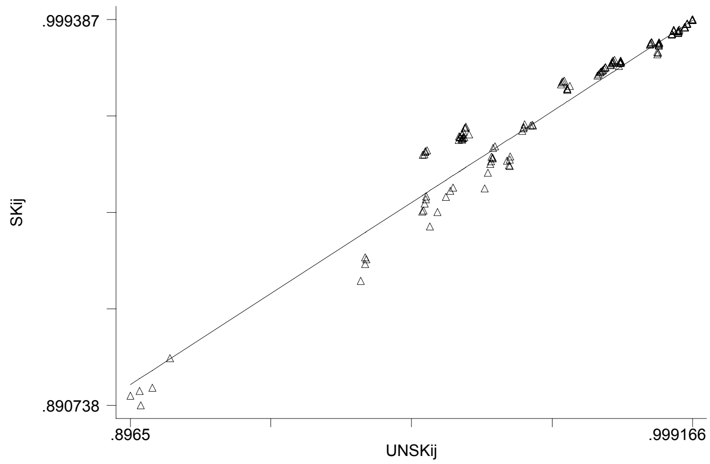


Figure 4: Relationship Between Skilled and Unskilled Labor.



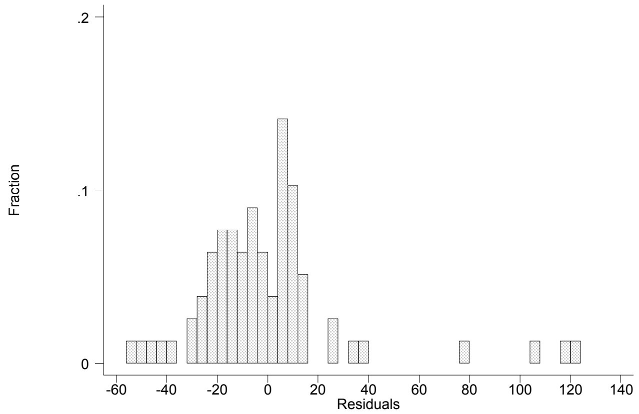
Source: International Labor Organization (ILO).

Figures 3 and 4 exhibit source country weighted skill labor (vertical-axis) and weighted unskilled labor (horizontal-axis) as in Barconier et al. (2002). These are derived as in the Figure 2 Edgeworth Box. Skilled labor is calculated as $SK_{ij} = (Si * Ni)/(Si * Ni + Sj * Nj) + j * Nj)si = (Si * Ni)/(Si * Ni + Sj * Nj)$ and unskilled labor as $UNSK_{ij} = (Ui * Ni)/(Ui * Ni + Uj * Nj)$. In Figure 3 all observations are in the upper right corner of the box, i.e. the northeast corner.

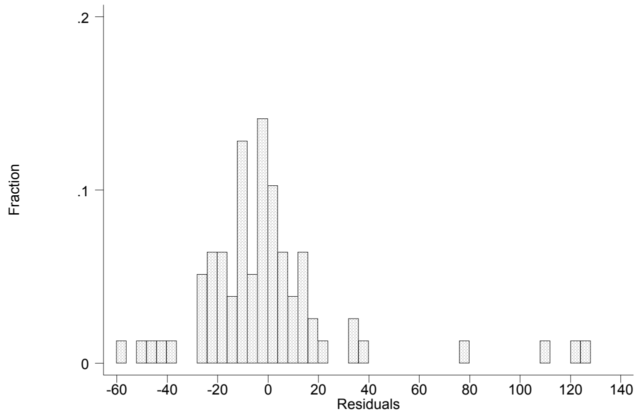
11 Appendix B Distribution of Residuals

Figure 5: Distribution of Residuals in Table 4, Fraction (% of 100).

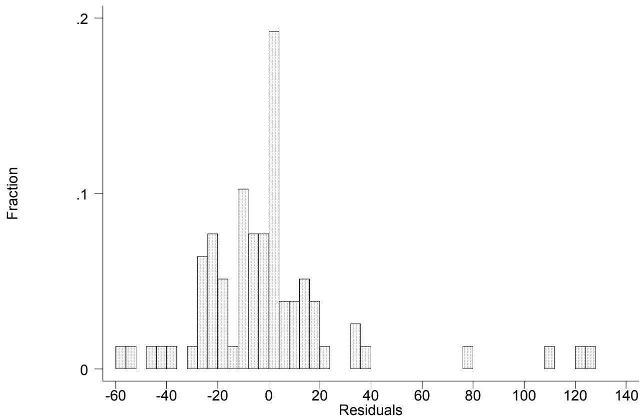
Distribution of Regression Residuals in Table 4. Column (a).



Distribution of Regression Residuals in Table 4. Column (b).



Distribution of Regression Residuals in Table 4. Column (c).



Source: Author's computations.

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