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Substitution Between Inward and Outward Foreign Direct Investment

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Abstract

This paper offers a new combination of the knowledge-capital and the gravity models. The model combination is applied to a small, remote country, which allows for testing of a corner case. Furthermore, the substitution effects between inward and outward foreign direct investment (FDI) are estimated, by use of a simultaneous equation system, and the estimates indicate that inward and outward FDI can be considered to be substitutes for each other.

Keywords: Foreign Direct Investment, Gravity Model, Knowledge-Capital Model, Simultaneous Equations
JEL Classifications Codes: C33, F18, F21, F23

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1 Introduction

So far the gravity and knowledge capital (KK) models have primarily been tested for bilateral flows of foreign direct investment (FDI) between range of countries. This paper, however, offers a testing of inward and outward flow of a single small remote country, and rather than testing the models separately, they are combined. Another feature of the analysis here is that the new equation specification makes it possible to analyze inward and outward flow simultaneously. The key country in question, Iceland, is an island far from all countries, with a Mid-Atlantic location equidistant from the US and Europe. Further factors adding to this unique case study are the small size of the Icelandic economy and the highly skilled labor force, which combine to create the perfect KK model corner case.

In recent years, it has been popular to capture the volume of export flowing between countries by means of a gravity model (Bergstrand, 1985) and more recently a popular way of capturing FDI has either been with means of a gravity model or a KK model (Markusen et al.1996, Carr et al. 2001). Helpman (1984) introduced the general equilibrium model for vertical FDI, and Markusen (1984) presented a general equilibrium model for horizontal FDI. Markusen et al. (1996) laid out the theoretical background of the KK model by combining the Helpman (1984) and Markusen (1984) general equilibrium models. Then Carr et al. (2001) went on and presented an econometric specification of the KK model. Helpman (1998) finds the gravity model primarily suitable for similar countries that have considerable intra-industry trade with each other. This implies that the model does better for horizontal activities. However, the KK model is designed to cover both horizontal and vertical incentives for investment. In the Carr et al. (2001) specification of the KK model, endowments are accounted for by including skill differences, country size differences, and trade and investment costs. The gravity and KK models are partly based on the proposition of the Heckscher-Ohlin model, implying that countries will export goods that intensively use their relatively abundant factors, with skill differences as a proxy for differences in relative factor endowments.

This paper introduces a new combination of the KK and gravity model that allows for inclusion of additional endowments in the KK model. Moreover the substitution effects between in- and outward FDI are estimated, by using a simultaneous equation system. I analyze these functions for the case country, Iceland, using data that spans from 1989 to 2001. The highlight of this data is that estimates indicate that inward and outward FDI can be considered substitutes of each other.

The paper proceeds as following. In Section 2 I introduce related literature, and in Section 3 I construct a model specification taking into account some of the features of the KK model and the gravity model, allowing for inclusion of endowment measures for this case. In Section 4, estimation results are introduced. Finally, Section 5 contains conclusions.

2 Literature

This paper seeks to explain to what extent trade and foreign direct investment (FDI) are substitutes. This paper also seeks to bring in the factor-proportions hypothesis implying that multinationals seek vertical production integration across countries to take advantage of different factor prices resulting from relative differences in factor supplies across countries. For this purpose I use some combinations of the gravity model and the knowledge capital (KK) model, which enables me to account for distance, population and gross domestic product. Also skillness is included together with additional proxies to account for factor endowments in the economy. The gravity model is a macro model by nature, however, Bergstrand (1985) provided microfoundations of the model. Some important contributions of the KK model include incorporation of source endowments as part of its components and other factors such as investment cost and trade cost to account for both horizontal and vertical motives for FDI. Just as soon the KK model was put forward it gained a lot of publicity and debate, and has been tested by several economists.

In a well known paper, Brainard (1997) proxies outward and inward FDI separately as the share of affiliate sales in total exports. Another more recent example of a share measure can be found in a paper by Slaughter (2000), where he constructs an investment share variable as the share which accounts for an FDI proxy (measured as majority owned affiliates) in overall multinational investment.

3 Basic Model Presentation

International firms are generally faced with the trade-off between producing in the domestic or foreign market, dependent on whether the marginal cost of supplying the foreign market is lower if production facilities are located abroad. This could be because wages are lower abroad, because of transport cost, tariffs, or simply because of the cost of overcoming governmental instability when entering a new market. Firms have incentive to start undertaking FDI if they find that entering a foreign market will increase their profits. By expanding their operations internationally they become multinationals.

***** INSERT TABLE 1 ABOUT HERE *****

The way I choose to estimate this, is by determining to which extent inward FDI is a function of outward FDI, and wise versa. More specifically, I use a simultaneous equations model, which allows me to estimate simultaneously inward FDI as function of outward FDI, and outward FDI as function of inward FDI. More specifically this procedure allows me to avoid the possible simultaneity which might exist among explanatory variables. I base the model presentation on the gravity and KK model equation, allowing me to account for economic sizes as well as transport costs and other factors. The basic specification for Equation (1) goes as follows:

$$\begin{aligned} FDI_{ij,t} &\equiv e^{\beta_0}(FDI_{ji,t})^{\beta_1}(Oil_t)^{\beta_2}(Fin\_Risk_{j,t})^{\beta_3} \quad \text{(1 a)} \\ &\quad (Exchr_{j,t})^{\beta_4}(Openness_{j,t})^{\beta_5}e^{\epsilon_{1,ij,t}} \\ FDI_{ji,t} &\equiv e^{\beta_6}(FDI_{ij,t})^{\beta_7}(GDP_{j,t})^{\beta_8}(GDP_{i,t})^{\beta_9} \quad \text{(1 b)} \\ &\quad (Skillness_{i,t})^{\beta_{10}}(Openness_{i,t})^{\beta_{11}}e^{\epsilon_{2,ji,t}} \end{aligned}$$

Equation (1) is a combined of Equation (1a) and Equation (1b), with the endogenous variables inward FDI and outward FDI as functions of each other, as well

as being functions of other relevant variables for inward and outward FDI. Generally in the gravity model presented by Bergstrand (1985) the "origin" or "source" country is denoted with (i), while the "recipient", or "host" country is denoted with (j). Here the (j) country is a single country (Iceland), however the source country (i) varies for different countries.

Since I prefer to estimate the equation in a linear format, and change the notation, I now present it in a log-linear format as shown in Equation (2). The basic model specification (specification 1) for the three-stage estimation for systems of simultaneous equations, can be presented as follows:

$$\begin{aligned}
\sinh^{-1}(FDI_{ij,t}) &= \beta_0 + \beta_1 \sinh^{-1}(FDI_{ji,t}) + \beta_2 \sinh^{-1}(Oil_t) && \text{(2 a)} \\
&\quad + \beta_3 \sinh^{-1}(Fin_Risk_{j,t}) + \beta_4 \sinh^{-1}(Exchr_{j,t}) \\
&\quad + \beta_5 \sinh^{-1}(Openness_{j,t}) + \epsilon_{1,ij,t} \\
\sinh^{-1}(FDI_{ji,t}) &= \beta_6 + \beta_7 \sinh^{-1}(FDI_{ij,t}) + \beta_8 \sinh^{-1}(GDP_{j,t}) && \text{(2 b)} \\
&\quad + \beta_9 \sinh^{-1}(GDP_{i,t}) + \beta_{10} \sinh^{-1}(Skillness_{i,t}) \\
&\quad + \beta_{11} \sinh^{-1}(Openness_{i,t}) + \epsilon_{2,ji,t}
\end{aligned}$$

Equation (2) shows a simultaneous equation system presenting FDI flow from various countries to Iceland over time (t) by ($FDI_{ij,t}$) in Equation (2a), and FDI flow from Iceland to various countries over time (t) by ($FDI_{ji,t}$) in Equation (2b).

The simultaneous equation system allows me to estimate the substitutability between inward FDI denoted by ij, and outward FDI denoted by ji. When transferring the equation system to a log-linear format I apply an Inverse Hyperbolic Sine Function (Johnston, 1949), rather than applying the natural logarithm function. The procedure transfers positive data in a similar way as the natural logarithm, however the conventional logarithm procedure does not function on zeros or negatives, but this procedure does. I therefore choose this procedure since it allows me to transform the data into a log-linear format without truncating zeros or negatives. The possibility of being able to transform zeros and negatives is important, since those

values occasionally show up in the data. Transformation by means of a inverse hyperbolic sine (IHS) function, rather than a logarithm function, has been used in studies on household wealth. The procedure has been found to provide a suitable in transforming household wealth data by Burbidge et al. (1988). Based on the fact that some households hold zero or negative net worth as explained by Carroll et al. (1999). The Inverse Hyperbolic Sine Function is presented in Figure 1 as $\sinh^{-1}(x) = \ln(x + (1 + x\hat{}2)\hat{}0.5)$.

***** INSERT FIGURE 1 ABOUT HERE *****

All regressions presented here are obtained from using STATA version 8.0.

4 Estimation Results

***** INSERT TABLE 2 ABOUT HERE *****

The regression results from estimating Equations (2a) and (2b) simultaneously for inward and outward FDI, are presented in Table 2.

Equation (2a), inward foreign direct investment $FDI_{ij,t}$ is presented as function of some or all the variables in the basic specification:outward FDI $FDI_{ji,t}$, world oil prices Oil_t, financial risk in the recipient country j $Fin\_Risk_{j,t}$, exchange rate of country j $Exchr_{j,t}$, and openness of the recipient country j $Openness_{j,t}$.

In Equation (2b), outward FDI $FDI_{ji,t}$ is presented as function of some or all the following variables in the basic specification: outward foreign direct investment $FDI_{ij,t}$, the recipient country's gross domestic product $GDP_{j,t}$, the investing country's gross domestic product $GDP_{i,t}$, skillness of the investing country $Skillness_{i,t}$, and the openness of the investing country $Openness_{i,t}$.

The overall results from estimating Equations (2a) and (2b) in a simultaneous equations system are presented in specifications 1 through 3, in Table 2. The results indicate that inward FDI is positively affected by outward FDI, and vice versa. This is as could be expected in the sense that there may be some complementary effects between inward and outward FDI, driving multinationals to increase their FDI, as result of increased multinational activities.

Let us then look at the explanatory variables. All the explanatory variables in Equation (2a) and Equation (2b) are estimated as having the same sign and all the variables and are also estimated to be similar in size.

Equation (2a) inward estimates indicate that inward FDI is positively affected by the pollution manufacturing quota, which is as could be expected, since increased quota allowance is likely to positively affect FDI. Moreover, I find inward FDI to be negatively affected by oil world prices, which is also as could be expected since increase energy prices is likely to halter investment incentives in the power industry, especially when hydropower price is tagged to world oil prices like in the case of

hydropower price in Iceland. Inward FDI is also found to be negatively affected by financial risk in the host country which is certainly as could be expected, since more financial risk in host is likely to reduce investment incentives in host. The third explanatory variable for inward FDI, that is the host country exchange rates, is also estimated to be negative. This is also as could be expected since it reflects on higher barriers for foreign investors when entering the host market. Also the openness variable is estimated to be negative, which indicates that investment decreases as the economy becomes more open. This is surprising, since one would expect FDI to increase with increased openness. However the variable is only estimated to be significant in one of the three cases, which diminishes the results.

Finally the last variable for greenhouse gas omission, presented in carbohydrate equivalence, is estimated to be positive. That is as could be expected, since more pollution allowance for the manufacturing industry is likely to positively influence investment incentives.

Equation (2b) outward estimates indicate that outward FDI is positively affected by both host country gross domestic production (GDP), which is in line with the gravity model based on Newtons hypothesis that as the mass of objects increases, the more flow between them. One of the interesting results is how much positive effects skillness is estimated to have on outward FDI. Finally, openness in the recipient country is estimated to have positive effects on outward FDI. That is as could be expected, since foreign markets can be expected to attract more FDI with an increase in openness.

5 Conclusions

This paper applies a combination of a knowledge capital (KK) model and a gravity model to analyze the substitution between inward and outward foreign direct investment. The study focus is on bilateral flows flowing in and out of the case country Iceland, a very remote small island in the middle of the Atlantic. A combination of a gravity model and KK model is well suited for this case since then remoteness, endowments and economics of scale can be accounted for. Estimating a country like Iceland by the KK model framework provides an opportunity to look at one corner of the KK model diagram, due to the smallness of the country and its highly skilled labor. Also, the use of Iceland as a case country allows for additional variable inclusion, since the country is rich in endowments like power resources, and human capital.

I also use a log-linear functional form derived from using a hyperbolic sine function, which enables me to incorporate both zeros and negatives.

The usage of simultaneous equation system allows for estimating in- and outflow of FDI as a function of each other. Taken together, estimates indicate that inward and outward FDI can be considered to be substitutes of each other.

6 Data Appendix

The variables included in the regressions are based on two data sources mainly, these are data from the Central Bank of Iceland, and the World Bank. The time period analyzed runs from 1989 through 2001. The foreign direct investment (FDI) data are obtained from the Central Bank of Iceland, both the inflow and outflow data. Data on gross domestic product (GDP) are obtained from World Bank, World Development Indicators (WDI) as GDP (constant 1995 US$). Data on Greenhouse gass omission allowance, in the manufacturing industry in host, is obtained from The Environment and Food Agency of Iceland. Openness indices for the host and home country are obtained from Penn-World Tables (as the ratio of imports and exports divided by GDP). Financial risk measures are obtained from the International Country Risk Guide. Data on Oil prices are received from the Energy Information Administration, Official Energy Statistics from the U.S. Government. Data on skilled labor are received from the International Labour Organization, as total employment, by occupation. Finally, exchange rate data are from IFS International Financial Statistics database, as national currency per US$, end of period.

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Table 1. Variable Definition

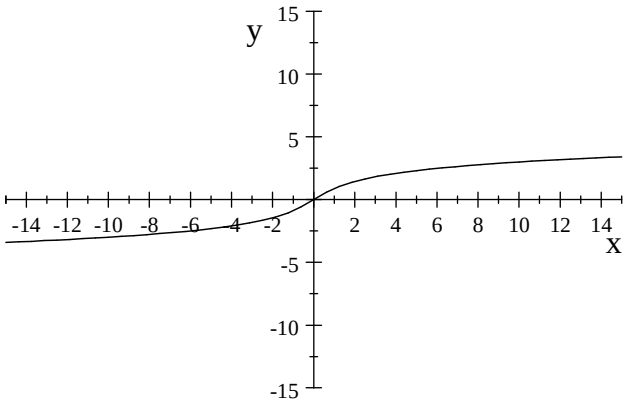
Variable	
$FDI_{ij,t}$	Foreign Direct Investment (FDI) from country (i) to (j), over time (t).
$FDI_{ji,t}$	Foreign Direct Investment (FDI) from country (j) to (i), over time (t).
$GDP_{j,t}$	Gross Domestic Product (GDP) of country (j) , over time (t).
$GDP_{i,t}$	Gross Domestic Product (GDP) of country (i) , over time (t).
$C0_2\_Manuf_{i,t-1}$	Greenhouse gass omission allowance in the manufacturing industry in country (i). Lagged by one time period denoted as (t-1). Gass omission presented in carbohydrate equivalence, thousands of tons.
$Openness_{j,t}$	Openness of country (j), over time (t).
$Openness_{i,t}$	Openness of country (i), over time (t).
Oil_t	World Oil price, over time (t).
$Skillness_{i,t}$	Skills in country (i) over time (t), as measured by the International Labor Organization (ILO).
$Fin\_Risk_{j,t}$	Financial Risk in country (j), over time (t).
$Exchr_{j,t}$	Exchange Rate of country (j), over time (t).

Table 2. Empirical Findings for Simultaneous Equation System

Regressors	Specification 1	Specification 2	Specification 3
$FDI_{ij,t}$			
$FDI_{ji,t}$	$.219^{***}$ (4.37)	$.229^{***}$ (4.73)	$.231^{***}$ (4.62)
Oil_t	-17.156^{**} (-1.99)	-13.096 (-1.62)	-15.558^{*} (-1.84)
$Fin\_Risk_{j,t}$	-45.422^{**} (-2.28)	-50.356^{**} (-2.48)	-44.543^{**} (-2.22)
$Exchr_{j,t}$	-14.549^{**} (-2.44)	-7.408 (-1.25)	-14.090^{**} (-2.39)
$Openness_{j,t}$	-10.477 (-1.19)	-24.545^{**} (-2.29)	-11.973 (-1.40)
$C0_2\_Manuf_{i,t-1}$		$.618^{*}$ (1.84)	
$Constant$	3936.918^{***} (3.03)	4152.419^{***} (3.23)	3935.279^{***} (3.01)
Obs.	180	180	180
R-Sq.	-0.058	-0.083	-0.089
χ^2	46.92	58.14	50.05
$FDI_{ji,t}$			
$FDI_{ij,t}$	1.041^{*} (1.79)	1.357^{**} (2.49)	1.1923^{**} (2.05)
$GDP_{j,t}$	$8.09e-07^{***}$ (4.87)	$7.31e-07^{***}$ (4.47)	$7.50e-07^{***}$ (4.73)
$GDP_{i,t}$	$1.85e-10^{***}$ (4.11)	$1.76e-10^{***}$ (3.83)	$2.02e-10^{***}$ (3.26)
$Skillness_{i,t}$	3222.261^{***} (2.80)	2989.466^{***} (2.70)	2819.861^{***} (2.57)
$Openness_{i,t}$			3.111 (0.81)
$Constant$	-6529.163^{***} (-5.08)	-5930.908^{***} (-4.70)	-6239.065^{***} (-4.83)
Obs.	180	180	180
R-Sq.	0.263	0.179	0.218
χ^2	69.80	67.44	74.18

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

Figure 1: The Inverse Hyperbolic Sine Function



Source: Author's computations.

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