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The vertical investment controversy: Re-estimating the knowledge-capital model for different types of FDI

by

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Abstract

The knowledge-capital model acknowledges that FDI has both vertical as well as horizontal elements. However, there is much controversy with regard to the empirical relevance of vertical FDI. We re-investigate this issue by looking at FDI at a more disaggregated level, using data on bilateral FDI in manufacturing and services for a number of industrialised countries. Our results are strongly supportive of a vertical FDI component within manufacturing. However, for service FDI our estimation results only give support to horizontal FDI. These findings clearly indicate that, once we take the heterogeneity in types of FDI into account, we can draw a more differentiated picture than previous studies providing evidence for vertical investment in manufacturing but not in services FDI.

JEL classification: F23

Keywords: Knowledge capital model, services FDI, vertical investment

Outline

1. *Introduction*
2. *Theoretical background*
3. *Econometric model and data*
4. *Estimation results*
5. *Conclusion*

Non-Technical Summary

In the wake of increasing "globalization" of the world economy, the location decisions of multinational firms have become intensely scrutinized in the public debate and popular media. A glance at the business press shows plenty of recent examples of firms moving part of their production facilities abroad, a move accompanied by an animated debate on the possible reasons for the decision and implications for the home country. In the public debate, production cost differences are generally highlighted as reasons for establishing facilities overseas – an indication of "vertical investment" by multinationals.

Of course, vertical investment is only one aspect of multinational activity, the other being horizontal Recently, the knowledge capital model provides a synthesis of theory in which both types of multinational firms can emerge endogenously, depending on characteristics of the home and host country. Carr, Markusen and Maskus (2001) provide an empirical estimation of this model and find evidence for both horizontal and vertical investment activity in their data for US multinationals. However, Blonigen, Davies and Head (2003) argue that the empirical implementation of the model is misspecified. Once specifying it correctly, they find no evidence for vertical investment in their empirical analysis.

This lack of evidence for vertical investment is puzzling, not least because of the plentiful case studies and anecdotes showing that firms move abroad to save on production costs, i.e., invest vertically. In the general equilibrium perspective of the KC model this should be mirrored by foreign direct investment (FDI) being responsive to differences in relative factor endowments. What has been neglected in the literature thus far is, however, a recognition that different types of FDI may be driven by different motives.

In this paper, we take this into account and look specifically at differences between manufacturing and services FDI. We argue that vertical investment in the knowledge capital model most appropriately describes manufacturing, rather than services activity. Our results show that, even in the basic estimation a la Blonigen, Davies and Head (2003) we find evidence for vertical investment in manufacturing, but not in services activities of multinationals. We implement our empirical approach using bilateral data on FDI for European and major non-European countries for the period 1994 to 2001, rather than unilateral data on US FDI as have been used in the earlier studies. While Blonigen et al. also estimate an additional model using OECD data, their data only cover 1982 to 1992, hence our analysis looks at a much more up-to-date time period. Furthermore, we allow for bilateral fixed effects in order to avoid omitted variable bias by controlling adequately for time invariant factors such as institutional and cultural factors that may determine foreign direct investment.

I Introduction

In the wake of increasing "globalization" of the world economy, the location decisions of multinational firms have become intensely scrutinized in the public debate and popular media. A glance at the business press papers shows plenty of recent examples of firms moving part of their production facilities abroad, a move accompanied by an animated debate on the possible reasons for the decision and implications for the home country. In the public debate, production cost differences are generally highlighted as reasons for establishing facilities overseas - an indication of "vertical investment" by multinationals.

Of course, vertical investment is only one aspect of multinational activity, the other being horizontal investment.[1] Recently, Markusen (2002) provides a comprehensive model in which both types of multinational firms can emerge endogenously, depending on characteristics of the home and host country. This model has become known as the *knowledge-capital-model (KC)*. Carr, Markusen and Maskus (2001) provide an empirical estimation of this model and find evidence for both horizontal and vertical investment activity in their data for US multinationals. However, Blonigen, Davies and Head (2003) argue that the empirical implementation of the model in Carr et al. is misspecified. Once specifying it correctly, they find no evidence for vertical investment in their empirical analysis.

This lack of evidence for vertical investment is puzzling, not least because of the plentiful case studies and anecdotes showing that firms move abroad to save on production costs, i.e., invest vertically. In the general equilibrium perspective of the KC model this should be mirrored by foreign direct investment (FDI) being responsive to differences in relative factor endowments, which is not the case in the empirical analysis by Blonigen et al. (2003). Recently a few studies have emerged that show that by using different econometric specifications or definitions of variables, the vertical investment motive attracts some evidence in

[1] See, for example, Markusen (1984) and Markusen and Venables (1998) for models of the former, and Helpman (1984) and Helpman and Krugman (1985) for models of the latter form of multinational activity.

an empirical estimation of the KC model (see, Braconier, Norbäck and Urban (2004) and Davies (2004)).[2]

What has been neglected in the literature thus far is, however, a recognition that different types of FDI may be driven by different motives. In this paper, we take this into account and look specifically at differences between manufacturing and services FDI. We argue that vertical investment in the knowledge capital model most appropriately describes manufacturing, rather than services activity. Our results show that, even in the basic estimation a la Blonigen et al. (2003) we find evidence for vertical investment in manufacturing, but not in services activities of multinationals. We implement our empirical approach using bilateral data on FDI for European and major non-European countries for the period 1994 to 2001, rather than unilateral data on US FDI as have been used in the studies by Carr et al. (2001) and Blonigen et al. (2003). While Blonigen et al. also estimate an additional model using OECD data, their data only cover 1982 to 1992, hence our analysis looks at a much more up-to-date time period. Furthermore, we allow for bilateral fixed effects in order to avoid omitted variable bias by controlling adequately for time invariant factors such as institutional and cultural factors that may determine foreign direct investment.

Section II discusses the theoretical background and summarizes previous empirical work. Section III introduces the empirical model and describes the data set, while the estimation results are discussed in Section IV. Finally, Section V concludes.

II Theoretical Background

Foreign direct investment essentially represents activities of multinational firms. Up until recently the theoretical literature on multinational firms was divided into models concerned with horizontal and vertical multinationals, respectively.

[2]Hanson, Mataloni and Slaughter (2001) also argue that the importance of vertical FDI is understated in these analyzes. They use data on intra-firm trade of US multinationals to show their importance.

Horizontal multinational firms can be characterized as multi-plant firms that produce similar goods and services in different countries. Models on horizontal multinational firms include seminal contributions by Markusen (1984), Horstmann and Markusen (1987) and Markusen and Venables (1998). The establishment of horizontal multinationals is essentially determined by a trade-off between economies of scale and trade costs. If trade costs were non-existing there would only be single-plant firms serving all markets from one location fully utilizing economies of scale. In this type of models trade and multinational activities are substitutes.

Vertical multinationals on the other hand are multi-plant firms that geographically fragment production into stages with different factor intensities economizing on factor price differences between countries. Models on vertical multinationals include Helpman (1984) and Helpman and Krugman (1985). Vertical multinationals in this class of models arise due to differences in relative factor endowments between countries. Trade costs are impediments to the establishment of multinational firms. As opposed to the implications of horizontal models, trade and vertical multinationals' activities are complements.

The recent contributions to the theoretical literature by Markusen (2002) integrate both strands of the theoretical literature. In the so called *knowledge-capital-model* three types of firms (national firms, horizontal multinationals and vertical multinationals) can arise endogenously depending on the characteristics of the home and foreign country. Horizontal multinational firms will be dominant if countries are similar in size and relative endowments and trade costs are sufficiently high. The intuition behind this is that if countries are very dissimilar in size but similar in endowments the larger country will be preferred as location as the firm can exploit economies of scale and export to the smaller country. Hence, there is no scope for horizontal multinationals.

On the other hand, if countries are different in relative endowments but similar in size then vertical multinationals will be the dominant firm type in the model, since factor price

differences motivate geographical fragmentation of production. If for instance the home country is skilled-labour abundant relative to the foreign country it is profitable to establish plants in the foreign country that specialize in low-skill intensive production stages, while skill-intensive headquarter activities will be located in the home country. This holds as long as trade costs from the host country to the home country are sufficiently low. Note that trade costs have different effects on horizontal and vertical multinationals; rising trade costs favour horizontal multinationals' activities but affect adversely activities of vertical multinationals.

In the empirical literature on the location of multinationals, a well known paper by Brainard (1997) is one of the first papers that estimates an empirical model of FDI closely related to the theory of horizontal multinationals. She presents evidence suggesting the importance of the "proximity-concentration hypothesis" for explaining the operations of horizontal multinationals.

More recently, a number of studies have emerged that are direct implementations of the knowledge-capital model. Related to the theory, variables used to identify the two different investment motives are differences in size and skill endowments between the home and the host country. Horizontal FDI is expected to dominate if countries are similar in relative size and endowments, hence FDI is assumed to be negatively related to variables measuring size and endowment differences. Vertical investment, on the other hand, is expected to increase with increasing differences in skill endowments. Therefore, an estimated positive coefficient on the proxy for differences in skill endowments is taken as evidence suggestive of vertical FDI.

Carr et al. (2001) use bilateral data for the US and a number of partner countries and specify an empirical model closely related to the theory. They find that total FDI decreases with differences in market size, but increases with differences in relative endowments between the US and the partner countries. The former result suggests horizontal investment, while the latter finding is consistent with vertical multinationals. Hence, their analysis provides

evidence for both types of investment in the data. In an extension of that analysis, using a similar data set and empirical specification, Markusen and Maskus (2001) however show that the support for the vertical motive in the earlier paper has to be qualified. In a specification using only data for US outward FDI they do not find evidence for vertical investment; a finding they explain mainly by the extremely large market size of the US relative to the partner countries.

Blonigen et al. (2003) argue that the original empirical implementation used by Carr et al. (2001) mis-specifies the proxy for relative skill endowments, the crucial variable to identify vertical FDI in the model. They show that, once correcting for the mis-specification, they do not find any evidence for vertical investment using the same data and specification as used by Carr et al. In their estimation, the evidence strongly supports horizontal FDI instead. They also apply the model to a sample of OECD data, with the same result.

A couple of recent papers argue that the failure to pick up vertical investment in the data is due to incomplete specification of the estimation equation in the earlier papers. Davies (2004) argues that a simple variable capturing relative endowments is not sufficient to capture vertical FDI. He shows that, when including a squared term of the relative skill endowments, there is some evidence for vertical investment in a sample of US FDI similar to the data used by Blonigen et al. (2003), and, to a lesser extent, also in a sample of OECD bilateral data. Braconier et al. (2004) also use different skill measures, which they argue are more closely related to theory, and find evidence for vertical FDI in OECD data.

Our paper takes a different approach towards solving the "vertical investment controversy". We go back to the specification used by Carr et al. (2001) taking account of the criticism by Blonigen et al. (2003). We argue that a reason for the failure to detect vertical FDI in this specification is that all papers thus far use data on *total* FDI and, hence, disregard the potential heterogeneity in different types of multinational activity. Specifically, we show that distinguishing manufacturing and services FDI is fruitful. Vertical multinationals

in the KC model are firms that move production processes to an unskilled labour abundant country, while headquarter services remain in the skilled labour abundant home country. The final (manufactured) good is then exported back to the home country. Arguably, this set up of vertical multinationals most appropriately describes manufacturing, rather than services activities, popular examples being sportswear or computers. Services, on the other hand, remain to a large part non-tradeable and foreign investment in these activities can, hence, be mostly assumed to be of a horizontal nature.[3] In our empirical estimations we find evidence for vertical FDI in manufacturing but not in services activities of multinational firms.

III Econometric Model and Data

We expand on Carr et al. (2001) and Blonigen et al. (2003) and estimate the following basic two-way panel model to explain bilateral FDI between countries i and j:

$$\begin{aligned} FDI_{ijt} &= \alpha + \beta_{GS}\, GDPsum_{ijt} + \beta_{GD}\, GDPdiff_{ijt} + \beta_{ED}\, ENDOWdiff_{ijt} \quad (1) \\ &+ \beta_{GED}\, (GDP - Diff \times ENDOW - Diff)_{ijt} \\ &+ \beta_{TCI}\, IMPT_{jit} + \beta_{TCE}\, EXPT_{ijt} \\ &+ \beta_{TED}\, (IMPT \times ENDOWdiff)_{jit} \\ &+ \delta_t + \vartheta_{ij} + \epsilon_{ijt} \end{aligned}$$

where FDI_{ijt} denotes the total outward stock of foreign direct investment from country i in country j at time t in real terms. The explanatory variables are closely related to the KC model.[4] The first term, $GDPsum$ denotes overall bilateral market size and is

[3] Only recently has vertical investment in certain financial services become more important, with, for example, certain US and UK banks and insurance companies locating some of their back office activities and call centres in developing countries.

[4] See the appendix for a definition of the variables.

intended to capture the positive effect of overall market size on foreign direct investment. $GDPdiff$ is calculated as the difference in market size between i and j in absolute values. The expected coefficient is negative, as the model predicts that horizontal FDI decreases as countries become more dissimilar. $ENDOWdiff$ denotes endowment differences, which we approximate by absolute GDP per capita differences following Baltagi, Egger and Pfaffermayr (2003). The definition of this variable is thus different from Carr et al. (2001) where endowment differences are calculated using data on the ratio of skilled workers in the labour force.[5] The variable is of particular interest in order to discriminate between vertical and horizontal FDI. If investment is of the vertical type, we would expect a positive correlation between relative endowment differences and FDI, while a negative correlation would indicate horizontal FDI. In order to take account of the criticism by Blonigen et al. (2003) we calculate the absolute value of the difference. Furthermore, we allow the effect of the variable to differ according to whether the endowment difference is positive or negative, i.e., whether the host is more or less skill abundant than the host country. In order to do so we define a dummy variable equal to one if the difference is positive, and zero if negative, and interact this dummy with $ENDOWdiff$.

Trade costs are also defined differently from Carr et al. (2001). The term $IMPT$ denotes trade costs in country i for imports from country j. Trade costs are calculated as the ratio of imports at values including cost, insurance, freight (cif) and exports at values free on board (fob). While the KC model assumes that trade costs are symmetric, this is not the case in the real world. Hence, we calculate a term $EXPT$ to capture costs of exporting from i to j. Since in the model horizontal foreign direct investment and trade are substitutes we expect

[5]The choice of definition is due to at least two reasons. First, the definition of skilled workers is based on broad occupational classifications which may not necessarily be comparable across countries. Hence, using GDP per capita may give a more objective measure. Second, data on GDP per capita are available for a larger group of countries, hence expanding our sample size.

a positive impact of trade cost on foreign direct investment. On the other hand, a negative sign may indicate vertical foreign direct investment as trade costs would make trade between parent and foreign affiliate more costly.

The model also includes an interaction term of size and endowment differences ($GDP - Diff \times ENDOW - Diff$) to take account of model nonlinearities.[6] If countries are different in size and endowments simultaneously Carr et al. (2001) argue that foreign direct investment is expected to be lower. In addition we interact import costs and endowment differences. Following Carr et al. (2001) we expect a negative coefficient as FDI that is driven by endowment differences (low-wage seeking) is hampered by trade costs.

Finally we decompose the error term into time specific components δ_t and following Hummels and Levinsohn (1995) bilateral fixed components ϑ_{ij}. The remaining error term ϵ_{ijt} is assumed to be idiosyncratic. Allowing for bilateral fixed effects as well as common time effects allows us to avoid omitted variable bias by comprehensively controlling for macro economic influences and time invariant country pair characteristics, such as distance, institutional and cultural factors (e.g., investment regulations and language) that may determine foreign direct investment.

Data on the outward stock of foreign direct investment was collected from the Eurostat *New Cronos* database which provides bilateral FDI data for European and major Non-European countries. The major advantage of this data as compared with FDI data from the OECD is that it enables us to differentiate simultaneously between sending and receiving countries as well as industries. In particular, the data allow us to distinguish FDI in manufacturing and non-manufacturing industries, where the latter is calculated as total minus manufacturing. According to the recent *World Investment Report* (United-Nations (2004)) 30 percent of outward FDI stocks from developed countries is in manufacturing, with 65 percent in services and only 5 percent in other industries. Hence, we refer to non-manufacturing

[6]Endowment and size differences are here not in absolute values.

as services FDI, given the predominance of services in non-manufacturing activities.

Our data relate to the period 1994 to 2001. While coverage of total FDI is fairly complete in the *New Cronos* data base, coverage of FDI in manufacturing industries is less satisfactory. In order to make our results comparable across manufacturing and services industries we also estimate the model for a joint sample where we only use observations for which both, total FDI as well as FDI in manufacturing are known. Table 1 lists the reporting countries and the number of bilateral observations that are available for each sample.

Information on GDP and population was obtained from the World Bank's *World Development Indicators* data base. All variables are expressed in real values, the respective deflators (capital stock deflator and GDP deflator) were also obtained from the World Bank.

Trade costs were calculated as the ratio between cif (cost insurance freight) imports and fob (free on board) exports utilizing information on imports and exports from the respective past three years. The respective trade data was obtained from the IMF Direction of Trade database.

In an alternative specification of the model we also include average tariff rates as an additional aspect of trade costs not captured with the cif/fob measure. Data for this variable were obtained from the World Bank. Furthermore, we include the Economic Freedom Index as a possible measure of investment cost to check the robustness of our results.[7] This index was provided by the Economic Freedom Network (http://www.freetheworld.com/download.html). Since the Economic Freedom Index is not available for all years we replaced missing information with previously available data in the respective year. Descriptive statistics on all variables of the model can be found in Table 4.

[7]This is somewhat similar to (Carr et al. (2001)) who use a similar index constructed from the *World Competitiveness Report* of the World Economic Forum. Unfortunately, after 1995 these data are not available in consistent form.

IV Estimation results

Table 2 Column I presents the estimated coefficients for the basic model using data on total FDI. Note, firstly, that an F-test for the joint significance of the bilateral fixed effects rejects the hypothesis that these are jointly equal to zero. Hence, the inclusion of this time invariant variable in the estimation is appropriate, and non-inclusion may lead to biased results.

In terms of the market size variables, our estimation supports the horizontal aspects of the KC model. Total FDI is positively associated with increasing size of both markets, but decreases as the two countries become more dissimilar in terms of their GDP.

We allow for different coefficients for country pairs with negative or positive endowment differences by including an interaction term between the absolute endowment difference and a dummy variable equal to one if the endowment difference is positive. This is in the spirit of Blonigen et al. (2003) who argue that the effects of endowment differences are not symmetric, that is they depend on whether the parent or the host country is more skill abundant. Blonigen et al. therefore estimate the model separately for a sample with positive and a sample with negative endowment differences. However, estimation over the full sample and simply interacting endowment differences is more efficient. The coefficients on endowment differences are statistically significant and negative indicating a dominance of horizontal FDI.

The interaction term of endowment and size differences is found to have a negative sign as predicted by the KC model. Trade costs particularly export costs have positive, albeit only weakly significant effects on FDI in this baseline specification. While these estimations provide, hence, some support to the horizontal motive, there is no statistically significant evidence to suggest vertical investment by multinationals. This is in line with Carr et al. (2001) and Blonigen et al. (2003). Hence, even though the definition of some of our variables differ from those papers, we obtain similar results on aggregate. Of course, so far we have looked at aggregate outward stocks of FDI only. These, as previously discussed, are dominated by investment in services industries. The KC model, however, arguably fits best

to manufacturing industries. We, therefore, distinguish total FDI into manufacturing and services and re-estimate Equation 1 for these two types of multinational activity separately.

Since the data on FDI, in total, services and manufacturing only partly overlap we re-estimate the model only using the joint sample for which data is available for all types of FDI. For the baseline specification with total FDI the formerly statistically significantly negative coefficients on endowment differences are now rendered insignificant. Also, we find no statistically significant trade cost effects on FDI (see Table 2 Column II) which can be explained by the different sample that exludes a number of country-partner pairs.

Columns III and IV in Table 2 present the estimated coefficients for service and manufacturing FDI. Again, for both types of FDI common market size has a strong statistically significantly positive effect on bilateral FDI while country size differences are found to be detrimental to FDI. As we expected, we can observe differences in the effects of endowment differences, the variable that according to Carr et al. (2001) allows us to distinguish vertical and horizontal FDI, for the two types of FDI.

For FDI in services we find no statistically significant effect of endowment differences indicating that FDI in services is likely dominated by horizontal FDI (see Table 2 Column III). Contrasting these results we find a positive and statistically significant coefficient on endowment differences for FDI in manufacturing. Furthermore this effect is indeed not symmetric. In line with the results of Blonigen et al. (2003) and Davies (2004) we find that for source countries that are better endowed with skills than the host country endowment differences have a smaller - yet still positive - impact on manufacturing FDI. Our results therefore indicate the presence of a vertical component to manufacturing, but not services FDI in the data.

In order to check the sensitivity of our results we estimate further specifications including additional control variables. Firstly we add the average tariff rate, which is a component of trade costs arguably not captured by the cif-over-fob trade costs variable. Also we include

the Economic Freedom Index of the respective host country as a potential indicator of investment costs. However, both additional control variables are statistically insignificant in all specifications and our results are not affected by this exercise (see Table 3).

Thus, independent of the used sample and chosen model specification our results suggest that the vertical component of the KC model fits better the data for manufacturing than for services FDI. This is intuitively plausible, as the set up of the theoretical model, in particular the description of vertical investment, arguably better describes manufacturing than services activities. The findings of our paper highlight that, once we take account of this heterogeneity in types of FDI, a simple implementation of the KC model a la Carr et al. (2001) and Blonigen et al. (2003) provides evidence for vertical investment in manufacturing but not in services FDI. This suggests that using data which aggregate manufacturing and other types of FDI may induce aggregation bias and hence make it more difficult to find convincing evidence for the KC model.

V Conclusion

While the recent theoretical literature, namely the KC model acknowledges that FDI has both vertical as well as horizontal elements there is much controversy with regard to the empirical relevance of vertical FDI. This controversy, however, can be resolved by looking at FDI at a more disaggregated level.

We expand on Carr et al. (2001) and Blonigen et al. (2003) in at least three ways. First, we differentiate between FDI in manufacturing and services and re-estimate the KC model for each separately. Second instead of using U.S. affiliate data we estimate the model for a large panel of 354 country-partner pairs controlling for bilateral fixed effects. Third, we allow for bilateral fixed effects in order to control for time invariant factors that may influence FDI. We also take account of the criticism by Blonigen et al. (2003) and calculate endowment differences in absolute values and allow the effect of the variable to differ according to whether

the home is more or less skill abundant than the host country. This is, however, achieved by interaction terms instead of by splitting up the sample and gives more efficient estimates.

We find a significant positive effect of endowment differences on manufacturing FDI, thus our results are strongly supportive of a vertical FDI component within manufacturing. However, for service FDI our estimation results only give support to horizontal FDI. These findings clearly indicate that, once we take the heterogeneity in types of FDI into account, we can draw a more differentiated picture than Blonigen et al. (2003) and Carr et al. (2001) providing evidence for vertical investment in manufacturing but not in services FDI. This suggests that the study of the determinants of FDI greatly benefits from the use of less aggregated data and after all lends support to the KC model at least within manufacturing industries.

VI Tables

Table 1: Bilateral Sample

	Number of bilateral observations	
Reporting country	Total Sample	Joint Sample
Albania	2	
Argentina	46	5
Australia	84	5
Austria	342	62
Belarus	26	
Belgium-Luxemburg	21	7
Brazil	60	5
Bulgaria	47	
Canada	126	52
Chile	24	
China	66	2
Colombia	22	
Croatia	31	3
Cyprus	27	
Czech Republic	126	24
Denmark	289	102
Egypt	24	
Estonia	32	8
Finland	277	182
France	401	117
Germany	413	124
Great Britain	379	179
Greece	78	37
Honk Kong	76	
Hungary	69	3
Iceland	77	
India	53	
Indonesia	44	
Iran	28	
Ireland	115	52
Israel	66	
Italy	266	121
Japan	229	62
Korea	79	5
Latvia	32	2
Lithuania	36	2
Malaysia	57	
Malta	15	
Mexico	50	2
Morocco	24	
Netherlands	368	126
New Zealand	35	
Norway	154	21
Philippines	23	
Poland	155	8
Portugal	180	46
Romania	24	
Russia	82	4
Serbia-Montenegro	20	
Singapore	76	2
Slovak Republic	70	35
Slovenia	125	
Spain	117	51
Sweden	196	75
Switzerland	358	24
Thailand	37	
Turkey	67	
Ukraine	41	
United States	408	138
Uruguay	24	
Sum	6819	1693

Table 2: Regression of *knowledge-capital-model*

	Joint Sample			
	Total FDI	Total FDI	Service FDI	Manufacturing FDI
$GDPsum$	0.019	0.027	0.023	0.004
	[30.13]***	[13.26]***	[13.21]***	[8.12]***
$GDPdiff$	-0.013	-0.016	-0.015	-0.001
	[18.38]***	[6.69]***	[7.10]***	[2.38]**
$ENDOWdiff$	-257903	188195	759	184643
	[3.99]***	[0.48]	[0.00]	[2.13]**
$ENDOWdiff * (POS = 1)$	170164	41567	184436	-139462
	[3.15]***	[0.12]	[0.63]	[1.87]*
$ENDOWdiff \times GDPdiff$	-0.105	-0.219	-0.174	-0.045
	[16.68]***	[6.60]***	[6.05]***	[6.10]***
$ENDOWdiff \times EXPT$	-40144.544	-122750	-82517.882	-40251.418
	[1.66]*	[0.59]	[0.46]	[0.88]
$IMPT$	52922065	1077000000	579300000	497800000
	[0.30]	[0.54]	[0.34]	[1.14]
$EXPT$	869200000	8572000000	7342000000	1216000000
	[1.69]*	[1.63]	[1.61]	[1.05]
Constant	-9032000000	-36170000000	-29770000000	-6386000000
	[8.95]***	[4.78]***	[4.53]***	[3.81]***
Observations	6819	1693	1693	1693
Number of country pairs	1227	354	354	354
R^2	0.29	0.33	0.3	0.28
F-test on fixed pair effects	$F = 12.99$	$F = 10.57$	$F = 7.92$	$F = 17.75$
	$p = 0.00$	$p = 0.00$	$p = 0.00$	$p = 0.00$

Notes: t-statistics in parentheses; regressions include full set of time, pair fixed effects.
Coefficient on interaction term $ENDOWdiff \times GDPdiff$*1000000

Table 3: Regression of *knowledge-capital-model* with joint sample and additional controls

	Total FDI	Service FDI	Manufacturing FDI
$GDPsum$	0.027	0.023	0.004
	[13.09]***	[13.01]***	[8.07]***
$GDPdiff$	-0.016	-0.015	-0.001
	[6.61]***	[7.00]***	[2.39]**
$ENDOWdiff$	184969	-1634	186603
	[0.47]	[0.00]	[2.13]**
$ENDOWdiff * (POS = 1)$	68170.492	220893.742	-152723.250
	[0.20]	[0.73]	[1.97]**
$ENDOW - Diff \times GDP - Diff$	-0.219	-0.174	-0.045
	[6.54]***	[6.00]***	[6.01]***
$ENDOWdiff \times EXPT$	-125738	-87819	-37918
	[0.61]	[0.49]	[0.82]
$IMPT$	1095000000	617300000	478100000
	[0.55]	[0.36]	[1.08]
$EXPT$	8749000000	7625000000	1124000000
	[1.66]*	[1.67]*	[0.96]
Average Tariff	-52850000	-103300000	50428678
	[0.21]	[0.46]	[0.88]
Economic Freedom Index	-370800000	-512600000	141800000
	[0.34]	[0.54]	[0.58]
Constant	-34270000000	-27110000000	-7160000000
	[3.67]***	[3.34]***	[3.44]***
Observations	1693	1693	1693
Number of country pairs	354	354	354
R^2	0.33	0.3	0.28
F-test on fixed pair effects	$F = 10.37$	$F = 7.75$	$F = 17.57$
	$p = 0.00$	$p = 0.00$	$p = 0.00$

Notes: t-statistics in parentheses; regressions include full set of time, pair fixed effects.
Coefficient on interaction term $ENDOWdiff \times GDPdiff$*1000000

Table 4: Descriptive Statistics

Variable	Total sample		Joint sample	
	Mean	Standard Deviation	Mean	Standard Deviation
$GDPsum$	2120000000000	2590000000000	2430000000000	2690000000000
$GDPdiff$	1690000000000	2380000000000	1760000000000	2310000000000
$ENDOWdiff$	16562	11147	12552	10227
$ENDOWdiff * (POS = 1)$	10627.17	12376.33	8991.90	10978.44
$ENDOWdiff \times GDPdiff$	27300000000	60000000000	18700000000	48500000000
$ENDOWdiff^2 \times EXPT$	20028.52	25193.57	14932.22	21460.24
$IMPT$	1.18	0.90	1.08	0.45
$EXPT$	1.16	0.99	1.09	0.49
Average Tarif	5.10	6.52	2.42	3.97
Economic Freedom Index	7.03	1.23	7.40	0.91

A Definitions of variables

FDI_{ijt} denotes the total outward stock of foreign direct investment from country i in country j at time t in real terms.

The explanatory variables are defined as follows:

$GDPsum_{ijt} = GDP_{it} + GDP_{jt}$

$GDPdiff_{ijt} = |GDP_{it} - GDP_{jt}|$

$ENDOWdiff_{ijt} = |\frac{GDP}{capita}_{it} - \frac{GDP}{capita}_{jt}|$

$POS = 1$ if $\frac{GDP}{capita}_{it} - \frac{GDP}{capita}_{jt} > 0$

$POS = 0$ otherwise

$ENDOW - Diff_{ijt} \times GDP - Diff_{ijt} = (\frac{GDP}{capita}_{it} - \frac{GDP}{capita}_{jt}) \times (GDP_{it} - GDP_{jt})$

$IMPT_{ijt} = IMP^{cif}_{ijt} / EXP^{fob}_{jit}$

$EXPT_{ijt} = IMP^{cif}_{jit} / EXP^{fob}_{ijt}$

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