Vertical FDI Revisited[¤]

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Abstract

In this study, we explore how relative skilled-wage premia a¤ect FDI. Contrary to previous studies based on factor endowment di¤erences, we ...nd strong support for vertical FDI, in the sense that more FDI is conducted in countries where unskilled labor is relatively cheap. In addition, we ...nd that relative skill-premia also a¤ect FDI activities that have previously been associated with horizontal FDI, i.e. local a¢liate sales. Consequently, the potential e¤ects of changes in relative wage costs on international production reallocation within MNEs are large. In fact, we assess that the 8% rise in the US skilled wage premium relative to the average host country from 1986 until 1994 has led to an increase in annual US a¢liate sales abroad amounting to about half a percentage point of US GDP.

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1 Introduction

Within the theory of multinational enterprises (MNEs), two different theories have been advanced. First, the theory of horizontal foreign direct investment (FDI) stresses the importance of trade costs and access to local markets as the primary motives of FDI location decisions. Second, the theory of vertical FDI stresses differences in relative factor costs and the fragmentation of production between countries. Through the increasing integration between countries in different stages of development, such as NAFTA or the enlargement of the EU, the focus of interest in the public debate has shifted towards vertical FDI theory. One of the main fears among policy makers is the loss of employment, as MNEs relocate production to low-wage countries to reap gains from factor cost differences.[1]

Contrary to these fears, empirical research has shown relatively little evidence of vertical FDI, whereas there is strong support in favor of the horizontal FDI model (Markusen and Maskus, 1999, 2001; Blonigen et al. 2002; Brainard, 1997). The rejection of the vertical FDI model is usually made in two steps. Firstly, as discussed by e.g. Brainard (1993), the scope for vertical FDI models is usually regarded as limited, as vertical FDI is defined as exports from affiliates to the home country. This narrow definition means that the scope for a vertical decomposition of production is small, given these exports' small share in total affiliate production.

The second reason why models of vertical FDI tend to be rejected is that relative labor endowments - measured as the ratio of skilled to unskilled workers - do not have a significant, or consistent, impact on MNEs' foreign affiliate sales (Carr et. al., 2001; Markusen and Maskus, 1999, 2001; Blonigen, 2002;). This has lead to the conclusion that vertical FDI and, hence, international differences in relative factor endowments, is of no importance for explaining MNE activities in general.

In contrast, we show that (1) FDI is strongly sensitive to relative factor costs rather than relative factor endowments, and (2) the scope for vertical decomposition of production

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[1]See e.g. the home page of the International Labor Organization (http://www.itcilo.it/english/ actrav/telearn/global/ilo/seura/mains.htm#Globalization and employment) on references to the anti-globalization debate.

across borders is much larger than shown by previous studies, as it encompasses both local sales of a¢liates as well as exports to third countries and imports of a¢liates from the home country. These new results follow from a number of empirical innovations in the paper namely; (a) replacing factor endowment data with previously unused relative wage costs, (b) pooling US and Swedish outward FDI data and (c) systematically investigating di¤erent components of a¢liate activities.

The use of relative factor costs rather than factor endowments has an obvious advantage, since …rms' incentives to conduct vertical FDI are directly related to relative factor costs, but only indirectly to factor endowments. There are several explanations why the link between factor costs and endowments may break down, for example di¤erences in preferences, labor market imperfections and distortions.[2] In fact, our data show that relative factor costs and relative factor endowments are not highly correlated. In addition, a low correlation between di¤erent measures of factor endowments suggests that measurement errors are important. In this study, we apply previously unused data on gross wages of engineers and production workers as measures of the skill premium, obtained from a published survey of the commercial bank UBS.

The pooling of Swedish and US outward FDI provides us with home-host country matches of relative endowments for which theory suggests a prevalence of vertical FDI, whereas the US data in previous studies lack observations exactly where vertical FDI is expected. The re…ned set of components of a¢liate activity allows a more precise measurement, because some of these components, e.g. exports to the home country and third countries, are more sensitive to factor costs than others, e.g. local sales.

In addition to our …nding that relative wage cost di¤erences between host and home countries a¤ect a¢liate sales, we also show that the impact of wage cost di¤erences varies systematically with the target for a¢liate sales. Our results show that the impact of differences in relative wage cost is larger on a¢liate exports to the MNEs' home country than a¢liate exports to other countries, whereas the latter are more dependent on di¤erences in relative wage cost than the a¢liates' local sales. Consequently, the impact of di¤erences

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[2] See e.g. Brainard (1997) for a discussion.

in relative wage cost is larger for the type of activities with a larger potential for vertical decomposition of production. Apart from the impact of differences in relative wage cost, we generally find that the quantitative effects of other explanatory variables, such as market size and distance, differ across the three types of affiliate sales. In most cases, these quantitative differences are in line with what would be expected from theory, where e.g. (host) market size is more important for local sales than for affiliate exports. We do not, however, find any qualitative differences in the impact from explanatory variables on the three types of affiliate activities and local sales, exports to the home country and exports to other countries thus seem to be driven by the same factors.

The rest of this paper is organized as follows. Previous studies are briefly discussed in section 2. In section 3, we discuss the contributions of the paper and how it is related to previous studies. The data is presented in section 4, while the empirical results are presented in section 5. In section 6, we give some concluding remarks.

2 Previous Literature

MNEs are often classified to be of the horizontal or vertical type according to their motive of affiliate operations. In general terms, horizontal MNEs conduct FDI in order to improve access to some host country market, while vertical FDI is undertaken in order to reap benefits from international factor price differences.[3]

The theoretical literature on horizontal FDI is well-known and does not constitute the focus of this paper.[4] Therefore, we concentrate on a brief discussion of vertical FDI models. In Helpman (1984), the formation of MNEs is driven by factor endowment differences. The geographical separation of high-skilled labor intensive headquater services and low-skilled labor intensive production activities, leads to cost savings for the MNE. Thus, vertical FDI is observed in countries sufficiently abundant in low-skilled labor.

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[3] See Hanson, Mattaloni, and Slaughter (2001) for this definition. Brainard (1993) uses the term factor proportion theory of FDI instead of vertical FDI theory. In contrast, Markusen (1995) defines vertical FDI as a geographical separation of production stages which we will refer to as fragmentation.

[4] See Markusen (1995) for a survey.

In the Knowledge Capital Model (KCM), developed by Markusen, et. al. (1996), FDI is driven by both factor costs and market access and, thus, the KCM model incorporates both vertical and horizontal FDI. Three ...rm types exist in this two-good, two-factor, and two-country model. The ...rst type duplicates a domestic production plant in the host country (horizontal FDI), whereas the second type slices up the value chain by locating high-skilled labor intensive headquater services in the high-skilled labor abundant home country and low-skilled labor intensive production activity in the low-skilled labor abundant host country (vertical FDI).[5] The third type produces solely in the home country and serves foreign markets by exports. MNEs of the vertical type export (part of) their production to the home country, while MNEs of the horizontal type sell all their production locally.[6]

These predictions are illustrated in the Edgeworth box in Figure 1. Country endowments of skilled and unskilled labor are measured on the vertical and horizontal axes, respectively. The origin of the home country is in the South-West corner, while the origin of the potential host country is in the North-East corner of the diagram. The triangle above the diagonal going through the origins is the parameter space, where the home country is abundant in skilled-labor. Hence, vertical FDI is found in the North-West corner of the Edgeworth box (VFDI), where relative endowments are very di¤erent, while horizontal FDI is found at the center of the Edgeworth box (HFDI), where relative endowments and relative country size are similar.

Confronting these theories with empirical evidence, we observe quite a diverse picture. Table 1 gives an overview of previous empirical results. The empirical evidence on horizontal FDI strongly supports the market access and tari¤ jumping hypothesis (Brainard, 1997) while there is little evidence on vertical FDI driven by relative factor endowments.[7]

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[5]Hence, vertical FDI is related to international production fragmentation (Venables, 1999), although the two concepts are not identical.

[6]The home country of a multinational ...rm is de...ned as the country where the headquater is located. The host country is de...ned as the country where the foreign a¢liates of the corresponding ...rm are located. Other countries are third countries that are neither host nor home countries, but export destinations of a¢liates.

[7]There is a strand of literature seeking indirect evidence by investigating whether a¢liate sales or production are complements or substitutes to trade ‡ows. See e.g. Swedenborg (1979) and Blonigen

Brainard (1993) finds mixed evidence for vertical FDI and concludes that it is not empirically important. In addition, and contrary to theory, Brainard (1997) finds that US affiliate production is significantly lower in countries with a relatively low GDP per worker, which is claimed to be a proxy for skill endowments.[8]

Carr et. al. (2001) find support for the Knowledge Capital Model (KCM) which encompasses both horizontal and vertical FDI. However, when regressing total US affiliate exports on differences in relative factor endowments, Markusen and Maskus (2001) find a negative relation contrary to vertical FDI theory. In addition, Markusen and Maskus (1999) reject the vertical FDI model, as well as the KCM model, in favor of the horizontal FDI model as an explanation for MNE production. Blonigen et al. (2002) argue that the contradicting results in the above papers stem from an incorrect empirical specification of the non-linear functional form in the skill difference term. This specification error becomes significant when pooling US-inward and outward FDI data. When correcting for this by using absolute values of factor endowment differences, they show that affiliate activity between countries decreases as absolute differences in skill-labor abundancy widen. This is taken as evidence in favor of horizontal FDI, rejecting the KCM and vertical FDI as a driving force for FDI activity while using the same data as Carr et al. (2001). ?******* substantive change in paragraph above *********?

Hanson, Mataloni, and Slaughter (2001) investigate US intra-firm trade flows (among others things) and show that production fragmentation is more widespread than previously thought. However, they do not regress affiliate flows on skill endowments or factor costs. Following Brainard (1997) they use GDP per capita as a skill measure. They obtain mixed evidence on vertical FDI in the sense that FDI is driven by relative factor cost differences, finding that higher host-country GDP per capita increases affiliate exports, as well as

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(2001). Another related strand of literature explores whether employment in different locations, within the same MNE, are complements or substitutes. See e.g. Brainard and Riker (1997) and Braconier and Ekholm (2000, 2001a, 2001b).

[8]Using Swedish data, Norbäck (2000) finds some evidence of a positive relation between the affiliate share of foreign sales and the ratio of GDP per capita between the home and host country.

imports from parents which contradicts vertical FDI theory.[9] [10]

Summing up, the existing empirical evidence on vertical FDI poses two puzzles: (i) why is there so little evidence on the relation between FDI and relative factor endowments? (ii) How do we reconcile the fears of exports of employment to cheap labor countries in the public debate with the fact that the potential scope for vertical FDI seems to be so small? The following empirical analysis addresses these two puzzles.

3 Contributions

This study makes three distinct improvements on previous literature. First, we employ new data on the skilled-wage premium rather than skill endowments. Second, we use a di¤erent dataset where we pool US and Swedish outward FDI data. Finally, we consider a more detailed decomposition of MNE activities.

3.1 Skill measure: Wage premium vs skill endowments

In the theory of vertical MNEs, FDI is driven by skill endowment di¤erences. As shown by Markusen et. al. (1996), there exists a monotonic relationship between relative skill endowments and relative skilled-wage premium. From a general equilibrium point of view, relative skill endowments are assumed to be exogenous, while relative skilled-wages are determined endogenously.[11] Yet, there are advantages in basing the empirical analysis on

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[9] However, the share of a¢liate imports for further processing in total a¢liate sales is signi...cantly smaller in countries with large GDP per capita.

[10] Matthae (2000) has investigated intra-...rm trade of Swedish outward FDI, but he has not used skill endowments or relative factor costs as explanatory variables either. Görg (2000) regresses US inward processing trade (within and outside MNEs) by industry into European countries on average rather than relative wage costs and ...nds that US inward processing trade into the EU periphery occurs when average wage costs are higher rather than lower.

[11] The endogeneity problem of using relative wages as an explanatory variable is probably negligible in practise, because FDI activity in any but a few host countries is too small to have an impact on the local economy. Some evidence of skilled-wage endogeneity is given by Feenstra and Hanson (1997) on US FDI in Mexico, but Mexico (and possibly Ireland) be considered a special case. Nevertheless, we will pay attention to the possible endogeneity of the wage premium in our econometric analysis.

skilled-wage premia rather than on skill endowments.

Firms' incentives to conduct vertical FDI are directly related to relative factor costs, but only indirectly to factor endowments. As the link between factor endowments and factor costs can break down for several reasons, factor costs may give an accurate picture of the relative pro...tability of producing in di¤erent countries, even though factor endowments may not.[12] There are numerous reasons why the mapping from relative endowments to relative factor costs may be weak, such as labor market distortions, taxes, non-homothetic preferences and measurement errors.[13] These sources of potential discrepancies between endowments and costs make it more fruitful to directly focus on relative costs.[14]

As shown in Table 2, the correlation between the host country's relative skill-premia - measured as the ratio of the skilled-to-unskilled wage in the host country in relation to the same ratio in the home country - and a number of measures of relative factor endowments is low.[15] Thus, we would expect endowments and relative skill premia to a¤ect FDI patterns di¤erently. The correlation matrix in Table 2 also points to potential measurement errors that show up in relative endowment measures, where the simple correlation between alternative endowment measures is often fairly low.

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[12] It is only in the case of factor price equalization that factor endowments are a more useful measure, since the latter determine trade patterns, while the former are not related to the previous two variables. However, there is no factor price equalization in the KCM model, because trade costs are an essential assumption for explaining the emergence of FDI in this model and factor price equlization breaks down, when trade costs are positive.

[13] In this study, we do not explore why the relation between labor endowments and factor costs may be weak. Instead, the wage gap debate o¤ers a whole range of explanatory variables and investigates them. For a survey, see Baldwin (1994).

[14] Note, however, that by focusing on relative costs, we are unable to test the general equilibrium features of e.g. the KCM-model.

[15] The variable SKR is the one used in the previous FDI literature (e.g. Carr et al, 2001) while TYR, SYR, HYR, ENROLLS are the well-known human capital measures of Barro and Lee (1994). TYRDF is the corrected TYR measure by Domenech and de la Fuente (2001), and WAGEP is the measure of the wage premium we apply in our analysis. All data are de...ned in the data appendix.

3.2 Sample coverage: Pooling US and Swedish data

Almost all studies on FDI and relative factor endowments are undertaken for US inward-and/or outward FDI. The US economy is, by far, the largest in the world. This can be illustrated in Figure 2 by inserting US outward and inward FDI observations into the Edgeworth box. The points show the division of bilateral total endowments of skilled and unskilled labor between the US and the host countries for the US outward data and the corresponding US inward data, where the US is the host-country. The ...gure clearly shows that the US on average is much larger than other host or home countries, as the bulk of outward US FDI observations are in the North-East corner and the bulk of inward observations are in the South-West corner.[16]

A problem with this data set is that the KCM model and the vertical FDI model of Helpman (1984) predict vertical FDI for the US in the North-West corner, where no observations are found. Consequently, the US outward FDI data are not appropriate for investigating vertical FDI. The inward data (treating the US as host country) also face a similar problem - these observations are located in the South-East corner where no vertical FDI should occur.

In contrast to the US, Sweden is a small- or medium-sized economy. This means that by pooling US and Swedish outward FDI data, the joint observations of bilateral FDI activities (e.g. US-UK, Sweden-UK) covers a much larger part of the endowment box, as shown in Figure 3. Speci...cally, the North-West corner - where we expect vertical FDI to be prevalent - has a fairly good coverage.

3.3 FDI measures: The scope of Vertical FDI

As was shown in Table 1, a number of di¤erent dependent variables have been used in the analysis of vertical FDI. Figure 4 illustrates the relationship between those variables. In the following, we argue why these alternative measures may be related to relative skill premia. We will also discuss to what extent relative skill premia a¤ect these di¤erent measures.

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[16] The outliers in both the inward and the outward sample are China and India.

According to KCM, relative factor costs mainly in‡uence exports back to the home country. As a consequence, vertical FDI is sometimes de...ned as these exports and exports back to the home country then determine the scope for factor costs to explain FDI.[17] However, if production is divided into several steps as in Venables (1999), the scope for factor costs in explaining FDI is greatly enhanced. To see this, assume that MNE production can be divided into two steps, upstream (skilled-labor intensive) and downstream (unskilled-labor intensive). Disregarding trade costs and market size, home MNEs are more likely to conduct downstream activities only at home if the relative costs of conducting unskilled-labor intensive activities in the potential host country are high, i.e. if unskilled labor is relatively expensive in the host country. This would correspond to serving the foreign market by exports.[18] If the relative costs of conducting downstream activities in the host country were lower, i.e. unskilled labor relatively cheap, we would expect to observe more downstream activities in the foreign country and a¢liate imports of intermediate goods from the parent company. In this case, a¢liate production will be sold only locally, because the additional transport costs for returning the ...nal good to the home country cannot be o¤set by the production cost savings (Venables, 1999). Thus, vertical linkages within MNEs can emerge even if the foreign a¢liate only sells the ...nal good in the local market.[19] Hence, a¢liate production both for the local market and for exports is likely to include elements of vertical integration and be a¤ected by relative factor costs. However, the degree of integration and the sensitivity to relative factor costs are expected to be stronger for a¢liate production for exports than for local sales. Moreover, a¢liate imports from parent companies in the home country are another measure of FDI depending on relative factor costs. !!!!!!!!!! Note changes in previous paragraph !!!!!!!!!

Another (inescapable) feature of the KCM model is that it only deals with two countries, whereas a large fraction of a¢liate production is actually exported to other countries

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[17] See Markusen (1995).

[18] If local sales and after sales services are important, this would of course imply that a vertical linkage exists between the parent and the sales a¢liate, even in this scenario.

[19] See Venables (1999) on so-called vertical FDI of horizontal type.

(export platform FDI). Given that exports to other countries constitute a large portion of aﬃliate total sales, investigating the role of relative wage costs is important in explaining these trade ﬂows. In a three-country setting, the MNE may supply the third market with ﬁnal goods by exporting from home, exporting from the second country or by local production. If the ﬁrms choose to sell from the second country, the third-country exports are associated with a vertical linkage between the parent and the aﬃliate in the second country. Thus, we would expect exports to a third country to be aﬀected by the relative wages of the home and the host country, but also by the relative wages in the export market.[20]

The relative importance of each MNE activity measure is illustrated in Table 3 where we have computed total aﬃliate exports to the home country, exports to third countries, and local sales as well as aﬃliate imports from the parents in the home country. All numbers are percentage shares of total aﬃliate sales for the years 1986, 1990, 1994 and 1998 and seperated by home country Sweden (Swe) and US.

Table 3 reveals signiﬁcant diﬀerences between the aﬃliate activities of US and Swedish MNEs. On average, aﬃliates of US MNEs export a larger share of local production back to the US, wheras the sales of Swedish aﬃliates are directed towards local markets. Much of this diﬀerence can be attributed to the importance of Mexico and Canada as hosts for US ﬁrms while Swedish ﬁrms focus on the European and US markets. Taken at face values, these numbers would suggest that the role for vertical FDI - in the strict sense of exports to the home country - is limited as their share of total aﬃliate sales only amounts to 16 and 7 percent, respectively, in 1998. However, the total exports of aﬃliates make up 44 and 31 percent, respectively, of total aﬃliate sales in 1998. In that respect the scope for vertical FDI seems much larger and the role for relative factor prices and endowments in explaining FDI may also be enhanced. Another observation is that although the bulk of aﬃliate sales still goes to the host market, that share is decreasing. This decreased reliance on local sales is accompanied by increased exports, both to the home market and other markets.

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[20]See Neary (2001) for a model of horizontal export platform FDI.

Summing up, not only the exports by a₵liates to the home country, but also exports to other countries, imports by a₵liates from parent companies and even local sales are potentially driven by relative factor endowments and/or costs, albeit to a di¤erent degree.

4 Data

Table 4 gives preliminary statistics on the dependent and the independent variables, which will be introduced step by step in the following subsections.

4.1 MNE activity measures

As discussed in section 3.3, we use a wide range of a₵liate measures: the sum of manufacturing a₵liate sales in a year by the home and the host country (Total Sales), a₵liate exports back to the home country (Exports to home-country), a₵liate exports to countries other than home and host countries (Exports to third countries), a₵liate sales to the host-country market (Local Sales), and imports of a₵liates from their parent company in the home country (Imports from parent)[21]. All data are reported in 1990 USD prices.

The MNE activity data for the US are collected by BEA and have previously been used in Carr et. al. (2001) and Markusen and Maskus (1999a,b).[22] The MNE activity data for Sweden is collected by the Research Institute of Industrial Economics (IUI) and described in Braunerhjelm and Ekholm (1998). The precise data de...nitions are provided in the data appendix.

The US data are originally annual and span over the time period 1986-1994. The Swedish data have been collected about every four years from 1970 until 1998. Since we pool the US and Swedish data, we choose the commonly available years 1986, 1990, 1994, and 1998.[23] Only those host countries are available for which we also have a complete set

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[21] From a theoretical perspective, it would have been ideal if data on intermediate goods imports of a₵liates from parent companies had been available. These data are not available for the US except for two years. The measure total imports from parents may contain direct parent exports to the host country without further processing by a₵liates.

[22] These data was kindly provided to us by James Markusen.

[23] We checked that the reduced US sample behaves in a very similar way as the full sample by replicating

of dependent variables. The country coverage for both the US and Swedish data is given in the data appendix.

As can be seen in table 4, aggregate affiliate sales by US MNEs are about 18 times larger than by Swedish MNEs in the average host country. This roughly reflects the difference in size between the US and Swedish economy (about 30 times).

4.2 Skill measures

There is a significant difference in the relative skill-structure between the two countries and their respective hosts. The relative difference in skill endowments , SKR, is measured as the ratio of skilled to unskilled workers in the home economy relative to the ratio in the host economy. These data, which are standard in the literature, (Markusen and Maskus, 1999, 2001, and Carr, Markusen, and Maskus, 2001) are obtained from the International Labour Organization (ILO). Professional, technical, administrative and managerial workers are classified as skilled labor. In terms of the relative endowments of skilled workers, Sweden appears significantly more well-endowed than the US compared to their respective host countries, as the former country has a 50 percent larger share of skilled workers in the labor force as compared to the second.[24] Hanson, Mataloni, and Slaughter (2001) use GDP per capita as a substitute for a skill measure. In terms of relative GDP per capita between the home and the host country (GDPCAP), the data reveal that Sweden invests more in countries with a lower GDP per capita.

Another measure of the potential benefits of vertical decomposition across countries for MNEs is the relative wage differences for skilled versus less skilled workers. More precisely, it is convenient to define the wage premium (WAGEP) as the ratio of the

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estimations of Markusen and Maskus (1999) and Carr et. al. (2001) on the reduced dataset and comparing this with their estimates.

[24] However, administrative and managerial workers are not reported separetely from clerical workers by ILO for Sweden in 1994. Thus, we had to include the category of clerical workers for Sweden which inflates the average skill endowment of Sweden. See the data appendix for details. Moreover, there is a switch in the classification from ISCO68 to ISCO88 in the ILO data for some countries at different points in time. See the data-appendix for details.

skilled-to-unskilled wage in the host country, in relation to the same ratio in the home country, as follows:

$$WAGEP \sim \frac{w_U^i = w_S^i}{w_U^j = w_S^j} \sim \frac{w_S^j = w_U^j}{w_S^i = w_U^i} \tag{1}$$

where w_S^i and w_U^i are the respective wages for skilled- and unskilled labor in the home country i, and where w_S^j and w_U^j are the respective wages for skilled and unskilled labor in the host country j. Note that the wage premium is high when unskilled labor in the host-country is relatively cheap. Note also that the KCM- and Helpman (1984) model predict both a positive relation between the variables SKR and $WAGEP$.

The relative wage costs of skilled and unskilled workers are taken from the Union Bank of Switzerland (UBS, various issues). About every three years, UBS reports the gross wages of particular professions: electrical engineers with ...ve years of professional experience and industrial workers with three years of vocational training and ten years of professional experience.[25] These data are collected in cities, wherever UBS has its own a¢liates. Thus, the wages often apply to the capital, the ...nancial center or other important business centers of a country.

An obvious advantage of these data is that they utilize categories of the labor force (engineers vs blue-collar workers) highly relevant for the location of multinational activites within the manufacturing sector. A slight disadvantage of these data is that they are not general indices. While highly relevant for manufacturing, these wages do by no means cover the entire spectrum of professions in manufacturing ...rms. However, labor market competition will ensure that similar professions will obtain similar wages. Moreover, data are collected only for a particular city. Wages are likely to di¤er across cities, since living costs di¤er. However, an average index of the same profession over the entire country may be inappropriate, because FDI appears to be highly concentrated to a few centers of a host country.[26] Hence, the restriction of the UBS to collect data only in centers may just be an appropriate approximation. Nevertheless, to ensure the credibility of the UBS data on

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[25]See the data appendix for a more precise description.

[26]See Stirböck (2001) for evidence on European regions and Shannon and Zeile (1999) for evidence on U.S. states.

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skilled-wage premia, we compare these in table 13 in the appendix for some countries with data from national statistical sources. In spite of large di¤erences of de…nitions across those sources, we …nd similar skilled-wage premia.

Table 13 also reveals that relative wages for engineers in relation to production workers are almost identical in Sweden (1.34) and the US (1.35). Still, in relation to the respective host countries, the US has a marginally lower skill premium than Sweden, indicating that US multinationals, on average, tend to invest in host countries with higher premiums on skilled workers. This is the opposite to what is suggested by relative factor endowment data and GDP per capita data.

4.3   Additional explanatory variables

Finally, we include investment costs and trade protection indices provided by World Economic Forum. Sources, de…nitions and computational methods are described in the Appendix. From Table 4 it follows that US and Swedish MNEs do invest in countries with somewhat di¤erent attributes. On average, US …rms are more inclined to invest in countries with a low GDP (GDP_j), high investment costs (INV), and high trade barriers ($PROT$).[27] Furthermore the US a¢liates are, on average, located further away from the home country than the Swedish ones, as measured by the distance between the capitals of the host and home countries ($DIST$). Once again, this relates to the stronger focus on Europe for the Swedish …rms and on emerging market economies for the US …rms.

5   Empirical Results

Two di¤erent estimation strategies have been used in the literature. First, the gravity equation as in Brainard (1993, 1997) or Hanson, Mataloni and Slaughter (2001) tests determinants of a¢liate sales by using a simple log-linear speci…cation. Second, Carr et. al. (2001) test the KCM model with a nonlinear speci…cation, including interaction e¤ects.

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[27] The di¤erence in host country size (GDP_j) is, of course, partially dependent on the size of the US economy as host of Swedish but not US FDI, which increases the average host-country size for Sweden as compared to the US.

In this paper, we will ...rst apply the general gravity equation and then use the more speci...c KCM model equation for a robustness check.

5.1 The gravity equation estimations

We successively use the FDI activity measures described in section 3.3, as dependent variable, denoted $sales_{ijt}$. We follow Brainard (1997) in estimating a log-linear gravity equation of FDI activity by home country i in host country j at time t, but use the same control variables as Carr et. al. (2001).[28]

$$sales_{ijt} = \bar{}_0 + \bar{}_1 gdp_{it} + \bar{}_2 gdp_{jt} + \bar{}_3 dist_{ij} + \bar{}_4 wagep_{ijt} + \bar{}_5 invc_{jt} + \bar{}_6 prot_{jt} + "_{ijt};$$

(2)

where lower case letters indicate natural logaritms of variables (i.e. $x = \ln(X)$) and $"_{ijt}$ is the usual error term. Furthermore, we include time dummies, a home country dummy US, and a home country-neighbour dummy ADJ to capture time-speci...c e¤ects, home-country speci...c e¤ects, and border e¤ects, respectively.[29] Our novel independent variable of interest is the skill premium ($wagep_{ijt}$). Since we argued in section 3.3 that a¢liate exports to the home country are expected to be most sensitive to skill di¤erences, we start out with results on this dependent variable.

5.1.1 A¢liate exports to home country

In table 5, column 1, we report the results obtained from regressing exports to the home country on the wage premium ($wagep_{ijt}$). This result gives strong support for vertical FDI, because the relative wage premium a¤ects exports home positively. This means that a¢liate exports to the home country are larger in host countries with high premiums

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[28] We need not include industry speci...c measures of scale economies and freight costs, since we apply country rather than industry data, contrary to Brainard (1997), for example. This is done because our variable of interest - the skill di¤erence variable - is a country-speci...c variable and could not explain additional variation in the dependent variable across industries.

[29] Host country dummies need not be included, because host country GDP accounts for the di¤erences. However, we do consider host country ...xed e¤ects for robustness check in table 6.

on skilled workers, i.e. countries with relatively cheap unskilled labor. The estimated elasticity of exports to the home country with respect to relative wage premia is 1.34, which is signi...cant also in economic terms.[30] Home and host GDP are both highly signi...cant. The high elasticity with respect to home GDP illustrates two points. First, an increase in the size of the home economy will tend to give rise to more home-based MNEs, which leads to more a¢liates abroad. Second, the increase in the size of the home economy tends to make this a more important export market for a¢liates, either in terms of ...nal goods or intermediate inputs. Thus, we would expect a high sensitivity to home GDP in a¢liate exports from hosts to the home country. The elasticity of exports to the home country with respect to host country GDP is close to one. Furthermore, countries located far away and with high levels of investment costs and high levels of protection are less likely to be used as bases for exports back to the home country.

The variable protection has the expected sign, but is not signi...cant. Investigating this variable, we ...nd that it is highly correlated with the investment cost variable (correlation coe¢cient 0.75), which leads to a severe problem of multicollinearity and, thus, insignif-icance of the regression coe¢cient of the protection variable. On a fundamental level, this simply means that host countries that pursue restrictive trade policies do also put restrictions on investment. On a more practical level, both variables are constructed out of questionnaires to decision makers in MNEs and there may therefore be a tendency to give similar answers to similar questions. Carr et. al. (2001) face the same multicollinearity problem.

Next, we compare our results on the wage premium with results on previously used measures of skill di¤erence. In column two, we report the results, when skill di¤erence is

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[30] For example in 1998, Swedish a¢liates in Belgium exported home from 2390 Mill.\$ and from Denmark 92 Mill.\$, while the former country has a wage premium of 1.63 and the latter of 1.39 and the regression scores without wages are very similar (17.2 versus 17.8). In another example, Swedish a¢liates have exported home from Portugal 22 Mill.\$, while from Austria 2 Mill.\$. At the same time, the Portuguese wage premium is 2.29 and the Austrian 1.74, while the regression scores without wages are 15 versus 15.6. Still for 1998, US a¢liates have exported home from Malaysia 4890 Mill.\$ and from Thailand 1910 Mill.\$, while the former country has a wage premium of 1.88 and the latter of 1.35 and the regression scores without wages are very similar (17.7 versus 17.9).

measured by relative skill endowments (skr_{ijt}) like in Carr et. al. (2001) and Markusen and Maskus (1999, 2001). The results demonstrate that differences in relative skill endowments have a positive, but not significant, effect on exports back to the home country. In column three, we replace relative labor endowments with GDP per capita ($gdpcap_{jt}$), which is claimed to be a substitute variable for skills by Brainard (1997) and Hanson, Mataloni, and Slaughter (2001). In this specification, the larger the GDP per capita of the home country relative to the host country the more vertical FDI is observed, although this effect is not significant either. Naturally, GDP per capita differences across countries may not only reflect skill differences but also endowment differences in other production factors or total factor productivity differences.

All in all, the base model with the relative wage premium seems to work quite well, whereas relative skill endowments or skill substitute variables do not give the expected results.[31] While GDP per capita may just be too imperfect a measure of skill differences, the disappointing results of using skill endowment differences are more disturbing. One explanation might be that the ILO data on professional occupation is not a good proxy for relative endowments of skilled workers.

A further indication of the problems related to the ILO measure on skilled labor is that the correlation between relative ILO skill levels and other indicators of human capital is low, as was demonstrated in section 3.1. This implies that measures of skills in a panel dataset with many countries and a long time horizon are very noisy and the ILO data are among the noisiest. Hence, it is difficult to establish robust results on the skill variable.

Moreover, section 3.1 has also shown that the links between factor endowments and factor costs are weak, even though all skill and human capital variables have the expected signs of the correlation. In the remaining part of the paper, we therefore focus on results based on the wage premium.

After having established the relative skilled-wage premium to be a strongly significant variable explaining vertical FDI, we test for the robustness of this result. The results on robustness are given in table 6. For the convenience of the reader, we repeat our baseline

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[31] We have also run extensive regressions on all skill and human capital variables described in the data appendix without finding any robust results.

speci...cation, table 5 column 1, again in table 6 column 1. Then, we reestimate this speci...cation using instrumental variables for the relative skilled wage premium, because Feenstra and Hanson (1997) argued that the skilled wage premium may be endogenously determined by US FDI in Mexico. The coe¢cient for the skilled-wage premium increases in size and remains strongly signi...cant. The coe¢cients of the control variables remain qualitatively the same, except that the coe¢cient of the trade protection variable switches sign, although it remains insigni...cant, and the home country GDP coe¢cient becomes insigni...cant.[32]

Next, we consider additional host-country ...xed e¤ects to control for omitted country characteristics. Once more, the coe¢cient on the skilled-wage premium remains signi...cant - albeit only at the 10% signi...cance level. However, the inclusion of host-country ...xed e¤ects changes the signs of the host country GDP- and investment cost coe¢cients. The ...xed e¤ects thus interact with those variables that have most of their variation in the cross-sectional rather than in the time dimension. Since the theories on FDI are typical long-run theories, the time dimension is less important and most explanatory power should stem from cross-sectional variation, which loses importance in speci...cations with host country ...xed e¤ects. Hence, speci...cations with host-country ...xed e¤ects are not our preferred ones.

Finally, we check the e¤ects of the wage-premium when speci...ed in absolute value.[33] Using the absolute value of the relative wage premium (in logs) includes the case that foreign a¢liates reap bene...ts from relatively cheap engineers as much as from relatively cheap production workers. The former case is relevant if some foreign a¢liate activity in some host countries is relatively high-skilled labor intensive, e.g. in research labs. As can be seen in column 4, table 6, the skill premium remains signi...cant at the ...ve percent level with correct sign. Hence, our sample is not signi...cantly ?*** replaces the word less ***/ sensitive to the critique of Carr et al. (2001) by Blonigen et al. (2002),

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[32] As instrument, we use the percentage of secondary school completed in the population.

[33] Blonigen et al. (2002) argue that this to be the correct speci...cation for testing the KCM model when investigating the e¤ect of di¤erences in relative endowments. An analogue speci...cation is therefore also provided for the gravity equation estimation.

who show that in the (mainly unskilled-labor abundant) US inward sample and in the (mainly skilled-labor abundant) outward US sample, skill-differences have opposite effects on affiliate activity.

We have also checked the robustness of the baseline estimation with respect to alternative measures of trade barriers, such as trade openness, import duties, export duties, or the additional inclusion of GDP per capita, the hourly average wage costs and the average effective corporate taxes of US affiliates.[34] The coefficient of the relative skilled-wage premium remains significant for them all.

5.1.2   Local sales

Next, we investigate how local sales depend on the wage premium. According to theory, the impact of the wage premium should be smaller on local sales than on exports to the home country, as local sales are more related to horizontal FDI. To simplify the comparison, we repeat the baseline specification with the dependent variable affiliate exports to home countries (from Table 5) in Table 7 (column 1) and then present the new results on local sales in column 2.

The qualitative results are in line with the previous regression, with the exception that relative wage costs now only have a marginally significant (and smaller) impact on the dependent variable. This reflects the fact that local sales are driven much less by wage cost considerations than are affiliate sales to the home country.

In quantitative terms, the results are somewhat different compared to the baseline. First, the size of the host market has a strong impact on sales, which is different from the effect on exports back to the home country. This is likely to reflect a demand side effect, as local sales are driven by market access motives, which depend on local market size. Second, the home country market size is of less importance. After all, local size does not depend on demand from the home country as do sales to the home country. Third, local sales are less sensitive to distance and investment costs than exports to home countries. Once again, this is in line with expectations, as horizontal MNEs are willing to accept these

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[34] See the data appendix for precise definitions of these additional control variables.

costs, if there is no alternative way of getting access to the local market without facing high trade costs. Finally, protection has an insigni...cant positive rather than negative impact on local sales, which may re‡ect the tari¤ jumping argument of horizontal FDI as found by Brainard (1997).

5.1.3 Exports to third countries

Column 3 gives the results where we have used a¢liate exports to third countries (export platform FDI) as the dependent variable. In qualitative terms, the results are similar to what happened to exports to the home country. In quantitative terms, some di¤erences arise. First, relative wage costs have a weaker, but still negative and strongly signi...cant, impact on exports to third markets compared to the home market. Consequently, relative wage premia are still important for exports to other countries, but the impact is marginally smaller than for exports to the home country. This may be due to the fact that exports to third countries depend more strongly on the relative wages of host and export-market country rather than those of the host and home country.[35]

Second, the home market e¤ect is signi...cantly smaller than for exports to the home country, which is due to the fact that the home market no longer a¤ects demand as in the case of exports to the home country. Consequently, the only impact from home GDP is through the "supply side" scale e¤ect, where larger countries are the homes of a larger number of MNEs. Third, host country GDP seems to be much more important for exports to third markets than to the home market. The combination of ...xed costs at the plant level and trade costs means that a¢liates are more likely to be located in large markets (see Braconier and Ekholm, 2001). Yet, local sales are more dependent on host-country

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[35]We do not know the destination of exports to other countries. If assuming that those export markets are primarily neighbouring countries, then average neighborhood variables for relative wage premia, relative GDP, and neighbourhood country import protection can be generated. We have run extensive regressions with these additional variables and ...nd that the relative skill premium of home and host country indeed becomes smaller (albeit it remains signi...cant at the 10 per cent level) and the skill premium of neighboring countries and the host country becomes highly signi...cant with the expected sign. Other neighboring country variables of protection and GDP are not signi...cant.

size than exports to third countries, since they are directly driven by host country demand while exports are not. Fourth, the distance to the home country plays a much smaller role in exports to third countries in comparison to exports to the home country, as the cost associated with transporting goods back to the home market is no longer important.[36] Finally, protection seems to have a very strong and negative impact on exports to third countries, suggesting that ...rms engage in platform FDI to countries with liberal trade regimes. This result follows directly from the fact that export platform FDI requires considerable trade ‡ows to many countries and is thus most sensitive to trade barriers. All in all, platform FDI seems to be driven by similar factors as "pure" vertical FDI and relative wage premia also play an important role in explaining a¢liate exports to other countries.

5.1.4 Total sales

In column 4 total sales are used as the dependent variable. This is the FDI measure most commonly used in the previous literature. We ...nd that all coe¢cients have the same sign as in the baseline regression with exports to the home country. In particular, the coe¢cient on the relative skilled-wage premium is signi...cant. In contrast to previous speci...cations, the trade protection variable becomes signi...cant with the expected sign. Not surprisingly, the quantitative size of all the coe¢cients is in between the coe¢cients of regressions of local sales and exports to the home country, as total sales are composed of the separate components local sales, and exports to home and third countries.

5.1.5 Imports from parents

Finally, column 5 gives the results for a regression where a¢liate imports from parent companies is used as the dependent variable. Qualitatively, all estimates are similar to the ones in the previous speci...cations. Once more, some quantitative di¤erences are worth

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[36]Still, distance has a signi...cant e¤ect on exports to third countries, which indicates that transport costs for intermediates from the home country to a¢liates or the costs of supervising remotely located a¢liates are signi...cant. Note also that cultural di¤erences and language di¤erences may increase with distance and render the export of management practices more di¢cult.

noting. The skilled-wage premium is of less importance for a¢liate imports from parent companies than for a¢liate exports to home and third countries, but more important than for local sales. While we argued that exports to the home country constitute the closest measure of vertical FDI and thus they are most sensitive to relative factor costs, a¢liate imports from parents may be less sensitive to factor costs, because some of these imports are not further processed and are thus ...nal-good exports of the parent company for which local factor costs are irrelevant. Moreover, some a¢liate imports from parents may contain speci...c technologies which would be disseminated as a public good if produced abroad (see Matouschek, 1999). Hence, they will be produced at the parent plant, even if its production costs were lower abroad. In contrast, the host country market size is more important for a¢liate imports from parents than for a¢liate exports to parent countries, because those imports may be sold after further processing in the host country market (vertical FDI of horizontal type in the terminology of Venables, 1999). Likewise, protection, investment cost, and distance are of less importance for a¢liate imports from parent companies than for a¢liate exports to parent countries, since those costs are borne to obtain access to the protected host country market.

5.2 The Knowledge Capital Model estimations

So far, we have established our results on the gravity equation approach. Here we show that our results also hold in the KCM approach. We use the speci...cation of the Knowledge Capital Model as speci...ed by Carr et. al. (2001) but replace their skill endowment variable with the skilled wage premium, i.e.:

$$
\begin{aligned}
RSALESI_{ijt} = {}^{-}_0 + {}^{-}_1 GDPsum_{ijt} + {}^{-}_2 (GDPdif_{ijt})^2 + {}^{-}_3 WAGEPd_{ijt} \qquad (3) \\
+ {}^{-}_4 INTER_{ijt} + {}^{-}_5 DIST_{ij} + {}^{-}_6 INVC_{jt} + {}^{-}_7 PROT_{jt} + "_{ijt};
\end{aligned}
$$

where $WAGEP_{ijt}$ is now de...ned as di¤erence between skilled-to-unskilled wage in the home country and the the same ratio in the host country, $GDPsum_{ijt}$ is the sum of home and host country real GDP, $GDPdif_{ijt}$ is the di¤erence between home and host country GDP, and $INTER_{ijt}$ is a multiplicative interaction term of $GDPdif_{ijt}$ and $WAGEP_{ijt}$.

The main di¤erence of this speci...cation to the gravity equation approach (2) is its non-linearity in relative country size and the wage premium, and the lack of log-linearization. Comparing with Figure 1, we expect the coe¢cients $\bar{}_2$ and $\bar{}_4$ to be negative as these should capture the e¤ect of moving away from the center of the Edgeworth-box, increasing dissimilarity in size. Note ...nally that the two approaches are non-nested hypotheses and cannot be directly compared. As in the gravity equation, we also add a home country neighbourhood dummy, and home country and year ...xed e¤ects.

We show the results of speci...cation (3) in Table 8, column 1. Our main result of this section is that the skilled-wage premium is not only signi...cant at the ...ve per cent level with the correct sign, but its non-linear interaction term is also signi...cant at the ten percent level with correct sign. In general, however, the ...t is not as good as for the gravity estimation, which is not surprising since direct levels rather than logarithms of all variables are used. The number of signi...cant control variables is also smaller. For example, neither the total market size of the host and home country, nor the squared size di¤erence of home and host markets are signi...cant. However, the insigni...cance of the square term constitutes support for the vertical FDI model, because there should be no inverse U-shape relation between vertical FDI and market size (see Figure 1). As in the gravity approach, investment cost and protection are insigni...cant. In addition, the protection variable also has the wrong sign. Only distance remains signi...cant at the ...ve per cent level. All in all, these results di¤er from Markusen and Maskus (2001) who ...nd a negative relation between relative skill endowments and a¢liate exports back to the US.

In column 2 we do a robustness check and estimate the KCM model with total sales as the dependent variable (see Markusen and Maskus, 1999, and Carr et al., 2001). Once more we ...nd that the skilled-wage premium and its non-linear interaction term are signi...cant with correct signs. Moreover, all control variables except protection are now signi...cant with the correct sign.

Finally, in column 3, we apply absolute values on the di¤erence variables. As argued in Blonigen et al. (2002), the contradicting results in Carr et al. (2001) and Markusen and Maskus (1999, 2001) may be due to misspeci...cation of the skill di¤erence terms in their empirical framework which becomes signi...cant when pooling the US-inward and

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outward data and they show that applying absolute values of skill-di¤erences and GDP-di¤erences causes a sign reversal of the skill variable. Interestingly, our data does not have this property and results are even somewhat sharper in the absolute value speci...cation. The explanation is that we do not pool inward and outward FDI data. Therefore, our home countries have cheaper high-skilled labor relative to almost all host countries and the absolute value is mostly not binding.

All in all, we ...nd empirical support for the vertical FDI model, based on skill-premia, while Markusen and Maskus (1999) reject it by using skill endowments. Thus the conclusion that vertical FDI is highly sensitive to relatively cheap low-skilled labor is robust across the di¤erent model speci...cations, the use of di¤erent FDI measures, di¤erent estimation techniques, and di¤erent control variables.

6   Concluding Remarks

In contrast to previous studies, we ...nd ample support for vertical FDI in the sense that MNEs' a¢liate activites are a¤ected by relative wage costs. We ...nd that a¢liate sales increase when there is an increase in relative skill premia between the host and the home country. Therefore, relative factor costs are important for explaining patterns of FDI, as suggested by the theoretical litterature, such as Helpman (1984) and Markusen et al. (1996). Our results are robust to a number of changes in the speci...cation of the empirical model and consequently, we are con...dent that we have found robust support for vertical FDI.

Not only do we ...nd evidence that relative skill premia a¤ect overall a¢liate activities, but we also investigate to what extent di¤erent types of a¢liate activities are driven by di¤erent determinants. The analysis shows that qualitatively, the results are similar irrespective of whether we analyze local sales, exports to the home country, exports to third countries or a¢liate imports from the parent in the home country. Consequently, relative wage premia even seem to a¤ect activities traditionally associated with horizontal FDI (i.e. local sales). This means that the potential e¤ects of factor di¤erences on FDI are larger than previously thought. To illustrate the e¤ects of relative skill-premia on FDI, we

use the (well-known) widening skill-premia in the US between 1986 and 1994 and assess how they have a¤ected FDI.[37] The rise in the wage premium in the US exceeded that of the average host country in our sample by 8%. Taking this change of the relative wage premium as exogenous, we attribute to it a permanent rise in annual US a¢liate sales abroad of about 30 billion USD (in 1990 USD prices) or about half a percentage point of US GDP. Hence, the scope of vertical FDI, i.e. FDI driven by relative factor costs, is large.

Although the qualitative e¤ects are similar across types of activities, the quantitative e¤ects di¤er substantially. In most cases, we ...nd that these quantitative di¤erences are in line with what should be expected from the theoretical literature. We do, for example, ...nd that exports to the home country are strongly dependent on relative skill premia and the size of the home market, whereas local a¢liate sales are more sensitive to the market size of the host country. Still, it is the qualitative similarity that is the most striking result.

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[37] An OECD (1996) study documents a rise in the income spread between the ten percentile top and the ten percentile bottom of 11% in the US during this period (p. 61f). In comparison, our speci...c wage premium variable rose by 10% .

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7 Appendix

7.1 Data Description:

The baseline speci...cation in table 5 uses data on the following countries with an observation for at least one year. Swedish a¢liates have positive exports to Sweden from Argentina Australia, Austria, Belgium, Brazil, Canada, China, Colombia, Czech Republic, Denmark, Finland, France, Germany, Hungary, India, Ireland, Italy, Japan, Korea, Luxembourg, Malaysia, Mexico, Netherlands, Norway, Philippines, Poland, Portugal, Russian Federation, Singapore, South Africa, Spain, Switzerland, Thailand, United Kingdom, United States, Venezuela. There are missing independent variables for Cyprus, Ecuador, Estonia, Lithuania, Malta, Slovak Republic, Slovenia, Sri Lanka. The data on the dependent variables can be considered as complete for Sweden.

US a¢liates export to the US from Argentina, Australia, Austria, Brazil, Belgium, Canada, Colombia, Denmark, Finland, France, Germany, Greece, Hong Kong, India, Ireland, Israel, Italy, Japan, Korea, Malaysia, Mexico, Netherlands, Norway, Philippines, Portugal, Singapore, South Africa, Spain, Sweden, Switzerland, UK, Venezuela. Missing on top of Markusen and Maskus (1999) are Chile, Ecuador, Guatemala, Indonesia, New Zealand, and Panama due to lack of information on some independent variables. The number of countries included in this study as well as in the two previous studies by Brainard (1993) and Markusen and Maskus (1999) include a rather small number of partner countries to the US. One may suspect that some countries with US a...liates are excluded from the database of Markusen and Maskus (1999), our data source, if independent variables are missing. Hence, we cannot be sure to have the complete universe of US a¢liates. In general, observations for the years 1986, 1990, 1994 and 1998 are used. Next, we give a de...nition and a description of the data used in our study as well as their sources.
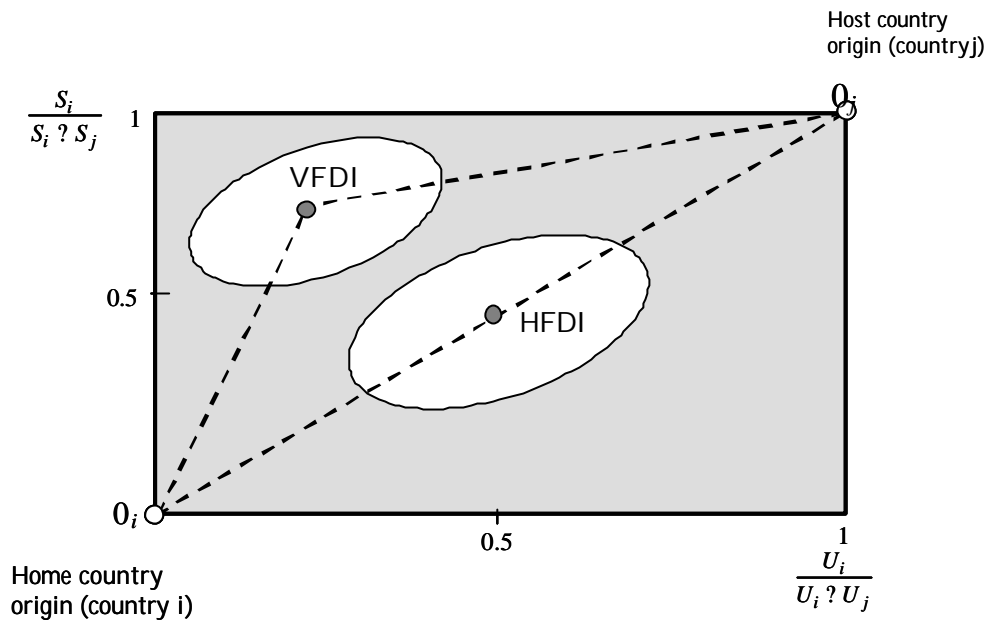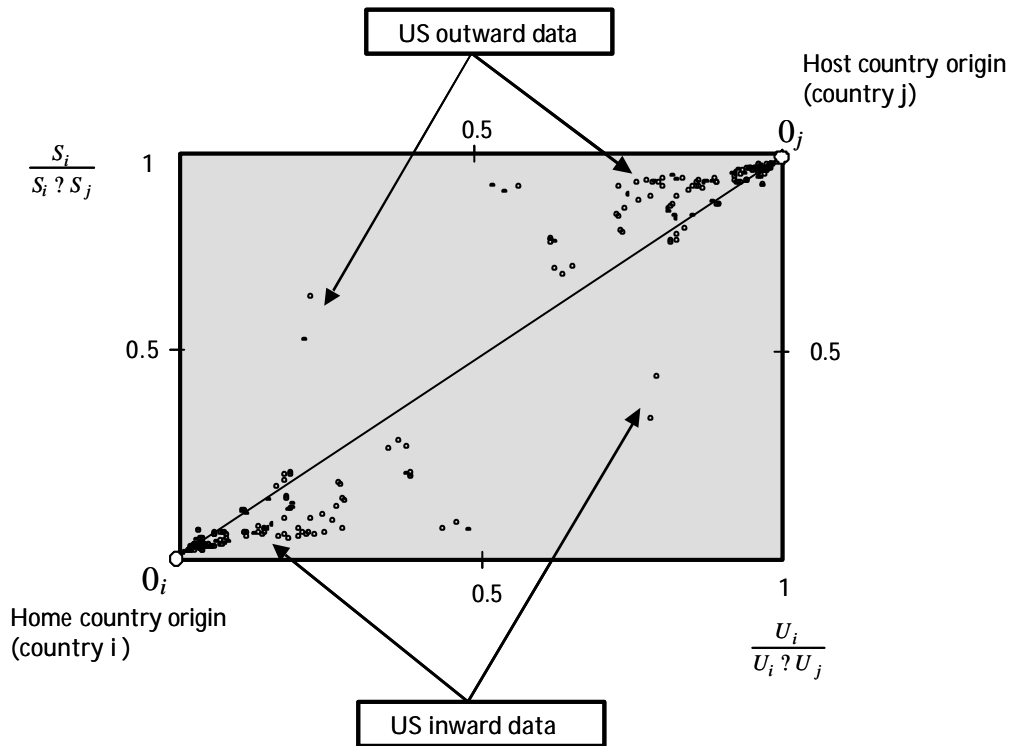
Figure 1: Regions of FDI in the KCM model.

Figure 2: Outward and inward FDI in Carr et al. (2001).
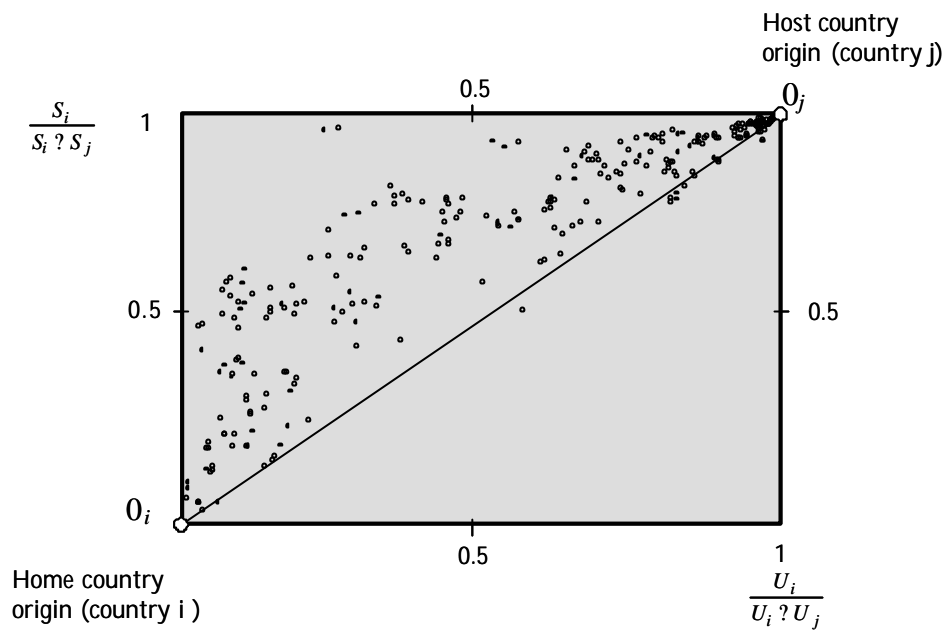
Figure 3: Outward FDI for Sweden and the US.
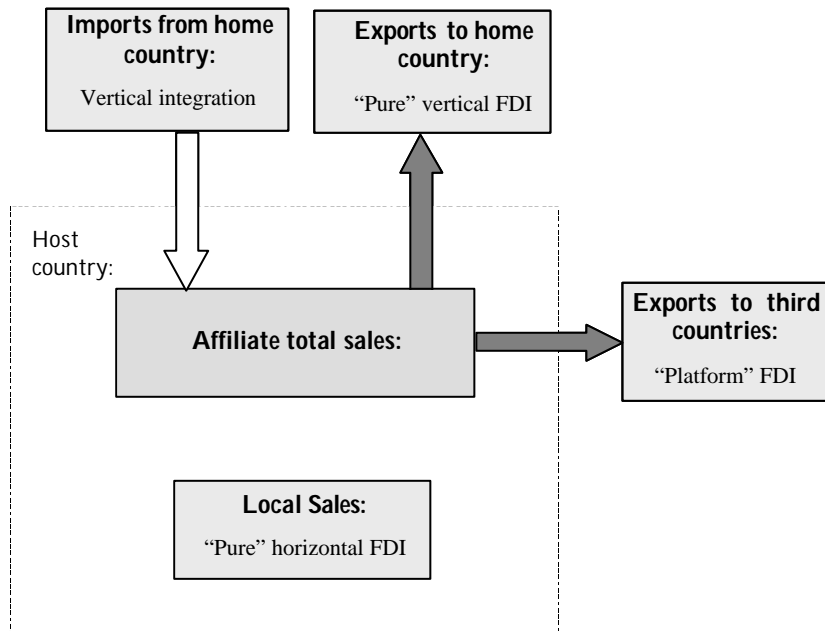
Figure 4: Illustrating di¤erent ‡ows of FDI.

Table 1: Previous empirical results.

	Main skill measure:	Sample coverage:	Main FDI measures:	Evidence for:	
				HFDI	VFDI
Brainard (1993)	Di¤erences in endowments of skilled and un-skilled labor, di¤-erences in GDP per capita	US inward and outward FDI, cross section of industries, (BEA)	Exports to the home country Local sales of a¢ liates		Mixed
Brainard (1997)	Di¤erence in GDP per worker	ibid	Total sales of a¢ liates	Yes	No
Carr, Markusen and Maskus (2001)	Di¤erences in relativ endow-ments of skilled labor (ILO)	US inward and outward FDI, (BEA)	Total sales of a¢ liates	Support for KCM	
Markusen and Maskus (1999)	ibid	ibid	Exports to the home country Total exports by a¢ liates A¢ liate local sales	Yes	Mixed (No support for VFDI and KCM in outward FDI)
Markusen and Maskus (2001)	ibid	ibid	Total sales of a¢ liates	Yes	No (Rejection of KCM)
Blonigen, Davies and Head (2002)	Absolute value of di¤erences in skill labor abundancy (ILO), Human capital (Barro-Lee)	US inward and outward FDI, (BEA) OECD countries	Total sales of a¢ liates, Bilateral FDI stocks	Yes	No (No support for KCM)
Hanson, Mataloni and Slaughter (2001)	GDP per capita of host country	US outward FDI, panel of industries, (BEA)	Total exports and local sales by a¢ liates Imports to a¢ liates for further processing from parents		Mixed
Braconier, Norbäck and Urban	Relative wage premium for host country skilled labor (UBS)	US and Swedish outward FDI, (BEA and IUI)	Exports to the home country and third countries Local sales and total sales of a¢ liates Imports from parents		Yes (Support for KCM model using wage data)

Table 2: Labor endowments and labor cost correlation matrix.

	SKR	TYRDF	TYR	SYR	HYR	ENROLLS	WAGEP
SKR	1						
TYRDF	0.60	1					
TYR	0.59	0.90	1				
SYR	0.50	0.86	0.86	1			
HYR	0.48	0.71	0.78	0.57	1		
ENROLLS	0.56	0.75	0.69	0.66	0.44	1	
WAGEP	0.32	0.42	0.36	0.36	0.31	0.41	1

Table 3: Destination of a¢liate sales as shares of total a¢liate sales.

	Local sales		Exports to the home market		Exports to other countries		Imports from parents	
Year:	US:	Swe:	US:	Swe:	US:	Swe:	US:	Swe:
1986	63	74	13	5	25	22	11	13
1990	61	68	12	4	27	27	8	10
1994	59	69	15	9	26	23	10	13
1998	56	69	16	7	28	24	8	12

Note: All numbers are in percentages of total a¢liate sales.

Table 4: Descriptive statistics.

	Mean		Std. Dev		Min/Max		No obs.	
	US:	Swe:	US:	Swe:	US:	Swe:	US:	Swe:
Dep variables:								
Total sales	17740	960	27927	2103	16/120316	0.02/13306	135	197
Exports to home country	2505	94	7641	339	0.9/52297	0.001/2595	136	121
Exports to third countries	4748	305	8342	606	0.8/43329	$3 \times 10^{i\,9}$/4854	137	151
Local sales	9022	682	15825	1636	12/65448	0.3/11345	159	194
Imports from home parent	1307	116	4378	204	0.8/35087	0.01/1062	202	167
Indep variables:								
GDPi:	6824	227	898	14	5681/8023	206/245	183	374
GDPj	373	357	756	1018	0.242/5319	0.095/8023	192	275
GDPCAP	11.18	16.31	20.95	28.07	0.55/116.05	0.57/251.49	179	270
SKR	2.07	3.72	1.42	5.73	0.58/10.42	0.90/53.63	151	165
WAGEP	1.465	1.459	0.75	0.90	0.64/7.23	0.54/9.92	150	149
INVC	37.13	37.84	11.57	12.02	12.50/79.43	12.50/79.43	158	162
PROT	32.13	32.58	15.91	15.58	6.80/85.08	6.90/85.08	158	162
DIST	7937	4171	4081.8	4170.8	734/163701	9.31/17480	212	297

Note: All dependent variables are measured in millions of USD. GDPi and GDPj are measued in billions of USD.

Table 5: Exploring "pure" vertical FDI.

Dep. variable:	A¢liate exports to the home country		
Skill measure:	Relative wage premium (wagep)	Relative skill endowment (skr)	Relative GDP per cap (gdpcap)
gdpi	7.08**	7.01*	6.37**
	(2.04)	(1.90)	(1.89)
gdpj	0.76***	0.61***	0.76***
	(7.65)	(5.99)	(7.37)
dist	-1.12***	-1.14***	-0.99***
	(-6.95)	(-7.09)	(-6.95)
prot	-0.42	-0.62	-0.83
	(-0.99)	(-1.42)	(-0.99)
invc	-1.66**	-0.86	-1.05
	(-2.54)	(-1.21)	(-1.05)
skill	1.34***	0.04	0.08
	(3.30)	(0.13)	(0.50)
ADJ	0.4	0.14	0.48
	(1.12)	(0.35)	(1.23)
US	-18.89	-18.90	-16.80
	(-1.61)	(-1.51)	(-1.46)
R^2	69.9	63.9	65.9
F	52.1***	43.5***	50.3***
Obs	219	204	232

Note: *, **, *** indicate the signi...cance at the one percent, ...ve percent and ten percent level, respectively. Heteroscedasticity consistent t-statistics are in parethesis. Unreported time dummies are always included. All variables in logs except US and ADJ

Table 6: Robustness of the skilled wage premium.

Dep. variable:	A¢liate exports to the home country			
Speci...cation:	(OLS)	(IV)	(FE)	(ABS)
gdpi	7.08**	3.64	7.78***	7.79**
	(2.04)	(0.85)	(2.66)	(2.20)
gdpj	0.76***	0.82***	-0.19	0.74***
	(7.65)	(6.31)	(-0.18)	(7.25)
dist	-1.12***	-1.34***	-1.66***	-1.07***
	(-6.92)	(-6.03)	(-9.19)	(-6.56)
prot	-0.42	0.27	-0.08	-0.59
	(-0.99)	(0.43)	(-0.20)	(-1.39)
invc	-1.66**	-3.23***	0.45	-1.50***
	(-2.54)	(-2.75)	(0.44)	(-2.23)
wagep	1.34***	5.21***	0.70*	1.07**
	(3.30)	(2.40)	(1.80)	(2.04)
ADJ	0.40	0.68	1.76***	0.35
	(1.12)	(1.54)	(2.85)	(0.93)
US	-18.89	-7.04	-20.92**	-21.36*
	(-1.61)	(-0.49)	(-2.12)	(-1.78)
R^2	69.9	53.9	86.6	68.0
F	52.1***	30.4***	48.7***	42.5**
Obs	219	254	232	219

Note: *, **, *** indicate the signi...cance at the one percent, ...ve percent and ten percent, level respectively. Heteroscedasticity consistent t-statistics are in parethesis. Unreported time dummies and home country dummies are always included in the OLS and IV speci...cations. The IV-speci...cation uses as instrument the percentage of secondary schooling completed in total population. In the FE-speci...cation, we also control for host-country ...xed e¤ects. Finally, the ABS-speci...cation uses the absolute value of the the wage premium variable, wagep. All variables in logs except US and ADJ

Table 7: Examining di¤erent FDI measures.

Type:	Vertical FDI:	Horizontal FDI:	Platform FDI:	FDI:	Vertical Integr:
Dep. variable	Exports to home country	Local sales	Exports to third countries	Total sales	Imports from parent
gdpi	7.08**	6.92***	4.77**	5.65***	6.02*
	(2.04)	(3.57)	(1.72)	(2.80)	(1.91)
gdpj	0.76***	1.18***	0.92***	0.98***	1.05***
	(7.65)	(18.33)	(11.81)	(17.01)	(12.89)
dist	-1.12***	-0.56***	-0.84***	-0.65***	-0.58***
	(-6.92)	(-5.50)	(-6.13)	(-6.38)	(-3.77)
prot	-0.42	0.06**	-0.78**	-0.39	-0.26
	(-0.99)	(0.28)	(-2.36)	(-1.64)	(-0.80)
invc	-1.66**	-0.85	-2.29**	-1.21***	-0.88
	(-2.54)	(-2.35)	(-4.52)	(-3.12)	(-1.47)
wagep	1.34***	0.54*	1.10***	0.61***	0.82**
	(3.30)	(1.70)	(3.40)	(2.40)	(2.47)
ADJ	0.40	0.34	-0.66*	0.15	1.76***
	(1.12)	(1.42)	(-1.66)	(0.61)	(2.85)
US	-18.89	-20.00***	-12.25	-15.39**	-17.50
	(-1.61)	(-3.43)	(-1.39)	(-2.25)	(-1.63)
R^2	69.9	80.2	72.9	80.7	54.6
F	52.1***	91.1***	54.7***	110.4***	38.7***
Obs	219	254	232	241	254

Note: *, **, *** indicate the signi…cance at the one percent, …ve percent and ten percent level, respectively. Heteroscedasticity consistent t-statistics are in parethesis. Unreported time dummies are always included. All variables in logs except US and ADJ

Table 8: The Knowledge Capital Model (KCM).

Dep. var:	Exports to the home country		Total sales of affiliates		
Spec:	(Exp. sign)	(OLS)	(Exp. sign)	(OLS)	(ABS)
GDPsum	(+)	1.97×10^{-4}	(+)	5.21×10^{-4}***	5.31×10^{-4}***
		(1.17)		(3.08)	(3.07)
(GDPdif)^2		1.68×10^{-17}	(-)	-5.96×10^{-16}***	-5.35×10^{-16}***
		(0.55)		(-2.63)	(12.89)
DIST		-2.43×10^5*		-9.65×10^5***	-10.19×10^5***
		(-1.96)		(-3.61)	(-3.66)
PROT		5.32×10^7		4.98×10^7	4.30×10^7
		(1.43)		(0.51)	(0.44)
INVC		-6.05×10^7		-3.60×10^8***	-3.58×10^8***
		(-1.35)		(-2.51)	(-2.65)
WAGEP	(+)	5.38×10^9**	(+)	1.36×10^{10}**	1.63×10^{10}**
		(2.01)		(2.24)	(2.29)
INTER	(-)	-0.002*	(-)	-0.004*	-0.006**
		(1.84)		(-1.71)	(-2.23)
ADJ		6.44×10^9***		8.39×10^9	7.85×10^9
		(2.64)		(1.42)	(1.30)
US		4.09×10^9**		1.71×10^{10}***	1.69×10^{10}***
		(2.24)		(3.07)	(3.13)
R^2		27.8		44.4	44.1
F		1.94*		6.45***	6.15***
Obs		219		241	241

Note: *, **, *** indicate the significance at the one percent, five percent and ten percent level, respectively. Heteroscedasticity consistent t-statistics are in parethesis. Unreported time dummies are always included. Expected sign taken from Markusen and Maskus (2001) and Carr et al. (2001), respectively. In the OLS-specification, WAGEP is defined as difference between skilled-to-unskilled wage in the home country and the the same ratio in the host country. In the ABS-specification, the absolute value is applied to this variable. The same applies to the difference in GDP, GDPdif, which is used in the interaction variable, INTER.

Table 9: Dependent variables

	Description:	Source:
Exports to home country:	Aggregate exports of all a¢liates in a host country to the home country (to parent company for Swedish MNEs) during a year expressed in 1990 USD, using current exchange rates and the US GDP de‡ator. Data on exchange rates and the GDP de‡ator have been taken from the OECD Economic Outlook no. 68, (2000). We employ data for 1986, 1990, 1994, and 1998;	Swedish a¢liate data: IUI Database; US a¢liate data: Bureau of Economic Analysis, U.S. Department of Commerce; Data are obtained from Markusen and Maskus (1999) except for 1998 which are found in table III.F4 on: http://www.bea.doc.gov/bea/ai/pi/idn0255.exe
Exports to third countries:	Aggregate exports of all a¢liates in a host country to third countries; other characteristics as above;	table III.F8;ibid;
Local sales:	Aggregate sales of a¢liates in host country; other characteristics as above;	table III.F7;ibid;
Imports from parents:	Aggregate imports from parents in the home country of all a¢liates in a host country;	Swedish a¢liate data: IUI database; US a¢liate data: Bureau of Economic Analysis, U.S. Department of Commerce, table III.I 9;

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Table 10: Wages by Skill

	Description:	Source:
Skilled wage	Pre-tax annual income in SFR of an, on average, 35-year old electrical engineer with university, technical university or higher technical college degree and at least …ve years of practical experience in the machinery or electrical equipment industry in a major city (usually the capital or …nancial center) of a country; The journal issue 1979/80 is matched with the observations of the year 1978, the issue 1985 with the year 1986, the issue 1991 with the year 1990, the issue 1994 with the year 1994 and the issue 1997 with the year 1998;	Union Bank of Switzerland (formerly SBV), Prices and Earnings, various years;
Unskilled wage:	Pre-tax annual income in SFR of industrial workers (toolmaker) of an, on average, 35-year old worker with 3 years of vocational training and at least ten years of practical experience in a large company of the metalworking industry; Data availability as above;	UBS (formerly SBV), Prices and Earnings, various years;
WAGEP:	Log of ratio of home-country skilled wage to unskilled wage divided by host-country skilled wage relative to unskilled wage;	

Table 11: Human Capital and Skill Endowment Variables

	Description:	Source:
SKR:	Ratio of high-skilled labor to total labor force; Skilled labor are the professional categories 0/1 and 2 according to the ISCO68 classi...cation of ILO; For 1998, most countries report according to the ISCO88 classi...cation which di¤ers substantially; To avoid a structural break in the variable construction,the growth rate of professional categories 1, 2 and 3 of ISCO88 from 1994 until 1998 is calculated and multiplied by the levels of ISCO68 values of the year 1994 to obtain estimated values for the year 1998 whenever possible. Sweden does not report category 2, ISCO68, separately from category 3 in the year 1994; Hence, category 3 is included in 1994; Another structural break occurs in 1998 when Statistic Sweden switches its reporting to ISCO88; Time ...xed e¤ects take fully account of this break; However, the time trend is not recoverable for Sweden;	International Labour Organization (ILO); Data for US a¢liates obtained from Markusen and Maskus (2001);
TYRDF:	Average years of schooling by country; Correction of Barro and Lee (1996) data for a number of countries; Data available quintannielly from 1970 until 1998; Matching of closest years;	Domenech and de la Fuente (2001)
TYR:	Average years of schooling; Data availability as above;	Barro and Lee (1996)
SYR:	Average years of secondary schooling in population;	ibid
HYR:	Average years of university education;	ibid
ENROLLS:	School enrollment, secondary schooling; %gross;	ibid
ENROLLT:	School enrollment, tertiary; % gross;	ibid
LSC:	Percentage of secondary schooling completed in total population;	ibid
		ibid

Table 12: Trade, Investment Barriers and other control variables:

	Description:	Source:
INVC:	Unweighted average of answers on ordinal scale between 1 (low cost) and 100 (high cost) to questions on obstacles to foreign direct investment answered by business representatives in the corresponding host country; 1986, 1990, 1994 from Markusen and Maskus (2001) and 1998 constructed from Global Competitiveness Report;	World Economic Forum
PROT:	Ordinal measure of protection on the scale 1 (free trade) to 100 (strongest protection) of host country from business survey; ibid;	ibid
Openness:	Sum of exports and imports divided by GDP;	World Development Indicators
DIST:	Distance of host country capital from home country capital;	IUI database and Markusen and Maskus (2001);
GDPi:	Home country GDP in constant 1995 USD;	World Development Indicators
GDPj:	Host country GDP in constant 1995 USD;	ibid
GDPCAP:	GDP per capita of home relative to host country;	ibid

Table 13: Labor endowments and labor cost correlation matrix.

	UBS data			O¢cial Data		
	Engineers	Production workers	Ratio	Engineers	Production workers	Ratio
Germany	69000 SFR	41000 SFR	1.66	7196 DM*	4761 DM*	1.51
Hungary	7400 SFR	4800 SFR	1.54	127225 HUF	58689 HUF	2.17
Japan	78800 SFR	72500 SFR	1.08	348000 Yen	326000 Yen	1.07
Sweden	54300 SFR	40600 SFR	1.34	26300 SEK*	16900 SEK*	1.56
UK	49900 SFR	41400 SFR	1.21	615.1 £**	388.6 £**	1.58
US	75500 SFR	56100 SFR	1.35	69400 $	60200 $	1.15

Note: Sources: UBS; Statistical Yearbook of Germany 1999, Statistical Yearbook of Japan 1998; Statistical Yearbook of Hungary 1998; Statistical Yearbook of Salaries, Statistics Sweden, 1997; New Earnings Survey 1997, Part D: analysis by occupation, UK O¢ce for National Statistics. German data are for 1995 (UBS for 1997); Remarks: *monthly earnings; ** weekly earnings; Hungarian and Japanese data are for 1998 (UBS 1997); average gross monthly earnings; Germany: Electrical engineer and tool-maker 30-34 years of age; Hungary: Mechanical engineer and mechanical instrument mechanics; Japan: System engineer and Machine inspecting worker in ...rms with 100 to 999 employees (contractual earnings); Sweden: civil engineers monthly gross wage and electrical installation worker monthly gorss wages in 1997. U.K.: electrical engineers and toolmakers, tool...tters or markers-out; avg. gross earnings at fulltime presence; US: median US salaries of civil engineers with M.A. (5 years of university education) and B.A. (3 years of college education) from non-random survey of 550 questionaires of a newsletter for civil engineers in 1998 (http://www.cenews.com/edsalsur0599.html); ; The correlation of the ratios of UBS data and o¢cial data is 0.57 .