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Vertical FDI Revisited

Henrik Braconier *

Pehr-Johan Norback **

Dieter Urban ***

* National Institute of Economic Research, Stockholm

** Research Institute of Industrial Economics, Stockholm

*** London School of Economics and Political Science

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Vertical FDI Revisited*

Henrik Braconier†, Pehr-Johan Norbäck‡ and Dieter Urban§

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Abstract

This study explores how relative skilled-wage premia affect FDI. Contrary to previous studies based on factor endowment differences, we find strong support for vertical FDI, in the sense that more FDI is conducted in countries where unskilled labor is relatively cheap. In addition, we find that relative skill-premia also affect FDI activities that have previously been associated with horizontal FDI, i.e. local affiliate sales. Consequently, the potential effects of changes in the relative wage costs on international production reallocation within MNEs are large. In fact, if not for the 8% rise in the US skilled wage premium relative to the average host country between 1986-1994, annual US affiliate sales abroad in relation to US GDP would have been half a percentage point higher.

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†National Institute of Economic Research, Stockholm, Sweden.

‡Research Institute of Industrial Economics (IUI), Stockholm, Sweden P.O. Box 5501, SE-114 85 Stockholm. E-mail: PJN@iui.se, Internet: www.iui.se.

§London School of Economics and Political Science.

1 Introduction

In the theoretical literature on 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 for 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 interest in the public debate has focused on vertical FDI theory. One of the main fears among policy makers is loss of employment, as MNEs relocate their 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; and Brainard, 1997). The rejection of the vertical FDI model is usually made in two steps. First, as discussed by e.g. Brainard (1993), the scope for vertical FDI models is usually regarded as limited, given that 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 the small share of these exports 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 the sales of MNEs' foreign affiliates (Carr et al., 2001; Markusen and Maskus, 1999, 2001; Blonigen et al., 2002). This has lead to the conclusion that vertical FDI and, hence, international differences in relative factor endowments, are of no importance for explaining MNE activities in general. The negative results for vertical FDI are all the more surprising, given the ample evidence of vertically integrated MNEs, with upstream and downstream production abroad (Hanson et al. 2001).

[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.

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 across borders is much larger than shown by previous studies, as it encompasses both local sales of affiliates as well as exports to third countries and imports of affiliates from the home country. These 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 different components of affiliate activities.

The use of relative factor costs rather than factor endowments has an obvious advantage, since firms' 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, such as differences 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 different 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 refined set of components of affiliate activity allows a more precise measurement, because some of these components, e.g. exports to the home country and third countries, are likely to be more sensitive to factor costs than others, e.g. local sales.

In addition to our finding that relative wage cost differences between host and home countries affect affiliate sales, we also show that the impact of wage cost differences varies systematically with the target for affiliate sales. Our results show that the impact of differences in the relative wage cost is larger on affiliate exports to the MNEs' home

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

country than on affiliate exports to other countries, whereas the latter are more dependent on differences in the relative wage cost than the affiliates' local sales. Consequently, the impact of differences in the relative wage cost is larger for activities with a larger potential for vertical decomposition of production. Apart from the impact of differences in the 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: 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 is not 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

[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, to which we will refer as fragmentation.

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

labor intensive production activities, leads to cost savings for the MNE. Thus, vertical FDI is observed in countries sufficiently abundant in low-skilled labor.

In the Knowledge Capital Model (KC model), developed by Markusen, et al. (1996), FDI is driven by both factor costs and market access and, thus, the KC model incorporates both vertical and horizontal FDI. Three firm types exist in this two-good, two-factor, and two-country model. The first 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 solely produces 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 broadly 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 different, 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 tariff jumping hypothesis (Brainard,

[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 firm is defined as the country where the headquater is located. The host country is defined as the country where the foreign affiliates of the corresponding firm are located. Other countries are third countries that are neither host nor home countries, but export destinations of the affiliates.

1997) while there is little evidence on vertical FDI driven by relative factor endowments.[7] 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 used as a proxy for skill endowments.[8]

Carr et al. (2001) find support for the Knowledge Capital Model (KC model) 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 KC model 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 increase. This is taken as evidence in favor of horizontal FDI, rejecting the KC model and vertical FDI as a driving force for FDI activity while using the same data as Carr et al. (2001).

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 relate these trade flows to relative skill endowments or factor costs. Following Brainard (1997), they use GDP per capita as a skill measure. They obtain mixed evidence on vertical FDI, finding that a higher host-country GDP per capita increases affiliate exports, as well as imports from parents, which contradicts

[7] There is a strand of literature seeking indirect evidence by investigating whether affiliate sales or production are complements or substitutes to trade flows. See e.g. Swedenborg (1979) and Blonigen (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] However, using Swedish data, Norbäck (2001) 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 the host country.

vertical FDI theory. However, the share of affiliate imports for further processing in total affiliate sales is significantly smaller in countries with a large GDP per capita.[9]

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 the previous literature. First, we employ new data on the skilled-wage premium rather than skill endowments. Second, we use a different 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 differences. As shown by Markusen et al. (1996), there exists a monotonic relationship between relative skill endowments and the 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.[10] Yet, there are advantages in basing the empirical analysis

[9] Matthae (2000) has investigated intra-firm 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 finds that US inward processing trade into the EU periphery occurs when the average wage costs are higher rather than lower.

[10] The endogeneity problem of using relative wages as an explanatory variable is probably negligible in practice, 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) should be considered as a special case. Nevertheless, we will pay attention to the possible endogeneity of the wage premium in our econometric analysis.

on 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 profitability of producing in different countries, even though factor endowments may not.[11] 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.[12] These sources of potential discrepancies between endowments and costs make it more fruitful to directly focus on relative costs.[13]

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.[14] Thus, we would expect endowments and relative skill premia to affect FDI patterns differently. 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.

[11] 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 KC model, because trade costs are an essential assumption for explaining the emergence of FDI in this model and factor price equalization breaks down, when trade costs are positive.

[12] In this study, we do not explore why the relation between labor endowments and factor costs may be weak. See Baldwin (1994), for a survey of this issue.

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

[14] 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 applied in our analysis. All data are defined 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 figure clearly shows that the US is, on average, much larger than other host or home countries, as the bulk of outward US FDI observations is in the North-East corner and the bulk of inward observations is in the South-West corner.[15]

A problem with this data set is that the KC 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, US outward FDI data are not appropriate for investigating vertical FDI. Even if US outward FDI data are pooled with inward FDI data, as done by e.g. Carr et al. (2001) and Blonigen et al. (2002), the dataset is far from optimal. The inward FDI observations (treating the US as host country) are located in the South-East corner where no vertical FDI should occur.

In contrast to the US, Sweden is a small- or medium-size 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) cover a much larger part of the endowment box, as shown in Figure 3. Specifically, 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 shown in Table 1, a number of different dependent variables have been used in the analysis of vertical FDI. Figure 4 illustrates their relationship. 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 affect these different measures.

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

According to the KC model, relative factor costs mainly influence exports back to the home country. As a consequence, vertical FDI is sometimes defined as these exports and exports back to the home country then determine the scope for factor costs in explaining FDI.[16] 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.[17] If the relative costs of conducting downstream activities in the host country were lower, i.e. unskilled labor were relatively cheap, we would expect to observe more downstream activities in the foreign country and affiliate imports of intermediate goods from the parent company. In this case, affiliate production will only be sold locally, because the additional transport costs for returning the final good to the home country cannot be offset by the production cost savings (Venables, 1999). Thus, vertical linkages within MNEs can emerge even if the foreign affiliate only sells the final good in the local market.[18] Hence, affiliate production both for the local market and for exports is likely to include elements of vertical integration and be affected by relative factor costs. However, the degree of integration and the sensitivity to relative factor costs are expected to be stronger for affiliate production for exports than for local sales. Moreover, affiliate imports from parent companies in the home country are another measure of FDI depending on the relative factor costs.

Another feature of the KC model is that it only deals with two countries, whereas a large fraction of affiliate production is actually exported to other countries (export platform FDI). Given that exports to other countries constitute a large portion of affiliate

[16] See Markusen (1995).

[17] 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 affiliate, even in this scenario.

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

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, 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.[19]

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 separated by home country, Sweden (Swe) and the US, respectively.

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 their 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 value, these numbers would suggest that the role of 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 of 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.

Summing up, not only exports by affiliates to the home country, but also exports to other countries, imports by affiliates from parent companies and even local sales are

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

potentially driven by relative factor endowments and/or costs, albeit to a different degree.

4 Data

Table 4 gives preliminary statistics on the dependent and 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 affiliate measures: the sum of manufacturing affiliate sales in a year by the home and the host country (*Total Sales)*, affiliate exports back to the home country (*Exports to home-country)*, affiliate exports to countries other than the home and host countries (*Exports to third countries)*, affiliate sales to the host-country market (*Local Sales*), and imports of affiliates from their parent company in the home country (*Imports from parent*)[20]. 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 (1999, 2001).[21] 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 definitions 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.[22] The country coverage for both the US and Swedish data is given in the data

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

[21] These data was kindly provided by James Markusen.

[22] We checked that the reduced US sample behaves in a very similar way to the full sample by replicating estimations of Markusen and Maskus (1999) and Carr et al. (2001) on the reduced dataset and comparing this with their estimates.

appendix.

As can be seen in Table 4, aggregate affiliate sales by US MNEs are about 18 times larger than those by Swedish MNEs in the average host country. This roughly reflects the difference in size between the US and the 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 that in the host economy. These data, which are standard in the literature (Markusen and Maskus, 1999, 2001, and Carr et al., 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.[23] 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 skilled-to-unskilled wage in the host country, in relation to the same ratio in the home country, as follows:

$$WAGEP \equiv \frac{w_U^i / w_S^i}{w_U^j / w_S^j} \equiv \frac{w_S^j / w_U^j}{w_S^i / w_U^i}, \tag{1}$$

[23] However, administrative and managerial workers are not reported separately from clerical workers by ILO for Sweden in 1994. Thus, we had to include the category of clerical workers for Sweden which inflates its average skill endowment. 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.

where w_S^i and w_U^i are the respective wages for skilled- and unskilled labor in the home country i, and 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 both the KC model and Helpman (1984) model predict 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 five years of professional experience and industrial workers with three years of vocational training and ten years of professional experience.[24] These data are collected in cities, wherever UBS has its own affiliates. Thus, the wages often apply to the capital, the financial 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 activities within the manufacturing sector. A slight disadvantage 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 firms. However, labor market competition will ensure that similar professions will obtain similar wages. Moreover, data are only collected for a particular city. Wages are likely to differ across cities, since the living costs differ. 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.[25] Hence, the restriction of the UBS to only collect data in centers may just be an appropriate approximation. Nevertheless, to ensure the credibility of the UBS data on skilled-wage premia, we compare these for some countries with data from national statistical sources in table 13 in the appendix. In spite of the large differences in definitions across those sources, we find similar skilled-wage premia.

Table 13 also reveals that the relative wages for engineers in relation to production

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

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

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, definitions and computational methods are described in the Appendix. From Table 4, it follows that US and Swedish MNEs do invest in countries with somewhat different attributes. On average, US firms are more inclined to invest in countries with a low GDP ($GDPj$), high investment costs (INV), and high trade barriers ($PROT$).[26] Furthermore US affiliates are, on average, located further 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 Swedish firms and on emerging market economies for US firms.

5 Empirical Results

Two different estimation strategies have been used in the literature. First, the gravity equation as in Brainard (1993, 1997) or Hanson, Mataloni and Slaughter (2001) tests the determinants of affiliate sales by using a simple log-linear specification. Second, Carr et al. (2001) test the KC model with a nonlinear specification, including interaction effects. In this paper, we will first apply the general gravity equation and then use the more specific KC model equation for a robustness check.

[26] Naturally, the difference in host country size ($GDPj$) is partially dependent on the size of the US economy as a host of Swedish, but not US, FDI which increases the average host-country size for Sweden as compared to the US.

5.1 The gravity equation estimations

We successively use the FDI activity measures described in section 3.3 as the 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):[27]

$$sales_{ijt} = \beta_0 + \beta_1 gdp_{it} + \beta_2 gdp_{jt} + \beta_3 dist_{ij} + \beta_4 wagep_{ijt} + \beta_5 invc_{jt} + \beta_6 prot_{jt} + \varepsilon_{ijt}, \quad (2)$$

where lower case letters indicate natural logarithms of variables (i.e. $x = \ln(X)$) and ε_{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-specific effects, home-country specific effects, and border effects, respectively.[28] Our novel independent variable of interest is the skill premium ($wagep_{ijt}$). Since we argued in section 3.3 that affiliate exports to the home country are expected to be most sensitive to skill differences, we start out with results on this dependent variable.

5.1.1 Affiliate 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, as the relative wage premium has a positive effect on exports home. This means that affiliate exports to the home country are larger in host countries with high premiums on skilled workers, i.e. countries with relatively cheap unskilled labor. The estimated elasticity of exports to the home country with respect to the relative wage premia is 1.34, which is also significant in economic terms. Home and host GDP are both highly significant. The high elasticity with respect to home GDP illustrates two points. First,

[27] We need not include industry-specific 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 difference variable - is a country-specific variable and could not explain additional variation in the dependent variable across industries.

[28] Host country dummies need not be included, because host country GDP accounts for the differences. However, we do consider host country fixed effects for a robustness check in Table 6.

an increase in the size of the home economy will tend to give rise to more home-based MNEs, which leads to more affiliates abroad. Second, the increase in the size of the home economy tends to make this a more important export market for affiliates, either in terms of final goods or intermediate inputs. Thus, we would expect a high sensitivity to home GDP in affiliate 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 significant. Investigating this variable, we find that it is highly correlated with the investment cost variable (correlation coefficient 0.75), which leads to a severe problem of multicollinearity and, thus, insignificance of the regression coefficient of the protection variable. On a fundamental level, this simply means that host countries pursuing restrictive trade policies 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 difference. In column two, we report the results, when skill difference is 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 et al. (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.[29] While GDP per capita may just be too imperfect a measure of skill differences, the disappointing results from 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 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 specification, Table 5 column 1, again in Table 6 column 1. Then, we reestimate this specification 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 coefficient for the skilled-wage premium increases in size and remains strongly significant. The coefficients of the control variables remain qualitatively the same, except that the coefficient of the trade protection variable switches sign, although it remains insignificant, and the home country GDP coefficient becomes insignificant.[30]

Next, we consider additional host-country fixed effects to control for omitted country characteristics. Once more, the coefficient on the skilled-wage premium remains significant - albeit only at the 10% significance level. However, the inclusion of host-country fixed

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

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

effects changes the signs of the host country GDP- and investment cost coefficients. The fixed effects 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 specifications with host country fixed effects. Hence, specifications with host-country fixed effects are not our preferred ones.

Finally, we check the effects of the wage-premium when specified in absolute value.[31] Using the absolute value of the relative wage premium (in logs) includes the case when foreign affiliates reap benefits from relatively cheap engineers as much as from relatively cheap production workers. The former case is relevant if some foreign affiliate 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 significant at the five percent level with the correct sign. Hence, our sample is not sensitive to the critique of Carr et al. (2001) by Blonigen et al. (2002), who show that in the (mainly unskilled-labor abundant) US inward sample and the (mainly skilled-labor abundant) US outward 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. 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,

[31] Blonigen et al. (2002) argue this to be the correct specification for testing the KC model when investigating the effect of differences in relative endowments. An analogue specification is therefore also provided for the gravity equation estimation.

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 as 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 sales do 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 the expectations, as horizontal MNEs are willing to accept these costs, if there is no alternative way of getting access to the local market without facing high trade costs. Finally, protection has an insignificant positive rather than a negative impact on local sales, which may reflect the tariff 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 affiliate 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 differences arise. First, relative wage costs have a weaker, but still negative and strongly significant, impact on exports to third markets as 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 the host and

export-market country, rather than those of the host and home country.[32]

Second, the home market effect is significantly smaller than for exports to the home country, as the home market no longer affects demand as in the case of exports to the home country. Consequently, the only impact from home GDP is through the "supply side" scale effect, 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 fixed costs at the plant level and trade costs means that affiliates are more likely to be located in large markets (see Braconier and Ekholm, 2001b). Yet, local sales are more dependent on host-country 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.[33] Finally, protection seems to have a very strong and negative impact on exports to third countries, suggesting that firms engage in platform FDI to countries with liberal trade regimes. This result follows directly from the fact that export platform FDI requires considerable trade flows 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 affiliate exports to other countries.

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

[33] Still, distance has a significant effect on exports to third countries, which indicates that transport costs for intermediates from the home country to affiliates or the costs of supervising remotely located affiliates are significant. Note also that cultural differences and language differences may increase with distance and render the export of management practices more difficult.

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 find that all coefficients have the same sign as in the baseline regression with exports to the home country. In particular, the coefficient on the relative skilled-wage premium is significant. In contrast to previous specifications, the trade protection variable becomes significant with the expected sign. Not surprisingly, the quantitative size of all the coefficients is in between the coefficients 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 affiliate imports from parent companies are used as the dependent variable. Qualitatively, all estimates are similar to the ones in the previous specifications. Once more, some quantitative differences are worth noting. The skilled-wage premium is of less importance for affiliate imports from parent companies than for affiliate 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, these are most sensitive to relative factor costs, affiliate imports from parents may be less sensitive to factor costs, because some of these imports are not further processed and are thus final-good exports of the parent company for which local factor costs are irrelevant. Moreover, some affiliate imports from parents may contain specific technologies which would be disseminated as a public good if produced abroad (see Matouschek, 1999). Hence, they would 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 affiliate imports from parents than for affiliate exports to parent countries, because those imports may be sold after further processing in the host country market (vertical FDI of the horizontal type in the terminology of Venables, 1999). Likewise, protection, investment cost, and distance are of less importance for affiliate imports from parent companies than for affiliate 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 KC model approach. We use the Knowledge Capital Model as specified by Carr et al. (2001) but replace their skill endowment variable with the skilled-wage premium, i.e.:

$$RSALESI_{ijt} = \beta_0 + \beta_1 GDPsum_{ijt} + \beta_2 \left(GDPdif_{ijt}\right)^2 + \beta_3 WAGEP_{ijt} + \beta_4 INTER_{ijt} + \beta_5 DIST_{ij} + \beta_6 INVC_{jt} + \beta_7 PROT_{jt} + \varepsilon_{ijt}, \quad (3)$$

where $WAGEP_{ijt}$ is now defined as the difference between skilled-to-unskilled wage in the home country and the same ratio in the host country, $GDPsum_{ijt}$ is the sum of home and host country real GDP, $GDPdif_{ijt}$ is the difference between home and host country GDP, and $INTER_{ijt}$ is a multiplicative interaction term of $GDPdif_{ijt}$ and $WAGEP_{ijt}$. The main difference of this specification to the gravity equation approach (2) is its non-linearity in relative country size and the wage premium, and the lack of log-linearization. Note that the KC model and gravity 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 fixed effects.

The results are provided in Table 8. For each specification, we also show the expected signs based on Markusen and Maskus (2001) and Carr et al. (2001). Examining exports back to the home country, we find that the skilled-wage premium is not only significant at the five-per cent level with the correct sign, but its non-linear interaction term is also significant at the ten-percent level with the correct sign. These results differ markedly from Markusen and Maskus (2001) who find a negative relation between relative skill endowments and affiliate exports back to the US. In general, however, the fit is not as good as for the gravity estimation, which is not surprising since direct levels rather than logarithms of all variables are used. For example, neither the total market size of the host and home country, nor the squared size difference of home and host markets are significant.

The number of significant control variables is also smaller.[34] [35]

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

Finally, in column 3, we apply absolute values on the difference 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 a misspecification when pooling the US-inward and outward data and they show that applying absolute values of skill-differences and GDP-differences causes a sign reversal of the skill variable in Carr et al.(2001). Interestingly, our data do not have this property and results are even somewhat sharper in the absolute value specification. The explanation is that we do not pool US inward and outward FDI data, instead we use US and Swedish outward FDI data. Hence, our home countries are skill-labor abundant and have cheaper high-skilled labor relative to almost all host countries so that the absolute value is mostly not binding. This can be seen by comparing Figures 2 and 3.

All in all, we find 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 different model specifications, the use of different FDI measures, different estimation techniques, and different control variables.

[34] As in the gravity approach, investment cost and protection are insignificant. In addition, the protection variable also has the wrong sign. Only distance remains significant at the five-per cent level.

[35] It is, however, interesting to note that the insignificance of the square-term and the GDP sum-term constitute support in a vertical FDI model without firm-level scale economies (see, Markusen and Maskus 1999), where the only motive for FDI is factor price differences. In contrast to horizontal FDI including scale economies at the firm–level, there should indeed be no inverse U-shape relation between vertical FDI and size difference.

6 Concluding Remarks

In contrast to previous studies, we find ample support for vertical FDI in the sense that MNEs' affiliate activities are affected by relative wage costs. We find that affiliate sales increase when there is an increase in the 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 specification of the empirical model and, consequently, we are confident that we have found robust support for vertical FDI.

Not only do we find evidence that relative skill premia affect overall affiliate activities, but we also investigate to what extent different types of affiliate activities are driven by different 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 affiliate imports from the parent in the home country. Consequently, relative wage premia even seem to affect activities traditionally associated with horizontal FDI (i.e. local sales). This means that the potential effects of factor differences on FDI are larger than previously thought. To illustrate the effects 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 affected FDI. The rise in the wage premium in the US exceeded that of the average host country in our sample by 8%.[36] Taking this change in the relative wage premium as exogenous, we attribute to it a permanent decline in annual US affiliate 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 effects are similar across types of activities, the quantitative effects differ substantially. In most cases, we find that these quantitative differences are in

[36] 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 specific wage premium variable rose by 10% .

line with what should be expected from the theoretical literature. We do, for example, find that exports to the home country are strongly dependent on relative skill premia and the size of the home market, whereas local affiliate 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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7 Appendix

7.1 Data Description:

The baseline specification in table 5 uses data on the following countries with an observation for at least one year. Swedish affiliates 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 affiliates 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 (2001) 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 (2001) include a rather small number of partner countries to the US. One may suspect that some countries with US afiliates are excluded from the database of Markusen and Maskus (2001), our data source, if independent variables are missing. Hence, we cannot be sure to have the complete universe of US affiliates. In general, observations for the years 1986, 1990, 1994 and 1998 are used. Next, we give a definition and a description of the data used in our study as well as their sources.

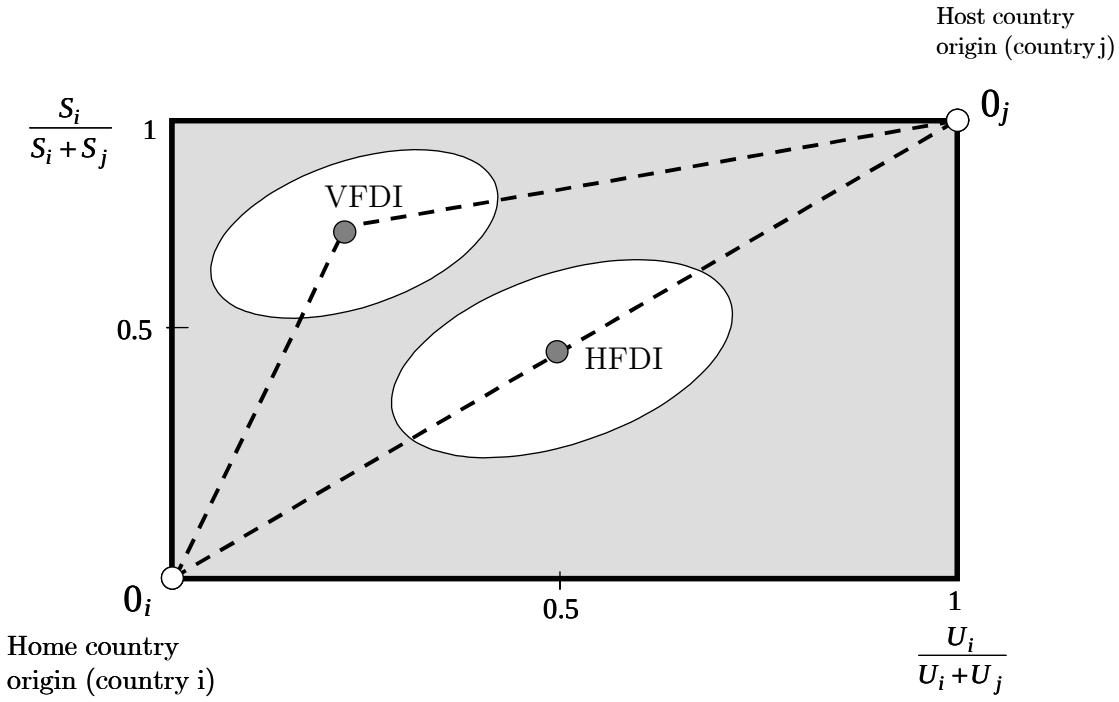

Figure 1: Regions of FDI in the KC model. *Note*: $S_i(S_j)$ is the home(host) country's endowment of skilled labor. $U_i(U_j)$ is the home(host) country's endowment of unskilled labor.

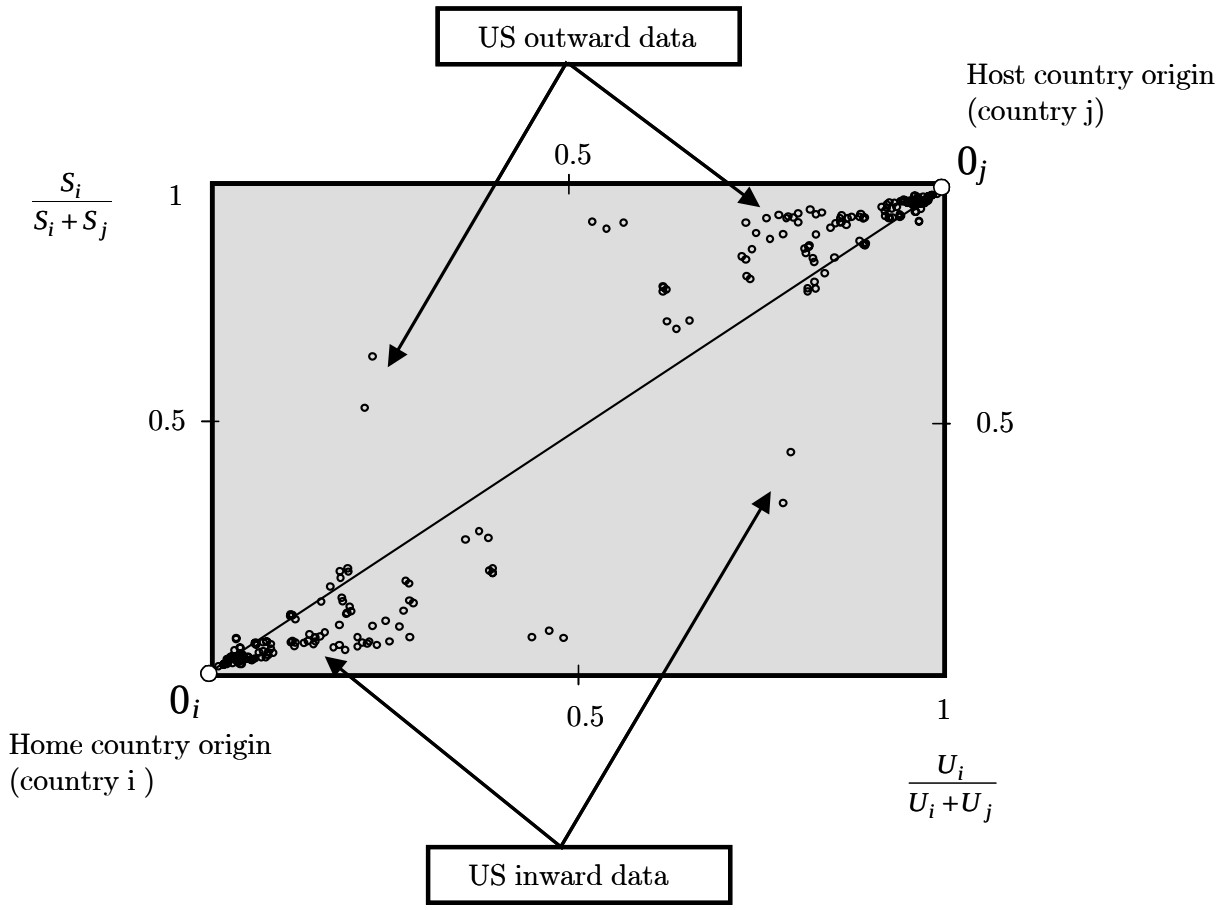

Figure 2: Outward and inward FDI in Carr et al. (2001).

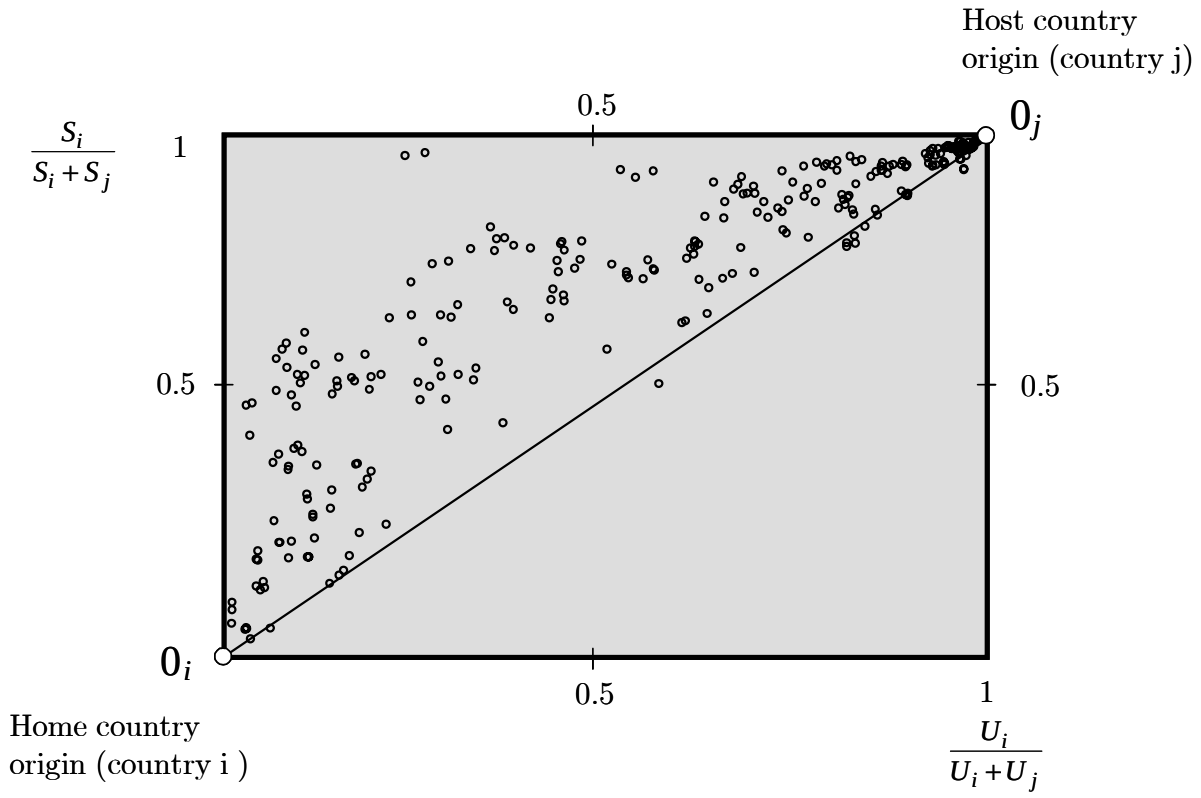

Figure 3: Outward FDI for Sweden and the US.

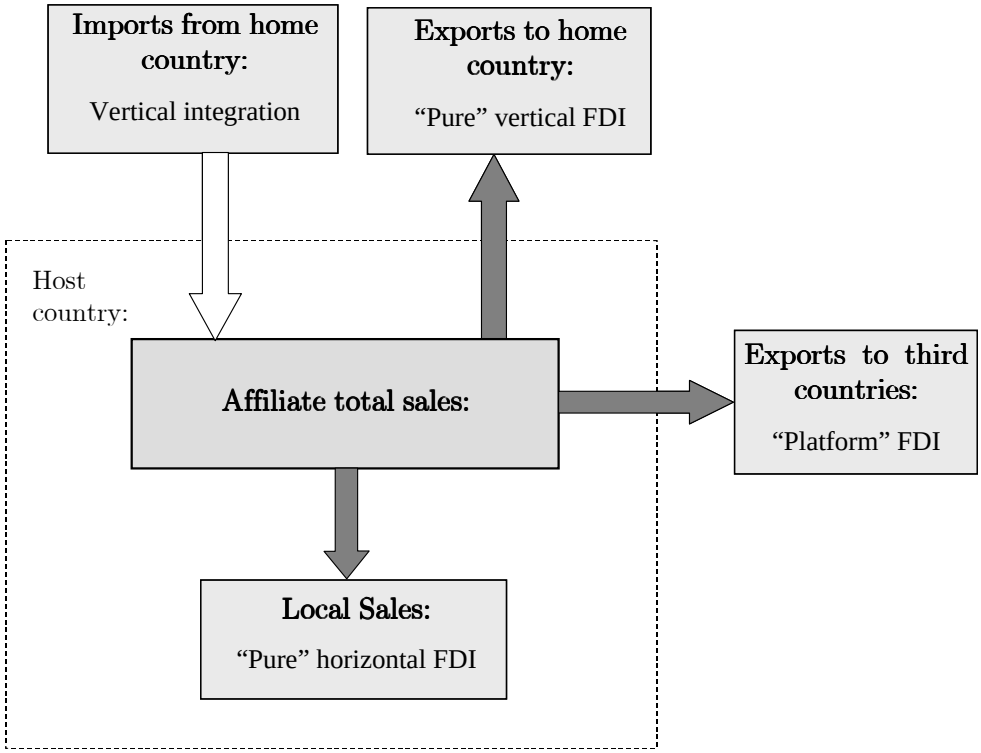

Figure 4: Illustrating different flows of FDI.

Table 1: Previous empirical results.

	Main skill measure:	Sample coverage:	Main FDI measures:	Evidence for:	
				HFDI	VFDI
Brainard (1993)	Differences in endowments of skilled and unskilled labor, differences in GDP per capita	US inward and outward FDI, cross section of industries, (BEA)	Exports to the home country Local sales of affiliates		Mixed
Brainard (1997)	Difference in GDP per worker	ibid	Total sales of affiliates	Yes	No
Carr, Markusen and Maskus (2001)	Differences in relativ endowments of skilled labor (ILO)	US inward and outward FDI, (BEA)	Total sales of affiliates	Support for KC model	
Markusen and Maskus (1999)	ibid	ibid	Exports to the home country Total exports by affiliates Affiliate local sales	Yes	Mixed (No support for the VFDI and KC models in outward FDI)
Markusen and Maskus (2001)	ibid	ibid	Total sales of affiliates	Yes	No (Rejection of KC model)
Blonigen, Davies and Head (2002)	Absolute value of differences in skill labor abundancy (ILO)	US inward and outward FDI, (BEA) FDI stocks (OECD)	Total sales of affiliates, Bilateral FDI stocks	Yes	No (No support for KC model)
Hanson, Mataloni and Slaughter (2001)	GDP per capita of host country	US outward FDI, panel of industries, (BEA)	Total exports and local sales by affiliates Imports to affiliates 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 affiliates Imports from parents		Yes (Support for KC 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 affilate sales as shares of total affiliate 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 affiliate 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	$3x10^{-9}$/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 million USD. GDPi and GDPj are measued in billion USD.

Table 5: Exploring "pure" vertical FDI.

Dep. variable:	Affiliate 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)	(-5.98)
prot	-0.42	-0.62	-0.83**
	(-0.99)	(-1.42)	(-2.06)
invc	-1.66**	-0.86	-1.05
	(-2.54)	(-1.21)	(-1.51)
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	-18.95	-16.76
	(-1.61)	(-1.51)	(-1.46)
R^2 (%)	69.0	63.9	65.9
F	52.1***	43.5***	50.3***
Obs	219	204	232

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

Table 6: Robustness of the skilled wage premium.

Dep. variable:	Affiliate exports to the home country			
Specification:	(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***	-1.30***	-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	-7.05	-20.92**	-21.36*
	(-1.61)	(-0.49)	(-2.12)	(-1.78)
R^2 (%)	69.0	53.9	85.6	68.0
F	52.1***	30.4***	48.7***	52.5***
Obs	219	215	219	219

Note: *, **, *** indicate the significance at the one percent, five percent and ten percent level, respectively. Heteroscedasticity consistent t-statistics are in parenthesis. Unreported time dummies and home country dummies are always included in the OLS and IV specifications. The IV-specification uses the percentage of secondary schooling completed in total population as instrument. In the FE-specification, we also control for host-country fixed effects. Finally, the ABS-specification uses the absolute value of the the wage premium variable, *wagep*. All variables are in logs except US and ADJ.

Table 7: Examining different 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	-0.11
	(-0.99)	(0.28)	(-2.36)	(-1.64)	(-0.26)
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)	(1.65)	(2.47)
ADJ	0.40	0.34	-0.66*	0.15	0.40
	(1.12)	(1.42)	(-1.66)	(0.61)	(0.82)
US	-18.89	-20.00***	-12.25	-15.39**	-17.50
	(-1.61)	(-3.04)	(-1.30)	(-2.25)	(-1.63)
R^2 (%)	69.0	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 significance at the one percent, five percent and ten percent level, respectively. Heteroscedasticity consistent t-statistics are in parenthesis. Unreported time dummies are always included. All variables are in logs except US and ADJ.

Table 8: The Knowledge Capital Model (KC model).

Dep. var:	Exports to the home country		Total sales of affiliates		
Spec:	(Exp. sign)	(OLS)	(Exp. sign)	(OLS)	(ABS)
$GDPsum$	(+)	0.20	(+)	5.21***	5.31***
		(1.17)		(3.08)	(3.07)
$(GDPdif)^2$	(-)	1.68x10^{-5}	(-)	-5.96x10^{-4}***	-5.35x10^{-4}***
		(0.55)		(-2.63)	(2.38)
$DIST$		-0.24*		-0.97***	-1.02***
		(-1.96)		(-3.61)	(-3.66)
$PROT$		53.16		49.80	42.99
		(1.43)		(0.51)	(0.44)
$INVC$		-60.47		-360.41***	-358.02***
		(-1.35)		(-2.51)	(-2.65)
$WAGEP$	(+)	5381.50**	(+)	13626.33**	16335.23**
		(2.01)		(2.24)	(2.29)
$INTER$	(-)	-2.11*	(-)	-4.34*	-5.84**
		(-1.84)		(-1.71)	(-2.23)
ADJ		6430.78***		8389.65	7851.10
		(2.64)		(1.42)	(1.30)
US		4089.64**		17059.16***	16904.94***
		(2.24)		(3.07)	(3.13)
R^2 (%)		27.8		44.4	44.1
F		2.43**		9.31***	8.46***
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 parenthesis. Unreported time dummies are always included. The expected signs are taken from Markusen and Maskus (2001) and Carr et al. (2001), respectively. In the OLS-specification, $WAGEP$ is defined as the difference between skilled-to-unskilled wage in the home country and 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, $INTER$. Affiliate sales are measured in million USD and GDP in billion USD.

Table 9: Dependent variables

	Description:	Source:
Exports to home country:	Aggregate exports of all affiliates in a host country to the home country (to the parent company for Swedish MNEs) during a year expressed in 1990 USD, using current exchange rates and the US GDP deflator. Data on exchange rates and the GDP deflator have been taken from the OECD Economic Outlook no. 68, (2000). We employ data for 1986, 1990, 1994, and 1998;	Swedish affiliate data: IUI Database; US affiliate 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 affiliates in a host country to third countries; other characteristics as above;	table III.F8;ibid;
Local sales:	Aggregate sales of affiliates in host country; other characteristics as above;	table III.F7;ibid;
Imports from parents:	Aggregate imports from parents in the home country of all affiliates in a host country;	Swedish affiliate data: IUI database; US affiliate data: Bureau of Economic Analysis, U.S. Department of Commerce, table III.I 9;

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 a university, technical university or higher technical college degree and at least five years of practical experience in the machinery or electrical equipment industry in a major city (usually the capital or financial 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 is the professional categories 0/1 and 2 according to the ISCO68 classification of ILO; For 1998, most countries report according to the ISCO88 classification which differs 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 fixed effects take fully account of this break; However, the time trend is not recoverable for Sweden;	International Labour Organization (ILO); Data for US affiliates 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	ibid
	population;	ibid

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

	Description:	Source:
INVC:	Unweighted average of answers on an 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 the 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
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			Official 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 Office 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 toolmaker 30-34 years of age; Hungary: Mechanical engineer and mechanical instrument mechanics; Japan: System engineer and Machine inspecting worker in firms with 100 to 999 employees (contractual earnings); Sweden: civil engineers monthly gross wage and electrical installation worker monthly gross wages in 1997. U.K.: electrical engineers and toolmakers, toolfitters or markers-out; avg. gross earnings at fulltime presence; US: median US salaries of civil engineers with an M.A. (5 years of university education) and a B.A. (3 years of college education) from a 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 official data is 0.57 .