THE ROLE OF SKILL ENDOWMENTS IN THE STRUCTURE OF U.S. OUTWARD FOREIGN DIRECT INVESTMENT

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Abstract—This paper reports the results of an empirical study of the industry and country determinants of U.S. outward foreign direct investment (FDI). These results contribute to the literature in two dimensions. First, they demonstrate that the structure of U.S. FDI reflects an interaction between country skilled-labor abundance and industry skilled-labor intensities that is consistent with comparative advantage. Second, they confirm the results of early studies that market access plays an important role in the structure of U.S. FDI. Together these results paint a broad picture of the structure of U.S. FDI that casts light on the predictions of the theory of multinational enterprise.

I. Introduction

THIS paper makes two contributions to the literature on the determinants of U.S. outward foreign direct investment (FDI). First, we show that U.S. outward FDI follows a pattern consistent with a chain of comparative advantage. To do this, we explore the interaction between the relative skilled-labor abundance of a wide range of countries with the skilled-labor intensity of a wide range of goods. Second, we confirm the results of earlier studies that trade frictions between countries, plant- and firm-level scale economies, and countries' relative market sizes influence the structure of U.S. outward FDI. Our results shed light on that structure across several important dimensions relevant to the theory of the multinational enterprise (MNE).

The centerpiece of the theory of the multinational enterprise is the *knowledge-capital* model.[1] This model incorporates two motives for firms to engage in FDI. First, firms may produce in multiple countries to avoid costs associated with international trade. We will refer to this as the *market access* motive. Second, if firms can decompose their production process into various stages, then they may produce in multiple countries in order to locate production activities where the factors used intensively in these activities are cheap. Since relative production costs can vary across countries and industries according to comparative advantage, we will call this the *comparative advantage* motive. Given these two motives, the model identifies a set of industry characteristics (such as transport costs, plant scale economies, and factor intensities) and a set of country characteristics (such as market sizes, tariff levels, and factor abundances) that interact to determine the structure of FDI.

The model's predictions over the structure of FDI are highly nonlinear in the relevant country and industry characteristics. There are, however, two special cases of the model that highlight the two distinct motives for FDI. First, if the factor intensities of different productive stages vary little and transport costs are nontrivial, then only the market-access motive to FDI remains. This special case has been termed the *horizontal* model. Second, if transport costs are negligible and production stages vary in their factor intensity, then only the comparative advantage motive remains. This special case has been termed the *vertical* model. The predictions of these special cases are very different.[2] For instance, the horizontal model predicts that FDI should occur between countries of similar factor abundance, whereas the vertical model predicts that FDI should occur between countries with large differences in relative factor abundance.

The knowledge-capital model has spawned a burgeoning empirical literature. We touch briefly on several of the major empirical strategies in this literature. In one branch of the literature, researchers have motivated their empirical specifications by simulating patterns of FDI across countries while holding industry characteristics fixed. These specifications are then applied to data aggregated across industries to the country level. Examples of papers within this branch of the literature are Carr, Markusen, and Maskus (2001), Markusen and Maskus (2001b), Markusen and Maskus (1999), and Blonigen, Davies, and Head (2002). In some sense, all of these papers find evidence that is consistent with some version of the knowledge-capital model. A consistent theme in this literature is that models assuming low transport costs (such as the purely vertical model) are rejected by the data in favor of models in which market access issues arise. Much of the discussion in this literature is over whether the aggregate data favor a theoretical specification in which factor intensity differences across production activities within an industry are important determinants of FDI (the knowledge-capital model) over one in which they are not (the horizontal model).

Another branch of the literature looks at the variance in the country-industry pairs. Researchers here consider a mixture of country and industry characteristics and ask whether these characteristics explain the variance in FDI across country-industry pairs in a manner consistent with the knowledge-capital model. Within this literature, Brainard (1997) has provided direct support for the market access motive underlying the model. FDI appears to be high in

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[1] See Markusen (1997) for an example of such a model, and Markusen and Maskus (2001a) for an excellent survey.

[2] For an example of a purely vertical model of FDI, see Helpman (1984). For an example of a purely horizontal model of FDI, see Markusen and Venables (2000).

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industry-country pairs in which transport costs are high and plant scale economies are low. Brainard (1993, 1997) has also explored the average effect of relative factor abundance differences across countries on the structure of FDI across country-industry pairs. In general, the results do not suggest an important role for the comparative advantage motive for FDI. On average, FDI is primarily attracted to developed countries and not to developing countries.

The preponderance of evidence suggests that the comparative advantage motive for FDI is far less important than the market access motive in explaining the bulk of FDI. There is, however, plenty of evidence that some component of FDI is motivated by the desire to shift production activities to countries in which factors are relatively cheap. In particular, LDCs are relatively more likely to act as export platforms back to their parent country (Brainard, 1993). Further, intrafirm trade varies across countries in a way consistent with a vertical motive for FDI in skilled-labor-scarce countries (Hanson, Mataloni, and Slaughter, 2001). Further, Maskus and Webster (1995) have shown that the factor usage of multinational affiliates in the United Kingdom and Korea appears to be consistent with the comparative advantage of those countries.

Our paper contributes to this literature in two ways. Our first contribution is to explain the country-industry pair variation by considering an empirical specification in which a country's skilled-labor abundance is interacted with an industry's skilled-labor intensity. This model is then estimated using data that, like the data used by Brainard (1993, 1997), are highly disaggregated in both dimensions. Our results show that the effect of a country's relative skilled-labor abundance on the volume of U.S. multinational sales in that country varies across industries in a manner consistent with comparative advantage. In industries with high skilled-labor intensities, U.S. MNEs favor skilled-labor-abundant countries over skilled-labor-scarce countries, whereas in sectors with low skilled-labor intensities U.S. MNEs favor skill-scarce countries over skill-abundant countries. This result helps to inform the theory of the multinational enterprise, which features the role of country skilled-labor abundances as a key determinant of FDI, by bringing this feature of the data to light.

Our second contribution is to provide evidence that is consistent with the market access motive. Our results confirm many of the results of Brainard (1997): Firms tend to substitute FDI for exports when transport costs are high and plant scale economies are low. We also confirm the result of Carr, Markusen, and Maskus (2001) that market size plays a critical role in determining the cross-country distribution of FDI. The results suggest that obtaining market access is a crucial motivation for U.S. MNE, and models based on this motive therefore obtain support from the data.

Finally, although our analysis confirms the existence of a statistically significant comparative advantage explanation for the industry-country variation in the data, its relative importance in explaining the structure of FDI is harder to assess. According to the magnitudes of the estimated coefficients, comparative advantage plays a nontrivial role in explaining the variation in industry-country pairs. Harder to quantify is the additional explanatory power offered by incorporating a comparative cost motive for investing abroad. Here the results vary considerably across specifications, but in ways that we believe are also informative to the theory of MNE.

II. Empirical Model

Our empirical framework is designed to analyze the underlying motives for FDI. Roughly speaking, theory suggests that the pattern of FDI should vary across country-industry pairs with the strength of market access motives and comparative advantage motives for FDI. The strength of the market access motive for FDI should vary with country-industry pair characteristics such as transport costs, tariffs, and plant- and corporate-scale economies (see, for instance, Horstmann and Markusen, 1992), and country characteristics such as market size (see, for instance, Markusen and Maskus, 2001a). The strength of the comparative advantage motive also varies across countries and industries, depending on the importance of factor price differentials across countries given an industry's production technology. We assume that the function relating these country and industry characteristics to the volume of U.S. FDI can be approximated by

$$FDI_{ij} = \beta_1 T_{ij} + \beta_2 SE_i + \beta_3 MKTSIZE_j + \beta_4 UC_{ij} + \beta_5 CTR_j + \varepsilon_{ij}, \tag{1}$$

where the subscript i indexes industries and the subscript j indexes countries. FDI is a measure of a feature of the scale of U.S. multinational operations abroad, T is a vector of transport cost variables, SE is a vector of scale economy variables, and $MKTSIZE$ is a measure of the host countries' market size.

If the data are consistent with the market access motive, then FDI should be increasing in transport costs (T_{ij}) as firms seek to avoid shipping costs by investing abroad, and decreasing in plant scale economies (SE_i) as firms seek to concentrate production in a few locations. Further, FDI should rise more than proportionally with respect to market size ($MKTSIZE_j$), for a large market increases both the scale of sales of multinationals that invest and the number of firms that invest in the market. Hence, we expect $\beta_1 > 0$, $\beta_2 < 0$, and $\beta_3 > 1$.

The comparative advantage motive for FDI enters into equation (1) via UC_{ij}, which is a vector of variables that reflect a potential host country's unit cost of production by sector. Since actual unit costs of production are not observed, we hypothesize the following expression for unit

costs of production by sector and country:

$$\beta_4 UC_{ij} = \beta_6 HC_j + \beta_7 HC_j \times SK_i + \beta_8 SK_i, \qquad (2)$$

where HC_j is the relative human capital abundance of host country j, and SK_i is the skilled-labor intensity of industry i.

By allowing a country's relative human capital abundance to interact with an industry's skilled-labor intensity, our specification is capable of capturing a pattern of FDI that reflects a *chain of comparative advantage.* To fix ideas, imagine a two-factor world (skilled and unskilled labor) and many goods ranked by their skilled-labor intensity. Further, suppose that there exist at least two sets of countries classified by their relative abundance of skilled labor (skilled-labor-abundant and skilled-labor-scarce). Finally, consider an equilibrium in which there are two cones of diversification. By construction, the relatively skilled-labor-abundant country would be the relatively low-cost producer in a set of industries characterized by relatively high skilled-labor intensities, whereas the relatively skilled-labor-scarce country would be the relatively low-cost producer in a set of industries characterized by relatively low skilled-labor intensities. If a low cost of production attracts FDI, then we would expect multinationals operating in high-skilled-labor-intensive industries to be attracted primarily to skilled-labor-abundant countries, and multinationals operating in low-skilled-labor-intensive industries to be attracted primarily to skilled-labor-scarce countries.

The attractive feature of equation (2) is that it allows the effect of a country's relative skilled-labor abundance on the structure of FDI to vary across industries. If $\beta_6 < 0$ and $\beta_7 > 0$, then skilled-labor-abundant countries (high HC_j) might enjoy less FDI than skilled-labor-scarce countries (low HC_j) in the least skilled-labor-intensive sectors (low SK_i), and more FDI in the most skilled-labor-intensive sectors (high SK_i). If $\beta_8 < 0$ and $\beta_7 > 0$, then a skilled-labor-abundant country might tend to receive a disproportionate amount of its FDI in skilled-labor-intensive industries, whereas a skilled-labor-scarce country would tend to receive a disproportionate quantity of its FDI in skilled-labor-nonintensive industries.

Our gauge of the extent to which a chain of comparative advantage appears in our sample is the sign and magnitude of the estimated coefficients. One possible outcome is that the coefficients have the signs discussed in the previous paragraph. In this case, we would conclude that the structure of FDI across industries and countries is consistent with a chain of comparative advantage. Note that transport costs and other market access considerations can be expected to make this prediction less sharp, leading to far less specialization than predicted by a free-trade, multiple-cone-of-diversification model.[3]

Finally, we include a vector of country-specific variables, CTR_j, to control for other determinants of FDI known to be important for FDI. The residuals ε_{ij} in equation (1) reflect a wide range of omitted variables, including other factor endowments that may play a role, important policy variables that affect the profitability of local production, unobserved industry-specific costs of investing abroad, and possible interaction terms between the included independent variables. Given the potential correlation of these omitted variables with our regressors, we will consider the sensitivity of our results to the inclusion of country and industry fixed effects.

III. Data

We begin by describing our three measures of the extent of U.S. FDI by country and industry. Each of these variables measures FDI in terms of the sales of U.S. multinationals as collected by the Bureau of Economic Analysis (BEA), which conducts a census of U.S.-majority-owned affiliates abroad. The data, which are aggregated to the industry level from the level of the affiliate, are taken from the Benchmark Survey of 1994 and covers 39 countries and 50 BEA manufacturing industries.[4] The three measures we consider are the sales made by U.S. multinational affiliates in country j to all customers (*TAS*, or total affiliate sales), the exports of these affiliates back to their parent companies (*XAS*, or export affiliate sales), and the ratio of all exports from the U.S. to a host country to the sum of local affiliate sales in that host country (total affiliate sales less affiliate exports to other countries) and exports from the U.S. to that host country (*EXSH*).[5] Each measure provides an alternative perspective on the pattern of U.S. MNE expansion abroad.

Now consider the regressors in equation (2), which we refer to as the comparative advantage variables. The measure of human capital, *HC*, is the average years of schooling per worker, taken from the World Bank.[6] The measure of an industry's skilled-labor intensity, *SK*, is calculated following Midelfart-Knarvik, Overman, and Venables (2000). It is the share of nonproduction workers in value added by industry. To obtain this measure, we constructed a weighted average of the skill intensities at all U.S. multinational affiliates by industry. This measure was then turned into an

[3] As shown in Deardorff (1979), such a chain of comparative advantage can break down in the presence of intermediate goods and transport costs. Since the existence of transport costs motivates horizontal FDI and the existence of trade in intermediate goods is almost a precondition for the existence of vertical FDI, one expects there to be weak links in the chain of comparative advantage. The existence of such weak links is one prime candidate for why vertical FDI is hard to perceive in the data.

[4] The industry and country coverage is shown in the data appendix.

[5] U.S. exports by industry and country are taken from Feenstra (2000). For a description and list of sources for the independent variables used in the analysis, see the appendix. Summary statistics are also shown in the appendix.

[6] Alternative measures of *HC* were considered, including GDP per worker and the average years of schooling from the Barro-Lee data set. These results are contained in a supplemental appendix available upon request.

index of which the value for the industry with the median skilled-labor intensity is equal to 100.[7]

Now consider the market access variables contained in equation (1). We use two measures of transport cost T, each of which varies by country and industry. The first is an ad valorem measure of freight and insurance cost, $FREIGHT_{ij}$, constructed from U.S. import data. The second, $TARIFF_{ij}$, was constructed from disaggregated SITC tariff data. The fixed cost variables, SE_i, vary only by industry. First, there is $PSCALE_i$, which is the average size of a plant in the United States in terms of production workers. This variable captures the cost of maintaining additional capacity. Second, we include a measure of corporate scale economies, $CSCALE_i$, which is the average number of nonproduction employees at the firm level. Higher corporate scale economies should increase FDI by giving entrants into the industry larger market shares, which tends to boost the importance of transport costs. The last market access variable, *MKTSIZE*, is simply a country's GDP.

We include two controls. The first is *CLOSEFDI*, which is a dummy variable, constructed from the survey results published in the *World Competitiveness Report* (Institute for Management Development, 1996), for a country that makes foreign ownership of local assets difficult to obtain. The final control is *TAX*, which is a measure of the corporate tax rate as calculated by Hines and Rice (1994).

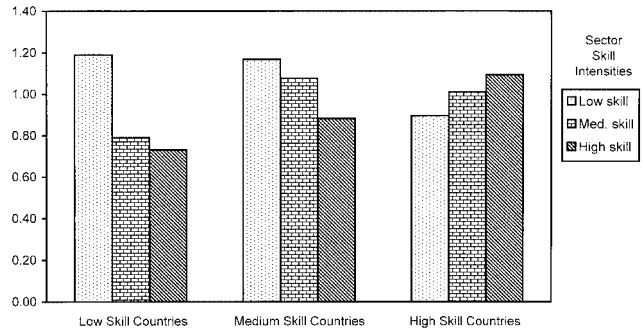
IV. Results

A. The Revealed Comparative Advantage of Host Countries

Before proceeding with the formal econometric analysis, we consider the broad pattern of FDI across sectors and countries. We sorted the countries into three equal-size groups based on their relative skilled-labor abundance, labeled low-, medium-, and high-skill countries. We then aggregated total affiliate sales by industry for each of these three country groupings and calculated revealed comparative advantage ratios for each industry by country grouping. Finally, we sorted the industries into three groups—of low, medium, and high skilled-labor intensity—and calculated the average of the revealed comparative advantage index for each country-industry grouping. The results of this exercise are shown in figure 1.

The cross-country and cross-industry pattern of FDI shown in figure 1 is supportive of a chain of comparative advantage. Skilled-labor-scarce countries appear to have a strong comparative advantage in the least skilled-labor-intensive industries and a strong comparative disadvantage in those with medium and high skilled-labor intensity. Moderately skilled-labor-abundant countries appear to have a strong comparative advantage in the least skilled-labor-intensive industries, a moderate comparative advantage in those with medium skilled-labor intensity, and a moderate comparative disadvantage in those with high skilled-labor intensity. Finally, the highly skilled-labor-abundant countries are the only ones to have a comparative advantage in highly skilled-labor-intensive industries and a comparative disadvantage in the least skilled-labor-intensive industries.

FIGURE 1.—REVEALED COMPARATIVE ADVANTAGE INDICES FOR COUNTRIES GROUPED BY SKILL ENDOWMENTS AND INDUSTRIES GROUPED BY SKILL INTENSITY



An interesting feature of the data is that the cross-industry variance in the revealed comparative advantage ratios is highest for the least skilled-labor-abundant countries and smallest for the most skilled-labor-abundant countries. This outcome may reflect the fact that the least skilled-labor-abundant countries have the smallest market sizes, and the most skilled-labor-abundant countries have the largest. This result might be expected if the market access motive for FDI outweighs the comparative cost motive when markets are large.

B. The Determinants of the Level of Total Affiliate Sales

We now proceed with the econometric analysis of the determinants of FDI on the level of U.S. affiliate sales. We begin by considering as our dependent variable the extent of the total sales by U.S. MNE affiliates (*TAS*) by industry and country.[8] It is this variable that has been the focus of many of the recent empirical investigations into the determinants of FDI. The results of our analyses are shown in table 1.

In column (1) of Table 1 are the results of estimating equation (1) by OLS. First, consider the market access variables. The coefficient on *FREIGHT* is negative, and the coefficient on *TARIFF* is positive. Shipping costs are associated with less FDI, and tariffs are associated with more. The coefficient on *PSCALE* is negative, as would be consistent with plant-level fixed costs acting as a deterrent to FDI. The coefficient on *CSCALE* is positive, as would be consistent with FDI being more pronounced in highly

[7] We also considered a similarly constructed measure using data from the U.S. Annual Survey of Manufactures. The results using this alternate proxy are similar and can be found in the supplemental appendix mentioned in footnote 6. We use these global average measures because of the real concern raised by Lipsey, Kravis, and Roldan (1978) and Lipsey (1999) that the activities carried out by MNE abroad are often very different than those carried out at home.

[8] To avoid dropping zero observations, the dependent variable is the log of $1 + TAS$.

TABLE 1.—THE DETERMINANTS OF THE LEVEL OF TOTAL AFFILIATE SALES

Variable	(1)	(2)	(3)	(4)
FREIGHT	−0.60	0.00		−0.49
	(0.35)	(0.16)		(0.33)
TARIFF	0.45	0.40		0.56
	(0.18)	(0.23)		(0.19)
PSCALE	−1.07			−1.05
	(0.72)			(0.72)
CSCALE	0.60			0.77
	(0.55)			(0.53)
MKTSIZE	1.79			1.82
	(0.11)			(0.11)
CLOSEFDI	−1.92		−2.25	−2.02
	(0.30)		(0.26)	(0.31)
TAX	−0.99		0.65	−1.07
	(0.25)		(0.21)	(0.25)
HC	−30.79		−25.64	
	(6.22)		(5.95)	
HC × *SK*	6.73	6.93	6.51	
	(1.35)	(1.23)	(1.29)	
SK	−15.42		−14.98	
	(3.04)		(2.77)	
N	1,930	1,930	1,930	1,930
R-square	0.255		0.093	0.239

Constant suppressed. In column (2), dummies are suppressed as well. Standard errors in parentheses are heteroskedascity-consistent and allow for clustering by industry. All variables except *CLOSEFDI* are in logs.

concentrated industries. Finally, the coefficient on *MKTSIZE* is significantly greater than 1: large markets enjoy disproportionately large levels of FDI.

These results are generally, although not completely, consistent with the market access motive for FDI. The one result not consistent with this motive is the negative coefficient on *FREIGHT*, which suggests that shipping costs deter the replication of productive activities across countries. The positive coefficient on *TARIFF*, however, is consistent with a tariff-jumping motive for FDI. Perhaps the greatest support for the horizontal motive for FDI is offered by the coefficient on *MKTSIZE*, which greatly exceeds 1. This result is consistent with Carr, Markusen, and Maskus (2001), who report a similar result in the aggregate FDI data, and is key evidence in favor of horizontal models for FDI that feature an interaction between shipping costs and fixed costs of investing abroad, which together make market size a crucial country determinant of FDI.

We now consider the coefficients on the comparative advantage variables. The coefficients on *HC* and *SK* are both negative; the coefficient on their interaction is positive. All three variables are highly statistically significant both jointly and severally. The signs of the coefficients on the comparative advantage variables are consistent with a chain of comparative advantage based on country skilled-labor abundance and industry skilled-labor intensity.

To gauge the importance of comparative advantage, we now consider the magnitudes of the coefficients. The effect of a change in a country's level of human capital on total affiliate sales is approximately given by

$$\frac{\partial \ln TAS}{\partial HC} = -30.79 + 6.73\ \mathrm{SK}.$$

This means that an increase in *HC* is associated with a decrease in *TAS* in that country for the 23 industries in the sample with a skill intensity index of less than 97 and an increase in *TAS* for the remaining 27 industries. The sizes of these coefficients can also be gauged by the implied effect of an increase in HC for the least and most skilled-labor-intensive industries. For the least skilled-labor-intensive industry, a one-standard-deviation increase in *HC* is associated with a 0.3-standard-deviation decrease in the log of total affiliate sales. For the most skilled-labor-intensive industry, a one-standard-deviation increase in *HC* is associated with a 0.16-standard-deviation increase in the log of total affiliate sales.

A similar analysis of the coefficients can be used to gauge the effect on an increase in an industry's skilled-labor intensity. The coefficient estimates reveal that for all but the most skilled-labor-abundant countries (those with years of schooling greater than 9.9 per capita), an increase in skilled-labor intensity is associated with less FDI. These results can be interpreted as suggesting that the motive for U.S. firms to invest abroad may be stronger in industries in which the United States does not have a comparative advantage.

Finally, the coefficients on the two controls, *CLOSEFDI* and *TAX*, are both sensible and statistically significant. Countries that maintain barriers to foreign investment receive less FDI than countries that do not, and countries that have a high corporate income tax also receive less FDI.

As a robustness check we consider a specification that includes fixed industry and country effects. The results of this exercise are shown in column (2) of table 1. The coefficients on both *TARIFF* and *HC* × *SK* in column (2) are essentially the same as those in column (1), and each coefficient continues to be statistically significant. The coefficient on *FREIGHT* does change, however. When a full set of industry and country dummy variables are included, the estimated coefficient on *FREIGHT* is almost exactly 0. This result suggests that the unexpected negative sign obtained on *FREIGHT* in the OLS specification stems from the omission of determinants of FDI that are highly correlated with shipping costs. These results increase our confidence that the pattern of FDI reflects both a horizontal and comparative cost motive.

The signs and statistical significance of both the market access and comparative advantage variables show that both play some role in determining the structure of FDI. In particular, the strong statistical significance of the comparative advantage variables suggests that an empirical specification that allows for a chain of comparative advantage is favored over empirical models that do not, in a narrowly defined statistical sense. Nevertheless, our analysis so far

says little about the explanatory power of the market access variables relative to comparative advantage variables. To obtain a crude gauge of that, we estimate the model alternately restricting the coefficients on each set of variables to 0 and assessing the corresponding change in the model's fit.

In column (3) of table 1 we show the consequences of restricting the market access variables to 0. The most dramatic consequence is the sharp dropoff in the R-square value, from 0.255 to 0.093. Most of this drop can be attributed to the omission of *MKTSIZE*: dropping all the market access variables except *MKTSIZE* results in a less drastic drop in the R-square to 0.236 (not shown). Other consequences can be seen in the coefficients of the remaining variables. Most spectacularly, the sign on *TAX* changes from negative to positive. Another consequence is that the coefficient on *HC* is smaller in absolute value in the absence of *MKTSIZE*.

In column (4) of Table 1 we show the consequences of restricting the comparative advantage variables to 0. As these results show, the consequences of dropping the comparative advantage variables are smaller. The R-square drops moderately, from 0.255 to 0.239. This drop is roughly the same as the loss in explanatory power associated with omitting all the market access variables except *MKTSIZE*. The coefficients on the remaining variables change slightly, those on *FREIGHT* and *TARIFF* changing the most.

This exercise of alternately restricting coefficients to zero shows that most of the explanatory power in our full empirical model is due to the single variable *MKTSIZE*.[9] In some sense, this is not surprising, given that virtually any theory would predict a relationship between the scale of FDI in a country and the scale of the market. We conclude that the results of our analysis are generally consistent with both a market access and a comparative advantage explanation for the structure of FDI, and that these results are robust to the inclusion of fixed effects by both industry and country, but that our ability to predict the level of total affiliate sales in data that are highly disaggregated across both industries and countries is low.

C. *Comparing Determinants of Local versus Export Affiliate Sales*

Our next exercise is to compare the determinants of the level of U.S. multinational sales abroad intended to serve the host country market with the determinants of FDI intended for export back to the United States. As noted by other authors (see, for instance, Brainard, 1993, and Markusen and Maskus, 2001b), the identifying feature of vertically integrated multinational firms is that they concentrate production in foreign markets to serve their home market.

Our exercise is to compare the results of estimating equation (1) using local affiliate sales (*LAS*) and using export sales back to the United States (*XAS*) as our dependent variables. Since there are a large number of zeros for *XAS*, we estimate both of our specifications using a standard tobit procedure to prevent attenuation bias from making our comparison nonsensical.[10] The results are reported in columns (1) (*LAS*) and (2) (*XAS*) of table 2.

TABLE 2.—THE DETERMINANTS OF AFFILIATE SALES TO THE HOST COUNTRY AND TO THE UNITED STATES

Variable	(1) *LAS*	(2) *XAS*
FREIGHT	−1.29	−3.67
	(0.22)	(0.29)
TARIFF	0.68	−0.13
	(0.21)	(0.28)
PSCALE	−1.16	0.28
	(0.37)	(0.49)
CSCALE	0.85	0.38
	(0.20)	(0.27)
MKTSIZE	3.13	4.62
	(0.15)	(0.23)
CLOSEFDI	−5.41	−6.49
	(0.47)	(0.66)
TAX	−1.40	−2.78
	(0.46)	(0.62)
HC	−50.58	−58.00
	(10.02)	(13.47)
HC × *SK*	11.08	12.55
	(2.19)	(2.93)
SK	−24.99	−25.98
	(4.58)	(6.17)
N	1,930	1,930
Log likel.	−4460	−3032

Constant suppressed. All variables except *CLOSEFDI* are in logs.

The results in table 2 reveal large differences between the determinants of the two types of sales. First, there are systematic differences in the coefficients on the transport cost variables. The variable *FREIGHT* is negative in both specifications, but its coefficient is much larger in the export specification. Large shipping costs deter vertical FDI more strongly than horizontal FDI. *TARIFF* is positive and statistically significant with respect to local sales, but appears to play no role in explaining export sales. The negative coefficient on *PSCALE* in column (1) indicates that plant scale economies deter sales to local customers, but the same effect is not present in the export equation in column (2). Interestingly, a large market size is even more important for export sales than it is for local sales. This result is in fact consistent with knowledge-capital models where the presence of transport costs makes it attractive to consolidate offshore production in large host countries (see, for instance, Zhang and Markusen, 1999).

[9] Regressing *TAS* on *MKTSIZE* alone yields an R-square of 0.20.

[10] Note that we do correct for heteroskedacity by modeling the variance of the residuals as being proportional to both industry and country size.

Turning to the controls, barriers to FDI and high corporate taxes are more of a deterrent to FDI for export than to FDI for the local market. This result is consistent with FDI for export being footloose in comparison with FDI for local markets.

Finally, the coefficients on the comparative advantage variables display the same sign patterns in each of the two specifications, suggesting that comparative advantage plays a role in both local and export sales. The coefficients on the variable *HC* is relatively larger in the export specification than in the local sales specification, suggesting that FDI for export back to the United States is moderately more concentrated in skill-scarce countries than is FDI for the local market. This result is consistent with earlier papers, such as Brainard (1993), which have shown a stronger tendency for FDI for export back to the United States to be affected by endowment differences across countries.

D. The Tradeoff between Exports and FDI

In this final subsection, we consider the determinants of the composition of international commerce between exports and FDI. The dependent variable that we consider, *EXSH*, is the logarithm of the ratio of exports from the United States to a host country divided by the sum of these exports plus U.S. multinational affiliate sales to host country customers. There are at least three benefits to using this measure. The first is that the measure is readily interpreted as the degree to which firms substitute one means of serving a foreign market for another. This is a natural choice for pure models of horizontal FDI, because these models typically posit that exports and FDI are substitutes. The second benefit is that by construction this variable helps to control for factors that affect the extent of total international commerce in a particular market and naturally scales the size of each industry, enhancing the comparability of the dependent variable across industries. The final benefit is that this measure is used in the highly influential study of Brainard (1997), and by considering it we are able to compare our results with hers.

Our exercise is to repeat the analyses of section IV B using instead *EXSH* as our dependent variable. The results of our full specification are shown in column (1) of table 3. Our first observation is that the coefficient estimates on our market access variables are each consistent with the horizontal motive for FDI and with the results reported in Brainard (1997). Both measures of transport cost, *FREIGHT* and *TARIFF*, are negative and statistically significant, indicating that firms tend to substitute FDI for exports when transport costs are high. Unlike the levels specification, the coefficient on *FREIGHT* is consistent with the horizontal motive for FDI, which suggests that the unexpected sign in the levels specification reflects an omitted variable bias. The coefficient on *PSCALE* is negative, and the coefficient on *CSCALE* is positive. Firms tend to substitute exports for FDI in those industries in which the fixed costs associated with replicating production over many locations is high. Further, in industries in which there is less competition because of high entry costs, firms tend to substitute FDI for exports.

TABLE 3.—THE DETERMINANTS OF THE COMPOSITION OF INTERNATIONAL COMMERCE

Variable	(1)	(2)	(3)	(4)
FREIGHT	−0.27	−0.13		−0.30
	(0.07)	(0.04)		(0.07)
TARIFF	−0.10	−0.02		−0.18
	(0.04)	(0.06)		(0.06)
PSCALE	0.34			0.33
	(0.17)			(0.20)
CSCALE	−0.15			−0.26
	(0.13)			(0.17)
MKTSIZE	−0.27			−0.26
	(0.02)			(0.02)
CLOSEFDI	0.56		0.51	0.61
	(0.09)		(0.06)	(0.10)
TAX	0.01		−0.25	0.02
	(0.04)		(0.04)	(0.05)
HC	6.32		2.45	
	(1.53)		(0.87)	
HC × *SK*	−1.31	−0.82	−0.58	
	(0.33)	(0.28)	(0.19)	
SK	3.93		2.12	
	(0.78)		(0.46)	
N	1,930	1930	1930	1930
R-square	0.223		0.135	0.149

Constant suppressed. Standard errors in parentheses are heteroskedascity-consistent and allow for clustering by industry. All variables except *CLOSEFDI* are in logs.

The coefficient on *MKTSIZE*, a variable not included in Brainard's analysis, is negative and statistically significant indicating that firms tend to substitute FDI for exports to large markets. This is highly consistent with models of horizontal FDI, where large markets make local production more attractive in the presence of fixed plant costs and unit shipping costs.

Turning to the coefficients on the comparative advantage variables, we find that they are again consistent with a hypothesis of a chain of comparative advantage. U.S.-based firms are more likely to export to high-human-capital countries in all but the most skilled-labor-intensive industries. The magnitude of the coefficients on *HC* and *HC* × *SK* indicate that an increase in *HC* is associated with a relative decrease in FDI in favor of exports in forty of the fifty industries in the sample. Further, a one-standard-deviation increase in *HC* is associated with an increase in the dependent variable of approximately 0.33 in the least skilled-labor-intensive industry, which is a somewhat larger effect than that of a one-standard-deviation in *MKTSIZE*. The tendency of firms in less skilled-labor-intensive industries to substitute FDI for exports is consistent with a comparative advantage motive for FDI. Finally, note that the coefficients on *HC* × *SK* and *SK* indicate that an increase in an

industry's skilled-labor intensity is associated with an increase in the export share ratio for all countries, although this effect is less pronounced for the most skilled-labor-abundant countries. This result is consistent with the U.S. having a comparative advantage in the most skilled-labor-intensive industries.

In column (2) of table 3, we consider the robustness of our results by including industry and country fixed effects. We find that the signs of all three of our variables that vary by both country and industry remain the same but become smaller in magnitude, with *TARIFF* becoming statistically insignificant. Both *FREIGHT* and $HC \times SK$ remain statistically significant, however, providing additional support to both the market access and comparative advantage motives for FDI.

Following our earlier analyses, we now attempt to gauge the relative explanatory power of the market access and comparative advantage variables by alternately restricting these coefficients to 0. In column (3) of table 3, we show the consequences of restricting all of the market access variables to 0. The most dramatic effect is to reduce the R-square from 0.223 to 0.135, indicating that these variables are highly important in explaining the composition of international commerce. Dropping the market access variables also affects the coefficients on the comparative advantage variables, which become much smaller, and the control, *TAX*, which switches sign.

In column (4) of table 3, we show the consequences of restricting the three comparative advantage variables to 0. Unlike the levels regressions, the consequence here is considerably more pronounced. The R-square falls from 0.223 to 0.149, which suggests a lower bound of one-third for the variance explained by the comparative advantage variables alone relative to the full model.[11] The full variance explained by the comparative advantage variables alone is unlikely to be much larger, however, since dropping the comparative advantage variables has only a small effect on the coefficients of the remaining variables.

V. Discussion and Conclusion

In this paper, we have explored various features of the structure of FDI in a highly disaggregated sample of U.S. outward FDI. Our results are consistent with many of the elements of the theory of MNE. Our most novel result is that the pattern of U.S. outward FDI is consistent with a chain of comparative advantage based on country skilled-labor abundance and industry skilled-labor intensity. After controlling for other determinants of FDI, we find that U.S. multinationals invest more in skill-scarce countries than in skilled-labor-abundant countries in the least skilled-labor-intensive industries. Our results are also consistent with a strong market access motive for FDI, and they confirm those presented in earlier studies that multinationals are more likely to be present when transport costs are high or plant scale economies are low, and in countries with substantial market sizes.

The relative importance of purely horizontal versus comparative-advantage-based explanatory variables differed considerably across specifications. In the levels regressions, the market access variables were clearly more important than the comparative advantage variables in their ability to predict the pattern of FDI. Much of this dominance clearly reflects the fact that in the levels regression, the dependent variable was not scaled, giving any measure of the scale of a country an advantage in explaining the pattern of FDI. Other market access variables, like *TARIFF* and *PSCALE*, offered less predictive ability, however, and the coefficient on *FREIGHT* had the wrong sign. When we considered the naturally scaled export share variable, *EXSH*, the explanatory dominance of the market access variables, particularly *MKTSIZE*, was less pronounced, with the comparative advantage variables offering no less than a third of the full model's explanatory power. Further, the coefficients on the other market access variables were more closely aligned with theory.

The stronger performance of the comparative advantage variables in the *EXSH* regressions than in the *TAS* regressions may have a straightforward explanation. It is true that the bulk of FDI is between developed countries, but it is equally true that the bulk of international trade is also between developed countries. In horizontal models of FDI, exports and FDI are substitutes. The variable *EXSH* is designed to capture exactly this relationship. Most tests of the theories of FDI have been conducted on levels of FDI alone, despite the fact that these models also make predictions over levels of exports. The results of our analysis suggest that empirical work to assess the predictions of these models should consider both sets of predictions to provide a more thorough test.

Finally, taken as a whole, our results can be interpreted as favoring models that incorporate both a market access and comparative advantage motive for FDI. If one associates vertical FDI with FDI from a skilled-labor-abundant country to a skilled-labor-scarce country in a skilled-labor-nonintensive industry, then our coefficient estimates on our comparative advantage variables are consistent with the existence of vertical FDI. Though purely horizontal models of FDI may outperform the knowledge-capital model in the aggregate data, a knowledge-capital model may be more appropriate for the least skilled-labor-intensive industries.

[11] Regressing *EXSH* on *MKTSIZE* alone yields an R-square of 0.066, which again highlights the importance of market size. Note that using this naturally scaled variable, the effect of *MKTSIZE* is far less overwhelming than in the levels regressions.

REFERENCES

Blonigen, Bruce, Ronald Davies, and Keith Head, "Estimating the Knowledge-Capital Model of the Multinational Enterprise: Comment," NBER working paper no. 8929 (2002).

Brainard, S. Lael, "An Empirical Assessment of the Factor Proportions Theory," NBER working paper no. 4269 (1993).

Brainard, S. Lael, "An Empirical Assessment of Proximity-Concentration Trade-off between Multinational Sales and Trade," *American Economic Review* 87 (September 1997), 520–544.

Carr, David, James Markusen, and Keith Maskus, "Estimating the Knowledge-Capital Model of the Multinational Enterprise," *American Economic Review* 91 (2001), 691–708.

Deardorff, Alan, "Weak Links in the Chain of Comparative Advantage," *Journal of International Economics* 9 (May 1979), 197–209.

Feenstra, Robert, "World Trade Flows, 1980–1997," Center for International Data, University of California, Davis (2000).

Hanson, Gordon, Raymond Mataloni, and Mathew Slaughter, "Expansion Strategies of U.S. Multinational Firms," NBER working paper no. 8433 (2001).

Helpman, Elhanan, "A Simple Model of Trade with Multinational Corporations," *Journal of Political Economy* 92 (1984), 452–471.

Hines, Jim, and Eric Rice, "Fiscal Paradise: Foreign Tax Havens and American Business," *Quarterly Journal of Economics* 109 (February 1994), 149–182.

Horstmann, Ignatius, and James Markusen, "Endogenous Market Structures in International Trade," *Journal of International Economics* 20 (1992), 225–247.

Institute for Management Development, *World Competitiveness Report* (1996).

Lipsey, Robert, Irving Kravis, and Romualdo Roldan, "Do Firms Adapt Factor Proportions to Relative Factor Prices," NBER working paper no. 293 (1978).

Lipsey, Robert, "Foreign Production by U.S. Firms and Parent Firm Employment," NBER working paper no. 7357 (Sept. 1999).

Markusen, James, "Trade versus Investment Liberalization," NBER working paper no. 6231 (1997).

Markusen, James, and Keith Maskus, "Discriminating among Alternative Theories of Multinational Enterprise," NBER working paper no. 7164 (1999).

Markusen, James, and Keith Maskus, "General-Equilibrium Approaches to the Multinational Firm: A Review of Theory and Evidence," NBER working paper no. 8334 (2001a).

Markusen, James, and Keith Maskus, "Multinational Firms: Reconciling Theory and Evidence," in Magnus Blomstrom and Linda Goldberg (Eds.), *Topics in Empirical International Economics: A Festschrift in Honor of Robert Lipsey* (Chicago, IL: University of Chicago Press for National Bureau of Economic Research, 2001b).

Markusen, James, and Anthony Venables, "The Theory of Endowment, Intra-industry and Multinational Trade," *Journal of International Economics* 52 (2000), 209–234.

Maskus, Keith, and Allan Webster, "Comparative Advantage and the Location of Inward Foreign Direct Investment: Evidence from the UK and South Korea," *World Economy* 18 (March 1995), 315–328.

Midelfart-Knarvik, Helene, Henry Overman, and Anthony Venables, "Comparative Advantage and Economic Geography: Estimating the Determinants of Industrial Location in the EU," London School of Economics working paper (2000).

Zhang, Kevin, and James Markusen, "Vertical Multinationals and Host-Country Characteristics," *Journal of Development Economics* 59 (August 1999), 233–252.

DATA APPENDIX

TABLE A1.—DATA DESCRIPTION

Variable	Description
FREIGHT	Freight costs by country and industry, CIF/FOB, from U.S. Census Import Data, 1994
TARIFF	Tariffs by country and industry, various sources and years for the 1990s, from APEC database, Official Journal of the European Union, and the Feenstra data set
PSCALE	Employment of production workers at the average-size U.S. plant, from Census Bureau, 1994
CSCALE	Employment of nonproduction workers at the average-size U.S. firm, from Census Bureau, 1994
MKTSIZE	1996 GDP in U.S. $billion at annual average exchange rate, from IFS
CLOSEFDI	Dummy representing a country's openness to FDI, constructed from *World Competitiveness Report*, 1996
TAX	Corporate income tax rate, taken from Hines and Rice (1994)
HC	Average years of schooling per worker for 1990, from the World Bank
SK	Average share of skilled workers in value added in U.S. MNE affiliates, from the confidential BEA data set

The countries in our sample are Argentina, Brazil, Canada, Chile, Colombia, Costa Rica, Guatemala, Ecuador, Mexico, Peru, Venezuela, Austria, Belgium, Denmark, France, Finland, Germany, Greece, Ireland, Italy, Netherlands, Portugal, Spain, Sweden, Switzerland, Turkey, United Kingdom, Australia, New Zealand, Hong Kong, Japan, Malaysia, Philippines, Singapore, South Korea, Taiwan, Thailand, Israel, and South Africa. The industries covered are the 52 BEA manufacturing industries included in the benchmark survey of U.S. outward FDI for 1994, less industries 271 and 265.

TABLE A2.—SUMMARY STATISTICS

Variable	Mean	S.D.	Min.	Max.
TAS, $ million	6.87	5.83	0	17.71
LAS, $ million	6.36	5.63	0	16.68
XAS, $ million	3.03	4.44	0	17.25
EXSH	−0.85	1.35	−9.82	0
FREIGHT, percent	−3.03	0.844	−8.86	−0.03
CLOSEFDI	0.27	0.44	0	1
TARIFF, percent	1.94	0.98	0	4.41
PSCALE, prod. workers/plant	−3.62	0.51	−5.04	−2.42
CSCALE, Nonprod. workers/ firm	−3.83	0.96	−5.76	−1.23
MKTSIZE, $ billion	11.58	1.35	8.56	14.87
TAX	−1.04	0.50	−3.21	−0.51
HC, yrs. of school	1.98	0.28	1.26	2.53
SK, median = 100	4.59	0.295	3.61	5.11

All data are in logs.