Bilateral and Third-Country Exchange Rate Effects on Multinational Activity*

Hartmut Egger†, Peter Egger‡ and Michael Ryan§

February 17, 2006

Abstract

This paper presents a three-country model with coexisting exporters and multinational firms that engage in Cournot competition. In this setting, we study how bilateral and third-country exchange rate shocks pass through into real effects. In particular, the impact of exchange rate movements on the number of foreign subsidiaries and the value of foreign direct investment is at the heart of the paper's interest. This impact depends on the following trade-off: On the one hand, an appreciation of a foreign currency raises the value of local affiliate sales there (a *revenue effect*). On the other hand, it reduces costs of foreign market penetration through exports, thereby fosters competition and renders ultinational activities in this country less attractive (a *competition effect*). The major hypotheses of the theoretical model are then empirically investigated using data on bilateral multinational outbound activities of the US and Japan. To accomplish this task, we employ a generalized method of moments estimation approach that accounts for cross-sectional dependence at the international level.

Key words: Exchange rate appreciation, Third-country effects, Multinational firms

JEL classification: C23; F12; F14; F23;

* *Acknowledgements*: We would like to thank seminar participants at the Universities of Linz, Mainz, Maryland, Munich, Nottingham, and Regensburg and the European Central Bank for helpful comments and suggestions. Especially, we are indebted to Daniel Bernhofen, Ron Davies, Harry Kelejian, Ingmar Prucha, John Rust, and Stephen Yeaple for numerous helpful suggestions. We have also benefited from discussions at the Midwest International Economics Spring 2005 Meeting, the Göttinger Workshop on International Economics 2005, the Summer Workshop on Trade and Location at the University of Kiel 2005, the European Economic Association Meeting 2005, the Annual Meeting of the German Economic Association 2005 and the Annual Meeting of the European Trade Study Group 2005.

† *Affiliation*: University of Zurich, CESifo Munich, and Centre for Globalization and Economic Policy, University of Nottingham. *Address*: Socioeconomic Institute, University of Zurich, Zurichbergstr. 14, 8032 Zurich, Switzerland.

‡ *Affiliation:* Ludwig-Maximilian University of Munich, CESifo Munich, and Centre for Globalization and Economic Policy, University of Nottingham. *Address:* Ifo Institute for Economic Research, Poschingerstr. 5, 81679 Munich, Germany.

§ *Affiliation:* Western Michigan University. *Address:* Department of Economics, Western Michigan University, Kalamazoo, MI 49008, USA.

1 Introduction

Profound empirical evidence points to the importance of exchange rate movements for multinational enterprise (MNE) activity (Caves, 1989; Blonigen, 1997). However, the effects are not fully understood yet, rendering "*the topic of exchange rate effects on FDI (...) an area rich for future work.*" (Blonigen, 2005, p. 8). This paper contributes to existing research in two respects. First, it extends previous theoretical work on exchange rate effects in the pricing-to-market framework (Krugman, 1987). Second, it presents novel empirical evidence on the role of exchange rates for MNE activity such as foreign direct investment (FDI), taking account of bilateral and third-country influences, separately. The empirical analysis is based on a panel data-set of outbound multinational activity of the US and Japan.

We derive empirically testable hypotheses regarding the impact of an exchange rate appreciation on MNE activity in a simple model with imperfect (Cournot) competition. Such an appreciation triggers real effects since it is passed-through only imperfectly on local prices.[1] This relates our work to the pricing-to-market literature (Krugman, 1987) which, in the late 1980s, has become the principle foundation of the empirically observed reluctance in price adjustments to exchange rate movements. These exchange rate movements are treated as exogenous shocks. The basic idea is that, under imperfect competition, markups adjust endogenously. This leads to an imperfect exchange rate pass-through on prices, if domestic and foreign producers compete for consumers at home and/or abroad (Venables, 1990). In this regard, Baldwin (1988) and Baldwin and Krugman (1989) show that even temporary shocks may have persistent real effects, if the incentive to foreign market penetration is changed and fixed costs are sunk after firm entry.

In contrast to the previous literature, we account for two types of producers: exporters and MNEs. On the one hand, we know from previous work that the magnitude of the exchange rate effects depends on market shares of domestic and foreign producers (see Fisher, 1989, and Froot and Klemperer, 1989). On the other hand, accounting for coexistence of exporters and MNEs provides novel insights on how exchange rate shocks can trigger real effects. One central finding

[1] Goldberg and Knetter (1997, p. 1248) define the exchange rate pass-through as "*the percentage change in local currency import prices resulting form a one percentage change in the exchange rate between the exporting and the importing countries.*

is that the effect of an exchange rate appreciation on bilateral MNE activity is determined by a trade-off. It causes, for a given output level, a positive *revenue effect* on bilateral MNE activity. But at the same time, it renders exporting to the foreign market more attractive and gives rise to a negative *competition effect*. The relative size of these two effects is determined by parent country factor endowments, transport and foreign investment costs.

Furthermore, our analysis differs substantially from previous contributions, as we consider a three-country setting and distinguish between bilateral and third-country exchange rate effects. Taking account of the empirical fact that multinational firms do not operate a foreign affiliate in each economy, we assume that they set up two production plants (one domestic and one foreign) and serve consumers in the third country through exports. This gives rise to *complex* forms of foreign market penetration and relates our model to recent theoretical work on the organizational structure of multinational firms. For example, Yeaple (2003) and Grossman, Helpman, and Szeidl (2003) analyze optimal integration strategies of MNEs in a three-country framework. Ekholm, Forslid, and Markusen (2005) emphasize the role of export-platform foreign direct investment, which is undertaken for the mere reason of serving consumers in a third market.[2] We keep the world-wide number of affiliates constant and explore the most important mechanisms at work in a static general equilibrium framework. This simplifies the exposition of the model considerably, rendering it still informative about the role of exchange rates for the location of foreign subsidiaries across possible host countries.

Empirical results on exchange rates and MNE activity are mainly available for FDI into the US (see Caves, 1989; Froot and Stein, 1991; Swenson 1994; Blonigen, 1997). The literature supports a positive impact of a dollar depreciation on US inward FDI. Our contribution to existing empirical work is twofold. First, we account for both bilateral and third-country exchange rate effects as determinants of bilateral MNE activity. In this regard, we rely on spatial econometric methods for panel data that are particularly suited to study third-country effects on bilateral outcome variables. There is growing empirical evidence that third-country effects on MNE activity are generally important (see Blonigen, Davies, Waddell, and Naughton, 2004; Baltagi, Egger, and Pfaffermayr, 2005; and Blonigen, 2005, for an overview). However, third-country

[2] Hanson, Mataloni, and Slaughter (2001, 2005) and Baltagi, Egger, and Pfaffermayr (2005) provide empirical support for such complex organization structures of MNEs. And Blonigen, Davies, Waddell, and Naughton (2004) find that export-platform motives may be important for US outbound FDI into Europe.

exchange rate effects on bilateral MNE activity have not been examined so far. Second, we study the exchange rate effects on outbound multinational activity of both the US and Japan. This gives insights in how far the previously identified exchange rate effects are robust to the choice of parent and host countries.

The main findings of our study can be summarized in the following way: (i) both bilateral and third-country exchange rates matter for MNE activity; (ii) the exchange rate effects are qualitatively identical for different measures of MNE activities: the number of foreign affiliates, the value of outbound foreign direct investment, and the value of foreign affiliate sales; (iii) bilateral and third-country exchange rate shocks exhibit different effects on multinational activity; (iv) the empirically identified exchange rate effects on US MNE activity are different from those on Japanese activity; (v) distance as well as factor endowment characteristics seem to be relevant for an explanation of these differences on the grounds of our theoretical model.

The remainder of this paper is organized as follows. In the next section we set up the theoretical model. Sections 3 and 4 provide a characterization of the equilibrium and a comparative static analysis. Section 5 presents the estimation approach and the empirical findings. In Section 6 we conduct a robustness analysis. The last section concludes with a short summary of the most important results.

2 Theoretical background

We set up a three-country model, where indices $c = i, j, k$ refer to the different economies. There are three primary factors of production: physical capital K, skilled labor S, and unskilled labor L. These factors are inelastically supplied in perfectly competitive and internationally segmented markets. Besides a perfectly competitive agricultural Y-sector, there is an infinite number of symmetric industrial X-sectors. In each of these X-sectors, a small number of oligopolistic firms competes in quantities. Trade in industrial goods is subject to iceberg transport costs, implying that only a fraction of $1/t$ of the quantity produced in the source country arrives abroad. There are no further trade impediments. In particular, transport costs for the agricultural good are zero.

Production of one unit of good Y requires one unit of unskilled labor, i.e., $Y = L$. Two types of oligopolistic firms are active in the industrial sectors, namely exporters, n, and MNEs, m.

(We use m- and n-variables to refer to the different firm types and the number of producers of a particular type.) One unit of skilled labor are required to headquarter a firm (MNE or exporter), and one unit of capital is required to set up a (MNE or exporter) production facility in the parent country. Local production can start immediately without further investment. However, if a firm decides to set up a production facility abroad, a fixed factor input of $g-1>0$ units of physical capital needs to be invested before production can start in the foreign economy.[3] An MNE with headquarters in country i is bound to country i's supply of capital and skilled labor, when setting up its production plants. Regarding production technologies in the industrial sector, we assume that all firms employ the same technology and use one unit of unskilled labor to produce one unit of final output.

Then, the resource constraints in country c are given by

$$\bar{K}_c \geq n_c + gm_c, \qquad \bar{S}_c \geq n_c + m_c, \qquad \bar{L}_c \geq X_c + Y_c, \tag{1}$$

where X_c and Y_c indicate overall X- and Y-supply in the respective economy. Note that $n_c, m_c > 0$ requires $g\bar{S} > \bar{K} > \bar{S}$. To focus on the most important features of our model, we assume $\bar{K}_j = \bar{K}_k = \bar{S}_j = \bar{S}_k = 0$, implying that production in countries j and k is specialized on the agricultural good and all industrial producers are headquartered in country i. Arguably, this assumption seems to be quite restrictive. However, the main economic mechanisms derived in this paper survive in a more general setting with industrial production in all three economies. Since it is our purpose to present our formal arguments in the most transparent way, we present the simplest possible theoretical framework and refer the interested reader to the working paper version in Egger, Egger, and Ryan (2006), where the third-country exchange rate effects are studied in a model variant with industrial production in all three economies.

Multinational firms set up a production facility at two locations and serve the third market via exports from their parent country, where their headquarters are located.[4] Hence, there are two types of MNEs, ones with an affiliate in country j (m_j) and ones with an affiliate in country

[3] In general, there may also be MNEs with three production plants. However, to focus the analysis on the most important features of our model, existence of such firms is ruled out by the assumption of prohibitively high fixed costs for setting up a third production facility.

[4] In principle, one could think of a setting, where the MNE is free to serve consumers in the third country from either plant. However, as shown in a longer version of this paper in Egger, Egger, and Ryan (2006), such an extension only increases the notational complexity, rendering the most important results unchanged.

k (m_k). The total number of multinational firms is $m = m_j + m_k$. In addition, there are n exporters. All producers of the industrial goods are headquartered in country i. To avoid messy notation, we use two different variables, namely q_c and x_c, to distinguish between export sales and local sales in country c. Of course, $q_i = 0$, if all industrial producers are headquartered in country i.[5]

Transport costs and foreign plant set-up costs induce the well-known proximity-concentration trade-off in a producer's decision about the profit-maximizing mode of foreign market penetration (Brainard, 1997). However, if the home and the foreign economy do not share the same currency, repatriation of revenues and profits also renders the exchange rate between the two currencies a key determinant of the export versus foreign production decision. The role of exchange rates is at the heart of our interest. Therefore, we introduce parameter ζ_c, $c = j, k$, to measure the value of country c's currency in terms of currency i. An increase of ζ_c implies an appreciation of currency c relative to currency i.

With regard to consumer demand, we assume that the representative agent in country c maximizes a utility function of the form

$$U\left(D_c(z), Y_c^D\right) = \int_0^1 \left(a - \frac{D_c\left(z\right)}{2E_c}\right) D_c\left(z\right) dz + Y_c^D, \tag{2}$$

where z is an industry index and $D_c\left(z\right)$, Y_c^D are consumption levels of a good from the z^{th} industry and the agricultural sector, respectively. In addition, $E_c \equiv L_c + S_c$ is the size of country c's population. In fact, we assume that workers inelastically supply one unit of unskilled or one unit of skilled labor, respectively. Note that $E_j = L_j$ and $E_k = L_k$ follow from $S_j = S_k = 0$. Capital in country i is distributed such that each individual consumes both types of goods. Variable a denotes a preference parameter, which is the same for all countries.

Under (2), demand for the industrial good is independent of income (at least, if a certain minimum level of income is exceeded). Moreover, due to the assumption of an infinite number of industrial sectors, oligopolistic firms consider their impact on the industry price, whereas aggregate variables such as factor returns are exogenous for the individual producer. Indirect

[5]Recall that all firms employ the same production technology, irrespective of their mode of foreign market penetration. Then, x_i is local production of multinationals and exporters in country i, while x_j and x_k denote local foreign production of m_j and m_k multinationals, respectively. Moreover, q_j are export sales in country j of exporters and m_k multinationals. Finally, q_k denote export sales of n- and m_j-type firms in country k.

demand for the industrial good in country $c = i, j, k$ is given by

$$p_c = a - (D_c/E_c)\,. \tag{3}$$

Since output in each industry is homogeneous, D_c equals the sum of exporter and MNE sales in country c. (Sector indices are suppressed, since all X-industries are presumed to be identical.)

3 Equilibrium analysis

To guarantee that the production pattern in country i is diversified, we assume that the unskilled labor endowment $\bar{L}_i$ is sufficiently high. Using Y_i as the numèraire (in terms of currency i), this implies that unskilled wages in country i equal one: $w_{Li} = 1$. In the absence of any trade frictions for the agricultural good, unskilled wages in countries j and k are given by $w_{Lj} = 1/\zeta_j$ and $w_{Lk} = 1/\zeta_k$, respectively.[6]

Profit maximization is a two-stage problem. At stage one, producers decide to enter as an exporter or as an MNE. And if they become an MNE, they decide to set up a foreign subsidiary in country j or k. At stage two, producers set their quantities under Cournot competition. If a is sufficiently high (which is assumed from now on), producers decide for a positive supply in all three economies. The two-stage equilibrium can be solved through backward induction.

At stage two, we have the text-book problem that firms simultaneously choose quantities to maximize their profits. In view of our technology and preference assumptions in Section 2, this gives rise to the following firm-level demand for MNEs and exporters:

$$x_i^* = E_i \left[\frac{a-1}{m+n+1} \right], \tag{4}$$

$$x_j^* = E_j \left[\frac{a + \left[(m_k + n)(t-1) - 1 \right] / \zeta_j}{m+n+1} \right], \tag{5}$$

$$x_k^* = E_k \left[\frac{a + \left[(m_j + n)(t-1) - 1 \right] / \zeta_k}{m+n+1} \right], \tag{6}$$

and[7]

$$q_j^* = x_j^* - E_j(t-1)/\zeta_j, \qquad q_k^* = x_k^* - E_k(t-1)/\zeta_k. \tag{7}$$

[6]This reflects the *law of one price*, which leads to perfect adjustments in foreign Y-prices after an exchange rate shock.

[7]Recall that MNEs with a foreign subsidiary in country j serve consumers in k through exports from i, while MNEs with a foreign subsidiary in k serve consumers in j through exports from i.

We can use (4)-(7) in (3) to determine equilibrium prices of the industrial good. This gives

$$p_i^* = x_i^*/E_i + 1, \quad p_j^* = x_j^*/E_j + 1/\zeta_j, \quad p_k^* = x_k^*/E_k + 1/\zeta_k. \tag{8}$$

Furthermore, under product market clearing, overall consumption and production of industrial goods in the three countries are given by

$$D_i = (n+m)x_i^*, \quad D_j = m_j x_j^* + (n+m_k)q_j^*, \quad D_k = m_k x_k^* + (n+m_j)q_k^*, \tag{9}$$

$$X_i^* = (m+n)x_i^* + (m_k+n)tq_j^* + (m_j+n)tq_k^*, \quad X_j^* = m_j x_j^*, \quad X_k^* = m_k x_k^*, \tag{10}$$

respectively. Note that X_i directly depends on parameter t, since exports are subject to iceberg transport costs.

At stage one, firms have an incentive to enter the market as long as positive profits are attainable. This leads to adjustments in the factor returns to skilled labor and capital. Substituting (4)-(8) into

$$\begin{aligned}
\pi_j^m &= (p_i^* - 1)\, x_i^* + \zeta_j \left(p_j^* - 1/\zeta_j\right) x_j^* + \zeta_k \left(p_k^* - t/\zeta_k\right) q_k^* - w_S - g w_K, & (11)\\
\pi_k^m &= (p_i^* - 1)\, x_i^* + \zeta_j \left(p_j^* - t/\zeta_j\right) q_j^* + \zeta_k \left(p_k^* - 1/\zeta_k\right) x_k^* - w_S - g w_K, & (12)\\
\pi^n &= (p_i^* - 1)\, x_i^* + \zeta_j \left(p_j^* - t/\zeta_j\right) q_j^* + \zeta_k \left(p_k^* - t/\zeta_k\right) q_k^* - w_S - w_K & (13)
\end{aligned}$$

and applying the zero-profit conditions,[8] gives

$$w_K^* = \begin{cases} (\zeta_j/E_j)\left[\left(x_j^*\right)^2 - \left(q_j^*\right)^2\right]/(g-1) & \text{if} \quad m_j > 0 \\ (\zeta_k/E_k)\left[(x_k^*)^2 - (q_k^*)^2\right]/(g-1) & \text{if} \quad m_k > 0 \end{cases}, \tag{14}$$

$$w_S^* = (1/E_i)\,(x_i^*)^2 + (\zeta_j/E_j)\left(q_j^*\right)^2 + (\zeta_k/E_k)\,(q_k^*)^2 - w_K^*. \tag{15}$$

While $t > 1$ is sufficient for a positive factor return to physical capital, it is not sufficient for a positive factor return to skilled labor. However, $w_S^* > 0$ is guaranteed if the investment cost parameter g is sufficiently high.[9] This is assumed throughout.

[8]By applying the zero-profit condition, we neglect the integer problem and treat firm numbers as continuous variables. See Baldwin (1988, 1990) for a similar approach in the context of pricing-to-market.

[9]Using (14) and (15), we can calculate $(\zeta_j/E_j)(q_j^*)^2 - w_K^* = [\zeta_j/(E_j(g-1))][gq_j^* - x_j^*]$ if $m_j > 0$ and $(\zeta_k/E_k)(q_k^*)^2 - w_K^* = [\zeta_k/(E_k(g-1))][gq_k^* - x_k^*]$ if $m_k > 0$. Then, accounting for (5)-(7), it is straightforward to show that $w_S^* > 0$ follows if g is sufficiently high.

Due to our assumption on factor use, the number of MNEs m and exporters n is determined by the factor market clearing conditions in (1) and only depends on S- and K-endowments of country i (as long as positive factor prices of skilled labor and capital are realized).[10] To focus on the empirically relevant case of coexisting exporters and MNEs, we consider a parameter domain with $g\bar{S} > \bar{K} > \bar{S}$, see the respective discussion below (1).[11] Then, equilibrium firm numbers are given by

$$m = \frac{\bar{K} - \bar{S}}{g-1}, \qquad n = \frac{g\bar{S} - \bar{K}}{g-1}. \tag{16}$$

Finally, to determine the equilibrium firm structure variables $m_j^*, m_k^* \in [0, m]$ we can look at the profit differential $\Omega \equiv \pi_j^m - \pi_k^m$. Substituting (7) and (8) into (11) and (12), we obtain

$$\begin{aligned}\Omega &= \left[\zeta_j(p_j^* - 1/\zeta_j)x_j^* - \zeta_j(p_j^* - t/\zeta_j)q_j^*\right] - \left[\zeta_k(p_k^* - 1/\zeta_k)x_k^* - \zeta_k(p_k^* - t/\zeta_k)q_k^*\right] \\ &= 2(t-1)x_j^* - E_j\,(t-1)^2/\zeta_j - 2\,(t-1)\,x_k^* + E_k\,(t-1)^2/\zeta_k.\end{aligned} \tag{17}$$

Accounting for (5) and (6) and noting $m_k = m - m_j$, we can rewrite (17) in the following way:

$$\begin{aligned}\Omega = (t-1)E_k \Bigg[\left(\frac{E_j}{E_k}\right) & \frac{2a + [(n+m-2m_j-1)(t-1)-2]/\zeta_j}{m+n+1} \\ & - \frac{2a + [(n-m+2m_j-1)(t-1)-2]/\zeta_k}{m+n+1}\Bigg].\end{aligned} \tag{18}$$

Differentiating (18) with respect to m_j, we obtain $\partial\Omega/\partial m_j < 0$. The more MNEs set up a foreign affiliate in country j, the more intensive is competition in this economy. This lowers the profit differential Ω and renders further investment in country j less attractive. Besides the competitive environment also market size variables E_j, E_k influence the investment decisions

[10] This feature of our model is not as restrictive as it might seem at a first glance. We conducted a simulation analysis, where we accounted for a Leontief technology in the X-sectors and assumed that all factors were used as variable production inputs. This modification rendered the number of MNEs and exporters headquartered in a particular economy endogenous and, thus, it gave rise to a more flexible model specification. It turned out that the basic mechanisms of our model survived under such a modification, but the additional feedback effects complicated the analysis. Therefore, we chose the simplest possible model structure to explore the main economic mechanisms in our model. In particular, these mechanisms work through adjustments in the firm structure variables m_j, m_k, as will be discussed in detail below.

[11] Since only country i has a positive endowment with physical capital and skilled labor, we neglect country indices for the sake of notational simplicity. Hence $\bar{S}$, $\bar{K}$ denote factor endowments of country i in the subsequent analysis.

of MNEs. The larger the market j relative to k, the more attractive it is for MNEs to operate their foreign subsidiary in j. If country j faces a substantial market size disadvantage, $\Omega < 0$ at $m_j = 0$ is possible. Then, all multinational producers choose local production in country k and export their goods to country j. In contrast, if market j is sufficiently large, $\Omega > 0$ at $m_j = m$ may be the outcome. Then, all MNEs operate their foreign subsidiary in country j and local industrial production is zero in k. For intermediate levels of E_j/E_k, both countries j and k host foreign subsidiaries of MNEs with headquarters in i. Then, the firm structure variable m_j is determined by $\Omega = 0$ (if we ignore the integer problem, again).[12] Finally, the size of m_j also depends on exchange rate parameters ζ_j, ζ_k. The impact of these variables is in the limelight of our interest and will be analyzed in detail in the next section.[13]

4 Comparative-static analysis: exchange rate effects on multinational activity

In a first step, we investigate the ζ_j, ζ_k effects on firm structure variables m_j and m_k. The insights from this analysis are essential to understand how a variation in the two exchange rate parameters affects the value of foreign direct investment (FDI).

4.1 Firm structure variable effects

From (16) it is obvious that the overall number of MNEs and exporters is independent of the exchange rate parameter ζ_c, $c = j, k$. However, a ζ_c-variation changes the attractiveness of a country for both local affiliate production and exporting. This may trigger changes in the

[12]Due to $\partial\Omega/\partial m_j < 0$, we can conclude that if $\Omega = 0$ has a solution in $m_j \in (0, m)$, this solution is unique.

[13]In principle, we can solve for m_j^* and use the resulting expression in (4)-(15) to obtain explicit solutions for the endogenous variables of the industrial sectors. However, since these results are not needed in the subsequent analysis, the respective calculations are left open for the interested reader. To complete our description of the equilibrium, also supply and demand of the agricultural good have to be determined. $Y_j = \bar{L}_j$ and $Y_k = \bar{L}_k$ directly follow from (1) if all the industrial production is in country i. Furthermore, there are four equations left to determine Y_i and Y_c^D, $c = i, j, k$: one factor market clearing condition for unskilled labor in country i and the budget constraints of consumers in countries $c = i, j, k$. The explicit solutions for Y_i and Y_c^D are not of further interest in this study, as we restrict our attention to the case of diversified production in country i and the quasilinear utility function in (2) rules out any income effects on the demand for industrial goods.

firm structure variables m_j, m_k, according to (18). Due to $m_k = m - m_j$, we can focus on the m_j-effects in the subsequent analysis. By virtue of (18), three parameter domains can be distinguished, according to

$$(n - m - 1)(t - 1) >, < 2 \quad \Leftrightarrow \quad \bar{S} >, < \frac{(g-1)(t+1) + 2\bar{K}(t-1)}{(t-1)(g+1)} \equiv \tilde{S}(g, t, \bar{K}), \tag{19}$$

$$(n + m - 1)(t - 1) >, < 2 \quad \Leftrightarrow \quad \bar{S} >, < \frac{t+1}{t-1}. \tag{20}$$

If country i is skilled labor abundant[14], i.e., if $(g+1)\bar{S} - 2\bar{K}$ is large, and if transport and foreign investment costs are sufficiently high, we end up in an *exporter scenario*, with $\bar{S} \geq \tilde{S}(g, t, \bar{K})$, according to (19).[15] In this case, both $(n+m-2m_j-1)(t-1)-2$ and $(n-m+2m_j-1)(t-1)-2$ are positive (non-negative) for any $m_j \in [0, m]$ and the exchange rate effects can be easily derived from the profit differential in (18). They are depicted in Figure 1.

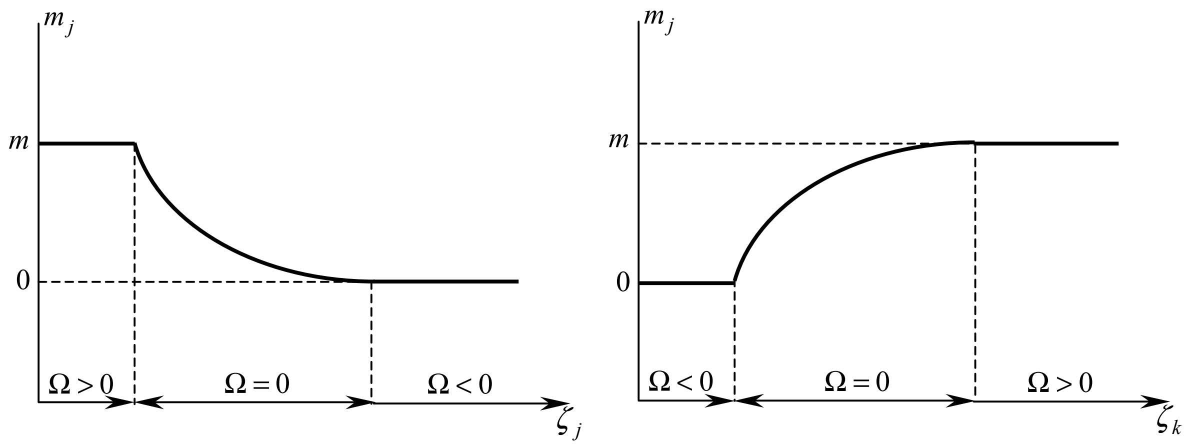

Figure 1: The impact of ζ_j and ζ_k on firm structure variable m_j if an exporter scenario prevails.

[14]We say that country i is skilled labor abundant if its skilled labor to physical capital endowment is relatively high as compared to the rest of the world. Since $\bar{K}_j = \bar{K}_k = \bar{S}_j = \bar{S}_k = 0$ has been assumed above, we can use $(g+1)\bar{S} - 2\bar{K}$ as a rough measure for the skilled labor abundance of country i.

[15]While $\partial\tilde{S}(\cdot)/\partial\bar{K} > 0$ and $\partial\tilde{S}(\cdot)/\partial t < 0$ are trivial, straightforward calculations reveal that $\partial\tilde{S}(\cdot)/\partial g < 0$ holds only if $\bar{K} > (t+1)/(t-1)$. Accounting for $\bar{K} > \bar{S}$, it follows from (20) that $m + n(= \bar{S}) \geq (t+1)/(t-1)$ is sufficient for $\partial\tilde{S}(\cdot)/\partial g < 0$. However, if $\bar{S} < (t+1)/(t-1)$, we have $n - m < (t+1)/(t-1)$, so that g becomes irrelevant, according to (19) and (20). We use the term exporter scenario, since the corresponding exchange rate effects can only arise if the number of exporters is sufficiently large.

For an intuition of the ζ_j-impact, note the following two effects. On the one hand, a higher ζ_j raises $\zeta_j(p_j^* - 1/\zeta_j)$ and, therefore, the value of foreign affiliate sales in country j for a given output level x_j^*. A ζ_j-increase also raises $\zeta_j(p_j^* - t/\zeta_j)$ and, thus, the value of exports to country j for a given q_j^*. However, since the existence of iceberg transport costs $t > 1$ leads to $x_j^* > q_j^*$, the foreign affiliate effect dominates. This leads to an increase in the profit differential Ω, which renders a second production facility in country j more attractive for MNEs. And it explains a *positive bilateral revenue effect* of an appreciation of currency j. On the other hand, a higher ζ_j leads to a decline in the costs of both exporters and local affiliates for serving consumers in country j. This cost reduction is stronger for exporters, due to the existence of iceberg transport costs, which explains an asymmetric change in the output levels. While for a given firm structure m_j, the impact of ζ_j on exports to country j is positive, it exhibits a negative effect on foreign affiliate sales in country j, if there is strong competition from firms that export their products to country j, i.e., if $(n + m - 2m_j)(t - 1) > 1$ according to (5). This gives rise to a *negative bilateral competition effect* of a ζ_j increase, which lowers the profit differential Ω and, therefore, renders MNE activity in j less attractive.[16] The higher the skill abundance in parent country i, the more exporters relative to MNEs are active, according to (16). Hence, if $(g + 1)\bar{S} - 2\bar{K}$ is sufficiently high, it is the competition effect that dominates and the firm-structure variable m_j is non-increasing in ζ_j. Higher foreign investment costs also raise the number of exporters relative to the number of MNEs. This reinforces the competition effect and, therefore, renders an exporter scenario more likely. Finally, higher transport costs magnify the cost reduction effect for exports after an increase in the bilateral exchange rate.[17] This strengthens the competition effect and again renders an exporter scenario more likely. The bilateral exchange rate effects in an exporter scenario are illustrated in the left panel of Figure 1.

The intuition for the third-country ζ_k effect in the right panel of Figure 1 is similar to that of the bilateral ζ_j effect. On the one hand, a higher ζ_k raises the value of foreign affiliate sales

[16]We speak of a competition effect, since the ζ_j-induced change in variable production costs affects the competitiveness of (n, m_k-type) firms with exports to country j relative to (m_j-type) firms with local affiliate sales in j.

[17]Note that a change in the transport cost parameter does neither affect the number of exporters nor the number of multinational producers, which are fully determined by $\bar{S}$, $\bar{K}$ and g, according to (16). However, it has an impact on factor prices w_K and w_S, according to (14) and (15), and it has an impact on the number of affiliates hosted in countries j and k, according to (18).

in country k relative to the value of exports to this economy. According to (17), this explains a *negative third-country revenue effect* on Ω, which tends to reduce m_j. On the other hand, there is a *positive third-country competition effect* on Ω. These two opposing third-country effects determine the impact of a ζ_k increase on m_j. If country i is skilled labor abundant and transport as well as foreign investment costs are high, it is the positive competition effect which dominates and m_j is non-decreasing in ζ_k.

Things are different, if country i has a low endowment level of skilled labor (in absolute terms and relative to the rest of the world) and transport costs are sufficiently low. Then, $\bar{S} \leq (t+1)/(t-1)$ and the positive bilateral revenue effect is stronger than the negative bilateral competition effect. As a consequence, a ζ_j increase exhibits a non-negative impact on m_j, while the ζ_k-effect is non-positive, as the negative third-country revenue effect dominates the positive third-country competition effect. In this case, we may speak of a *multinational scenario*. The respective exchange rate effects are depicted by Figure 2.[18]

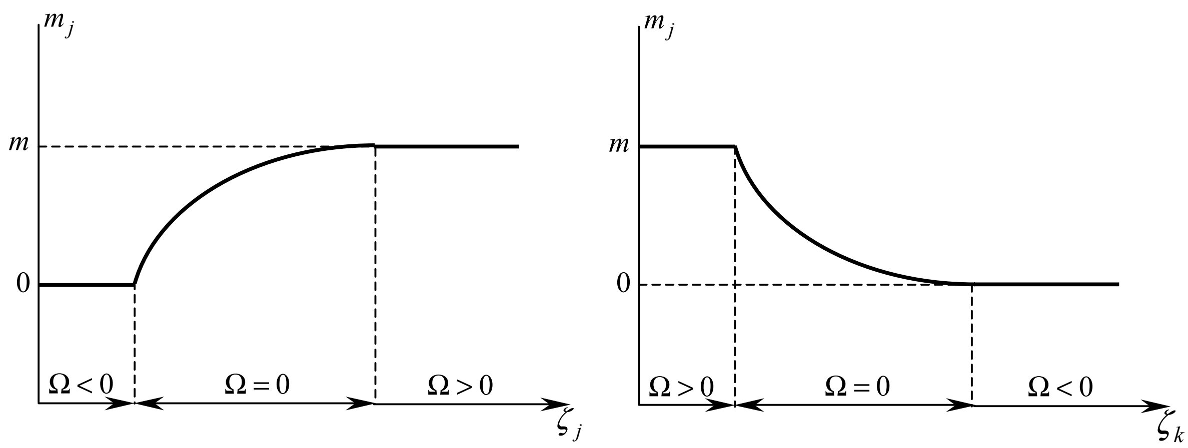

Figure 2: The impact of ζ_j and ζ_k on firm structure variable m_j if a multinational scenario prevails.

Finally, if

$$n + m > \frac{t+1}{t-1} > n - m \quad \Leftrightarrow \quad \frac{(g-1)(t+1) + 2\bar{K}(t-1)}{(t-1)(g+1)} > \bar{S} > \frac{t+1}{t-1}, \tag{21}$$

the sign of $dm_j/d\zeta_c$, $c = j, k$ depends on the size of m_j. The reason is that the relative strength

[18]The term multinational scenario is chosen, since the exchange rate effects in Figure 2 can only arise if (i) the number of exporters is sufficiently small and (ii) the revenue effect is sufficiently strong.

of competition and revenue effects depends on the number of competitors that export their products to country j, i.e., on $n + m_k$. If m_j is close to zero, the negative bilateral competition effect dominates the positive revenue effect, so that ζ_j has a non-positive impact on m_j. However, if m_j is sufficiently high, only a small number of multinationals export their products to country j, so that the positive bilateral revenue effect is relatively strong and gives rise to a non-negative impact of ζ_j on m_j. The intuition for the third-country effect is different. A lower m_j is associated with a lower number of multinationals that export their products to country k. This weakens the third-country competition effect, rendering a negative impact of ζ_k on Ω more likely, according to (17). As a consequence, the third-country exchange rate exhibits a non-positive impact on the firm structure variable m_j, if m_j is sufficiently small. However, if m_j is high, it is the positive third-country competition effect that dominates, explaining a non-negative impact of ζ_k on m_j.

There remains one problem with the comparative static results in the last paragraph: m_j itself is an endogenous variable. Therefore, we have to analyze under which conditions a low/high m_j is realized. From our discussion below (18), we know that a larger market in country j relative to country k (E_j/E_k) raises the profit differential Ω and, therefore, renders FDI in j more attractive. This gives rise to a non-negative impact of E_j/E_k on m_j. With these market size implications at hand, we can construct Figure 3, which depicts the sign of $\partial m_j/\partial\zeta_j$ (left panel) and the sign of $\partial m_j/\partial\zeta_k$ (right panel) for different ζ_c-E_j/E_k combinations.[19] If the market in country j is sufficiently small relative to the market in country k, multinational firms lose their incentive to invest in country j. In contrast, if E_j/E_k is sufficiently large, country j hosts all foreign production plants. In both of these cases, marginal variations in the exchange rate parameters ζ_j, ζ_k do not exhibit an impact on firm structure variable m_j.

For intermediate values of E_j/E_k both countries j and k host some of the foreign subsidiaries. In this case, we have $\Omega = 0$ so that MNEs are indifferent between locating their foreign subsidiary in j or k. By virtue of (18), we can determine a critical E_j/E_k-level, e_c^*, at which both $\Omega = 0$ and $\partial m_j/\partial\zeta_c = 0$ simultaneously hold. This critical market size ratio separates the region of a negative exchange rate effect from the region of a positive exchange rate effect. The respective

[19]The two Ω_0-curves represent ζ_c-E_j/E_k combinations for which $\Omega|_{m_j=0} = 0$. They are upward-sloping, since (i) $\partial\Omega/\partial(E_j/E_k) > 0$ and (ii) $\partial\Omega/\partial\zeta_c < 0$ at $m_j = 0$. The two Ω_m-loci represent ζ_c-E_j/E_k combinations for which $\Omega|_{m_j=m} = 0$. They are downward-sloping, since (i) $\partial\Omega/\partial(E_j/E_k) > 0$ and (ii) $\partial\Omega/\partial\zeta_c > 0$ at $m_j = m$.

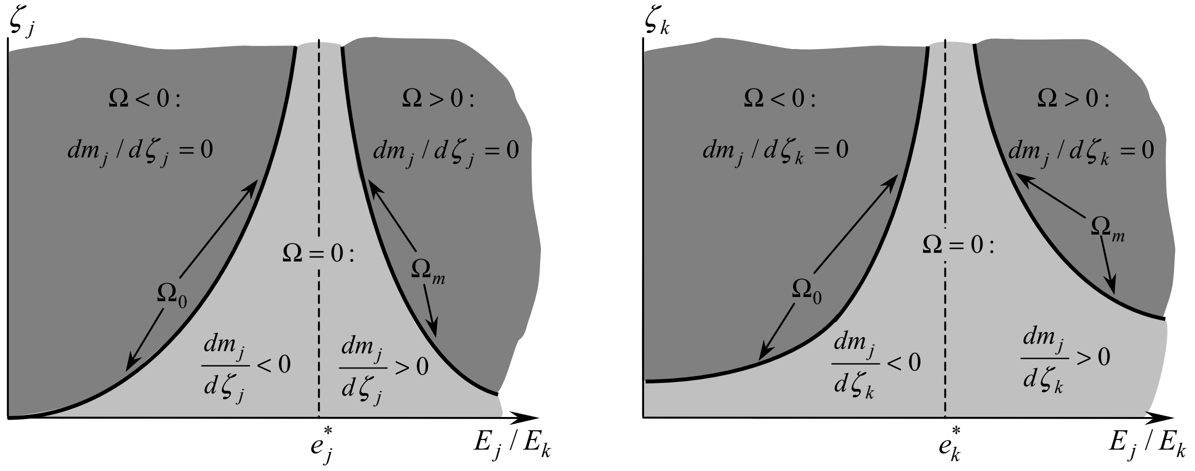

Figure 3: The impact of ζ_j and ζ_k on firm structure variable m_j if $n+m > (t+1)/(t-1) > n-m$

critical m_j-levels are determined by (18). They are given by[20]

$$\tilde{m}_j^j = \frac{1}{2}\left[n + m - \frac{t+1}{t-1}\right], \qquad \tilde{m}_j^k = \frac{1}{2}\left[\frac{t+1}{t-1} - (n-m)\right]. \tag{22}$$

The ranking of $\tilde{m}_j^j \gtrless \tilde{m}_j^k$ is not clear-cut in general (and $\tilde{m}_j^j \neq \tilde{m}_j^k$ holds except of a borderline case). The higher t, the higher is $\tilde{m}_j^j$ and the lower is $\tilde{m}_j^k$. In broad terms, we can therefore conclude that a negative bilateral and a positive third-country exchange rate effect arises if transport costs are sufficiently high and the relative market size E_j/E_k has an intermediate value. The opposite holds true if transport costs are sufficiently low.

To summarize the main result, we formulate the following proposition, where we carefully distinguish between the bilateral effects of a change in ζ_j and the third-country effect of a change in ζ_k.

Proposition 1. *If transport costs and foreign investment costs are high and/or the parent country is skilled labor abundant, an increase in the bilateral exchange rate ζ_j exhibits a non-positive impact on firm structure variable m_j, while the impact of the third-country exchange-rate ζ_k is non-negative. The opposite holds true if transport costs are low and/or country i has a low endowment level of skilled labor. In this case, a higher bilateral exchange rate has a non-negative impact on m_j, while a higher third-country exchange rate has a non-positive effect.*

[20] The two variables $\tilde{m}_j^j$ and $\tilde{m}_j^k$ are implicitly determined by $(n+m-2m_j-1)(t-1) = 2$ and $(n-m+2m_j-1)(t-1) = 2$, respectively.

Proof. Proposition 1 follows from Figures 1-3 and the formal discussion in the text. □

4.2 Foreign direct investment effects

Based on the firm structure effects identified in subsection 4.1, we can investigate the implications of exchange rate variation on foreign direct investment (FDI). Denoting the value of country i's FDI in country j by FDI_j and accounting for $FDI_j \equiv m_j(g-1)w_K$,

$$FDI_j = \begin{cases} (m_j\zeta_j/E_j)\left[(x_j^*)^2 - (q_j^*)^2\right] & \text{if} \quad m_j > 0 \\ (m_j\zeta_k/E_k)\left[(x_k^*)^2 - (q_k^*)^2\right] & \text{if} \quad m_k > 0 \end{cases}, \tag{23}$$

follows from (14). Then, using (5)-(7), we can derive the following bilateral and third-country exchange rate effects.

Proposition 2. *Three cases can be distinguished: (i) If* $\Omega|_{m_j=0} < 0$*, there is no direct investment in country* j *and* $\partial FDI_j/\partial\zeta_c = 0$*,* $c = j,k$*. (ii) If* $\Omega|_{m_j=0} > 0 > \Omega|_{m_j=m}$ *and preference parameter* a *sufficiently high, the exchange rate effects on* FDI_j *are fully determined by their firm structure effects, i.e.,* $\partial FDI_j/\partial\zeta_c >,=,< 0$ *if* $\partial m_j/\partial\zeta_c >,=,< 0$*. (iii) If* $\Omega|_{m_j=m} > 0$ *the bilateral exchange rate effect on* FDI_j *is negative in an exporter scenario with* $(n-m-1)(t-1) > 2$ *and positive (non-negative) otherwise. The variation in the third-country exchange rate does not affect* FDI_j*, i.e.,* $\partial FDI_j/\partial\zeta_k = 0$*.*

Proof. Recall that $\Omega|_{m_j=0} < 0$ implies $m_j = 0$, according to (18). Then, setting $m_j = 0$ in (23), proves part (i) of the proposition. Moreover, note that $\Omega|_{m_j=0} > 0 > \Omega|_{m_j=m}$ implies $m_j, m_k \in (0,m)$. Then, substituting (5)-(7) into the first and the second line of (23), we obtain

$$FDI_j = \begin{cases} \frac{m_j(t-1)E_j\{2a+[(n+m-2m_j-1)(t-1)-2]/\zeta_j\}}{m+n+1} & \text{if} \quad m_j > 0 \\ \frac{m_j(t-1)E_k\{2a+[(n-m+2m_j-1)(t-1)-2]/\zeta_k\}}{m+n+1} & \text{if} \quad m_k > 0 \end{cases}.$$

Differentiating the second line with respect to ζ_j, it follows immediately that $\partial FDI_j/\partial\zeta_j >,= ,< 0$ if $\partial m_j/\partial\zeta_j >,=,< 0$. Furthermore, differentiating the first line with respect to ζ_k, we see that $\partial FDI_j/\partial\zeta_k$ has the same sign as $\partial m_j/\partial\zeta_k$ if preference parameter a is sufficiently high. This confirms part (ii) of the proposition. To prove part (iii), recall that $\Omega|_{m_j=m} > 0$ implies $m_j = m$. Then, using (5) and (7), (23) can be reformulated in the following way:

$$FDI_j = \frac{m(t-1)E_j\left\{2a + [(n-m-1)(t-1)-2]/\zeta_j\right\}}{m+n+1}.$$

Differentiating this expression with respect to ζ_j and ζ_k, gives the respective exchange rate effects in part (iii) of the proposition. $\square$

A higher bilateral exchange rate ζ_j has two consequences. For a given firm structure variable m_j it affects the value of a multinational's repatriated profits from country j relative to the value of operative profits associated with export sales there. As in the previous section, we can distinguish two channels of influence, a positive bilateral revenue and a negative bilateral competition effect. If the revenue effect dominates, a higher ζ_j leads to a higher w_K, since setting up a multinational firms is a relatively capital intensive task, as compared to setting up an exporting firm. In addition to the direct impact of ζ_j, there is an indirect one, working through adjustments in the firm structure variable. As outlined above, this indirect effect is also determined by the positive bilateral revenue and the negative bilateral competition effect. Since a higher m_j raises FDI_j for a given w_K, the two effects tend to work into the same direction. To be more precise, neither the direct nor the indirect bilateral effect arises if $\Omega|_{m_j=0} < 0$ and thus $FDI_j = 0$. To the contrary, if $\Omega|_{m_j=m} > 0$, only the indirect effect exists, while $dm_j/d\zeta_j = 0$. However, if $\Omega|_{m_j=0} > 0 > \Omega|_{m_j=m}$, both the direct and the indirect effect are relevant and $\partial FDI_j/\partial\zeta_j$ and $\partial m_j/\partial\zeta_j$ have the same signs. With regard to the third-country exchange rate effect, things are more complicated, as the w_K and the m_j effect (may) go into opposite directions. The m_j effect dominates if preference parameter a is sufficiently high. In this case, $\partial FDI_j/\partial\zeta_k >, =, < 0$ if $\partial m_j/\partial\zeta_k >, =, < 0$.

To complete our discussion on comparative static effects, we summarize the main theoretical hypotheses, which will be confronted with empirical evidence in the next section. First, with respect to the bilateral and third-country exchange rate effects on firm structure variable m_j, we have identified skilled labor and physical capital endowments as well as trade and investment costs to be key determinants. If the parent country is skilled labor abundant and/or trade and foreign investment costs are high, a non-positive effect of ζ_j and a non-negative effect of ζ_k can be expected, while the opposite holds true if transport costs are low and/or the parent country has a low endowment level of skilled labor. Second, it is plausible from a theoretical point of view that bilateral and third-country exchange rate effects go into opposite directions. Third, in the empirically relevant case of $m_j \in (0, m)$ the effects of a ζ_c shock on foreign direct investment FDI_j are fully determined by its impact of firm structure variable m_j (at least if preference parameter a is sufficiently high).

5 Empirical analysis

In the empirical analysis, we use panel data on outbound MNE activity of both the US and Japan over the period 1990-1999. Our theoretical model suggests that both bilateral and third-country exchange rates should be important for MNE activity. Moreover, total and relative economic size, factor endowments as well as trade and investment costs are key determinants. Motivated by our theoretical analysis and previous empirical work, we specify the following empirical model to estimate the exchange rate effects on MNE activity[21]

$$\begin{aligned} y_{jt} &= \beta_0 + \beta_1 SGDP_{jt} + \beta_2 RGDP_{jt} + \beta_3 RK_{jt} + \beta_4 RS_{jt} + \beta_5 RL_{jt} \\ &\quad + \beta_6 RKG_{jt} + \beta_7 D_j + \beta_8 \zeta_{jt} + \lambda_t \\ &\quad + \gamma_1 WSGDP_{kt} + \gamma_2 WRGDP_{kt} + \gamma_3 WRK_{kt} + \gamma_4 WRS_{kt} + \gamma_5 WRL_{kt} \\ &\quad + \gamma_6 WRKG_{kt} + \gamma_7 WD_k + \gamma_8 W\zeta_{kt} + W\lambda_t + u_{kt}, \end{aligned} \tag{24}$$

where y_{jt} is either the number of foreign affiliates (as a proxy for m_j) or the value of outbound foreign direct investment (associated with FDI_j) in host-country j and year t. The explanatory variables consist of bilateral and third-country ones. Let us start with a short description of the bilateral explanatory variables. They are defined as follows:[22] $SGDP_{jt} = \ln(GDP_{it} + GDP_{jt})$ is a measure of total bilateral economic size, where GDP refers to real gross domestic product. Although, income effects were ruled out by the assumption of quasi-linear utility in the theoretical model, we may interpret $SGDP_{jt}$ as being related to market size parameter E_j in our theoretical model. In this case, we would expect a positive sign of coefficient β_1, according to our discussion following equation (18). $RGDP_{jt} = \ln\{1 - [GDP_{it}/(GDP_{it} + GDP_{jt})]^2 - [GDP_{jt}/(GDP_{it} + GDP_{jt})]^2\}$ measures two countries' similarity in economic size (see Helpman, 1987). $RK_{jt} = \ln(K_{it}/K_{jt})$, $RS_{jt} = \ln(S_{it}/S_{jt})$, $RL_{jt} = \ln(L_{it}/L_{jt})$ refer to parent-to-host endowment ratios in physical capital (K), skilled labor (S), and unskilled labor (L). Due to our focus on exchange rate effects, the theoretical model does not provide deeper insights into the role of bilateral relative market size ($RGDP_{jt}$) and bilateral relative factor endowments (RK_{jt}, RS_{jt}

[21] All variables are in logs, so that the coefficients can be interpreted as elasticities.

[22] A detailed description of data sources is provided in the Appendix.

and RL_{jt}) for multinational activity. However, previous empirical research suggests accounting for the impact of these variables to guard against an omitted variables bias (see, e.g., Baltagi, Egger, and Pfaffermayr, 2005). $RKG_{jt} = RK_{jt} \times SGDP_{jt}$ is an interaction term, which may have a positive or a negative sign. According to Markusen and Maskus (2002) and Egger and Pfaffermayr (2004), we expect a negative parameter, if horizontal MNEs are prevalent, and a positive one, if vertical MNEs are of relevance.[23]

To assess the impact of bilateral transport and investment costs

we include geographical distance (D_j) as a control variable (see Lipsey, 1999, for a similar approach). We do not account for the impact of transport costs separately, because reliable data are not available for our country sample. Some authors use indirect measures of transport costs based on matched partner cif/fob ratios.[24] However, as rigorously discussed in Hummels and Lugovskyy (2003), cif/fob ratios are often affected by serious measurement error. In our country sample, cif values are often lower than fob values. Hence, cif/fob ratios cannot be used as reliable measures of bilateral transport costs in our analysis.[25] Variable ζ_{jt} is the value of host j's currency expressed in units of parent i's currency. Accordingly, an increase in ζ_{jt} indicates an appreciation of host j's currency relative to the parent one. The impact of exchange rates is at the heart of our interest. Hence, we will discuss in detail how the empirical results are related to our theoretical hypotheses in Section 4. Finally, λ_t are fixed time effects that capture all time-specific observable and unobservable determinants of MNE activity.

In addition to the bilateral determinants, we focus on the role of third-country variables, here. In line with the spatial econometrics literature, these effects are represented by weighted averages that capture the impact of changes in the determinants in foreign markets other than j. In line with our theoretical model, third-country variables are denoted by subscript k. In

[23]Markusen and Maskus (2002) account for the interaction between skilled labor endowment differences and the sum of bilateral GDP but do not control for physical capital endowment effects. In our theoretical analysis, physical capital is a direct determinant of FDI. Therefore, we include an interaction term between the bilateral sum of GDP and the absolute difference in physical capital endowments (instead of skilled labor endowments).

[24]The abbreviations *cif* and *fob* have their usual interpretations, namely *cost, insurance and freight* (cif) and *free on board* (fob).

[25]In an extension to our parsimonious model, we accounted for information on investment risk from the International Country Risk Guide as a rough measure of foreign investment costs. However, it turns out that this leads to a loss of observations, while our main results do not change and the explanatory power is only marginally increased. Therefore, we focus on the parsimonious model in (24).

addition, an initial letter "W" indicates that the the underlying variables are weighted averages. The third-country control variables are motivated by our theoretical model ($WGDP_{kt}$, $W\zeta_{kt}$ and WD_k) and previous empirical work on the role of third-country variables for bilateral FDI. The results in Blonigen, Davies, Waddell, and Naughton (2004) suggest to control for $WGDP_{kt}$ as a measure of market potential. Furthermore, Baltagi, Egger, and Pfaffermayr (2005) point to the role of third-country factor endowments. This supports the use of WRK_{kt}, WRS_{kt} and WRL_{kt} as additional controls. Finally, $WRKG_{kt}$ accounts for an interaction between market potential and third-country capital endowments. As outlined above, this interaction may be an important determinant of horizontal versus vertical multinational activity.[26]

To calculate the respective third-country effects, we use inverse distances as weights, since cross-country interactions are presumed to be stronger between countries with shorter distance. For the ease of interpretation, we ensure that weights sum up to one for each host-country and year. Let N be the unique number of host-country pairs and m the number of observations. In matrix notation, the disturbance term is assumed to be $\mathbf{u} = \rho \mathbf{W} \mathbf{u} + \varepsilon$, $\varepsilon = \mathbf{\Delta_1} \mu + \nu$, where $\mathbf{W}$ is a row-normalized, block-diagonal spatial weighting scheme of size $m \times m$ whose entries are inversely related to bilateral distances between host countries, $\mu \sim IID(0, \sigma_\mu^2)$ is an $N \times 1$ vector of random host-country effects, and $\nu \sim IID(0, \sigma_\nu^2)$ is an $m \times 1$ vector of classical errors. Let $\mathbf{D}_t$ denote an $N_t \times N$ matrix obtained from I_N by eliminating the rows corresponding to host countries that are missing in year t. $\mathbf{\Delta}_1 = \begin{pmatrix} \mathbf{D}_1' & \mathbf{D}_2' & \cdots & \mathbf{D}_T' \end{pmatrix}'$ is the $m \times N$ selector matrix, which picks up the host-country effects. The elements in μ and ν are assumed to be independent of each other and among themselves. According to our assumption about the error process, there is spatial dependence in $\mathbf{u}$ through $\mathbf{W}$, similar to the explanatory variables.

Under the present assumptions about the data generating process of the error term, neither ordinary least squares (OLS) nor traditional random effects generalized least squares (GLS) estimation gives efficient estimates. But rather, spatial dependence and random effects have to be accounted for simultaneously in the estimation. For this purpose, we estimate the model

[26] The use of our third-country control variables is also consistent with theoretical insights on optimal integration strategies of the multinational producer. The results in Yeaple (2003) and Ekholm, Forslid, and Markusen (2005) indicate that trade and foreign investment costs in the third country should be relevant for a multinational producer's incentive to set up a foreign production facility. Furthermore, Grossman, Helpman, and Szeidl (2003) point to the role of market size in the third country. Finally, Yeaple (2003) imposes an assumption on relative skill abundance, which suggests controlling for third-country factor endowments.

using the generalized method of moments (GMM) approach of Kapoor, Kelejian, and Prucha (2005).[27] The moment conditions for unbalanced panel data estimation are derived in Baltagi, Egger, and Pfaffermayr (2005) and summarized in the Appendix. The model estimation proceeds as follows. First, consistent estimates of β, γ, λ, $\mathbf{W}\lambda$, and $\mathbf{u}$ are obtained from OLS on (24). The six moment conditions listed in the Appendix make use of $\mathbf{u}$. Estimates of ρ, σ_ν^2, and σ_μ^2 are obtained as solutions of the system of non-linear moment equations. The data are first Cochrane-Orcutt-transformed as $\mathbf{z}^* = \mathbf{z} - \widehat{\rho}\mathbf{W}\mathbf{z}$. Finally, each observation in $\mathbf{z}^*$ is transformed according to $\widetilde{z}_{kt}^* = z_{kt}^* - \widehat{\theta}_k \overline{z}_{k.}^*$, where $\overline{z}_{k.}^*$ are host-country means of Cochrane-Orcutt-transformed variables, and $\widehat{\theta}_k = 1 - [\widehat{\sigma}_v^2/(T_k\widehat{\sigma}_\mu^2 + \widehat{\sigma}_v^2)]^{0.5}$ are host-country-specific GLS weights due to unbalancedness (i.e., the number of observed periods T_k differs among the cross-sectional units). Hence, the model is estimated by feasible GLS.

> Table 1 about here <

Table 1 summarizes the descriptive statistics for all three types of US and Japanese MNE activities and the explanatory variables. Due to our weighting of third-country variables, the latter exhibit first and second moments that are similar to the bilateral ones within each panel data-set. The estimation results based on spatial GMM estimation for unbalanced panel data are summarized in Tables 2 and 3.

> Tables 2 and 3 about here <

Table 2 presents the results for bilateral aggregate data of the United States' MNE activity. Both measures of multinational activities, namely the number of affiliates and the value of outbound foreign direct investment, are available in this panel data-set. The model fit is well and the spatial autocorrelation parameter is fairly high. According to a Lagrange-multiplier test, spatial pooled OLS is rejected against spatial random effects estimation throughout. According to the Hausman test, the spatial random effects model is not rejected against a standard fixed effects model which ignores spatial correlation. The relative importance of the between variance component is huge. This results in a fairly high average GLS-weight $\widehat{\theta}_k$, which eliminates most of the between variation in the data and renders the estimates unbiased.

[27] In our application, spatial random effects is even preferable over spatial fixed effects according to a Hausman test. One reason for this is that the inclusion of third-country effects eliminates correlation between the explanatory variables and the panel error.

Most of the bilateral effects are well in line with previous empirical results. Economic size, physical capital and unskilled labor endowments are particularly important for MNE activity. The significant positive impact of the capital-size interaction term points to some relevance of vertical multinationals. The empirical results indicate that a depreciation of the US dollar fosters US outbound MNE activity (see the positive coefficient of ζ_{jt} in Table 2). In terminology of our theoretical results, a positive bilateral exchange rate effect means dominance of the positive bilateral revenue effect over the negative bilateral competition effect.

Let us now turn to the third-country effects. The negative coefficient of the $WSGDP_{jt}$ variable is consistent with our theoretical finding that a lower E_j/E_k leads to a decline in number of foreign affiliates in country j (see the respective discussion below (18)).[28] And the negative coefficient of the third-country exchange rate variable, $W\zeta_{kt}$, confirms the dominance of revenue over competition effects. Putting together, the pattern of exchange rate effects indicates that the US is in a multinational scenario (see Figure 2). The opposite signs of bilateral and third-country exchange rate effects are also well in line with this interpretation. Finally, that exchange rates exhibit qualitatively similar effects on the number of foreign affiliates and the value of outbound foreign direct investment is consistent with the theoretical results in subsection 4.2.

In Table 3, we investigate the determinants of multinational activity for bilateral Japanese MNE data. Again, we can use two measures of multinational activity, namely the number of foreign affiliates (m_j in our theoretical model) and outbound foreign direct investment (FDI_j). The explanatory power of the empirical model turns out to be lower for Japan than the US. Furthermore, the bilateral exchange rate variable exerts a significant negative impact on both measures of multinational activities. This confirms the finding in Blonigen (1997, p. 447) that "*real dollar depreciations make Japanese acquisitions more likely in US industries*". However, in view of the results in Table 2, we can also conclude that Blonigen's finding does not point to a general exchange rate effect that is equally important in all economies. Moreover, the third-country exchange rate coefficients for the US and Japan also exhibit different signs. Overall, the exchange rate effects for Japan point to an exporter scenario and an opposite impact of the bilateral and the third-country exchange rate is consistent with Figure 1. Finally, against the background of our theoretical insights in subsection 4.2, it is not surprising that the exchange

[28] The negative sign of the $WSGDP_{kt}$ coefficient is also consistent with the negative market potential in Blonigen, Davies, Waddell, and Naughton (2004) for the full OECD country sample.

rate effects on the number of foreign affiliates and the value of outbound foreign direct investment point into the same direction.[29]

The different signs of exchange rate effects in the US and the Japanese data-set give rise to a novel result in the literature, which can be rationalized by the theoretical insights in Section 4. For this, recall that the existence of an exporter/multinational scenario depends on three factors: (i) the size of transport and foreign investment costs, (ii) the absolute skilled labor endowment of the parent country, and (iii) the skilled labor abundance of the parent country. Let us first look at the role of transport and foreign investment costs. From proposition 1, we know that higher transport and investment costs reinforce the competition effects and therefore render an exporter scenario more likely. As far as higher distance is associated with higher transport and investment costs[30], we can conclude that the respective coefficients in Tables 2 and 3 are consistent with our theoretical hypotheses, if D_{jt} and WD_{kt} are higher for Japan than for the US. This turns out to be the case, if we evaluate the bilateral and third-country distance variables at their respective means, according to Table 1.

Second, noting $RS_{US} = -0.30$ and $RS_{Japan} = -0.20$ from Table 1, the ranking of skilled labor endowments, $RS_{US} < RS_{Japan}$ also renders a multinational scenario in the US and an exporter scenario in Japan plausible.[31] Third, we can approximate the capital-to-skill endowment ratio of the parent country by $KS \equiv RK_{j.} - RS_{j.}$. According to Table 1, this gives $KS_{US} = -2.86$ and $KS_{Japan} = -2.45$, which indicates that Japan is relatively capital rich (as compared to the US). However, this is no contradiction to the role of skilled labor abundance in section 4, which is determined by the size of $(g+1)\bar{S} - 2\bar{K}$. Associating higher distance with higher foreign investment costs, $KS_{US} < KS_{Japan}$ is consistent with an exporter scenario in

[29]The country coverage for the US and Japan is slightly different. Therefore, we have investigated the robustness of our results when using the overlapping host-country sample. It turns out that the results are not affected by this modification. In particular, the different signs of the bilateral and third-country exchange rate effects are robust in this regard.

[30]Markusen and Maskus (2002, p. 702) argue that "*[d]istance may encourage horizontal investments abroad in preference to exports, but it also raises the cost of doing business abroad.*"

[31]However, it should be noted that the ranking of countries according to this criterion critically depends on the particular skill measure in use. To substantiate this point, let us use data available from the Barro and Lee (2000) data-set on cross-country education patterns. There, we find the US to be better endowed with skilled labor in the 1990s if enrollment rates in post-primary schooling are compared, whereas Japan turns out to be better endowed with skilled labor if total years of schooling are used instead.

Japan. The latter conclusion is also supported by the relatively stronger outward FDI position of the US as compared to Japan.

Summing up, we can conclude that the theoretical model provides a rationale for explaining the different exchange rate effects in Tables 2 and 3. Due to its relative remoteness from important trade and investment partners and its relatively sizeable skilled labor endowment, Japan is in an exporter scenario, with a negative bilateral and a positive third-country exchange rate effect. The opposite holds true for the US, which is in a multinational scenario with positive bilateral and negative third-country exchange rate effects on MNE activity. The potentially counteracting effects of the capital-to-skill endowment ratios do not revert this result.

6 Robustness of the empirical results

The aim of this section is to provide insights into the robustness of our empirical results with respect to a different measure of multinational activity, the use of alternative weighting schemes for third-country effects and the level of aggregation (bilateral aggregate versus bilateral industry-level data on MNE activity). In Table 4 we present empirical results for a regression, where the value of foreign affiliate sales serves as the dependent variable. In all other respects the empirical model is identical to the one used in the previous section. Interestingly, the explanatory power of the empirical model turns out to be higher for Japan than the US, if the value of foreign affiliate sales instead of firm numbers or FDI is used as dependent variable. The coefficients of the bilateral exchange rate variable in the US data-set and the third-country exchange rate variable in the Japanese data-set become insignificant. However, the point estimates of the exchange rate variables exhibit the same sign as in Tables 2 and 3. This indicates that our findings are robust with respect to the choice of the measure of MNE activity.

> Table 4 about here <

In Table 5, we use (i) inverse squared distances and, alternatively, (ii) inverse square root distances as weights for the third-country effects. It is hard to test assumptions about the form of the weighting scheme. However, in GMM estimation the value of the criterion function or the R^2 could be used for guidance (with maximum likelihood estimation, one would rather stick to log-likelihood values). In our application, we find that the regressions based on inverse square root distances in Table 5 perform slightly better than others in terms of the R^2-values. Additionally, we consider the impact of (iii) once lagged or (iv) twice lagged exchange rates rather than contemporaneous ones to account for the possibility that a related change in investment plans takes some time to be implemented. Finally, (v) we run regressions based on bilateral industry-level data.[32] However, it should be mentioned that these are not always directly comparable to the aggregate bilateral ones. For instance, only 20 partner countries are available in the regressions of Japanese foreign affiliate sales at the industry level. The set of partner countries for US industry-level FDI is much larger and comparable to the aggregate one.

> Table 5 about here <

In general, the point estimates show qualitatively similar effects to the ones reported in Tables 2 and 3, independent of which weighting scheme is considered. However, the *bilateral* exchange rate effects of the US are always insignificant, if inverse square root distances are used as weights. This is different for Japan, where the respective bilateral exchange rate effects are always significant if spatial weights for third-country variables are based on inverse square root distances. With respect to the third-country determinants, we find that the negative impact of weighted exchange rates $W\zeta_{kt}$ identified in the US data-set is stronger if the inverse square root distance weight is used. In contrast, the respective impact is not always significant if inverse squared distances are used as weights. Moreover, the weighted exchange rates become insignificant in the outbound FDI regression on Japanese data if inverse square root distances are used as weights.

Regarding the use of once or twice lagged exchange rates, the findings are qualitatively similar to the ones in the baseline regressions. The associated point estimates of the lagged effects tend to be somewhat smaller than the contemporaneous ones. However, the difference is not statistically significant in most cases. This holds true for both US and Japanese MNE activity.

At the industry level (11 US industries and 18 Japanese industries, see the Appendix), no information on the number of foreign affiliates is available for country pairs. Thus, we restrict our analysis to foreign affiliate sales and outbound FDI as dependent variables. The point

[32] There, we employ fixed industry-time effects instead of fixed time effects and random host-country-industry effects instead of random host country effects.

estimates of the bilateral determinants at the industry level are quite similar to those obtained from aggregate data.[33] The negative impact of the weighted exchange rate variable $W\zeta_{kt}$ seems to be robust in all regressions using US data, which lends strong support to the multinational scenario in our theoretical analysis. Regarding Japanese data, we find that the industry-level results for foreign affiliate sales indicate a significant effect of the weighted exchange rate variable, while the respective effect was insignificant at the aggregate level. For outbound FDI, we obtain similar results at both the aggregate and the industry level.

7 Conclusions

The impact of exchange rates on multinational activity is an important topic in economic research. This paper sets up a three-country oligopoly model with coexisting exporters and multinationals to study the impact of exchange rate shocks. A novel feature of our model is the determination of third-country exchange rate effects on multinational activity. To investigate our main theoretical hypotheses empirically, we rely on aggregate and industry-level data on outbound multinational activity of both the US and Japan. Following the theoretical insights and previous empirical work, country size and endowment characteristics as well as geographical distance and, especially, exchange rates are used as the main explanatory variables. The empirical specification simultaneously uses bilateral as well as third-country determinants. To account for the cross-country dependence in general equilibrium, spatial econometric methods are applied with inverse distances as weights for the third-country effects.

It turns out that the bilateral and the third-country exchange rate effects are quite different for US outbound activities as compared to those of Japan. Our theoretical model rationalizes these differences and gives an intuition for the observed patterns of exchange rate effects on outbound multinational activity at the bilateral level. Due to its remoteness from important trade and investment partners and its relatively good skilled labor endowment characteristics, Japan finds itself in an exporter scenario, where the dominance of competition over revenue effects explains a negative impact of the bilateral and a positive one of the third-country exchange rate variable. The opposite holds true for the US which is in a multinational scenario with a

[33] It is worth noting that industry-specific endowments of the respective parent economy are fully controlled for by the use of industry-time dummies, in these regressions.

dominance of the revenue effect. In that case, we find a positive bilateral and a negative third-country exchange rate effect on bilateral outbound multinational activity.

Appendix

Data sources:

Data on foreign affiliate sales and outbound foreign direct investment of majority owned multinationals at the industry level are from the Bureau of Economic Analysis (USA), and UNCTAD (Japan). Explanatory variables are based on raw data from the World Bank's World Development Indicators. Specifically, we used real GDP figures at constant parent country exchange rates to construct bilateral sum of GDP ($SGDP_{ijt}$) and similarity in GDP ($RGDP_{ijt}$). Capital stocks are computed according to the perpetual inventory method, where gross fixed capital formation at constant parent country exchange rates were used and a depreciation rate of 13.3%, following Leamer (1984). Skilled labor endowments are based on the tertiary school enrollment share times a country's labor force. Unskilled labor endowments are defined as the difference between labor force and skilled labor endowments. Bilateral distance is based on the greater circle distance between two countries' capitals (own calculations).

Country coverage

USA: Argentina, Australia, Austria, Brazil, Canada, Chile, China, Colombia, Costa Rica, Denmark, Dominican Republic, Ecuador, Egypt, Finland, France, Germany, Greece, Guatemala, Honduras, Hong Kong, India, Indonesia, Ireland, Israel, Italy, Jamaica, Japan, Korea, Malaysia, Mexico, Netherlands, New Zealand, Nigeria, Norway, Panama, Peru, Philippines, Portugal, Singapore, South Africa, Spain, Sweden, Switzerland, Thailand, Trinidad and Tobago, Turkey, United Arab Emirates, United Kingdom, Venezuela.

Japan: Argentina, Australia, Austria, Belgium, Brazil, Canada, Chile, China, Colombia, Costa Rica, Czech Republic, Denmark, Egypt, Finland, France, Germany, Hong Kong, Hungary, India, Indonesia, Ireland, Israel, Italy, Jamaica, Republic of Korea, Liberia, Malaysia, Mexico, Netherlands, New Zealand, Nigeria, Norway, Panama, Peru, Philippines, Poland, Portugal, Russia, Singapore, South Africa, Spain, Sweden, Switzerland, Thailand, Turkey, USA, United Arab

Emirates, United Kingdom, Venezuela.

Industry coverage in regressions based on disaggregated data

USA: Petroleum; Food and kindred products; Chemicals and allied products; Primary and fabricated metals; Machinery, except electrical; Electric and electronic equipment; Transportation equipment; Other manufacturing; Wholesale trade; Finance (except banking), insurance, and real estate; Services.

Japan: Agriculture, fishing and forestry; Oil and coal; Mining; Food products; Fibre and textiles; Wood, pulp, and paper; Chemicals and allied products; Steel; Non-steel metal products; Machinery, except electric, precision, and transport; Electric machinery; Transport machinery; Precision machinery; Miscellaneous machinery; Miscellaneous industries; Construction; Wholesale and retail; Services.

Moment conditions:

The generalized method of moments unbalanced random effects estimation is based on the moment conditions derived in Baltagi, Egger, and Pfaffermayr (2005). Let m be the overall number of observations and N the number of unique host countries (host-country-industry pairs in case of industry-level data) in the panel. Further, define D_t as a $N_t \times N$ matrix which is obtained from I_N by skipping the rows corresponding to missing host countries (host-country-industry pairs) in year t. Note that, $\sum_{t=1}^{T} N_t = m$. In matrix notation, the disturbance term is $\mathbf{u} = \rho \mathbf{W} \mathbf{u} + \varepsilon$, $\varepsilon = \mathbf{\Delta_1} \mu + \nu$, where $\mu \sim IID(0, \sigma_\mu^2)$ is a $N \times 1$ vector of random host-country (host-country-industry) effects, $\nu \sim IID(0, \sigma_\nu^2)$ is a classical error term, and $\mathbf{\Delta}_1 = \begin{pmatrix} \mathbf{D}_1' & \mathbf{D}_2' & \cdots & \mathbf{D}_T' \end{pmatrix}'$ is the $m \times N$ selector matrix, which picks up the host-country (host-country-industry) effects. Both μ and ν are assumed independent of each other and among themselves. However, there is spatial dependence in $\mathbf{u}$ through $\mathbf{W}$ which exhibits row-normalized entries that are inversely related to bilateral distances between host countries. Further, let the projection matrix $\mathbf{P} = \mathbf{\Delta_1} \left(\mathbf{\Delta_1'} \mathbf{\Delta_1} \right)^{-1} \mathbf{\Delta_1'}$ with $\mathbf{\Delta_1'} \mathbf{\Delta_1} = \sum_{t=1}^{T} \mathbf{D}_t' \mathbf{D}_t = diag(T_i)$, where T_i indicates the number of years we observe host-country (host-country-industry pair) i. $\mathbf{Q} = \mathbf{I}_m - \mathbf{P}$, with $tr(\mathbf{P}) = N$ and $tr(\mathbf{Q}) = m - N$.

$$\begin{aligned}
E((\mathbf{u}-\rho\mathbf{Wu})'\,\mathbf{Q}\,(\mathbf{u}-\rho\mathbf{Wu}) - \sigma_\nu^2(m-N)) &= 0\\
E((\mathbf{u}-\rho\mathbf{Wu})'\,\mathbf{P}\,(\mathbf{u}-\rho\mathbf{Wu}) - m\sigma_\mu^2 - N\sigma_\nu^2) &= 0\\
E(\left(\mathbf{Wu}-\rho\mathbf{W^2u}\right)'\,\mathbf{Q}\,\left(\mathbf{Wu}-\rho\mathbf{W^2u}\right)) - \sigma_\nu^2 tr(\mathbf{W'QW}) - \sigma_\mu^2 tr(\mathbf{W'QW\Delta_1\Delta_1'}) &= 0\\
E(\left(\mathbf{Wu}-\rho\mathbf{W^2u}\right)'\,\mathbf{P}\,\left(\mathbf{Wu}-\rho\mathbf{W^2u}\right)) - \sigma_\nu^2 tr(\mathbf{W'PW}) - \sigma_\mu^2 tr(\mathbf{W'PW\Delta_1\Delta_1'}) &= 0\\
E(\left(\mathbf{Wu}-\rho\mathbf{W^2u}\right)'\,\mathbf{Q}\,(\mathbf{u}-\rho\mathbf{Wu})) &= 0\\
E(\left(\mathbf{Wu}-\rho\mathbf{W^2u}\right)'\,\mathbf{P}\,(\mathbf{u}-\rho\mathbf{Wu})) &= 0
\end{aligned}$$

These can be solved for estimates of ρ, σ_ν^2, and σ_μ^2.

References

Baldwin, Richard (1988), Hysteresis in Import Prices: The Beachhead Effect, *American Economic Review* **78**, 773-785.

Baldwin, Richard (1990), Hysteresis in Trade, *Empirical Economics* **15**, 127-142.

Baldwin, Richard and Paul R. Krugman (1989), Persistent Trade Effects of Large Exchange Rate Shocks, *Quarterly Journal of Economics* **54**, 635-654

Baltagi, Badi H., Peter Egger, and Michael Pfaffermayr (2005), Estimating Models of Complex FDI: Are There Third-Country Effects, *Journal of Econometrics*, forthcoming.

Barro, Robert J. and Jong-Wha Lee (2000). International Data on Educational Attainment: Updates and Implications, manuscript, Harvard University, February 2000.

Blonigen, Bruce A. (1997), Firm-Specific Assets and the Link Between Exchange Rates and Foreign Direct Investment, *American Economic Review* **87**, 447-465.

Blonigen, Bruce A. (2005), A Review of the Empirical Literature on FDI Determinants, NBER Working Paper No. 11299.

Blonigen, Bruce A., Ronald B. Davies, Glen R. Waddell, and Helen Naughton (2004), FDI in Space: Spatial Autoregressive Lags in Foreign Direct Investment, NBER Working Paper No. 10939.

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

Caves, Richard E. (1989), Exchange Rate Movements and Foreign Direct Investment in the United States, in David B. Audretsch and Michael P. Claudon (eds.), *The Internationalization of Markets*, New York: New York University Press, 199-228.

Egger, Hartmut, Peter Egger, and Michael Ryan (2006), Exchange Rate Effects on Multinational Activity, unpublished manuscript.

Egger, Peter and Michael Pfaffermayr (2004), Distance, Trade and FDI: A Hausman-Taylor SUR Approach, *Journal of Applied Econometrics* **19**, 227–246.

Ekholm, Karolina, Rikard Forslid, and James R. Markusen (2005), Export-Platform Foreign Direct Investment. Revised version of NBER Working Paper No. 9517.

Fisher, Eric (1989), A Model of Exchange Rate Pass-Through, *Journal of International Economics* **26**, 119-137.

Froot, Kenneth A. and Paul D. Klemperer (1989), Exchange Rate Pass-Through When Market Share Matters, *American Economic Review* **79**, 636-654.

Froot, Kenneth A. and Jeremy C. Stein (1991), Exchange Rates and Foreign Direct Investment: An Imperfect Capital Markets Approach, *Quarterly Journal of Economics* **106**, 1191-1217.

Goldberg, Pinelopi K. and Michael M. Knetter (1997), Goods Prices and Exchange Rates: What Have We Learned?, *Journal of Economic Literature* **35**, 1243-1272.

Grossman, Gene M., Elhanan Helpman, and Adam Szeidl (2003), Optimal Integration Strategies for the Multinational Firm, NBER Working Paper No. 10189.

Hanson, Gordon H., Raymond Mataloni, and Matthew J. Slaughter (2001), Expansion Strategies of U.S. Multinational Firms, in Dani Rodrik and Susan Collins (eds), *Brookings Trade Forum 2001*, 245-294.

Hanson, Gordon H., Raymond Mataloni, and Matthew J. Slaughter (2005), Vertical Production Networks in Multinational Firms, *Review of Economics and Statistics*, forthcoming.

Helpman, Elhanan (1987), Imperfect Competition and International Trade: Evidence from Fourteen Industrial Countries, *Journal of the Japanese and the International Economies* **1**, 62-81.

Hummels, David and Volodymyr Lugovskyy (2003), Usable Data? Matched Partner Trade Statistics as a Measure of International Transportation Costs, forthcoming in *Review of International Economics.*

Kapoor, Mudit, Harry H. Kelejian, and Ingmar R. Prucha (2005), Panel Data Models With Spatially Correlated Error Components, *Journal of Econometrics*, forthcoming.

Krugman, Paul R. (1987), Pricing to Market When the Exchange Rate Changes, in Sven W. Arndt and J. David Richardson (eds.), *Real-Financial Linkages Among Open Economies*, Cambridge: MIT Press, 49-70.

Leamer, Edward E. (1984), *Sources of International Comparative Advantage: Theory and Evidence*, Cambridge, MA: MIT Press.

Lipsey, Robert E. (1999), The Location and Characteristics of U.S. Affiliates in Asia, NBER Working Paper 6876.

Markusen, James R. and Keith E. Maskus (2002), Discriminating Among Alternative Theories of the Multinational Enterprise, *Review of International Economics* **10**, 694-707.

Swenson, Deborah L. (1994), Impact of U.S. Tax Reform on Foreign Direct Investment in the United States, *Journal of Public Economics* **54**, 243-266.

Venables, Anthony, J. (1990), Microeconomic Implications of Exchange Rate Variations, *Oxford Review of Economic Policy* **6**, 18-27.

Yeaple, Stephen R. (2003) The Complex Integration Strategies of Multinationals and Cross Country Dependencies in the Structure of Foreign Direct Investment, *Journal of International Economics* **60**, 293-314.

Table 1 - Descriptive Statistics for the U.S. and Japan

Explanatory variables	USA Mean	USA Std. dev.	USA Minimum	USA Maximum	Japan Mean	Japan Std. dev.	Japan Minimum	Japan Maximum
	Dependent variables							
Number of foreign affiliates	5.14	0.94	3.04	7.89	2.59	1.74	0.00	7.06
Outbound foreign direct investment (FDI)	5.35	2.22	0.00	11.37	4.95	2.33	-1.08	10.15
Foreign affiliate sales	6.62	2.14	0.69	11.05	13.98	1.77	7.86	17.74
	Bilateral determinants							
Bilateral sum of GDP ($SGDP_{jt}$)	29.66	0.18	29.38	30.32	29.22	0.19	28.97	30.25
Similarity in GDP ($RGDP_{jt}$)	-3.19	1.45	-6.93	-0.72	-2.81	1.46	-9.88	-0.72
Relative capital endowments (RK_{jt})	-3.16	1.46	-6.29	-0.30	-2.65	1.46	-7.53	0.58
Relative skilled labor endowments (RS_{jt})	-0.30	0.19	-0.86	-0.01	-0.20	0.20	-0.86	0.09
Relative unskilled labor endowments (RL_{jt})	-2.49	1.54	-5.58	1.68	-1.77	1.52	-4.19	2.41
Capital-size interaction term (RKG_{jt})	-93.60	43.01	-187.31	-9.05	-77.19	42.42	-219.70	17.50
Distance (D_{jt})	-5.79	7.53	-27.14	9.80	8.56	0.54	6.67	9.35
Exchange rate (ζ_{jt})	-2.48	2.84	-12.95	11.70	-2.08	2.70	-11.25	8.67
Years	1994.29	2.73	1990.00	1999.00	1995.92	2.57	1992.00	2000.00
	Third-country determinants (spatially weighted)							
Bilateral sum of GDP ($WSGDP_{kt}$)	29.66	0.14	29.40	30.00	29.21	0.18	28.97	30.25
Similarity in GDP ($WRGDP_{kt}$)	-3.16	0.68	-5.61	-1.56	-2.99	1.42	-9.88	-0.72
Relative capital endowments (WRK_{kt})	-3.18	0.59	-5.12	-1.68	-3.01	1.36	-7.53	0.58
Relative skilled labor endowments (WRS_{kt})	-0.28	0.08	-0.58	-0.07	-0.17	0.19	-0.84	0.09
Relative unskilled labor endowments (WRL_{kt})	-2.58	0.49	-4.09	-0.36	-2.27	1.33	-4.19	2.41
Capital-size interaction term ($WRKG_{kt}$)	-94.24	17.35	-152.09	-49.91	-87.74	39.68	-219.70	17.50
Distance (WD_{kt})	-5.15	2.80	-12.85	0.48	8.57	0.53	6.67	9.35
Exchange rate ($W\zeta_{kt}$)	-2.42	0.81	-6.30	1.27	-2.35	2.28	-5.40	8.67

Notes: All variables are in logarithms. The corresponding numbers of observations are given in Table 2 and 3, respectively.

Table 2 - Spatial Panel Data Estimation for US Data
(Random Host-Country Effects, Generalized Moments Estimates)

Explanatory variables	Number of foreign affiliates			Outbound foreign direct investment		
	Bilateral determinants					
	β	std.		β	std.	
Bilateral sum of GDP ($SGDP_{jt}$)	9.193	1.310	***	18.984	2.176	***
Similarity in GDP ($RGDP_{jt}$)	0.165	0.084	*	1.190	0.147	***
Relative capital endowments (RK_{jt})	-15.097	1.658	***	-17.473	2.854	***
Relative skilled labor endowments (RS_{jt})	-0.099	0.661		-4.649	1.156	***
Relative unskilled labor endowments (RL_{jt})	-0.372	0.170	**	-0.958	0.290	***
Capital-size interaction term (RKG_{jt})	0.531	0.055	***	0.591	0.095	***
Distance (D_{jt})	-0.094	0.745		0.191	1.265	
Exchange rate (ζ_{jt})	0.028	0.014	*	0.052	0.026	**
	Third-country determinants (spatially weighted)					
	γ	std.		γ	std.	
Bilateral sum of GDP ($WSGDP_{kt}$)	-5.290	2.655	**	-1.663	7.783	
Similarity in GDP ($WRGDP_{kt}$)	0.105	0.270		-0.834	0.498	*
Relative capital endowments (WRK_{kt})	-8.268	6.889		20.010	12.136	*
Relative skilled labor endowments (WRS_{kt})	0.127	1.307		-6.465	2.609	**
Relative unskilled labor endowments (WRL_{kt})	0.042	0.365		-1.146	0.767	
Capital-size interaction term ($WRKG_{kt}$)	0.267	0.228		-0.627	0.404	
Distance (WD_{kt})	-0.426	1.004		-2.243	1.889	
Exchange rate ($W\zeta_{kt}$)	-0.266	0.069	***	-0.289	0.164	*
Observations	480			530		
R^2	0.689			0.719		
Estimated ρ	0.254			0.417		
Estimated σ_{ν}^2	0.027			0.056		
Estimated σ_{μ}^2	1.414			2.476		
Average estimated θ_k	0.956			0.954		
	Test-statistic	p-value		Test-statistic	p-value	
Random versus fixed effects (Hausman test)	5.614	1.000		0.013	1.000	
Host-country effects (Lagrange multiplier test)	169.884	0.000		146.582	0.000	
Time effects (F-test)	1.550	0.111		1.100	0.361	

Notes: *** significant at 1%; ** significant at 5%; * significant at 10%.

Table 3 - Spatial Panel Data Estimation for Japanese Data
(Random Host-Country Effects, Generalized Moments Estimates)

Explanatory variables	Number of foreign affiliates			Outbound foreign direct investment		
	Bilateral determinants					
	β	std.		β	std.	
Bilateral sum of GDP ($SGDP_{jt}$)	3.529	1.901	*	6.391	3.068	**
Similarity in GDP ($RGDP_{jt}$)	0.256	0.250		1.015	0.437	**
Relative capital endowments (RK_{jt})	-0.552	8.034		1.577	14.408	
Relative skilled labor endowments (RS_{jt})	-2.527	1.853		-5.298	2.784	*
Relative unskilled labor endowments (RL_{jt})	0.139	0.370		-0.761	0.573	
Capital-size interaction term (RKG_{jt})	0.018	0.274		-0.041	0.492	
Distance (D_{jt})	-2.531	1.202	**	-1.990	2.221	
Exchange rate (ζ_{jt})	-0.179	0.066	***	-0.266	0.111	**
	Third-country determinants (spatially weighted)					
	γ	std.		γ	std.	
Bilateral sum of GDP ($WSGDP_{kt}$)	-1.696	1.576		-2.541	2.684	
Similarity in GDP ($WRGDP_{kt}$)	0.170	0.241		-0.080	0.445	
Relative capital endowments (WRK_{kt})	6.614	8.662		6.758	15.864	
Relative skilled labor endowments (WRS_{kt})	0.562	1.157		-1.573	2.158	
Relative unskilled labor endowments (WRL_{kt})	-0.020	0.140		-0.155	0.262	
Capital-size interaction term ($WRKG_{kt}$)	-0.228	0.297		-0.230	0.543	
Distance (WD_{kt})	1.176	1.087		0.317	2.115	
Exchange rate ($W\zeta_{kt}$)	0.102	0.042	**	0.129	0.078	*
Observations	378			396		
R^2	0.317			0.285		
Estimated ρ	0.212			0.254		
Estimated σ_ν^2	0.281			0.929		
Estimated σ_μ^2	2.521			5.467		
Average estimated θ_k	0.883			0.858		
	Test-statistic	p-value		Test-statistic	p-value	
Random versus fixed effects (Hausman test)	5.794	1.000		21.873	0.528	
Host-country effects (Lagrange multiplier test)	22.770	0.000		13.301	0.000	
Time effects (F-test)	2.660	0.008		1.160	0.322	

Notes: *** significant at 1%; ** significant at 5%; * significant at 10%.

Table 4 - Bilateral and Third-Country Exchange Rate Effects on the Value of Foreign Affiliate Sales
(Random Host-Country Effects, Generalized Moments Estimates)

Explanatory variables	Foreign affiliate sales (US)			Foreign affiliate sales (Japan)		
	Bilateral determinants					
	β	std.		β	std.	
Bilateral sum of GDP ($SGDP_{jt}$)	30.939	3.043	***	1.400	1.517	
Similarity in GDP ($RGDP_{jt}$)	2.277	0.209	***	1.171	0.295	***
Relative capital endowments (RK_{jt})	-32.017	4.112	***	-1.155	9.248	
Relative skilled labor endowments (RS_{jt})	-3.053	1.700	*	-2.061	3.001	
Relative unskilled labor endowments (RL_{jt})	-1.607	0.460	***	-4.748	5.948	
Capital-size interaction term (RKG_{jt})	1.115	0.137	***	0.182	0.224	
Distance (D_{jt})	0.429	2.135		-0.378	0.739	
Exchange rate (ζ_{jt})	0.054	0.038		0.242	0.098	**
	Third-country determinants (spatially weighted)					
	γ	std.		γ	std.	
Bilateral sum of GDP ($WSGDP_{kt}$)	10.337	15.178		-2.741	1.402	*
Similarity in GDP ($WRGDP_{kt}$)	-2.592	0.743	***	0.363	0.393	
Relative capital endowments (WRK_{kt})	18.348	18.472		13.029	9.378	
Relative skilled labor endowments (WRS_{kt})	2.092	3.629		-7.642	3.124	**
Relative unskilled labor endowments (WRL_{kt})	1.365	1.212		-0.710	6.233	
Capital-size interaction term ($WRKG_{kt}$)	-0.633	0.605		-0.419	0.213	*
Distance (WD_{kt})	-4.000	3.625		0.057	0.795	
Exchange rate ($W\zeta_{kt}$)	-0.598	0.257	**	0.156	0.257	
Observations	499			174		
R^2	0.629			0.945		
Estimated ρ	0.689			-0.352		
Estimated σ_ν^2	0.025			0.199		
Estimated σ_μ^2	1.891			32.768		
Average estimated θ_k	0.963			0.974		
	Test-statistic	p-value		Test-statistic	p-value	
Random versus fixed effects (Hausman test)	0.000	1.000		23.139	0.512	
Host-country effects (Lagrange multiplier test)	144.109	0.000		18.435	0.000	
Time effects (F-test)	1.520	0.129		225.880	0.000	

Notes: *** significant at 1%; ** significant at 5%; * significant at 10%.

Table 5 - Sensitivity Analysis of the Bilateral and Third-Country Exchange Rate Effects
(Random Host-Country Effects, Generalized Moments Estimates)

Dependent variables	Bilateral exchange rate (ζ_{jt})		Third-country exchange rate ($W\zeta_{kt}$)	
	β	std.	γ	std.
US data:	*Spatial weights are based on inverse squared distance*			
Number of foreign affiliates	0.031	0.013 **	-0.093	0.028 ***
Foreign affiliate sales	0.029	0.018 *	-0.066	0.051
Outbound foreign direct investment	0.011	0.012	-0.301	0.178 *
	Spatial weights are based on inverse square root distance			
Number of foreign affiliates	0.009	0.008	-0.307	0.093 ***
Foreign affiliate sales	0.002	0.008	-0.458	0.132 ***
Outbound foreign direct investment	0.022	0.019	-0.571	0.278 **
	Original inverse distance weights but once lagged exchange rates			
Number of foreign affiliates	0.021	0.016	-0.218	0.081 ***
Foreign affiliate sales	0.043	0.055	-0.683	0.391 *
Outbound foreign direct investment	0.052	0.021 **	-0.259	0.131 **
	Original inverse distance weights but twice lagged exchange rates			
Number of foreign affiliates	0.001	0.018	-0.244	0.090
Foreign affiliate sales	-0.006	0.083	-1.301	0.595 **
Outbound foreign direct investment	0.013	0.022	-0.308	0.139 **
	Industry-level data; spatial weights based on inverse distance			
Foreign affiliate sales	0.073	0.031 **	-0.335	0.071 ***
Outbound foreign direct investment	0.064	0.023 ***	-0.103	0.052 **
Japanese data:	*Spatial weights are based on inverse squared distance*			
Number of foreign affiliates	-0.126	0.081	0.142	0.069 **
Foreign affiliate sales	0.238	0.094 **	0.168	0.253
Outbound foreign direct investment	-0.316	0.125 **	0.165	0.091 *
	Spatial weights are based on inverse square root distance			
Number of foreign affiliates	-0.248	0.126 *	0.722	0.263 ***
Foreign affiliate sales	0.358	0.140 **	-0.043	0.300
Outbound foreign direct investment	-0.247	0.116 **	0.074	0.109
	Original inverse distance weights but once lagged exchange rates			
Number of foreign affiliates	-0.109	0.053 **	0.094	0.036 ***
Foreign affiliate sales	0.396	0.289	-0.233	0.371
Outbound foreign direct investment	-0.157	0.078 **	0.087	0.042 **
	Original inverse distance weights but twice lagged exchange rates			
Number of foreign affiliates	-0.060	0.046	0.092	0.039 **
Foreign affiliate sales	0.020	0.037	-0.770	0.428 *
Outbound foreign direct investment	-0.109	0.129	0.721	0.308 **
	Industry-level data; spatial weights based on inverse distance			
Foreign affiliate sales	0.015	0.021	0.089	0.037 **
Outbound foreign direct investment	-0.061	0.026 **	0.115	0.054 **

Notes: *** significant at 1%; ** significant at 5%; * significant at 10%.