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Spatial Autoregressive Patterns in Inbound  
FDI**

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# **Spacey Parents:**

## **Spatial Autoregressive Patterns in Inbound FDI<sup>#</sup>**

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**Abstract:**

Increasing attention has been given to the impact of third countries on outbound FDI to a given host country. Here, we consider potential third-country effects on *inbound* FDI. A simple model suggests two sources of such effects on a country's inbound FDI. First, it will tend to receive more FDI from home countries proximate to large third countries. Second, FDI from third countries may increase or decrease FDI from the home country in question depending on whether production spillovers or crowding out effects dominate. Using data on US inbound FDI from OECD countries during 1980-2000, we find strong evidence for home market proximity effects. We find robust results for third country FDI effects only in a European subsample. There, crowding out effects dominate.

*JEL Classification:* F21, F23.

*Keywords:* Foreign direct investment; multinational enterprises; spatial econometrics.

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## **1. Introduction**

Of the many directions in the current work on foreign direct investment (FDI), the effort to expand our understanding of multinational enterprises (MNEs) to include the influence of third countries is one of the most promising. Working from a strong base of theory and evidence describing the influence of home- and host-country factors on FDI, much of which is summarized in Caves (1996) and Markusen (2002), recent work examines the influence of additional potential host countries on the outbound FDI decision. Papers in this vein include those of Ekholm, Forslid, and Markusen (2003), Yeaple (2003), and Bergstrand and Egger (2004) who analyze what has been termed "export platform FDI." In contrast to Markusen's (1984) horizontal model in which the MNE serves each of its markets through a local plant, in the export platform model, the MNE establishes a single overseas plant in one of the many potential hosts. Output from this centrally-located plant is then sold in both the host and other nearby markets. Recent evidence by Blonigen, et. al. (2004) and Baltagi, Egger, and Pfaffermayr (2004) finds compelling evidence for this export platform motivation in outbound FDI data.

Although this work has focused on outward investment and the choice among host locations, it is just as important to recognize that third country effects may be important for inbound FDI as well. In this paper, we identify two potential channels for such effects using a simple model of the MNE. First, we show that the home (or parent) country's proximity to additional markets alters the margin of whether to service the host market through exports from home or through FDI. When the home country has low-cost access to large markets, this increases the opportunity cost of exporting to the host. Therefore, subsidiary production in the host will rise even though the host itself is not an

export platform. We call this the home market proximity effect, which contrasts with *host* country market proximity effects (often called market potential effects) in previous literature such as Head and Mayer (2004) and Blonigen, et. al. (2004). Second, when there are MNEs from many countries active in the host, they may influence each other. If the various MNEs compete for scarce resources, then FDI from any single home country may be crowded out by FDI from other home countries. Alternatively, if FDI from other home countries provide positive production externalities in the host country through technological transfer or market linkages, then greater third country FDI could encourage FDI from the home country in question.

This then suggests two testable hypotheses. First, we expect that more FDI will come from countries near large third-country markets. Second, more FDI from third countries in the host can mean more or less FDI from home depending on whether spillover or crowding-out effects dominate. To analyze these issues, we turn to a dataset on US inbound FDI from twenty OECD countries over 1980-2000. We find strong evidence for home market proximity effects - evidence that is robust to a variety of specifications. The effect of FDI from third countries, however, depends on the sample. When using our full OECD dataset, we find no robust result for this variable. When restricting the analysis to a European subsample – a subsample that excludes the geographically distant countries of Australia, Canada, and Japan – we find a robustly negative impact of third country FDI. Thus, at least for the European sample, it seems as if FDI from one country may crowd out investment from another.

This paper proceeds as follows. In Section 2, we sketch out a simple, partial equilibrium model of the multinational firm in order to frame our predictions. In Section

3, we discuss our empirical strategy and data. Section 4 presents our results and Section 5 concludes.

## 2. A Simple Model of the Multinational Firm

In this section our goal is to frame our empirical methodology with a simple, partial equilibrium model of a multinational firm. While this model clearly lacks many of the general equilibrium properties that typify fully-specified models such as Markusen (2002) or Helpman, Melitz, and Yeaple (2004), our goal here is simply to elucidate some of the ways in which third-country effects may be important for a country's inbound FDI from a particular home.

Consider a firm that produces in two countries, home and host.<sup>1</sup> Countries are numbered such that the host country is country 1 and the home is country 2. In addition, there is a third country 3. The output from home country 2 is produced at a total variable production cost  $C(Q)$  where  $Q$  is the total amount produced in the home country.<sup>2</sup> This output can be sold in any of the three countries, where  $Q_i$  is the amount of home-produced output sold in country  $i$ . To do so, the firm must incur a per-unit shipping cost  $t_i \geq 0$ , where  $t_2 = 0$ , i.e. home production can be sold in the home country without additional cost. In addition to home production, the multinational produces in the host, incurring the total variable production cost  $C^*(Q^*; \Omega)$  where  $Q^*$  is the total host production and  $\Omega$  is a function of the other (non-modeled) MNEs active in the host

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<sup>1</sup> In the interest of brevity, we assume that the firm is a multinational. Such decisions lie at the heart of many models of FDI as discussed by Markusen (2002). Our model could easily be broadened to include the choice of whether to go multinational or not. There, because of the need to cover additional fixed costs  $\gamma_1$  when setting up the host plant, this choice would depend on host market size and the relative cost savings (avoiding  $t_1$  and the increasing home marginal cost). Since formal presentation of this possibility does not significantly contribute to our goals for this section, we omit it.

<sup>2</sup> In the rest of this section we refer to home country 2 as simply the “home country.”

(more on this below). Both production cost functions are increasing, convex functions.<sup>3</sup>

We assume that all output from the host plant is sold in the host, i.e. that this is a purely horizontal MNE, in order to eliminate any effects that would arise from an export-platform motivation for host production. We also assume that in equilibrium all quantities will be positive, implying that the firm does not import from the host.<sup>4</sup>

Defining  $q_i$  as the total amount sold in each country, each country's local price is  $P_i(q_i; \beta_i)$ . Note that for the host country  $q_1 = Q_1 + Q^*$  whereas the total amount sold in the other two countries is equal to their respective  $Q_i$ . We assume that these inverse demand functions are decreasing in their respective quantities and that the associated marginal revenue functions are declining in quantity.<sup>5</sup> The  $\beta_i$  term in the inverse demand is a shift parameter. We assume that, all else equal, an increase in a country's  $\beta$  increases both the price and the slope of the price function, i.e. where superscripts denote derivatives, that both  $P_i^\beta$  and  $P_i^{q_i\beta}$  are positive. These  $\beta$  terms are intended to represent terms that increase the size of a given market; the bigger the market, for a given quantity, the higher and the less sensitive the price will be. Finally, in addition to its variable costs, each plant costs the firm a fixed cost  $\gamma_i$  and the firm incurs a firm-level fixed cost  $\alpha$ .

The MNE's profits are given by:

$$\Pi^{MNE} = \sum_{i=1}^3 P_i(q_i; \beta_i)q_i - C(Q) - C^*(Q^*; \Omega) - \sum_{i=1}^3 t_i Q_i - \gamma_1 - \gamma_2 - \alpha. \quad (1)$$

Profit maximization implies that:

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<sup>3</sup> Note that this assumption differs from many models in which production is constant returns to scale (CRS). If we assume CRS production in our partial equilibrium model, then host production will not depend on third country variables, although it would still depend on  $\Omega$ .

<sup>4</sup> Our theory can certainly encompass this possibility, however. The primary change is that an increase in trade costs between 1 and 2 would decrease the need for overseas production.

<sup>5</sup> This latter assumption is guaranteed if the inverse demand functions are concave.

$$P_i^{q_i}(q_i; \beta_i)q_i + P_i(q_i; \beta_i) = C^Q\left(\sum_{i=1}^3 Q_i\right) + t_i \text{ for } i = 1, 2, 3 \quad (2)$$

and

$$C^{*Q^*}(Q^*; \Omega) = C^Q\left(\sum_{i=1}^3 Q_i\right) + t_1. \quad (3)$$

Equation (2) is the standard markup condition for a monopolist. Note that unlike many models of FDI, we are ignoring competition in output markets with other firms (either domestic, foreign, or multinational). We take this partial equilibrium approach for simplicity since demonstrating these interactions is not the primary goal of our theory, which is instead to highlight the role of third countries. Equation (3) highlights the tradeoff of this horizontal firm between home production (and exports) and host production.

From the four first order conditions, we can calculate how host production moves in response to changes in our exogenous parameters. This is given in the following proposition.

**Proposition 1:** *Host production is:*

- a) *increasing in country 1's transport cost,*
- b) *decreasing in country 3's transport cost,*
- c) *increasing in any country's market size.*

**Proof:** It will prove convenient to define some notation. Denote the change in a country's marginal revenue with respect to the quantity sold there by:

$$\tilde{P}_i \equiv P_i^{q_i q_i}(q_i; \beta_i)q_i + 2P_i^{q_i}(q_i; \beta_i) < 0. \quad (4)$$

Also, define

$$\begin{aligned}\Phi \equiv C^{QQ}(Q)C^{*Q^*Q^*}(Q^*; \Omega) & \left[ \tilde{P}_1\tilde{P}_2 + \tilde{P}_1\tilde{P}_3 + \tilde{P}_2\tilde{P}_3 \right] \\ & - \tilde{P}_1\tilde{P}_2\tilde{P}_3 \left[ C^{QQ}(Q) + C^{*Q^*Q^*}(Q^*; \Omega) \right] > 0.\end{aligned}\quad (5)$$

Using equations (2) and (3), we can calculate the following comparative statics (dropping the arguments of functions):

$$\frac{dQ^*}{dt_1} = \Phi^{-1}\tilde{P}_1 \left[ C^{QQ}(\tilde{P}_2 + \tilde{P}_3) - \tilde{P}_2\tilde{P}_3 \right] > 0, \quad (6)$$

$$\frac{dQ^*}{dt_3} = \Phi^{-1} \left[ -C^{QQ}\tilde{P}_1\tilde{P}_2 \right] < 0, \quad (7)$$

$$\frac{dQ^*}{d\beta_1} = \Phi^{-1}\tilde{P}_2\tilde{P}_3C^{QQ} \left[ P_1^{q,\beta}q_1 + P_1^\beta \right] > 0, \quad (8)$$

$$\frac{dQ^*}{d\beta_2} = \Phi^{-1}\tilde{P}_1\tilde{P}_3C^{QQ} \left[ P_2^{q,\beta}q_2 + P_2^\beta \right] > 0, \quad (9)$$

and

$$\frac{dQ^*}{d\beta_3} = \Phi^{-1}\tilde{P}_1\tilde{P}_2C^{QQ} \left[ P_3^{q,\beta}q_3 + P_3^\beta \right] > 0. \quad (10)$$

**Q.E.D.**

The intuition behind these results is straightforward. When the transport cost to the host rises, this lowers the relative marginal cost of host production compared to producing at home and exporting. Thus the MNE shifts production to the host. When the transport cost to country 3 rises, it reduces exports from home to country 3. This frees up home-produced output for exporting to the host, leading to a reduction in host output. When the host market size rises, this increases the return to selling there, thereby increasing host production (as well as exports from home to the host). When the market size of either of

the other countries rises, the MNE will divert home output away from the host and replace a portion of this decline with increased host production.

This illustrates one way in which third countries can impact FDI in the host. When the home country has easy access to large third markets, the firm's home activities will be geared more heavily towards those markets. As a result, firms from such countries will expand host production to serve that particular market. The second way in which third countries can impact the MNE's decision is through the effect of their multinationals on the firm's host production costs, i.e. through  $\Omega$ . Again using the first order conditions, we find that:

$$\frac{dQ^*}{d\Omega} = \Phi^{-1} C^{*\varrho^* \Omega} \left[ \tilde{P}_1 \tilde{P}_2 \tilde{P}_3 - C^{\varrho\varrho} \left[ \tilde{P}_1 \tilde{P}_2 + \tilde{P}_1 \tilde{P}_3 + \tilde{P}_2 \tilde{P}_3 \right] \right] \quad (11)$$

which has the opposite sign of  $C^{*\varrho^* \Omega}$ . If  $C^{*\varrho^* \Omega}$  is positive, i.e. greater MNE activity by other firms increases this firm's marginal cost of host production, then more FDI from other countries will reduce the output of MNEs from the home country. This would be consistent with a situation in which MNEs compete for scarce host resources.

Alternatively, if we were to embed this  $\Omega$  in the host price function, such an impact could arise due to greater competition in the host. On the other hand, more FDI from other countries could lower the marginal cost of host production due to spillovers. As discussed by Blomström and Kokko (1998), there is a sizable body of evidence suggesting that multinationals provide positive production externalities to other firms, benefits which may well extend to other MNEs in the host. Given these conflicting possibilities, we have no a priori expectations on the net effect of third countries' FDI and therefore turn to the data for additional insights.

### 3. Empirical Methodology and Data

In this section, we discuss our empirical specification and data.

#### 3.1. Empirical Specification

Our empirical approach will utilize US inbound FDI data and apply a modification of the commonly-used gravity model of FDI. Ignoring time subscripts for notational purposes and where all non-discrete variables are measured in natural logs, our primary regression specification is given by:

$$FDI = \alpha_0 + \alpha_1 HomeVariables + \alpha_2 Trends + \alpha_3 Home\ Market\ Proximity + \rho \cdot W \cdot FDI + \varepsilon. \quad (12)$$

As in other gravity specifications for FDI, including those of Eaton and Tamura (1994) and Brainard (1997), we include several controls for the home country. Thus, *Home Variables* in equation (12) includes home GDP, home population, and measures of trade frictions between home and host. In addition, following the insights of Carr, Markusen, and Maskus (2001), we include a measure of home country skill. Typically, gravity models include a comparable set of host country variables. In our case, since the US is always the host country, these variables were insignificant once trends were included.<sup>6</sup> Therefore we omit these in favor of *Trends*, which is a quadratic time trend.

In addition to the standard set of controls guided by prior literature, the above theory also suggests the inclusion of two additional variables. The first of these is a measure of the home country's proximity to non-host markets. In their study of Japanese outbound FDI into Europe, Head and Mayer (2004) use several different measures of host country market proximity and find that a distance-weighted sum of proximate countries'

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<sup>6</sup> These alternative results are available upon request. The omitted variables include US GDP, population, openness, skill, and an index of investment barriers.

GDPs provides the best fit for the data.<sup>7</sup> Taking their lead, we construct a comparable

variable, home market proximity, which for home country  $i$  is equal to  $\sum_{j \neq i} \frac{173}{d_{ij}} GDP_j$

where  $d_{ij}$  is the distance between the home country in question ( $i$ ) and other non-US countries ( $j$ ).<sup>8</sup> Note that although the construction of this variable is analogous to the host market potential measure of Head and Thierry (2004) and Blonigen, et. al. (2004), its interpretation is quite different because of the home versus host country distinction. In the previous papers, the authors analyze outbound FDI data and the variable measures the proximity of the host country to additional surrounding markets which can be served by exports from this host. In this paper, we are constructing a variable that measures proximity of the home country to other surrounding markets and, thus, is a measure of the ease with which firms can export from their home location. Also note that this variable differs from the distance between the home country  $i$  and the US, a standard gravity model control variable that we include separately. This home market proximity variable captures two aspects of the theory. First, third country GDP ( $GDP_j$ ) corresponds to the demand shift parameter,  $\beta_3$ , in our theory section. Second,  $t_3$ , the trade costs between home and country 3, are captured by the distance between home and this third country. A rise in  $\beta_3$  or a fall in  $t_3$  both would imply an increase in home market proximity. Since the theory predicts that either change would increase FDI in the host, we expect that  $\alpha_3 > 0$ .

In addition to home market proximity, we include information about concurrent FDI from other home countries. This is done to investigate whether there is indeed any

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<sup>7</sup> Since our host country is the US in all observations, as with the other US variables, we exclude host market potential in favor of quadratic trends.

<sup>8</sup> In line with the FDI weighting matrix discussed below, the 173 is the shortest distance between country pairs, implying that Belgium's GDP gets a weight of one for the Netherlands and vice versa. Since this is a constant, this simply scales the estimated coefficient on home market proximity.

evidence supporting the  $\Omega$  effect in the theory. The primary difficulty in doing so is that, due to the fact that FDI from  $i$  affects FDI from  $j$  and vice versa, there is an endogeneity problem that must be addressed. One possible approach is to construct instruments for the other countries' investment. An alternative, and the one we choose here, is the use of autoregressive spatial estimation. As detailed in Anselin (1988), this maximum-likelihood procedure deals with the endogeneity problem present in OLS. In equation (12), the effect of  $\Omega$  is represented by  $\rho \cdot W \cdot FDI$ , where FDI is a vector of investment into the US and  $W$  is the spatial lag weighting matrix, which is an  $n \times n$ , block-diagonal matrix with each block capturing a single year's observations (where  $n$  is the number of observations). In our baseline case, we weight FDI using a simple inverse distance function where the shortest distance within the sample (the 173 kilometers separating Brussels and Amsterdam) gets a weight of one and all other distances get a weight that declines with distance. This inverse distance weighting scheme results in a control variable for FDI from country  $i$  in year  $t$  of  $\sum_{j \neq i} \frac{173}{d_{ij}} FDI_{j,t}$ , i.e. a distance-weighted average of FDI from the other home countries in year  $t$ . The coefficient on this term,  $\rho$ , is referred to as the spatial lag. If the spatial lag is negative, this would be consistent with the crowding out story discussed above in which more FDI from other locations implies less FDI from the home country in question. A positive spatial lag would be consistent with the spillover story. Note that in either case, the spatial lag only captures the net effect of FDI from other countries and does not rule out coexistence of these mechanisms. Also note that this spatial lag indicates the impact of other countries' inbound FDI and does not consider the interaction of firms from country  $i$  nor does it capture spillovers or crowding out by US firms (the effect of which is captured by the

trend terms). As the particular choice of weighting scheme is ad hoc, we utilize several alternative functional forms below. Furthermore, it is not clear that we should weight FDI by distance if what matters for  $\Omega$  is total FDI from other sources irrespective of where it comes from. Therefore, one of our alternative weighting schemes will consider this possibility.

Although spatial studies of outbound FDI have been undertaken by Coughlin and Segev (2000), Baltagi, Egger, and Pfaffermayr (2004) and Blonigen, et. al. (2004), to our knowledge this technique has yet to be applied to inbound FDI data. Therefore, we are the first to consider the interaction between FDI from various home countries. In particular our use of inbound data implies an important difference in the interpretation of their spatial lag variable and ours. In their estimates, the spatial lag estimates the impact of FDI from a single home country  $i$  into third country  $k$  on its FDI into  $j$ . In our estimates, the spatial lag captures the impact of FDI from third country  $k$  into  $j$  on FDI from home country  $i$  into  $j$ . Note that this also differs from the interpretation of the results of Head, Ries, and Swenson (1995), who find evidence of agglomeration of Japanese subsidiaries in the US, since there too the estimated effect is how FDI from a single source in one location depends on FDI from the same source in other locations.

### *3.2. Data*

For our dataset, we use a panel of annual data on US inbound FDI from the major developed countries between 1980 and 2000 as listed in Table 1. We choose these data for several reasons. First, the FDI from these countries is more likely homogeneous and may be more comparable across home countries. As noted by Blonigen and Davies (2004), combining rich and poor countries in FDI data can often lead to implausibly-sized

coefficient estimates. Furthermore, since the motivations behind investment from developed and developing countries may be quite different, combining FDI from the two groups may introduce undesirable noise into the data. In addition, as demonstrated by Markusen and Maskus (2001) and Blonigen, Davies, and Head (2003), estimates relying on pooled outbound and inbound data can give very different results for variables such as skill when compared to separate regressions on each sub-sample. Our second reason for choosing these data is that, by restricting ourselves to a relatively small sample of countries, this greatly eases the computation time that spatial autoregressive techniques require. This is a particular issue when the weighting matrix gives positive weight to all countries in the sample, an issue we must grapple with in many of our specifications. Third, by utilizing this set of countries, it allows a better comparison to the results of Blonigen, et. al. (2004) who consider US outbound FDI to this same set of countries. Despite the limitations utilizing this group of countries causes, it is worth noting that in 2000, the countries in our full sample constituted 88 percent of total US inbound FDI. Finally, one added benefit of using US inbound data is that, compared to European countries, the US is far less likely to be an export platform since most output by MNEs in the US is sold in the US.

Our dependent variable is the real stock of inward US FDI as reported by the Bureau of Economic Analysis. We use the FDI stock evaluated at historical cost and convert it into real millions of dollars using the chain-type price index for gross domestic investment from the Economic Report of the President.<sup>9</sup> Availability of these data limit our time period to 1980 and later. Home country real GDP per capita and population data

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<sup>9</sup> The BEA's FDI data can be found at <http://www.bea.doc.gov/bea/di/di1fdibal.htm>. The price deflator can be found at <http://www.gpoaccess.gov/usbudget/fy05/sheets/b7.xls>.

come from Penn World Tables (PWT). These data run up to 2000.<sup>10</sup> Our trade-cost measure is the inverse of the openness measure reported by the PWT, which itself is equal to exports plus imports divided by GDP. A secondary trade cost measure is the distance between the US and the home country. It should be noted, however, that this distance can also capture the difficulty in managing a distant subsidiary and may therefore capture the impact of such a barrier to FDI. Distance is measured using great circle distances between capital cities, denominated in kilometers.<sup>11</sup> Home country skill is measured by the average years of schooling for those over age 25, reported every five years for 1960-2000.<sup>12</sup> We used linear interpolation to construct values for other years. Summary statistics for our data are found in Table 2.

One admitted shortcoming of this dataset is that it utilizes country-level data, a potential issue since the theory of Section 2 does not provide clear guidelines in the mapping between an individual firm's decisions and a country's aggregate amount of FDI. This shortcoming plagues many studies of FDI, particularly those that seek to identify effects generated in firm-level models. Although firm-level studies do exist (e.g. Head and Mayer (2004)), the use of country level data is still popular in the literature. To the extent that more-aggregate country-level data mask heterogeneous patterns at the firm- or industry-level, it will bias our analysis toward not finding any statistically significant effects. For example, crowding out effects may outweigh positive production externalities in some industries, with the opposite true in other industries. Such patterns in the data would make an estimate of the spatial lag likely insignificant when using

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<sup>10</sup> The PWT Version 6.1 data are available online at [http://pwt.econ.upenn.edu/php\\_site/pwt\\_index.php](http://pwt.econ.upenn.edu/php_site/pwt_index.php).

<sup>11</sup> With the exception of Belgium, these data were provided by Raymond Robertson at his website. Belgian distances were acquired from <http://www.indo.com>.

<sup>12</sup> Acquired from Barro and Lee (2000), International Data on Educational Attainment.

country-level data. As we next show, despite this aggregation bias, we find generally statistically significant results using country-level data.

#### **4. Results**

In our estimation, we begin with the full OECD sample. Following this, we restrict ourselves to a European subsample in order to test the sensitivity of our results. In Blonigen, et. al. (2004), which used US outbound FDI, the results on the spatial lag term depend somewhat on whether geographic outliers such as Japan and Australia are included. Therefore it is important to look for comparable sensitivity in US inbound FDI.

##### *4.1. OECD Results*

Table 3 presents our initial results from the OECD sample. Column (1) provides the standard OLS gravity estimates so that we can determine to what extent they are sensitive to the inclusion of third country effects. As is common in gravity models of FDI, we find that most US inbound FDI comes from large, skilled economies. We also find that more FDI tends to come from countries with small populations. Under the log specification, this would be consistent with more FDI from wealthy countries (i.e. holding GDP equal, those with smaller populations). In column (1) we also find that more FDI comes from countries near to the US, although as will be seen this finding is very sensitive.

In column (2), we add home market proximity to the baseline gravity specification. We find that it is both positive and significant, consistent with our hypothesis that a larger market surrounding the home country increases the opportunity cost of exporting to the host, thus increasing FDI and affiliate production in the host

country. Our other coefficients change little in terms of either significance or magnitude. The one exception is that the distance from the US becomes insignificant. In column (3), we omit the home market proximity, but include the spatial lag in the baseline gravity specification. We find that the spatial lag is insignificant and that its inclusion does not greatly change our estimates relative to column (1). Finally, column (4) includes both the spatial lag and home market proximity. Again, the spatial lag is insignificant. Otherwise, our results are quite similar to those in column (2) which indicate a significant positive effect of home market proximity.

#### *4.2. Robustness to Alternative Weighting Schemes*

One potential issue with the spatial lag estimates in Table 3 is that the weighting matrix construction is ad hoc. In the theory, the term  $\Omega$  represents the influence that FDI from third countries exerts on FDI from another country. There is no a priori reason to expect that this influence is an inverse function of geographic distance. Furthermore, the inverse distance weights used in Table 3 assign positive weight to all countries, regardless of their distance from the home country in question. Finally, it seems just as possible that distance between home countries should not factor into  $\Omega$  at all and that what matters is simply the total FDI from third countries. To examine whether these alternatives provide a different picture of the effect of third country FDI, in Table 4 we use several alternative specifications for the weighting matrix used to construct the spatial lag term.<sup>13</sup>

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<sup>13</sup> Throughout Table 4 we use the same inverse-distance weighting scheme for home market proximity. We do this to isolate the impact the weighting matrix has on the spatial lag's estimated coefficient.

The first alternative (the results of which are in column (1)), uses a negative exponential weight, i.e. for an observation from country  $i$ , the weight on FDI into the US from country  $j$  is:

$$w_y(d_{i,j}) = e^{-d_{i,j}/1000} \quad \forall i \neq j. \quad (13)$$

As with the inverse distance, this too assigns positive weight to all other home countries. Therefore, the next alternative assigns zero weight to other home countries  $j$  beyond a certain distance from home country  $i$ . In column (2), we use the weights:

$$w_y(d_{i,j}) = \left(1 - \left(\frac{d_{i,j}}{11,155}\right)^2\right)^2 \quad \forall i \neq j \text{ if } d_{i,j} \leq 11,155; 0 \text{ otherwise.} \quad (14)$$

In our sample, the smallest maximum separation of any country-pair (the distance between Lisbon and Tokyo) is 11,155 kilometers whereas the largest maximum separation is 18,074 kilometers (the distance between Lisbon and Sydney). As such, this scheme gives positive weight only to those pairings closer than 11,155. Because this weighting scheme uses the minimum maximum distance as a cutoff, with apologies to game theorists everywhere, we refer to this as the "minmax" weight. The third weighting scheme, found in column (3), is similar to the minmax weight in form but assigns positive weights to all countries except the pair with the greatest distance. This scheme is given by:

$$w_y(d_{i,j}) = \left(1 - \left(\frac{d_{i,j}}{18,074}\right)^2\right)^2 \quad \forall i \neq j \text{ if } d_{i,j} \leq 18,074; 0 \text{ otherwise.} \quad (15)$$

Since this weighting scheme uses the maximum maximum distance between countries as the cutoff point, we refer to it as the "maxmax" weight. Finally, column (4) does not weight by distance at all. Here, the weight is:

$$w_y(d_{i,j}) = 1 \quad \forall i \neq j; 0 \text{ otherwise} \quad (16)$$

implying that the spatial lag is the total FDI from all other countries  $j$ .<sup>14</sup> We refer to this as equal weights.

As Table 4 shows, similar to Table 3's column (4) which is repeated in Table 4, the magnitude and significance of the standard gravity model variables change little across the various weighting matrix specifications. Home market proximity also does not change greatly across the various specifications, although in the maxmax results of column (3) it falls outside the standard significance levels. Thus, it appears that this too is reasonably robust to the way in which third country FDI is included in the regression. The spatial lag term, however, is quite dependent on the choice of weighting matrix. Across the five different weighting matrices, the spatial lag is negative twice, insignificant twice, and positive once. Thus, no clear-cut conclusions can be drawn regarding the potential impact or importance of third-country FDI in the OECD data. Although the specification with the highest log-likelihood is the equal-weight specification where the spatial lag is negative and significant, the difference in log-likelihoods is small. Unfortunately, as discussed by Anselin (1988), there is no good mechanism for choosing a preferred weighting matrix.<sup>15</sup> We must therefore conclude that, although the home market proximity effect is reasonably robust in the OECD data, that the same is not true for the spatial lag.

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<sup>14</sup> Note that with this scheme, unlike the others, we do not row standardize. This is because doing so converts this term into average FDI from countries other than  $i$ . By construction, this average is going to be bigger for countries with small amounts of FDI and smaller for countries with large amounts of FDI. This then will tend to lead to a negative coefficient on the spatial lag simply as a result of the variable's construction.

<sup>15</sup> As Anselin (1988) discusses in Chapter 14, depending on the criterion used, the relative ranking of weighting matrices can change dramatically. Furthermore, since choosing a different weighting matrix is tantamount to choosing a different control variable, such comparisons do not have analogies to comparisons between restricted and unrestricted estimations.

### *4.3. European Results*

As illustrated in Figure 1, nearly one-half of US inbound FDI in our sample comes from three countries: Australia, Canada, and Japan. One factor that sets these three countries apart from the others is their geographic isolation since the others are relatively tightly packed into Europe. To examine the extent to which these geographic outliers influence our results, we next restrict our dataset to the European countries as illustrated in Figure 2.<sup>16</sup> In Table 5, we repeat our regressions from Table 3 using this subsample. In column (1), we include only the standard set of gravity model variables. As in the full sample, we find that most FDI comes from large, skilled, open home countries. Unlike the OECD results, home population is insignificant. Also unlike the OECD results, we find that, as in most studies of FDI, distance from the US is a detriment to FDI and that this result is robust to alternative specifications.<sup>17</sup>

Turning to the home market proximity variable, as in OECD regressions, it is positive and significant. A key difference between the European and OECD results, however, is that including home market proximity does impact the coefficients of two gravity model variables – home GDP and home population. In both columns (2) and (4), including home market proximity reduces the point estimate of home GDP by about half. This suggests that, at least in this sample, excluding this variable tends to overstate the importance of the home country's size. In addition, including home market proximity switches the sign of home population from negative to positive. In fact, in column (4), home population becomes significantly positive. Although this latter change is fairly

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<sup>16</sup> In 2000, this subsample comprised two-thirds of total US inbound FDI therefore we are still discussing a large share of overall US inbound FDI.

<sup>17</sup> This change is primarily due to exclusion of Canada from the dataset.

weak (as will be seen in Table 6), it again suggests that including measures of the home market's proximity to additional markets may be important for estimating FDI activity.

Unlike the OECD results, the European data yields a significantly negative spatial lag. This is consistent with a crowding out story in which the presence of multinationals from other countries decreases the net benefit of FDI from the country in question. Comparing columns (3) and (4), this effect grows stronger in both magnitude and significance when the market potential variable is included. Thus, as in Blonigen, et. al. (2004), the exclusion of the geographic outliers tends to increase the magnitude of the estimated spatial lag. Given the estimated spatial lag coefficient in our preferred specification of column (4), a one percent rise in FDI by all other home countries decreases FDI by the remaining home country by 0.85 percent. This suggests that to the extent that crowding out occurs, it happens on a less than one-to-one basis.

In Table 6, we again use four alternative weighting matrices for the spatial lag.<sup>18</sup> Note that both the minmax and the maxmax weights were adjusted to reflect changes in the maximum distances the sample change created. Here, our results change little across the various weighting matrices. In each, home market proximity is significantly positive and the spatial lag is significantly negative. Thus, regardless of how we combine third countries' FDI, we find that more FDI comes from countries nearer to other large markets. Furthermore, our estimates suggest that more FDI from one European country appears to crowd out FDI from another and that this effect is less than one-to-one. The only gravity variable that changes across specifications is the home population which, as noted above, is only significant when using the inverse distance weights.

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<sup>18</sup> As in Table 4, throughout Table 6 we use the same inverse-distance weighting scheme for home market proximity.

Finally, in unreported results, we in turn dropped Belgium, the Netherlands, the Scandinavian countries, and those countries which individually comprised less than one percent of US inbound FDI from Europe.<sup>19</sup> In each of these, we found a positive home market proximity coefficient and a negative spatial lag, both of which were significant at the one percent level. This indicates that the European results are robust to sub-samples within Europe and that the exclusion of the three geographic outliers is the driving force of the difference between the OECD and European samples.

## **5. Conclusion**

The goal of this paper has been to provide some initial insights into how the presence of other home countries might affect how much FDI a particular home country undertakes. This line of thought is intended to complement the existing work on how the presence of additional host countries affects how much FDI a given host receives. Using a simple model, we suggest two avenues for such effects: home market proximity and interaction between FDI from different homes. Using samples of OECD and European FDI into the US, we find strong evidence for a positive effect of home market proximity. However, only in the European subsample do we find a robust effect of FDI from other countries. There, we find that the more FDI that other countries have in the US, the less FDI a given home will have. This would be consistent with increased competition in input or output markets by these other countries' multinationals.

This latter effect suggests that such crowding out appears to be the dominate force at play in the European sample. However, there are two critical caveats that must be

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<sup>19</sup> The Scandinavian countries excluded were Denmark, Norway, Sweden, and Finland. The countries with less than one percent were Portugal, Turkey, Greece, Norway, Spain, Denmark, Finland, Austria and Italy.

noted. First, this is only the net effect from third country FDI. As such it should not be interpreted as implying that no positive production externalities exist. Second, we are dealing with highly aggregated data for the purpose of comparing our results to the bulk of the literature. This level of aggregation may mask important interactions at the industry or firm level that we do not capture. Nevertheless, our hope is that the present results highlight the potential usefulness of considering the impact of other home countries on FDI and that they spur both more detailed theory and empirical work in this area.

**Table 1: Sample of Countries and Number of Years in the Sample**

Country	Years in Sample	Number of Years in the Sample
Australia	1980-2000	21
Austria	1980-2000	21
Belgium	1980-2000	21
Canada	1980-2000	21
Denmark	1980-2000	21
Finland	1980-2000	21
France	1980-2000	21
Germany	1980-2000	21
Greece	1980-84, 1986-2000*	20
Ireland	1980-84, 1986-2000*	20
Italy	1980-2000	21
Japan	1980-2000	21
Netherlands	1980-2000	21
Norway	1980-2000	21
Portugal	1980-83, 1986-89, 1992, 1994-95*	11
Spain	1980-2000	21
Sweden	1980-2000	21
Switzerland	1980-2000	21
Turkey	1984-2000*	17
United Kingdom	1980-2000	21

\* Missing years are due to one of two reasons: either FDI data were censored by the BEA due to confidentiality, or FDI stock reported was zero or negative.

**Table 2: Descriptive Statistics (Full Sample)**

Variable	Mean	Standard Deviation	Minimum	Maximum
FDI	20,895	35,271	1	229,509
Home GDP (\$millions)	482	601	19	3,290
Home Population (thousands)	30,495	31,957	3,401	126,919
Home Trade Costs	0.022	0.012	0.005	0.070
Home Skill	8.479	1.841	3.264	11.860
Home Distance from US (km)	7,018	2,771	734	15,958
Home Market Proximity (\$millions)	1,060	732	58	3,618

**Table 3: Spatial Analysis of US Inbound FDI.**

Independent variable	OLS		Spatial ML	
	(1)	(2)	(3)	(4)
Ln(Home GDP)	2.840 (0.280)***	2.652 (0.288)***	2.790 (0.282)***	2.623 (0.288)***
Ln(Home Population)	-1.039 (0.297)***	-0.911 (0.299)***	-1.016 (0.294)***	-0.899 (0.296)***
Ln(Home Trade Cost)	-2.006 (0.152)***	-1.582 (0.225)***	-1.903 (0.188)***	-1.523 (0.242)***
Ln(Home Skill)	4.469 (0.349)***	4.760 (0.365)***	4.482 (0.345)***	4.760 (0.360)***
Ln(Distance from US in km)	0.174 (0.095)*	0.079 (0.101)	0.147 (0.099)	0.063 (0.104)
Trend	-0.159 (0.037)***	-0.164 (0.036)***	-0.161 (0.036)***	-0.166 (0.036)***
Trend <sup>2</sup>	0.002 (0.001)	0.002 (0.001)	0.001 (0.001)	0.002 (0.002)
Spatially Weighted FDI (i.e., $W*FDI$ )			0.105 (0.116)	0.073 (0.118)
Home Market Proximity		0.230 (0.091)**		0.224 (0.090)**
Constant	-54.127 (2.511)***	-54.602 (2.501)***	-53.572 (2.556)***	-54.205 (2.553)***
Observations	404	404	404	404
Adjusted R <sup>2</sup> /Log-Likelihood	.85	.86	-549.81	-546.75

Standard errors in parentheses.

\* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%

**Table 4: Spatial Analysis of US Inbound FDI—Sensitivity Tests.**

Independent variable	Table 3	Alternative Weighting Matrices			
	(4)	(1)	(2)	(3)	(4)
Ln(Home GDP)	2.623 (0.288)***	2.496 (0.294)***	2.651 (0.285)***	2.647 (0.281)***	2.477 (0.279)***
Ln(Home Population)	-0.899 (0.296)***	-0.781 (0.301)***	-0.909 (0.296)***	-0.930 (0.292)***	-0.868 (0.287)***
Ln(Home Trade Cost)	-1.523 (0.242)***	-1.387 (0.242)***	-1.576 (0.235)***	-1.669 (0.223)***	-1.449 (0.218)***
Ln(Home Skill)	4.760 (0.360)***	4.806 (0.359)***	4.761 (0.361)***	4.669 (0.358)***	4.398 (0.358)***
Ln(Distance from US)	0.063 (0.104)	-0.015 (0.110)	0.075 (0.114)	0.163 (0.105)	0.065 (0.097)
Trend	-0.166 (0.036)***	-0.170 (0.036)***	-0.165 (0.037)***	-0.131 (0.038)***	0.033 (0.053)
Trend <sup>2</sup>	0.002 (0.002)	0.002 (0.001)	0.002 (0.001)	0.004 (0.002)**	0.002 (0.001)
Spatially Weighted FDI (i.e., $W*FDI$ )	0.073 (0.118)	0.143 (0.072)**	0.007 (0.088)	-0.444 (0.181)**	-0.068 (0.014)***
Home Market Proximity	0.224 (0.090)**	0.312 (0.098)***	0.236 (0.112)**	0.118 (0.100)	0.221 (0.087)**
Constant	-54.205 (2.553)***	-54.116 (2.470)***	-54.681 (2.667)***	-49.915 (3.102)***	-42.092 (3.486)***
Observations	404	404	404	404	404
Adjusted R <sup>2</sup> /Log-Likelihood	-546.75	-544.97	-546.93	-543.71	-535.05

Standard errors in parentheses.

\* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%

**Table 5: Spatial Analysis of US Inbound FDI from European OECD.**

Independent variable	OLS		Spatial ML	
	(1)	(2)	(3)	(4)
Ln(Home GDP)	1.782 (0.297)***	0.968 (0.285)***	1.832 (0.293)***	0.907 (0.260)***
Ln(Home Population)	-0.082 (0.307)	0.302 (0.282)	-0.076 (0.302)	0.444 (0.258)*
Ln(Home Trade Cost)	-1.729 (0.192)***	-0.384 (0.234)	-1.926 (0.220)***	-0.716 (0.219)***
Ln(Home Skill)	4.915 (0.370)***	4.626 (0.337)***	4.925 (0.363)***	4.575 (0.307)***
Ln(Distance from US in km)	-4.350 (0.554)***	-3.317 (0.516)***	-4.606 (0.564)***	-3.972 (0.482)***
Trend	-0.108 (0.038)***	-0.173 (0.036)***	-0.100 (0.038)***	-0.164 (0.033)***
Trend <sup>2</sup>	0.002 (0.002)	0.005 (0.001)***	0.003 (0.002)*	0.008 (0.001)***
Spatially Weighted FDI (i.e., $W*FDI$ )			-0.224 (0.130)*	-0.849 (0.134)***
Home Market Proximity		1.638 (0.191)***		2.142 (0.191)***
Constant	-3.717 (6.509)	-28.527 (6.564)***	-1.606 (6.507)	-28.152 (5.984)***
Observations	341	341	341	341
Adjusted R <sup>2</sup> /Log-Likelihood	.86	.89	-449.09	-397.25

Standard errors in parentheses.

\* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%

**Table 6: Spatial Analysis of US Inbound FDI—Sensitivity Tests from European OECD.**

Independent variable	Table 5	Alternative Weighting Matrices			
	(4)	(1)	(2)	(3)	(4)
Ln(Home GDP)	0.907 (0.260)***	1.212 (0.270)***	1.753 (0.332)***	1.184 (0.277)***	0.874 (0.274)***
Ln(Home Population)	0.444 (0.258)*	0.066 (0.267)	-0.467 (0.328)	0.021 (0.278)	0.298 (0.270)
Ln(Home Trade Cost)	-0.716 (0.219)***	-0.534 (0.220)**	-0.498 (0.225)**	-0.393 (0.223)*	-0.316 (0.225)
Ln(Home Skill)	4.575 (0.307)***	4.412 (0.317)***	4.260 (0.334)***	4.335 (0.329)***	4.318 (0.330)***
Ln(Distance from US)	-3.972 (0.482)***	-4.783 (0.559)***	-5.322 (0.692)***	-4.700 (0.612)***	-3.184 (0.495)***
Trend	-0.164 (0.033)***	-0.157 (0.033)***	-0.194 (0.034)***	-0.125 (0.036)***	-0.043 (0.045)
Trend <sup>2</sup>	0.008 (0.001)***	0.007 (0.001)***	0.007 (0.001)***	0.007 (0.001)***	0.005 (0.001)***
Spatially Weighted FDI (i.e., $W*FDI$ )	-0.849 (0.134)***	-0.752 (0.146)***	-0.400 (0.097)***	-0.721 (0.190)***	-0.061 (0.013)***
Home Market Proximity	2.142 (0.191)***	1.808 (0.181)***	1.561 (0.183)***	1.450 (0.188)***	1.571 (0.183)***
Constant	-28.152 (5.984)***	-16.078 (6.578)**	-13.371 (7.267)*	-8.335 (8.207)	-19.842 (6.575)***
Observations	341	341	341	341	341
Adjusted R <sup>2</sup> /Log-Likelihood	-397.25	-403.08	-407.99	-408.69	-406.40

Standard errors in parentheses.

\* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%

Figure 1: Sample of OECD.

Sample countries included: Australia, Austria, Belgium, Canada, Denmark, France, Germany, Greece, Ireland, Italy, Japan, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, United Kingdom.

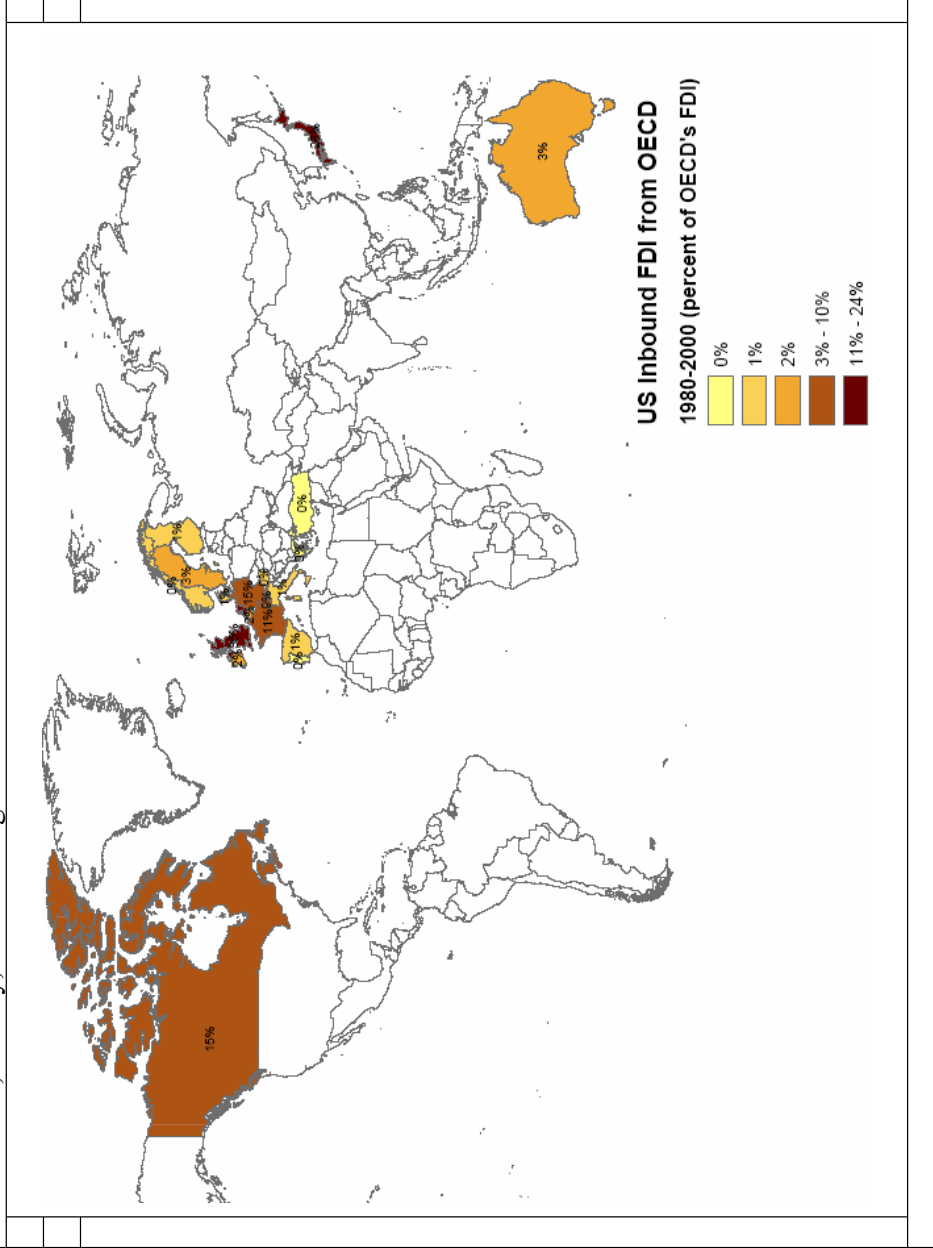
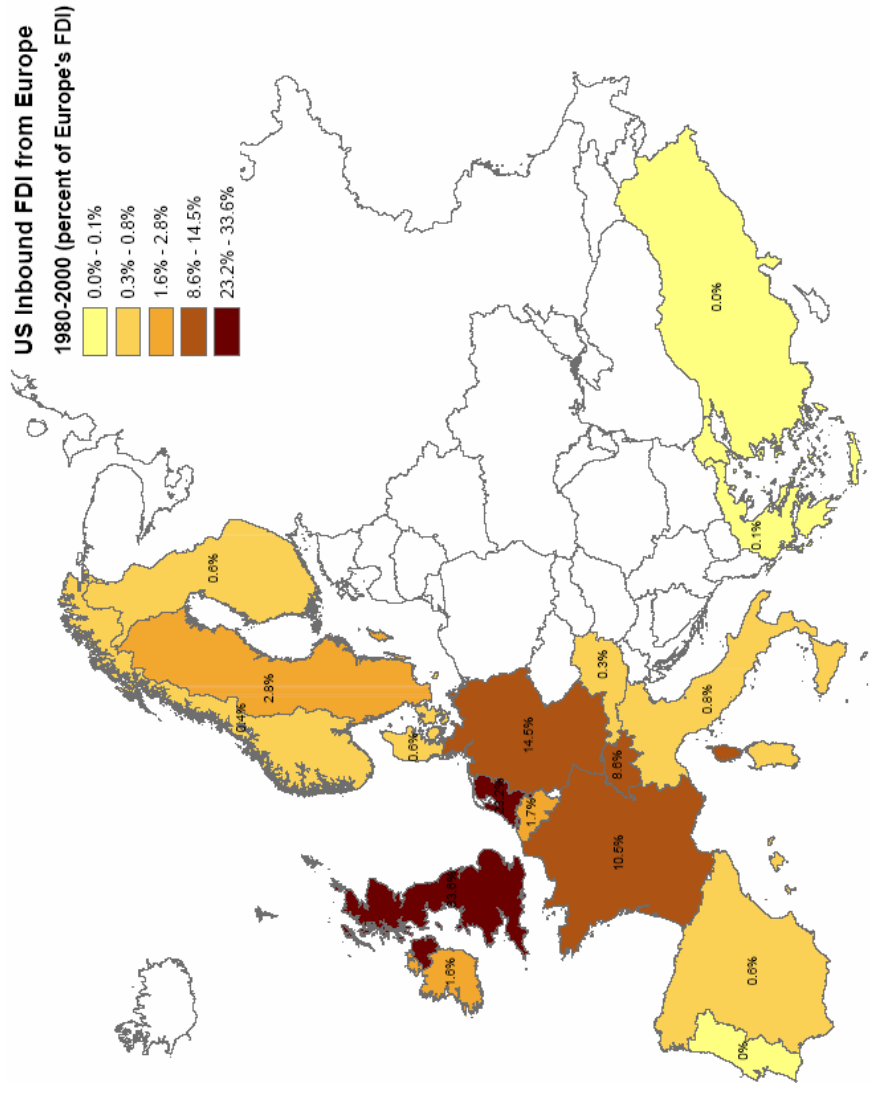


Figure 2: Sample of European OECD.

Sample countries included: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, United Kingdom.



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