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An Assignment Theory of Foreign Direct Investment

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We develop an assignment theory to analyse the volume and composition of foreign direct investment (FDI). Firms conduct FDI by either engaging in greenfield investment or in cross-border acquisitions. Cross-border acquisitions involve firms trading heterogeneous corporate assets to exploit complementarities, while greenfield FDI involves setting up a new production division in the foreign country. In equilibrium, greenfield FDI and cross-border acquisitions coexist within the same industry, but the composition of FDI between these modes varies with firm and country characteristics. Firms engaging in greenfield investment are systematically more efficient than those engaging in cross-border acquisitions. Furthermore, most FDI takes the form of cross-border acquisitions when production-cost differences between countries are small, while greenfield investment plays a more important role for FDI from high-cost into low-cost countries. These results capture important features of the data.

1. INTRODUCTION

Multinational enterprises (MNEs) play a dominant role in an increasingly globalized world. In 1999, the domestic operations of the approximately 2400 U.S. multinational enterprises (MNEs) accounted for approximately 26% of U.S. GDP, 63% of U.S. exports, 37% of U.S. imports, and 68% of U.S. R&D expenditures (Mataloni and Yorgason, 2002). That year, nearly half of all U.S. manufacturing workers were employed by U.S. multinationals.

Despite their economic importance, the investment decisions of multinationals are not yet well understood. With few exceptions, the trade literature has not distinguished between the two modes in which a MNE can engage in foreign direct investment (FDI): cross-border acquisition (entering a foreign market by buying an existing enterprise) and greenfield FDI (entering a foreign market by building a new enterprise). Consequently, the literature has been preoccupied with understanding the volume of FDI, neglecting its composition across modes.

As we show in this paper, the two modes of FDI differ significantly in both the characteristics of the firms that engage in these modes as well as in the characteristics of the host countries in which firms invest. First, U.S. parent firms that favour greenfield investment over cross-border acquisition are systematically more efficient than those firms that choose cross-border acquisitions. Second, a U.S. parent firm is more likely to favour cross-border acquisition over greenfield investment the more developed is the host country. Third, a U.S. parent firm is more likely to favour greenfield investment over cross-border acquisition the greater is the geographical proximity of the host country to the U.S. These findings show that MNEs do not view cross-border acquisitions and greenfield FDI as perfect substitutes. Any change in policies towards FDI is likely to affect cross-border acquisitions and greenfield FDI differently. Therefore, the volume of FDI cannot fully be understood without first understanding its composition.

In this paper, we develop an assignment theory of FDI to explain multinationals' FDI mode choice. According to much of the business literature, acquisitions allow firms to exploit complementarities in their assets. This view of mergers and acquisitions is in line with the fact that more than half of all mergers and acquisitions in the U.S. involve trade in individual plants and divisions rather than entire corporations; see Maksimovic and Phillips (2001). These observations show that firms are in the business of buying and selling corporate assets and that these assets are heterogeneous and complementary. Indeed, as Caves (1998, p. 1963) points out:

> For the reshuffling of plants (or lines of business) among firms to be productive, there must be sources of heterogeneity. [...] These heterogeneities cause assets' productivities to vary substantially depending on the other business assets with which they collaborate within the firm.

We therefore model the merger market as a market in which heterogeneous firms buy and sell heterogeneous corporate assets to exploit complementarities. In our model, there are two types of corporate assets: one embodied in the headquarter (entrepreneur), the other embodied in the production division. The equilibrium of the merger market induces an assignment of production divisions to headquarters. Because the assets embodied in headquarters and production divisions are complementary in generating profits, the equilibrium involves positive assortative matching within each country: better production divisions will be managed by better headquarters.

In our model, a cross-border acquisition involves purchasing a foreign production division that the acquirer lacks. Greenfield FDI, on the other hand, involves relocating an existing production division to the foreign country so as to allow the firm to deploy its corporate assets abroad. There are two countries that can freely trade with one another. Motivated by our empirical finding that the host country's level of development is an important determinant of FDI mode choice, we assume that countries differ in wage levels, labour productivity, and in the distributions of entrepreneurial abilities (or some other corporate assets). These wage and productivity differences give rise to an incentive for headquarters to relocate their production division from the high-cost to the low-cost country. But since relocating production is costly, only the best production divisions will be relocated to the low-cost country. The wage and productivity differences between countries also imply that otherwise identical production divisions have different values, depending on the country in which they are located. This, in turn, will affect the equilibrium assignment of production divisions to headquarters. In equilibrium, a production division located in the high-cost country will be managed by a worse headquarter than an otherwise identical production division located in the low-cost country. Hence, in our model, wage and productivity differences give rise to both greenfield FDI (from the high-cost to the low-cost country) and to cross-border acquisitions (from each country to the other). Cross-country differences in entrepreneurial abilities give rise only to cross-border acquisitions (from each country to the other). Our model thus generates (potentially large) two-way FDI flows even in the absence of transport costs and production-cost differences between countries.

Our model gives rise to a rich set of empirical predictions. (1) As production-cost differences become small, almost all FDI takes the form of cross-border acquisitions. This prediction is consistent with our empirical finding that the share of cross-border acquisition in total U.S. FDI is increasing in the host country's level of development: production-cost differences between the U.S. and rich, developed countries are arguably much smaller than between the U.S. and poor, developing countries. (2) The propensity of firms in the high-cost country to engage in cross-border acquisitions rather than greenfield FDI is decreasing in the relative supply of corporate assets in the low-cost country. To the extent that poor, developing countries have fewer attractive corporate assets than rich, developed countries, this result is also consistent with our empirical finding. (3) An increase in the cost of setting up a new production division results in an increase in the share of cross-border acquisitions in total FDI from the high-cost to the low-cost country. To the extent that such costs are decreasing with the geographical proximity of the host country, this prediction holds true in the data. (4) Firms engaging in greenfield FDI are, on average, more efficient than those engaging in cross-border acquisitions. As we will show, this is consistent with the data on U.S. outward FDI. (5) The volume of cross-border acquisitions is governed by a gravity-type equation. In a recent paper, Head and Ries (2007) show that the data on cross-border acquisitions fit well such a gravity-type equation. (6) By permitting a re-assignment of corporate assets across countries, cross-border acquisitions induce a magnification of the underlying cost differences between countries.

1.1. *Related literature*

Our paper is mainly related to two strands in the theoretical trade literature. A feature common to both strands, and shared by our paper, is the assumption that contracting problems prevent arm's-length relationships.[1]

In our model, FDI arises because of underlying differences across countries. Since there are no trade costs, there is a tendency for each firm to locate production in only one country. It is this feature that our paper shares with the literature on "vertical FDI" (*e.g.* Helpman, 1984; Neary, 2007). Indeed, recent empirical work by Hanson, Mataloni and Slaughter (2003) documents a tendency for multinationals to concentrate production in low-wage countries. None of the papers on vertical FDI consider FDI mode choice. In Helpman (1984), there is only greenfield FDI, while in Neary (2007), there are only cross-border acquisitions (motivated by market power). Unlike Helpman (1984) and Neary (2007), our model generates two-way FDI flows.

Our paper is also related to the recent and growing literature on firm heterogeneity, which is concerned with the selection of heterogeneous firms into different modes of serving global markets. We extend this literature by introducing an international merger market. Within this literature, the two papers that are most closely related to ours are Helpman, Melitz and Yeaple (2004) and Nocke and Yeaple (2007).[2] However, in Helpman *et al.* (2004) there is no motive for firms to engage in cross-border acquisitions, and so greenfield is the only mode of FDI. On the other hand, Nocke and Yeaple (2007) consider cross-border acquisitions but analyse the interaction between trade costs (which are absent in the present model) and the source of firm heterogeneity (mobile vs. non-mobile capabilities). In the present paper, we are able to analyse general heterogeneity in all corporate assets, which is precluded by the presence of trade costs in Nocke and Yeaple (2007). Another benefit of abstracting from trade costs in the present paper is that it allows us to analyse large country differences.

A key feature of our model is that each firm consists of a set of tangible and intangible assets that are complementary in generating profits. There are some recent papers that share this feature. For instance, in Jovanovic and Braguinsky (2004) a firm consists of a manager and a project, both of which may differ in their qualities. A merger allows firms to exploit complementarities between managers and projects. In Gabaix and Landier (2007), the gross profit of a firm is the product of its exogenous size and the talent of its CEO. In labour market equilibrium, more talented CEOs are assigned to larger firms. Antras, Garicano and Rossi-Hansberg (2006) analyse

1. There is, however, an interesting recent literature that explores the trade-offs between in-house production and outsourcing; see Antras (2003), Antras and Helpman (2004), and Grossman and Helpman (2004).

2. Other papers in the literature on firm heterogeneity include Melitz (2003), Bernard, Eaton, Jensen and Kortum (2003), and Eaton, Kortum and Kramarz (2004).

a model of the assignment of heterogeneous agents into international teams. None of these papers is concerned with FDI.

1.2. *Plan of the paper*

In the next section, we present new empirical facts on FDI mode choice of U.S. parent firms. In Section 3, we present our assignment model. Then, in Section 4, we derive the equilibrium assignment of corporate assets and the equilibrium location of production. Further, we explore the implications of the assignment for the distribution of firm efficiencies across countries. In Section 5, we solve for the FDI flows implied by the equilibrium assignment and location decisions. We show that greenfield FDI and cross-border acquisitions coexist but that, in the limit as production-cost differences vanish, all FDI takes the form of cross-border acquisitions and its volume is characterized by a gravity-type equation. Next, in Section 6, we analyse the link between firm characteristics and FDI mode choice. We show that firms engaging in greenfield FDI are systematically more efficient than those engaging in cross-border acquisitions. Then, in Section 7, we investigate the relationship between country and industry characteristics on the one hand and the composition of FDI on the other. For instance, we show that the fraction of cross-border acquisitions in total FDI from the high-cost country to the low-cost country is increasing with the cost of setting up a foreign production division. In Section 8, we discuss some key assumptions of our model. We conclude in Section 9.

2. SOME EMPIRICAL FACTS

Little is known about firms' choice between the two modes of FDI, greenfield investment and cross-border acquisition. In this section, we show that there is systematic variation in the mode choice of U.S. multinationals. First, U.S. multinationals engaging in greenfield investment are, on average, more efficient than those engaging in cross-border acquisition. Second, U.S. multinationals are more likely to choose cross-border acquisition over greenfield investment the more developed is the host country. Third, U.S. multinationals are less likely to choose cross-border acquisition over greenfield investment the larger is the geographical proximity of the host country to the U.S. All three empirical facts are consistent with the theory presented in this paper.

2.1. *Specification*

We estimate a logit model of U.S. parent firms' mode choice. The dependent variable y_{ijkl} takes the value of 1 if parent firm i in parent industry j acquires an existing foreign enterprise in industry k and country l and takes the value of 0 if that investment is conducted via greenfield. The latent model relates the propensity to favour cross-border acquisition over greenfield FDI to a linear index function of a set of parent firm characteristics and a set of host country characteristics.[3]

2.2. *Data*

Using data from the Bureau of Economic Analysis (BEA) for the years 1994–1998, we relate U.S. parent firms' mode choice to the efficiency of these parent firms and to the characteristics of the host countries in which they are investing. (For the description of the data, the reader is referred to the Appendix.) Since standard models of firm heterogeneity predict that more efficient firms

3. As a robustness check, we also estimated the index function via OLS (linear probability model). The results were qualitatively similar.

have larger sales, we use the logarithm of sales of the U.S. parent firm in the U.S. (USSALE) to measure the efficiency of the U.S. multinational. As a robustness check, we use the logarithm of the parent firm's value-added per employee (VADDPW) as an alternative efficiency measure. When using VADDPW as our measure of firm efficiency, we control for firm size using EMP, the number of workers employed by the parent.[4]

In our analysis, we control for other characteristics of the U.S. parent firms that might be correlated with firm efficiency. First, we include RDSALE, which is the logarithm of a firm's R&D expenditures to its total sales. Second, we include DIV, which is a measure of a firm's diversification across industries.[5] Third, to quantify a parent firm's previous experience in a foreign country, we include an indicator variable, EXP, which is equal to 1 if the parent firm owned an enterprise in that country prior to the sample period and is 0 otherwise. Fourth, we include the variable INTRAIM, which is the ratio of a parent firm's intra-firm imports to total imports so as to measure the extent of the firm's international vertical integration. Finally, since large firms invest in many countries, we control for the logarithm of the number of countries in which the U.S. parent firm owns affiliates, COUNT. All parent firm characteristics are from 1994, the first year of our sample.

Our primary interest with respect to the characteristics of the host country is that country's level of development. We measure a host country's level of development by the logarithm of its real GDP *per capita*, RGDPPC. We control for the host country's size using POP, the logarithm of the size of its population. Since the U.S. parent firm's mode choice is likely to be affected by the host country's trade policies, we include OPEN, the logarithm of the ratio of the sum of exports and imports to GDP. The aforementioned country-level data are from 1994 and are taken from the Summers and Heston data set. To allow for the possibility that the relative cost of the two modes of FDI varies with geographical proximity of the host country, we include DIST, the logarithm of the distance between the U.S. and the host country.[6]

2.3. *Results*

The results are shown in Table 1, where the heading of each column indicates the measure of productivity used in that specification. The columns are organized by the number of controls included in the analysis with the first two corresponding to the most parsimonious specifications, the next two corresponding to specifications including the firm-level controls, and the last two corresponding to specifications that also include fixed effects by affiliate industry and by host country. All six specifications include parent industry fixed effects. Standard errors (shown in parentheses) are robust to heteroskedasticity and clustering by firm.

In all six specifications, the coefficient of the efficiency measure is negative and statistically significant: efficient firms enter foreign markets through greenfield FDI rather than through cross-border acquisition. This relationship holds true even after controlling for a wide range of parent characteristics and after including fixed effects by parent industry, affiliate industry, and host country.

4. The correlation between USSALES and VADDPW is 0·46.

5. DIV is defined as

$$\log\left(\sum_j s_{pj}^2\right)^{-1},$$

where s_{pj} is the share of the parent firm's sales in industry j, and the sum is over the eight largest industries in which the parent firm sells.

6. The data is taken from Andrew Rose's website, http://faculty.haas.berkeley.edu/arose/. We thank a referee for suggesting this variable.

TABLE 1

Greenfield FDI vs. cross-border acquisitions as a function of firm and host country characteristics

	(1) USSALE	(2) VADDPW	(3) USSALE	(4) VADDPW	(5) USSALE	(6) VADDPW
Efficiency	−0·217**	−0·967**	−0·268**	−1·152**	−0·300**	−1·428**
	(0·076)	(0·312)	(0·108)	(0·427)	(0·151)	(0·548)
EMP		−0·147*		−0·110		−0·097
		(0·076)		(0·118)		(0·185)
DIV			−0·078	−0·348	−0·547	−0·910*
			(0·316)	(0·320)	(0·420)	(0·481)
RDSALE			0·088	0·113	0·023	0·042
			(0·139)	(0·154)	(0·186)	(0·203)
EXP			0·308	0·289	0·744**	0·767**
			(0·242)	(0·243)	(0·303)	(0·309)
INTRAIM			−0·291	−0·593	−0·915	−1·295*
			(0·447)	(0·500)	(0·622)	(0·709)
COUNT			−0·166	−0·051	−0·222	−0·077
			(0·105)	(0·114)	(0·145)	(0·160)
RGDPPC	0·768**	0·745**	0·686**	0·691**		
	(0·172)	(0·165)	(0·187)	(0·185)		
POP	0·049	0·070	0·006	0·023		
	(0·092)	(0·096)	(0·100)	(0·103)		
OPEN	−0·656**	−0·590**	−0·652**	−0·638**		
	(0·187)	(0·191)	(0·203)	(0·209)		
DIST	0·199	0·256*	0·377**	0·400**		
	(0·130)	(0·133)	(0·156)	(0·154)		
FE: Parent industry	Yes	Yes	Yes	Yes	Yes	Yes
FE: Affiliate industry	No	No	No	No	Yes	Yes
FE: Host country	No	No	No	No	Yes	Yes
Observed	856	849	724	725	627	628
Log-likelihood	−487·5	−478·2	−407·7	−403·9	−278·8	−276·1

Notes: S.E. (shown in parentheses) are robust to heteroskedasticity and allow for clustering by parent firm. The efficiency measure corresponding to each specification is shown under the column number.
* Significance level at 10%
** Significance level at 5%.

Turning to country characteristics, in all six specifications, the coefficient on RGDPPC is positive and statistically significant: U.S. parent firms tend to enter rich, developed countries through cross-border acquisition rather than through greenfield FDI. Further, the coefficient on DIST is positive and statistically significant in three out of four specifications: U.S. parent firms are more likely to favour cross-border acquisition over greenfield investment, the farther is the host country, indicating that the relative cost of the two modes varies with geographical proximity.[7] (Note that all country-level variables drop out after including fixed effects by host country.)

7. We also experimented with another proximity variable, BORDER, that takes the value of 1 if the U.S. shares a common border with the host country. When DIST is replaced by BORDER, the coefficient on the latter is negative and statistically significant. Because of the multicollinearity of DIST and BORDER in our sample, which has only one source country (the U.S.), the two proximity variables cannot be identified separately.

3. THE MODEL

We consider a general-equilibrium model of the world economy. There are two countries, 1 and 2, that can freely trade with one another. There are no transport costs or tariffs, and so arbitrage implies that the price of each good is the same in both countries.

3.1. *Consumers*

The world is populated by a unit mass of consumers with identical CES preferences. The representative consumer's utility function is given by

$$U = \ln\left[\int_{\Psi} m(\psi)^{1/\sigma} x(\psi)^{(\sigma-1)/\sigma} d\psi\right]^{\sigma/(\sigma-1)} + y, \tag{1}$$

where $x(\psi)$ is consumption of good $\psi \in \Psi$, y is the consumption of the outside good, $m(\psi)$ is a parameter that measures the weight of good ψ in the utility function, and $\sigma > 1$ is the elasticity of substitution between goods. Since goods with a larger weight in the utility function will, at equal prices, be consumed in larger volumes, we will henceforth refer to $m(\psi)$ as the "market size" of good ψ.[8] We assume that consumer income is sufficiently large so that the representative consumer spends a positive fraction of her income on the outside good.

3.2. *Outside good industry*

Firms in the outside good industry have a constant returns-to-scale technology and behave as price takers. Assuming that the outside good is produced in each country, the wage in country i, ω_i, is pinned down by the world price of the outside good and labour productivity in that industry in country i.[9] Since the outside good industry will not play any further role, we will henceforth focus on the differentiated goods industry.

3.3. *Firms*

In the differentiated goods industry, a firm consists of two divisions: a headquarter division and a production division. The headquarter division is a tuple $(\widetilde{a}, j)$, consisting of one (unique) entrepreneur of ability $\widetilde{a}$ from country j. An entrepreneur's ability $\widetilde{a}$ may be thought of as productivity-enhancing headquarter services that can be provided independently of the location of production but only within the firm. Equivalently, $\widetilde{a}$ may be interpreted as the "organizational capital" of the headquarter division. The headquarter of the firm is always located in the firm's (entrepreneur's) home country j. The production division is a tuple (m, i), consisting of property rights over the production of a good with market size m and a plant designed to produce exclusively that good in country i. Each firm $\{(\widetilde{a}, j), (m, i)\}$ can produce (at most) one good, using entrepreneurial ability $\widetilde{a}$ and labour.

There are two types of costs. First, there is a constant unit cost of production that is decreasing in the entrepreneur's ability and increasing in the wage level. In particular, firm $\{(\widetilde{a}, j), (m, i)\}$ can produce any one unit of its good using $(\eta_i \widetilde{a})^{-1}$ units of labour in country i, where η_i is labour

8. As one referee suggested to us, variation in the market size of goods may be due to goods being at different stages in their life cycle.

9. This assumption is common in the literature on market structure in international trade, for example, Antras and Helpman (2004), Grossman and Helpman (2004), and Melitz and Ottaviano (2005). An immediate implication of this assumption is that there are no general equilibrium effects that work through factor markets.

productivity in country i. Hence, the firm's unit cost of production is given by $\omega_i(\eta_i\widetilde{a})^{-1}$, where ω_i denotes the wage rate in country i. Second, there is a fixed cost of relocating a production division. Setting up a (good-specific) production division in country i requires ϕ/η_i units of labour from country i. For simplicity, we abstract from costs of headquarter services; but see our discussion in Section 8.

For notational convenience, we will henceforth use the following (monotone) transform of the entrepreneur's ability: $a \equiv \widetilde{a}^{\sigma-1}$.

3.4. *Endowments of firms*

In country i, there is a fixed mass E_i of firms. Each firm in country i is initially endowed with (i) a headquarter division (a, i), (ii) a production division (m, i) that includes the property rights over the production of a unique good with market size m and a plant to produce that good in country i.

Goods differ in their market sizes. In each country, $H(m)$ denotes the fraction of goods with market size less than or equal to m. We allow for cross-country differences in the distribution of endowments with entrepreneurial abilities. In country i, $G_i(a)$ denotes the fraction of entrepreneurs of ability less than or equal to a. The distribution function of entrepreneurial abilities in the world is then $G(\cdot) \equiv (E_1G_1(\cdot) + E_2G_2(\cdot))/(E_1 + E_2)$. All distribution functions are continuously differentiable and strictly increasing on $[0, \infty)$. The associated density functions are denoted by h, g_i, and g, respectively. We make no further assumption on the joint distribution of m and a across firms.

3.5. *Merger market*

There exists a perfectly competitive global market for corporate assets in which firms (headquarters) can buy and sell production divisions. Indeed, as discussed in the introduction, more than half of all M&A activity in the U.S. involves acquisitions and divestitures of divisions rather than entire firms. Let $W_i(m)$ denote the market price of a production division in country i for a good with market size m. The value of the headquarter (a, i), $i \in \{1, 2\}$, is denoted $V(a)$. (Note that $V(a)$ is independent of the headquarter's location i since the headquarter can manage equally well a production division in either country and since, for now, we abstract from headquarter costs.)

3.6. *Foreign direct investment*

Since there are no transport costs and tariffs, each firm will choose to produce in only one country and export to the other country. However, a firm may decide to manage a production division abroad. There are two modes of FDI: greenfield FDI and cross-border acquisition. A firm from country i engages in *greenfield FDI* if (i) it manages a production division that originated in country i, and (ii) it relocates that production division to country $k \neq i$.[10] A firm (or entrepreneur) from country i engages in a *cross-border acquisition* if it acquires a production division from a firm originating in the other country k. Since greenfield FDI from country i to country j requires building a new production division in country j, this form of FDI involves incurring the fixed cost $\omega_j\phi/\eta_j$. In contrast, since a cross-border acquisition involves only a change of ownership

10. A firm engaging in greenfield FDI may not necessarily manage the production division with which it was initially endowed as the firm may have divested its production division and acquired a different one from some other domestic firm.

of an existing production division and since the merger market is assumed to be frictionless, the only type of fixed cost associated with this form of FDI is the endogenous market price of the acquired production division.

3.7. *Timing*

The sequence of moves is as follows. First, firms trade production divisions in the merger market. Second, each firm decides where to locate its production division. Third, firms set prices, and consumers make their purchasing decisions.

4. EQUILIBRIUM ASSIGNMENT

In this section, we turn to the equilibrium analysis of our model. We assume that, in equilibrium, country 2 is the low-cost location of production: $\omega_2/\eta_2 < \omega_1/\eta_1$, where ω_i is the wage rate in country i. For notational simplicity, we set $\omega_2/\eta_2 \equiv 1$. We solve the model backwards. First, we solve the consumer's choice problem. Second, we solve a firm's pricing problem and derive its equilibrium profit as a function of its assets. Third, we consider a firm's choice of location of production. Fourth, we analyse firms' buying and selling decisions in the market for production divisions. Finally, and most importantly, we characterize equilibrium.

4.1. *Consumer's choice problem*

Solving the representative consumer's utility maximization problem, we obtain the following demand for good ψ:

$$x(\psi) = \frac{m(\psi)p(\psi)^{-\sigma}}{\int_{\Psi} m(\psi')p(\psi')^{1-\sigma}d\psi'},$$

where $p(\psi)$ is the price of good ψ.

4.2. *A firm's pricing problem*

Profit maximization implies that each firm charges a fixed mark-up, and so the consumer price of good ψ, when produced in country i, is given by $p(\psi) = c_i(\psi)\sigma/(\sigma-1)$, where $c_i(\psi)$ is the unit cost of production.[11] The gross profit of a firm producing good ψ in country i is then given by $Sm(\psi)c_i(\psi)^{1-\sigma}$, where the mark-up-adjusted residual demand level S is given by

$$S = \left[\sigma \int_{\Psi} m(\psi)c_i(\psi)^{1-\sigma}d\psi\right]^{-1}. \tag{2}$$

Writing gross profit as a function of entrepreneurial ability a, market size m, demand level S, and location of production i, we have:

$$\Pi_i(a,m) = \begin{cases} \theta Sam & \text{for } i=1, \\ Sam & \text{for } i=2, \end{cases} \tag{3}$$

11. The consumer price of good ψ is independent of $m(\psi)$, while demand is increasing in $m(\psi)$, holding the consumer price fixed. This shows that the preference parameter $m(\psi)$ should indeed be interpreted as the good's "market size" rather than quality: some goods are consumed more frequently or in larger quantities than others, and such differences are intrinsic to the goods rather than the producers.

where $\theta \equiv (\omega_1/\eta_1)^{1-\sigma}$. The parameter $\theta < 1$ captures the cost disadvantage of producing in country 1. Note that the profit is independent of the location of the firm's headquarter. Note also that $\Pi_i(a,m)$ is supermodular in a and m. This reflects the complementarity between the firm's entrepreneurial ability and the market size of the good produced by that firm: the larger the market size of the good produced, the larger is the cost saving associated with an increase in the firm's entrepreneurial ability.

4.3. *A firm's location decision*

Consider a firm of type $\{(a,j),(m,i)\}$. If this firm produces in country i, where its existing production division is located, then its profit is $\Pi_i(a,m)$. If instead it chooses to produce in country $k \neq i$, its profit is $\Pi_k(a,m) - \phi\omega_k/\eta_k$. Since $\Pi_1(a,m) < \Pi_2(a,m)$, a firm with production facilities in the low-cost country 2 will always want to produce in that country. Hence, there is no greenfield FDI into the high-cost country 1. In contrast, if the existing production facilities are in country 1, then the firm will move production to the low-cost country 2 if and only if m is sufficiently large.[12]

4.4. *A firm's acquisition decision in the merger market*

Since the market for production divisions is frictionless, we can think of each firm divesting the production division with which it was endowed and acquiring another production division. The value of firm $\{(a,i),(m,i)\}$ is equal to the sum of the value of its headquarter and the value of the production division with which the firm was endowed, $V(a) + W_i(m)$. The value of the headquarter is

$$V(a) = \max\left\{\max_{m'}\left[\theta Sam' - W_1(m')\right], \max_{m'}\left[Sam' - W_1(m') - \phi\right], \max_{m'}\left[Sam' - W_2(m')\right]\right\}, \tag{4}$$

where the first term in brackets corresponds to the option of acquiring a production division in country 1 and producing in country 1, the second term corresponds to the option of acquiring a production division in country 1 but relocating production to country 2, while the last term corresponds to the option of acquiring a production division in country 2 and producing in country 2. Depending on the country of origin of the firm, each acquisition may either be a domestic acquisition or else a cross-border acquisition.

4.5. *Equilibrium in the merger market*

So far, we have considered the decision problems of individual firms. We now turn to the equilibrium in the market for production divisions. Our analysis proceeds in two steps. First, we derive some properties of the equilibrium price schedules for production divisions, $W_1(\cdot)$ and $W_2(\cdot)$. Second, we derive the equilibrium assignment of production divisions to headquarters (or entrepreneurs) and characterize the equilibrium location of the production divisions.

The following lemma is an immediate implication of clearing in the market for production divisions.

12. If the production division $(m,1)$ was previously acquired by a domestic firm with headquarter division $(a,1)$, the relocation of production to country 2 constitutes greenfield FDI. If, however, the production division $(m,1)$ was previously acquired by a foreign firm with headquarter division $(a,2)$, then the acquisition of the production division constitutes a cross-border acquisition while the relocation of production to country 2 is not FDI.

Lemma 1. *The equilibrium price schedule $W_i(\cdot)$ is*

(i) *strictly increasing,*
(ii) *continuous,*
(iii) *weakly convex, and*
(iv) *satisfies $W_i(0) = 0$.*

Proof. See Appendix. ||

Let Δ_{11} denote the set of m's associated with production divisions that originated in country 1 and will remain in country 1 and Δ_{12} those that will be relocated to country 2. Since $\Pi_1(a,m) = \Pi_2(a,\theta m)$ and since the fixed cost of relocating production to country 2 is ϕ, clearing in the merger market implies the following link between the equilibrium prices for production divisions originating in the two countries:

$$W_1(m) = \begin{cases} W_2(\theta m) & \text{if } m \in \Delta_{11}, \\ W_2(m) - \phi & \text{if } m \in \Delta_{12}. \end{cases} \tag{5}$$

The following lemma characterizes the sets Δ_{11} and Δ_{12}.

Lemma 2. *There exists a market size threshold $\overline{m} > 0$ such that $\Delta_{11} = [0,\overline{m}]$ and $\Delta_{12} = [\overline{m},\infty)$. That is, production division $(m,1)$ will remain in country 1 if $m < \overline{m}$ and will be relocated to country 2 if $m > \overline{m}$.*

Proof. See Appendix. ||

We now turn to the equilibrium assignment of production divisions to headquarters (or entrepreneurs). Let $a_i(m)$ denote the entrepreneurial type that will, in equilibrium, acquire production division (m,i). From (4), the first-order conditions of a firm's acquisition decision imply

$$a_1(m) = \begin{cases} \frac{W_1'(m)}{\theta S} & \text{if } m \in [0,\overline{m}], \\ \frac{W_1'(m)}{S} & \text{if } m \in [\overline{m},\infty), \end{cases} \tag{6}$$

and

$$a_2(m) = \frac{W_2'(m)}{S} \text{ for all } m \geq 0. \tag{7}$$

From (5), (6), and (7), it follows that

$$a_1(m) = \begin{cases} a_2(\theta m) & \text{if } m \in [0,\overline{m}], \\ a_2(m) & \text{if } m \in [\overline{m},\infty). \end{cases} \tag{8}$$

Hence, in equilibrium, production division $(m,1)$ will be acquired by a less able entrepreneur than production division $(m,2)$ if the market size of the good satisfies $m < \overline{m}$ since production costs are higher in country 1. In contrast, the initial location of the production division does not matter for the equilibrium assignment if $m > \overline{m}$ since, in that case, production division $(m,1)$ will be relocated to country 2.

The following lemma is a result of the individual optimality conditions (6)–(8) and merger market clearing.

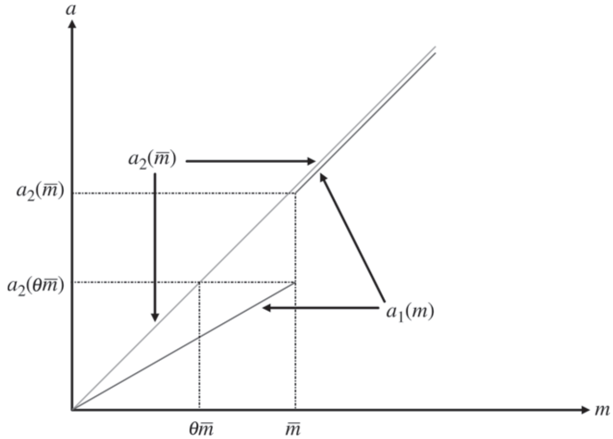

FIGURE 1

The equilibrium assignment of production divisions to headquarters

Lemma 3. *The equilibrium assignment of production divisions to headquarters is*

$$a_1(m) = \begin{cases} G^{-1}\left(\frac{E_1 H(m)+E_2 H(\theta m)}{E_1+E_2}\right) & \text{if } m \in [0, \overline{m}], \\ G^{-1}(H(m)) & \text{if } m \in [\overline{m}, \infty), \end{cases} \tag{9}$$

and

$$a_2(m) = \begin{cases} G^{-1}\left(\frac{E_1 H(m/\theta)+E_2 H(m)}{E_1+E_2}\right) & \text{if } m \in [0, \theta\overline{m}] \\ G^{-1}\left(\frac{E_1 H(\overline{m})+E_2 H(m)}{E_1+E_2}\right) & \text{if } m \in [\theta\overline{m}, \overline{m}] \\ G^{-1}(H(m)) & \text{if } m \in [\overline{m}, \infty). \end{cases} \tag{10}$$

Proof. See Appendix. ||

The lemma shows that $a_2(\cdot)$ is single-valued, strictly increasing, and continuous. Moreover, $a_2(\cdot)$ is differentiable, except at $\theta\overline{m}$ and $\overline{m}$. Similarly, except at $\overline{m}$, $a_1(\cdot)$ is also single-valued, strictly increasing, and differentiable. At $\overline{m}$, $a_1(\overline{m})$ takes two values: $\lim_{m\uparrow\overline{m}} a_1(m) = a_2(\theta\overline{m})$ and $\lim_{m\downarrow\overline{m}} a_1(m) = a_2(\overline{m})$. The equilibrium assignment exhibits positive assortative matching between entrepreneurial ability a and the market size m of a good within each country i. This follows from the supermodularity of the gross profit function $\Pi_i(a, m)$. The equilibrium assignment is illustrated in Figure 1.

Consider a firm with entrepreneurial ability $\lim_{m\uparrow\overline{m}} a_1(m) = a_2(\theta\overline{m})$ from country 1. This firm is indifferent between acquiring production division $(\overline{m}, 1)$ at price $W_1(\overline{m})$ while keeping production in country 1 and acquiring production division $(\theta\overline{m}, 2)$ at price $W_2(\theta\overline{m})$ while keeping production in country 2. In contrast, a firm with entrepreneurial ability $\lim_{m\downarrow\overline{m}} a_1(m) = a_2(\overline{m})$ from country 1 is indifferent between acquiring production division $(\overline{m}, 1)$ at price $W_1(\overline{m})$ while relocating production to country 2 (incurring a fixed cost ϕ) and acquiring production division $(\overline{m}, 2)$ at price $W_2(\overline{m})$ while keeping production in country 2. Any firm with intermediate entrepreneurial ability $a \in (a_2(\theta\overline{m}), a_2(\overline{m}))$ from country 1 will acquire a production division in country 2 and keep production in that country. This explains the discontinuity of $a_1(\cdot)$ at $\overline{m}$.

Using equation (7), we obtain the equilibrium price schedule for production divisions originating in country 2:

$$W_2(m) = W_2(0) + \int_0^m W_2'(z)dz = S\int_0^m a_2(z)dz, \tag{11}$$

where $a_2(m)$ is given by (10). The corresponding price schedule for production divisions originating in country 1, $W_1(\cdot)$, can be derived from $W_2(\cdot)$ using equation (5).

From equation (5) and Lemma 2, the market size threshold $\overline{m}$ satisfies $W_2(\theta\overline{m}) = W_2(\overline{m}) - \phi$. Using (11), this indifference condition can be rewritten as

$$S\int_{\theta\overline{m}}^{\overline{m}} a_2(m)dm = \phi. \tag{12}$$

Given the mark-up-adjusted residual demand level S and equation (10), the indifference condition (12) determines the equilibrium value of the market size threshold $\overline{m}$. From equation (2) and the equilibrium assignment of production divisions to headquarters derived above, the mark-up-adjusted residual demand level is given by

$$S = \sigma^{-1}\left[E_1\theta\int_0^{\overline{m}} ma_1(m)dH(m) + E_2\int_0^{\overline{m}} ma_2(m)dH(m) + (E_1+E_2)\int_{\overline{m}}^{\infty} ma_2(m)dH(m)\right]^{-1}. \tag{13}$$

We are now in the position to define equilibrium in this assignment model and prove existence and uniqueness.

Definition 1. An equilibrium is a collection $\{a_1(\cdot), a_2(\cdot), W_1(\cdot), W_2(\cdot), \overline{m}, S\}$ satisfying equations (5), and (9)–(13).

Proposition 1. *There exists a unique equilibrium.*

Proof. See Appendix. ||

4.6. *Endogenous cross-country differences in the distribution of firm efficiencies*

The equilibrium assignment of production divisions to headquarters and firms' location of production decisions have important implications for aggregate productivity differences between countries.

Proposition 2. *In equilibrium, the endogenous distribution of entrepreneurial abilities associated with firms that own production divisions in country* 2 *first-order stochastically dominates that in country* 1.

Proof. See Appendix. ||

This result follows from two observations, as can be seen in Figure 1. First, in equilibrium, all of the best firms, namely those with entrepreneurial ability $a > a_2(\overline{m})$, will acquire a production division that will ultimately be located in country 2, independently of where the production division was originally located. Second, for any $m < \overline{m}$, production division $(m, 2)$ will be acquired by a firm with better entrepreneurial ability than production division $(m, 1)$, that is, $a_2(m) > a_1(m)$ for $m < \overline{m}$.[13]

Holding fixed entrepreneurial ability a, a firm producing a good with market size m in country 2 has, by assumption, lower unit costs than a firm producing the same type of good in country 1. Consequently, the production division in country 2 will produce at a larger scale than that in country 1. Since entrepreneurial ability a and market size m are complementary in generating profits, the merger market will re-assign a firm with better entrepreneurial ability to manage production division $(m, 2)$ than to $(m, 1)$, resulting in more productive firms producing in country 2 than in country 1. That is, the merger market magnifies the underlying cost differences between countries. Note that this does *not* mean that country 2 is necessarily the more productive country as wage differences can explain country 2's cost advantage. Rather, it means that measured productivity in country 2 increases because of the incoming FDI. Proposition 2 shows that the empirical research on the sources of comparative advantage needs to take the productivity effects of both types of FDI into account.

5. FOREIGN DIRECT INVESTMENT

In the previous section, we derived the equilibrium assignment of production divisions to headquarters and the equilibrium location of production divisions. What still needs to be analysed is the implied equilibrium pattern of trade and FDI. In this section, we interpret the assignment and location decisions in terms of choice of FDI mode. We then present two key results. First, all greenfield FDI is one way within the same industry: from the high-cost to the low-cost country, while cross-border acquisitions occur in both directions. Second, in the limit as production-cost differences between countries vanish, all FDI takes the form of cross-border acquisitions, and the volume of FDI is described by a gravity-type equation.

5.1. *National and multinational firms*

Recall that there is an integrated global product market; there are no transport costs or tariffs. Hence, all firms engage in international trade. In our model, there are both national and multinational firms. At the production stage, a national firm owns a headquarter division and a production division in the same country. Such a firm thus exports to the foreign country. At the production stage, a multinational firm owns a headquarter division in the home country and a production division in the foreign country. Such a firm thus imports the final good to the home country.

5.2. *Types of FDI*

In our model, there are two types of FDI. *Greenfield investment* from country i to country k occurs whenever a firm from country i relocates a production division from country i to country

13. In a recent paper, Gabaix and Landier (2007) present evidence showing that CEO pay in the U.S. is higher than in other countries. In our model, the value of the headquarter, $V(a)$, can be interpreted in at least two ways. (1) If a is organizational capital, the value $V(a)$ will accrue to the owner(s) of the firm. (2) If a is the ability of the CEO, $V(a)$ could be interpreted as the pay of that CEO. Under the latter interpretation, what does our model have to say about the distribution of CEO wages in the two countries? Since the headquarter of a firm remains in its home country, the distribution of CEO wages in country i is determined by the distribution of CEO ability in that country. In particular, the distribution of CEO pay in country 1 first-order stochastically dominates that in country 2 if $G_1(\cdot)$ first-order stochastically dominates $G_2(\cdot)$.

k. A *cross-border acquisition* from country i to country k occurs whenever a firm from country i purchases a production division in country k. If the acquirer from country i keeps production in country k, then the firm will become a multinational. If instead the acquirer relocates production from country k to country i, then the firm will be a national firm at the production stage; nevertheless, a cross-border acquisition has occurred.

5.3. *Equilibrium selection*

Both the assignment of production divisions to headquarters and the location of production divisions by market size of the produced good are uniquely pinned down in equilibrium. However, since entrepreneurs of any given ability but originating in different countries are perfect substitutes, there is indeterminacy in the equilibrium gross flows of FDI.[14] Since the assumption of no frictions in the market for cross-border acquisitions may be viewed as a limiting case where such frictions become small, we henceforth confine attention to the equilibrium pattern of FDI that minimizes the volume of cross-border acquisitions. This equilibrium selection implies that, for any given m, all cross-border acquisitions are one way: if a production division located in country i, (m, i), is acquired by a (foreign) firm from country $k \neq i$, then any production division that produces a good with the same market size in country k, (m, k), will be acquired by a firm from the same country k. But the direction of flow of cross-border acquisitions will vary with m.

5.4. *The structure of international ownership and location of production*

We are now in the position to provide a first characterization of FDI flows. Since all production divisions originating in country 2 will remain in that country, any greenfield FDI must be one way from country 1 to country 2. Consider a production division $(m, 1)$ with $m > \overline{m}$. This production division will be relocated from country 1 to country 2. The relocation of production may be accomplished in two ways: (i) a firm from country 1 may engage in greenfield FDI in country 2, or (ii) a firm from country 2 may acquire that production division and relocate it to country 2. Since we restrict attention to the equilibrium pattern of FDI that minimizes the volume of cross-border acquisitions, the latter will occur only if, in country 1, there is an insufficient number of appropriate headquarters $(a_1(m), 1)$ to acquire production divisions of type $(m, 1)$ in their home country. Consider now a production division $(m, 1)$ with $m \in [0, \overline{m})$ or $(m, 2)$ with $m \in [0, \infty)$. Such a production division will not be relocated. It will be acquired by a domestic firm with entrepreneurial ability $a_i(m)$, or else if the domestic stock of such firms is too small, by a foreign firm with that ability.

More formally, let $\psi_i(m)$ denote the ratio between the mass of headquarters from country i that, in equilibrium, will be assigned to a production division $(m, 1)$ or $(m, 2)$, and the mass of production divisions (m, i) originating in the same country i. If $\psi_i(m) < 1$, then a fraction $1 - \psi_i(m)$ of these production divisions must be acquired by foreign firms. A production division (m, i) will be acquired by a firm with entrepreneurial ability $a_i(m)$, and so

$$\psi_i(m) = \lim_{\Delta \to 0} \frac{E_i[G_i(a_i(m+\Delta)) - G_i(a_i(m))]}{E_i[H(m+\Delta) - H(m)]}$$

$$= \frac{g_i(a_1(m))}{h(m)} a_i'(m).$$

14. The same type of indeterminacy is present in Helpman (1984).

Hence, using equations (9) and (10),

$$\psi_1(m) = \begin{cases} \dfrac{g_1(a_1(m))}{g(a_1(m))}\left[\dfrac{E_1}{E_1+E_2} + \dfrac{\theta E_2}{E_1+E_2}\dfrac{h(\theta m)}{h(m)}\right] & \text{if } m \leq \overline{m}, \\ \dfrac{g_1(a_1(m))}{g(a_1(m))} & \text{otherwise,} \end{cases} \tag{14}$$

and

$$\psi_2(m) = \begin{cases} \dfrac{g_2(a_2(m))}{g(a_2(m))}\left[\dfrac{E_2}{E_1+E_2} + \dfrac{E_1/\theta}{E_1+E_2}\dfrac{h(m/\theta)}{h(m)}\right] & \text{if } m \leq \theta\overline{m}, \\ \dfrac{g_2(a_2(m))}{g(a_2(m))}\left[\dfrac{E_2}{E_1+E_2}\right] & \text{if } m \in (\theta\overline{m}, \overline{m}], \\ \dfrac{g_2(a_2(m))}{g(a_2(m))} & \text{if } m > \overline{m}. \end{cases} \tag{15}$$

Observe that both functions ψ_1 and ψ_2 are continuous, except that ψ_1 has a discontinuity at $\overline{m}$, while ψ_2 exhibits discontinuities at $\theta\overline{m}$ and $\overline{m}$. Note also that the value of $\psi_i(m)$ depends directly on the relative supply of firms in country i, $E_i/(E_1+E_2)$, production-cost differences, as summarized by θ, and the relative supply of entrepreneurial abilities in country i, $g_i(a_i(m))/g(a_i(m))$; it also depends on the assignment mapping $a_i(\cdot)$, provided there are cross-country differences in the distributions of entrepreneurial abilities, that is, $g_i \neq g$.

Using the functions ψ_1 and ψ_2, we can derive measures of FDI volume. Let γ_i and μ_i denote the fractions of firms from country i that will engage in greenfield FDI and cross-border acquisitions, respectively. Since all greenfield FDI is directed towards the country with the comparative advantage in production, $\gamma_2 = 0$. On the other hand,

$$\gamma_1 = \int_{\overline{m}}^{\infty} \min\{\psi_1(m), 1\} dH(m) \tag{16}$$

since a fraction $\min\{\psi_1(m), 1\}$ of production divisions of type $(m, 1)$ with $m > \overline{m}$ will be relocated to country 2 through greenfield FDI (while the remaining fraction $\max\{1-\psi_1(m), 0\}$ will be acquired and relocated by firms from country 2).

As regards cross-border acquisitions, we have

$$\mu_1 = \frac{E_2}{E_1}\int_0^{\infty} \max\{1-\psi_2(m), 0\} dH(m). \tag{17}$$

To see this, note that if $\psi_2(m) < 1$, there is an insufficient number of firms from country 2 that have the "right" entrepreneurial ability to acquire a production division $(m, 2)$, and so a fraction $1-\psi_2(m)$ of these production divisions will be acquired by firms from country 1. Similarly, we have

$$\mu_2 = \frac{E_1}{E_2}\int_0^{\infty} \max\{1-\psi_1(m), 0\} dH(m). \tag{18}$$

We can now make two important observations. First, the flows of cross-border acquisitions will be balanced in equilibrium,

$$E_1\mu_1 = E_2\mu_2.$$

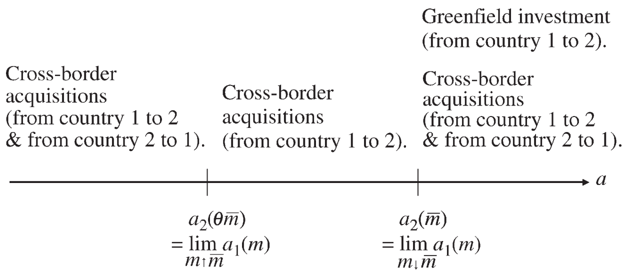

FIGURE 2

Foreign direct investment flows as a function of the firm's entrepreneurial ability a

Balancedness obtains since, in each country, the mass of headquarter divisions is equal to the mass of production divisions, both before the merger market opens as well as after the merger market closes. Moreover, each greenfield investment involves one headquarter division and one production division from the same country. Second, all firms from country 1 with entrepreneurial ability $a \in (a_2(\theta\overline{m}), a_2(\overline{m}))$ will be engaged in cross-border acquisitions in country 2, and so $\mu_1 = (E_2/E_1)\mu_2 > 0$.

We summarize our results in the following proposition and illustrate them in Figure 2.

Proposition 3. *In equilibrium, greenfield FDI and cross-border acquisitions coexist in the same industry. All greenfield FDI is one way: from country* 1 *to country* 2*, but not in the reverse direction. In contrast, cross-border acquisitions are two way: from country* 1 *to country* 2*, and from country* 2 *to country* 1.

Existing models of vertical FDI (*e.g.* Helpman, 1984) predict that at any given production stage, all FDI flows are one way: the only receiving country is the one that has a comparative advantage in that stage of production. Yet, there is overwhelming empirical evidence showing that FDI flows are generally two way.[15] In light of this stylized fact, trade theorists have relied on models with transport costs to generate two-way FDI. As Proposition 3 shows, transport costs are not necessary to generate this stylized fact.

To the extent that the U.S. may be viewed as the high production-cost country in most manufacturing industries *vis-à-vis* most countries, the model would predict that the greenfield share of U.S. inward FDI is smaller than the greenfield share of U.S. outward FDI. This is indeed consistent with the data on U.S. manufacturing: the greenfield share of outward FDI over the period 1990–1998 is about 40% while that of inward FDI is only about 20%. Finally, while the model predicts that FDI flows are two way, it also predicts that there is more FDI flowing from the high-cost country to the low-cost country than in the reverse direction.

There is ample evidence that many governments are wary of foreign acquisitions of domestic establishments that result in the closure of local production. Our model can indeed generate such FDI. The measure of firms involved in such FDI is

$$E_1 \int_{\overline{m}}^{\infty} \max\{1 - \psi_1(m), 0\} dH(m),$$

15. This holds true even between the U.S. and developing countries. For example, according to the 1997 Benchmark Survey of FDI in the U.S., Mexico had 168 affiliates in the U.S., while the number for Taiwan is 150. This compares to Italy with 217 affiliates.

which is positive if and only if $g_1(a) < g_2(a)$ for some $a > a_2(\overline{m})$. Interestingly, if foreign acquisitions result in the closure of local production divisions, they involve the goods commanding a large market (of size $m > \overline{m}$) from country 1.[16]

5.5. *Vanishing cross-country cost differences*

As documented in Section 2, cross-border acquisitions are the dominant mode of FDI between the U.S. and most developed countries (where, arguably, production-cost differences are not very large). In contrast, a much larger fraction of FDI flows from the U.S. to the poor, developing countries (where, arguably, production-cost differences play an important role) involve greenfield investment.

To explain these findings within our model, we analyse the composition of FDI in the limit as production-cost differences become small, that is, as $\theta \to 1$. An immediate observation is that the market size threshold $\overline{m} \to \infty$ as $\theta \to 1$.[17] Consequently, greenfield investment disappears as production-cost differences become small: $\gamma_1 \to 0$ as $\theta \to 1$. Next, as can be seen from equations (14) and (15), for any m and country i,

$$\psi_i(m) \to \frac{g_i(a_i(m))}{g(a_i(m))} \text{ as } \theta \to 1,$$

where $a_i(m) = G^{-1}(H(m))$ is independent of i. Using equations (17) and (18) and changing variables, we obtain a gravity-type equation for the volume of FDI from country i to country k:

$$\mu_i E_i = \frac{E_1 E_2}{E_1 + E_2}\Gamma_{ik},$$

where

$$\Gamma_{ik} = \int_0^\infty \max\{g_i(a) - g_k(a), 0\}da.$$

Generically, $g_1(a) \neq g_2(a)$ for (almost) any a, and so the volume of cross-border acquisitions is bounded away from 0, even as $\theta \to 1$. We therefore obtain the following key result.

Proposition 4. *There always exist cross-border acquisitions in both directions, independently of production-cost differences between countries. In contrast, greenfield FDI disappears in the limit as production-cost differences vanish. Hence, as $\theta \to 1$, all FDI takes the form of cross-border acquisitions.*

This proposition highlights that there are two reasons for cross-border acquisitions, but only one reason for the existence of greenfield FDI. In our model, greenfield FDI occurs only because firms want to exploit cost differences by relocating production from a high-cost to a low-cost location. In contrast, cross-border acquisitions not only exist because of cost differences, but also because the distribution of entrepreneurial abilities (or, more generally, of firm-specific assets) varies from one country to another.[18]

16. The total mass of production divisions that will be closed in country 1 and relocated to country 2 is $\gamma_1 E_1 + E_1 \int_{\overline{m}}^{\infty} \max\{1 - \psi_1(m), 0\}dH(m) = (1 - H(\overline{m}))E_1$.

17. To see this, suppose otherwise that $\overline{m}$ is bounded from above, independently of θ. But then, (observing that S is bounded; see equation (13)) the L.H.S. of equation (12) goes to 0 as θ goes to 1, while the R.H.S. is equal to ϕ, and so is bounded away from 0; a contradiction.

18. This may be reminiscent of Grossman and Maggi (2000), where trade between countries occurs because of differences in the distributions of workers' talent.

More generally, the following features of our model are necessary to obtain two-way cross-border acquisitions in the absence of production-cost differences between countries: there must be heterogeneity in both types of corporate assets (entrepreneurial abilities and the market sizes of goods), these corporate assets must be complementary, and there must be distributional differences across countries in at least one of the two types of corporate assets. This highlights the importance of "two-sided" heterogeneity in our assignment model.

6. FIRM EFFICIENCY AND CHOICE OF FDI MODE

In this section, we further explore the mapping from a firm's efficiency (as measured by a) to its choice of FDI mode. For this purpose, we impose additional structure on the distributions of entrepreneurial abilities. We then obtain another key result: firms that engage in greenfield FDI are systematically more efficient than those that engage in cross-border acquisitions. Moreover, we show that, under some modest regularity condition on the distribution of goods' market sizes, the probability that a firm from country 1 engages in FDI is weakly increasing in entrepreneurial ability.

6.1. *Efficiency differences: greenfield FDI vs. cross-border acquisitions*

As documented in Section 2, U.S. firms engaging in greenfield FDI are systematically more efficient than U.S. firms engaging in cross-border acquisitions. Our model generates this result under a variety of distributional assumptions. A natural restriction on the distribution of entrepreneurial abilities that allows us to obtain this result is the following symmetry condition.

(C1) The distributions of entrepreneurial abilities are the same in both countries: $G_1 \equiv G_2$.

Given this symmetry in entrepreneurial abilities across countries, all FDI is motivated by production-cost differences. As can be seen from equations (14) and (15), (C1) implies that $\psi_1(m) = \psi_2(m) = 1$ for all $m \geq \overline{m}$. Hence, all cross-border acquisitions involve production divisions with $m < \overline{m}$, while all greenfield FDI still involves only production divisions with $m > \overline{m}$. Positive assortative matching between a and m in each country then implies the following proposition.

Proposition 5. *Firm engaging in greenfield FDI are more efficient than firms engaging in cross-border acquisitions.*

If we were to relax the symmetry condition (C1), we would still obtain that firms engaging in greenfield FDI are, *on average*, more efficient than firms engaging in cross-border acquisitions. To see this, note that, even in the absence of (C1) greenfield FDI involves only firms with $a > a_2(\overline{m})$ and production divisions with $m \geq \overline{m}$, while cross-border acquisitions are the only FDI mode chosen by firms with less able entrepreneurs and involving production divisions with goods of a smaller market size. To violate our weaker prediction, one would thus need a very strong departure from symmetry, namely that one country has a much larger supply of the very best entrepreneurs than another.

Through the lens of this proposition, it may become apparent why the governments of many host countries appear to favour greenfield FDI over cross-border acquisitions. Policy-makers may perceive two important differences between the two FDI modes. First, greenfield FDI involves the creation of new production divisions. Second, greenfield FDI involves the best foreign firms, and therefore a large number of workers.

6.2. *Efficiency differences: cross-border acquisitions vs. domestic production*

To further tighten our predictions on the efficiency differences between firms engaging in different modes of serving the world market, we impose a mild regularity condition on the distribution of goods' market sizes.

(C2) The elasticity of the density function h,

$$\frac{mh'(m)}{h(m)}$$

is strictly decreasing in m.

It can easily be verified that condition (C2) is satisfied by a number of standard distributions, for example, by the two-parameter family of Weibull distributions, $H(m) = 1 - e^{-(m/\beta)^{\alpha}}$, $\alpha > 0$, $\beta > 0$ (which includes the exponential distribution as a special case with $\alpha = 1$) and the two-parameter family of Gamma distributions (which includes the chi-squared distribution as a special case). Henceforth, we will assume that both distributional conditions, (C1) and (C2), hold.

(C1) implies that $\psi_1(0) < 1 < \psi_2(0)$. Moreover, (C1) and (C2) imply that $\psi_1(\cdot)$ is strictly increasing on $[0, \overline{m}]$, and $\psi_2(\cdot)$ is strictly decreasing on $[0, \theta\overline{m})$, has a downward jump at $\theta\overline{m}$, and is constant on $[\theta\overline{m}, \overline{m}]$. It will prove useful to define a second threshold market size, $\widehat{m}$. If $\lim_{m\uparrow\overline{m}} \psi_1(m) > 1$, the threshold $\widehat{m}$ is such that $\psi_1(\widehat{m}) = 1$; otherwise, $\widehat{m} = \overline{m}$. Hence,

$$\widehat{m} = \begin{cases} \psi_1^{-1}(1) & \text{if } \lim_{m\uparrow\overline{m}} \psi_1(m) > 1, \\ \overline{m} & \text{otherwise.} \end{cases} \tag{19}$$

Using this threshold $\widehat{m}$ and equations (16)–(18), we can summarize the relationship between firm efficiency and FDI mode choice as follows.

Proposition 6. *Consider the mapping from entrepreneurial ability to mode of FDI. For firms with entrepreneurial ability $a < a_2(\theta\widehat{m}) = a_1(\widehat{m})$, all FDI involves cross-border acquisitions in country 1. For firms with entrepreneurial ability $a \in (a_2(\theta\widehat{m}), a_2(\overline{m}))$, all FDI involves cross-border acquisitions in country 2. For firms with entrepreneurial ability $a > a_2(\overline{m})$, all FDI involves greenfield FDI in country 2.*

Consider a firm with headquarter division $(a, 1)$. (i) If $a \leq a_1(\widehat{m}) = a_2(\theta\widehat{m})$, the firm will not engage in FDI. (ii) If $a \in (a_2(\theta\widehat{m}), a_2(\theta\overline{m}))$, the firm will, with positive probability, acquire a production division in country 2. The probability that a production division $(m, 2)$ with $m \in (\theta\widehat{m}, \theta\overline{m})$ will be acquired by a foreign firm is $1 - \psi_2(m) \geq 0$ and is strictly increasing in m. Positive assortative matching between a and m then implies that the probability that a country-1 firm with $a \in (a_2(\theta\widehat{m}), a_2(\theta\overline{m}))$ engages in cross-border acquisitions is strictly increasing in a. (iii) If $a > a_1(\overline{m}) = a_2(\theta\overline{m})$, the firm will engage in FDI with probability 1, namely in cross-border acquisitions if $a \in (a_2(\theta\overline{m}), a_2(\overline{m}))$ and in greenfield FDI if $a > a_2(\overline{m})$. We thus obtain the following monotonicity result.

Proposition 7. *The probability that a firm from country 1 engages in FDI is weakly increasing in entrepreneurial ability a.*

Proposition 7 implies, in particular, that in the high-cost country, firms engaging in cross-border acquisitions are, on average, more efficient than firms producing domestically.

7. COMPARATIVE STATICS

In this section, we generate a number of additional predictions by analysing the effects of changing various exogenous variables on the equilibrium assignment and location of production and the volumes of different types of FDI.

Throughout this section, we assume that conditions (C1) and (C2) hold. Using equations (14) and (19), the FDI shares given by (16)–(18) simplify to

$$\mu_1 = \frac{E_2}{E_1}\mu_2 = \frac{E_2}{E_1+E_2}[H(\widehat{m}) - H(\theta\widehat{m})], \tag{20}$$

and

$$\gamma_1 = 1 - H(\overline{m}). \tag{21}$$

7.1. *The fixed cost of relocating a production division*

We now explore the effects of changing the fixed cost ϕ of relocating a production division to country 2. Intuitively, one would expect that an increase in ϕ raises the threshold $\overline{m}$ and hence reduces the share γ_1 of firms from country 1 engaging in greenfield FDI in country 2. Indeed, this can easily be established using equations (12) and (13). Further, $\overline{m} \to 0$ as ϕ becomes small, and $\overline{m} \to \infty$ as ϕ becomes large. Next, note that if $\widehat{m} < \overline{m}$, $\widehat{m}$ is implicitly defined by $\theta h(\theta\widehat{m})/h(\widehat{m}) = 1$, and hence (locally) independent of ϕ; otherwise $\widehat{m} = \overline{m}$, and so $\widehat{m}$ is strictly increasing in ϕ. We thus have the following lemma.

Lemma 4. *The threshold $\overline{m}$ is strictly increasing in ϕ, $\overline{m} \to 0$ as $\phi \to 0$, and $\overline{m} \to \infty$ as $\phi \to \infty$. Further, if $\widehat{m} < \overline{m}$, then $\widehat{m}$ is (locally) independent of ϕ. Hence, there exists a unique $\widehat{\phi} > 0$ such that $\widehat{m} < \overline{m}$ for all $\phi > \widehat{\phi}$, and $\widehat{m} = \overline{m}$ for all $\phi \leq \widehat{\phi}$.*

The following proposition is concerned with the effect of changes in the fixed cost ϕ on the volume of greenfield FDI and cross-border acquisitions.

Proposition 8. *A small increase in the fixed cost ϕ of building a plant, $d\phi > 0$, has the following effects:*

$$d\gamma_1 < 0, \quad d\mu_1 = \frac{E_2}{E_1} d\mu_2 \begin{cases} > 0 & \textit{if } \phi < \widehat{\phi} \\ = 0 & \textit{otherwise.} \end{cases}$$

Proof. See Appendix. ‖

To the extent that the fixed cost ϕ of setting up a production division in a foreign country is decreasing with the geographical proximity of the host country to the firm's home country, Proposition 8 predicts that the share of greenfield investment in total FDI from a high-cost country to a low-cost country is decreasing in the distance between the two countries. Indeed, this holds true in the data for U.S. outward FDI, as reported in Section 2.[19]

7.2. *Population of entrants*

Consider now a small decrease in the number of entrants in country 2, E_2, holding the total number of entrants in the two countries, $E_1 + E_2$, fixed. That is, the aggregate mass of firms is

19. We thank a referee for suggesting that ϕ decreases with proximity.

held constant, while firms from country 2 are becoming relatively more scarce. For simplicity, we confine attention to the case $\phi > \widehat{\phi}$. We obtain the following proposition.

Proposition 9. *A small decrease in the number of entrants in country 2, E_2, holding the total number of entrants, $E_1 + E_2$, fixed, has the following effects:*

$$d\gamma_1 > 0 \text{ and } d\mu_1 = -d\mu_2 < 0.$$

Proof. See Appendix. ||

Intuitively, a relative decrease in the number of entrants in country 2 implies that there are fewer attractive corporate assets in country 2 that firms from country 1 can acquire. Hence, as $E_2/(E_1 + E_2)$ decreases, firms from country 1 will substitute away from cross-border acquisitions in favour of greenfield FDI. This effect is reinforced by the indirect effect through the mark-up-adjusted residual demand level: the shift in endowments in favour of the high-cost country raises S, which further increases the incentive for firms from the high-cost country to engage in greenfield FDI. In the limit as the relative number of entrants from country 2 goes to 0, all FDI from country 1 to country 2 will be in the form of greenfield FDI, that is, $\mu_1 \to 0$, while γ_1 is bounded away from 0. This is an alternative explanation for our empirical finding that U.S. MNEs are much more likely to choose greenfield FDI when engaging in FDI in poor, developing countries (where, arguably, there are fewer attractive target firms) than when engaging in FDI in rich, developed countries.

A small decrease in the fraction of entrants that originate in country 2 makes the countries "more similar" if $E_1 < E_2$, and "more dissimilar" if the reverse inequality holds. An interesting question is whether the number of cross-border acquisitions, $E_1\mu_1 + E_2\mu_2$, increases or decreases as the two countries become more similar. From equations (17) and (18), we have

$$E_1\mu_1 + E_2\mu_2 = \frac{2E_1E_2}{E_1 + E_2}[H(\widehat{m}) - H(\theta\widehat{m})].$$

Recall that $\widehat{m}$ is independent of the number of entrants. Hence, the volume of cross-border acquisitions follows a gravity-type equation: it increases as the two countries become more similar in terms of the sizes of their populations of entrants.

8. DISCUSSION

In this section, we discuss some key assumptions.

8.1. *Factor use of headquarter services*

For simplicity, we abstracted from costs of headquarter services. The simplest way to introduce such costs is by assuming that the unit cost of firm $\{(\widetilde{a}, i), (m, k)\}$ is given by

$$\frac{\omega_{s,i}^{\alpha}\omega_{u,k}^{1-\alpha}}{\widetilde{a}\eta_k},$$

where $\omega_{s,i}$ is the wage of skilled labour used for headquarter services in country i, $\omega_{u,k}$ is the wage of unskilled labour used for production in country k, and $\alpha \in [0, 1)$. Note that this cost function is consistent with a Cobb–Douglas production function. The analysis in the main text is a special case of this specification where $\alpha = 0$. If we assume that the wage of skilled labour is the same in both countries, $\omega_{s,1} = \omega_{s,2}$, then all of our results continue to hold. If, instead, we assume that $\omega_{s,1} \neq \omega_{s,2}$, then this is isomorphic to shifting the distributions of entrepreneurial abilities. In particular, if $\omega_{s,1} < \omega_{s,2}$, then this is isomorphic to an upward shift of entrepreneurial ability in country 1. A rather different way of introducing costs of headquarter services would be to assume that there is a fixed cost to maintaining a headquarter. Under this assumption, there would exist thresholds $\underline{a} > 0$ and $\underline{m} > 0$ such that all headquarters with entrepreneurial ability $a < \underline{a}$ and all production divisions with $m < \underline{m}$ in country 1 and $m < \theta\underline{m}$ in country 2 would close down. The assignment of production divisions to headquarters would be unaffected by the existence of fixed headquarter costs. However, if the fixed cost were sufficiently large, then there might not be FDI flowing from country 2 to country 1, not even under assumption (C1), because the mass of unproduced goods in country 1 would be larger than that in country 2.

8.2. *Cost of relocating a production division*

We assumed that relocating a production division to country i requires ϕ/η_i units of labour from country i, independently of the market size of the good. It is possible to show that our results are robust to assuming that the labour requirement for setting up a new production division (m, i) is $\phi \cdot \chi(m)/\eta_i$, provided $\chi(0) > 0$ and $\chi(\cdot)$ is not "too convex".

8.3. *Initial endowment*

In our model, we assumed that greenfield FDI involves building a new plant in the foreign country and therefore requires incurring a fixed set-up cost. A cross-border acquisition, on the other hand, involves a transfer of ownership of an existing plant (and property rights over the production of a good). Since we assume that all firms own a plant in their home country *before* FDI decisions take place and since the merger market is frictionless, this implies that the only fixed cost associated with a cross-border acquisition is the endogenous market price of the acquired production division. The assumption that all firms are initially endowed with a production division can be justified as being the equilibrium outcome of an extended model where firms learn their entrepreneurial ability only after producing (which requires building a plant) and FDI is banned. This is also consistent with the empirical observation that many cross-border acquisitions involve the acquisition of existing plants or other physical corporate assets. If, instead, we were to assume that all plants were built only *after* FDI decisions take place, then both types of FDI would involve incurring the same fixed set-up cost. In this case, all active firms would choose to locate their plants in the low-cost country, and the country of origin of the firms would not matter.

9. CONCLUSION

In this paper, we have developed an assignment theory to analyse both the volume of FDI and its composition between cross-border acquisitions and greenfield investment. In our model, a firm consists of a bundle of heterogeneous and complementary corporate assets. The merger market allows firms to trade these corporate assets to exploit complementarities. A cross-border acquisition involves purchasing foreign corporate assets, while greenfield FDI involves building production capacity in the foreign country to allow the firm to deploy its corporate assets abroad. Equilibrium in the merger market induces an assignment of production divisions to headquarters.

There are two countries that can freely trade with one another. Production-cost differences between countries give rise to greenfield FDI and to cross-border acquisitions, while cross-country differences in entrepreneurial abilities (or organizational capital) give rise only to cross-border acquisitions. In equilibrium, greenfield FDI is always one way: from the high-cost to the low-cost country, while cross-border acquisitions are always two way. Hence, our model can generate two-way FDI flows even in the absence of transport costs and production-cost differences. Firms' choice between the two modes of FDI, and the re-assignment of corporate assets on the international merger market have an important impact on aggregate productivity by magnifying underlying Ricardian differences between countries.

We have derived the following key predictions. (1) Firms engaging in greenfield FDI are systematically more efficient than those engaging in cross-border acquisition. As we have shown, this is consistent with the data. (2) As production-cost differences between countries vanish, all FDI takes the form of cross-border acquisitions. To the extent that production-cost differences reflect underlying wage differentials, this prediction is consistent with our observation that U.S. multinationals are more likely to favour cross-border acquisitions over greenfield FDI in rich, developed countries rather than poor, developing countries. (3) As the relative supply of corporate assets in the low-cost country decreases, firms in the high-cost country substitute away from cross-border acquisitions in favour of greenfield FDI. Again, this is consistent with our observation that the share of cross-border acquisition in total U.S. FDI is decreasing in the host country's level of development. (4) As the cost of setting up a new production division abroad increases, firms substitute away from greenfield investment in favour of cross-border acquisitions. This is consistent with our finding that the share of cross-border acquisition in total U.S. FDI is decreasing with the geographical proximity of the host country. (5) In two limiting cases (when cross-country cost differences become small and when cross-country differences in entrepreneurial ability become small), the volume of cross-border acquisitions follows a gravity-type equation. As shown by Head and Ries (2007), this is consistent with the data. (6) Underlying cost differences between countries are magnified by the re-assignment of production divisions to headquarters across countries.

While outside the scope of this paper, our model may also fruitfully be used as a framework for policy analysis. For instance, it would be interesting to compute the welfare implications of various policy experiments, such as restrictions on cross-border acquisitions or greenfield FDI. From the host country's point of view, cross-border acquisitions involve a change in ownership of local production (and may even lead to the closure of local production), while greenfield FDI involves the opening of a new establishment. In this sense, cross-border acquisitions bring "less" to the host country's economy than greenfield FDI. Moreover, greenfield FDI involves better foreign firms than cross-border acquisitions. Hence, the optimal government policy towards FDI should be tailored to the particular mode of FDI: greenfield FDI vs. cross-border acquisitions. We believe this to be an exciting avenue for future research.

APPENDIX

Description of data. Our firm-level data come from the Bureau of Economic Analysis (BEA), which conducts a mandatory survey each year of all U.S. firms with foreign affiliates above a certain size threshold. Firms that come to own a new enterprise abroad are required to report (i) whether that enterprise was obtained through cross-border acquisition or greenfield FDI,[20] (ii) in which industry that enterprise produces, and (iii) in which country that enterprise is located. From this database, we collected every recorded investment by those multinationals whose mainline of business is a traded good over the five-year period 1994–1998.[21] The BEA data set also contains a wide range of data on the characteristics of the U.S. parent firms that are conducting FDI abroad, which are used as explanatory variables in our analysis.

In the construction of our sample, we classify investments to facilitate interpretation of the results. In particular, we aggregate a firm's investments over the sample period 1994–1998 so that, for each firm, a country–industry pair appears at most once. For firms that made more than one investment in a particular country and industry, a country–industry observation for a firm was coded as a cross-border acquisition if and only if all investments made over the five-year period in that country–industry cell were cross-border acquisitions, and was coded as a greenfield investment otherwise.[22]

20. This is question 5 on the BEA questionnaire BE-11B (both short form and long form).

21. That is, we confine attention to the industries that fall within SIC100 to SIC399.

22. Almost all industry–country pairs were either entirely characterized by cross-border acquisition or greenfield. Only a handful of country–industry pairs in the sample involved both cross-border acquisitions and greenfield FDI. The results that obtain from estimating the same model on the raw data offer very similar results.

TABLE A1

Descriptive statistics

Variable	Mean	S.D.	Description
ACQ	0·435	0·496	Indicator for acquisition
USSALE	15·2	1·61	Sales in U.S.
VADDPW	4·45	0·523	(Gross product)/Employees
EMP	10·0	1·44	Employees
DIV	−1·01	0·658	Herfindahl index for parent firm sales
RDSALE	−0·389	1·32	(R&D Expenditure)/Sales
EXP	0·696	0·460	Indicator for previous country experience
INTRAIM	0·610	0·336	(Intra-firm imports)/(Total Imports)
COUNT	2·17	1·77	Number of countries with affiliate
RGDPPC	9·81	0·723	Real GDP *per capita*
POP	16·7	1·38	Population
OPEN	3·94	0·648	(Exports plus imports)/GDP
DIST	8·72	0·69	Distance U.S. to host country

All continuous variables (except INTRAIM) in logarithms.

The descriptive statistics of all firm-level and country-level variables are summarized in Table A1.

Proof of Lemma 1.

(i) Suppose to the contrary that there are two production divisions (m', i) and (m'', i) with $m'' > m'$ such that $W_i(m') \geq W_i(m'')$. Since $\Pi_i(a, m)$ is strictly increasing in m, no entrepreneur would acquire production division (m', i), implying that the merger market does not clear.

(ii) Suppose to the contrary that there is a market size m' such that $\lim_{m \uparrow m'} W_i(m) < \lim_{m \downarrow m'} W_i(m)$. Since $\Pi_i(a, m)$ is continuous in m, no entrepreneur would acquire production division $(m' + \varepsilon, i)$ for $\varepsilon > 0$ sufficiently small, implying that the merger market does not clear.

(iii) Suppose to the contrary that there is a market size m' such that $W_i(\cdot)$ is strictly concave at m'. Since $\Pi_i(a, m)$ is linearly increasing in m, no entrepreneur would acquire production division (m', i), implying that the merger market does not clear.

(iv) Suppose to the contrary that $W_i(0) > 0$. Since $\Pi_i(a, 0) = 0$, no entrepreneur would acquire production division (ε, i) for $\varepsilon \geq 0$ sufficiently small, implying that the merger market does not clear. ‖

Proof of Lemma 2. We first claim that Δ_{11} and Δ_{12} are closed sets. To see this, suppose otherwise that there exists some $m' \in \Delta_{1i}$, $i \in \{1, 2\}$, $m' \notin \Delta_{1k}$, $k \in \{1, 2\}$, $k \neq i$, and $m' \in C(\Delta_{ik})$, where $C(\Delta_{ik})$ is the smallest closed set containing Δ_{ik}. From (5), this implies that $W_1(\cdot)$ is not continuous at m', contradicting Lemma 1.

Next, we show that $m \in \Delta_{11}$ for m sufficiently small and $m \in \Delta_{12}$ for m sufficiently large. To see this, note that the profit of a headquarter with entrepreneurial ability a acquiring production division $(m, 1)$ and relocating production to country 2 is $\Pi_2(a, m) - W_1(m) - \phi$, while the profit of keeping production in country 1 is $\Pi_1(a, m) - W_1(m)$. Let $\Theta(m) \equiv \Pi_2(a, m) - \phi - \Pi_1(a, m)$. Since $\Theta(0) = -\phi$ and $\Theta(\cdot)$ is continuous, it follows that $m \in \Delta_{11}$ for m sufficiently small. Since $\Theta(m) > 0$ for m sufficiently large, it follows that $m \in \Delta_{12}$ for m sufficiently large.

Finally, since $\theta < 1$ and $W_i(\cdot)$ is weakly convex, it follows that $\theta W_2'(\theta m) < W_2'(m)$ for all $m \geq 0$. Hence, there can be at most one $\overline{m}$ such that $W_2(\theta\overline{m}) = W_2(\overline{m}) - \phi$. This implies that $\Delta_{11} = [0, \overline{m}]$ and $\Delta_{12} = [\overline{m}, \infty)$, and $\overline{m} > 0$. ‖

Proof of Lemma 3. First, we derive $a_2(m)$ for $m > \overline{m}$. Since any production division $(m, 1)$ with $m > \overline{m}$ will be relocated to country 2, and any production division $(m, 2)$ with $m > \overline{m}$ will remain in country 2, and since, from (7) and Lemma 1, $a_2(\cdot)$ is weakly increasing, we have

$$(E_1 + E_2)[1 - G(a_2(m))] = (E_1 + E_2)[1 - H(m)] \text{ for } m \geq \overline{m},$$

where $G(\cdot) \equiv [E_1 G_1(\cdot) + E_2 G_2(\cdot)]/(E_1 + E_2)$ is the global distribution function of entrepreneurial abilities. The term on the L.H.S. represents the mass of entrepreneurs with ability of at least $a_2(m)$, while on the R.H.S. is the mass of goods with market size m and greater. Solving for $a_2(m)$, yields

$$a_2(m) = G^{-1}(H(m)) \text{ for } m \geq \overline{m}. \quad (22)$$

Next, we derive $a_2(m)$ for $\theta\overline{m} \leq m \leq \overline{m}$. From the no-arbitrage condition (5), $a_1(m) = a_2(\theta m)$ for $m < \overline{m}$. Hence, any firm with entrepreneurial ability $a_2(\theta\overline{m}) \leq a \leq a_2(\overline{m})$ will acquire a production division in country 2 and keep production in that country, independently of the firm's country of origin. We thus have

$$(E_1 + E_2)[G(a_2(\overline{m})) - G(a_2(m))] = E_2[H(\overline{m}) - H(m)] \quad \text{for } m \in [\theta\overline{m}, \overline{m}].$$

Since (22) implies $G(a_2(\overline{m})) = H(\overline{m})$, we obtain

$$a_2(m) = G^{-1}\left(\frac{E_1 H(\overline{m}) + E_2 H(m)}{E_1 + E_2}\right) \quad \text{for } m \in [\theta\overline{m}, \overline{m}].$$

Finally, we derive $a_2(m)$ for $m < \theta\overline{m}$. We have

$$(E_1 + E_2)G(a_2(m)) = E_1 H(m/\theta) + E_2 H(m) \quad \text{for } m < \theta\overline{m}.$$

The term on the L.H.S. represents the mass of entrepreneurs from both countries who have ability less than or equal to $a_2(m)$. The second term on the R.H.S. is the mass of goods with market size m or less that will be produced in (and originate from) country 2. Since $a_2(m) = a_1(m/\theta)$, the first term on the R.H.S. represents the mass of goods that will be produced in (and originate from) country 1 and that will be managed by firms with entrepreneurial ability $a_2(m)$ or less. Solving the equation for $a_2(m)$, yields

$$a_2(m) = G^{-1}\left(\frac{E_1 H(m/\theta) + E_2 H(m)}{E_1 + E_2}\right) \quad \text{for } m \leq \theta\overline{m}.$$

The assignment correspondence $a_1(\cdot)$ follows immediately from $a_2(\cdot)$ and the no-arbitrage condition (5). ||

Proof of Proposition 1. Before proving existence and uniqueness, we show that S is strictly increasing in $\overline{m}$. To see this, note that equation (13) is of the form $S = \sigma^{-1}[D(\overline{m})]^{-1}$, where

$$D(\overline{m}) = E_1\theta \int_0^{\overline{m}} m a_2(\theta m) dH(m) + E_2 \int_0^{\overline{m}} m a_2(m) dH(m) + (E_1 + E_2) \int_{\overline{m}}^{\infty} m a_2(m) dH(m).$$

Hence, $dS/d\overline{m} > 0$ if and only if $D'(\overline{m}) < 0$. We have

$$\begin{aligned} D'(\overline{m}) &= E_1 h(\overline{m}) \left\{ \overline{m}[\theta a_2(\theta\overline{m}) - a_2(\overline{m})] + \int_{\theta\overline{m}}^{\overline{m}} \left(\frac{E_2}{E_1 + E_2}\right) \frac{m h(m)}{g(a_2(m))} dm \right\} \\ &= E_1 h(\overline{m}) \left\{ \overline{m}[\theta a_2(\theta\overline{m}) - a_2(\overline{m})] + \int_{\theta\overline{m}}^{\overline{m}} m a_2'(m) dm \right\}. \end{aligned}$$

Integrating by parts yields

$$\begin{aligned} D'(\overline{m}) &= E_1 h(\overline{m}) \left\{ \overline{m}[\theta a_2(\theta\overline{m}) - a_2(\overline{m})] + [\overline{m} a_2(\overline{m}) - \theta\overline{m} a_2(\theta\overline{m})] - \int_{\theta\overline{m}}^{\overline{m}} a_2(m) dm \right\} \\ &= -E_1 h(\overline{m}) \int_{\theta\overline{m}}^{\overline{m}} a_2(m) dm < 0. \end{aligned}$$

We now are in the position to prove existence and uniqueness. First, note that, conditional on $\overline{m}$ and S, $a_1(\cdot)$ and $a_2(\cdot)$ are uniquely determined by equations (9) and (10). Second, note that, conditional on $\overline{m}$ (and $a_1(\cdot)$ and $a_2(\cdot)$), S is uniquely determined by (13). Third, we need to show that there exists a unique $\overline{m}$ satisfying equations (12) and (13). Let

$$\Phi(\overline{m}) \equiv S \int_{\theta\overline{m}}^{\overline{m}} a_2(m) dm - \phi,$$

where S is a function of $\overline{m}$ and given by (13). We now prove that there exists a unique $\overline{m}$ such that $\Phi(\overline{m}) = 0$. Differentiating, we obtain

$$\Phi'(\overline{m}) = S\left\{a_2(\overline{m}) - \theta a_2(\theta\overline{m}) + \left(\frac{E_1}{E_1+E_2}\right)\int_{\theta\overline{m}}^{\overline{m}} \frac{h(\overline{m})}{g(a_2(m))}dm\right\} + \frac{dS}{d\overline{m}}\int_{\theta\overline{m}}^{\overline{m}} a_2(m)dm.$$

Since $a_2(\overline{m}) > \theta a_2(\theta\overline{m})$ and, as shown above, $dS/d\overline{m} > 0$, $\Phi'(\overline{m}) > 0$. Next, note that $\Phi(0) = -\phi < 0$. Finally, observe that $a_2(\overline{m}) - \theta a_2(\theta\overline{m}) \geq (1-\theta)a_2(\overline{m})$ and so $\Phi'(\overline{m}) \to \infty$ as $\overline{m} \to \infty$, which implies that $\lim_{\overline{m}\to\infty}\Phi(\overline{m}) = \infty$. Hence, there exists a unique $\overline{m} > 0$ such that $\Phi(\overline{m}) = 0$. Finally, note that, given S, $\overline{m}$, and $a_2(\cdot)$, $W_2(\cdot)$ is uniquely determined by equation (11), which in turn uniquely determines $W_1(\cdot)$ through equation (5). ‖

Proof of Proposition 2. Let $\lambda_i(a)$ denote the fraction of firms producing in country i with entrepreneurial ability less than or equal to a. We need to show that $\lambda_1(a) > \lambda_2(a)$ for all $a > 0$.

For $a \geq a_1(\overline{m})$, we have

$$\lambda_1(a) = 1 > \lambda_2(a).$$

Consider now $0 < a < a_1(\overline{m})$, and let $m_i(a)$ be such that $a = a_i(m_i(a))$, that is, $m_i(a)$ is the market size of the good that will, in equilibrium, be produced by a firm with entrepreneurial ability a in country i. We have

$$\begin{aligned}
\lambda_1(a) &\equiv \frac{E_1 H(m_1(a))}{E_1 H(\overline{m})} \\
&> \frac{H(m_1(a))}{1+(E_1/E_2)[1-H(\overline{m})]} \\
&> \frac{E_2 H(m_2(a))}{E_2 + E_1[1-H(\overline{m})]} \equiv \lambda_2(a),
\end{aligned}$$

where the second inequality follows from the observation that $m_1(a) > m_2(a)$. ‖

Proof of Proposition 8. An increase in ϕ induces an increase in the threshold $\overline{m}$ (see Lemma 4), which in turn leads to an increase in γ_1 (see equation (21)).

Consider now the effect of an increase of ϕ on μ_i. Let $\varphi(m) \equiv h(m) - \theta h(\theta m)$. Further, let $\widetilde{m}$ be defined by $\varphi(\widetilde{m}) = 0$. To see that $\widetilde{m}$ is unique, note that

$$\varphi'(\widetilde{m}) = h'(\widetilde{m}) - \theta^2 h'(\theta\widetilde{m}).$$

Further,

$$h'(\widetilde{m}) < \theta^2 h'(\theta\widetilde{m})$$

if and only if

$$\frac{\widetilde{m}h'(\widetilde{m})}{h(\widetilde{m})} < \frac{\widetilde{m}\theta h'(\theta\widetilde{m})}{h(\theta\widetilde{m})}$$

since $h(\widetilde{m}) = \theta h(\theta\widetilde{m})$. However, the last inequality must hold by condition (C2). Hence, $\varphi'(\widetilde{m}) < 0$, and so $\varphi(m) > 0$ for any $m < \widetilde{m}$, and $\varphi(m) < 0$ for any $m > \widetilde{m}$.

From (14) and (19), we have $\widehat{m} = \min\{\widetilde{m}, \overline{m}\}$. If $\phi \geq \widehat{\phi}$, then $\widehat{m} = \widetilde{m}$, and so an increase in ϕ has no effect on $\widehat{m}$, and hence (by equation (20)) no effect on μ_i. If $\phi < \widehat{\phi}$, then $\widehat{m} = \overline{m} < \widetilde{m}$. From Lemma 4, it follows that a small increase in ϕ leads to an increase in $\overline{m}$. Using equation (20) and the implicit function theorem, an increase in $\overline{m}$ induces an increase in μ_i if $\varphi(\overline{m}) \equiv h(\overline{m}) - \theta h(\theta\overline{m}) > 0$. However, since $\overline{m} < \widetilde{m}$ if $\phi < \widehat{\phi}$, it follows indeed that $\varphi(\overline{m}) > 0$. ‖

Proof of Proposition 9. Observe that the effect of a decrease in E_2, holding $E_1 + E_2$ fixed, is equivalent to the effect of increasing E_1, holding $E_1 + E_2$ fixed. Hence, we need to prove that $d\gamma_1/dE_1 - d\gamma_1/dE_2 > 0$ and $d\mu_1/dE_1 - d\mu_1/dE_2 < 0$. To this end, we first show that $\overline{m}$ is decreasing in E_1, holding $E_1 + E_2$ fixed. From equation (12), $\overline{m}$ is given by

$$\varphi(E_1, E_2, \overline{m}) \equiv \frac{\phi}{S} - \int_{\theta\overline{m}}^{\overline{m}} a_2(m)dm = 0,$$

where S is a function of E_1, E_2, and $\overline{m}$ and given by (13). Since $\partial\varphi(E_1, E_2, \overline{m})/\partial\overline{m} < 0$ (see the proof of Proposition 1), we need to show that $\partial\varphi(E_1, E_2, \overline{m})/\partial E_1 - \partial\varphi(E_1, E_2, \overline{m})/\partial E_2 > 0$. We obtain

$$\frac{\partial\varphi(E_1, E_2, \overline{m})}{\partial E_1} - \frac{\partial\varphi(E_1, E_2, \overline{m})}{\partial E_2} = \sigma\phi\left[\theta\int_0^{\overline{m}} ma_1(m)dH(m) - \int_0^{\overline{m}} ma_2(m)dH(m)\right.$$

$$
\begin{aligned}
&+E_1\theta\int_0^{\overline{m}} m\left.\frac{\partial a_1(m)}{\partial E_1}\right|_{E_1+E_2=\text{const.}} dH(m)\\
&\left.+E_2\int_0^{\overline{m}} m\left.\frac{\partial a_2(m)}{\partial E_1}\right|_{E_1+E_2=\text{const.}} dH(m)\right]\\
&-\int_{\theta\overline{m}}^{\overline{m}}\left.\frac{\partial a_2(m)}{\partial E_1}\right|_{E_1+E_2=\text{const.}} dm.
\end{aligned} \tag{23}
$$

The sum of the third and fourth terms in brackets can be rewritten as

$$
E_1\theta\int_0^{\overline{m}} m\frac{H(m)-H(\theta m)}{[E_1+E_2]g(a_2(\theta m))}dH(m)+E_2\int_0^{\theta\overline{m}} m\frac{H(m/\theta)-H(m)}{[E_1+E_2]g(a_2(m))}dH(m)
$$

$$
+E_2\int_{\theta\overline{m}}^{\overline{m}} m\frac{H(\overline{m})-H(m)}{[E_1+E_2]g(a_2(m))}dH(m).
$$

Changing variables, we obtain

$$
\theta\int_0^{\overline{m}} m[H(m)-H(\theta m)]\frac{E_1h(m)+\theta E_2h(\theta m)}{[E_1+E_2]g(a_2(\theta m))}dm+E_2\int_{\theta\overline{m}}^{\overline{m}} m\frac{H(\overline{m})-H(m)}{[E_1+E_2]g(a_2(m))}dH(m).
$$

Integrating by parts yields

$$
\theta\overline{m}[H(\overline{m})-H(\theta\overline{m})]a_2(\theta\overline{m})-\theta\int_0^{\overline{m}} a_2(\theta m)\{[H(m)-H(\theta m)]+m[h(m)-\theta h(\theta m)]\}dm
$$

$$
-\theta\overline{m}[H(\overline{m})-H(\theta\overline{m})]a_2(\theta\overline{m})-\int_{\theta\overline{m}}^{\overline{m}} a_2(m)\{[H(\overline{m})-H(m)]-mh(m)\}dm
$$

$$
\begin{aligned}
&=-\theta\int_0^{\overline{m}} a_1(m)[H(m)-H(\theta m)]dm-\theta\int_0^{\overline{m}} ma_1(m)dH(m)+\int_0^{\theta\overline{m}} ma_2(m)dH(m)\\
&-\int_{\theta\overline{m}}^{\overline{m}} a_2(m)[H(\overline{m})-H(m)]dm+\int_{\theta\overline{m}}^{\overline{m}} ma_2(m)dH(m),
\end{aligned}
$$

where the equality follows again from integrating by parts. Substituting this expression for the third and fourth terms in brackets in equation (23), we obtain that

$$
\begin{aligned}
\frac{\partial\varphi(E_1,E_2,\overline{m})}{\partial E_1}-\frac{\partial\varphi(E_1,E_2,\overline{m})}{\partial E_2}&=\sigma\phi\left[-\theta\int_0^{\overline{m}} a_1(m)[H(m)-H(\theta m)]dm\right.\\
&\left.-\int_{\theta\overline{m}}^{\overline{m}} a_2(m)[H(\overline{m})-H(m)]dm\right]-\int_{\theta\overline{m}}^{\overline{m}}\left.\frac{\partial a_2(m)}{\partial E_1}\right|_{E_1+E_2=\text{const.}} dm\\
&=-\sigma\phi\theta\left\{\int_0^{\overline{m}} a_1(m)[H(m)-H(\theta m)]dm\right.\\
&\left.-\int_{\theta\overline{m}}^{\overline{m}} a_2(m)[H(\overline{m})-H(m)]dm\right\}-\int_{\theta\overline{m}}^{\overline{m}}\frac{H(\overline{m})-H(m)}{[E_1+E_2]g(a_2(m))}dm,
\end{aligned}
$$

which is clearly negative. From (21), it then follows that γ_1 is increasing in E_1, holding E_1+E_2 fixed.

Observing that $\widehat{m}$ is independent of E_1 (since $\phi > \widehat{\phi}$ by assumption), we obtain from (20) that

$$\frac{d\mu_1}{\partial E_1} - \frac{d\mu_1}{\partial E_2} = -\frac{H(\widehat{m}) - H(\theta\widehat{m})}{E_1 + E_2} < 0,$$

and

$$\frac{d\mu_2}{\partial E_1} - \frac{d\mu_2}{\partial E_2} = \frac{H(\widehat{m}) - H(\theta\widehat{m})}{E_1 + E_2} > 0. \quad \|$$

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