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Optimal degree of foreign ownership under uncertainty

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Summary
This paper studies the determinants and consequences of equity ownership in multinational affiliates. We construct a multi-period model of foreign direct investment with incomplete contracts and uncertainty to analyse the size of equity stakes. The productivity of a multinational parent and its supplier is unknown initially to both sides and revealed only after joint production. This kind of match-specific learning implies a dynamic market for corporate equity with considerable impact on reallocation within narrowly defined industries and trading activity. We identify heterogeneity in productivity to be the key determinant of foreign equity shares, which in turn determine the intensive margin in firm imports and business survival. We test the implications of our theory with plant-level data on ownership shares and find support for the model.

Keywords: equity ownership, foreign direct investment, uncertainty, productivity

JEL Classification: D23, F23, L23

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1 Introduction

Multinational firms are prominent in the global economy. A growing share of international trade takes place between multinational firms and their foreign affiliates, while affiliate sales in host economies can dwarf trade flows (Bernard et al., 2012). These affiliates become part of a multinational's network through acquisitions or greenfield investments. In either case, a multinational needs to decide on how to integrate it into its corporate network; should it own the new affiliate fully or hold a partial equity stake? If it opts for partial ownership, how much equity position should it take? In the words of Desai et al. (2004), "the appropriate ownership of productive enterprise is a central issue in economic theory and a practical question for multinational firms establishing new foreign affiliates". Yet, we know relatively little about ownership structures in multinational affiliates and how they translate into economic outcomes at the firm and industry level.

This paper studies the determinants and consequences of equity ownership in multinational affiliates. We develop a model of firm boundaries based on the property rights approach with a costly search framework that enables us to capture the dynamics of foreign acquisitions. The main finding is that productivity heterogeneity is the primary determinant of equity ownership choices, which in turn determine the survival of affiliates and their degree of involvement in international trade. To date, most theoretical work has been on static models of multinationals' decision-making, which do not reflect the long-term strategies of these companies when they invest in unfamiliar environments. Our multi-period model highlights one way in which multinationals' ownership strategies impact on aggregate productivity and provides a new explanation for persistent within-industry differences.

Our main theoretical contribution is to extend the cross-border integration model by Antras and Helpman (2004) with incomplete contracts along two dimensions. First, we explicitly model the choice of equity shares in new investments and account for the presence of partial ownership. This allows us to highlight within-sector heterogeneity in productivity as the key determinant of ownership forms in contrast to Antras and Helpman (2004), who emphasise sector-specific factor intensities. Second, we embed the model in a multi-period framework to describe optimal firm boundaries when there is uncertainty over the productivity of new investments. In the model, a multinational firm searches for a supplier abroad with an eye to produce a final good after integrating the supplier within its production network. However, there is uncertainty over how efficiently the parent company and its newly acquired supplier can work together. Partnerships often begin in a state of uncertainty (Rauch and Watson, 2003) and they can raise issues of incentives and governance. For instance, one of the parties in a joint venture cannot agree to reward its collaborator highly for its contribution of a proprietary technology without evidence of the technology's worth (Caves, 2007).

We model this uncertainty in a search and matching framework built on Jovanovic (1979). Specifically, the multinational parent and the supplier receive a noisy signal about their true "match quality" before any production takes place. If the two parties decide to carry out production, they agree on an initial division of equity shares. True match quality is revealed only after joint production takes place, whereby the multinational can update its equity investment or divest completely based on the knowledge it acquired about the supplier. This implies that multinationals follow reservation strategies with regard to observed productivity levels when they make equity investment decisions. In equilibrium, we only see the highly productive suppliers targeted by multinationals and the most productive staying in business relationships with them. The model delivers a nondegenerate distribution of equity shares that depends on within-sector heterogeneity and it suggests that the average degree of foreign ownership rises with affiliate age. At the same time, it identifies the degree of foreign equity participation as a determinant of the intensive margin in intrafirm trade, which existing models are silent on.

In the empirical sections of the paper we draw on a panel of plant level observations from the census of manufacturers in Turkey, which has the advantage of reporting the exact equity share owned by foreign investors. Our model is motivated by three observations from this database. First, most multinational affiliates operating in Turkey have only a partial equity stake by their parent companies regardless of industry or size. Data reveal substantial variation in the degree of ownership across affiliates, which are represented in all sectors of the economy.[1] Second, the average degree of foreign equity stake at affiliates rises with years of operation. This is driven both by the divestment in affiliates with mostly minority shares and increases in the degree of parent equity as production continues into future years. Third, firms display substantial heterogeneity within sectors in productivity, factor use, import activity and the contractibility of inputs. Within-sector heterogeneity in productivity is well documented in the literature, while heterogeneity in import activity and input contractibility is not understood as well. An advantage of our database is that we can match plants with detailed product level data on domestic and imported inputs to study the intensive margin in trade and input contractibility.

Despite the empirical evidence, theoretical models of foreign direct investment (FDI) are mostly silent on partial ownership. Existing models of firm boundaries based on the property rights approach only account for the binary definition of ownership; either the parent has complete ownership or the supplier does (Antras and Helpman, 2004, 2008). Previous work on equity sharing in FDI instead focuses on bargaining (Svejnar and Smith, 1984), transaction costs (Asiedu and Esfahani, 2001), information asymmetries (Raff et al., 2009), contractual hazards and financial market frictions (Henisz, 2000; Antras et al., 2009; Assche and Schwartz, 2013) and debt shifting (Schindler and Schjelderup, 2012).[2] While these studies touch on the role of firm-specific assets, their focus is on host country characteristics in determining ownership structures.

We contribute to this theoretical literature by highlighting the role of firm heterogeneity. Our model inherits the notion from the property rights approach that a multinational parent should be given a higher share of equity when its input is relatively more important in production. However, we explicitly model firm heterogeneity and show that it is more important than inputs in production to explain equity shares at foreign affiliates. This is due to the fact that any foreign investment project entails long lasting interest and control. A parent company demands a greater

[1]This phenomenon is not unique to Turkey; a number of studies have reported the prevalence of partial ownership using commercial databases. Using SDC Thompson's International Mergers and Acquisitions database for 16 emerging countries over the period 1990-2007, Alquist et al. (2014) document that more than half of acquisitions by foreign investors entail partial ownership. Similarly, Fons-Rosen et al. (2013) use the ORBIS database for 30 developed and emerging countries to show that the majority of foreign firms in their manufacturing sample are partially owned.

[2]See Caves (2007) for a review of the transaction costs approach.

share of equity at its newly established affiliate when it observes a persistently high level of productivity as this is the key determinant of a firm's value. This more than makes up for the potential loss in revenue due to its supplier's under-investment, which arises as a result of a lower share of revenues accruing to the supplier in such a case.

The model in Antras and Helpman (2004) inherits the silence of the property rights framework on revenue sharing; ownership of an asset translates into a fixed outside option in ex post bargaining. We depart from this set-up by allowing for the outside option of the asset owner to vary with its share of equity in the firm, which we model as a partial claim on manufactured inputs.[3] Equity shares have a monotonic impact on the share of revenue that accrues to a multinational investor via its outside option, but the presence of incomplete contracting provides gains from ex post negotiation.[4] This is in line with the evidence in Bhattacharyya and Lafontaine (1995) that in practice sharing rules tend to be linear and optimal. Revenue sharing thus follows a bargaining game in which partial ownership of assets vary parties' outside options. In that sense, our set-up resonates with those in Dasgupta and Tao (2000), Harbaugh (2001) and Van den Steen (2002) in which partial equity stakes increase relationship efficiency by changing the threat points in the bargaining game over joint surplus (Fee et al., 2006). This alleviates the hold-up problem between the partners and helps us to capture the importance of firm-level productivity over sector-level intensities.

Our framework provides an alternative explanation to selection patterns of host country firms targeted by multinational investors and the subsequent industry reallocation. The literature has often argued that foreign investors transfer similar technologies from parent firms to affiliate firms, which subsequently see increases in their productivity. However, such a mechanism would imply a negative selection of host country firms whereby the least productive targets are subject to acquisition (Guadalupe et al., 2012). Empirical evidence suggests otherwise and documents positive selection of target firms.[5] We add to this literature on "cherry-picking" by providing further evidence and offering a theoretical framework to rationalise it. In our framework, cherries are acquired in the expectation that they can be productive manufacturers of inputs to fit a multinational's firm-specific assets. If target firms turn out not to be cherries, then they are divested. In equilibrium, multinationals retain and control only the most productive local firms, which generates the observed productivity advantage of foreign affiliates over domestic firms. In addition, divestment of relatively low quality affiliates shifts the productivity distribution and preserves the superiority of high quality affiliates. Hence, the model generates cherry-picking and accounts for the two empirically robust observations of the productivity literature on the persistence of within-industry differences and firm survival (Syverson, 2011).

[3]Residual control rights remain with the multinational investor regardless of the division of equity in our setting. This is because headquarter services can only be provided by the multinational parent, while an infinite supply of input suppliers remains available to match with. Our analysis therefore focuses only on the influence of equity on revenue sharing and abstracts from the control aspects. See Halonen (2002), Cai (2003) and Wang and Zhu (2005) for theoretical discussions on the optimality of joint ownership and control.

[4]We retain the assumption that an enforceable profit-sharing contract cannot be written, so an ex ante division of revenues is not possible. Bai et al. (2004) and Wang and Zhu (2005) present frameworks where revenue-sharing contracts are explicitly modelled.

[5]For empirical evidence on cherry-picking see Ramondo (2009) for Chile, Arnold and Javorcik (2009) for Indonesia, Criscuolo and Martin (2009) for the United Kingdom and Guadalupe et al. (2012) for Spain.

Understanding the ownership structure of firms in contractual settings has important implications for aggregate productivity. When productivity is relationship-specific and contracts are incomplete, multinational companies need to be sufficiently incentivised to commit resources to production. This can be achieved by allocating a greater share of an affiliate's equity to the multinational, but it runs the risk of discouraging investment by the local partner. Unless operations are sufficiently profitable, the multinational is unlikely to enter a long-term project in which it cannot exert sufficient control. When affiliates are not deemed sufficiently productive, they are divested and the relationship-specific capital is destroyed. This tends to lower aggregate efficiency and highlights why relationship stability is important to productivity (Kellogg, 2011).[6]

Existing firm-level literature has studied intra-firm trade when foreign affiliates are wholly owned.[7] However, the prevalence of partial ownership calls for a theory that can explain the incidence of different equity structures and how they affect intra-firm trade at the same time. Corcos et al. (2013) suggest that the property rights model of FDI can be extended to allow for firm-specific technologies to account for the wide variation in factor intensities within narrowly defined sectors. They also suggest that intrafirm import shares are driven by the intensive margin rather than individual sourcing choices. Our model can explain these phenomena by linking heterogeneity in productivity and import values to the degree of foreign ownership. We find that affiliates with greater foreign equity should also receive greater flows of inputs from their headquarters within an industry. In the empirical section of the paper, we offer suggestive evidence in support of this mechanism. We show that higher foreign equity participation leads to more imported inputs, but we cannot ascertain whether these constitute intra-firm transfers as our data do not distinguish between affiliated-party and arm's length trade. However, we show that foreign equity shares are inherently associated with the share of relationship-specific inputs used in production, thereby indicating the degree of relationship formation at an affiliate.

We present further empirical evidence to demonstrate how firm heterogeneity shapes decisions over equity ownership, explaining more of the variation in the latter than sector-level indicators. We show that multinational investors target the most productive suppliers, taking up higher equity stakes at relatively more productive ones and only retaining control of affiliates that lie at the highest end of the productivity distribution. Instrumental variables estimation suggests that the mechanisms we identify, first from productivity to equity shares and second from equity shares to import values, represent causal relationships rather than simple correlations.

Other recent work discusses the impact of multinationals on productivity dynamics. Guadalupe et al. (2012) show how foreign acquisitions can sustain within-industry differences by focusing on the market access provided by multinationals and the incentives to innovate following acquisitions. Fons-Rosen et al. (2013) document cherry-picking in a large set of countries and focus on spillovers from FDI, estimating that it is not important for country-level productivity growth. Our work also relates to the empirical literature on multinationals' ownership preferences. Earlier studies tested the implications of transaction costs and bargaining models (Nakamura and Xie, 1998; Asiedu and Esfahani, 2001; Bai et al., 2004). Desai et al. (2004) document the increased

[6]Our treatment of relationship-specific productivity is similar to the concept in Kellogg (2011) in that multinationals cannot transfer knowledge acquired with a supplier to working with other suppliers. However, our framework differs crucially from his in that match-specific productivity does not increase with experience.

[7]This literature has so far focused on the decision between outsourcing versus related-party trade; see Kohler and Smolka (2009), Corcos et al. (2013) and Defever and Toubal (2013) for firm-level evidence.

propensity of US multinationals to prefer full ownership over partial ownership at their affiliates since the 1980s as a result of liberalised ownership restrictions and joint venture tax penalties of 1986. They find that the increased use of 100 per cent equity stakes led to greater intra-firm trade and transfer of technology, which is in line with the model developed in the current paper.

The rest of the paper is organised as follows. Section 2 documents the extent of partial ownership and the dynamics of equity investment at foreign affiliates in Turkey. We build our two-stage model in Section 3 to account for the empirical regularities. Section 4 presents the econometric strategy to test the implications of the model and the results of these tests. Section 5 concludes. All proofs, a detailed description of the variables used in the empirical analysis and additional results can be found in the Appendix.

2 Partial ownership and equity investment dynamics

We use data on foreign equity investment from the Industrial Analysis Database provided by the Turkish Statistical Institute (TurkStat). The database contains an annual census of manufacturers in Turkey with 10 or more employees over the period 1993-2001 with detailed information on plant characteristics.[8] The distinctive advantage of the database is that we can observe the exact equity share held by multinational investors at each plant and track these investments over time. A fully liberal equity framework has been in place in Turkish manufacturing during this period with minimal requirements on screening and prior approval, personnel or other operations (Kalinova et al., 2010). This enables us to observe multinationals' decisions over equity stakes across sectors and time that are not induced artificially by the country's legal framework.

We define a firm to be a multinational affiliate in any given year if it has a positive level of equity held by a foreign investor. In the sample, the minimum equity stake is 1 per cent and the maximum is 100 per cent.[9] Table 1 summarises the presence of multinationals in our sample. Multinational affiliates were large and important players over this period, employing around 13 per cent of the labour force and contributing close to a third of the value added in manufacturing. They were most prevalent in sectors such as chemicals, transport equipment and electrical machinery, but also active in sectors such as food and beverages, wearing apparel and textiles, and represented across each sector. Most interestingly, there is substantial variability in the degree of ownership at multinational affiliates. Chart 1 points to the prevalence of partial ownership and the heterogeneity in foreign equity participation observed at the affiliates. One can notice the full range of equity stakes across different intervals, with equity stakes slightly more abundant around 50 per cent and above 90 per cent. Table 2 alternatively documents the prevalence of partial ownership (panel (a)); more than a third of the affiliates were under minority control during this period, while only a fifth is completely integrated with the parent company. In unreported figures, we find these patterns to be robust across sectors and firm sizes.

In Table 2, we document the equity dynamics at multinational affiliates. Panel (b) shows that the equity breakdown in foreign investment projects remains mostly the same from one year to the next when multinational parents remain in control of the plant ("continuing investments"). This is not surprising in light of costly corporate restructuring and the theoretical model we develop later, which predicts no change in the equity breakdown once learning takes place. However, there are considerable changes in equity shares and ownership in any given year. On average 34 affiliates experience either an increase or decrease in their equity structure exceeding 1 percentage point in any given year even as they remain under the same multinational's control.[10] When we additionally consider new acquisitions by multinationals, the average number of firms experiencing a change in their equity structure jumps to 72, which roughly constitutes one-fifth of all affiliates in any given year. At the same time, on average 45 affiliates were divested by their

[8]TurkStat collected information at the plant level during this period but the overwhelming majority of firms in Turkey are single-plant firms (Ozler et al., 2009). We therefore use the terms firm and plant interchangeably.

[9]FDI is typically defined as involving an equity stake of 10% or more in national and international accounting standards, with stakes less than 10% classified as portfolio investment. In our sample only around 8% of foreign investment projects would be classified as portfolio investment.

[10]This number is only slightly reduced when we look at changes exceeding 5 percentage points. This implies that when equity changes occur they typically involve sizeable stakes.

multinational parents in any given year.

These figures point to an active market in equity at firms targeted and controlled by multinational investors. Panel (c) demonstrates this active market, where we report transition probabilities across different intervals of equity shares, including the case of domestic ownership. First, there is a less than 1 per cent chance of a domestic firm in any period becoming a multinational affiliate in the next period, but if it does so it will most likely be partially owned. Second, reading across the diagonal of the matrix shows that any affiliate has at least a 10 per cent chance of seeing a change in its equity structure from one year to the next. This probability is declining in the affiliate's initial degree of foreign equity, with affiliates under minority control facing at least a 15 per cent chance of change in their equity structure in any given year. Third, a change in the equity structure for an affiliate most likely involves a divestment or an increase in its foreign equity share, with the former the more probable option.[11] This implies that for surviving multinational affiliates, the average degree of foreign equity should rise over time. Indeed, Chart 2 demonstrates this phenomenon, where we plot average foreign equity share across affiliates against the number of years that the affiliates have been in operation.[12] We confirm in an additional appendix (Table C.1) that equity shares rise with the age of the affiliate even after controlling for sector, year or firm-level fixed effects.

Head and Ries (2008) report that from 1987 to 2001 about two-thirds of FDI took the form of mergers and acquisitions rather than new investments; this pattern is mirrored in our data. In Table 2 we finally investigate whether the equity dynamics differ by this breakdown. Panel (d) shows that the rise in average foreign equity shares with affiliate age is more pronounced for greenfield investments than acquisitions. This could arise if there is greater uncertainty over the efficiency of a new plant than an existing one that is an acquisition target, or if initial investment contracts give more flexibility to multinationals over the equity structure in newly established plants. Panel (d) also reveals the dynamics of firm size by type of investment, which shows an upward trend with affiliate age in each case.

One concern about changes in equity and divestments in the data could be regarding the type of foreign investor. If foreign investors are private equity firms or venture capitalists, which typically acquire a partial equity stake in target companies and look to exit within several years, then we might overestimate the importance of equity investment dynamics. This should not be a concern in our case, as private equity was almost non-existent for the period under consideration in Turkey.[13]

There are several empirical regularities that emerge from the data. First, we observe multinational

[11] Partially owned affiliates often remain so even when they see increases in their foreign equity share. In the data, there is only a 2.8 per cent chance in any period that a partially owned affiliate will become fully owned the next period.

[12] We construct this chart using only those affiliates that have entered the sample after 1993 and for which we can pin down the exact number of years of operation. In the chart, predicted foreign equity participation is a univariate fractional-polynomial estimate.

[13] A recent report by the consultancy Deloitte records all the private equity investments in Turkey between 1995 and 2007. In our period of analysis, there were only 11 investments in total by foreign private equity firms in manufacturing sectors. The report is available at http://www.deloitte.com/assets/Dcom-Turkey/Local%20Assets/Documents/turkey-en_cf_PEinTurkey_210607.pdf.

activity not only in sectors that are relatively intensive in their use of headquarter services, but also in sectors where manufactured inputs constitute the primary factor of production. Second, we see partial ownership as the most commonly preferred equity structure across sectors with significant dispersion of foreign equity stakes across affiliates. Third, the average equity share of foreign investors increases with affiliate age as multinationals often acquire smaller equity stakes in earlier years of investment and adjust their stakes over time. At the same time, affiliates are often subject to divestments by parent companies. Data also reveal substantial heterogeneity within sectors in productivity, factor use and trading activity (see section 4.1). These features of the data have gone unaddressed in the theoretical literature before.

3 The model

3.1 Partial integration

In this section we extend the model in Antras and Helpman (2004), henceforth AH, to incorporate partial ownership in the study of FDI.

There are two countries, North and South, and a single factor of production, labour. Preferences are as in AH, so that the world population consists of a unit measure of consumers with identical preferences given by: $U = x_0 + \frac{1}{\mu}\sum_{j=1}^{J} X_j^{\mu}$, where x_0 represents consumption of a homogeneous good, μ is a parameter and aggregate consumption in sector j is a CES function of the consumption of different varieties $x_j(i)$: $X_j = \left[\int x_j(i)^{\alpha} di\right]^{1/\alpha}$. We retain the AH assumption that varieties within a sector are more substitutable for each other than they are for x_0 or for varieties from a different sector; that is, $1 > \alpha > \mu > 0$. These preferences imply that final goods producers face the following inverse demand function for each variety i in sector j: $p_j(i) = X_j^{\mu-\alpha} x_j(i)^{\alpha-1}$.

There is a perfectly elastic supply of labour in each country, and wages are given by w_N and w_S in the North and the South, respectively. Assume $w_N > w_S$. Output is produced using a combination of two inputs that are specific to the variety, $h_j(i)$ and $m_j(i)$, where the headquarter services input $h_j(i)$ can be produced only in the North. The manufactured components $m_j(i)$ can be produced in either country. Essentially, however, every final good producer needs to contract with a manufacturing plant operator for the provision of the variety-specific components (AH). This means that an input that is crafted to be used in a certain variety has no valuable use in the production of some other variety. Accordingly, output is produced following the Cobb-Douglas function:

$$x_j(i) = \theta \left[\frac{h_j(i)}{\eta_j}\right]^{\eta_j} \left[\frac{m_j(i)}{1-\eta_j}\right]^{1-\eta_j}, 0 < \eta_j < 1, \tag{1}$$

where θ is a match-specific productivity parameter that is unknown to both the final good producer and the manufacturing supplier at the time of the match. Note that this parameter should in fact be denoted as θ_i; we drop the subscript to simplify notation. The parameter η_j controls the headquarter intensity of the production and is sector-specific.

A major assumption built into the model is that there exists a non-degenerate distribution of productivities for a final good producer across different suppliers. We interpret θ as a measure of how complementary the two sides to the match are and as reflecting the cost-saving advantages to the final good producer of monitoring the supplier. This will show variation across suppliers due to plant-specific factors such as location, organisational form or labour composition. The match-specific productivity is unknown in the first period and is revealed to both sides only after continued joint production in the second period. As in Jovanovic (1979), θ is distributed independently across suppliers, which means that the "informational capital" generated through joint production is completely match-specific. Hence, the final good producer's previous experience with other suppliers carries no information about its productivity with new suppliers.

The distribution of θ in the population is known and we follow the common assumption regarding firm productivities: $\theta \sim Pareto(b, \gamma)$, where $b > 0$ is the scale parameter and $\gamma > 2$ is the shape parameter.[14] Accordingly, the cdf is given by: $G(\theta) = 1 - (b/\theta)^{\gamma}$ with $\theta \geq b$. In order to draw the match-specific parameter with a supplier, the final good producer pays a fixed cost of entry $w_N f_E$. Upon payment of this fixed cost, the final good producer matches with a supplier with probability one and receives a noisy signal on θ. Since the signal relates to match-specific productivity, it only carries partial information about the supplier's initial productivity. In practice, this information is acquired as a result of the multinational's search for a partner as captured by, for instance, site visits. Our interpretation is reflected in the summary of US buyers looking for partners in developing countries (Egan and Mody, 1992):

"Buyers looking for either new sources of supply or joint venture partners search for suppliers who manage their factories efficiently, often regardless of the level of technology those factories currently employ [...]. For many buyers, management was the most important factor in defining an ideal supplier. It was also the main reason to visit a factory before forming a relationship: to observe management in action."

If a match persists, the final good producer decides on the ownership structure of the match ("the firm"), which determines the additional *fixed organisational costs* to be incurred. Following AH, we interpret these costs as the sum of all costs that pertain to the search for a supplier in the South and to the management of the firm, which entails supervision, quality control, accounting and marketing among other things. We assume in addition that the fixed organisational costs are increasing in the final good producer's ownership share. This assumption reflects the idea, for instance, that a multinational firm may be required to hire a larger team of management and devote more time to training at a firm in which it has majority share. Due to economies of scale in operation, however, a multinational may not incur as high fixed costs once it achieves effective control of the firm. Hence, the fixed organisational costs are denoted as $w_N \delta^{\phi}$, where $\delta \in (0, 1)$ is the equity share of the multinational at the firm and $\phi \in (0, 1)$ is an exogenous parameter.

We focus specifically on vertical integration as the organisational form of the firm in this paper. We assume that the multinational has already made its decision to obtain the manufactured input from a vertically integrated supplier in the South. AH establish that there always exist high productivity final good producers that choose to acquire manufactured inputs via FDI. The crucial question we ask is: where does the multinational draw its boundaries in owning the manufacturing plant operator in any given period? In other words, is there an optimal level of integration, $\delta^* \in (0, 1)$, for each period given the multinational's characteristics?

We adopt the incomplete contracts setting due to Antras (2003), where ownership of the suppliers entitles final good producers to residual rights of control. Following the property-rights approach, input suppliers and final good producers cannot sign enforceable contracts specifying the purchase of a certain type of intermediate input for a certain price (Antras, 2003). As such, the division of the firm's revenue is determined by an ex post bargaining procedure following the production of the inputs. As in AH, ex post bargaining takes place under all organisational forms and is modelled as a generalised Nash bargaining game over potential revenue, which is given

[14] $\gamma > 2$ is required for the distribution to have finite variance.

by: $R_j(i) = p_j(i)x_j(i) = X_j^{\mu-\alpha} x_j(i)^{\alpha}$.

In the Nash bargaining procedure, the outside option of the supplier is always zero since its input is completely variety-specific. The final good producer's outside option, however, depends positively on the share of the firm it controls. Specifically, δ determines the fraction of the manufactured input that the final good producer has residual rights over. In the ex post bargaining, the final good producer can seize its share of the manufactured input, δ, once production has already taken place and sell an amount $\delta x(i)$.[15] This translates into a fraction δ^{α} of the revenue if the final good producer carries out production on its own. Let $\beta \in (0, 1)$ denote the fraction of the ex post gains from entering a production relationship that go to the final good producer. Given this definition of residual rights, the share of the revenue that the final good producer captures is given by $\beta_V = \delta^{\alpha} + \beta(1-\delta^{\alpha})$ as a result of generalised Nash bargaining, which reflects the final good producer's outside option plus its share of ex post gains. The revenue share for the supplier is $(1-\beta)(1-\delta^{\alpha})$, or equivalently $1-\beta_V$. This division rule reflects the idea that partial ownership of a firm is necessarily associated with the rights to claim part of the firm's profit streams and asset ownership is often regarded as entailing the claim on the returns, or more precisely residual income, from the asset (Wang and Zhu, 2005). This is especially the case in joint ventures where revenue sharing is a common practice (Dasgupta and Tao, 2000; Hauswald and Hege, 2009).

The final element of the model is an upfront payment in each period by the supplier to participate in the match. The upfront payment could be either positive or negative and is included in the contract that is offered to the potential supplier by the multinational. The contract offer follows the decision for the level of integration. As in AH, we assume an infinitely elastic supply of suppliers so that their profits from the relationship inclusive of the upfront payment are equal to their ex ante outside option, which is set to zero for simplicity.

The timeline of the model is outlined below.

1. Period 1 starts. The final good producer enters the industry and pays the fixed cost of entry, $w_N f_E$.
2. An unmatched supplier and the final good producer form a pair and draw a random match parameter θ from a known distribution with cumulative distribution function $Prob\{\theta \leq s\} = G(s)$. The value of θ is unknown to both sides of the match at this point.
3. After the match is formed, the final good producer and the supplier receive a signal y, which is a random draw from the uniform distribution over the range $(0, \theta]$.[16] [17] Following the realisation of the noisy signal, the final good producer may choose to exit the match or offer

[15] Restricting δ to be less than 1 ensures that the supplier produces a positive amount of the manufactured input in each period. It is straightforward to account for the case of complete integration ($\delta = 1$) by assuming that the final good producer can only sell an amount $\delta \times (1-\varepsilon)$ of output with ε fixed. We focus on internal solutions in the remainder of the paper to keep the model simpler.

[16] We let the signal be a random draw from the uniform distribution for purposes of tractability. In particular, this set-up yields the Pareto distribution to be "conjugate"; that is, the posterior distribution of the parameter of interest belongs to the same family as the prior distribution. The model could be easily extended to the case where the signals are also distributed Pareto - in this case, the posterior distribution will belong to the Gamma family of distributions when the shape parameter is unknown, and to the Pareto family when the scale parameter is unknown.

[17] Notice that the lower boundary on the range of the signal is known, while the upper boundary is not. One can also imagine a case where the lower boundary is unknown as well, for example some range $[\theta_1, \theta_2]$. This could be

a contract to the supplier. If the final good producer leaves, it can seek out a new supplier, draw a new match parameter, θ', and receive a noisy signal on it, y', the next period.

4. If the final good producer stays, it negotiates a multi-period contract with the supplier. The contract sets forth the share of the firm that the multinational will own this period, δ_1, with the understanding that this can be updated when the uncertainty is resolved. The contract also specifies an upfront payment, t, that is to be paid by the supplier for each period that the match survives and can be updated. Note that t could be positive or negative and the supplier has an outside option of zero in each period.

5. If the parties to the match cannot reach an agreement, the match breaks up. The final good producer can then seek out a new supplier and draw a new match parameter, θ', in the next period. If the multi-period contract is accepted, the match survives into the next period.

6. Upon acceptance of the contract, the final good producer acquires its negotiated stake, δ_1, as specified in the contract. The final good producer and the supplier then independently choose their quantities, h and m respectively, to maximise their own pay-offs.

7. Output for the first period is sold and the resulting revenue is divided following a generalised Nash bargaining procedure. Period 1 ends.

8. Period 2 starts. In the case of survival, the true value of θ is revealed to both sides of the match as a result of continued joint production. The final good producer has the option to terminate the contract at this point or update it. If the multi-period contract is updated, the final good producer picks its optimal stake this period, δ_2, which will apply in all subsequent periods as well.

9. The final good producer and the supplier choose their quantities non-cooperatively to maximise their own pay-offs. Output for this period is sold and the resulting revenue is shared following a generalised Nash bargaining procedure. Period 2 ends.

The current model endogenises the likelihood of divestment over time. It is still of interest, however, to study an exogenous impact that may dissolve a match, which ensures that there exists a set of domestic suppliers that remain unmatched in each period. We assume that a firm in production is subject to adverse liquidity shocks with the hazard of separation occurring at the exogenous rate λ. Once joint production starts, the firm could receive a liquidity shock in any of the future periods.

Before describing the equilibrium under uncertainty, we study the per-period problem that the final good producer and the supplier face. In the case that parties reach agreement, one can write the revenue in each period, using (1), as:

$$R(i) = X^{\mu-\alpha}\theta^{\alpha}\left[\frac{h(i)}{\eta}\right]^{\alpha\eta}\left[\frac{m(i)}{1-\eta}\right]^{\alpha(1-\eta)}, \tag{2}$$

handled similarly where the prior joint distribution of θ_1 and θ_2 are bilateral bivariate Pareto, which gives rise to a posterior joint distribution in the same family of distributions.

where we have dropped the subscript, j, to focus on a single industry. In the case of disagreement, the outside option of the supplier remains zero but that of the final good producer depends on its share of the firm, δ.

Following the final good producer's choice of δ in each period, the parties to the match independently choose the quantities of their inputs. Given the non-contractibility of the supply of inputs, each input supplier maximises its own pay-off. The final good producer's problem is to pick the amount of headquarter services to maximise $\beta_V R(i) - w_N h(i)$, and the supplier's problem is to pick the amount of intermediate inputs to maximise $(1-\beta_V)R(i) - w_S m(i)$. Substituting the expression in (2) for $R(i)$ and taking first order conditions, the Nash equilibrium quantities are:

$$h^*(i) = \eta \left(X^{\mu-\alpha}\theta^\alpha \alpha\right)^{\frac{1}{1-\alpha}} \left(\frac{\beta_V}{w_N}\right)^{\frac{1-\alpha(1-\eta)}{1-\alpha}} \left(\frac{1-\beta_V}{w_S}\right)^{\frac{\alpha(1-\eta)}{1-\alpha}} \tag{3}$$

$$m^*(i) = (1-\eta) \left(X^{\mu-\alpha}\theta^\alpha \alpha\right)^{\frac{1}{1-\alpha}} \left(\frac{\beta_V}{w_N}\right)^{\frac{\alpha\eta}{1-\alpha}} \left(\frac{1-\beta_V}{w_S}\right)^{\frac{1-\alpha\eta}{1-\alpha}} \tag{4}$$

These quantities reflect the optimal decisions of the sides to the match after uncertainty is resolved; that is, at stage 9 of the game. When the input suppliers are making their input decisions prior to the resolution of the uncertainty, at stage 6, they will be picking their quantities conditional on the information that they receive about the true joint productivity. The optimal quantities under uncertainty are then given by the first order conditions to each supplier's programme, which maximise own per-period *expected* pay-offs. Since both input suppliers are assumed to update their beliefs about θ in a Bayesian fashion, the expected pay-offs substitute $E[\theta^\alpha|y]$ in place of θ in (2).

The ratio of headquarter services to manufactured inputs is given by:

$$\frac{h^*(i)}{m^*(i)} = \frac{\eta}{1-\eta} \frac{\delta^\alpha(1-\beta)+\beta}{1-\delta^\alpha(1-\beta)-\beta} \frac{w_S}{w_N}, \tag{5}$$

since $\beta_V = \delta^\alpha(1-\beta)+\beta$. Notice that taking headquarter intensity and wages as fixed, $h^*(i)/m^*(i)$ depends only on δ. Hence, the model generates within-sector heterogeneity in factor use due to the level of integration. The optimal intensity of headquarter services is independent of θ due to the symmetry between the two input suppliers' (lack of) information about θ in each period. In the first period, they both observe the same signal y, which returns the same conditional expectation about θ, while in the second period the true value of θ is revealed to both sides. This informational symmetry prevents the sides to the match from learning more about θ through each other's input choices. Given this, the final good producer's optimal level of integration will be changing as the firm endures to the extent that it is affected by the resolution of the uncertainty. In particular, the production line will be getting more intensive in the use of headquarter services if δ increases following the removal of uncertainty in equilibrium. There is also a cross-sectional prediction that *h/m* should be higher at affiliates with higher levels of foreign equity within the same industry.

Using the first order conditions in (3) and (4) along with (2) gives the total per-period value of the firm as measured by total operating profits:

$$\pi(\delta, \theta, X, \eta) = X^{\frac{\mu-\alpha}{1-\alpha}} \theta^{\frac{\alpha}{1-\alpha}} \psi(\delta, \eta) - w_N \delta^{\phi} \quad (6)$$

where

$$\psi(\delta, \eta) = \alpha^{\frac{\alpha}{1-\alpha}} \left(\frac{\beta_V}{w_N}\right)^{\frac{\alpha\eta}{1-\alpha}} \left(\frac{1-\beta_V}{w_S}\right)^{\frac{\alpha(1-\eta)}{1-\alpha}} (1 - \alpha\eta\beta_V - \alpha(1-\eta)(1-\beta_V)) \quad (7)$$

$$\beta_V = \delta^{\alpha}(1-\beta) + \beta$$

and $w_N \delta^{\phi}$ reflects the (per-period) fixed costs of integration. Recall that $\phi > \alpha$ is a parameter that describes the marginal fixed cost of acquiring an ownership stake at the firm. We assume that this marginal fixed cost decreases with the level of integration as the final good producer is required to commit a greater amount of resources initially to take control of the firm. Accordingly, $\phi \in (0, 1)$. Profits are strictly increasing in θ and strictly decreasing in w^N and w^S as expected.

Following AH, we consider an industry with high headquarter intensity η such that operating profits excluding organisational costs are increasing in the final good producer's share of the revenue.[18] This set-up highlights the importance of the input by the final good producer and lays the basis for the observation that most FDI takes place in hi-tech-intensive industries. Since we focus specifically on vertical integration in the South, this is equivalent to the set-up in AH where $\psi(\beta_V, \eta)$ is increasing in β_V regardless of where production takes place. The intuition here is that in a high headquarter intensity sector, "the marginal product of headquarter services is high, making under-investment in $h(i)$ especially costly and integration especially attractive" (AH).

In solving any given period's subgame, the upfront payment specified in the multi-period contract, t, ensures that the final good producer effectively maximises the total value of the firm in every period.[19] Given the structure of the profits in the stage game, is there an optimal level of integration δ^* that maximises (6)? This is the question that the final good producer needs to answer at stage 8 of the game after both parties to the match learn the true value of θ (the same question needs to be answered also in the first period at stage 6, when θ is still unknown). It is equivalent to asking whether the firm's operating profits, (6), are concave in δ^{α}; for if not, then the optimal level of integration happens either at extremes (for example in the case of linearity) or at multiple points.

Proposition 1 There exists a unique optimal value for the level of integration, $\delta^* \in (0, 1)$, that maximises the total operating profits of the multinational firm at the stage game.

Chart 3, panel (a), shows the relationship between the firm's operating profits and its degree

[18] Where deemed useful, we comment on how the model can accommodate low headquarter intensity sectors (see, for example, the proof of Proposition 1) and provide intuition for comparison purposes.

[19] See AH for proof of this assertion.

of integration for various levels of headquarter intensity; profits are maximised at intermediate levels of integration in all cases. Notice also that the optimal level of integration is increasing in η. For industries that are relatively more intensive in the use of headquarter services, both the optimal integration level and the absolute level of profits are rising in η. The reason for this lies at the heart of the hold-up problem, whereby a larger share of the manufactured input's ownership should be given to the side whose investment has greater impact on the joint surplus. In high η industries, the marginal product of the input from the headquarters is much greater than that of the supplier's. Therefore, the under-investment in the manufactured input that is caused by a higher degree of integration is more than offset by the rise in total revenues driven by increased employment of headquarter services. Consequently, the share of the revenue that the final good producer captures from the relationship is increasing in the intensity of headquarter services. We refer to this dependence of the optimal degree of integration on η as the "Antras effect."

A second important result from the stage game concerns how δ^* changes with match-specific productivity. As seen from (2), the revenues of the firm are strictly increasing in θ. Given a higher level of productivity, a final good producer is inclined towards capturing a greater share of the revenue. However, this decreases the share that is left to the supplier, causing under-investment in the manufactured input. The downward pressure on the revenue level caused by the supplier's under-investment can potentially outweigh the gains from a productivity increase. Yet, in an industry with high headquarter intensity, the marginal product of the manufacturing input is relatively low. This enables the final good producer to choose a higher stake at the firm without distorting the incentives of its supplier by too much.

Proposition 2 The optimal level of integration is increasing in the match-specific productivity level; that is, $\partial\delta^*(\theta)/\partial\theta > 0$.

We refer to this dependence of the optimal degree of integration on θ as the "match quality effect." Chart 3, panel (b), relates operating profits to δ for a range of joint productivities in the same industry. While the Antras effect highlights the role that sector-specific headquarter intensity plays in determining δ^*, the match quality effect emphasises within-sector heterogeneity along joint productivity. Given a non-degenerate distribution of θ, the stage games produce a non-degenerate distribution of δ^* among the affiliates. Producers show variation in their level of integration not only along headquarter intensity, but also their joint productivities within similar industries. Which one of these effects is more instrumental in determining δ^* is essentially an empirical question. Another important implication of Proposition 2 is that the optimal ratio of investments in headquarter services and manufacturing inputs, given by (5), is higher for those affiliates with a higher match quality in any given industry. Within-sector heterogeneity in productivity translates into factor intensity heterogeneity for the affiliates due to the variation in their optimal degree of foreign ownership.

3.2 Equilibrium under uncertainty

In serving a host country market, the multinational seeks to maximise the expected present value of its profits. Given the structure of the multi-period contract, this will be equivalent to maximising the total profit stream of the match. The problem for the multinational is to determine the optimal path of integration with a manufacturing supplier to achieve this goal. This includes the option that the final good producer withdraw from the partnership in order to seek a new match at any period in the relationship. We solve the problem by working backwards, starting in period 2.[20]

From stage 8 onwards, the final good producer knows the true value of θ, which will be its joint productivity with the supplier in this and all future periods. Let $J(\theta)$ denote the expected present value of profits to a firm who has a known match quality θ and is behaving optimally. Note that having realised its true productivity, the final good producer could calculate its optimal level of investment, δ_2^*, and stipulate this level in the contract to be updated. Therefore, θ is a sufficient statistic for the firm's expected present value at any period in time, which allows us to write the value function in terms of θ only.

Let r be the firm's discount rate. If the contract is updated, then the value of the firm is given by $\pi(\theta)+\frac{1}{r+\lambda}J(\theta)$, where[21]

$$\pi(\theta)=X^{\frac{\mu-\alpha}{1-\alpha}}\theta^{\frac{\alpha}{1-\alpha}}\psi(\delta_2,\eta)-w_N\delta_2 \tag{8}$$

is the per-period profit of the firm at the outcome of the stage game in period 2. Recall that λ is the exogenously given separation rate due to adverse liquidity shocks.

If the contract is terminated, no production will take place this period as the final good producer would have no provision of the manufactured inputs. The final good producer could then start searching for a new supplier next period and draw a new match parameter. Let Q be the present value of profits of a final good producer who withdraws from a match and behaves optimally. Since the search for a new supplier involves drawing a new value of θ independent of the previous matches, Q will be a constant under the assumptions of an infinite horizon and constant discount rate (Jovanovic, 1979).[22]

The Bellman equation that characterises the value of the game to the final good producer in period 2 is then given by: $J(\theta)=max\{\pi(\theta)+\frac{1}{r+\lambda}J(\theta),\ \frac{1}{r}Q\}$. We depict this equation in Chart 4. The value of continued joint production is rising in the match parameter while the value of withdrawal is constant. As is clear from the chart, the optimal policy is one that updates the contract for values of θ above a certain level and terminates it below this threshold level. The solution to the Bellman equation in period 2 is given by:

[20] The solution concept here is similar to the discussion in Ljungqvist and Sargent (2004), who work with a simplified version of Jovanovic's model in its original context of labour markets. We also work with a simple discrete time version of Jovanovic's model; however, we differ significantly from the original in certain respects, such as its contracting structure and probability distributions.

[21] We suppress the other arguments of the per-period profit function for notational simplicity.

[22] In the current model, the constancy of Q implies that if a final good producer withdraws from a match with a supplier, it will never choose to carry out joint production with this particular supplier in the future.

$$J(\theta) = \begin{cases} \pi(\theta) + \frac{1}{r+\lambda} J(\theta) & for\, \theta \geq \underline{\theta} \\ \frac{1}{r} Q & for\, \theta \leq \underline{\theta} \end{cases} \tag{9}$$

where the threshold level $\underline{\theta}$ satisfies:[23]

$$\frac{r+\lambda}{r+\lambda-1}\pi(\underline{\theta}) = \frac{1}{r}Q \tag{10}$$

The final good producer's optimal policy in period 2 implies that, in equilibrium, only those matches that have high enough productivities will continue joint production in future periods. If the true value of θ is revealed to be below $\underline{\theta}$, the firm will be dissolved since continuing the relationship indefinitely at a low θ yields a lower expected present value of profits than the alternative matches. This aspect of the model can explain why multinationals are among the most productive firms in an industry. Since the multinational can sample from a large pool of potential suppliers and it locks itself in a relationship with the same supplier, its optimal policy is to wait until it finds itself in a match with high enough productivity. In equilibrium, only those multinationals that realise a certain threshold level of productivity persist in the industry. The optimal policy implies that matches break up only between the first and second periods. Hence, divestment is negatively correlated with the age of the multinational, implying that most plant closures by multinationals occur in the early stages of the partnership.

Given the optimal policy of contract updating in period 2, we now turn to the final good producer's decision-making in period 1 in the presence of uncertainty. Having received a noisy signal on the match parameter, y, the final good producer follows Bayesian updating to calculate the posterior probability distribution of θ. The following lemma describes the properties of the posterior distribution.

Lemma Let y denote a random draw from a uniform distribution over the range $(0, \theta]$. The $Pareto(b, \gamma)$ distribution has density:

$$f(\theta) = \begin{cases} \frac{\gamma b^{\gamma}}{\theta^{\gamma+1}} & if\, \theta \geq b \\ 0 & otherwise \end{cases}$$

where $b > 0$ and $\gamma > 2$. Let $\tilde{\gamma} = \gamma + 1$ and $\tilde{b} = max(y, b)$. The posterior density of θ is defined by:

$$f(\theta|y) \propto \begin{cases} \frac{1}{\theta^{\tilde{\gamma}+1}} & if\, \theta \geq \tilde{b} \\ 0 & otherwise \end{cases}$$

which takes the same form as the prior. Hence $\theta|y$ is $Pareto(\tilde{\gamma}, \tilde{b})$ with $E(\theta|y) = \frac{\tilde{\gamma}\tilde{b}}{\tilde{\gamma}-1}$ and $Var(\theta|y) = \left[\frac{\tilde{\gamma}}{\tilde{\gamma}-2} - \left(\frac{\tilde{\gamma}}{\tilde{\gamma}-1}\right)^2\right]\tilde{b}$.

[23]Notice that (9) implies $J(\theta) = \frac{r+\lambda}{r+\lambda-1}\pi(\theta)$ for $\theta \geq \underline{\theta}$.

Proof See Leonard and Hsu (1999).

Lemma 1 expresses the posterior expected value of θ in terms of the parameters of the distribution and the signal. In order for the signal to be informative about θ, we assume for the remaining analysis that the lower bound for the signal is b, so that $\tilde{b} = y$.[24] This setup leads the firm to infer that the true value of its θ is increasing in the value of the signal that it receives, as the posterior mean is given by: $\tilde{\theta} = E(\theta|y) = \frac{\tilde{\gamma}}{\tilde{\gamma}-1}y$. Notice that since y is uniformly distributed, the posterior mean is also distributed uniformly, characterized by the parameters $\hat{b}$ and $\hat{\gamma}$, where $\hat{b} = \frac{\tilde{\gamma}}{\tilde{\gamma}-1}b$ and $\hat{\gamma} = \frac{\tilde{\gamma}}{\tilde{\gamma}-1}\theta$.[25] We denote the distribution of the posterior mean by $G(\tilde{\theta}|\hat{\gamma}, \hat{b})$.

Let $V(\tilde{\theta})$ be the value to a final good producer who has received signal y and is behaving optimally in period 1. If the final good producer chooses to remain in the match, the outcome of the game in period 1 yields a per-period profit of $\pi(\tilde{\theta})$, where[26]

$$\pi(\tilde{\theta}) = X^{\frac{\mu-\alpha}{1-\alpha}} E\left[\theta^{\frac{\alpha}{1-\alpha}}|y\right]\psi(\delta_1, \eta) - w_N\delta_1 \tag{11}$$

In the event that the match breaks up, the final good producer receives a per-period profit of zero and it can seek out a new supplier next period. If it survives, the true value of θ is revealed. Then $V(\tilde{\theta})$ satisfies:

$$V(\tilde{\theta}) = max\left\{\pi(\tilde{\theta}) + \frac{1}{r+\lambda}\int J(\theta')dP(\theta'|\tilde{\gamma}, \tilde{b}),\ \frac{1}{r}Q\right\} \tag{12}$$

In (12), $P(\theta'|\tilde{\gamma}, \tilde{b})$ is the conditional distribution of joint productivities for the next period when the true θ is revealed. As with the contract updating policy in period 2, (12) implies an optimal policy for the final good producer that continues the match above a certain level of $\tilde{\theta}$ and withdraws from it below this threshold.[27] Hence, we can explain why multinationals cherry-pick the high productivity firms to the extent that the noisy signal delivers information on a supplier's initial productivity. The solution to the Bellman equation for the first period is given by:

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[24] One can interpret this by assuming, for instance, that the firm receives a signal above a certain value in expectation of the productivity gains from a takeover. Note that when $y < b$, the posterior mean becomes $\tilde{\gamma}b/(\tilde{\gamma}-1)$, which is independent of y, and therefore the signal becomes uninformative.

[25] The support of a uniform distribution is defined by its upper and lower bounds.

[26] The following equations are written with some abuse of notation. Notice that equation (11) is actually defined in terms of $E\left[\theta^{\frac{\alpha}{1-\alpha}}|y\right]$, which is not the same as $\tilde{\theta} = E(\theta|y)$. To be more precise, one can calculate $E\left[\theta^{\frac{\alpha}{1-\alpha}}|y\right]$ as $\frac{\tilde{\gamma}}{\tilde{\gamma}-\alpha/(1-\alpha)}y^{\alpha/(1-\alpha)}$ by using the density function $f(\theta)$ in Lemma 1. Notice that just like $E(\theta|y)$, $E\left[\theta^{\frac{\alpha}{1-\alpha}}|y\right]$ is determined by $\tilde{\gamma}$ and y. Likewise, taking α as given, the distribution of the posterior expectation is uniform and characterised by similar parameters.

[27] To see this, notice that both $\pi(\tilde{\theta})$ and $\frac{1}{r+\lambda}\int J(\theta')dP(\theta'|\tilde{\gamma}, \tilde{b})$ are increasing in $\tilde{\theta}$ while $\frac{1}{r}Q$ is constant.

$$V(\tilde{\theta}) = \begin{cases} \pi(\tilde{\theta}) + \frac{1}{r+\lambda}\int J(\theta')dP(\theta'|\tilde{\gamma},\tilde{b}) & for\, \tilde{\theta} \geq \underline{\tilde{\theta}} \\ \frac{1}{r}Q & for\, \tilde{\theta} \leq \underline{\tilde{\theta}} \end{cases} \tag{13}$$

where $\underline{\tilde{\theta}}$ satisfies:

$$\pi(\underline{\tilde{\theta}}) + \frac{1}{r+\lambda}\int J(\theta')dP(\theta'|\tilde{\gamma},\tilde{b}) = \frac{1}{r}Q \tag{14}$$

It is possible to show (see Appendix) that $\pi(\underline{\theta}) > \pi(\underline{\tilde{\theta}})$; that is, the final good producer requires a higher level of profits in period 2 to stay in the match compared with the level of profits it would accept in period 1 to continue joint production. The reason for the increase in the "reservation profits" is the resolution of the uncertainty over the joint productivity parameter. Since the final good producer knows that the firm's total profits will be determined by the true value of θ in period 2 and thereafter, it becomes more selective in establishing a long-term relationship with a supplier. An immediate implication of this result is that $\underline{\theta} > \underline{\tilde{\theta}}$, because the per-period profit function $\pi(.)$ is strictly increasing in θ. Therefore, the final good producer's optimal policy implies divestment whenever the true productivity level with the supplier turns out to be lower than the threshold value of the posterior mean.

The increase in the reservation productivity level of the final good producer explains the argument that foreign investors tend to retain high-productivity firms under their ownership and sell low-productivity firms to uninformed agents since they gain crucial information about the productivity of the firms under their control (Loungani and Razin, 2001). Note, however, that in order to gain this crucial information, the final good producer should commit to at least one period of joint production with its supplier. What happens following this learning stage is a selection process which eliminates low quality matches. As a result, multinational producers lie at the high end of the productivity distribution for a universe of plants in host economies.

We now study whether there exists a unique solution to the final good producer's dynamic problem. The final good producer's optimal policy consists of a threshold strategy in each of the two periods of the model. If the final good producer leaves the match at either of these periods, it can match with a new supplier and receive a noisy signal on its joint productivity with the new partner. The expected present value from a new match is given by:

$$Q = \int V(\tilde{\theta})dG(\tilde{\theta}|\hat{\gamma},\hat{b}) \tag{15}$$

The final good producer's optimal policy is characterised by the equations (9), (13), and (15), which give rise to a single Bellman equation in V:

$$V(\tilde{\theta}) = max\left\{\pi(\tilde{\theta})+\frac{1}{r+\lambda}\int max\left\{\frac{r+\lambda}{r+\lambda-1}\pi(\theta),\frac{1}{r}\int V(\tilde{\theta}')dG(\tilde{\theta}'|\hat{\gamma},\hat{b})\right\}dP(\theta|\tilde{\gamma},\tilde{b}),\right.$$
$$\left.\frac{1}{r}\int V(\tilde{\theta}')dG(\tilde{\theta}'|\hat{\gamma},\hat{b})\right\} \quad (16)$$

The following result establishes the solution to the final good producer's dynamic problem and is proved in the Appendix.

Theorem There exists a unique, bounded, and continuous solution for V in (16).

What does the learning process imply about the optimal level of integration? Recall that the final good producer designs a multi-period contract in period 1 (stage 4) which specifies its share of the manufactured input in the first period and gives the right to update this share when the uncertainty is resolved (stage 8). We are interested in how this share evolves as the match endures. Within the property-rights framework of the multinational firm, we expect the resolution of the uncertainty to lead to a more efficient allocation of residual rights as joint production reveals the optimal mix of headquarter services and manufactured inputs. The multi-period contract should be updated to reflect this allocation of rights over the manufactured input.

Consider a final good producer in period 1 that has received a signal such that its posterior expected value of θ, say $\tilde{\theta}_t$, lies between $\underline{\theta}$ and $\underline{\tilde{\theta}}$. In equilibrium, this marginal producer will start production with its supplier in the first period but it will divest and withdraw from its match if the true value of its θ eventually turns out to be less than $\underline{\theta}$. For the producer to survive with its current match into future periods, its true θ should turn out to be greater than $\underline{\theta} > \tilde{\theta}_t$. This implies that the true joint productivity with the supplier should surpass the posterior expected value, which is calculated from the signal, for surviving firms. Recalling the earlier result that $\partial\delta^*(\theta)/\partial\theta > 0$, the marginal producer will increase its optimal level of integration with the supplier in the case that the match survives. It is then intuitive to see the following proposition:

Proposition 3 The optimal level of integration for an average firm in its second period is higher than the optimal level of integration for an average firm in its first period. In other words, the optimal degree of foreign ownership is rising over time for an average multinational.

Proposition 3 explains the empirical regularity demonstrated in Section 2 that foreign equity participation rises with affiliate age. The intuition follows the selection of high productivity matches into future periods. Low productivity matches dissolve if the true value of their θ is not higher than their posterior mean. High productivity matches survive into the second period and the multi-period contract is updated to reflect the true value of productivity. Note that because low productivity matches will also have a less favourable signal in the first period, the multinational parent will only acquire a low level of equity stake at such matches. When these are divested as a result of learning, surviving affiliates will be the high productivity matches that had relatively stronger signals and thus higher equity stakes initially. This is the main channel that explains

Chart 2. A secondary channel is also at work, however. For high quality matches that are not divested, if true productivity turns out to be better than what the initial signal implied, then the multinational parent may choose to acquire a greater equity stake. This reinforces the main selection mechanism.

The selection mechanism highlighted above leads us to the following proposition:

Proposition 4 The optimal ratio of investments in headquarter services and manufactured inputs, h^*/m^*, rises with the age of the integrated firm.

Proposition 4 is relatively easy to see from equation (5). Notice that (5) depends positively on δ after controlling for industry characteristics. Since the optimal level of integration is increasing over time for an average multinational, we immediately have that h^*/m^* is higher in the second period than in the first period. Hence, the model predicts that production gets more intensive in the use of headquarter services as the integrated firm continues production. In the second period, there is a greater transfer of headquarter services from the North to the production plant in the South. Therefore, the model generates transfer of technology that is driven by the degree of foreign ownership and explains the empirical finding that multinational plants get more headquarter-intensive over time.[28]

The inner workings of the dynamic model essentially depend on a selection mechanism whereby low productivity matches dissolve as the uncertainty over match quality is resolved. This selection mechanism determines the rise in the threshold levels of joint productivity from period 1 to period 2 and leads to the optimal reallocation of property rights within the firm. According to the model, the probability of a match being dissolved in period 2 is given by $Prob\{\theta' < \underline{\theta}|\tilde{\theta}\} = P(\underline{\theta}|\tilde{\gamma}, \tilde{b})$, which is obviously negatively correlated with $\tilde{\theta}$, the posterior expected value for joint productivity. We summarise this selection mechanism in the following proposition:

Proposition 5 The probability of a match being dissolved subsequently is negatively correlated with the current level of joint productivity.

The dynamic model can explain the empirical regularities identified in Section 2 and a set of well-known facts from the literature. It also presents some testable implications about the interaction between equity shares, match quality and imported inputs. We analyse this interaction next.

[28] See the discussion in Arnold and Javorcik (2009) for how factor intensity and use of imported inputs evolves in multinationals over time.

4 Econometric evidence

4.1 Data

We combine the census of manufacturers introduced earlier with the Annual Manufacturing Statistics Database provided by TurkStat for the same period with firm identification codes. This database provides information on each firm's domestic and imported inputs, output and exports at the 8-digit product level following a national classification based on the ISIC Rev. 2. We focus on the use of domestic and imported inputs from the product-level database to test the model implications. The Data Appendix describes the variables used in the analysis and the cleaning of the data in detail.

When some investments are contractible, then what matters is the importance of non-contractible headquarter investments relative to non-contractible supplier investments (Antras and Helpman, 2008; Nunn and Trefler, 2013). While we do not incorporate this additional layer in our model, higher foreign equity ownership is likely associated with greater use of non-contractible inputs. For instance, Dasgupta and Tao (2000) show that equity ownership at a supplier by a downstream firm pushes the supplier into more relationship-specific investments. An important advantage of the product-level database is that we can test this hypothesis by calculating a firm-level measure of input contractibility. Our construction follows Corcos et al. (2013) in that we apply the relationship-specificity index of Nunn (2007) to domestic and imported products directly. We thus capture input contractibility at the firm level and improve on earlier approaches that use input-output matrix coefficients as weights.

We proxy match quality by deriving a total factor productivity estimate. We follow Wooldridge (2009) and Levinsohn and Petrin (2012) to estimate the parameters in the production function and recover the predicted levels of productivity (see the Data Appendix). Chart 5, panel (a), plots foreign equity shares against our productivity estimates at multinational affiliates. There is a strong and positive relationship between the two measures, with a simple least squares regression of foreign equity participation on productivity returning an estimate of 3.27 (s.e.=0.50). Alternatively, panel (b) provides Kernel density plots of joint productivity by quartiles of foreign equity participation; the weight of the productivity distribution moves to the right with each higher quartile. In unreported results, we confirm via two-sample Kolmogorov-Smirnov tests that the equality of distribution functions is rejected at the 5 per cent level for each bilateral comparison of the quartiles. These findings suggest that conditional on observing foreign ownership, higher joint productivity is associated with higher levels of foreign equity as predicted by the model.

Table 3 presents summary statistics by ownership type and provides evidence on the superiority of multinational affiliates, which are more than twice as productive on average as domestic firms. This confirms the model's prediction that, in equilibrium, only the most productive plants are controlled by multinational investors. Accordingly, multinational plants are larger and more capital- and skill-intensive. The majority of affiliates are also importers and engage in substantial trading activity. The average affiliate imports three times as many distinct inputs at much higher unit values as the average domestic plant and it uses a greater share of imported inputs in production. Considering that not all affiliates import inputs, these numbers underestimate the importing activity carried out by those affiliates that actually do. At the same time, affiliates use a slightly larger number of inputs in production that are less contractible, which points to greater incentives for vertical integration.

Table 3 also provides a decomposition of standard deviations into a between- and a within-sector component. In line with previous evidence (cf. Corcos et al. (2013)), we find substantial variation in productivity and factor intensities overall. More importantly, almost all of this variation is due to firm-level heterogeneity *within* sectors and not between them. Table 3 shows that 83 per cent of the variation in joint productivity, 88 per cent of the variation in input contractibility and almost all of the variation in the share of imported inputs come from within-sector differences. These figures support the idea that the firm is the correct unit of analysis in order to study the determinants of foreign equity participation. We establish this next.

4.2 Match quality and the degree of foreign ownership

What determines the degree of foreign ownership in multinational affiliates? Theory suggests two primary factors. The first is the sector-level intensity of the production line in headquarter services, η, which we refer to as the "Antras effect." The second factor is the match-specific productivity, θ, which we call the "match quality effect". Previous studies proxy η by industry-level data on capital and skill intensity, although headquarter intensity is understood to represent R&D and advertising as well. We complement these proxies with three additional measures to capture headquarter intensity and let the data speak on which measure best captures the sectoral effect. In particular, we construct sector-level measures for the share of technical workers in production, the share of imported capital in fixed assets, and the share of intangibles expenditure to sales.[29] We compute these measures for 85 sectors defined at the ISIC 4-digit level.

We treat the level of foreign equity as the outcome of an optimisation problem in line with theory. The model implies that match quality not only drives the probability of a foreign acquisition, but it also determines the level of foreign equity conditional on being foreign owned. Accordingly, we estimate the following Tobit type-one model:

$$y_{it}^* = \alpha + \beta_\theta log(\theta)_{it} + \beta_\eta' log(\boldsymbol{\eta})_{gt} + \mu_t + \varepsilon_{it} \tag{17}$$

$$y_{it} = \begin{cases} 0 & if\, y_{it}^* \leq 0 \\ y_{it}^* & if\, 0 < y_{it}^* \leq 100 \\ 100 & if\, y_{it}^* > 100 \end{cases} \tag{18}$$

where i indexes plants, g indexes sectors, and t indexes time. In (17), y_{it}^* is a latent variable indicating optimal foreign equity participation, but in the data we simply observe y_{it}. The vector $\boldsymbol{\eta}_{gt}$

[29]Technical intensity in production is measured as the share of technical workers in production workers, which is different from skill intensity measured as the ratio of non-production to production workers. If foreign technologies increase demand for technical workers, then the first measure is potentially a better proxy for headquarter-intensity.

collects the five measures we constructed for sectoral headquarter intensity and μ_t capture year effects. We are interested in the magnitudes of β_θ and β'_η and the explanatory power of alternative specifications. To judge the goodness of fit across specifications, we follow Wooldridge (2002) and calculate R^2 as the square of the correlation coefficient between y_{it} and $\hat{y}_{it}$, where $\hat{y}_{it}$ is the Tobit estimate of $E(y_{it}|\mathbf{x} = \mathbf{x}_{it})$ with $\mathbf{x}$ being the vector of explanatory variables.

Table 4 reports the estimates from this exercise. Standardised "beta" coefficients are reported in all columns, which makes the magnitudes of the coefficients comparable. Columns (1) and (2) show that joint productivity alone can explain more of the variation in foreign equity participation compared with the five sectoral measures of headquarter intensity combined as judged by the goodness of fit. Column (3) provides a more direct comparison and indicates that variation in joint productivity has twice as much impact on the variation in foreign equity shares compared with technical intensity in production and thrice as much compared with intangibles intensity at the sectoral level. Across different specifications, a one standard deviation rise in joint productivity is associated with around a 0.3 standard deviation rise in foreign equity participation, an effect that dominates the estimated impact of all sectoral measures. Hence, the results indicate that the match quality effect outweighs the Antras effect in determining the degree of foreign ownership.

That sectoral measures of headquarter intensity are not powerful explanators in (17) is consistent with high within-sector heterogeneity in factor use. For instance, Corcos et al. (2013) find factor intensity to be an important determinant of sourcing decisions when measured at the firm level but not at the industry level, which they attribute to this fact. In order to determine whether match quality still matters when this heterogeneity is taken into account, we estimate (17) with firm-level measures instead of sector-level measures in the remainder of Table 4. Column (4) shows that factor intensities measured at the firm level are indeed much stronger explanators. Column (5) shows, however, that match quality retains its significance and economically large effect. Controlling for both sector-specific fixed effects and heterogeneity in factor use in column (6), match quality explains a significantly higher proportion of the variation in foreign equity shares compared with the other firm-level measures.

We further quantify the impact of match quality on foreign equity participation by estimating the following pooled Tobit model:

$$y^*_{it} = \alpha + \beta_\theta log(\theta)_{it} + \gamma' \mathbf{X}_{it} + \mu_t + \nu_g + \varepsilon_{it}, \tag{19}$$

where y^*_{it} is defined by (18) and μ_t and ν_g control for time- and sector-specific effects, respectively. $\mathbf{X}_{it}$ is a vector of firm-level controls including headquarter intensity measures and plant size; we complement it with firm-level indicators of intangibles spending and engagement in international trade in alternative specifications. The pooled Tobit model is preferable in that it does not maintain strict exogeneity of the explanatory variables; while ε_{it} are assumed to be independent of the covariates, the relationship between the current error term and the covariates in the other time periods is unspecified (Wooldridge, 2002). This means that we can safely estimate explanatory variables that are affected by feedback from previous periods, which might happen, for instance, if equity shares in earlier periods impact on future realisations of productivity.

Table 5 reports the estimates from this exercise. We are interested in the effect of match quality on the *observed* level of foreign equity; therefore, we report marginal effects conditional on acquisition taking place, that is, $\partial E[y|\mathbf{X}, y > 0]/\partial x$, evaluated at the mean values of $\mathbf{X}$ in the sample of foreign affiliates. Column (1) indicates that a one unit increase in (log) productivity is associated with a 6.2 percentage point increase in foreign equity participation. This implies that an affiliate with a level of productivity one standard deviation above the mean has 15 percentage points higher equity share holdings by its parent company compared with an affiliate that is one standard deviation below the mean. This is an economically significant effect that points to considerable variation in foreign equity shares due to productivity heterogeneity within narrowly defined sectors.

Other determinants of the level of foreign equity that emerge from Table 5 are plant size and firm-level capital and skill intensity, which have the expected signs. Intangibles intensity seems to be insignificant in column (1); this could be because of the traditionally low levels of expenditures on intangibles at Turkish firms, which will occupy a tiny portion of sales, especially if R&D activity is carried out primarily by large firms. Therefore, we instead include an indicator term for observing positive levels of R&D and advertising in column (2) and simply the level of such expenditure in column (3) to get a better proxy. Intangibles now have a positive and statistically significant impact on the level of foreign ownership. We finally control for plants' exporting and importing status. Both indicators of trade are positively associated with foreign equity participation. Most importantly, the coefficient estimate on joint productivity is little changed and it remains highly significant across the different specifications.

Endogeneity issues

One should be cautious in interpreting the results above as causal evidence. A valid concern is whether the degree of foreign ownership impacts on productivity and thereby induces some reverse causality.[30] For instance, a multinational parent may acquire a high equity stake at its affiliate today in anticipation of future transfers of headquarter assets that could impact on productivity. While the pooled Tobit model allows for such correlation across time periods, if equity investments and transfer of firm-specific assets take place concurrently then joint productivity is potentially endogenous in (19). We therefore turn to an instrumental variables approach to establish the causal link from joint productivity to the degree of foreign ownership.

We use (log) price-cost margin (PCM) at the firm level as a time-varying instrument for productivity. PCM proxies a firm's average mark-up over marginal costs and the competition a firm faces, so it is plausibly independent of the equity structure. Note that it also likely captures idiosyncratic demand shifters rather than pure production efficiency differences, as prices reflect shifts in demand or market power variation within an industry (Foster et al., 2008). These in turn are closely associated with firm-level productivity, which renders PCM a strong and relevant

[30]The evidence on whether there is a causal effect of foreign ownership on productivity is inconclusive. Harris and Robinson (2002) and Benfratello and Sembenelli (2006) find that foreign ownership has no effect on productivity. In contrast, Arnold and Javorcik (2009) and Guadalupe et al. (2012) find a positive effect of foreign acquisitions on productivity in Indonesia and Spain, respectively. In a review of the literature, Navaretti and Venables (2004) argue that "the evidence reported up to now supports a statistical association between foreign ownership and productivity, but not a causal link".

instrument. In the sample of the multinational affiliates, the simple correlation between PCM and productivity is 0.37, while the correlation between PCM and foreign equity participation is 0.06. While we cannot test directly for the exogeneity condition of the instrument, earlier research suggests that mark-ups do not affect multinationals' ownership preferences (Barbosa and Louri, 2002; Bai et al., 2004), making its exclusion from the second stage valid.

Table 6 reports the IV-Tobit estimates of (19) using maximum likelihood.[31] The IV estimates return slightly smaller coefficients for the impact of joint productivity compared with the estimates in Table 5. The standard errors are slightly larger as a result of instrumentation, but joint productivity remains a highly significant determinant of foreign equity participation. A one unit increase in (log) productivity leads to a 4.3 percentage point increase in columns (1)-(3) and to a 3.2 percentage point increase in column (4). First stage results indicate that PCM is a strong predictor of joint productivity and an F-test on the instrument returns a statistic that is comfortably above critical values. Controlling for firms' R&D spending as well as export and import status in columns (2)-(4) is important to make sure that the instrument remains uncorrelated with the error term in the second stage.

In order to check the robustness of the IV results and to derive over-identifying restrictions, we use a more direct measure to capture firms' market power and work with a firm's number of products as an additional instrument. This is reminiscent of the idea that multi-product firms are more productive and it more likely captures a firm's overall efficiency instead of picking up demand effects. However, if higher equity stakes are systematically related to the introduction of new variety, then using a simple count of products might render the instrument invalid. We therefore normalise each firm's number of products by the total number of variety on offer in a given industry at the 4-digit level to guard against the violation of the exclusion restriction. We report the results of this exercise in Table C.2 of the Appendix. The additional instrument enters the first stage significantly and it lessens the standard errors as expected. The coefficient estimate on productivity remains highly significant at around 3.3 percentage points. However, the test of over-identifying restrictions returns very low p-values. This test is suspect when all the instruments share a common rationale (Murray, 2006), which is likely in our case as both of our instruments proxy market power and competition.

In sum, the estimates from Tables 5 and 6 point to a statistically and economically significant effect of joint productivity on the degree of foreign ownership and the evidence is supportive of a causal story. Multinational companies acquire sizeable equity shares in the subsidiaries that they perceive to be highly productive in line with our theory. We next analyse how the resulting ownership of equity translates into importing activity at the affiliates.

[31] We also estimate the IV-Tobit model in a two-step procedure following Smith and Blundell (1986) and Wooldridge (2002), in which residuals from a first stage estimation of productivity on all variables are included in (19) and a standard Tobit is estimated at the second stage. The first stage is estimated with ordinary least squares including (log) PCM, which serves as the identifying exclusion restriction. This procedure returns identical coefficient estimates to those reported but smaller standard errors given the two-step procedure. Results are available upon request.

4.3 Ownership structure and imports

An immediate implication that comes out of the model is that affiliates with higher foreign equity stakes import a greater share of their inputs from their parent companies regardless of sector. Unfortunately our data do not allow us to test this mechanism directly as we cannot identify whether import activity is conducted with a related party or not.[32] This is an important drawback of the data. However, studying the trading patterns of multinational affiliates is likely to inform us substantially about importing activity in general. Around half of US imports take place within the boundaries of the firm (Bernard et al., 2012) and earlier evidence suggests that imports by affiliates most likely occur within firm boundaries. For instance, Hanson et al. (2005) document that approximately 90-95 per cent of imports from the United States by foreign affiliates of US multinationals are from parent firms. They also argue that even when affiliate imports come from another entity, the parent company may still have arranged the transaction. We expect headquarters to be more involved in the arrangement of these transactions if they can exert control over the affiliate. We therefore interpret the findings below as the impact of multinationals' equity structures on overall importing activity and not as a direct test of a model of intra-firm trade.

Note that the majority of multinational affiliates import inputs but not all affiliates engage in importing. We therefore restrict our focus in this subsection to those affiliates that source some of their inputs from abroad. Table 7 reports least squares estimates of the impact of foreign equity participation on importing activity using this sample. We control for various firm characteristics and sector and year effects. Column (1) indicates that a 1 percentage point increase in the foreign equity stake leads to a 0.32 per cent increase in total affiliate imports in a year. This is an economically large effect; a fully owned affiliate is predicted to import 16 per cent more inputs compared with an affiliate that is only half-owned. We need to check that this result is not driven by the possibility that affiliates with higher foreign equity stakes are also likely to expand and buy more inputs in general. This is indeed the case in column (2), where a percentage point rise in foreign equity is associated with a 0.20 per cent increase in total input purchases, but our result is not driven by it. When we regress the ratio of imported inputs to total inputs on foreign equity participation in column (3), we find a significant and positive impact. According to this estimate, a fully owned affiliate is predicted to have a 6 percentage point higher share of imported inputs in production compared with an affiliate with 50 per cent foreign equity. These results suggest that within-sector heterogeneity in imported inputs is considerably affected by the variation in ownership structures.

Table 7 documents an additional finding on the firm-level contractibility of inputs used in production. Column (4) shows that affiliates with higher foreign equity stakes use relatively fewer contractible inputs. Column (5) suggests this is also the case for imported inputs. However the coefficient is not estimated with enough precision. While our model does not differentiate between the choice of contractible and non-contractible inputs, these results suggest that higher equity stakes indeed represent greater integration between the supplier and the headquarter as both seem to invest in relationship-specific inputs.

[32] A few studies use data on related-party trade to test variants of the model by Antras and Helpman (2004); see Kohler and Smolka (2009) and Defever and Toubal (2013). These papers analyse the choice of input sourcing between an affiliated party and an arm's length supplier. Our focus is narrower and on the intensive margin of trade.

A potential concern is that multinationals might choose higher equity shares at the same time as importing more inputs in anticipation of greater profitability. In order to sidestep this problem, we instrument for the level of foreign equity in Table 8. Theory says that joint productivity is the foremost determinant of foreign equity participation; this is indeed what we have shown in Tables 4-6. Moreover, it is only through the share of equity that productivity can impact on the use of inputs in the model. We therefore choose joint productivity as our first instrument. The validity of the instrument can be doubted, however, if importing activity impacts on current productivity. We therefore include a second instrument and test the over-identifying restrictions. We use information on the country of origin of the multinational investor and include an indicator term for whether it is from a country that shares the same legal origin as Turkey, which is French. Legal origin presumably affects the degree of foreign ownership but is unlikely to have any links with the disturbance term in the importing equation. The transaction costs approach to asset ownership suggests that operating in a different legal environment creates issues of contractual hazards, which raises the costs of monitoring and supervision, leading multinationals to share ownership with locals. We would therefore expect common legal origin to have a positive impact on foreign equity participation.

The first stage results in Table 8 show that our instruments are sufficiently strong and the test of over-identifying retrictions fails to reject that both instruments are valid.[33] Our qualitative results are unchanged with regard to the impact of equity structure on imports. However, the second stage estimates suggest that the previous least squares estimates could be biased downward significantly as column (1) indicates that a 1 percentage point increase in foreign equity participation now leads to a 3.54 per cent increase in total imports. This is around 10 times larger than the estimate in Table 7 and accordingly the standard errors are also much larger. Column (3) indicates that a fully owned affiliate uses a 30 percentage point higher share of imported inputs in production compared with an affiliate with 50 per cent foreign equity. This is a remarkably large difference and demonstrates the extent to which multinationals' equity structures impact on the intensive margin of imports.

An important difference in Table 8 from earlier is that the coefficients in columns (4) and (5) now have a positive sign; higher levels of foreign equity seem to be associated with greater input contractibility. The reversal of the sign suggests that multinationals might be initially targeting and integrating suppliers that provide less contractible inputs, which is in line with the property rights approach, but a higher foreign equity share in itself does not lead to greater use of fewer contractible (imported) inputs following an acquisition. In fact, affiliates with greater foreign equity participation may choose to use more contractible inputs in production in order to minimise the bargaining position of suppliers of relationship-specific inputs. If suppliers' inputs are highly specific to the multinational parent, then the latter can demand a large share of the revenue

[33] Both our instruments are highly significant with the expected signs in the first stage. However, the F-stat does not rule out the presence of a small bias. We therefore carry out two procedures to ensure that our estimates are reliable. First, we estimate the same model with limited information maximum likelihood (LIML), which is known to be more robust to weak instruments than 2SLS. Second, we construct weak instrument robust confidence intervals based on the Anderson-Rubin, Lagrange multiplier and conditional likelihood-ratio tests following Finlay and Magnusson (2009). We find that the LIML coefficient estimates and standard errors are marginally higher than those reported in Table 8 but retain the same levels of statistical significance. At the same time, the weak-IV-robust confidence intervals are only marginally wider than the corresponding Wald confidence interval and reject the null hypothesis when the Wald test does. These results are available upon request.

without having to hold a large equity stake. When inputs are less specific, then a greater level of equity is needed to increase ex post bargaining power. This result provides an interesting perspective on the classical property rights premise of asset ownership (Grossman and Hart, 1986), which assumes all investments to be non-contractible. When we acknowledge that in practice many investments are general and not relationship-specific, the equity breakdown at a firm can have important consequences for the choice of input contractibility and partial ownership can indeed be optimal.[34] However, the empirical evidence presented here is in contrast to the earlier theoretical literature, which argues that equity ownership incentivises suppliers into more relationship-specific investments (Dasgupta and Tao, 2000).

4.4 Match quality and selection

The main mechanism in the model that generates the observed rise in foreign equity shares over time is a selection framework that weeds out the low quality matches as a result of learning. Specifically, Proposition 5 predicts that the probability of divestment is negatively correlated with an affiliate's productivity. At the same time, one can observe the pattern in Chart 2 if affiliates were divested at random but the surviving ones saw increases in foreign equity participation by parent companies. This subsection analyses to what extent each of these mechanisms is at work.

We first test the selection story of Proposition 5. In order to do this, we restrict our sample to the set of foreign affiliates and define divestment as either a decrease in foreign equity participation that exceeds 1 percentage point or a closure of the affiliate. We have a total of 2,091 observations that are defined as time at risk and 233 cases of divestment. If affiliates that experienced no divestment during the sample period behave differently from those that did, then a purely non-parametric estimator of survival may return biased results. Cox (1972) suggests a semi-parametric method that handles such cases as well as any unobserved heterogeneity. Let the hazard function for divestment be given by:

$$\lambda(T_i) = exp(-\beta'\mathbf{X}_i)\lambda_0(T_i) \tag{20}$$

where λ_0 is the baseline hazard, T_i is the time until divestment occurs and $\mathbf{X}_i$ is a vector of covariates. We stratify the observations into groups i by sector and year, which allows for equal coefficients on the covariates across these pairings but generates baseline hazards unique to each group. Cox's partial likelihood estimator provides consistent estimates of β without specifying the form and the estimation of $\lambda_0(T_i)$.[35] Since we are primarily interested in how productivity impacts the probability of divestment, the Cox PH (proportional hazards) model provides the best trade-off between the purely non-parametric and the more restrictive parametric models. An additional advantage is the robustness of this estimator against end-points censoring.

[34] For a detailed theoretical discussion on the choice of contractible inputs and joint ownership, see Dasgupta and Tao (2000) and Cai (2003).

[35] We therefore guard against sectoral and economy-wide shocks in a given year that may render the baseline hazards for these pairs non-proportional. This could be a concern in the Turkish data as Turkey experienced two financial crises in 1994 and 2001, which were accompanied by devaluation of the Turkish lira. We test for the proportionality of the baseline hazards in what follows.

Table 9 presents estimates of (20) with different sets of controls. We report coefficient estimates instead of hazard ratios so that a negative coefficient is associated with better chances of survival. We find strong evidence that the survival prospects of multinational affiliates are positively and strongly linked to their productivity. The most conservative estimate in column (3) indicates that a unit increase in joint productivity in log terms increases the probability of survival by 19 per cent. Considering that the standard deviation of (log) productivity is just over 1 in the sample, the estimates in columns (1)-(4) imply large differences between the survival prospects of affiliates that lie at the opposite ends of the productivity distribution. We find the technical intensity of the production line, intangibles intensity and R&D, and importing status as additional firm characteristics that increase the chances of survival. Somewhat surprisingly, the share of imported capital seems to increase the hazard rate of divestment, though the estimated coefficient is small. Test statistics for the proportional hazards assumption based on the scaled Schoenfeld residuals indicate the validity of this assumption across all columns.

The model suggests that low quality matches should have low levels of foreign equity at the start of the relationship due to unfavourable signals. Taken together with the findings of Table 9, this implies that affiliates with lower levels of foreign equity should be subject to greater rates of divestment. We test this non-parametrically by comparing the equality of the Kaplan-Meier survivor functions defined by quartiles of foreign equity participation. Table C.3 in the Appendix provides the results of this log-rank test, which controls for sector and year effects. The log-rank test rejects the equality of survivor functions, with minority-controlled affiliates subject to greater than expected divestment. As a further check, we re-estimate the Cox model in (20) using foreign equity participation at the first year of an affiliate's production instead of joint productivity. In Table C.4 in the Appendix, we find that it is indeed those affiliates with lower levels of initial foreign equity that are subject to greater divestment.

We next test whether joint productivity leads to changes in foreign equity participation at continuing investments. Recall that in the model if the multinational parent retains control of the affiliate, then it can update its equity share in the second period after learning the true level of match quality. Restricting our data to the set of continuing foreign investments, we estimate a multinomial logit model predicting how the multinational parent's equity stake changes from one year to the next when there are three possibilities: a decrease in foreign equity participation that exceeds 1 percentage point, an increase in this share that exceeds 1 percentage point, and minimal $(\leq 1\, ppt)$ change in this share. Our reference category is the last one.

Table 10 presents the results of this estimation in columns (1) and (2). In column (1), where we do not control for sector and year effects, we find that highly productive affiliates see a rise in foreign equity participation controlling for a set of firm characteristics. The coefficient estimate on productivity for the second category is statistically significant; along with the estimate on plant size, it suggests that more productive and larger affiliates have a higher propensity to receive additional foreign equity investment than seeing no change in their equity structures. This is in line with the model. When we control for sector and year effects in column (2), however, more productive affiliates are no more likely to see changes in the equity structure. In both columns, the estimate for the impact of productivity on the probability of seeing a fall in equity share is insignificant and it carries a positive sign, whereas the model would predict a negative sign. This is possible since multinational parents will still retain a certain share of the firm in highly productive matches even if they lower their equity stake. According to the model, this happens when the signal about productivity is overly optimistic.

In an alternative specification, we focus on how the initial productivity of the affiliate impacts on changes in the equity structure of the affiliate in the later years. We collapse our data to a cross-sectional sample of first-time foreign investments only and estimate the determinants of subsequent changes in equity structure on this sample. The results of this exercise are reported in column (3). While affiliates with low levels of productivity in their first year of production are subsequently very likely to see declines in foreign equity participation, affiliates with higher levels of productivity are not necessarily likelier to see increases in foreign equity in later years. Across all three columns, a Wald test of the joint significance of the productivity coefficients on both alternative categories fails to reject the null hypothesis that the coefficients are jointly insignificant.

These results suggest that the equity dynamics identified in Table 2 are driven by joint productivity and not by other firm characteristics or shocks at the sector-year level. More importantly, they show that divestment at affiliates occurs primarily at the cross-section through a process of learning about match quality rather than at a longitudinal level through affiliates reacting to changes in productivity. In practice, transaction costs of negotiating and implementing ownership changes may be too large for a continuous updating of the ownership structure. This is partly reflected in the data where we see changes in ownership structure on average for 10 per cent of continuing foreign investment projects.

4.5 Robustness and discussion

We tested the model's main comparative statics with the Tobit model, which makes the assumption that both the acquisition decision and the level of equity shares are determined by the same probability mechanism. While theory motivates this choice, this assumption may be too strong in practice.[36] Tobit estimation treats zero observations as a corner solution in the sense that changes in covariates might induce positive levels of equity to be realised. There may be reason to think that regardless of changes in covariates some domestic firms never become targets for multinational investors. An additional limitation is that the effects in both the acquisition and level of equity decision stages are restricted to the same sign and magnitude.

An alternative procedure is the hurdle model, which would allow the mechanisms for the acquisition decision and the level of equity shares to be separated. In this procedure, we first model the binary probability of observing a positive level of foreign equity using the whole sample of firms, that is, we estimate the probability of a firm becoming a multinational affiliate. We then restrict the sample to the affiliates only and model foreign equity participation as a function of affiliate characteristics. This allows us to test and control for the effects of investor characteristics that would otherwise drop out of Tobit estimation since they would perfectly predict acquisition. Table C.5 in the Appendix presents these results in two panels. Column (1) in panel (a) presents the

[36] A good example is the role of investor origin, which the literature has suggested might impact on equity share decisions but not necessarily on the acquisition decision.

probit estimation results of observing the incidence of foreign ownership while columns (2)-(5) present OLS estimates of firm- and investor-level characteristics on (log) foreign equity participation. Panel (b) presents the results when we instrument joint productivity with PCM.

We find that our results are qualitatively unchanged when we allow for separate mechanisms for the acquisition and equity structure decisions. Probit results show that high productivity firms are consistently targeted by multinationals. These firms are larger and more capital- and skill-intensive at the same time. This is in line with the model's prediction and the growing evidence in the literature of cherry-picking.[37] Columns (2)-(5) in each panel show that conditional on picking these firms, multinational companies consistently acquire higher equity stakes in the relatively more productive ones. Column (2) controls for potential differences in the equity structure across greenfield investments and affiliates established through mergers and acquisitions, and column (3) controls for the countries of origin of the foreign investors as grouped into five sociocultural groups.[38] In column (4) we find that physical distance from the multinational's headquarters lowers foreign equity participation, while in column (5) we find that sharing the same legal background increases it. These findings lend support to a transactions cost story of equity ownership in which investor characteristics that increase the costs of running an affiliate lead to greater shared ownership. Across different specifications and the two panels, estimates are consistent for our main variable of interest. This implies that a unit increase in productivity is associated with an increase in foreign equity participation of around 8 to 11 percentage points, a larger effect compared with the Tobit results.

The results presented so far provide strong evidence for the theoretical model and shed light on the mechanisms that generate the empirical regularities we initially identified. Table 4 shows that the productivity of a multinational affiliate is the most prominent factor in explaining the variation in foreign equity stakes. Tables 5 and 6 quantify this impact and document the causal effect. These results explain the incidence of multinational investment and the variation in equity shares within narrowly defined sectors as a result of productivity heterogeneity. Tables 7 and 8 show that this variation in equity structures translates into heterogeneity in the use of imported inputs and input contractibility within narrowly defined sectors. Tables 9 and 10 show that multinational companies only retain control of highly productive affiliates, often divesting completely in low productivity ones instead of engaging in costly equity restructuring. The rise in the average degree of foreign ownership identified in Chart 2 is thus mostly about the stability of relationships and survival of the fittest.

These findings have important implications for the evolution of aggregate productivity and its distribution. It is well understood that plant births and deaths contribute disproportionately to industry productivity growth and plant shutdowns shape the dynamics of industrial restructur-

[37] See footnote 5. Note that our cherry-picking result is not driven by multinationals targeting firms that become productive in the run-up to an acquisition. When we estimate the probability of becoming a multinational affiliate on the base year (first year the firm appears in the sample) productivity of domestic firms in the cross-section, we find that initially productive domestic firms have a highly significant chance of becoming acquired later in the panel. These results are available upon request.

[38] Sociocultural distance between the headquarters and the local affiliate may raise the cost of acquiring information to monitor and evaluate business activities (Asiedu and Esfahani, 2001). This raises the bargaining power of the local supplier and the transaction costs of obtaining inputs via vertical integration, which is expected to weigh down on foreign equity participation.

ing (Bernard and Jensen, 2007). Our results suggest that average productivity may in fact fall if multinationals cherry-pick their suppliers but only retain the most productive ones, shutting down the less productive affiliates in the process. Surely, however, discrepancies across firms in productivity levels remain. In the absence of general equilibrium effects, whereby entry by multinationals may drive out the least productive domestic firms as in heterogenous firm models, the selection mechanism we identify contributes to the persistence of within-sector differences in productivity across plants. This gap between the best and the rest becomes even more acute as retained plants benefit from greater transfers of technology and investment. These results suggest substantial reallocation within sectors due to the dynamics of ownership structures at foreign affiliates.

5 Conclusion

Understanding the ownership structure of foreign investment projects is important because it affects the incentives of the investors to apply their resources to the project (Asiedu and Esfahani, 2001). This paper developed a model that both describes the determinants of ownership structure in foreign investment projects and shows how the resulting structure impacts on the transfer of investors' resources to these projects. The model allows us to account for a number of empirical observations on within-industry heterogeneity in productivity, factor use and trade. One of these observations is that businesses with higher measured productivity levels tend to grow faster and are more likely to survive than their less productive industry cohorts (Foster et al., 2008). In our model, multinationals gradually learn about the efficiency of their new affiliates and base their equity investment decisions on this learning process. This leads to a selection mechanism that can account for the high productivity-growth-survival nexus that has proven to be robust in many empirical studies. It can also explain why multinational investors frequently partner with a local firm to set up operations but then take full control if they decide to incorporate the host site into the parent's internal sourcing network (Moran, 2007).

Equity shares vary across affiliates in our sample and they are likely to determine not only revenue-sharing mechanisms but also allocation of control at the subsidiary. Bai et al. (2004) report that the simple correlation between the equity share of the foreign partner and its voting share on the board is 78 per cent in a sample of Chinese joint ventures. Even if cash flow and voting rights are highly correlated, non-linearities in the impact of equity participation on firm-level outcomes might arise at equity shares that trigger changes in corporate control. Unfortunately, our data do not contain information on board composition or voting rules, which prevents us from testing the role of control allocation.

Two additional drawbacks of the data prevent us from exploring the model further. First, the data do not allow us to identify domestic acquisitions, which arguably follow a learning and investment cycle similar to that of foreign acquisitions as discussed in this paper. Second, we cannot ascertain whether imports by affiliates take place within firm boundaries. This would have allowed us to carry a more rigorous test of our property rights theory of equity structure. Further empirical research that does not suffer from these limitations would be welcome.

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Chart 1: Distribution of foreign ownership in the pooled sample

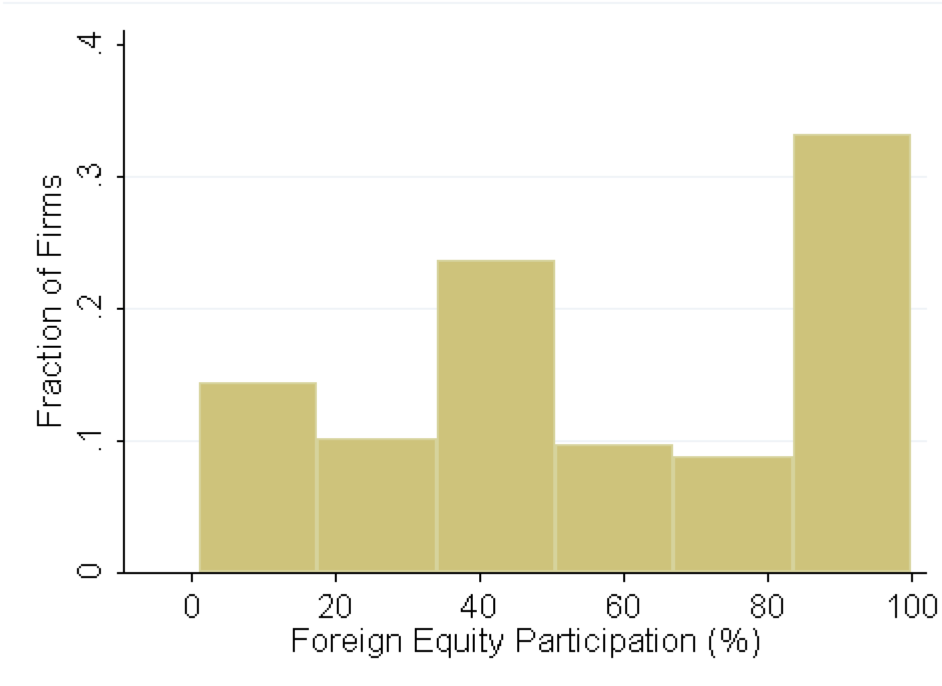


Chart 2: Average degree of foreign ownership by age

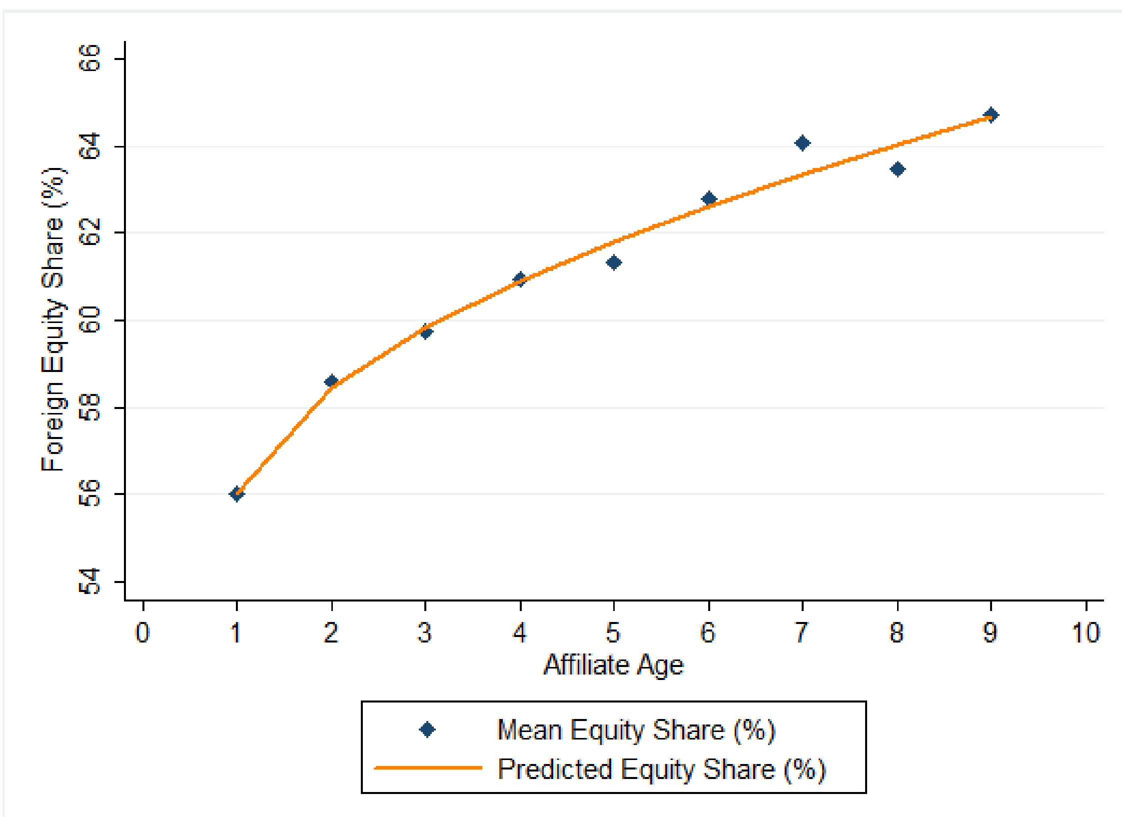
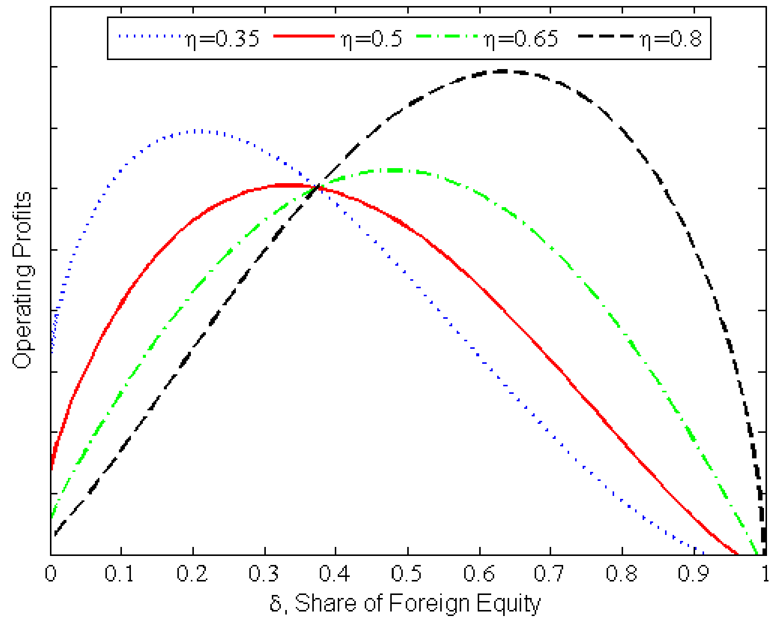


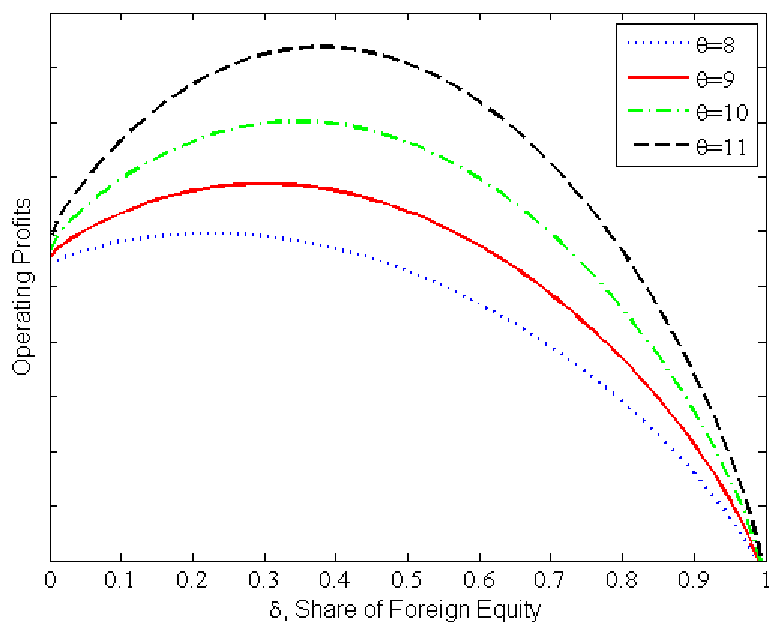
Chart 3: Operating profits and the level of integration

(a) Different headquarter intensities



Note: This chart simulates the behaviour of the operating profits function in (6) for different values of headquarter intensity, η. The parameter values used in the simulation are: $\beta = 0.1$, $\alpha = 0.75$, $\mu = 0.4$, $\theta = 30$, $X = 10$, $\phi = 0.8$, $w_N = 1.1$, and $w_S = 1$.

(b) Different match qualities



Note: This chart simulates the behaviour of the operating profits function in (6) for different values of the match quality, θ. The parameter values used in the simulation are: $\beta = 0.1$, $\alpha = 0.7$, $\mu = 0.4$, $\eta = 0.7$, $X = 10$, $\phi = 0.8$, $w_N = 1.1$, and $w_S = 1$.

Chart 4: Optimal policy in period 2

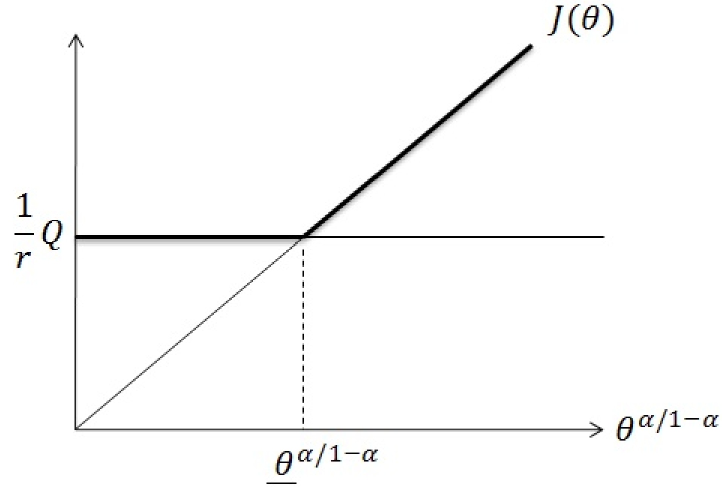
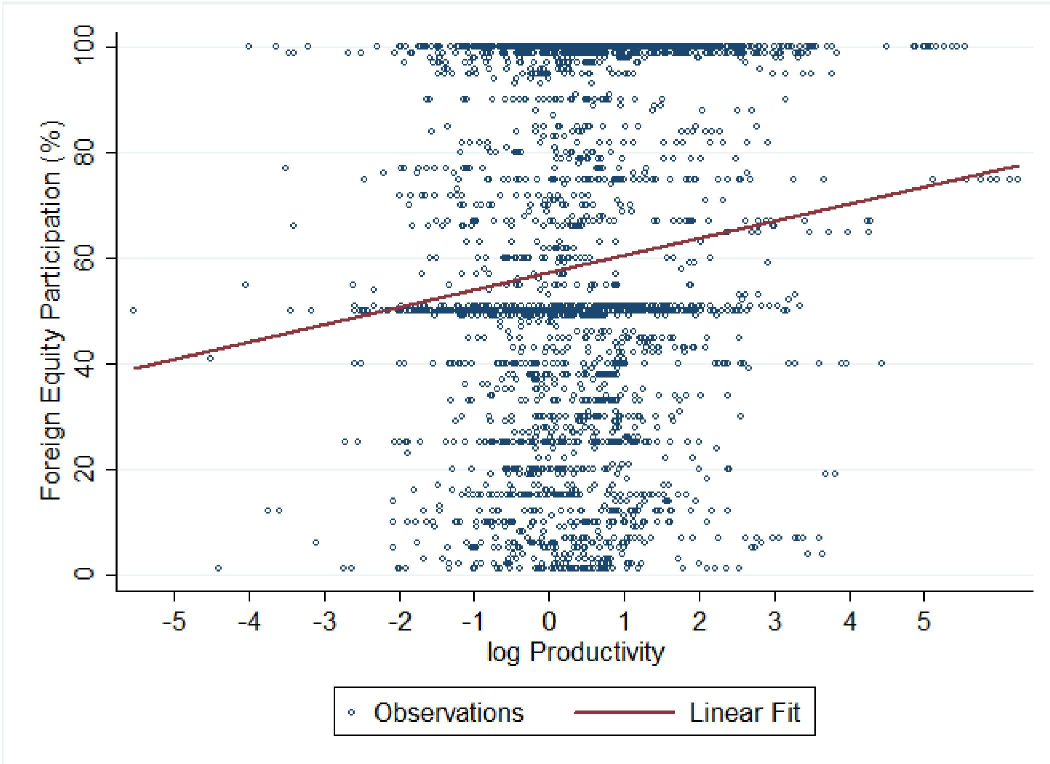


Chart 5: Foreign ownership and joint productivity

(a) Distribution of equity shares and productivity



(b) Productivity by equity intervals

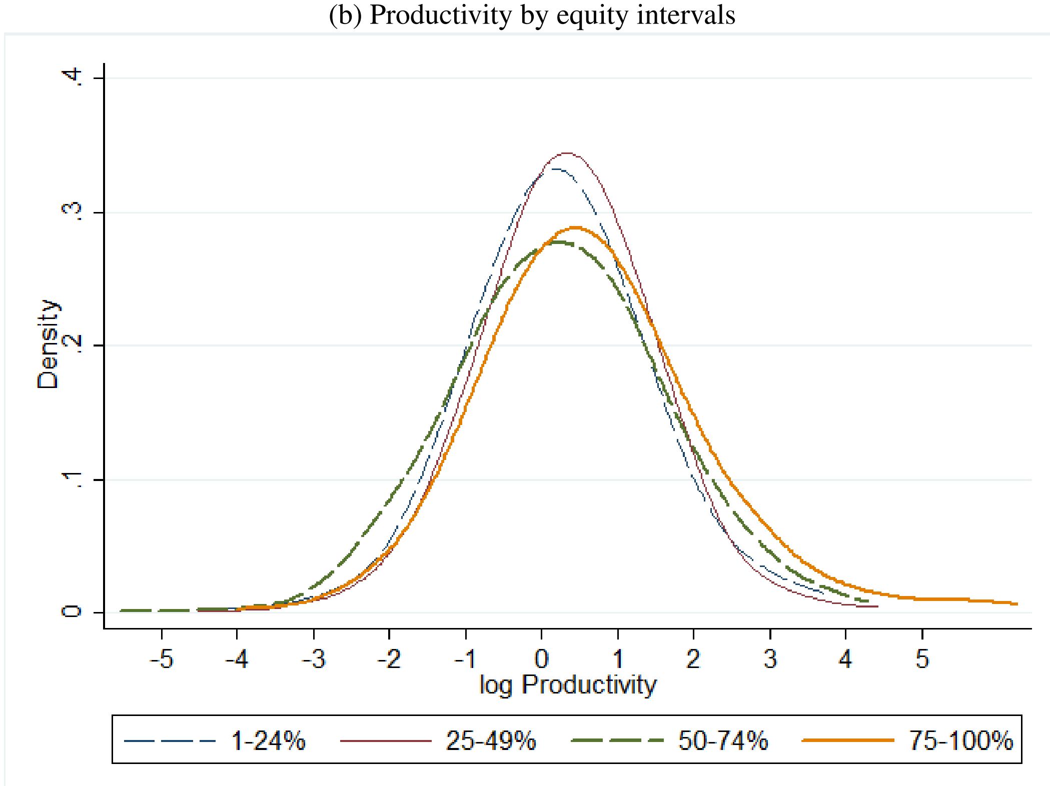


Table 1: Multinationals in Turkish manufacturing, 1993-2001

(a) Multinational presence by year

	1993	1994	1995	1996	1997	1998	1999	2000	2001
Number of multinationals	301	312	325	326	360	405	411	416	439
Total number of firms	10,266	9,815	9,904	10,264	11,005	11,916	10,851	10,698	10,871
Multinationals' share of labour (%)	13.11	13.25	12.82	13.01	12.80	12.68	13.62	13.62	14.14
Multinationals' share of value added (%)	30.17	26.30	28.52	28.95	28.08	26.37	27.85	31.75	31.68

(b) Multinational presence by sector

ISIC	Sector	Firm-Year Obs.		Share of MNEs (%)
		Multi-nationals	*Total*	
311	Food	235	6,764	3.47
312	Other food	116	1,978	5.86
313	Beverage	43	657	6.54
314	Tobacco	53	217	24.42
321	Textiles	175	10,605	1.65
322	Wearing apparel	199	7,040	2.83
323	Leather	1	787	0.13
324	Footwear	3	693	0.43
331	Wood products	10	1,128	0.89
332	Furniture	7	935	0.75
341	Paper products	36	1,009	3.57
342	Printing and publishing	11	1,166	0.94
351	Industrial chemicals	74	602	12.29
352	Other chemicals	294	1,831	16.06
353	Petroleum refineries	8	63	12.70
354	Other petroleum	67	229	29.26
355	Rubber products	54	812	6.65
356	Other plastic products	103	2,564	4.02
361	Pottery, china, earthenware	11	278	3.96
362	Glass products	43	524	8.21
369	Non-metallic mineral products	156	3,649	4.28
371	Iron and steel	46	1,697	2.71
372	Non-ferrous metal	23	728	3.16
381	Fabricated metal products	147	5,032	2.92
382	Non-electrical machinery	175	4,158	4.21
383	Electrical machinery	285	2,809	10.15
384	Transport equipment	293	2,821	10.39
385	Scientific and optical equipment	48	628	7.64
390	Other manufacturing	41	683	6.00

Note: Sector classification follows the International Standard Industry Classification system (ISIC) Rev. 2 at the 3-digit level.

Table 2: Equity investment dynamics at multinational affiliates

(a) Multinational presence by degree of ownership

Foreign ownership	Observations	Share (%)	Cum. share (%)
1-24%	554	16.81	16.81
25-49%	611	18.54	35.36
50-74%	839	25.46	60.82
75-100%	1,291	39.18	100.00

(b) Investment dynamics

	1993	1994	1995	1996	1997	1998	1999	2000	2001	*Total*
New acquisitions	35	28	26	29	38	49	45	43	52	345
Greenfield investments	34	9	20	22	48	40	20	21	32	246
Continuing investments	232	275	279	275	274	316	346	352	355	2704
Decreases in equity	10	18	16	14	15	15	12	13	10	123
No Changes in equity	209	233	244	240	246	280	317	312	321	2402
Increases in equity	13	24	19	21	13	21	17	27	24	179
Divestments	20	23	31	49	52	49	58	61	63	406

(c) Dynamics of equity shares, transition probabilities

Foreign equity share	0%	1-24%	25-49%	50-74%	75-100%	*Total*
0%	99.54	0.10	0.11	0.10	0.15	100
1-24%	12.65	81.38	3.10	0.48	2.39	100
25-49%	8.87	2.16	84.17	2.40	2.40	100
50-74%	6.81	0.97	1.30	84.93	6.00	100
75-100%	8.66	0.12	0.36	1.08	89.77	100
Total	95.58	0.78	0.82	1.13	1.68	100

(d) Equity and firm size dynamics by type of investment

Affiliate age	Mean equity share (%)		Mean plant size	
	Acquisition	Greenfield	Acquisition	Greenfield
1	54.22	62.97	234.85	114.10
2	55.62	63.66	254.38	127.61
3	56.40	63.34	242.74	145.80
4	56.74	65.13	249.91	169.79
5	55.26	66.01	247.10	199.06
6	56.65	70.70	283.16	222.47
7	59.81	75.12	313.48	282.53

Note: A decrease (increase) in equity occurs when the share of foreign equity at the firm falls (rises) from one year to the next by more than 1 percentage point. Divestment occurs either when a multinational affiliate is shut down or the multinational parent withdraws all of its equity investment (that is, a sale to domestic owners). Affiliate age is the number of years since the multinational affiliate started operations. Plant size is the average yearly number of full-time employees at a plant.

Table 3: Summary statistics

	Obs.	Mean	Std. dev.	Intra-sector variation	Means by ownership	
					Domestic	*Foreign*
Foreign equity participation	61,796	2.55	13.78	0.97	0.00	58.73
(log) Productivity	61,040	-0.50	1.14	0.83	-0.55	0.41
(log) Value added	61,050	3.12	1.76	0.92	3.02	5.40
(log) Plant size	61,796	4.02	1.13	0.93	3.97	5.15
(log) Capital intensity	61,786	-1.10	1.69	0.96	-1.15	-0.07
(log) Skill intensity	61,796	-1.92	1.58	0.94	-1.96	-0.92
Technical intensity in production	61,291	0.08	0.13	0.94	0.08	0.13
Foreign capital share	61,796	0.65	9.53	0.99	0.65	0.52
Intangibles intensity	61,775	0.01	0.43	0.99	0.01	0.01
R&D and advertising dummy	61,796	0.34	0.47	0.99	0.33	0.60
(log) R&D and advertising expenditure	61,796	0.20	0.62	0.96	0.16	1.06
(log) Price-cost margin	59,230	-1.45	0.89	0.97	-1.46	-1.07
Product market share	54,437	0.05	0.07	0.79	0.05	0.07
Exporter dummy	54,437	0.24	0.43	0.97	0.23	0.49
Importer dummy	54,437	0.27	0.44	0.97	0.25	0.59
Number of total products	54,437	2.51	2.76	0.92	2.49	2.91
Number of exported products	54,437	0.46	1.28	0.96	0.44	0.92
Number of total inputs	54,437	6.04	4.94	0.95	6.01	6.61
Number of imported inputs	54,437	0.66	1.54	0.97	0.61	1.80
(log) Imported inputs, value	61,796	0.10	0.39	0.97	0.08	0.44
(log) Imported inputs, unit value	54,437	0.36	1.20	0.98	0.34	0.78
Imported inputs / Total inputs	61,796	0.20	0.36	0.98	0.20	0.32
Total input contractibility	54,976	0.67	0.38	0.88	0.67	0.62
Imported input contractibility	14,138	0.63	0.44	0.89	0.63	0.62

Note: See Data Appendix for variable definitions; the calculation of productivity estimates is described in the text. Intra-sector variation refers to the ratio between the standard deviation within ISIC 4-digit sectors and the overall standard deviation; higher values of this ratio indicate that a greater share of variability is explained by within-sector variation. Sectoral intensity variables are calculated at the ISIC 4-digit level.

Table 4: Sector- and firm-level determinants of foreign equity participation

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable: Foreign equity participation, $y_{i,t}$ (%)						
Joint productivity	0.3464***		0.3261***		0.2815***	0.2928***
	(0.0242)		(0.0409)		(0.0206)	(0.0196)
Sectoral capital intensity		-0.0024	0.0511			
		(0.0376)	(0.0351)			
Sectoral skill intensity		0.0925*	0.0372			
		(0.0543)	(0.0548)			
Sectoral technical intensity in production		0.1843***	0.1519***			
		(0.0482)	(0.0520)			
Sectoral foreign capital share		0.0461	-0.0267			
		(0.0618)	(0.0422)			
Sectoral intangibles intensity		0.0519	0.0958***			
		(0.0738)	(0.0334)			
Capital intensity				0.2417***	0.2647***	0.2140***
				(0.0215)	(0.0212)	(0.0173)
Skill intensity				0.3680***	0.2858***	0.1776***
				(0.0329)	(0.0306)	(0.0222)
Technical intensity in prod.				0.0579***	0.0314**	-0.0075
				(0.0122)	(0.0125)	(0.0105)
Foreign capital share				-0.0015	-0.0119	-0.0058
				(0.0121)	(0.0153)	(0.0079)
Intangibles intensity				0.0011	0.0009	0.0016
				(0.0026)	(0.0024)	(0.0018)
Year effects	Yes	Yes	Yes	Yes	Yes	Yes
Sector effects						Yes
$-log L$	21,328	21,892	20,920	21,030	20,189	19,388
$\hat{\sigma}$	153.69	158.14	148.20	149.05	140.06	129.02
R^2	0.0349	0.0202	0.0602	0.0490	0.0871	0.1471
N	61,039	61,592	60,839	61,260	60,527	60,527

Note: This table reports Tobit estimates of (17). Standardised "beta" coefficients are reported; robust standard errors are given in parentheses and clustered at the sector level in columns (2)-(3) and at the firm level in the remaining columns; *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively. Sectoral intensity measures are calculated at the ISIC 4-digit level. All variables in logs, except for technical intensity in production, foreign capital share and intangibles intensity. Sector effects are included at the ISIC 4-digit level. Variable definitions are described in the Data Appendix and the calculation of R^2 is described in the text. $-log L$ is the negative of the log pseudolikelihood and $\hat{\sigma}$ is the estimated standard error of the fitted model.

Table 5: Match quality and foreign equity participation

	(1)	(2)	(3)	(4)
Dependent variable: Foreign equity participation, $y_{i,t}$ (%)				
Joint productivity	6.2115***	6.0965***	5.7425***	5.9455***
	(0.5900)	(0.5861)	(0.5688)	(0.5895)
Plant size	4.8774***	4.5785***	3.8555***	4.2764***
	(0.4371)	(0.4368)	(0.4536)	(0.4419)
Capital intensity	3.4392***	3.3335***	3.1606***	3.1862***
	(0.3450)	(0.3462)	(0.3435)	(0.3422)
Skill intensity	3.3444***	3.2548***	3.2561***	3.3396***
	(0.5115)	(0.5111)	(0.5065)	(0.5128)
Technical intensity in prod.	1.9475	1.6976	1.3243	1.6429
	(2.5681)	(2.5983)	(2.6397)	(2.5984)
Foreign capital share	-0.0353	-0.0355	-0.0363	-0.0330
	(0.0298)	(0.0299)	(0.0288)	(0.0296)
Intangibles intensity	0.1320			
	(0.1200)			
R&D and advertising dummy		4.0206***		
		(0.7090)		
R&D and advertising			2.9096***	
expenditure			(0.4177)	
Exporter dummy				1.9209**
				(0.8344)
Importer dummy				3.2057***
				(0.8485)
Sector & year effects	Yes	Yes	Yes	Yes
$-log L$	19,040	19,005	18,959	17,417
$\hat{\sigma}$	125.47	124.98	123.76	122.71
N	60,527	60,544	60,544	53,324

Note: This table reports Tobit estimates of (19). Marginal effects conditional on acquisition are reported; robust standard errors clustered at the firm level are given in parentheses; *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively. All variables in logs, except for technical intensity in production, foreign capital share and intangibles intensity. Sector effects are included at the ISIC 4-digit level. Variable definitions are described in the Data Appendix. $-log L$ is the negative of the log likelihood of the fitted model and $\hat{\sigma}$ is the estimated standard error of the fitted model.

Table 6: Match quality and foreign equity participation: MLE-IV estimates

	(1)	(2)	(3)	(4)
Dependent variable: Foreign equity participation, $y_{i,t}$ (%)				
Joint productivity	4.3022***	4.2505***	4.3017***	3.2259***
	(0.8258)	(0.8340)	(0.8378)	(0.7432)
Plant size	5.2201***	4.9176***	4.1850***	4.6464***
	(0.4302)	(0.4332)	(0.4586)	(0.4254)
Capital intensity	3.0039***	2.9105***	2.8246***	2.6083***
	(0.3324)	(0.3339)	(0.3337)	(0.3189)
Skill intensity	3.3173***	3.2298***	3.2516***	3.3334***
	(0.4761)	(0.4784)	(0.4803)	(0.4703)
Technical intensity in prod.	2.9595	2.6598	2.1359	3.0911
	(2.5364)	(2.5698)	(2.6315)	(2.5663)
Foreign capital share	-0.0296	-0.0301	-0.0317	-0.0290
	(0.0286)	(0.0287)	(0.0281)	(0.0289)
Intangibles intensity	0.1161			
	(0.1004)			
R&D and advertising dummy		4.0594***		
		(0.6755)		
R&D and advertising expenditure			3.0886***	
			(0.4157)	
Exporter dummy				2.1751***
				(0.8062)
Importer dummy				3.7421***
				(0.8296)
Sector & year effects	Yes	Yes	Yes	Yes
$-log L$	77,760	77,630	76,930	67,890
$\hat{\sigma}$	123.76	123.30	122.31	120.55
N	58,748	58,750	58,750	51,679
		First stage		
Dependent variable: Joint productivity				
Price-cost margin	0.5302***	0.5291***	0.5266***	0.5438***
	(0.0065)	(0.0065)	(0.0065)	(0.0070)
F-test on IV	6571.47	6567.46	6618.50	6033.64

Note: This table reports IV-Tobit estimates of (19) via maximum likelihood. Marginal effects conditional on acquisition are reported except for the first stage estimates; robust standard errors clustered at the firm level are given in parentheses; *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively. All variables in logs, except for technical intensity in production, foreign capital share and intangibles intensity. Sector effects are included at the ISIC 4-digit level. Variable definitions are described in the Data Appendix. $-log L$ is the negative of the log likelihood of the fitted model and $\hat{\sigma}$ is the estimated standard error of the fitted model. F-test on IV is the F-statistic (χ^2) for the test that the excluded instruments are jointly insignificant.

Table 7: Foreign equity participation and input use

	(1)	(2)	(3)	(4)	(5)
Dependent variable:	Total imports	Total inputs	Imports / Inputs	Input contractibility	Import contractibility
Foreign equity participation	0.0032***	0.0020**	0.0012***	-0.0009**	-0.0003
	(0.0010)	(0.0009)	(0.0004)	(0.0004)	(0.0005)
Plant size	0.4351***	0.6130***	0.0051	-0.0363***	-0.0097
	(0.0367)	(0.0344)	(0.0124)	(0.0134)	(0.0150)
Capital intensity	0.1298***	0.1485***	0.0136	0.0194*	0.0168
	(0.0284)	(0.0240)	(0.0098)	(0.0116)	(0.0131)
Skill intensity	0.0278	-0.0219	0.0111	-0.0022	0.0270
	(0.0397)	(0.0339)	(0.0139)	(0.0171)	(0.0191)
Technical intensity in prod.	0.0332	-0.1940	0.2339***	-0.0967	-0.1592*
	(0.2282)	(0.2890)	(0.0688)	(0.0866)	(0.0958)
Foreign capital share	0.0235***	0.0128	0.0166***	-0.0043	-0.0061
	(0.0087)	(0.0105)	(0.0027)	(0.0061)	(0.0081)
Intangibles intensity	0.3940	0.6282	0.4728	0.3485	1.1892***
	(0.8946)	(1.0312)	(0.4088)	(0.4222)	(0.3694)
Exporter dummy	-0.0410	0.0246	-0.0238	-0.0000	0.0139
	(0.0743)	(0.0626)	(0.0270)	(0.0284)	(0.0309)
Sector & year effects	Yes	Yes	Yes	Yes	Yes
R^2	0.4941	0.7024	0.1626	0.2339	0.1573
N	1,462	1,462	1,462	1,459	1,411

Note: This table reports OLS estimates of foreign equity participation on input use. Robust standard errors are given in parentheses and clustered at the firm level; *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively. All variables in logs, except for imports/inputs, contractibility measures, foreign equity participation, technical intensity in production, foreign capital share and intangibles intensity. Sector effects are included at the ISIC 2-digit level. Variable definitions are described in the Data Appendix.

Table 8: Foreign equity participation and input use: IV estimates

	(1)	(2)	(3)	(4)	(5)
Dependent variable:	Total imports	Total inputs	Imports / Inputs	Input contractibility	Import contractibility
Foreign equity participation	0.0354***	0.0351***	0.0059*	0.0062*	0.0048
	(0.0111)	(0.0104)	(0.0032)	(0.0034)	(0.0033)
Plant size	0.5879***	0.7677***	0.0271	-0.0031	0.0133
	(0.0790)	(0.0738)	(0.0189)	(0.0236)	(0.0231)
Capital intensity	0.0555	0.0726	0.0030	0.0038	0.0069
	(0.0515)	(0.0513)	(0.0118)	(0.0176)	(0.0180)
Skill intensity	-0.0663	-0.1165	-0.0031	-0.0230	0.0090
	(0.0747)	(0.0730)	(0.0183)	(0.0241)	(0.0236)
Technical intensity in prod.	0.0630	-0.1650	0.2469***	-0.0730	-0.1333
	(0.3225)	(0.3807)	(0.0746)	(0.0884)	(0.0925)
Foreign capital share	0.0883***	0.0816***	0.0275***	-0.0005	-0.0100
	(0.0300)	(0.0298)	(0.0066)	(0.0092)	(0.0093)
Intangibles intensity	-3.5269*	-3.3922	-0.1053	-0.5602	0.5019
	(2.0628)	(2.2291)	(0.5249)	(0.5461)	(0.5158)
Exporter dummy	-0.1423	-0.0810	-0.0385	-0.0212	-0.0047
	(0.1208)	(0.1142)	(0.0335)	(0.0384)	(0.0377)
Sector & year effects	Yes	Yes	Yes	Yes	Yes
N	1,448	1,448	1,448	1,445	1,397
			First stage		
Dependent variable: Foreign equity participation					
Joint productivity	3.4533**	3.4533**	3.4533**	3.4388**	3.5205***
	(1.3631)	(1.3631)	(1.3631)	(1.3651)	(1.2830)
French legal origin	6.9934**	6.9934**	6.9934**	7.0093**	6.7136*
	(3.5349)	(3.5349)	(3.5349)	(3.5384)	(3.5653)
F-test on IV	6.1384	6.1384	6.1384	6.1106	6.2723
Partial R^2	0.0293	0.0293	0.0293	0.0293	0.0293
R^2	0.1446	0.1446	0.1446	0.1456	0.1471
Over-id test (*p-value*)	0.2818	0.3672	0.3141	0.1558	0.2906

Note: This table reports instrumental variables estimates of foreign equity participation on input use. Robust standard errors are given in parentheses and clustered at the firm level; *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively. All variables in logs, except for imports/inputs, contractibility measures, foreign equity participation, technical intensity in production, foreign capital share and intangibles intensity. Sector effects are included at the ISIC 2-digit level. Variable definitions are described in the Data Appendix. F-test on IV is the F-statistic (χ^2) for the test statistic that the excluded instruments are jointly insignificant. Over-id test is the test of overidentifying restrictions; p-value reported.

Table 9: Divestment hazard at multinational affiliates

	(1)	(2)	(3)	(4)
Dependent variable: Hazard rate of divestment				
Joint productivity	-0.2274**	-0.2386**	-0.1883**	-0.2956**
	(0.0945)	(0.0958)	(0.0953)	(0.1166)
Plant size	-0.0808	-0.0955	-0.0213	-0.1395
	(0.0758)	(0.0790)	(0.0786)	(0.0962)
Capital intensity	-0.0805	-0.0875	-0.0585	-0.1037
	(0.0561)	(0.0568)	(0.0574)	(0.0686)
Skill intensity	-0.0909	-0.1000	-0.0799	-0.0511
	(0.0963)	(0.1000)	(0.0947)	(0.1220)
Technical intensity in prod.	-1.6893***	-1.8451***	-1.7916***	-2.1008***
	(0.6178)	(0.6312)	(0.6080)	(0.7633)
Foreign capital share	0.0680***	0.0687***	0.0698***	0.1094***
	(0.0248)	(0.0257)	(0.0239)	(0.0310)
Intangibles intensity	-9.1496**			
	(4.0079)			
R&D and advertising dummy		0.0806		
		(0.1867)		
R&D and advertising expenditure			-0.1581**	
			(0.0636)	
Exporter dummy				-0.0790
				(0.1982)
Importer dummy				-0.4840**
				(0.2050)
PH test, *p-value*	0.86	0.68	0.87	0.72
$-\log L$	212.25	213.92	212.21	164.19
N	2,045	2,045	2,045	1,895

Note: This table reports Cox PH estimates of (20). All specifications are stratified by sector and year. Coefficient estimates instead of hazard ratios are reported; robust standard errors are given in parentheses; *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively. All variables in logs, except for technical intensity in production, foreign capital share and intangibles intensity. Variable definitions are described in the Data Appendix. $-\log L$ is the negative of the log likelihood of the fitted model. PH test is a test for the null hypothesis of proportional hazards, distributed χ^2; p-value is reported.

Table 10: Changes to equity shares at continuing investments

	(1)		(2)		(3)	
Dependent variable:	Fall in equity share	Rise in equity share	Fall in equity share	Rise in equity share	Fall in equity share	Rise in equity share
Joint productivity	0.0863	0.1078*	0.1115	0.0999	-0.4263**	0.0094
	(0.0938)	(0.0617)	(0.1056)	(0.0712)	(0.2154)	(0.1219)
Plant size	0.1931**	0.1454**	0.2841***	0.1405**	-0.2314	0.1836
	(0.0947)	(0.0717)	(0.0949)	(0.0700)	(0.2491)	(0.1237)
Capital intensity	0.1040	-0.0220	0.1831**	0.0109	0.3822***	0.1319
	(0.0869)	(0.0635)	(0.0912)	(0.0693)	(0.1428)	(0.0979)
Skill intensity	-0.1416	-0.0405	-0.0579	-0.0307	-0.0606	-0.0386
	(0.1022)	(0.0950)	(0.1182)	(0.1031)	(0.1830)	(0.1346)
Technical intensity in	-2.3482**	-1.0306*	-1.6959	-1.0146*	0.0405	-1.2583
prod.	(1.1387)	(0.5702)	(1.1030)	(0.5848)	(1.8820)	(1.0198)
Foreign capital share	0.0653	0.0005	0.0742	-0.0028	0.4008***	0.0702
	(0.0457)	(0.0554)	(0.0485)	(0.0614)	(0.1444)	(0.0939)
Intangibles intensity	-5.0461	-1.3193	-7.4466	-2.0333	4.0502	-7.2447
	(7.6266)	(3.3399)	(7.9810)	(3.4328)	(4.6381)	(5.2501)
Sector & year effects			Yes		Yes	
$-log L$	952.37		928.03		217.34	
Wald test [Fall=Rise]	3.77 (0.15)		2.90 (0.23)		3.99 (0.14)	
$\chi^2 (p-value)$						
N	2,229		2,223		340	

Note: This table reports multinomial logit regression results of changes in foreign equity participation on firm characteristics. Columns (1) and (2) report estimates from the panel sample of all continuing investments of affiliates, while column (3) reports estimates from the cross-sectional sample of first-time foreign investments. The reference category is "minimal change in equity share". Robust standard errors are given in parentheses and clustered at the firm level in column (1) and (2); *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively. All variables in logs, except for technical intensity in production, foreign capital share and intangibles intensity. Sector effects are included at the 2-digit level in columns (2) and (3). Variable definitions are described in the Data Appendix. $-log L$ is the negative of the log likelihood of the fitted model. Wald test [Fall=Rise] is a Wald test of joint significance of the joint productivity coefficients estimated on the two alternative categories in reference to the base category; p-values are reported in parentheses.

A Appendix

This Appendix contains proofs of intermediate results and propositions mentioned in the text.

A.1 Proof of proposition 1

The proof consists of two parts. In the first, we show that there exists a solution $\delta^* \in (0,1)$ to the final good producer's problem. In the second, we show that this optimal level of integration is unique. In order to simplify the analysis, we show these results for the optimal fraction of revenues that accrue to the final good producer, β_V^*. Recall that $\beta_V = \delta^\alpha(1-\beta)+\beta$. Since the choice of the level of integration, δ, uniquely determines the division rule of the surplus, β_V, it will be sufficient to pin down an optimal $\beta_V \in (0,1)$. One can then back out $\delta^* \in (0,1)$ from $\delta = [(\beta_V^* - \beta)/(1-\beta)]^{1/\alpha}$.[39]

Existence:

We rewrite the final good producer's problem of maximising per-period profits in terms of β_V (we suppress the other arguments for notational simplicity):

$$\max_{\beta_V} \pi(\beta_V) = X^{\frac{\mu-\alpha}{1-\alpha}} \theta^{\frac{\alpha}{1-\alpha}} \psi(\beta_V) - w_N \left(\frac{\beta_V - \beta}{1-\beta}\right)^{\frac{\phi}{\alpha}} \tag{21}$$

where

$$\psi(\beta_V) = \alpha^{\frac{\alpha}{1-\alpha}} \left(\frac{\beta_V}{w_N}\right)^{\frac{\alpha\eta}{1-\alpha}} \left(\frac{1-\beta_V}{w_S}\right)^{\frac{\alpha(1-\eta)}{1-\alpha}} (1-\alpha\eta\beta_V - \alpha(1-\eta)(1-\beta_V)).$$

The first order condition to this program yields:

$$\begin{aligned} \frac{\partial \pi(\beta_V)}{\partial \beta_V} &= \left[\frac{\alpha^\alpha X^{\mu-\alpha}\theta^\alpha}{w_N^{\alpha\eta} w_S^{\alpha(1-\eta)}}\right]^{\frac{1}{1-\alpha}} \left[\frac{\alpha \beta_V^{\frac{\alpha\eta}{1-\alpha}-1}(1-\beta_V)^{\frac{\alpha(1-\eta)}{1-\alpha}-1}}{(1-\alpha)}\right] \\ &\quad \times \left[\beta_V^2(2\eta-1) + \beta_V(2\eta(\alpha-\alpha\eta-1)) + \eta(1-\alpha+\alpha\eta)\right] \\ &\quad - \frac{\phi w_N}{\alpha(1-\beta)} \left(\frac{\beta_V-\beta}{1-\beta}\right)^{\frac{\phi-\alpha}{\alpha}} \\ &= 0 \end{aligned} \tag{22}$$

[39] Notice also that the first order condition that defines the optimal level of integration, $\partial\pi(\delta)/\partial\delta = 0$, can be written as $(\partial\pi(\beta_V)/\partial\beta_V)(\partial\beta_V/\partial\delta) = 0$. The partial derivative of β_V with respect to δ is always non-zero, so that δ^* is defined by $\partial\pi(\beta_V)/\partial\beta_V = 0$.

For operating profits to have at least one local maximum $\beta_V \in (0, 1)$, we require $\partial\pi(\beta_V)/\partial\beta_V > 0$ as $\beta_V \to \beta$ (this is the case when $\delta \to 0$) and $\partial\pi(\beta_V)/\partial\beta_V < 0$ as $\beta_V \to 1$ (this is the case when $\delta \to 1$). First consider the case when $\beta_V \to 1$. The second term in (22) is clearly negative and the first term converges to zero when $\frac{\alpha(1-\eta)}{1-\alpha} - 1 > 0$. If $\frac{\alpha(1-\eta)}{1-\alpha} - 1 < 0$, then the sign of the quadratic equation in β_V in the square brackets becomes important as the first term in the expression tends to infinity. However, notice that the quadratic equation goes to $-1+\eta(1+\alpha-\alpha\eta)$ as $\beta_V \to 1$. Let $g(\eta) = -1+\eta(1+\alpha-\alpha\eta)$. It is easy to check that $g(\eta)$ is increasing in η and $g(0) = -1$ and $g(1) = 0$. Since η takes on values in the open interval $(0, 1)$, $g(\eta)$ is always negative.

Next consider $\beta_V \to \beta$. The second term in the first order condition vanishes since $\phi > \alpha$. The sign of the first order condition is then determined by the quadratic expression $\beta^2(2\eta-1) + \beta(2\eta(\alpha-\alpha\eta-1)) + \eta(1-\alpha+\alpha\eta)$, which is required to be positive to show existence. For high enough values of η, this expression is positive for almost all $\beta \in (0, 1)$. Since we focus on high headquarter intensity industries in this paper, the existence of δ^* follows without much restriction on β.[40] For low headquarter intensity industries, however, the model requires the bargaining power parameter β to be low enough for vertical integration to arise. In particular, assume η is less than $\frac{1}{2}$ for low headquarter intensity industries; one can check that for $\eta < \frac{1}{2}$, β should also be less than $\frac{1}{2}$ for integration to arise in equilibrium. Chart C.1 demonstrates the permissible set of β's for two industries, one with relatively high headquarter intensity and the other with relatively low headquarter intensity.

The intuition here comes from the trade-off faced by the final good producer between maximising the level of profits versus maximising its share of the revenue when it decides on the level of integration. By picking a higher degree of ownership, the final good producer grabs a bigger fraction of the revenue, but causes its manufacturing supplier to underinvest, which leads to a lower overall level of profits. As the headquarter intensity of the production line increases, the relative importance of the manufacturing supplier's input goes down. This means that the supplier's underinvestment has minimal effect on the overall level of profits when η is high, thereby tilting the final good producer's trade-off in favour of a higher share of the revenue.

Notice that the final good producer always receives at least a fraction β of the revenue. In low η industries, its input is of relatively low importance, so a high bargaining power β already compensates it for its investment. Any additional increase in the final good producer's share of the revenue will lower overall profits. In such industries, one needs the manufacturing supplier to have the upper hand in the ex post bargaining stage, that is, $1-\beta$ to be high, for vertical integration to occur. In high η industries, however, the relatively high importance of its input leads the final good producer to claim a larger fraction of the revenue even if it has a high bargaining power to start with. Hence, the permissible set of β's enlarges with headquarter intensity.

Uniqueness:

We now prove that the optimal level of integration is unique. A sufficient condition for this result is that operating profits are strictly quasi-concave in δ. To get this result, we again work with β_V and we show the strict concavity of the profit function in δ. Note that β_V is a strictly concave function of δ, since $\beta_V = \delta^\alpha(1-\beta)+\beta$ and $\alpha \in (0, 1)$, and profits are strictly increasing in β_V by

[40] Only very high values for β may reverse the sign of the quadratic expression in β.

the model assumptions. Hence, one needs only to show that profits are concave in β_V to establish strict concavity in δ.[41]

Since $\phi > \alpha$, the costs of organisational form in (21) are convex. Subtracting a convex function from a concave function returns another concave function; we therefore check whether $X^{\frac{\mu-\alpha}{1-\alpha}}\theta^{\frac{\alpha}{1-\alpha}}\psi(\beta_V)$ in (21) is concave in β_V. The second order condition to the final good producer's problem is given by:

$$\begin{aligned}\frac{\partial^2\pi(\beta_V)}{\partial\beta_V^2} = \; & \frac{\alpha}{(1-\alpha)^2}\left[\frac{X^{\mu-\alpha}\theta^{\alpha}\alpha^{\alpha}}{w_N^{\alpha\eta}w_S^{\alpha(1-\eta)}}\right]^{\frac{1}{1-\alpha}}\left[\beta_V^{\frac{\alpha\eta}{1-\alpha}-2}(1-\beta_V)^{\frac{\alpha(1-\eta)}{1-\alpha}-2}\right] \\ & \times[\beta_V^3(1-2\eta)\alpha+\beta_V^2(1+\alpha\eta-\alpha)(4\alpha\eta-1) \\ & +\beta_V(1+\alpha\eta-\alpha)(2-3\alpha-2\alpha\eta)\eta+(1+\alpha\eta-\alpha)(\alpha+\alpha\eta-1)\eta] \\ & -\frac{\phi w_N(\phi-\alpha)}{\alpha^2(1-\beta)^2}\left(\frac{\beta_V-\beta}{1-\beta}\right)^{\frac{\phi-\alpha}{\alpha}-1}\end{aligned} \tag{23}$$

where the first term is the second derivative of $X^{\frac{\mu-\alpha}{1-\alpha}}\theta^{\frac{\alpha}{1-\alpha}}\psi(\beta_V)$ with respect to β_V.

In order for operating profits to be concave in β_V, it is sufficient for the value of the cubic equation in β_V that is expressed in the square brackets to be negative.[42] The sign of this expression is determined by the values of the parameters in the model. In Chart C.1, we plot the cubic equation for various values of α and η. As can be seen from the chart, the cubic equation is everywhere less than zero whenever $\alpha < \frac{1}{2}$, regardless of what value η takes. When $\alpha > \frac{1}{2}$, the curvature of the cubic equation is reversed; as a result, the value of the equation becomes only slightly positive when evaluated at the extreme end values of β_V. This may occur, for instance, when both α and η are sufficiently high. However, recall that β_V is the share of revenue that accrues to the final good producer, which has a lower bound of β, and $1-\beta_V$ is the share of revenue that accrues to the manufacturing input supplier. As a result, one can comfortably conjecture that the value of β_V in equilibrium will be away from the end points of 0 and 1. This establishes the concavity of the profit function in β_V.

[41]This is relatively easy to see. Let D be a convex set and $f : D \to \mathbb{R}$ be strictly concave. Let B contain $f(D)$ and $g : B \to \mathbb{R}$ be concave and strictly increasing. Consider any $a, b \in D$ and $t \in [0, 1]$. Let $d = ta + (1-t)b$. The strict concavity of f means that:

$$f(d) = f(ta+(1-t)b) > tf(a)+(1-t)f(b)$$

Then $g(f(d))$ is strictly concave since:

$$g(f(d)) > g(tf(a)+(1-t)f(b)) \geq tg(f(a))+(1-t)g(f(b))$$

where the first inequality follows from g being strictly increasing and the second (weak) inequality from its concavity.

[42]Note that this is more restrictive than necessary. The second term in (23) is unambiguously negative since $\phi > \alpha$. Negativity of the first term ensures that $\partial^2\pi(\beta_V)/\partial\beta_V^2 < 0$. However, the second order condition could still be negative when the first term is positive, depending on the relative sizes of the two terms.

A.2 Proof of proposition 2

In order to show the result, we again work with β_V instead of working with δ directly. Since $\frac{\partial\delta^*}{\partial\theta} = \left(\frac{\partial\delta^*}{\partial\beta_V(\delta)}\right)\left(\frac{\partial\beta_V(\delta)}{\partial\theta}\right)$ and β_V rises monotonically in δ^*, it is sufficient to sign the partial derivative $\partial\beta_V(\delta)/\partial\theta$.

The final good producer's optimal share of revenues is implicitly defined by the first order condition in (22). Define the function $g(\beta_V, \theta) = \frac{\partial\pi(\beta_V)}{\partial\beta_V}$. Using the implicit function theorem:

$$\frac{\partial\beta_V}{\partial\theta} = -\frac{\partial g(\beta_V, \theta)/\partial\theta}{\partial g(\beta_V, \theta)/\partial\beta_V}$$

Notice that $\partial g(\beta_V, \theta)/\partial\beta_V$ is simply the second order condition given by (23). We show in the proof of proposition 1 that (23) is negative. Now consider $\partial g(\beta_V, \theta)/\partial\theta$. This is given by:

$$\begin{aligned}\frac{\partial g(\beta_V, \theta)}{\partial\theta} &= \frac{\alpha}{1-\alpha}\left[\frac{1}{\theta}\frac{\alpha^{\alpha}X^{\mu-\alpha}}{w_N^{\alpha\eta}w_S^{\alpha(1-\eta)}}\right]^{\frac{1}{1-\alpha}}\left[\frac{\alpha\beta_V^{\frac{\alpha\eta}{1-\alpha}-1}(1-\beta_V)^{\frac{\alpha(1-\eta)}{1-\alpha}-1}}{(1-\alpha)}\right] \\ &\quad \times\left[\beta_V^2(2\eta-1)+\beta_V(2\eta(\alpha-\alpha\eta-1))+\eta(1-\alpha+\alpha\eta)\right]\end{aligned}$$

Since $\psi(\beta_V, \eta)$ is assumed to be increasing in β_V in high headquarter intensity industries, we have:[43]

$$\begin{aligned}\frac{\partial\psi(\beta_V, \eta)}{\partial\beta_V} &= \left[\frac{\alpha^{\alpha}}{w_N^{\alpha\eta}w_S^{\alpha(1-\eta)}}\right]^{\frac{1}{1-\alpha}}\left[\frac{\alpha\beta_V^{\frac{\alpha\eta}{1-\alpha}-1}(1-\beta_V)^{\frac{\alpha(1-\eta)}{1-\alpha}-1}}{(1-\alpha)}\right] \\ &\quad \times\left[\beta_V^2(2\eta-1)+\beta_V(2\eta(\alpha-\alpha\eta-1))+\eta(1-\alpha+\alpha\eta)\right] > 0\end{aligned}$$

It is then straightforward to see that $\frac{\partial g(\beta_V, \theta)}{\partial\theta} > 0$. Hence, the partial derivative $\partial\beta_V/\partial\theta$ is positive as a result of the implicit function theorem, which establishes that δ^* is strictly increasing in θ.

A.3 Proof of $\pi(\underline{\theta}) > \pi(\underline{\tilde{\theta}})$

In the body of the paper, we made the assertion that the level of profits required by the final good producer to stay in the match rises from the first period to the second. We now show formally why this holds.

[43] To see this result, note that the quadratic term in β_V in square brackets goes to $(\beta_V - 1)^2$ as $\eta \to 1$; that is, for high enough values of headquarter intensity, the quadratic expression is positive.

Using (9) and (10) in equation (14), and adding and subtracting like terms where necessary, we get:

$$
\begin{aligned}
\frac{r+\lambda}{r+\lambda-1}\pi(\underline{\theta}) &= \pi(\underline{\tilde{\theta}})+\frac{1}{r+\lambda}\int_{-\infty}^{\infty} J(\theta')dP(\theta'|\tilde{\gamma},\tilde{b}) \\
\frac{r+\lambda}{r+\lambda-1}\pi(\underline{\theta}) &= \pi(\underline{\tilde{\theta}})+\frac{1}{r+\lambda}\int_{-\infty}^{\underline{\theta}} \frac{1}{r}QdP(\theta'|\tilde{\gamma},\tilde{b})+\frac{1}{r+\lambda}\int_{\underline{\theta}}^{\infty}\frac{r+\lambda}{r+\lambda+1}\pi(\theta')dP(\theta'|\tilde{\gamma},\tilde{b}) \\
\frac{r+\lambda}{r+\lambda-1}\pi(\underline{\theta}) &= \pi(\underline{\tilde{\theta}})+\frac{\pi(\underline{\theta})}{r+\lambda-1}\int_{-\infty}^{\underline{\theta}} dP(\theta'|\tilde{\gamma},\tilde{b})+\frac{1}{r+\lambda-1}\int_{\underline{\theta}}^{\infty}\pi(\theta')dP(\theta'|\tilde{\gamma},\tilde{b}) \\
(r+\lambda)\pi(\underline{\theta}) &= (r+\lambda-1)\pi(\underline{\tilde{\theta}})+\pi(\underline{\theta})\int_{-\infty}^{\underline{\theta}} dP(\theta'|\tilde{\gamma},\tilde{b})+\int_{\underline{\theta}}^{\infty}\pi(\theta')dP(\theta'|\tilde{\gamma},\tilde{b}) \\
(r+\lambda-1)\left[\pi(\underline{\theta})-\pi(\underline{\tilde{\theta}})\right] &= \pi(\underline{\theta})\int_{-\infty}^{\underline{\theta}} dP(\theta'|\tilde{\gamma},\tilde{b})+\int_{\underline{\theta}}^{\infty}\pi(\theta')dP(\theta'|\tilde{\gamma},\tilde{b})-\pi(\underline{\theta}) \\
(r+\lambda-1)\left[\pi(\underline{\theta})-\pi(\underline{\tilde{\theta}})\right] &= \pi(\underline{\theta})\int_{-\infty}^{\underline{\theta}} dP(\theta'|\tilde{\gamma},\tilde{b})+\int_{\underline{\theta}}^{\infty}\pi(\theta')dP(\theta'|\tilde{\gamma},\tilde{b}) \\
&\quad -\int_{-\infty}^{\underline{\theta}}\pi(\underline{\theta})dP(\theta'|\tilde{\gamma},\tilde{b})-\int_{\underline{\theta}}^{\infty}\pi(\underline{\theta})dP(\theta'|\tilde{\gamma},\tilde{b}) \\
\pi(\underline{\theta})-\pi(\underline{\tilde{\theta}}) &= \frac{1}{r+\lambda-1}\int_{\underline{\theta}}^{\infty}\left[\pi(\theta')-\pi(\underline{\theta})\right]dP(\theta'|\tilde{\gamma},\tilde{b}) \\
\pi(\underline{\theta})-\pi(\underline{\tilde{\theta}}) &> 0
\end{aligned}
$$

The last line can be easily seen as the right hand side of the equation is certainly positive due to the fact that $\pi(.)$ is an increasing function of θ.

A.4 Proof of theorem 1

We check Blackwell's sufficient conditions to establish the existence of an appropriate operator and show its properties. Let T denote the operator which defines V as the fixed point of the equation (16), so that $V = TV$.

First, T transforms bounded and continuous functions into other bounded and continuous functions. Boundedness follows since the profit function in terms of the posterior expected value of productivity, $\pi(\tilde{\theta})$, is bounded. To see this, note that from equation (6), the profit function is bounded from below trivially by the fixed cost (when $\theta = 0$). The support of θ is $(0,\infty)$, but as θ rises, proposition 2 implies that the optimal level of integration, and thus the final good producer's share of revenue,β_V, should also rise. From (7), one can see that this negates the initial effect on profits from the rise in θ. As β_V tends to 1, operating profits collapse to zero. Continuity follows in a more straightforward manner as the profit function is continuous in $\tilde{\theta}$.

Second, consider $V(\tilde{\theta}) \geq W(\tilde{\theta})$ from the set of bounded and continuous real-valued functions on

θ. Then:

$$
\begin{aligned}
TV &= max\left\{\pi(\tilde{\theta}) + \frac{1}{r+\lambda}\int max\left[\frac{r+\lambda}{r+\lambda-1}\pi(\theta), \frac{1}{r}\int V(\tilde{\theta}')dG(\tilde{\theta}'|\hat{\gamma},\hat{b})\right] dP(\theta|\tilde{\gamma},\tilde{b}),\right.\\
&\quad \left.\frac{1}{r}\int V(\tilde{\theta}')dG(\tilde{\theta}'|\hat{\gamma},\hat{b})\right\}\\
&\geq max\left\{\pi(\tilde{\theta}) + \frac{1}{r+\lambda}\int max\left[\frac{r+\lambda}{r+\lambda-1}\pi(\theta), \frac{1}{r}\int W(\tilde{\theta}')dG(\tilde{\theta}'|\hat{\gamma},\hat{b})\right] dP(\theta|\tilde{\gamma},\tilde{b}),\right.\\
&\quad \left.\frac{1}{r}\int W(\tilde{\theta}')dG(\tilde{\theta}'|\hat{\gamma},\hat{b})\right\}\\
&= TW
\end{aligned}
$$

This establishes the monotonicity of T. For Blackwell's other sufficient condition, we have:

$$
\begin{aligned}
T(V+c) &= max\left\{\pi(\tilde{\theta}) + \frac{1}{r+\lambda}\int max\left[\frac{r+\lambda}{r+\lambda-1}\pi(\theta), \frac{1}{r}\int \left\{V(\tilde{\theta}')+c\right\} dG(\tilde{\theta}'|\hat{\gamma},\hat{b})\right] dP(\theta|\tilde{\gamma},\tilde{b}),\right.\\
&\quad \left.\frac{1}{r}\int \left\{V(\tilde{\theta}')+c\right\} dG(\tilde{\theta}'|\hat{\gamma},\hat{b})\right\}\\
&= max\left\{\pi(\tilde{\theta}) + \frac{1}{r+\lambda}\int max\left[\frac{r+\lambda}{r+\lambda-1}\pi(\theta), \frac{1}{r}\int V(\tilde{\theta}')dG(\tilde{\theta}'|\hat{\gamma},\hat{b}) + \frac{c}{r}\right] dP(\theta|\tilde{\gamma},\tilde{b}),\right.\\
&\quad \left.\frac{1}{r}\int V(\tilde{\theta}')dG(\tilde{\theta}'|\hat{\gamma},\hat{b}) + \frac{c}{r}\right\}\\
&= max\left\{\pi(\tilde{\theta}) + \frac{1}{r+\lambda}\int max\left[\frac{r+\lambda}{r+\lambda-1}\pi(\theta), \frac{1}{r}\int V(\tilde{\theta}')dG(\tilde{\theta}'|\hat{\gamma},\hat{b})\right] dP(\theta|\tilde{\gamma},\tilde{b}),\right.\\
&\quad \left.\frac{1}{r}\int V(\tilde{\theta}')dG(\tilde{\theta}'|\hat{\gamma},\hat{b})\right\} + \frac{c}{r}\\
&= TV + \frac{c}{r}
\end{aligned}
$$

Hence, T is a contraction operator with modulus $1/r$ which gives us that the functional equation in (16) has a unique fixed point in the space of bounded and continuous functions.

A.5 Proof of proposition 3

Since the optimal level of integration is strictly increasing in the level of productivity due to proposition 2, we need only to show that the average productivity in the second period is greater than in the first period. The rest of the proof closely follows Ljungqvist and Sargent (2004).

The mean values of productivity in period 1 and in period 2 are calculated using Bayes rule. The probability that a previously unmatched multinational offers a contract to its supplier in the first period is given by $\int_{\underline{\tilde{\theta}}}^{\infty} dG(\tilde{\theta}|\hat{\gamma},\hat{b})$. The probability that a previously unmatched multinational offers a contract in the first period *and* updates it in the second period is given by: $\int_{\underline{\tilde{\theta}}}^{\infty}\int_{\underline{\theta}}^{\infty} dP(\theta|\tilde{\gamma},\tilde{b})dG(\tilde{\theta}|\hat{\gamma},\hat{b})$. Following Bayes rule, average productivity in period 1 and period 2 is respectively given by:

$$\bar{\bar{\theta}}_1 = \frac{\int_{\underline{\tilde{\theta}}}^{\infty} \tilde{\theta} dG(\tilde{\theta}|\hat{\gamma},\hat{b})}{\int_{\underline{\tilde{\theta}}}^{\infty} G(\tilde{\theta}|\hat{\gamma},\hat{b})}$$

$$\bar{\theta}_2 = \frac{\int_{\underline{\tilde{\theta}}}^{\infty}\int_{\underline{\theta}}^{\infty} \theta dP(\theta|\tilde{\gamma},\tilde{b})dG(\tilde{\theta}|\hat{\gamma},\hat{b})}{\int_{\underline{\tilde{\theta}}}^{\infty}\int_{\underline{\theta}}^{\infty} dP(\theta|\tilde{\gamma},\tilde{b})G(\tilde{\theta}|\hat{\gamma},\hat{b})}$$

Using the fact that $\tilde{\theta} = \int_{b}^{\infty} \theta dP(\theta|\tilde{\gamma},\tilde{b})$, one gets:

$$\begin{aligned}
\bar{\bar{\theta}}_1 &= \frac{\int_{\underline{\tilde{\theta}}}^{\infty}\int_{b}^{\infty} \theta dP(\theta|\tilde{\gamma},\tilde{b})dG(\tilde{\theta}|\hat{\gamma},\hat{b})}{\int_{\underline{\tilde{\theta}}}^{\infty} G(\tilde{\theta}|\hat{\gamma},\hat{b})} \\
&= \frac{\int_{\underline{\tilde{\theta}}}^{\infty}\int_{b}^{\underline{\theta}} \theta dP(\theta|\tilde{\gamma},\tilde{b})dG(\tilde{\theta}|\hat{\gamma},\hat{b}) + \bar{\theta}_2 \int_{\underline{\tilde{\theta}}}^{\infty}\int_{\underline{\theta}}^{\infty} dP(\theta|\tilde{\gamma},\tilde{b})dG(\tilde{\theta}|\hat{\gamma},\hat{b})}{\int_{\underline{\tilde{\theta}}}^{\infty} G(\tilde{\theta}|\hat{\gamma},\hat{b})} \\
&< \frac{\int_{\underline{\tilde{\theta}}}^{\infty} \left\{\bar{\theta}P(\bar{\theta}|\tilde{\gamma},\tilde{b}) + \bar{\theta}_2\left[1 - P(\bar{\theta}|\tilde{\gamma},\tilde{b}\right]\right\} dG(\tilde{\theta}|\hat{\gamma},\hat{b})}{\int_{\underline{\tilde{\theta}}}^{\infty} G(\tilde{\theta}|\hat{\gamma},\hat{b})} \\
&< \bar{\theta}_2
\end{aligned}$$

Thus, average productivity rises over time which leads to a greater degree of foreign ownership at the average integrated firm.

A.6 Proofs of propositions 4 and 5

In the text.

B Data appendix

In this section we provide a detailed description of the database and the construction of the variables used in the paper. All data come from TurkStat's Industrial Analysis and Annual Manufacturing Statistics databases and are available in a machine-readable format at TurkStat's premises in Turkey. We focus on plants with more than 10 employees, which is a close approximation of Turkish manufacturing plants. Accordingly we restrict our frame of analysis to 1993-2001 to retrieve data consistent across years although we use data starting from 1990 to calculate some variables. This is a period of stable foreign investment inflows as the share of FDI stock in GDP grew from 5.54 per cent to 10.36 per cent (UNCTAD, 2013). All variables in the data set are measured in 1990 prices (Turkish liras). Product level data are provided at the level of TurkStat's national product classification, which classifies products into more than 2,700 categories at the 8-digit level, with the first four digits referring to the ISIC Rev. 2. Inclusion of firm identification codes allows us to match the plant level data to the product level data, which include information on intermediate inputs, imported inputs, final products and exports.

B.1 Estimation of joint productivity

We derive our productivity estimates using a production function approach. In the model, output is produced according to (1). We assume that both the headquarter firm and the manufacturing supplier employ physical capital, labour, and some intermediate inputs to provide h and m, respectively. While we do not observe the quantities of inputs that are used in the production of h, we do observe the inputs used by the supplier firm to produce m. Specifically, we assume that m is produced following a Cobb-Douglas function of the form:

$$m_j(i) = k_j(i)^a l_j(i)^b n_j(i)^c e_j(i)^d \tag{24}$$

where k represents physical capital, l represents labour, n represents raw material inputs, and e represents energy consumption. Substituting (24) into the final production function and taking logs yields:

$$log x_j(i) = \beta_0 + \beta_1 log h_j(i) + \beta_2 log k_j(i) + \beta_3 log l_j(i) + \beta_4 log n_j(i) + \beta_5 log e_j(i) + log\theta + \varepsilon_j(i)$$

where $log\theta$ is the productivity shock that is observed by the producer but not by the econometrician, $\varepsilon(i)$ are unobservable shocks to efficiency and β's are defined appropriately. Productivity shocks $log\theta$ are assumed to follow a first-order Markov process. We follow a value-added estimation approach and let $v_j(i)$ represent value added, that is, gross output net of both imported and domestic intermediate inputs; then rewrite the production function as:

$$log v_j(i) = \beta_0 + \beta_k log k_j(i) + \beta_l log l_j(i) + log\theta + \varepsilon \tag{25}$$

We deflate our measure of value added by the relevant output price deflator defined at the four-digit industry level while the investment series to construct the capital stock are deflated using an aggregate measure as sector-specific deflators are unavailable. We follow Levinsohn and Petrin (2012) to derive consistent estimates of the parameters in (25) and recover the predicted levels of productivity from $\hat{\theta} = exp(logv - \hat{\beta}_k logk - \hat{\beta}_l logl)$.

A typical complication in estimating (25) arises from the simultaneous determination of variable inputs and shocks to productivity. To overcome this complication, we adopt the instrumental variables approach suggested by Wooldridge (2009), which improves on the two-step estimation of Levinsohn and Petrin (2003) that relies on firms' intermediate inputs to proxy for productivity shocks potentially correlated with inputs of production. The Wooldridge (2009) modification corrects for the simultaneous determination of inputs and productivity, does not maintain constant returns to scale or require cost minimisation without input adjustment costs to identify production function parameters, and is robust to the Ackerberg et al. (2006) criticism (Levinsohn and Petrin, 2012). In our estimations, we use raw materials as our proxy and a third order polynomial approximation of the unknown functions. We estimate the parameters of (25) at the ISIC Rev.2 3-digit industry level.[44]

We carry out two rounds of checks for the estimates. First, we construct double deflated value added using the output price deflator for gross revenue and the input price deflator for materials, both at the three-digit level. Second, we include a full set of time period dummies in (25) to allow for heterogeneity over time in the production function and productivity (Wooldridge, 2009). Our productivity estimates are little changed in both cases.

B.2 Other variables

Foreign Ownership information is included for each firm in the breakdown of equity shares into three groups: government institutions, domestic private entities and foreign investors. The equity shares for these three groups are given in percentages and total 100. If a firm reports having any foreign equity participation, a further breakdown of this share into the top three shareholding countries and their respective shares are provided. In the data, only around 10 per cent of all affiliates have shareholders from multiple countries; in this case, we aggregate the shares. Foreign manufacturing firms in Turkey are typically controlled by a single multinational parent. We classify a firm with at least a 1 per cent foreign equity participation as an affiliate. In the sample, the minimum share of foreign ownership was 1 per cent and the maximum share was 100 per cent.

Total Imports are calculated by adding up the values of each 8-digit imported input by firm-year pairs. Similarly, *Total Inputs* are calculated by adding up each 8-digit input used in production, including those that are imported. *Imports/Inputs* is the simple ratio of the former to the latter. We observe quantities as well as values for each product, which allows us to construct unit values.

Input Contractibility is measured based on the same idea as Nunn (2007), but with the important

[44]We estimate categories 313 (beverages) and 314 (tobacco) jointly as well as 361 (pottery, china, earthenware) and 362 (glass products) to increase the sample size for the estimation at the sector level. For the same concern, the production function is not estimated for the petroleum refinery and other petroleum sectors (ISIC codes 353 and 354), which leaves out 367 plant-year observations from the analysis.

distinction that inputs are classified directly at the product level rather than relying on sector level input-output matrices for weights. Let R_j be an indicator variable that takes value 1 if the 8-digit product j is neither sold on an organised exchange nor reference priced as in Rauch (1999), and $s_{i,j}$ be the share of the 8-digit product j in total input usage of firm i. We calculate the degree of contractibility at the firm level as $\mu_i = 1 - (\sum_j s_{i,j} R_j)$ by year. Similarly, we calculate *Imported Contractibility* for each importer firm, this time applying the definition of R_j to each imported product at the 8-digit level and using weights $s_{i,j}$ as the share of the imported product in total imports. To construct these measures, we created a manual concordance between Rauch's classification at the SITC Rev. 2 4-digit level and TurkStat's national product classification based on ISIC Rev. 2 at the 8-digit level, mapping 2,711 national product codes into Rauch's classification. This mapping is available in English upon request.

Employment is measured as the average number of paid workers of the plant in a given year. Number of paid workers is reported for production and non-production workers four times during a given year (in February, May, August, and November) and the average of these four observations constitutes the *Plant Size*.

Skill Intensity is measured as the ratio of non-production workers to production workers. Non-production employees consist of management, office personnel, laboratory workers and others. Further disaggregation of skills among production workers is available. Employees working in production are classified into technical workers, foremen, and workers, while technical workers are further disaggregated into high- and mid-level technical personnel. We take advantage of this disaggregation and define *Technical Intensity in Production* as the share of technical workers in total production workers.

Sales are measured as revenues generated from the annual sales of final products and contract manufacturing, deflated by the relevant four-digit output price deflator provided by TurkStat.

Intangibles Expenditure is measured as total annual spending on research and development (excluding market research) as well as intangible property, including patents, copyrights, and so on. Consequently, *Intangibles Intensity* is defined as the ratio of *Intangibles Expenditure* to *Sales*. Alternatively, we capture total spending on research and development purposes as well as advertising efforts in *R&D and Advertising Expenditure*.

Value Added is calculated by TurkStat and takes into account revenues generated from the annual sales of firms' final products, contract manufacturing, change in inventories and material inputs including intermediates and energy. The series are deflated by the relevant 4-digit output price deflator.

Investment data are available in detail by type and whether investment goods are imported or not. The database includes information on investment in machinery and equipment, building and structures (which cannot be imported by default), transportation equipment, office fixtures, computers and software, and advertisements. All series are available from 1990, except for computers and software, which are available from 1995. Since the disaggregated investment deflator is not available, we use an annual aggregate investment deflator provided by TurkStat to deflate all series.

Capital Stock is constructed using the reported investment data and the perpetual inventory method. We use depreciation rates of 5 per cent, 10 per cent, 20 per cent, and 30 per cent, respectively, for building and structures; machinery, equipment and office fixtures; transportation equipment; and computers, software and advertisements. We observe zero initial investment for a small number of plants, for which we calculate initial capital stock at the year that they first report positive investment and then iterate back by dividing capital stock by one minus the depreciation rate. After calculating the capital stock series separately for each type of investment, we aggregate the series to form the total capital stock. The database provides information on imported investment so we follow the same approach to calculate the stock of imported capital.

Price-Cost Margin is calculated as the ratio of the difference between value added and the total wage bill to the gross value of production.

Product Market Share is the simple ratio of the number of unique products a firm produces in any given year to the total number of unique products that are produced by all the firms operating in the same 4-digit ISIC industry.

French Legal Origin indicates whether the legal system of the multinational investor's main home country is French.

Distance from HQ indicates the physical distance in 1,000 km from the multinational investor's main home country to Turkey.

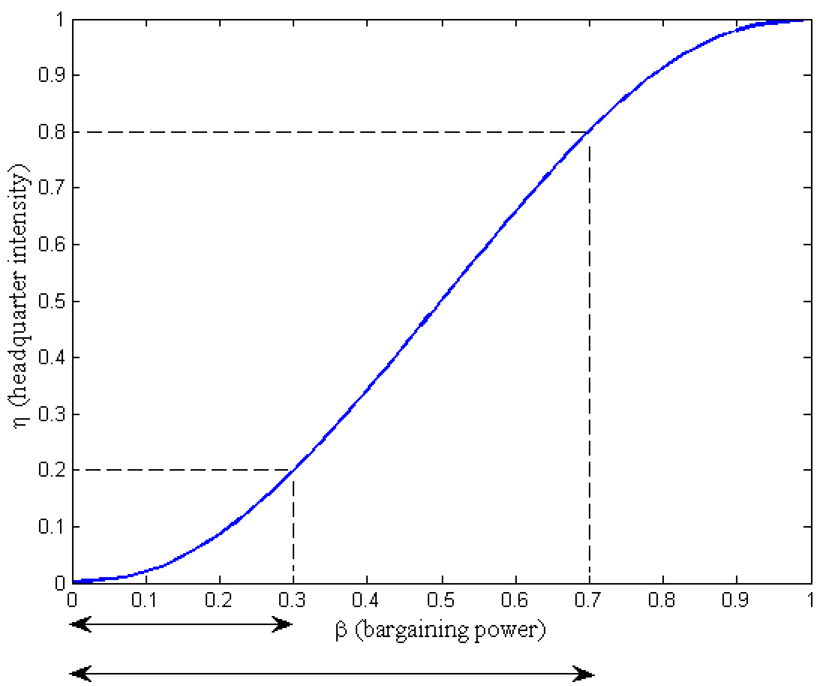
B.3 Data cleaning

The database is cleaned thoroughly as we check for inconsistent firm identifier codes, detect any duplicate observations and remove them. We follow two additional rules to clean the data. First, plants that have "gaps" in the panel are excluded from the analysis. Second, observations with a non-positive value for capital stock or value added are also excluded. This removes 36,798 firm-year observations out of a total of 98,924 from the raw data. Most eliminated observations are due to missing capital stock. However, this variable is created for most foreign affiliates and larger firms, which are in general immune to data collection problems. Plants for which we were unable to calculate a capital stock had a mean of 44 employees while our resulting database has a mean of 128 employees, suggesting that the resulting sample captures the vast majority of total manufacturing activity as smaller plants drop. In the end, we get a fairly balanced panel of firms, of which around 5 per cent are multinationals.

C Additional Charts and Tables

Chart C.1: Required parameter values for an internal solution

(a) The permissible set of β's for various headquarter intensities



(b) The sign of the cubic equation in β_V for different parameter values

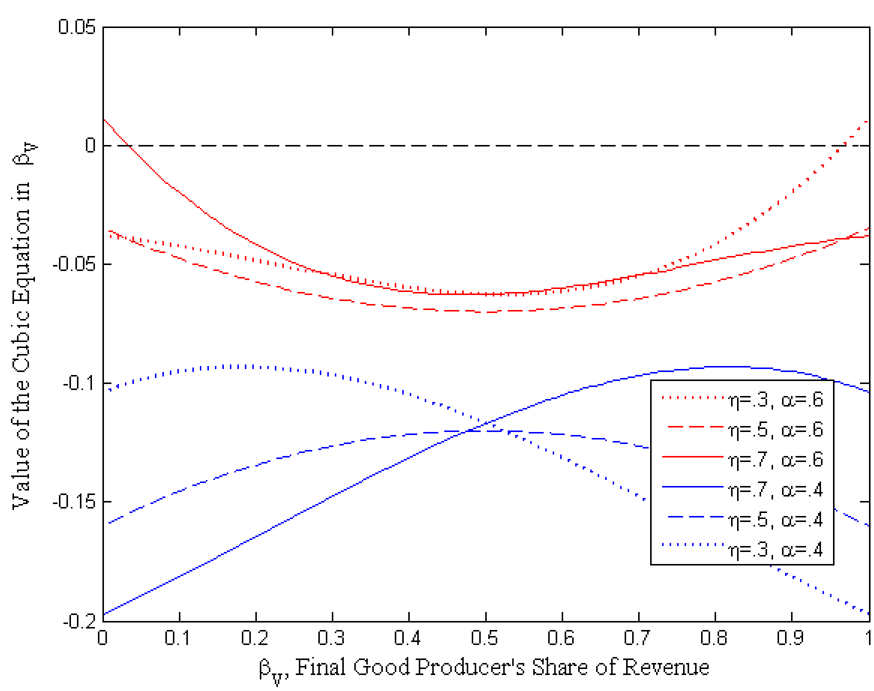


Table C.1: Foreign equity participation by affiliate age

	(1)	(2)	(3)
Dependent variable: foreign equity participation (%)			
Affiliate age	0.7983***	0.5914*	0.6427**
	(0.3064)	(0.3286)	(0.2905)
Year effects		Yes	Yes
Sector effects		Yes	
Firm-level effects			Yes
R^2	0.0037	0.0263	0.0265
N	1,805	1,802	1,805

Note: This table reports OLS results for a regression of Foreign Equity Participation on Affiliate Age using data from the balanced sample to construct Chart 2. Robust standard errors are given in parentheses; *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively. Sector effects are included at the 2-digit level. Affiliate Age is the number of years since the multinational affiliate started operations.

Table C.2: Match quality and the level of foreign ownership: MLE-IV estimates

	(1)	(2)	(3)	(4)
Dependent variable: Foreign equity participation, $y_{i,t}$ (%)				
Joint productivity	3.2768***	3.2039***	3.2457***	3.1504***
	(0.7209)	(0.7262)	(0.7374)	(0.7389)
Plant size	5.2639***	4.9888***	4.2531***	4.6582***
	(0.4098)	(0.4105)	(0.4350)	(0.4257)
Capital intensity	2.7952***	2.7010***	2.6195***	2.5974***
	(0.3160)	(0.3180)	(0.3205)	(0.3183)
Skill intensity	3.4292***	3.3488***	3.3783***	3.3358***
	(0.4625)	(0.4623)	(0.4669)	(0.4698)
Technical intensity in prod.	3.3230	3.0443	2.5001	3.1369
	(2.5152)	(2.5468)	(2.6254)	(2.5630)
Foreign capital share	-0.0238	-0.0241	-0.0263	-0.0291
	(0.0256)	(0.0254)	(0.0254)	(0.0290)
Intangibles intensity	0.1095			
	(0.0890)			
R&D and advertising dummy		3.7736***		
		(0.6548)		
R&D and advertising expenditure			3.0720***	
			(0.3921)	
Exporter dummy				2.1822***
				(0.8053)
Importer dummy				3.7543***
				(0.8285)
Sector & year effects	Yes	Yes	Yes	Yes
$-log L$	68,550	68,440	67,790	67,880
$\hat{\sigma}$	120.88	120.46	119.48	120.53
N	51,677	51,679	51,679	51,679
		First stage		
Dependent variable: Joint productivity				
Price-cost margin	0.5485***	0.5473***	0.5447***	0.5436***
	(0.0071)	(0.0070)	(0.0070)	(0.0071)
Product market share	0.3176***	0.3088***	0.2024*	0.2489**
	(0.1046)	(0.1047)	(0.1061)	(0.1029)
F-test on IV	6065.67	6061.87	6089.32	6063.75
Over-id test *(p-value)*	0.0018	0.0012	0.0001	0.0004

Note: This table reports IV Tobit estimates of (19) via maximum likelihood. Marginal effects conditional on acquisition are reported except for the first stage estimates; robust standard errors clustered at the firm level are given in parentheses; *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively. All variables in logs, except for technical intensity in production, foreign capital share, intangibles intensity and product market share. Sector effects are included at the ISIC 4-digit level. Variable definitions are described in the Data Appendix. - *log L* is the negative of the log likelihood of the fitted model and $\hat{\sigma}$

is the estimated standard error of the fitted model. F-test on IV is the F-statistic (χ^2) for the test that the excluded instruments are jointly insignificant. Over-id test is the test of overidentification restrictions; p-value reported.

Table C.3: Log-rank test for equality of survivor functions

Foreign ownership	Events observed	Events expected
1-24%	69	56.07
25-49%	43	38.52
50-74%	50	61.78
75-100%	71	76.63
Total	233	233.00
$\chi^2(p-value)$	18.85 (0.0003)	

Note: χ^2 is the log-rank statistic for the equality of survivor functions defined by quartiles of the degree of foreign ownership.

Table C.4: Divestment hazard at multinational affiliates

	(1)	(2)	(3)	(4)
Dependent variable: Hazard rate of divestment				
Foreign equity participation	-0.0075***	-0.0080***	-0.0074***	-0.0120***
	(0.0028)	(0.0028)	(0.0029)	(0.0033)
Plant size	-0.1266	-0.1500*	-0.0599	-0.2008**
	(0.0770)	(0.0808)	(0.0814)	(0.1018)
Capital intensity	-0.0681	-0.0750	-0.0471	-0.0953
	(0.0568)	(0.0565)	(0.0570)	(0.0662)
Skill intensity	-0.1253	-0.1311	-0.1009	-0.1148
	(0.0982)	(0.1013)	(0.0973)	(0.1334)
Technical intensity in prod.	-1.7583***	-1.8872***	-1.8242***	-2.1635***
	(0.6376)	(0.6485)	(0.6236)	(0.7845)
Foreign capital share	0.0495**	0.0492**	0.0512**	0.0756**
	(0.0235)	(0.0237)	(0.0230)	(0.0301)
Intangibles intensity	-7.9272**			
	(4.0444)			
R&D and advertising dummy		0.0968		
		(0.1918)		
R&D and advertising expenditure			-0.1621**	
			(0.0658)	
Exporter dummy				-0.1334
				(0.1948)
Importer dummy				-0.6250***
				(0.2031)
PH test, *p-value*	0.86	0.78	0.90	0.81
$-log L$	212.84	214.19	212.34	161.92
N	2,066	2,066	2,066	1,914

Note: This table reports Cox PH estimates of (20). All specifications are stratified by sector and year. Coefficient estimates instead of hazard ratios are reported; robust standard errors are given in parentheses; *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively. All variables in logs, except for foreign equity participation, technical intensity in production, foreign capital share and intangibles intensity. Variable definitions are described in the Data Appendix. $-log L$ is the negative of the log likelihood of the fitted model. PH test is a test for the null hypothesis of proportional hazards, distributed χ^2; p-value is reported.

Table C.5: Match quality and the level of foreign ownership: Hurdle model estimates

(a) Hurdle model estimates under exogeneity of joint productivity

	(1)	(2)	(3)	(4)	(5)
Model:	*Probit*		*OLS*		
Dependent variable:	Foreign ownership dummy	(log) Foreign equity participation			
Joint productivity	0.3195***	0.1057***	0.0942***	0.1087***	0.1067***
	(0.0131)	(0.0216)	(0.0215)	(0.0214)	(0.0214)
Plant size	0.2734***	-0.0946***	-0.1060***	-0.1130***	-0.1168***
	(0.0099)	(0.0189)	(0.0177)	(0.0176)	(0.0175)
Capital intensity	0.1786***	0.0543***	0.0641***	0.0602***	0.0575***
	(0.0077)	(0.0146)	(0.0146)	(0.0145)	(0.0145)
Skill intensity	0.1660***	0.0666***	0.0725***	0.0613***	0.0604***
	(0.0122)	(0.0219)	(0.0218)	(0.0218)	(0.0218)
Technical intensity in prod.	0.1230	0.0297	0.0284	0.0462	0.0370
	(0.0869)	(0.1381)	(0.1372)	(0.1368)	(0.1367)
Foreign capital share	-0.0014	-0.0515***	-0.0377***	-0.0542***	-0.0565***
	(0.0019)	(0.0112)	(0.0113)	(0.0152)	(0.0151)
Intangibles intensity	0.0063	1.9211***	1.9685***	1.9622***	1.8360**
	(0.0213)	(0.7214)	(0.7177)	(0.7154)	(0.7149)
Distance from HQ				-0.0220***	
				(0.0085)	
French legal origin					0.1300***
					(0.0407)
Sector & year effects	Yes	Yes	Yes	Yes	Yes
Greenfield dummy		Yes			
Sociocultural distance dummies			Yes		
$-log L$	6,999	3,407	3,386	3,370	3,367
R^2		0.2069	0.2191	0.2119	0.2132
N	58,902	2,633	2,633	2,623	2,622

(b) Hurdle model estimates under endogeneity of joint productivity

	(1)	(2)	(3)	(4)	(5)
Model:	*IV-Probit*		*IV-2SLS*		
Dependent variable:	Foreign ownership dummy		(log) Foreign equity participation		
Joint productivity	0.2261***	0.0876**	0.0726*	0.0772*	0.0860**
	(0.0276)	(0.0440)	(0.0438)	(0.0437)	(0.0436)
Plant size	0.3010***	-0.0960***	-0.1068***	-0.1124***	-0.1180***
	(0.0114)	(0.0197)	(0.0187)	(0.0185)	(0.0184)
Capital intensity	0.1605***	0.0554***	0.0660***	0.0604***	0.0589***
	(0.0084)	(0.0147)	(0.0146)	(0.0146)	(0.0146)
Skill intensity	0.1714***	0.0648***	0.0712***	0.0619***	0.0598***
	(0.0125)	(0.0225)	(0.0224)	(0.0223)	(0.0223)
Technical intensity in prod.	0.1703*	0.0915	0.0900	0.1099	0.0956
	(0.0898)	(0.1403)	(0.1391)	(0.1389)	(0.1388)
Foreign capital share	-0.0012	-0.0526***	-0.0384***	-0.0562***	-0.0586***
	(0.0018)	(0.0111)	(0.0111)	(0.0150)	(0.0149)
Intangibles intensity	0.0057	2.2465***	2.2471***	2.2848***	2.0589**
	(0.0216)	(0.8248)	(0.8187)	(0.8185)	(0.8184)
Distance from HQ				-0.0224***	
				(0.0083)	
French legal origin					0.1267***
					(0.0407)
Sector & year effects	Yes	Yes	Yes	Yes	Yes
Greenfield dummy		Yes			
Sociocultural distance dummies			Yes		
N	57,226	2,579	2,579	2,569	2,568
			First stage		
Dependent variable: Joint productivity					
Price-cost margin	0.5298***	0.5782***	0.5798***	0.5794***	0.5791***
	(0.0033)	(0.0187)	(0.0187)	(0.0187)	(0.0186)
F-test on IV		959.41	960.35	962.25	965.09
Partial R^2		0.2777	0.2779	0.2787	0.2794
R^2		0.7309	0.7324	0.7311	0.7317

Note: This table reports hurdle model estimates as an alternative to the Tobit estimates presented in the paper. Standard errors are given in parentheses; *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively. Sociocultural distance dummies group countries of foreign investors into one of five categories (British Heritage, Non-Anglo Europe, Asia, Latin America, and Other); see Table C.5. Sector effects are included at 4-digit level. All variables in logs, except for skill intensity in production, foreign capital share, distance from HQ and French legal origin. Variable definitions are described in the Data Appendix. $-log L$ is the negative of the log likelihood of the fitted model. F-test on IV is the F-statistic (χ^2) for the test that the excluded instruments are jointly insignificant.

Table C.6: Classification of countries by sociocultural distance

British heritage	Non-Anglo Europe	Asia	Latin America
Australia	Austria	Hong Kong	Argentina
Canada	Belgium	India	Brazil
Ireland	Denmark	Japan	Chile
New Zealand	Finland	S. Korea	Colombia
United Kingdom	France	Malaysia	Ecuador
United States	Germany	Philippines	Mexico
	Greece	Singapore	Panama
	Italy	Thailand	Peru
	Netherlands		Venezuela
	Norway		
	Portugal		
	Spain		
	Sweden		
	Switzerland		

Note: All other countries are grouped into “Other”.