Optimal Degree of Foreign Ownership under Uncertainty

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Abstract

This paper studies the integration strategies of multinational firms in a multi-period model under incomplete contracts and uncertainty. I incorporate continuous levels of integration to the study of organizational choice in an existing model of foreign direct investment (Antras and Helpman, 2004) and extend the model to a multi-period framework of learning. The joint productivity of the two partners in an integrated firm is unknown initially to both sides and is revealed only after continued joint production. The model gives rise to a nondegenerate distribution of foreign ownership at the firm level and shows that the optimal level of integration rises with the age of the joint venture. These patterns are supported by detailed plant-level data on share of foreign ownership. The model predicts that technology transfer occurs through intra-firm trade over time as a result of increased control by multinationals.

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1 Introduction

In a comprehensive empirical and theoretical review of multinational firms, Navaretti and Venables (2004) identify three facts of foreign direct investment (FDI) activity. First, mergers and acquisitions (M&As) account for the dominant share of FDI flows; this share increased steadily from 66.3% in the 1980s to 76.2% in the late 1990s. Second, most FDI is concentrated in skill- and technology-intensive industries. Third, multinational firms are increasingly engaged in international production networks, which gives rise to intra-firm trade that currently takes up around one third of world trade (Antras, 2003).

The incomplete contracts setting of Antras (2003) has proved extremely useful in explaining the recent trend in intra-firm trade and how it depends on industry-level factor intensities. Antras and Helpman (2004) extend this approach to the integration strategies of multinational firms but has restricted attention to two forms of sourcing inputs abroad: complete outsourcing and complete integration. However, the majority of FDI activity takes place through M&As, which suggests a substantial degree of partial integration among multinationals and their domestic partners. As Desai et al. (2004) note, multinational firms frequently have the option to own 100%, majority, or minority shares of newly created foreign entities. In their words, “the appropriate ownership of productive enterprise is a central issue in economic theory and a practical question for multinational firms establishing new foreign affiliates.”

I refer to the variety of organizational forms that entail less than 100% ownership for a multinational abroad as partial integration.1 The current study integrates partial integration to an existing model of vertical integration in order to generate the full spectrum of foreign ownership at the plant level. I focus on integration strategies by a foreign direct investor in a search and matching framework under a setting of incomplete contracts and uncertainty. In this paper, FDI is understood “as an investment involving a long-term relationship and reflecting a lasting interest and control of a resident entity in the source country (foreign direct investor or parent firm) in the host country” (Razin and Sadka, 2007). Given the long-term nature of the investment relationship with a host country firm, I study not only a static problem of integration, but also a dynamic problem of optimal takeover strategies.

I extend the model in Antras and Helpman (2004) (hereafter AH) to describe the optimal path of integration when there is uncertainty over the quality of the match between integrated firms. The uncertainty is modelled as the lack of sufficient information on the joint productivity of the integrated firms in the first period of production. While doing this, I allow for partial integration that is characteristic of multinational activity. I am primarily interested in the evolution of the share that the multinational controls in the target firm as the match endures. I also study the implications of the evolution

1I use several terms interchangeably in the body of the paper. First, I do not distinguish between a ‘firm’ and a ‘plant’ and assume that the unit of production can be referred to as either. Second, I use the terms ‘joint venture’ and ‘integrated firm’ to refer to any firm which has a breakdown of ownership between a multinational and a domestic partner. This also includes cases of complete integration.
of foreign ownership share, which can explain a number of empirical findings and suggestions in the literature. The driving force behind the optimal path of integration is a learning framework that is built on Jovanovic (1979).

The multi-period model developed here is motivated by and able to explain several empirical findings from the literature on FDI. Firstly, the most common argument in the literature is that domestic firms that are controlled by foreign direct investors are typically the cream (Razin and Sadka, 2007). Djankov and Hoekman (2000) provide empirical evidence in favor of “cream-skimming” of high productivity firms in transition economies. Second, labor productivity improves faster over time and faster with age in foreign-owned establishments, which is accounted for by the greater capital intensity of multinationals (Razin and Sadka, 2007). Third, citing Pérez-González (2005) and Chari et al. (2010), Razin and Sadka (2007) argue that control by multinationals increases the efficiency and value of the firm.

The structure of the paper and its contributions are as follows. Section 2 uses detailed firm-level data to demonstrate two empirical regularities that are novel in the literature. I show that there exists a nondegenerate distribution of foreign ownership in integrated firms and that the degree of foreign ownership rises over time. Sections 3 and 4 develop the static and dynamic sides of the model, respectively. The multi-period model is able to generate the two empirical regularities identified as well as “cream-skimming.” In addition, I show that the optimal ratio of investment by the multinational firm to that of the supplier rises over time. The model also identifies the source of technology transfer within integrated firms as the share of foreign ownership. Section 5 concludes.

2 Plan-Plant-Level Evidence on Extent of Integration

Plant-level data for the current study come from the Industrial Analysis Database collected by the Turkish Statistical Institute (TURKSTAT). TURKSTAT annually conducts a census of all manufacturing establishments in Turkey with ten or more employees with detailed information on plant characteristics such as size, wages, investment, inventories, and value added. The database has been recently used in a study of export decision by Ozler et al. (2009) and discussed in more detail there. Most importantly for the current study, the database indicates whether the plant is vertically integrated with a multinational firm and provides a breakdown of equity ownership between the foreign direct investor and the Turkish plant operator. I focus on the period 1993-2001, which is a period of stable capital inflows to Turkey. Since Turkey did not practice any limitations on the foreign ownership of manufacturing plants in this period, I am able to

\[2\text{The database actually includes further information about the foreign direct investor as surveyed in the census form. If a plant is vertically integrated, plants are asked to report the countries which the top three shareholders of the foreign direct investor are from and their respective shares at the plant. Since I do not focus on this further breakdown and the origin of the multinational in my model, I simply work with the share of the foreign direct investment at the plant level.}\\]
observe maximal amount of variation in the amount of foreign direct investment at the plant level. In addition, I am able to differentiate between cases of partial vs. complete integration.

The database includes plant identification codes which enables me to construct a panel and follow the plants over time. Table 1 summarizes the presence of multinationals in the Turkish manufacturing industry from 1993 to 2001. I define a plant to be an “FDI plant” (or multinational) in any given year if it has any positive ratio of equity held by a foreign direct investor. The ratio of FDI plants in the manufacturing industry increased from 2.85% to 3.88% over the period under focus. The average share of foreign ownership at plants owned partially or fully by foreigners steadily rose from 58.78% in 1993 to 64.33% in 2001. In the sample, the minimum share of foreign ownership was 1% and the maximum share was 100%.

While the average level of foreign ownership has slightly gone up over time, what is most telling is a non-trivial distribution of the equity share owned by multinationals at the plant-level. In each of the years in the sample, there is a sizeable spread in plant-level FDI which stretches from very low stakes in the single digits to complete integration cases. Table 2 displays the distribution of foreign ownership share in the whole sample of firm-year observations for multinationals in the period under coverage. In the sample, the mean share of multinationals was 60.1% with a standard deviation of 32.3%. When the data are broken down into intervals, one can see that around 12.1% of all observations had less than 15% ownership, 9.5% had between 16-30% ownership, 26.3% had between 31-50% ownership, and 52.1% had more than 50% ownership.

The figures in Table 2 indicate that a majority of the multinationals operating in Turkey choose to do so in a partially integrated setting with a Turkish partner. The sample includes cases of integration when the foreign direct investor is a majority stake holder as well as cases with FDI holders in the minority. The breakdown between minority and majority stake holders seems to be half and half. The mean value of foreign ownership share in the 51-100% interval is around 86%, which indicates that a significant portion of the multinationals in the sample practice high degrees of integration.

In the TURKSTAT database, each manufacturing plant is classified under an industry category following the International Standard Industry Classification system (ISIC Rev. 2). The classification includes 9 categories at the 2 digit level. In the period 1993-2001, foreign firms were most prevalent in the fabricated metals, machinery, etc. industry with an average of 35% of all multinationals in this period operating in the industry. On average, 21% of multinationals operated in the chemicals and chemical products industry, and 17% operated in the food products industry over the same period. These figures suggest that multinational firms invest primarily in highly capital-intensive sectors.
intensive industries, which include some of Turkey’s largest plants such as the French manufacturer of cars and trucks Renault.\footnote{In addition, multinationals are big players in their markets. Despite their small number in the overall population of plants, multinationals have employed 260 employees on average in a year compared to 87 in wholly owned domestic plants.} This lends some support to theoretical results as in Antras and Helpman (2004) where vertical integration arises only in those industries that are relatively intensive in the use of headquarter services.

Given the panel structure of the database, I am able to identify when a plant is acquired by a foreign direct investor, the level of equity share obtained initially by the multinational, and how this share evolves over time under the multinational’s ownership. Likewise, I can see years in which the multinational withdraws from a partnership or decreases its share of ownership (disinvestment). Figure 1 depicts how foreign ownership at the plant level changes with the age of the multinational. For instance, a plant which is owned domestically in the previous period but newly acquired by a foreign direct investor this period is in its first age. If such a plant continues to be classified as an FDI plant in its next period as well, i.e. at least 1% of it is foreign owned, it will be in its second age.

In the figure, the average level of foreign ownership at the plant level is plotted against the age of the multinational. Dots refer to actual data and the nonlinear fit is a fractional-polynomial estimate of FDI share from age. It is clear from the figure that average level of foreign ownership rises with age in the first few years of integration and levels off after around age three. The biggest change occurs going from age one to age two. In the first year of a multinational’s operation, the foreign direct investor owns on average less than 40% of the plant. Conditional on staying as an FDI plant in the second year, this share jumps to almost 60% and stays around that level pretty evenly for the rest of its course.

There are two empirical regularities that the Turkish data strongly demonstrate. First, the majority of FDI plants operate in partial integration with a domestic partner, which implies that partial integration is a more prevalent form of foreign direct investment than complete integration. Moreover, there is significant heterogeneity in the degree of integration among firms that are subject to FDI. Second, the average share of ownership by foreign direct investors starts out low in a joint venture but reaches a majority share from the second year of the partnership onward. This suggests that multinational firms follow a dynamic policy of integration with their supplier.

### 3 Optimal Integration

In this section, I modify the model in Antras and Helpman (2004) to incorporate joint ventures to the study of foreign direct investment.

There are two countries, the North and the South, and a unique factor of production, labor. Preferences are as in AH, so that the world population consists of a unit measure of consumers with identical preferences given by:
\[ U = x_0 + \frac{1}{\mu} \sum_{j=1}^{J} X_j^\mu, \quad 0 < \mu < 1, \]

where \( x_0 \) represents consumption of a homogeneous good, \( \mu \) is a parameter, and aggregate consumption in sector \( j \) is a CES function:

\[ X_j = \left[ \int x_j(i)^\alpha di \right]^{1/\alpha}, \quad 0 < \alpha < 1 \]

of the consumption of different varieties \( x_j(i) \). I 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; i.e. \( \alpha > \mu \). These preferences imply that final goods producers face the inverse demand function for each variety \( i \) in sector \( j \):

\[ p_j(i) = X_j^{\mu - \alpha} x_j(i)^{\alpha - 1} \tag{1} \]

There is a perfectly elastic supply of labor 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 (Antras and Helpman, 2004). This means that an input which 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:

\[ x_j(i) = \theta \left[ \frac{h_j(i)}{\eta_j} \right]^{\eta_j} \left[ \frac{m_j(i)}{1 - \eta_j} \right]^{1-\eta_j}, \quad 0 < \eta_j < 1, \tag{2} \]

where \( \theta \) 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.\(^6\) The parameter, \( \eta_j \), controls the headquarter intensity of the production and is sector-specific.

A major assumption built into the model is that there exists a nondegenerate distribution of productivities for a final good producer across different suppliers. I interpret \( \theta \) 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 and supervising the supplier. This will show variation across suppliers due to plant-specific factors such as location, industry, organizational form, or skill 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), \( \theta \) is distributed

\(^6\)Note that the match-specific parameter should in fact be denoted as \( \theta_i \); I drop the subscript to simplify notation.
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 \( \theta \) in the population is known and I follow the common assumption regarding firm productivities: i.e. \( \theta \sim \text{Pareto}(b, \gamma) \), where \( b > 0 \) is the scale parameter and \( \gamma > 2 \) is the shape parameter. \(^7\) Accordingly, the cdf is given by:

\[
G(\theta) = 1 - \left( \frac{b}{\theta} \right)^\gamma, \quad \theta \geq b
\]

In order to draw the match-specific parameter with a manufacturing 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 about the true value of its joint productivity with its supplier. If the match persists, the final good producer decides on the organizational form of the joint venture, which determines the additional fixed organizational costs to be incurred. Following AH, I interpret the fixed organizational costs as the sum of all costs that pertain to the search for a supplier in the South and to the management of the joint venture, which entails “supervision, quality control, accounting, and marketing” among other things.

I assume in addition that the fixed organizational 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 establish a joint venture in which it has majority share. Due to economies of scale in operation, however, a firm may not incur as high fixed costs once it achieves effective control of the firm. Hence, the fixed organizational costs are denoted as \( w_N \delta^\phi \), where \( \delta \in (0, 1) \) is the share of the multinational at the joint venture and \( \phi \in (0, 1) \) is an exogenous parameter.

I focus specifically on vertical integration as the organizational form of the firm in this paper. I assume that the multinational has already made its decision to obtain the manufactured input from a vertically integrated supplier in the South; i.e. foreign direct investment. AH establish that there always exist high productivity final good producers that choose to acquire manufactured inputs via FDI. The crucial question I ask is: where does the multinational draw its boundaries in controlling/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?

I adopt the incomplete contracts setting due to Antras (2003), where ownership of the suppliers entitles final good producers to some residual rights of control. Following the property-rights approach to the boundaries of the firm, 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 joint venture’s revenue is determined by an ex post bargaining procedure following

\(^7\gamma > 2\) is required for the distribution to have finite variance.
the production of the inputs. As in AH, ex post bargaining takes place under all organizational forms and is modeled as a generalized Nash bargaining game, where \( \beta \in (0, 1) \) denotes the fraction of the ex post gains from trade that go to the final good producer.

In the Nash bargaining procedure, the outside option of the manufacturing 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 joint venture it controls. Specifically, \( \delta \) 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, \( \delta \), once production has already taken place, and sell an amount \( \delta x(i) \).\(^8\) Given this definition of residual rights, the share of the revenue that goes to the final good producer is given by \( \beta V = \delta \alpha + \beta (1 - \delta \alpha) \) as a result of generalized Nash bargaining, which reflects the final good producer’s outside option plus its share of ex post gains. The share of the revenue for the manufacturing supplier is \( (1 - \beta)(1 - \delta \alpha) \), or equivalently, \( 1 - \beta V \).

The final element of the model is an upfront payment in each period by the manufacturing supplier to participate in a joint venture. 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, I assume an infinitely elastic supply of manufacturing 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 as follows:

1. Period 1 starts. The final good producer enters the industry and pays the fixed cost of entry, \( w_N f_E \).

2. At the same time, an unmatched supplier of manufactured inputs and the final good producer form a pair and jointly draw a random match parameter \( \theta \) from a known distribution with cumulative distribution function \( \text{Prob}\{\theta \leq s\} = F(s) \). The value of \( \theta \) 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 \((0, \theta)\).\(^9\)\(^10\) Following the realization of the noisy signal, the final good producer

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\(^8\)Note that restricting \( \delta \) to be strictly less than one ensures that the supplier chooses to produce a positive amount of the manufactured input in each period.

\(^9\)I let the signal be a random draw from the uniform distribution for purposes of tractability. In particular, this setup 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.

\(^10\)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, e.g. some range
may choose to leave the match or offer a contract to the supplier. If the final good producer leaves, it can seek out a new supplier, draw a new match parameter, $\theta'$, 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 joint venture that the multinational will own this period, $\delta_1$, with the understanding that this can be updated when the uncertainty is resolved. The contract also specifies a transfer, $t$, that is to be paid by the supplier for each period that the match survives and that 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 a negotiation, the match breaks up. The final good producer can then seek out a new supplier and draw a new match parameter, $\theta'$, 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 picks its optimal stake, $\delta_1$, as specified in the contract. The final good producer and the supplier then independently choose their quantities to maximize their own payoffs.

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

8. Period 2 starts. In the case of survival, the true value of $\theta$ 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, $\delta_2$, which will be effective in all subsequent periods as well.

9. The final good producer and the supplier choose their quantities noncooperatively to maximize their own payoffs.

10. Output for this period is sold and the resulting revenue is shared following a generalized Nash bargaining procedure. Period 2 ends.

The current model can characterize what happens to the likelihood of disinvestment over time (i.e. a break up of the match) endogenously. It is still of interest, however, to study how an exogenous impact that may dissolve a match, such as an adverse liquidity shock, affects the optimal level of investment. I assume that a firm in production is subject to adverse liquidity shocks with the hazard of separation occurring at the exogenous rate $\lambda$. Once joint production starts, the firm could receive a liquidity shock in any of the future periods.

$[\theta_1, \theta_2]$. This could be handled similarly where the prior joint distribution of $\theta_1$ and $\theta_2$ are bilateral bivariate Pareto, which gives rise to a posterior joint distribution in the same family of distributions.
Before describing the equilibrium under uncertainty, I study the per-period problem that the final good producer and the manufacturing supplier face. In each period, the potential revenue in the case that parties reach agreement is given by:

\[ R(i) = p(i)x(i) = X^{\mu-\alpha}x(i)^\alpha \]

Using (2), one can write revenues as:

\[ R(i) = X^{\mu-\alpha}\theta^\alpha \left[ \frac{h(i)}{\eta} \right]^\eta \left[ \frac{m(i)}{1-\eta} \right]^{1-\eta}, \quad (3) \]

where I have dropped the subscript, \( j \), to focus attention 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 joint venture, \( \delta \).

Following the final good producer’s choice of \( \delta \) in each period, the parties to the match independently choose the quantities of their inputs. Given the noncontractibility of the supply of inputs, each input supplier maximizes their own payoff. The final good producer’s problem is to pick the amount of headquarter to services to maximize \( \beta_V R(i) - w_N h(i) \), and the manufacturing supplier’s problem is to pick the amount of intermediate inputs to maximize \( (1 - \beta_V)R(i) - w_S m(i) \). Substituting the expression in (3) for \( R(i) \) and taking first order conditions, the optimal quantities are:

\[ h^*(i) = \eta \left( X^{\mu-\alpha}\theta^\alpha \right)^{\frac{1}{\alpha}} \left( \frac{\beta_V}{w_N} \right)^{\frac{1-\alpha(1-\eta)}{\alpha}} \left( \frac{1 - \beta_V}{w_S} \right)^{\frac{\alpha(1-\eta)}{1-\alpha}}, \quad (4) \]

\[ m^*(i) = (1 - \eta) \left( X^{\mu-\alpha}\theta^\alpha \right)^{\frac{1}{\alpha}} \left( \frac{\beta_V}{w_N} \right)^{\frac{\alpha}{1-\alpha}} \left( \frac{1 - \beta_V}{w_S} \right)^{\frac{1-\alpha}{1-\alpha}}, \quad (5) \]

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 program, which maximize own per-period expected payoffs. Since both input suppliers are assumed to update their beliefs about \( \theta \) in a Bayesian fashion, the expected payoffs substitute \( E[\theta^\alpha | y] \) in place of \( \theta \) in (3).

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

\[ \frac{h^*(i)}{m^*(i)} = \frac{\eta}{1-\eta} \frac{\delta^\alpha(1-\beta) + \beta \ w_S}{1-\eta \ 1-\delta^\alpha(1-\beta) - \beta \ w_N}, \quad (6) \]

since \( \beta_V = \delta^\alpha(1-\beta) + \beta \). Notice that taking headquarter intensity and wages as fixed, \( h^*(i)/m^*(i) \) depends only on \( \delta \). The optimal intensity of headquarter services
is independent of \( \theta \) due to the symmetry between the two input suppliers’ (lack of) information about \( \theta \) in each period. In the first period, they both observe the same signal, \( y \), which returns the same conditional expectation about \( \theta \), while in the second period, the true value of \( \theta \) is revealed to both sides. This informational symmetry prevents the sides to the match to learn more about \( \theta \) through each other’s input choices. Given this, the final good producer’s optimal level of integration will be changing as the joint venture 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 \( \delta \) increases following the removal of uncertainty in equilibrium. I show this result in the next section.

Using the first order conditions in (4) and (5) along with (3) gives the total per-period value of the joint venture as measured by total operating profits:

\[
\pi(\delta, \theta, X, \eta) = X^{\frac{\alpha}{1-\alpha}} \theta^{\frac{\alpha}{1-\alpha}} \psi(\delta, \eta) - w_N \phi
\]

where

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

and \( w_N \phi \) reflects the (per-period) fixed costs of integration. Here \( \phi > \alpha \) is a parameter that describes the marginal fixed cost of acquiring an ownership stake at the joint venture. I 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 \( \theta \) and strictly decreasing in \( w_N^\alpha \) and \( w_S^\alpha \) as expected.

Following AH, I consider an industry with high headquarter intensity \( \eta \) such that operating profits excluding organizational costs are increasing in the final good producer’s share of the revenue.\(^{11}\) This setup highlights the importance of the input by the final good producer and lays the basis for the observation that most foreign direct investment takes place in high technology intensive industries. Since I focus specifically on vertical integration in the South, this is equivalent to the setup in AH where \( \psi(\beta_V, \eta) \) is increasing in \( \beta_V \) 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 underinvestment in \( h(i) \) especially costly and integration especially attractive” (Antras and Helpman, 2004).

In solving any given period’s subgame, the upfront payment specified in the multi-period contract, \( t \), ensures that the final good producer effectively maximizes the total

\(^{11}\)Where deemed useful, I 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.
value of the joint venture in every period.\footnote{See Antras and Helpman (2004) for a proof of this assertion.} Given the structure of the profits in the stage game, is there an optimal level of integration $\delta^*$ that maximizes (7)? Moreover, is $\delta^*$ unique? 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 $\theta$ (the same question needs to be answered also in the first period at stage 6, when $\theta$ is still unknown). It is equivalent to asking whether the joint venture’s operating profits, (7), are concave in $\delta^\alpha$; for if not, then the optimal level of integration happens either at extremes (e.g. in the case of linearity) or at multiple points.\footnote{Proofs for Proposition 1 and all other results are contained in the Appendix.}

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

Figure 2 shows the relationship between the multinational firm’s operating profits and its degree of integration, $\delta$, for various values of headquarter intensity. Firstly, the optimal level of integration lies strictly away from the end points for a range of headquarter intensities. I included a depiction of operating profits as a function of $\delta$ for a low headquarter intensity industry (the dotted line) as well as an intermediate (the solid line) and two high headquarter intensity (the dashed and dot-dashed lines) industries. For all such industries, profits are maximized at an intermediate level of integration.

Secondly, notice that the optimal level of integration is increasing in $\eta$ across the board. For industries that are relatively more intensive in the use of headquarter services (i.e. $\eta > 0.5$), both the optimal integration level and the absolute level of profits are rising in $\eta$.\footnote{Notice that the absolute level of profits for $\eta = 0.35$ is actually higher than that for $\eta = 0.5$. The upper envelope of operating profits as a function of $\delta$ seems to be U-shaped, with the bottom of the U being reached at an intermediate level of $\eta$.} 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, following the optimal allocation of property rights. In high $\eta$ industries, the marginal product of the input from the headquarters is much greater than that of the input from the manufacturing supplier. Therefore, the underinvestment in the manufactured input that is caused by a higher degree of integration is more than offset by the increase in total revenues driven by increased use of the input from the headquarters. Consequently, the share of the revenue that the final good producer captures from the relationship is increasing in the intensity of headquarter services.

A second important result from the stage game concerns how $\delta^*$ changes with match-specific productivity. As seen from (3), the revenues of the joint venture are strictly increasing in $\theta$. 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 manufacturing supplier, causing underinvestment in the manufactured input. The downward pressure on the revenue level caused by the supplier’s underinvestment

\footnotesize{12}See Antras and Helpman (2004) for a proof of this assertion.

\footnotesize{13}Proofs for Proposition 1 and all other results are contained in the Appendix.

\footnotesize{14}Notice that the absolute level of profits for $\eta = 0.35$ is actually higher than that for $\eta = 0.5$. The upper envelope of operating profits as a function of $\delta$ seems to be U-shaped, with the bottom of the U being reached at an intermediate level of $\eta$.}
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, \( \partial \delta^\ast(\theta)/\partial \theta > 0 \).

Given a non-degenerate distribution of joint productivities, the stage games produce a non-degenerate distribution of the optimal level of integration among plants that are subject to foreign direct investment. Producers show variation in their level of integration not only along headquarter intensity, but also their joint productivities within similar industries. An important implication of this result is that the optimal ratio of investments in headquarter services and manufacturing inputs, given by (6), is higher for those joint ventures with a higher match quality in any given industry.

4 Equilibrium under Uncertainty

In serving a host country market, the multinational seeks to maximize the expected present value of its profits. Given the structure of the multi-period contract, this will be equivalent to maximizing the total profit stream of the whole relationship (the integrated firm) associated with a 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 might withdraw from the partnership in order to seek a new match at any period in the relationship. I solve the problem by working backward, starting in period 2.\(^{15}\)

From stage 8 on, the final good producer knows the true value of \( \theta \), 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 \( \theta \) and is behaving optimally. Note that having realized its true productivity, the final good producer could calculate its optimal level of investment, \( \delta^\ast_2 \), and stipulate this level in the contract to be updated. Therefore, \( \theta \) is a sufficient statistic for the firm’s expected present value at any period in time, which allows me to write the value function in terms of \( \theta \) only.

Let \( r \) be the firm’s discount rate. If the contract is updated, then the value of the joint venture is given by \( \pi(\theta) + \frac{1}{r+\lambda} J(\theta) \), where\(^{16}\)

\[
\pi(\theta) = X^{\frac{\alpha}{1-\alpha}} \theta^{\frac{\alpha}{1-\alpha}} \psi(\delta_2, \eta) - w_N \delta_2
\]  

\(^{15}\)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 labor markets. I also work with a simple discrete time version of Jovanovic’s model; however, the current model differs significantly from the original in certain respects, such as its contracting structure.

\(^{16}\)I suppress the other arguments of the per-period profit function for notational simplicity.
is the per-period profit of the joint venture at the outcome of the stage game in period 2. Recall that $\lambda$ 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 manufacturing input 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 $\theta$ independent of the previous matches, $Q$ will be a constant under the assumptions of an infinite horizon and constant discount rate (Jovanovic, 1979).\textsuperscript{17}

The Bellman equation that characterizes the value of the game to the final good producer in period 2 is then given by: $J(\theta) = \max\{\pi(\theta) + \frac{1}{r+\lambda}J(\theta), \frac{1}{r}Q\}$. I depict this equation in Figure 3. The value of continued joint production is rising in the match parameter while the value of withdrawal is constant. As is clear from the figure, the optimal policy is one that updates the contract for values of $\theta$ above a certain level and terminates it below this threshold level. The solution to the Bellman equation in period 2 is given by:

$$J(\theta) = \begin{cases} \pi(\theta) + \frac{1}{r+\lambda}J(\theta) & \text{for } \theta \geq \theta_1 \\ \frac{1}{r}Q & \text{for } \theta \leq \theta_1 \end{cases}$$

(10)

where the threshold level $\theta_1$ satisfies:\textsuperscript{18}

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

(11)

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 $\theta$ is revealed to be below $\theta_1$, the firm will be dissolved since continuing the relationship indefinitely at a low $\theta$ yields a lower expected present value of profits than the alternative matches. This aspect of the model can explain the often mentioned case of “cherry-picking” in foreign direct investment, whereby multinational firms invest only in the high productivity plants in the host economy. 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 realize a certain minimum level of productivity persist in the industry.

\textsuperscript{17}In the current model, the constancy of $Q$ implies that if a final good producer withdraws from a joint venture with a supplier, it will never choose to carry out joint production with this particular supplier in the future.

\textsuperscript{18}Notice that (10) implies $J(\theta) = \frac{r+\lambda}{r+\lambda-1} \pi(\theta)$ for $\theta \geq \theta_1$. 

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Given the optimal policy of contract updating in period 2, I 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 \( \theta \). The following lemma describes the properties of the posterior distribution.

**Lemma 1:** Let \( y \) denote a random draw from a uniform distribution over the range \((0, \theta]\). The Pareto\((b, \gamma)\) distribution has density:

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

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

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

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

**Proof:** See Leonard and Hsu (1999).

Lemma 1 expresses the posterior expected value of \( \theta \) in terms of the parameters of the distribution and the signal. In order for the signal to be informative about \( \theta \), I assume for the remaining analysis that the lower bound for the signal is \( b \), so that \( \tilde{b} = y \).\(^{19}\) This setup leads the firm to infer that the true value of its \( \theta \) is increasing in the value of the signal that it receives, as the posterior mean is given by: \( \tilde{\theta} = E(\theta|y) = \frac{\tilde{\gamma} b}{\tilde{\gamma} - 1} y \). Notice that since \( y \) is uniformly distributed, the posterior mean is also distributed uniformly, characterized by the parameters \( \tilde{b} \) and \( \tilde{\gamma} \), where \( \tilde{b} = \frac{\tilde{\gamma}}{\til{\gamma} - 1} b \) and \( \tilde{\gamma} = \frac{\til{\gamma}}{\til{\gamma} - 1} \gamma \).\(^{20}\) I denote the distribution of the posterior mean by \( G(\tilde{\theta}|\til{\gamma}, \til{b}) \).

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 \( \pi(\til{\theta}) \), where\(^{21}\)

\(^{19}\)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 \( \frac{\til{\gamma} b}{\til{\gamma} - 1} \), which is independent of \( y \), and therefore the signal becomes uninformative.

\(^{20}\)The support of a uniform distribution is defined by its upper and lower bounds.

\(^{21}\)The following equations are written with some abuse of notation. Notice that equation (12) is actually defined in terms of \( E[\theta^{\gamma-\alpha}|y] \), which is not the same as \( \tilde{\theta} = E(\theta|y) \). To be more precise, one can calculate \( E[\theta^{\gamma-\alpha}|y] \) as \( \frac{\til{\gamma}}{\til{\gamma} - \alpha} y^{\alpha/(1-\alpha)} \) by using the density function \( f(\theta) \) in Lemma 1. Notice that just like \( E(\theta|y) \), \( E[\theta^{\gamma-\alpha}|y] \) is determined by \( \til{\gamma} \) and \( y \). Likewise, taking \( \alpha \) as given, the distribution of the posterior expectation is uniform and characterized by similar parameters.
\[ \pi(\tilde{\theta}) = X^{\frac{\alpha - \alpha}{\alpha}} E \left[ \theta^{\frac{-\alpha}{\alpha}} \left| y \right. \right] \psi(\delta_1, \eta) - w_N \delta_1 \]  

(12)

In the case 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 \( \theta \) is revealed. Then \( V(\tilde{\theta}) \) satisfies:

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

(13)

In (13), \( P(\theta' | \tilde{\gamma}, \tilde{b}) \) is the conditional distribution of joint productivities for the next period when the true \( \theta \) is revealed. As with the contract updating policy in period 2, (13) 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.\(^{22}\) The solution to the Bellman equation for the first period is given by:

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

(14)

where \( \tilde{\theta} \) satisfies:

\[ \pi(\tilde{\theta}) + \frac{1}{r + \lambda} \int J(\theta') dP(\theta' | \tilde{\gamma}, \tilde{b}) = \frac{1}{r} Q \]  

(15)

It is possible to show (see Appendix) that \( \pi(\theta) > \pi(\tilde{\theta}) \); that is, the final good producer requires a higher level of profits in period 2 to stay in the match compared to 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 \( \theta \) 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 \( \theta > \tilde{\theta} \), because the per-period profit function \( \pi(.) \) is strictly increasing in \( \theta \). Therefore, the final good producer’s optimal policy implies disinvestment 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 direct 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

\(^{22}\) 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.
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.\footnote{This mechanism implies a lemons problem in the market for corporate stocks when foreign owners are disinvesting. It would not be surprising to see a decline in the value of a firm when corporate control is handed from foreign owners back to the initial owners of the firm.}

I 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 any 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:

\[ Q = \int V(\tilde{\theta}) dG(\tilde{\theta}|\tilde{\gamma}, \tilde{b}) \]  

The final good producer’s optimal policy is characterized by the equations (10), (14), and (16), which give rise to a single Bellman equation in \( V \):

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

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

**Theorem 1** There exists a unique, bounded, and continuous solution for \( V \) in equation (17).

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). I am interested in how this share evolves as the match endures. Within the property-rights framework of the multinational firm, I 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 which has received a signal such that its posterior expected value of \( \theta \), say \( \tilde{\theta}_i \), lies between \( \theta \) and \( \tilde{\theta} \). In equilibrium, this marginal producer will start production with its supplier in the first period but it will disinvest and withdraw from its match if the true value of its \( \theta \) eventually turns out to be less than \( \theta \). For the producer to survive with its current match into future periods, its true \( \theta \) should turn out to be greater than \( \tilde{\theta} > \tilde{\theta}_i \). 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 level of optimal integration for an average firm in its second period is higher than the level of optimal integration for an average firm in its first period. In other words, the degree of foreign ownership is rising over time for an average multinational.

Proposition 3 explains the empirical regularity demonstrated in Section 2 that foreign direct investment at the plant level rises with the age of the integrated firm. The intuition is fairly straightforward and depends on the selection of high productivity matches into future periods. Low productivity matches dissolve if the true value of their \( \theta \) 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 revelation of the true value of productivity. This selection mechanism 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 (6). Notice that (6) depends only on \( \delta \), and positively. 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 future periods. In the second period, there is a greater transfer of headquarter services that are produced in 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.

## 5 Conclusion

Using firm-level data on foreign direct investment, I uncovered two empirical regularities that are unknown in the literature. Motivated by these findings and earlier ones in the literature, I develop a multi-period model of foreign direct investment under uncertainty. I show that there exists a nondegenerate distribution of foreign ownership in integrated firms and that the degree of foreign ownership rises over time. The multi-period model is also able to generate several empirical findings in the literature and can explain “cream-skimming.” An important point that emerges from the model is that technology transfer within integrated firms is facilitated by the evolution of the share of foreign ownership.
Appendix

The Appendix contains some intermediate results and proofs of the propositions and theories that are mentioned in the body of the text.

Proof of Proposition 1:

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

Existence:

I rewrite the final good producer’s problem of maximizing per-period profits in terms of \( \beta^*_V \) (I suppress the other arguments for notational simplicity):

\[
\max_{\beta^*_V} \pi(\beta^*_V) = X^{\frac{\alpha}{1-\alpha}} \delta^{\frac{\alpha}{1-\alpha}} \psi(\beta^*_V) - w_N \left( \frac{\beta^*_V - \beta}{1 - \beta} \right)^{\frac{\alpha}{\beta}}
\]

where

\[
\psi(\beta^*_V) = \alpha^{\frac{\alpha}{1-\alpha}} \left( \frac{\beta^*_V}{w_N} \right)^{\frac{\alpha}{1-\alpha}} \left( \frac{1 - \beta^*_V}{w_S} \right)^{\frac{\alpha(1-\eta)}{1-\alpha}} (1 - \alpha\eta\beta^*_V - \alpha(1-\eta)(1 - \beta^*_V)).
\]

The first order condition to this program yields:

\[
\frac{\partial \pi(\beta^*_V)}{\partial \beta^*_V} = \left[ \frac{\alpha^\alpha X^{\mu-\alpha} \theta^\alpha}{w_N^{\alpha\eta} w_S^{\alpha(1-\eta)}} \right]^{\frac{1}{1-\alpha}} \left[ \frac{\alpha \beta^*_V^{\frac{\alpha}{1-\alpha}} (1 - \beta^*_V)^{\frac{\alpha(1-\eta)}{1-\alpha}}}{1 - \alpha} \right] \times \left[ \beta^*_V^2 (2\eta - 1) + \beta^*_V (2\eta(\alpha - \alpha\eta - 1)) + \eta (1 - \alpha + \alpha\eta) \right] - \frac{\phi w_N}{\alpha (1 - \beta)} \left( \frac{\beta^*_V - \beta}{1 - \beta} \right)^{\frac{\phi-\alpha}{\alpha}} = 0
\]

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 \( \partial \pi(\beta^*_V)/\partial \beta^*_V < 0 \)

\(24\) 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 \( \beta^*_V \) with respect to \( \delta \) is always non-zero, so that \( \delta^* \) is defined by \( \partial \pi(\beta^*_V)/\partial \beta^*_V = 0 \).
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 (19) 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 $\beta_V$ 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 $\eta$ and $g(0) = -1$ and $g(1) = 0$. Since $\eta$ 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 $\eta$, this expression is positive for almost all $\beta \in (0, 1)$. Since I focus on high headquarter intensity industries in this paper, the existence of $\delta^*$ follows without much restriction on $\beta$. For low headquarter intensity industries, however, the model requires the bargaining power parameter $\beta$ to be low enough for vertical integration to arise. In particular, assume $\eta$ is less than $\frac{1}{2}$ for low headquarter intensity industries; one can check that for $\eta < \frac{1}{2}$, $\beta$ should also be less than $\frac{1}{2}$ for integration to arise in equilibrium. Figure A1 demonstrates the permissible set of $\beta$’s for two industries, one with relatively high headquarter intensity and the other with relatively low headquarter intensity.

The intuition here comes from the tradeoff faced by the final good producer between maximizing the level of profits versus maximizing 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 $\eta$ is high, thereby tilting the final good producer’s tradeoff in favor of a higher share of the revenue.

Notice that the final good producer always receives at least a fraction $\beta$ of the revenue. In low $\eta$ industries, its input is of relatively low importance, so a high bargaining power $\beta$ 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, i.e. $1 - \beta$ to be high, for vertical integration to occur. In high $\eta$ 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 $\beta$’s enlarges with headquarter intensity.

**Uniqueness:**

I 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 $\delta$. To get this result,

\[25\text{Only very high values for } \beta \text{ may reverse the sign of the quadratic expression in } \beta.\]
I again work with $\beta_V$ and I show the strict concavity of the profit function in $\delta$. Note that $\beta_V$ is a strictly concave function of $\delta$, since $\beta_V = \delta^\alpha(1 - \beta) + \beta$ and $\alpha \in (0, 1)$, and profits are strictly increasing in $\beta_V$ by the model assumptions. Hence, one needs only to show that profits are concave in $\beta_V$ to establish strict concavity in $\delta$.\footnote{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.

\footnote{Note that this is more restrictive than necessary. The second term in (20) is unambiguously negative since $\phi > \alpha$. Negativity of the first term ensures that $\partial \pi(\beta_V)/\partial \beta_V < 0$. However, the second order condition could still be negative when the first term is positive, depending on the relative sizes of the two terms.}

Since $\phi > \alpha$, the costs of organizational form in (18) are convex. Subtracting a convex function from a concave function returns another concave function; I therefore check whether $X^{\frac{\mu-\alpha}{\alpha}} \theta^{\frac{-\alpha}{\alpha}} \psi(\beta_V)$ in (18) is concave in $\beta_V$. The second order condition to the final good producer’s problem is given by:

$$\frac{\partial^2 \pi(\beta_V)}{\partial \beta_V^2} = \frac{\alpha}{(1 - \alpha)^2} \left[ \frac{\mu - \alpha \theta \alpha}{w_N \theta w_S(1 - \theta)} \right]^{\frac{1}{\alpha}} \left[ \beta_V^{\frac{\alpha \eta - 2}{(1 - \beta)} - \frac{\alpha(1 - \eta)}{1 - \alpha} - 2} \right] (20)$$

where the first term is the second derivative of $X^{\frac{\mu-\alpha}{\alpha}} \theta^{\frac{-\alpha}{\alpha}} \psi(\beta_V)$ with respect to $\beta_V$. In order for operating profits to be concave in $\beta_V$, it is sufficient for the value of the cubic equation in $\beta_V$ that is expressed in the square brackets to be negative.\footnote{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:}

$$\frac{\partial \pi(\beta_V)}{\partial \beta_V} = \frac{\alpha}{(1 - \alpha)^2} \left[ \frac{\mu - \alpha \theta \alpha}{w_N \theta w_S(1 - \theta)} \right]^{\frac{1}{\alpha}} \left[ \beta_V^{\frac{\alpha \eta - 2}{(1 - \beta)} - \frac{\alpha(1 - \eta)}{1 - \alpha} - 2} \right] (20)$$

The sign of this expression is determined by the values of the parameters in the model. In Figure A2, I plot out the cubic equation for various values of $\alpha$ and $\eta$. As can be seen from the figure, the cubic equation is everywhere less than zero whenever $\alpha < \frac{1}{2}$, regardless of what value $\eta$ 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 $\beta_V$. This may occur, for instance, when both $\alpha$ and $\eta$ are sufficiently high. However, recall that $\beta_V$ is the share of revenue that accrues to the final good producer, which has a lower bound of $\beta$, and $1 - \beta$ is the share of revenue
that accrues to the manufacturing input supplier. As a result, one can comfortably conjecture that the value of $\beta_V$ in equilibrium will be away from the end points of 0 and 1. This establishes the concavity of the profit function in $\beta_V$.

(Recall that $\alpha$ governs the elasticity of substitution between any two varieties within a sector through the CES function for aggregate consumption.)

**Proof of Proposition 2:**
In order to show the result, I again work with $\beta_V$ instead of working with $\delta$ directly. Since

$$\frac{\partial \delta^*}{\partial \theta} = \left(\frac{\partial \delta^*}{\partial \beta_V}\right) \left(\frac{\partial \beta_V}{\partial \theta}\right) \text{ and } \beta_V \text{ rises monotonically in } \delta^*,$$

it is sufficient to sign the partial derivative $\frac{\partial \beta_V}{\partial \theta}$.

The final good producer’s optimal share of revenues is implicitly defined by the first order condition in (19). 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 $\frac{\partial g(\beta_V, \theta)}{\partial \beta_V}$ is simply the second order condition given by (20). I show in the proof of Proposition 1 that (20) is negative. Now consider $\frac{\partial g(\beta_V, \theta)}{\partial \theta}$. This is given by:

$$\frac{\partial g(\beta_V, \theta)}{\partial \theta} = \frac{\alpha}{1 - \alpha} \left[ \frac{1}{\theta w_N^{\alpha N} w_S^{(1-\eta)}} \right]^{\frac{1}{1-\alpha}} \left[ \frac{\alpha \beta_V^{\alpha n - 1} (1 - \beta_V) \alpha (1 - \eta)^{1-\alpha - 1}}{(1 - \alpha)} \right] \times \left[ \beta_V^2 (2\eta - 1) + \beta_V (2\eta \alpha - \alpha \eta - 1) + \eta (1 - \alpha + \alpha \eta) \right].$$

Since $\psi(\beta_V, \eta)$ is assumed to be increasing in $\beta_V$ in high headquarter intensity industries, we have\(^{28}\):

$$\frac{\partial \psi(\beta_V, \eta)}{\partial \beta_V} = \left[ \frac{\alpha^n}{w_N^{\alpha N} w_S^{\alpha (1-\eta)}} \right]^{\frac{1}{1-\alpha}} \left[ \frac{\alpha \beta_V^{\alpha n - 1} (1 - \beta_V) \alpha (1 - \eta)^{1-\alpha - 1}}{(1 - \alpha)} \right] \times \left[ \beta_V^2 (2\eta - 1) + \beta_V (2\eta \alpha - \alpha \eta - 1) + \eta (1 - \alpha + \alpha \eta) \right] > 0.$$

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

**Proof of** $\pi(\theta) > \pi(\tilde{\theta})$:
In the body of the paper, I 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. I now show formally why this holds.

\(^{28}\)To see this result, note that the quadratic term in $\beta_V$ in square brackets goes to $(\beta_V - 1)^2$ as $\eta \rightarrow 1$; i.e. for high enough values of headquarter intensity, the quadratic expression is positive.
Using (10) and (11) in equation (15), and adding and subtracting like terms where necessary, we get:

\[
\frac{r + \lambda}{r + \lambda - 1} \pi(\theta) = \pi(\tilde{\theta}) + \frac{1}{r + \lambda} \int_{-\infty}^{\infty} J(\theta') dP(\theta'|\tilde{\gamma}, \tilde{b})
\]

\[
\frac{r + \lambda}{r + \lambda - 1} \pi(\theta) = \pi(\tilde{\theta}) + \frac{1}{r + \lambda} \int_{-\infty}^{\theta} -Q dP(\theta'|\tilde{\gamma}, \tilde{b}) + \frac{1}{r + \lambda} \int_{\theta}^{\infty} \pi(\theta)dP(\theta'|\tilde{\gamma}, \tilde{b})
\]

\[
\frac{r + \lambda}{r + \lambda - 1} \pi(\theta) = \pi(\tilde{\theta}) + \frac{1}{r + \lambda - 1} \int_{-\infty}^{\theta} dP(\theta'|\tilde{\gamma}, \tilde{b}) + \frac{1}{r + \lambda - 1} \int_{\theta}^{\infty} \pi(\theta)dP(\theta'|\tilde{\gamma}, \tilde{b})
\]

\[
(r + \lambda) \pi(\theta) = (r + \lambda - 1) \pi(\tilde{\theta}) + \pi(\theta) \int_{-\infty}^{\theta} dP(\theta'|\tilde{\gamma}, \tilde{b}) + \int_{\theta}^{\infty} \pi(\theta')dP(\theta'|\tilde{\gamma}, \tilde{b}) - \pi(\theta)
\]

\[
(r + \lambda - 1) \left[\pi(\theta) - \pi(\tilde{\theta})\right] = \pi(\tilde{\theta}) \int_{-\infty}^{\theta} dP(\theta'|\tilde{\gamma}, \tilde{b}) + \int_{\theta}^{\infty} \pi(\theta')dP(\theta'|\tilde{\gamma}, \tilde{b}) - \pi(\theta)
\]

\[
(r + \lambda - 1) \left[\pi(\theta) - \pi(\tilde{\theta})\right] = \pi(\tilde{\theta}) \int_{-\infty}^{\theta} dP(\theta'|\tilde{\gamma}, \tilde{b}) + \int_{\theta}^{\infty} \pi(\theta')dP(\theta'|\tilde{\gamma}, \tilde{b}) - \pi(\theta)
\]

\[
\pi(\theta) - \pi(\tilde{\theta}) = \frac{1}{r + \lambda - 1} \int_{\theta}^{\infty} [\pi(\theta') - \pi(\tilde{\theta})] dP(\theta'|\tilde{\gamma}, \tilde{b})
\]

\[
\pi(\theta) - \pi(\tilde{\theta}) > 0
\]

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 \(\theta\).

**Proof of Theorem 1:**

I 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 (17), 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, \(\pi(\hat{\theta})\), is bounded. To see this, note that from equation (17), the profit function is bounded from below trivially by the fixed cost (when \(\theta = 0\)). The support of \(\theta\) is \((0, \infty)\), but as \(\theta\) rises, Proposition 2 implies that the optimal level of integration, and thus the final good producer’s share of revenue, \(\beta_{\gamma}\), should also rise. From (8), one can see that this negates the initial effect on profits from the rise in \(\theta\). As \(\beta_{\gamma}\) tends to 1, operating profits collapse to zero. Continuity follows in a more straightforward manner as the profit function is continuous in \(\hat{\theta}\).

Second, consider \(V(\hat{\theta}) \geq W(\hat{\theta})\) from the set of bounded and continuous real-valued functions on \(\theta\). Then:
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}'|\tilde{\gamma}, \tilde{b}) \right] dP(\theta|\tilde{\gamma}, \tilde{b}), \frac{1}{r} \int V(\tilde{\theta}') dG(\tilde{\theta}'|\tilde{\gamma}, \tilde{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}'|\tilde{\gamma}, \tilde{b}) \right] dP(\theta|\tilde{\gamma}, \tilde{b}), \frac{1}{r} \int W(\tilde{\theta}') dG(\tilde{\theta}'|\tilde{\gamma}, \tilde{b}) \right\}
= TW

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

\begin{align*}
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}'|\tilde{\gamma}, \tilde{b}) \right] dP(\theta|\tilde{\gamma}, \tilde{b}), \frac{1}{r} \int \left\{ V(\tilde{\theta}') + c \right\} dG(\tilde{\theta}'|\tilde{\gamma}, \tilde{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}'|\tilde{\gamma}, \tilde{b}) + \frac{c}{r} \right] dP(\theta|\tilde{\gamma}, \tilde{b}), \frac{1}{r} \int V(\tilde{\theta}') dG(\tilde{\theta}'|\tilde{\gamma}, \tilde{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}'|\tilde{\gamma}, \tilde{b}) \right] dP(\theta|\tilde{\gamma}, \tilde{b}), \frac{1}{r} \int V(\tilde{\theta}') dG(\tilde{\theta}'|\tilde{\gamma}, \tilde{b}) \right\} + \frac{c}{r}
& = TV + \frac{c}{r}
\end{align*}

Hence, T is a contraction operator with modulus 1/r which gives us that the functional equation in (17) has a unique fixed point in the space of bounded and continuous functions.

**Proof of Proposition 3:** (Ljungqvist and Sargent, 2004)

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 \( \int_{\tilde{b}}^{\infty} dG(\tilde{\theta}|\tilde{\gamma}, \tilde{b}) \). The probability that a
previously unmatched multinational offers a contract in the first period and updates it in the second period is given by: $\int_0^\infty \int_0^\infty dP(\theta|\tilde{\gamma}, \tilde{b})dG(\tilde{\theta}|\tilde{\gamma}, \tilde{b})$. Following Bayes rule, average productivity in period 1 and period 2 is respectively given by:

$$\bar{\theta}_1 = \frac{\int_0^\infty \tilde{\theta}dG(\tilde{\theta}|\tilde{\gamma}, \tilde{b})}{\int_0^\infty G(\tilde{\theta}|\tilde{\gamma}, \tilde{b})}$$

$$\bar{\theta}_2 = \frac{\int_0^\infty \int_0^\infty \theta dP(\theta|\tilde{\gamma}, \tilde{b})dG(\tilde{\theta}|\tilde{\gamma}, \tilde{b})}{\int_0^\infty \int_0^\infty dP(\theta|\tilde{\gamma}, \tilde{b})G(\tilde{\theta}|\tilde{\gamma}, \tilde{b})}$$

Using the fact that $\tilde{\theta} = \int_0^\infty \bar{\theta}dP(\theta|\tilde{\gamma}, \tilde{b})$, one gets:

$$\bar{\theta}_1 = \frac{\int_0^\infty \int_0^\infty \bar{\theta}dP(\theta|\tilde{\gamma}, \tilde{b})G(\tilde{\theta}|\tilde{\gamma}, \tilde{b})}{\int_0^\infty G(\tilde{\theta}|\tilde{\gamma}, \tilde{b})}$$

$$= \frac{\int_0^\infty \int_0^\infty \bar{\theta}dP(\theta|\tilde{\gamma}, \tilde{b})G(\tilde{\theta}|\tilde{\gamma}, \tilde{b}) + \bar{\theta}_2 \int_0^\infty \int_0^\infty dP(\theta|\tilde{\gamma}, \tilde{b})G(\tilde{\theta}|\tilde{\gamma}, \tilde{b})}{\int_0^\infty G(\tilde{\theta}|\tilde{\gamma}, \tilde{b})}$$

$$< \frac{\int_0^\infty \left\{ \bar{\theta}P(\bar{\theta}|\tilde{\gamma}, \tilde{b}) + \bar{\theta}_2 \left[ 1 - P(\bar{\theta}|\tilde{\gamma}, \tilde{b}) \right] \right\} dG(\bar{\theta}|\tilde{\gamma}, \tilde{b})}{\int_0^\infty G(\bar{\theta}|\tilde{\gamma}, \tilde{b})}$$

$$< \bar{\theta}_2$$

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

**Proof of Proposition 4:**
In the text.
References


Table 1: FDI Presence in the Turkish Manufacturing Industry, 1993-2001

<table>
<thead>
<tr>
<th>Year</th>
<th>No. of FDI Plants</th>
<th>Total No. of Plants</th>
<th>Foreign Presence (%)</th>
<th>Average Share of Foreign Ownership at FDI Plants (%)</th>
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</thead>
<tbody>
<tr>
<td>1993</td>
<td>301</td>
<td>10,567</td>
<td>2.85</td>
<td>58.78</td>
</tr>
<tr>
<td>1994</td>
<td>312</td>
<td>10,127</td>
<td>3.08</td>
<td>58.95</td>
</tr>
<tr>
<td>1995</td>
<td>325</td>
<td>10,229</td>
<td>3.18</td>
<td>59.96</td>
</tr>
<tr>
<td>1996</td>
<td>326</td>
<td>10,590</td>
<td>3.08</td>
<td>58.48</td>
</tr>
<tr>
<td>1997</td>
<td>362</td>
<td>11,365</td>
<td>3.19</td>
<td>57.04</td>
</tr>
<tr>
<td>1998</td>
<td>416</td>
<td>12,321</td>
<td>3.38</td>
<td>59.25</td>
</tr>
<tr>
<td>1999</td>
<td>406</td>
<td>11,262</td>
<td>3.61</td>
<td>60.08</td>
</tr>
<tr>
<td>2000</td>
<td>414</td>
<td>11,114</td>
<td>3.73</td>
<td>62.01</td>
</tr>
<tr>
<td>2001</td>
<td>439</td>
<td>11,311</td>
<td>3.88</td>
<td>64.33</td>
</tr>
</tbody>
</table>

Table 2: The Distribution of Foreign Ownership Share in the Pooled Sample, 1993-2001

<table>
<thead>
<tr>
<th>FDI Share</th>
<th>Observations</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-15%</td>
<td>383</td>
<td>7.7%</td>
<td>4.7%</td>
<td>1%</td>
<td>15%</td>
</tr>
<tr>
<td>16-30%</td>
<td>296</td>
<td>24.1%</td>
<td>4.1%</td>
<td>16%</td>
<td>30%</td>
</tr>
<tr>
<td>31-50%</td>
<td>825</td>
<td>45.5%</td>
<td>5.8%</td>
<td>31%</td>
<td>50%</td>
</tr>
<tr>
<td>51-100%</td>
<td>1636</td>
<td>86.3%</td>
<td>17.8%</td>
<td>51%</td>
<td>100%</td>
</tr>
<tr>
<td>All FDI firms</td>
<td>3140</td>
<td>60.1%</td>
<td>32.3%</td>
<td>1%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Figure 1: Evolution of the Level of Foreign Ownership with Age
Figure 2: Operating Profits and the Level of Integration

Figure 3: Optimal Policy in Period 2
Figure A1: The Permissible Set of $\beta$'s for Various Headquarter Intensities

Figure A2: The Sign of the Cubic Equation in $\beta_V$ for Different Parameter Values