SHARED OWNERSHIP IN THE INTERNATIONAL MAKE OR BUY DILEMMA

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Shared ownership in the international make or buy dilemma.

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Abstract

The traditional Grossman-Hart-Moore property right theory of the firm and subsequent works do not consider shared ownership as an optimal solution because of the incentives losses it would carry. This paper provides an extension of Antrás & Helpman (2008) international integration dilemma under partially incomplete contracts to joint-ventures (JVs), and identifies several cases where JVs are optimal for foreign investors. The model insists on the interaction between firm-level and country-level parameters, with higher productivity giving increasing access to higher control in countries with stronger contractual enforceability, consistent with empirical observations. Potential heterogeneous spillovers effects can be deduced from this framework.

Keywords: Property Right Theory; International Joint Ventures; Contracting Institutions; Firms Heterogeneity; Multinational Enterprises.

JEL codes: D23; F23 ; L23

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1 Introduction

International joint ventures are common practice among multinational enterprises (MNEs). According to the Orbis dataset (Bureau Van Dijk), in 2017, 25% of foreign affiliates were only partially owned, and 40% of the 38,471 multinational companies listed were holding at least one international Joint Venture (JV)\(^1\). Yet, investigating international joint ventures is a continuing concern within standard approaches of industrial organization based on the Property Right Theory (PRT) of the firm which rules out shared ownership as a sub-optimal arrangement, because of the net investments incentives loss it would be responsible for (see Gattai and Natale (2015); Holmstrom (1999)).

Tackling this limitation, we show the possibility for a MNE to opt for a partial ownership strategy of foreign subsidiaries. Throughout this paper, we study two channels determining the ownership share: the first one is the endogenous effect of the firms’ own level of Total Factor Productivity (TFP), in line with the literature on firms’ heterogeneity after Melitz (2003). The second is exogenous through the host country and industry influence on foreign ownership. Then we detail how these two factors interact together.

The seminal approach of the international integration issue - the “global sourcing” line of models, mostly developed by Pol Antràs (Antràs, 2014; Antràs and Helpman, 2004, 2008) - deepens the PRT conception with the inclusion of firm heterogeneity to investigate differences in integration choices within-industry. Because of its PRT foundations, it doesn’t consider shared ownership as a possible ownership structure, as it would virtually give null disagreement payoffs because no one has the residual rights over the totality of the firm’s assets\(^2\).

Since then, many works have challenged the traditional PRT assumptions to allow partial ownership and international joint ventures (see Gattai and Natale (2015) for a review). Among them, Cui (2011) finds vertical integration - either through JV or full integration - to be associated with greater productivity of the parent firm. Assuming partially incomplete contracts, in a framework close to Antràs and Helpman (2008), Eppinger and Kukharskyy (2017) investigate the role of countries’ contractual institutions into the optimal ownership share within joint

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\(^1\) Statistics from European countries, which benefit from the better coverage in Orbis (see Bloom, Sadun, and Van Reenen (2012)). Shared ownership defined as an ownership share below 95\% for the main owner.

\(^2\) Throughout this paper, disagreement payoffs refer to the revenue the party could obtain from its investments outside of the relationship (i.e. in case of bargaining failure). Outside option refer to ex-ante revenue the party could chose instead of engaging into the relationship.
By mixing these features, this paper main contribution is to reconcile shared ownership and the international make or buy models. Not only it links firm-level productivity to ownership choices and distinguishes between partial and full integration, but details how this relationship’s elasticity depends on host country contractual institutions. Specifically, while the higher productivity allows the MNE to control better their foreign affiliates, this relationship is strengthened in countries with strong contractual institutions.

The rest of the paper is built as follows. In the second section I detail the set-up of the model as an extension of Antràs and Helpman (2008) baseline. In section 3, I identify the ownership share that ensures the interior equilibrium. In the fourth section I broaden the analysis to alternative ownership structures, i.e. outsourcing and whole ownership. The fifth section discusses the influence of the host-country contract enforceability in the optimal ownership structure the firms choose. The last section concludes.

2 Basic set-up

Consider a two countries world, where one is referred as domestic (D) and another one as foreign (F), populated by a unit measure of consumers with identical preferences represented by:

\[ U = q_0 + \frac{1}{\mu} \sum_{g=1}^{G} Q_g^\mu , \quad 0 < \mu < 1 \quad (1) \]

\( q_0 \) is the consumption of a homogeneous good. There are another \( G \) industries and \( Q_g \) is an index of aggregate consumption in industry \( g \), which is a CES function.

\[ Q_g = \left[ \int q_g(f)^\alpha df \right]^{1/\alpha} , \quad 0 < \mu < \alpha < 1 \quad (2) \]

The elasticity of substitution between any two varieties in a given industry is \( \frac{1}{1-\alpha} \), greater than unity. \( \mu \) denotes inter-industry elasticity of substitution, and is supposed to be lower than \( \alpha \). Labour is the only production factor and is immobile between countries. International trade is free such that in equilibrium, the price of \( q_0 \) is the same in each country, and normalized to one. The productivity of producing \( q_0 \) is fixed in each country, and determines the wage level.

As labour allocation and wages are fixed, the labour income in each country is given. Utility
maximization sets the inverse demand function as:

\[ p_g(f) = Q_g^{\mu-\alpha} q_g(f)^{\alpha-1} \] (3)

Where \( p_g(f) \) is the market price of variety \( f \). Henceforth, we drop industry and firm subscripts (\( g \) and \( f \)), for clarity purposes when detailing the production process under partial contractibility. Equation (3) could be rewritten:

\[ q = A p^{-1/(1-\alpha)} \] (4)

With \( A = Q^{\frac{\mu}{1-\alpha}} > 0 \), a demand shifter. This demand function yields the revenue

\[ R = q^\alpha A^{(1-\alpha)} \] (5)

The production of a final good \( q \) requires the cooperation of two types of producers: a final-good producer and a (manufacture) intermediate-good supplier. We assume that only domestic workers (from country \( D \)) have the know-how to produce final goods through their headquarter services \( h \), but that intermediate goods \( m \) can only be produced by a manufacture supplier \( M \), located in the foreign country for natural endowment reasons. This assumption is a convenient tool to simultaneously explain why an agency problem between two producers rises, and to focus only on international transactions. The final good producer’s integration strategy corresponds to the choice of the ownership structure of the foreign supplier, between outsourcing, full integration, or any intermediate ownership share by \( H \), within a joint venture.

The production function of the final good combines both inputs using a Cobb-Douglas function:

\[ q = \theta \left( \frac{h}{\eta} \right)^\eta \left( \frac{m}{(1-\eta)} \right)^{(1-\eta)} , \quad 0 < \eta < 1 \] (6)

Following the contribution of Acemoglu, Antràs, and Helpman (2007), each of the two inputs is produced with a set of activities indexed by points on the interval \([0, 1]\), according to the Cobb-Douglas production function

\[ j = \exp \left[ \int_0^1 \log x_j(i) \, di \right] , \quad j = h, m \]
where \( x_j(i) \) is the investment in activity \( i \) for inputs \( j = h, m \). Investments in activities are input-specific and can only be used to produce the input for which they were designed.

As in all Melitz (2003) like models, the \( \theta \) parameter in the production function \([6]\) corresponds to the firm’s total factor productivity. It is worth noting that this firm-specific level of productivity affects the final-good production function but doesn’t play a role in the investments payoffs. As in Antràs and Helpman (2008), more productive firms do not benefit from neither lower variable costs of investment \( c_j \) per unit \( x_j, j = h, m \); nor from increased inputs production \([6]\).

We further assume that an exogenous threshold \( 0 \leq \mu \leq 1 \) exists for \( M \)’s input activity, such that activities in the range \([0; \mu]\) are contractible \textit{ex-ante}. Conversely, the set of activities in \([\mu; 1]\) is not contractible, in the sense that they cannot be fully specified in an \textit{ex-ante} contract, or at least cannot be verified by third parties (courts), which makes the contract not enforceable \textit{ex-post}\([4]\).

We summarize the timing of events in this game:

- In \( t = 1 \), \( H \) enters the industry, incurring exogenous fixed costs of entry consisting in \( F \) units of domestic labour. She draws a productivity level \( \theta \) and then decides whether to exit the market or not. If she stays, she decides of her organizational structure.

- In \( t = 2 \) \( H \) offers a contract to a foreign manufacture supplier (\( M \)), which stipulates: (i) the organizational structure for the venture decided in \( t = 1 \); (ii) the supplier’s required investments in the contractible activities \( m_c \equiv \exp \left[ \int_0^{\mu} \log x_m(i) \, di \right] \), and (iii) an upfront payment of \( \tau_m \) (positive or negative) from \( H \) to \( M \). We assume \( M \)’s outside option to be null.

- In \( t = 3 \), both parties invest in non-contractible activities and provide their amount of inputs.

\[\text{This assumption could be justified by assuming common investments of all firms in a given industry. However, it could be released without qualitative changes in the model predictions, as long as the productivity in intermediate inputs is positively correlated with } H \text{'s TFP.}\]

\[\text{For simplicity purposes we assume } h \text{ to be fully non-contractible ex-ante, such that the partial (and varying) contractual incompleteness only affects } m, \text{ as done by Eppinger and Kukharskyv 2017.}\]
• In $t = 4$, the parties bargain over the surplus from the relationship (or the “quasi-rent”).

• In $t = 5$: If an agreement has been reached in $t = 4$ final goods are produced and sold, and the revenue is distributed across the parties. Otherwise, the two parties leaves the game with their disagreement payoffs.

3 Equilibrium in Joint Ventures

For now, let’s solve this game by backward induction considering a continuous ownership share smoothly adjustable in $[0; 1]$. In such case, intermediates inputs $m$ are jointly owned, such that no one can walk with them in case of bargaining failure, as repeatedly noted by the PRT. However, instead of concluding to null disagreement payoffs each party would get in $t = 5$ in absence of agreement, we assume them to proceed to a division of surplus in liquidation [Cui 2011]. Already reported by Cai (2003) to be a common practice in the real-world, this implies that when a bargaining failure occurs in a JV, the two parties jointly sell their inputs and each recover a share of the revenue equal to their ownership share in the common entity. Hence, one’s disagreement payoff increases with its ownership share.

In $t = 4$, the two parties find an agreement, and the result of this Nash-bargaining game gives each player its disagreement payoff plus a fraction of the quasi-rent $Q = (1 - \delta)R$, where $0 < \delta < 1$ is the fraction of the final revenue recovered through selling jointly all inputs to another final-good producer during the liquidation instead of selling the final good. The fraction of this cooperation surplus the parties obtain corresponds to their bargaining power, assumed exogenous, such that $H$ recovers a share $\beta Q$ of this quasi rent, besides its disagreement payoffs, and $M$ gets $(1 - \beta)Q$, with $0 < \beta < 1$.\textsuperscript{6}

In $t = 3$, both parties simultaneously and non-cooperatively invest in their non-contractible activities. Each party anticipates the outcome of the forthcoming bargaining game, and chooses the amount of non-contractible activities that will maximize her payoff. Because we assumed\textsuperscript{5} this practice assumes that inputs are (more) valuable when jointly sold, while relationship-specificity make these inputs’ value close to zero when sold independently.\textsuperscript{6} Cui (2011) and Eppinger and Kukharsky (2017) both considered cases where $\beta$ is endogenous, without notable change in their conclusions. It would also be the case here if firm-level $\beta_i$ is positively correlated with the firms’ total factor productivity (TFP) $\theta_i$.  

\textsuperscript{6}
all $h$ to be non contractible, the final-good producer’s problem is

$$\max_{\{x_h(i)\}_{i=0}^1} \pi_H = s\delta R + \beta Q - c_h \int_0^1 x_h(i)di - \tau_m - F$$

The first term $s\delta R$ corresponds to its disagreement payoff, i.e. its revenue in case of division of surplus in liquidation, because $s$ stands for the ownership share held by $H$. The second term corresponds to $H$’s share of the quasi-rent.

Final-good producer program could be rewritten:

$$\max_{\{x_h(i)\}_{i=0}^1} \pi_H = (s\delta + \beta (1 - \delta)) R - c_h \int_0^1 x_h(i)di - \tau_m \quad (7)$$

Following Antràs and Helpman (2004, 2008), we note $\beta_h$ the final share of revenue that goes to the final-good producer, with here $\beta_h = (s\delta + \beta (1 - \delta))$.

From eq. (5) and (6), we find the amount of non contractible activities:

$$x_{hn} = \frac{1}{c_h} \eta \alpha R \beta_h \quad (8)$$

Meanwhile, $M$ sets the amount of non-contractible activities to invest in, to maximize its own profit.

$$\max_{\{x_m(i)\}_{i=\mu}} \pi_M = (1 - \beta_h)R - c_m \int_{\mu}^1 x_m(i)di + \tau_m$$

Whereby $(1 - \beta_h)$ is the share of the revenue recovered by $M$ and is equal to $(1 - \beta_h) = (\delta(\beta - s) + (1 - \beta))$

The maximization program yields

$$x_{mn} = (1 - \beta_h) \left(1 - \frac{\eta}{c_m}\right) \alpha R \quad (9)$$

These two values are expressed as functions of revenue, which in turn could be rewritten using equations (6), (8) and (9) into equation (5).
\[ R = \left( \alpha^{a(1-\mu(1-\eta))} \theta^a A^{1-\alpha} \eta^{-\alpha \eta(1-\eta)} \left( \frac{\beta_h \eta}{c_h} \right)^{\alpha \eta} \right) \left( \frac{(1 - \beta_h)(1-\eta)}{c_m} \right)^{\alpha(1-\eta)(1-\mu)} \left( \exp \alpha(1-\eta) \int_0^\mu \log x_m(i) \, di \right)^{\frac{1}{1-\alpha(1-\mu(1-\eta))}} \] (10)

From equations (8) and (9), we directly see that the ownership share determines the investments in the non-contractible activities. The higher its ownership share, the more the party will engage into non-contractible investments, because it limits the hold-up issue, by increasing the disagreement payoff.

In \( t = 2 \), \( H \) specifies in the contract the investments in contractible activities that would maximize its own payoff \( \beta_h R - c_h \int_0^1 x_h(i) \, di - \tau_m \). However, the final-good producer must consider the participation constraint of \( M \). Since we assume no \textit{ex-ante} outside options, this constraint is

\[(1 - \beta_h)R - c_m \int_0^1 x_m(i) \, di + \tau_m \geq 0\]

Therefore, \( H \) satisfies this participation constraint by setting

\[(1 - \beta_h)R - c_m \int_0^1 x_m(i) \, di = -\tau_m\]

We can substitute the result into the final-good producer’s objective function, and the final-good producer’s choice of contractible investments comes from the program

\[
\max_{\{x_m(i)\}_{i=0}^\mu} \pi_H = R - c_h \int_0^1 x_h(i) \, di - c_m \int_0^1 x_m(i) \, di - F
\] (11)

Using the first order condition together with eq. (9) gives:

\[x_{mc} = 1 - \frac{\alpha(\beta_h \eta_h + (1 - \beta_h) \mu(1 - \eta))}{1 - \alpha(1 - \mu(1 - \eta))} \frac{(1 - \eta)}{c_m} \alpha R\] (12)

Note that the profit function in (11) can also be written:

\[\pi_H = R - c_h x_{hn} - c_m (1 - \mu)x_{mn} - c_m \mu x_{mc} - F\]
From (8), (9) and (12) we have

\[ \pi_H = (1 - \alpha) \left( \frac{1 - \alpha(\beta h \eta + (1 - \beta h)(1 - \eta)(1 - \mu))}{1 - \alpha(1 - \mu(1 - \eta))} \right) R - F \quad (13) \]

Substituting the value of \( x_{mc} \) given by (12) in (10) gives a new value of \( R \), which can be plugged into the above value of \( \pi_H \) in (13), and gives

\[ \pi_H = (1 - \alpha) A \theta \left[ \frac{\alpha^\alpha c_h^{\alpha\eta} c_m^{\alpha(1-\eta)(1-\beta h)\alpha(1-\mu)(1-\eta)\beta_h^{\alpha\eta}}}{1 - \alpha(1 - \mu(1 - \eta))} \right]^{\frac{1}{1-\alpha}} - F \quad (14) \]

Interestingly, the revenue isn’t not monotonic in \( \beta_h \), because of the tradeoff between increasing the revenue share obtained at the expense of a smaller total revenue, due to \( M \)’s lower willingness to cooperate. There is only one value of \( \beta_h \) that maximizes \( H \)’s revenue and is given by:

\[ \beta_h^* = \frac{\sqrt{\eta(1 - \alpha(1 - \eta)(1 - \mu))}}{\eta - (1 - \eta)(1 - \mu)} \left( \sqrt{\eta(1 - \alpha(1 - \eta)(1 - \mu))} - \sqrt{(1 - \eta)(1 - \mu)(1 - \alpha\eta)} \right) \quad (15) \]

Eventually, in \( t = 1 \), \( H \) chooses the optimal ownership share that maximizes its profit. Recall that in a joint-venture, the revenue share of \( H \) is a function of its ownership share because of the possibility of a division of surplus in liquidation, we have \( \beta_h = (s\delta + \beta(1 - \delta)) \) Therefore, the ownership share that maximizes the profit is given by:

\[ s^* = \frac{\beta_h^*}{\delta} - \frac{\beta(1 - \delta)}{\delta} \]

which could be rewritten as:

\( ^7 \max_{\beta_h} \pi_H \) is equivalent to \( \max_{\beta_h} (1 - \beta_h)^{\alpha(1-\mu)(1-\eta)\beta_h^{\alpha\eta}} \left( 1 - \alpha(\beta_h \eta + (1 - \beta h)(1 - \eta)(1 - \mu)) \right) \). First order condition gives two roots for polynomial from the partial derivative, the first one corresponds to (15), the second one is out of the \([0;1]\) interval and not discussed here.
\[ s^* = \frac{\sqrt{\eta(1 - \alpha(1 - \eta)(1 - \mu))}}{\delta(\eta - (1 - \eta)(1 - \mu))} \left( \sqrt{\frac{\eta(1 - \alpha(1 - \eta)(1 - \mu))}{\eta(1 - \alpha(1 - \eta)(1 - \mu))}} - \sqrt{\frac{(1 - \eta)(1 - \mu)(1 - \alpha \eta)}{(1 - \eta)(1 - \mu)}} \right) - \frac{\beta(1 - \delta)}{\delta} \] (16)

First of all, in this framework the optimal ownership share \( s^* \) depends on various parameters of the model, but it worth noting that it is independent from the firms’ productivity level - because no trade-off between fixed and variable costs is introduced -. Also, contrary to the optimal revenue share \( \beta_h^* \) which is bounded between 0 and 1 (see Appendix (A.1) for proof), \( s^* \) doesn’t belong to that interval. On its upper bond, we see that \( s^* < \beta_h^* < 1 \), meaning that within joint-ventures, high control is meaningless as it would led to set \( \beta_h \) beyond its optimal value. It also implies that this framework cannot be simply extended to understand full integration, and other mechanisms are at stake there. On the other side, \( s^* \) can be below zero depending on the parameters. This possibility stresses the opportunity of second-best corner solutions, here setting \( s \) to zero when \( s^* \) is negative, which breaks with the joint-venture framework. By introducing alternative ownership structures to joint ventures, the next section deals with these two issues.

4 Outsourcing, joint-venturing or integrating.

Let us now broaden our analysis to explicitly consider outsourcing and full integration as proper integration strategies. The nature of the ownership structure changes two parameters: (i) The fixed costs. Assuming that each ownership structure involves a different sunk cost, a tradeoff may occur between increasing revenue share at the expense of higher fixed costs, whose solution is given by the firm’s TFP. (ii) The revenue sharing, because the liquidation mechanism detailed above is only valid for JVs.

4.1 Ownership structure and sunk costs

While within a JV, the precise division of the equity share doesn’t change the entry sunk cost born by the final good producer, as we will explain, changing the nature of the ownership structure does influence these fixed costs. Specifically, like the majority of related models, we
assume full integration implies a higher fixed costs than outsourcing does.\footnote{To our knowledge, only Defever and Toubal (2013) assumed a reverse order: $F_O > F_V$, based on Williamson (1979) Transaction Costs Theory argument. However, transaction costs are operating costs, and not the entry sunk costs we picture here in the line of Melitz (2003) and Antras and Helpman (2004).} By denoting $F_k$ the sunk costs associated to each ownership structure $k = O, J, V$ ($O$, and $V$ respectively indicate Outsourcing and (full) Vertical integration, $J$ stands for joint venture) we have $F_V > F_0$.

The novelty of this model is about characterizing the fixed costs of a joint venture $F_J$. One would easily agree on the assumption that these costs are superior to outsourcing fixed costs $F_O$ (because a local plant needs to be settled), but inferior to full integration ones $F_V$. The latter point deserves to be further detailed though. Indeed, the joint venture fixed costs are shared between the two owners. However, we know the participation constraint of $M$ being satisfied with equality, through the ex-ante lump-sum transfer, such that the fixed costs borne by $M$ (reducing $M$’s profit), ends up entirely in increasing the up-front payment from $H$ to $M$. So that actually $H$ bears entirely the fixed costs of a JV, because it compensates $M$ for its part. This makes $F_J$ independent from the exact division of equity within JVs, as earlier assumed. Hence, if the total fixed costs of setting up a JV were the same as those of a wholly owned affiliate, $H$ wouldn’t see any difference between $F_V$ and $F_J$. However, we make the reliable assumption that it is less costly for $M$ to open an affiliate in his own country, than it would be for $H$ to open it in the foreign country.\footnote{This assumption is grounded in Antras and Helpman (2004) p.358) statement that “the fixed costs of search, monitoring, and communication are significantly higher in the foreign country”.} Such that the costs $H$ should compensate $M$ for, are lower than the costs it would have payed for by itself. Therefore we assume $M$ to open the local affiliate at a costs $F_J$, between $F_O$ and $F_V$, and $H$ offsets this costs through the lump-sum payment. For ease of understanding though, we do not include these costs into $\tau_m$ the ex-ante transfer, but as a separated flow, to distinguish $F_J$ in the profit function. It follows the fixed organizational costs ranking:

$$F_O < F_J < F_V$$ (17)

4.2 Ownership structure and revenue share

We note $\beta_{h,k}$ the revenue share of the final good producer for each organizational structure $k = \{O, J, V\}$. We examined in the previous section the mechanism that determines the revenue share obtained by the final good producer in a joint venture, and found $\beta_{h,J} = \beta + \delta (s - \beta)$.\footnote{This assumptions is grounded in Antras and Helpman (2004) p.358) statement that “the fixed costs of search, monitoring, and communication are significantly higher in the foreign country”.}
However, the division of surplus in liquidation is not adapted to the case of outsourcing, because the inputs are not jointly owned, therefore under this organizational structure, we follow the standard assumption that gives no disagreement payoff to both parties. Hence we find $H$’s payoff to be $0 + \beta(R - 0 - 0) = \beta R$, such that $\beta_{h,O} = \beta$.

Consider complete vertical integration now. A simple extension of the division of surplus in liquidation would suggest that $H$, who has access to all the inputs, sells them together to a third party, resulting in a revenue $\delta R$. Yet, another choice is offered to $H$. Since the final good producer benefits from all the inputs, it can assemble them together and sell the output. However, as stated in GHM models, doing so without $M$’s participation implies an efficiency loss, and the final good producer only recovers $\delta_p R$. We have no valuable reasons to think that $\delta_p = \delta$. To the contrary, we believe the (costless) assembly of inputs increases their market value. We therefore consider that $\delta_p > \delta$. The latter solution dominates the liquidation strategy, such that under complete integration, if the bargaining fails, $H$ would produce and sell on its own and gets $\delta_p R$. Meanwhile, $M$ has no disagreement payoffs. $H$’s payoffs become $= \delta_p R + \beta(R - \delta_p R - 0)$. So that $\beta_{h,V} = \beta + \delta_p (1 - \beta)$

If we compare these revenue shares, it is obvious that $\beta_V > \beta_{h,O}$, and from $\delta_p > \delta$ and $0 < s < 1$, we also have $\beta_{h,V} > \beta_{h,J}(s)$, $\forall s \in ]0; 1[$.

The sorting becomes less straightforward when comparing the revenue shares granted by joint venture and outsourcing. Actually $\beta_{h,J}(s) > \beta_{h,O}$ if $s > \beta$, and the reverse otherwise. This means that a JV would give $H$ more than outsourcing revenue share, only if she owns a share higher than its relative bargaining weight. The reason for that is simple: under outsourcing, she will get her bargaining power times the final revenue ($\beta R$), but under JV, she gets $\beta$ over a fraction of $R$ (namely, the relationship-surplus ($(1 - \delta)R$)), but $s$ over the remaining part of $R$ (the sum of disagreement payoffs ($\delta R$)).

The two possible rankings of revenue share can be summarized as follows:

$$\beta_{h,O} < \beta_{h,J}(s) < \beta_{h,V}, \forall s \in ]0; 1[$$

$$\beta_{h,J}(s) \leq \beta_{h,O} < \beta_{h,V}, \forall s \in ]0; \beta[$$

Note that the result holds even for $\delta_p = \delta$
4.3 Optimal integration choice

Using information on both \(\beta_{h,k}\) and \(F_k\), we can rewrite \(H\)'s profits from (14)

\[
\pi_{H,k} = \Theta Z_k - F_k
\]

(20)

Where \(\Theta = \theta^{\alpha/(1-\alpha)}\) and

\[
Z_k = (1-\alpha)A\left(\alpha^m c_h^{-\alpha} c_m^{\alpha(1-\eta)} (1-\beta_{h,k})^{\alpha(1-\mu)(1-\eta)} \beta_{h,k}^{\alpha(1-\mu)(1-\eta)} \left(1 - \alpha (\beta_{h,k} \eta + (1 - \beta_{h,k})(1 - \eta)(1 - \mu)) \right)^{1-\alpha(1-\mu)(1-\eta)} \right)^{1/\alpha}
\]

(21)

is a derived parameter proportional to \(H\)'s gross revenue which depends on a set of fixed parameters of the model (the demand level, and elasticity, the input costs, the coverage of contractible activities, and the importance of headquarter services in the final good). By construction, \(\beta_{h}^*\) is the revenue share that maximizes the income \(\Theta Z_k\). Such that \(Z_k\) increases in \(\beta_{h,k}\) if \(\beta_{h,k} < \beta_{h}^*\) and decreases otherwise. Yet, the final good producer cannot freely choose ex-ante the division of the revenue \(\beta_{h}^*\), but can only choose \(\beta_{h}\) in the set \{\(\beta_{h,O}^*\), \(\beta_{h,J}^*\), \(\beta_{h,V}^*\)\}. Naturally, no organizational form always minimizes the distance to \(\beta_{h}^*\), but, because the ownership share \(s\) is smoothly adjustable within joint ventures, \(H\) can always choose \(s\) such as \(|\beta_{h,J}(s) - \beta_{h}^*| \leq |\beta_{h,O} - \beta_{h}^*|\), from eq. (18) and (19). It means that joint ventures always grant \(H\) a higher income than outsourcing. This implies \(Z_J > Z_O\), and an ambiguous sorting of \(Z_V\) and \(Z_J\) with two potential cases. One where \(|\beta_{h,J}(s) - \beta_{h}^*| > |\beta_{h,V} - \beta_{h}^*|\), such that \(Z_V > Z_J\). We will refer to this situation as the one where \(\beta_{h}^*\) is high (because remember \(\beta_{h,V} > \beta_{h,J}\)). The opposite sorting arise when \(\beta_{h}^*\) is low, such that \(\beta_{h,J}\) is closer to \(\beta_{h}^*\) than \(\beta_{h,V}\) (formally \(|\beta_{h,J}(s) - \beta_{h}^*| < |\beta_{h,V} - \beta_{h}^*|\)), resulting in \(Z_J > Z_V\). In the latter case, ranking between \(Z_O\) and \(Z_V\) doesn’t matter as we will show.

Nonetheless, the profit maximization program results from a tradeoff between the revenue and the fixed cost of each ownership structure, and depends ultimately on the firms’ productivity. From the statement on each sunk cost \(F_J\), the intercept of the profit function, and the observation on the slope \(Z_k\) the above results can be summarized in\[11]\n
\[11\]

Actually additional cases can be derived from the framework. For ease of understanding we set \(Z_O < Z_J < \frac{F_J}{F_V} Z_O\), and \(0 < Z_V < \frac{Z_J - Z_O}{F_J - F_O} (F_V - F_J) + Z_J\) if \(\beta_{h}^*\) is high, to avoid any productivity threshold overlapping (see Appendix A.2). If these assumptions were not satisfied, the integration process would skip intermediary steps, but the dynamic remains similar.
Proposition 1

(i) In every country-sector, there exists a cutoff $\theta_0$, such that firms with a productivity $\theta < \theta_0$ do not produce.

(ii) In every country-sector, there exists a cutoff $\theta_J > \theta_0$, such that firms with $\theta \in [\theta_0; \theta_J]$ proceed to outsourcing.

(iii.a) When $\beta_h^*$ is low, all firms with a productivity $\theta > \theta_J$ set up an international joint venture.

(iii.b) When $\beta_h^*$ is high, there exists a cutoff $\theta_V > \theta_J$, such that only firms with a productivity $\theta \in [\theta_J; \theta_V]$ engage in international joint ventures, while firms with $\theta > \theta_V$ fully integrate their foreign supplier.

The figure represents these two situations and the profit curves each solution offers. It directly shows that when $\beta_h^*$ is high, joint ventures appear to be an intermediate solution between outsourcing and full integration, more easily accessible for middle productive firms. But partial ownership agreements are not only that intermediate solution that could be ignored for the ease of understanding. Indeed, when $\beta_h^*$ is low, partial ownership becomes the optimal integration solution even for top productive firms because it yields a better revenue, and benefits from a lower sunk costs, such that it dominates the full integration solution. In this situation, the respective slopes of $\pi_O$ and $\pi_V$ is irrelevant, as soon as $Z_J > Z_V$ as shows the right panel. In all cases, outsourcing is optimal only for low productive firms unable to bear the cost of a foreign investment.

5 Interaction and complementarity between firm and country-level characteristics

As in every make or buy model since Grossman and Hart (1986), the background of the team production is crucial in determining the ownership solution chosen by the final good producer. Traditionally, this importance is embedded in $\eta$ which reflects the final good intensity of $H$’s input and supposed to be industry-specific. We broaden the scope here to explicitly consider the influence of the host-country characteristics over the ownership structure chosen, through the
level of contractibility $\mu$ they offer, which reflects the legal enforceability of contracts granted to foreign investors. If a country offers a poor contractual enforcement for foreign investors, the local partner would have a greater leeway not to follow what is specified in the contract, resulting in a lower share effective contractible activities $\mu$.

Here, the value of $\beta^*_h$ depends almost exclusively on these two parameters $\mu$ and $\eta$ (see 15). Considering the elasticity demand parameter $\alpha$ as fixed, the environment defined by the host country-sector is the only determinant of whether $\beta^*_h$ is high or low. But moreover, within each case, the background the firm evolves in also changes the value of the productivity thresholds, through shifting $Z_k$. This result is summarized in

**Proposition 2** A higher contractability $\mu$

(i) fosters increased foreign ownership, and
(ii) boosts the firm’s TFP leverage over ownership by lowering each productivity cutoffs.

The first one comes directly from $\frac{\partial \hat{\beta}^*_h}{\partial \mu} > 0$, and $\frac{\partial \beta^*_h}{\partial \mu} > 0$, meaning that a higher $\mu$ increases the probability to find $\beta^*_h$ closer to $\beta_J$ or even $\beta_H$ than to $\beta_O$. Even for the firms that will not proceed to full integration, their ownership share within JVs is increased with an higher $\mu$. The rationale for that is quite simple. The more contractible (and enforceable) are the tasks provided by $M$ the foreign supplier, the smaller the hold-up issue, because it can only underinvest on a smaller fraction of its inputs. Therefore, it becomes more interesting for $H$ to increase its revenue share - through an increased ownership share - as the threat of the supplier non cooperation reduces.

But more interestingly, the second part of Proposition 2 states the interaction between firm-level and host-country parameters, as stronger contractual environments increase the TFP leverage over foreign ownership. Indeed, we have $\frac{\partial^2 Z_k}{\partial \beta_{h,k} \partial \mu} > 0$ if $\beta_{h,k} < \beta^*_h$, and the reverse otherwise, implying that the slope $Z_J$ increase more than the one of $Z_O$ in $\mu$, with $Z_V$ increasing even more if $\beta^*_h$ is high. As a result, this boosts the TFP effect toward integration as all the productivity cutoffs decrease with a stronger legal environment in the host country. Then, the range of firms choosing international integration increases, as the requisite productivity decreases. To the contrary, where the contractibility is low, fewer firms will be able to enter the

---

\[12\] We won’t discuss here the obvious legal constraints to foreign ownership that some countries have enforced, since we are identifying the real economic arbitrage that make ownership structure change, even in absence of any restriction as JVs are observed in all countries but in different proportions.

\[13\] Proofs are in mathematical appendix A.3
market (only the most productive ones), and international joint-ventures will be more frequently used.

Therefore, there is a complementarity between firm-level characteristics and host countries ones in ownership choices, as a lack of TFP can be filled by an improvement in the contractual environment. However, the two are not pure substitute though, because $\mu$ also determines the value of $\beta^*_h$, the optimal revenue share recovered by $H$, when the TFP doesn’t interfere into it.

This host country side of the make or buy dilemma and its interplay with firm-level determinants have not been explicitly addressed in the existing literature, although they fit particularly well with the evidence repeatedly reported by related research. Notably our result explains why smaller and least productive firms opt more frequently for international JVs than the big multinationals do (Hollenstein 2005; Mutinelli and Piscitello 1998; Raff, Ryan, and Stähler 2006, 2009). But also, why joint ventures are more often chosen in “southern” destinations with weaker rule of law (Beamish 2012). This evidence is a priori puzzling, as we known that they are also the biggest and more productive firms that target southern countries in FDIs (Yeaple 2009). By allowing the integration strategy to be influenced by both firm-level and host country characteristics, our model allows to solve this puzzle.

6 Concluding remarks

We built a model of complex integration strategies in the line of the Antrás and Helpman (2008) framework. The GHM-like assumption of non contractible and relationship-specific inputs, rises the hold-up problem as ex-ante inefficiencies. Using Cai (2003) mechanism that gives both parties a disagreement payoff if the bargaining fails under a joint venture, shared ownership is shown not to be always sub-optimal anymore. To the contrary, we show it to be an optimal choice in two different cases: (i) For medium-productive firms where top productive firms would opt for full integration. (ii) As a dominant integration choice over full integration in country-sectors associations that make the local partner non-contractible inputs important enough. This second finding underlines the role of the host-country legal environment in the integration choice where the combination of three levels parameters (firm - industry - host country) is important in defining the optimal ownership structure.

Our model concludes that most productive firms can invest a wider range of host-countries,
and these firms should own more their foreign affiliates, at least in favorable country-sector associations, opting for full integration when least productive MNE would opt for joint ventures. Our predictions are actually comforted by most of empirical observations on the global distribution of joint ventures.

Overall, this model provides a clearer comprehension of the ownership choices of multinationals, when increasing research shows this choice to have potential welfare implications through the intensity of spillovers to the host-country. Specifically, joint ventures are reported to foster immediate local spillovers ([Iršová and Havránek, 2011 2013]). This calls for dedicated research in development economics exploiting firm heterogeneity, and considering the potential of middle productive investors.
References


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A Mathematical Appendices

A.1 Limits of $\beta_h^*$
Let us rewrite (15)

$$
\beta_h^* = \sqrt{\eta(1-\alpha\omega)} - \sqrt{\omega(1-\alpha\eta)}
$$

where $\omega = (1-\eta)(1-\mu)$ and represents the final good’s intensity in non contractible $M$’s activities. As $\eta$ and $\mu$, $\omega$ belongs to the $[0; 1]$ interval.

The root at the numerator being positive, the examination of the sign of $\beta_h^*$ results in examining the sign of the two differences $\eta - \omega$ and $\sqrt{\eta(1-\alpha\omega)} - \sqrt{\omega(1-\alpha\eta)}$. Focussing on the latter, we find

$$
\sqrt{\eta(1-\alpha\omega)} - \sqrt{\omega(1-\alpha\eta)} > 0 \Leftrightarrow \sqrt{\eta(1-\alpha\omega)} > \sqrt{\omega(1-\alpha\eta)}
$$

$$
\Rightarrow \eta(1-\alpha\omega) > \omega(1-\alpha\eta)
$$

$$
\Rightarrow \eta > \omega
$$

Such that the two differences are of the same sign, implying that $\beta_h^* > 0$.

We can also easily verify that $\beta_h^* < 1$. Indeed, this consists in showing that

$$
\frac{\eta(1-\alpha\omega)}{\eta - \omega} - \sqrt{\frac{\eta(1-\alpha\eta)(1-\alpha\omega)}{\eta - \omega}} < 1.
$$

First consider the case where $\eta > \omega$.

The previous inequality gives then $\eta(1-\alpha\omega) - \sqrt{\eta(1-\alpha\eta)(1-\alpha\omega)} < \eta - \omega$

Which can be rewritten as $\omega(1-\alpha\eta) < \sqrt{\omega(1-\alpha\eta)} \sqrt{\eta(1-\alpha\omega)}$, and eventually gives

$$
\sqrt{\omega(1-\alpha\eta)} < \sqrt{\eta(1-\alpha\omega)},
$$

which is always verified for $\eta > \omega$.

The symmetric result is found when assuming $\eta < \omega$. Therefore, we have $0 < \beta_h^* < 1$

A.2 Characterization of productivity cutoffs
Let $\theta_O$ be the productivity level for which the firm is indifferent between outsourcing or exit the market, that is, when $\pi_O = 0$, from $\pi_k = \Theta Z_k - F_k$ it gives

$$
\Theta_O = \frac{F_O}{Z_O}
$$

Let $\theta_J$ be the productivity level that ensures $\pi_J = \pi_O$, meaning $\theta_J Z_J - F_J = \theta_J Z_O - F_O$. This gives

$$
\Theta_J = \frac{F_J - F_O}{Z_J - Z_O}
$$

Similarly,

$$
\Theta_V = \frac{F_V - F_J}{Z_V - Z_J} \text{ iff } Z_V > Z_J
$$

For each integration solution to be possible for the firms, we need to set $\Theta_J > \Theta_O$, giving $Z_J < \frac{F_O}{Z_O} Z_O$, and (when $\Theta_V$ exists) $\Theta_V > \Theta_J$ which gives the following condition $Z_V < \frac{F_V - F_J}{F_J - F_O} (Z_J - Z_O) + Z_J$. 

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A.3 Proof of Proposition 2

A.3.1 Examination of $\frac{\partial \beta^*_h}{\partial \eta}$ and $\frac{\partial \beta^*_m}{\partial \mu}$

The exact value of $\frac{\partial \beta^*_h}{\partial \eta}$ cannot be determined, however, we can show its sign to be unambiguously positive. Keeping in mind that $\frac{\partial \beta^*_h}{\partial \mu} = \frac{\partial \beta^*_h}{\partial \omega} \frac{\partial \omega}{\partial \mu}$, and that the latter is obviously negative from $\omega = (1 - \eta)(1 - \mu)$, we seek to determine the sign of $\frac{\partial \beta^*_m}{\partial \omega}$.

Let us define $\beta^*_m = 1 - \beta^*_h$ the optimal revenue share that goes to $M$. From the previous result, we also have $0 < \beta^*_m < 1$.

From (15), we can express this share as $\beta^*_m = \frac{\omega(1 - \alpha \eta) - \sqrt{\eta \omega(1 - \alpha \eta)(1 - \alpha \omega)}}{\omega - \eta}$, such that

$$\beta^*_h - \beta^*_m = \frac{\sqrt{\eta(1 - \alpha \omega) - \sqrt{\omega(1 - \alpha \eta)}^2}}{\eta - \omega}$$

Since $\beta^*_m = 1 - \beta^*_h$, actually $\beta^*_h - \beta^*_m = 2\beta^*_h - 1$, which gives:

$$\beta^*_h = \frac{\sqrt{\eta(1 - \alpha \omega) - \sqrt{\omega(1 - \alpha \eta)}^2}}{2(\eta - \omega)} + \frac{1}{2}$$ (A.1)

With this expression, it is straightforward to see that $\beta^*_h > 0.5$ iif $\eta > \omega$, and the reverse otherwise. Eq. (A.1) also gives

$$2(\eta - \omega)\beta^*_h = (\eta - \omega)\left[\sqrt{\eta(1 - \alpha \omega) - \sqrt{\omega(1 - \alpha \eta)}^2}\right]^2$$ (A.2)

For ease of understanding, we use the notation $F' = \frac{\partial F}{\partial \omega}$. Next differentiate (A.2) to obtain

$$(2(\eta - \omega))'\beta^*_h = (\eta - \omega)'\beta^*_h + (\eta - \omega)'(1 - 2\beta^*_h)$$

Yet, by construction, we also have

$$2(\eta - \omega)\beta^*_h = (\eta - \omega)(1 - 2\beta^*_h)$$

From this two expressions and using $(\eta - \omega)' = -1$ and recalling that $(1 - 2\beta^*_h) = -(\beta^*_h - \beta^*_m)$, we find:

$$\beta^*_h = \frac{2\left[\sqrt{\eta(1 - \alpha \omega) - \sqrt{\omega(1 - \alpha \eta)}^2}\right]^2}{2(\eta - \omega)^2}$$

(A.3)

Now, we study whether $\beta^*_h < 0$. Under the assumption of $(\eta > \omega)$, it implies that

$$2(\eta > \omega)\left[\sqrt{\eta(1 - \alpha \omega) - \sqrt{\omega(1 - \alpha \eta)}^2}\right] < -\left[\sqrt{\eta(1 - \alpha \omega) - \sqrt{\omega(1 - \alpha \eta)}^2}\right]$$

Using expression of the derivative $2\left[\sqrt{\eta(1 - \alpha \omega) - \sqrt{\omega(1 - \alpha \eta)}^2}\right]' = \frac{-\alpha \eta}{\sqrt{\eta(1 - \alpha \omega)}} - \frac{1 - \alpha \eta}{\sqrt{\omega(1 - \alpha \eta)}}$, we obtain

$$\frac{\eta(1 - \alpha \eta) - (1 - \eta)\omega \alpha}{\eta(1 - \alpha \eta)} < \frac{\sqrt{\eta(1 - \alpha \omega)}}{\sqrt{\omega(1 - \alpha \eta)}}$$

The left-hand side of this inequation is clearly inferior to one, while the right-hand term is superior to one (as $\eta > \omega$ is assumed). Therefore we have $\beta^*_h < 0$. This result is also true when
η < ω, as the sign of the inequation changes.

Ultimately, we have: \( \frac{\partial \beta^*}{\partial \mu} = -(1-\eta) \frac{\partial \beta}{\partial \omega} > 0 \), showing that the optimal revenue share recovered by \( H \) increases in the contractual completeness of the host country.

At last, remember that within joint ventures, the optimal ownership share \( s^* \) is given by \( s^* = \frac{\beta^*}{\delta} - \frac{\beta(1-\delta)}{\delta} \), such that within JVs, we have \( \frac{\partial s^*}{\partial \mu} > 0 \). These two results confirm the first statement of proposition 2.

### A.3.2 Slope of profit curves and level of productivity cutoffs

**Examination of \( \frac{\partial Z_k}{\partial \mu} \)**

To prove the second part of Proposition 2, we first have to show that the slopes \( Z_k \) of the profit lines increase in \( \mu \). As the precise value of \( \frac{\partial Z_k}{\partial \mu} \) cannot be determined, we demonstrate that it is unambiguously positive. For this purpose first note that \( Z_k \) defined as in (21) is increasing in \( \mu \) if and only if

\[
Z = (1 - \beta_{h,k})^{\omega} \beta_{h,k} \left( \frac{1 - \alpha(\beta_{h,k}\eta + (1 - \beta_{h,k})\omega)}{1 - \alpha(\omega + \eta)} \right)^{1-\alpha(\omega+\eta)}
\]

is decreasing in \( \omega = (1 - \eta)(1 - \mu) \). Taking the logarithms of both sides and differentiating gives

\[
\frac{\partial \ln(Z)}{\partial \omega} = \alpha \ln(1 - \beta_{h,k}) - \alpha \ln \left( \frac{1 - \alpha(\beta_{h,k}\eta + (1 - \beta_{h,k})\omega)}{1 - \alpha(\omega + \eta)} \right) + \frac{\alpha(\beta_{h,k}(1 - \alpha\eta)) + (1 - \beta_{h,k})\alpha\eta}{1 - \alpha(\beta_{h,k}\eta + (1 - \beta_{h,k})\omega)}
\]

We therefore note that

\[
\frac{\partial^2 \ln(Z)}{\partial \omega^2} = -\frac{\alpha^2[1 - \alpha\beta_{h,k}\eta - (1 - \beta_{h,k}(1 - \alpha\eta)]^2}{(1 - \alpha(\beta_{h,k}\eta + (1 - \beta_{h,k})\omega))^2(1 - \alpha(\eta + \omega)) < 0}
\]

because \( 1 - (\alpha(\eta + \omega)) > 0 \) from \( \eta + \omega = 1 - \mu + \eta \mu < 1 \).

Let us define \( g(\eta) = \frac{\partial \ln(Z)}{\partial \omega} \big|_{\omega=0} \)

From the previous statement, we have \( \frac{\partial \ln(Z)}{\partial \omega} < g(\eta) \) Such that if \( g(\eta) \) is strictly negative, it would imply \( \frac{\partial Z_k}{\partial \omega} < 0 \) because \( \frac{\partial Z_k}{\partial \mu} \) is of the same sign as \( \frac{\partial \ln(Z)}{\partial \omega} \).

For this purpose, first let’s state that \( g(0) = \alpha(\ln(1 - \beta_{h,k}) + \beta_{h,k}) < 0 \), because \( 0 < \beta_{h,k} < 1 \). Then, examine the derivative

\[
g'(\eta) = \frac{-\alpha^2(1 - \beta_{h,k})(\beta_{h,k} + \alpha\eta - 2\beta_{h,k}\alpha\eta)}{(1 - \beta_{h,k}\alpha\eta)^2(1 - \alpha\eta)} < 0
\]

Therefore, \( g(\eta) \) is always negative.

We can summarize the findings as

\[
\frac{\partial \ln(Z)}{\partial \omega} < g(\eta) < 0
\]

We therefore have proved that \( Z_k \) is decreasing in \( \omega = (1 - \eta)(1 - \mu) \). Note that the only channel through which \( \mu \) affects \( Z_k \) is through \( \omega \). Hence, \( Z_k \) is increasing in \( \mu \).
Examination of $\frac{\partial^2 Z_k}{\partial \beta_{h,k} \partial \mu}$

The result of first partial derivative $\frac{\partial Z_k}{\partial \beta_{h,k}}$ is similar to what done with eq. (14) to find $\beta^*_h$, and gives an expression proportional to the polynomial

$$(\eta - \omega)\beta^2_{h,k} - 2\eta(1 - \alpha \omega)\beta_{h,k} + \eta(1 - \alpha \omega)$$

where $\omega = (1 - \eta)(1 - \mu)$

Now we derive (A.4) with respect to $\omega$, which gives

$$-\beta^2_{h,k} + \alpha \eta (\alpha \beta_{h,k} - 1) < 0$$

we deduce that $\frac{\partial^2 Z_k}{\partial \beta_{h,k} \partial \mu} > 0$, which directly implies:

$$\left. \frac{\partial Z}{\partial \mu} \right|_{\beta_{h,k} = \beta_J} > \left. \frac{\partial Z}{\partial \mu} \right|_{\beta_{h,k} = \beta_O} \forall \beta^*_h \in [0; 1],$$

and

$$\left. \frac{\partial Z}{\partial \mu} \right|_{\beta_{h,k} = \beta_V} > \left. \frac{\partial Z}{\partial \mu} \right|_{\beta_{h,k} = \beta_J} \text{ if } \beta^*_h \text{ is high}$$

Thus, an increase in the contractibility $\mu$ increases more the profits of the highest integration forms, because the steeper slopes increase much than the other.

**Productivity cutoffs**

How the productivity cutoffs vary with $\mu$ is given by $\frac{\partial \theta_k}{\partial \mu}$. Using the result above and denoting $Z'k \equiv \frac{\partial Z_k}{\partial \mu}$, we find

$$\frac{\partial \theta_O}{\partial \mu} = \frac{-Z'_O F_O}{Z_O} < 0,$$

$$\frac{\partial \theta_J}{\partial \mu} = \frac{-(F_J - F_O)(Z'_J - Z'_O)}{(Z_J - Z_O)^2} < 0,$$

and

$$\frac{\partial \theta_V}{\partial \mu} = \frac{-(F_V - F_J)(Z'_V - Z'_J)}{(Z_V - Z_J)^2} < 0 \text{ if } Z_V > Z_J$$

Thus, each cutoff decreases in $\mu$, which should reduce the minimal and the average productivity of firms engaged in each integration level. Therefore, the TFP leverage over integration is strengthened.

Moreover, we note that, under the conditions $Z'_J > Z'_O \left( \frac{Z'_J}{Z_O} \right)$ and $(Z'_V - Z'_J) > (Z'_J - Z'_O) \left( \frac{Z'_V - Z'_J}{Z_J - Z_O} \right)$ (if $\beta^*_h$ is high) the higher cutoffs reduce more than the lower ones. In such cases, an increase in $\mu$ fosters clearly integration of the most productive firms, more than for least productive ones. Yet, this is not essential for Proposition 2 to hold.
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