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# Multinational firms' organisational dynamics\*

*Competition intensity and the ownership decision under uncertainty.*

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## Abstract

I analyse firms organisational choices when they face uncertainty about institutional conditions in foreign locations with heterogeneous final good producers and incomplete contracts. As firms learn about the conditions abroad, the increasing offshoring activity increases competition in the final goods market, leading to a progressive vertical disintegration of the supply chains. Initially, the firms that decide to explore offshoring potential choose integration. As competition in final good markets intensifies, the least productive ones among them switch sequentially to arm's length trade. In the fully domestic supply chains, the increasing competition promotes a sequential disintegration of the domestic intermediate input suppliers. I test for the predictions of the model using sectoral-level data for the US manufacturing sectors.

*Keywords:* Firm theory, multinational firms, incomplete contracts, global sourcing, uncertainty, sequential offshoring, information externalities, learning, competition, outsourcing, forward and backward integration, FDI.

*JEL:* D21, D23, D81, D83, F14, F21, F23, L22

## 1 Introduction

The growing role of multinational firms in the organisation of global trade has aroused the attention of many scholars. A growing share of the literature on global sourcing has focused the attention on the

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determinants of firms' organisational choices under incomplete contracts<sup>1</sup>, with a particular emphasis on the role of institutions in the organisation of the supply chains.

A common feature of the sourcing decisions in a global context is that firms often face uncertainty about the prevailing institutional conditions in foreign countries. It may rise in diverse contexts, and it may be related to different aspects of the institutional framework<sup>2</sup>. The lack of previous experience of firms in foreign countries may be a common situation where the institutional uncertainty emerges. A second possible situation may arise after the implementation of a deep institutional reform by foreign governments, when the firms do not fully believe in the scope of the reforms. In such a context, the firms face uncertainty about the new institutional regime in place.

The model concentrates in the case of uncertainty in the general institutional conditions in foreign locations, modelled as uncertain per-period fixed organisational costs of offshoring operations<sup>3</sup>. Up to my knowledge, the consequences of this type of uncertainty on firms' sourcing decisions have not been addressed by the literature on global sourcing, with the exception of Larch and Navarro (2021)<sup>4</sup>. The main difference with respect to the latter is that I focus the attention on the dynamics of the ownership structure, i.e. of the allocation of property rights, and thus I simplify the implications in the location dimension of the sourcing decisions. In this sense, the model complements Larch and Navarro (2021).

The model shows a sequential offshoring equilibrium path led by the most productive final good producers, *pari passu* an increasing intensity in the competition in the final goods market. The model shows that the latter is a direct effect of the endogenous increase in the offshoring activity in intermediate inputs that comes from the sequential offshoring equilibrium path.

In terms of the dynamic allocation of property rights, the model shows the following main dynamic predictions. The increasing competition generates two different simultaneous paths of vertical disintegration<sup>5</sup>. The domestically integrated final good producers experience a monotonic sequential vertical disintegration, shifting the organisation of the supply chain towards domestic independent suppliers (*domestic outsourcing*). On the other hand, a subset of the offshoring final good producers reorganise

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<sup>1</sup>See Grossman and Helpman (2002, 2004, 2005); Antràs (2003); Antràs and Helpman (2004, 2008); Antràs (2015).

<sup>2</sup>For instance, firms have a vague knowledge about the general institutional conditions in locations where they have never been active before. This situation may be represented by an uncertain knowledge of the firms about the organisational fixed costs of overseas operations with respect to those foreign locations. On the other hand, the uncertainty may instead be related to more specific aspects of the institutional framework, such as the quality of the foreign court system. The latter may have a direct impact in the perceptions of the degree of enforceability of the contracts, and thus in the optimal allocation of property rights.

<sup>3</sup>The case of uncertainty in the quality of contractual institutions will be covered in a future version of the model.

<sup>4</sup>There is a small literature that studies uncertainty in global sourcing decisions, which I summarise below. The closest reference in the global sourcing literature is the model in Larch and Navarro (2021). It characterises the location choices in a world with multiple countries under complete contracts. Nevertheless, it focuses on the effects of uncertainty in the location dimension of the sourcing decisions, and thus in the impact on the sectoral specialisation of countries.

<sup>5</sup>The increasing competition also induces the least productive final good producers to sequentially leave the market.

sequentially their supply chains from foreign integration towards arm's length trade (*foreign outsourcing*)<sup>6</sup>. The theoretical predictions of the model are consistent with the empirical disintegration trends in the global economy identified by Feenstra (1998).

I introduce first a model with two countries (North-South) and  $J + 1$  sectors: a perfectly competitive homogeneous sector ( $j = 0$ ) and  $J$  differentiated sectors with monopolistic competition. Each of the differentiated sectors have a continuum of heterogeneous final good producers. The production of the varieties in the differentiated industries requires of the investment in relation-specific assets to produce two inputs:  $x_{h,j}$  and  $x_{m,j}$ . The first refers to services provided by the final good producer  $H$  such as design, marketing and assembly of the final good<sup>7</sup>, while the second indicates the intermediate inputs supplied by a manufacturer  $M$ .

I assume that the know-how for the production of the services  $x_{h,j}$  is possessed only by northern final good producers<sup>8</sup>. However, they can decide to contract with northern or southern manufacturers for the supply of the intermediate inputs. Furthermore, they are able to decide the optimal ownership structure by offering a contract to manufacturer  $M$ , which defines the allocation of residual rights. In sum, the final good producer's organisational decision comprehends the location of  $M$  and the optimal allocation of property rights (Antràs, 2003; Antràs and Helpman, 2004, 2008). I assume further that the final good producers face ex-ante perfectly elastic supply of manufacturers in both locations<sup>9</sup>. Ex-post, however, the parties are locked into a bilateral exchange. Due to incomplete contracts, they are subject to opportunistic behaviour and thence hold up in their respective investment decisions (Williamson, 1971, 1979).

The model takes roots in two branches of the literature. First, in the literature on global sourcing, and in particular in the models developed by Grossman and Helpman (2002, 2005); Antràs (2003); Antràs and Helpman (2004, 2008). The model contributes at the same time to this literature by analysing how institutional uncertainty affects the firms' organisational choices, and thus the respective sectoral structure, from both a static and a dynamic perspective.

After an institutional reform is introduced in a foreign country, the final good producers face a prior uncertainty about the new institutional regime. However, they are able to progressively reduce progres-

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<sup>6</sup>The foreign integration (FDI) productivity cutoff shows a non-monotonic behaviour over time. It decreases in early periods of the offshoring sequence, as the leading producers choose FDI. The FDI productivity cutoff increases in later periods, when the more intensive competition in the final good markets induces a sequential disintegration of the least productive producers under foreign integration.

<sup>7</sup>The assembly could be provided instead by supplier, while the final good producer focuses on the services of design and marketing. See Feenstra (1998) for the cases of Mattel and Nike, and Gereffi et al. (2005) for apparel industry.

<sup>8</sup>In other words, I assume that the northern firms have a high enough comparative advantage in the design and marketing of the final goods, such that those services are always produced in North (Antràs and Helpman, 2004).

<sup>9</sup>The participation constraints bind due to the ex-ante competitive structure among suppliers and the lump-sum transfer.

sively the prior uncertainty by observing at any period  $t$  the behaviour of the other already offshoring final good producers (informational externalities). In such a context, the final good producers that are not offshoring face a trade-off. They can delay the exploration of their offshoring potential (i.e. wait) and receive new information that reduces the risk of the decision. But they can do it at the cost of realising lower profits (in expected terms), by sourcing domestically during the waiting period. I characterise the sectoral equilibrium path as a Markov decision process, in which the final good producers update their prior uncertainty through a Bayesian learning mechanism<sup>10</sup>.

As already mentioned, the model shows that the higher intensity in the competition in the final goods market, which arise due to the increasing share of offshoring final good producers, induces a sequential vertical disintegration towards a sectoral structure with more outsourcing. Grossman and Helpman (2002) has shown, in a static approach, the effect that a stronger competition has on the make-or-buy decision. They analysed how an exogenous increase in the elasticity of substitution, which derives in a stronger competition in the final goods market, may induce more outsourcing (less integration). From a dynamic perspective, instead, I show that disintegration is a consequence of an endogenous increase in the competition intensity due to the more extensive offshoring activity, while the consumers' preferences, and thus the elasticity of substitution, remain constant.

From a dynamic approach, Antràs (2005) characterises an organisational equilibrium path of a differentiated sector in a context of a Vernon's product cycle. The author defines an exogenously given law of motion of the technology and characterises the resulting equilibrium path of the sectoral organisational structure. As the technology becomes more standardised, the final good producers start offshoring production in low wage countries. At first under integration (FDI), and at a later stage of standardisation through arm's length trade. Instead, I consider the technology as given. Therefore, both models can be taken as complementary mechanisms for sectoral dynamics characterised by an initial offshoring phase of FDI followed by a progressive vertical disintegration over time. While Antràs (2005) centers the attention in the progressive standardisation of the technology, my paper focuses instead on the determinants that come from the competition intensity in the final goods market under uncertainty.

In regard to the literature of uncertainty in global sourcing decisions, the main difference is that it focuses on how the exposure of firms to exogenous shocks (in the demand or the supply side) affect the sourcing decisions, but assuming a perfect knowledge of the stochastic nature of the world (Carballo, 2016; Kohler et al., 2018). I model, instead, a situation in which firms are able to reduce the uncertainty

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<sup>10</sup>The closest literature to my approach are Rob (1991); Segura-Cayuela and Vilarrubia (2008); Larch and Navarro (2021), and the general literature on recursive methods and stochastic decisions (Stokey and Lucas, 1989; DeGroot, 2005).

progressively by exploiting informational externalities derived from other firms' behaviour.<sup>11</sup>

Firm theory is a second branch of the literature from which this model draws, in particular the property rights approach. The closest references are Grossman and Hart (1986); Hart and Moore (1990, 1999) and Grossman and Helpman (2002). However, the model also incorporates elements that can be traced back or linked to the transaction costs literature (Coase, 1937; Williamson, 1979, 1985) and the evolutionary theory of the firm (Nelson and Winter, 1982, 2002; Nelson, 1995; Dosi et al., 2000; Teece, 2009).

The characterisation of the firm is mainly based on the Grossman and Hart (1986)'s version developed by Antràs (2003) and Antràs and Helpman (2004). The main departure from the last two comes from the expansion of the decision space of the final good producers, which allows for a more flexible allocation of property rights. Furthermore, I trace some elements in the firm characterisation that can be related to the evolutionary theory of the firm. In particular, I identify the presence of tacit knowledge and idiosyncratic routines as determinants of the efficiency with which each party can produce their respective inputs with a given level of investments in relationship-specific assets. Therefore, I show how the relevance of those routines and tacit knowledge affects the integration vs. outsourcing decisions.

The model shows that different ownership structures result in different distortions in the ex-ante investments. The optimal allocation is defined as the one that minimises the distortions in the ex-ante investments. Therefore, the residual rights should be allocated on the party that contributes more to the relationship. Following Grossman and Hart (1986) and Hart and Moore (1990), in addition to outsourcing in an independent supplier, I allow for integration in either of the two directions, i.e. final-good producer's control (*backward integration*) and supplier's control (*forward integration*)<sup>12</sup>.

Additionally, I assume that integration imposes additional costs that come from the management of a more complex structure of a larger and more diversified organisation (Grossman and Helpman, 2002). In terms of the transaction costs approach, these costs can be identified as managerial or governance costs associated to the integration of the two independent parties into a hierarchical structure within the firm boundaries (Coase, 1937; Williamson, 1979, 1985). I model these additional costs from integration as a higher per-period fixed organisational cost relative to outsourcing. In other words, the organisational fixed costs of outsourcing in one location cannot be larger than the organisational fixed costs of any integration type in that same location.

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<sup>11</sup>There is a more extensive literature of uncertainty in trade, in particular in export decisions, with the characterisation of learning mechanisms available to the firms (Rob and Vettas, 2003; Segura-Cayuela and Vilarrubia, 2008; Alborno et al., 2012; Nguyen, 2012; Aeberhardt et al., 2014; Araujo et al., 2016).

<sup>12</sup>These organisational types generate a sectoral classification of three types of industries: i) H-intensive sectors, ii) M-intensive sectors; iii) Balanced-intensity sectors.

Therefore, the final good producers face a trade off between minimising the hold up by allocating the residual rights on the party that contributes more to the relationship, and the higher managerial costs of running a larger and more complex organisation<sup>13</sup>. Figure 1 illustrate the discrete set of possible alternative organisational types considering both, the ownership and the location dimensions:

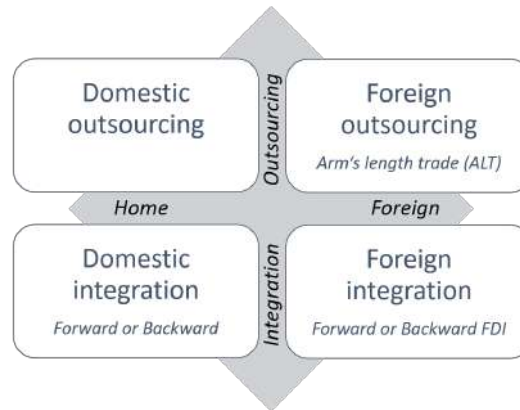


Figure 1: Organisational types

Nevertheless, I show that the characterisation of the equilibrium paths and the results of the model are robust to the specification in Antràs and Helpman (2004), where only outsourcing and forward integration types are considered.

In section 3.3, I develop a novel measure for the tacit knowledge and routines, and test for the characterisation of the organisational choices under perfect information predicted by the respective theoretical model. I use sectoral-level data of the US manufacturing sectors<sup>14</sup>. For the identification of the determinants of the sectoral component-intensity empirical model, I build on Yeaple (2006); Nunn (2007); Nunn and Trefler (2013) and Antràs (2015). As robustness, I build a synthetic measure of the component-intensity of the sectors by two alternative approaches: Factor Analysis (FA) and Principal Component Analysis (PCA), and reduce the multidimensionality of the previous models to a unique index.

I extend the theoretical model to multiple countries in section 6. The extension shows that an institutional reform in one country with lower marginal costs in the production of the intermediate inputs (e.g. East) triggers a sequential exploration of the offshoring potential towards that country. The exploration involves also the potential relocation of suppliers of final good producers that are already offshoring from other countries (e.g. South) to eastern suppliers. The lower marginal costs in the new location pushes the sectoral price index further down, which boosts the increase in the intensity in the competition in the final goods markets. Therefore, together with the sequential offshoring characterised in the two-country model, the relocation of supply chains towards new locations with lower marginal costs induce a further

<sup>13</sup>This trade-off is similar to the situation characterised by Grossman and Helpman (2002) and Antràs and Helpman (2004).

<sup>14</sup>For description of the different data sources, see section 3.3.

disintegration of the supply chains.

In section 7, I consider the role of free trade agreements (FTA). This extension complements the literature on trade liberalization and global sourcing (Ornelas and Turner, 2008, 2012; Ornelas et al., 2020), and identifies an additional role that tariffs reduction in intermediate inputs may have on the global sourcing decisions, when firms have uncertainty about the institutional conditions in the foreign partner countries.

If the prior beliefs about the institutional conditions in the partner country are strongly pessimistic, it may happen that no final good producer find it attractive to explore the offshoring potential in that location previous to the agreement. Therefore, the sector shows a suboptimal organisation of the supply chains in terms of location and property rights allocations, with the respective negative welfare consequences. However, when the FTA produces a small but sufficiently large reduction in the tariffs for intermediate inputs, it may create enough incentives to induce a sequential offshoring exploration of that country by at least the most productive final good producer in the differentiated sectors. Therefore, the small changes in the tariffs can potentially induce a sectoral reorganisation that extends beyond the expected changes that arise from an approach that accounts only for the tariffs changes and ignores the presence of institutional uncertainty and informational spillovers.

In section 8, using the US manufacturing sectoral data, I test for the consistency of the empirical sectoral dynamics with the theoretical predictions of the dynamic model with uncertainty. In particular, I focus on the disintegration effects of sequential offshoring and relocations of suppliers towards locations with lower marginal costs.

The paper is organised as follows. Section 2 defines the setup of the model. Section 3 characterises the sectoral classification and the perfect information equilibrium for each case. In 3.3, I test for the main predictions of the sectoral organisational structure under perfect information. Section 4 introduces uncertainty in the organisational fixed costs in the South, defines the learning mechanism and the firms' decision. Section 5 follows by characterising the dynamic equilibrium paths for each type of sector. Section 6 extends the model to multiple countries, and shows the reallocation dynamics after an institutional reform in East. In section 7, I introduce tariffs for the intermediate inputs and analyse the effects of a FTA. Using sectoral-level data of the US manufacturing sectors, I test the main predictions of the dynamic model in section 8.



## 2 The two-country model: North-South

The model consists of a world economy with two countries, North ( $N$ ) and South ( $S$ ), and a unique factor of production, labour ( $\ell$ ). The preferences are represented by equation (1), where  $q_{0,t}$  is the per period consumption of a homogeneous good in period  $t$ , and  $Q_{j,t}$  is the per period aggregate consumption index in the differentiated sector  $j$ .

$$U_t = \gamma_0 \ln q_{0,t} + \sum_{j=1}^J \ln Q_{j,t} \quad , \quad \sum_{j=0}^J \gamma_j = 1 \quad (1)$$

For the moment, I assume that all the goods are tradable in the world market, there are no transport costs nor trade barriers, and consumers have identical preferences across countries.

The per-period aggregate consumption in the differentiated sector  $j$  is defined as:

$$Q_{j,t} = \left[ \int_{i \in I_{j,t}} q_{j,t}(i)^{\alpha_j} di \right]^{1/\alpha_j} \quad , \quad 0 < \alpha_j < 1 \quad (2)$$

which consists of the aggregation of the consumed varieties  $q_{j,t}(i)$  on the range of varieties  $i$  of sector  $j$  in period  $t$ . The elasticity of substitution between any two varieties in sector  $j$  is  $\sigma_j = 1/(1 - \alpha_j)$ .

The inverse demand function for variety  $i$  of sector  $j$  in  $t$  is given by (3), where  $E$  denotes the per period total (world) expenditure<sup>15</sup>.

$$p_{j,t}(i) = \gamma_j E Q_{j,t}^{-\alpha_j} q_{j,t}(i)^{\alpha_j - 1} \quad (3)$$

and the sectoral price index in  $t$  is defined as:

$$P_{j,t} \equiv \left[ \int_{i \in I_{j,t}} p_{j,t}(i)^{1-\sigma_j} di \right]^{\frac{1}{1-\sigma_j}} \quad (4)$$

The final good varieties in differentiated sectors  $j = 1, \dots, J$  are produced with a Cobb-Douglas technology given by:

$$q_j(i) = \theta \left( \frac{x_{h,j}(i)}{\eta_j} \right)^{\eta_j} \left( \frac{x_{m,j}(i)}{1 - \eta_j} \right)^{1-\eta_j} \quad (5)$$

where  $\eta_j \in (0, 1)$  is a technology parameter, which measures the  $H$ -services intensity of the sector  $j$ , and the parameter  $\theta$  represents the productivity level of the final good producer.

The quantity of services supplied by the final good producer  $H$  is denoted by  $x_{h,j}$ , while  $x_{m,j}$  in-

<sup>15</sup>See Appendix A.1 for the derivation of the demand functions.

indicates the quantity of intermediate inputs provided by the supplier  $M$ . The parties produce these inputs after investing in the relationship-specific assets  $h_j(i), m_j(i)$ , respectively, that fully depreciate in one period. The investments in the relationship specific assets require the use of labour. The production technology of the intermediate inputs have constant returns and are given by  $x_{h,j}(i) = h_j(i)$  and  $x_{m,j}(i) = m_j(i)$ .

I assume that the final good producers are located only in the North, and thus the services  $x_{h,j}$  can be produced only by northern producers (Antràs and Helpman, 2004). The final good producers can decide to contract with northern or southern manufacturers  $M$  for the supply of the intermediate inputs. I assume that final good producers face *ex-ante* a perfectly elastic supply of manufacturers in all the locations. When the final good producer decides to contract with a southern supplier, she must pay an offshoring sunk cost  $s_j^r$  in northern labour units. This sunk cost represents a market research cost in order to analyse the feasibility of the organisation of the supply chain in the South, and the analysis of the optimal organisational structure.

Moreover, each organisational type has an associated per-period organisational fixed cost denoted by  $f_{k,j}^l$ , with  $l = N, S$  indicating the location of the intermediate input supplier and  $k = O, V_H, V_M$  referring to the type of allocation of property rights<sup>16</sup>. The per-period organisational cost is defined in northern units of labour in all the cases.

The homogenous sector has a constant returns to scale technology given by  $q_0 = A_{0,l}\ell_0$ , where  $A_{0,l} > 0$  refers to the productivity parameter in country  $l$ . I assume that the productivity of northern workers in the homogeneous good sector is higher than southern workers, i.e.  $A_{0,S} < A_{0,N}$ . Therefore,  $w^N > w^S$ . Furthermore, I assume that  $\gamma_0$  is large enough such that the homogeneous good is produced in every country.

**Entry cost and productivity draw.** Final good producers enter the market according to a Melitz (2003)'s type mechanism. After the payment of a market entry sunk cost  $s_j^e$  in northern units of labour, i.e.  $w^N s_j^e$ , the final good producer discovers her productivity level  $\theta$ . The productivity is drawn from a c.d.f. distribution  $G_j(\theta)$ .

### 3 Perfect information equilibrium

If the final good producer decides to remain active in the market after entry, she must choose among the organisational types illustrated in Figure 1. After the choice of an organisational form, she offers

<sup>16</sup> $O, V_H, V_M$  refer to outsourcing, backward integration and forward integration, respectively.

a contract to potential suppliers, which defines the location of the supplier, the chosen organisational structure and an upfront payment. The suppliers apply to the contract and the final good producer chooses one among the candidates.

Both parties in the relationship decide simultaneously their respective investment levels in the specific assets that are used in the production of the inputs  $x_{h,j}(i), x_{m,j}(i)$ . The output is produced and sold. The revenues distribute according to a Nash bargaining.

Figure 2 shows a simplified sequence of the timing of events. From now on, I focus the analysis in one differentiated sector, there for simplicity in the notation I drop the subscript  $j$ .

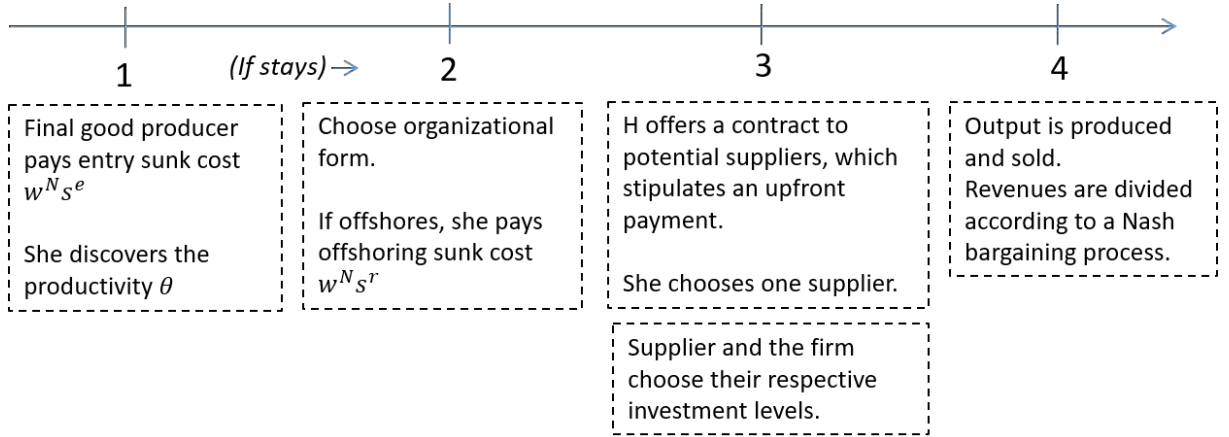


Figure 2: Timing of events

### 3.1 Organisational choice: backward induction solution.

The final good producer's problem must be solved by backward induction, starting from the Nash bargaining stage. For simplicity in the notation under perfect information, I drop momentarily the time index, and I reintroduce it back in the dynamic model with uncertainty.

#### 3.1.1 Nash bargaining.

Let's define  $\beta$  as the bargaining power of the final good producer in the asymmetric Nash bargaining. I denote the location of the intermediate input supplier as  $l = N, S$ . The parties bargain on the revenues given by:

$$r(i) = p(i)q(i) \Rightarrow r(i) = \gamma EQ^{-\alpha} \theta^\alpha \left[ \left( \frac{x_h(i)}{\eta} \right)^\eta \left( \frac{x_m(i)}{1-\eta} \right)^{1-\eta} \right]$$

**Outsourcing (O).** Both parties remain as independent specialised firms. Therefore, they keep the control over their respective assets and the inputs' output obtained from their use. If they do not reach an agreement, they receive their respective outside options,  $\omega_h = \omega_m = 0$ . Instead, if they agree, the

final good variety is produced and the revenues divided according to the Nash bargaining equilibrium. The final good producer  $H$  realises revenues given by  $\beta r(i)$ , where the revenue share of outsourcing in location  $l$  is denoted as  $\beta_O^l = \beta$ . The supplier  $M$ , on the other hand, receives  $(1 - \beta)r(i)$ .<sup>17</sup>

**Backward integration ( $V_H$ ).** The final good producer has the control over both types of assets, and thus she is the only claimant of the residual rights. If the final good producer and the manager of the integrated supplier  $M$  fail to reach an agreement, they both receive their respective outside options. The outside option of the manager of  $M$  is still  $\omega_m = 0$ . The final good producer can instead fire the manager and seize the manufacturing facilities. Thus,  $H$  can use the assets at the supplier's location to produce the intermediate inputs without the manager's cooperation.

Under the non-cooperative outcome,  $H$  faces an efficiency loss in the production of the intermediate inputs, which is represented by  $\tilde{x}_m(i) = (1 - \delta_{V_H}^l)m(i)$  with  $\delta_{V_H}^l \in (0, 1)$ . Equivalently,  $\tilde{x}_m(i) = (1 - \delta_{V_H}^l)x_m(i)$ , with  $x_m(i)$  denoting the ex-post efficient level of production of the intermediate input that would have been produced by the original manager of  $M$ , given the investment level  $m(i)$  in the relationship-specific assets.

The efficiency loss can be motivated from the evolutionary theory of the firm (Nelson and Winter, 1982, 2002; Nelson, 1995; Dosi et al., 2000; Teece, 2009). This literature identifies the presence of the non-codifiable knowledge and routines as key determinants of firm's (in this case supplier's) productivity. When  $H$  fires the manager of the manufacturing facilities, she may involuntarily induce a disruption or perturbation on the routines and the tacit knowledge in the supplier's organisation. In consequence,  $H$  faces a negative impact on the efficiency of the manufacturing process of the intermediate input, for a given level of investment  $m(i)$  in specific-assets. On the other hand, given the firm-specific nature of the routines and tacit knowledge, the manager of  $M$  cannot use it when he finds a new position at another firm, hence his outside option is still zero.

Thus, the quantity produced of the final good variety is given by  $(\delta_{V_H}^l)^{1-\eta}q(i)$ , and the total revenue is  $(\delta_{V_H}^l)^{\alpha(1-\eta)}r(i)$ . The outside option of the final good producer is now given by  $\omega_h = (\delta_{V_H}^l)^{\alpha(1-\eta)}r(i)$ , where  $q(i)$  and  $r(i)$  denote the total output and total revenues realised if the final good producer does not fire the manager of  $M$  and the parties reach an agreement.<sup>18</sup>

<sup>17</sup>For solution of the bargaining stage, see Appendix A.2.

<sup>18</sup>The efficiency loss can easily include a general loss in the production of both inputs as in Antràs and Helpman (2004), together with a specific additional loss in the seized input. The first loss may be related to the higher complexity involved in the management of both facilities by  $H$ , while the second loss relates to the destruction of tacit knowledge and routines in supplier's location. In such a case, the production of the variety would be given by  $(\delta^l + (\delta_{m,V_H}^l)^{1-\eta})q(i)$ , where  $(1 - \delta^l)$  refers to the general loss and  $(1 - \delta_{m,V_H}^l)$  refers to the input  $m$  specific dimension. Therefore, in terms of revenues:  $(\delta^l + (\delta_{m,V_H}^l)^{1-\eta})^\alpha r(i)$ .

Instead, if parties cooperate, the Nash bargaining equilibrium defines a distribution of the revenues:

$$\begin{cases} \text{Final good producer:} & \beta_{V_H}^l r(i) = (\delta_{V_H}^l)^{\alpha(1-\eta)} r(i) + \beta[1 - (\delta_{V_H}^l)^{\alpha(1-\eta)}] r(i) \\ \text{Supplier:} & (1 - \beta_{V_H}^l) r(i) = (1 - \beta)[1 - (\delta_{V_H}^l)^{\alpha(1-\eta)}] r(i) \end{cases}$$

where  $\beta_{V_H}^l$  denotes the revenue's share of the final good producer under backward integration and a supplier  $M$  located in  $l$ <sup>19</sup>. Figure 3 shows  $\beta_{V_H}^l$  as a function of  $\eta$  and  $\delta_{V_H}^l$ .

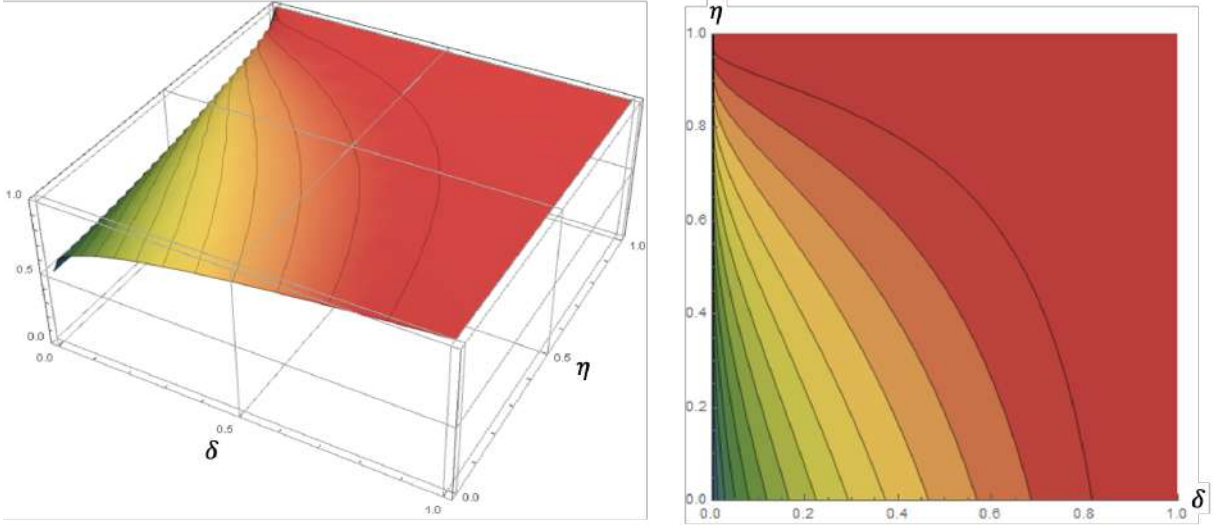


Figure 3: H's revenues share - backward integration,  $\beta_{V_H}^l(\eta, \delta_{V_H}^l)$ . [ $\beta = 0.5$ ,  $\alpha = 0.4$ ]

**Forward integration ( $V_M$ ).** The manufacturer  $M$  has the control over all the assets. The outside option of the manager of the integrated final good producer is now  $\omega_h = 0$ . The manufacturer, on the other hand, can fire the manager of  $H$  after the investment in specific assets and seized the northern facilities.  $M$  can thus take control of the production of the final good production services and of the final good variety.

However, the manufacturer faces an efficiency loss represented by  $\tilde{x}_h(i) = (1 - \delta_{V_M}^l)h(i) = (1 - \delta_{V_M}^l)x_h(i)$ . As before, this lower efficiency comes from the disruption on the routines of the final good production facilities due to the loss of the manager of  $H$ . Thus, the revenue realised by  $M$  is  $(\delta_{V_M}^l)^{\alpha\eta}r(i)$ , which defines his outside option  $\omega_m$  under forward integration. As before, given the firm-specific nature of the routines and tacit knowledge, the manager of  $H$  has an outside option equal to zero.

If instead the parties agree, the Nash bargaining equilibrium defines a distribution of revenues given

<sup>19</sup>The revenues obtained by the supplier are equivalent to the contractible (negative) upfront payment that the final good producer establishes in the contract. Thus, no rents are left to the supplier and  $M$ 's participation constraint binds.

by:

$$\begin{cases} \text{Final good producer:} & \beta_{V_M}^l r(i) = \beta[1 - (\delta_{V_M}^l)^{\alpha\eta}]r(i) \\ \text{Supplier:} & (1 - \beta_{V_M}^l)r(i) = (\delta_{V_M}^l)^{\alpha\eta}r(i) + (1 - \beta)[1 - (\delta_{V_M}^l)^{\alpha\eta}]r(i) \end{cases}$$

where  $\beta_{V_M}^l$  denotes the revenue's share of the final good producer under forward integration with a supplier located in  $l$ <sup>20</sup>. Figure 4 shows  $\beta_{V_M}^l$  as a function of  $\eta$  and  $\delta_{V_M}^l$ .

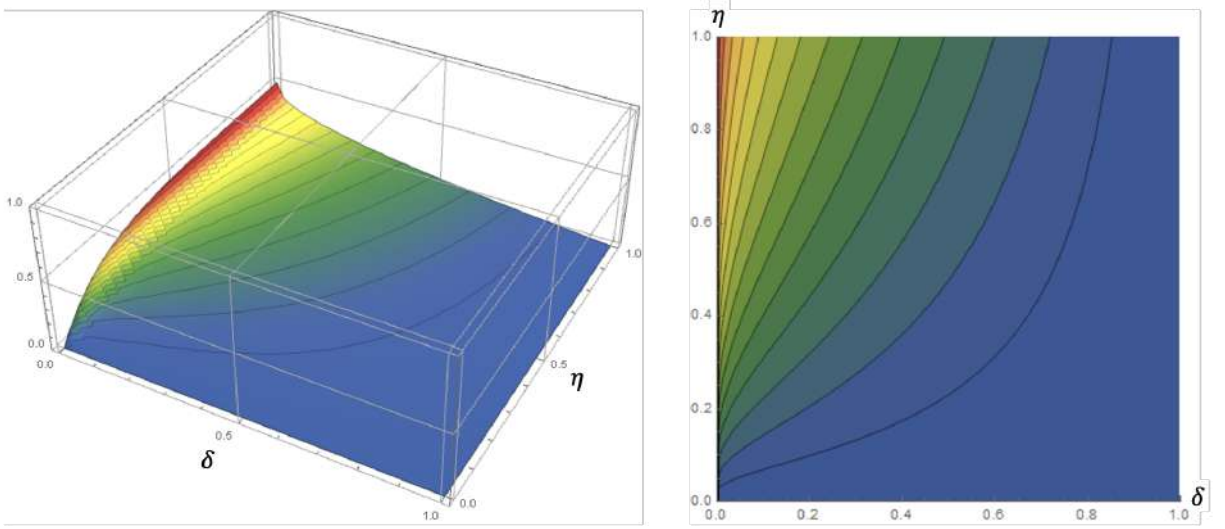


Figure 4: H's revenues share - forward integration,  $\beta_{V_M}^l(\eta, \delta_{V_M}^l)$ . [ $\beta = 0.5, \alpha = 0.4$ ]

**Assumption A. 1.**  $\delta_{V_H}^N \geq \delta_{V_H}^S > 0$  and  $\delta_{V_M}^N \geq \delta_{V_M}^S > 0$ .

The assumption A.1 states that the efficiency losses are larger in the case of multinational operations. This may reflect the presence of technological and/or cultural frictions related to the management or monitoring of overseas operations, compared to fully domestic supply chains. Therefore, the revenue shares of the final good producer under each organisational type are:

$$\beta_{V_H}^N \geq \beta_{V_H}^S > \beta_O^N = \beta_O^S = \beta > \beta_{V_M}^S \geq \beta_{V_M}^N \quad (6)$$

### 3.1.2 Investment decisions and input provision.

Both parties internalise the respective revenues' shares  $\beta_k^l$  in their investment decisions. The investments in the relationship-specific assets  $h(i), m(i)$  require the use of labour according to the following constant return technologies:  $h_k^l(i) = \ell_{h,k}^l(i)$  and  $m_k^l(i) = \ell_{m,k}^l$ , where  $l$  denotes the location of  $M$  and  $k =$

<sup>20</sup>The revenues received by  $M$  according to the Nash equilibrium is equivalent to the contractible (negative) upfront payment that the final good producer establishes in the contract. The final good producer extracts all the rents from the supplier and the participation constraint of the latter is binding.

$O, V_H, V_M$  indicates the type of ownership structure.<sup>21</sup>

The ex-post production levels of the respective inputs for the variety  $i$  are a function of the ex-ante investment decisions in the specific assets. The quantity produced of each input for a given investment in relationship-specific assets are given by:  $x_{h,k}^l(i) = h_k^l(i)$  and  $x_{m,k}^l(i) = m_k^l(i)$ .

Therefore, the parties decide their respective investment by solving their respective maximisation programs. Using the expressions above to replace the investment decisions by the respective input levels produced with those assets, the respective programs are given by:

$$\begin{aligned} \text{Final-good producer's program:} \quad & \max_{x_{h,k}^l(i)} \pi_{H,k}^l = \beta_k^l r_k^l(x_{h,k}^l(i)) - w^N x_{h,k}^l(i) - w^N f_k^l \\ \text{Supplier's program:} \quad & \max_{x_{m,k}^l(i)} \pi_{M,k}^l = (1 - \beta_k^l) r_k^l(x_{m,k}^l(i)) - w^l x_{m,k}^l(i) \end{aligned} \quad (7)$$

From the FOCs, the optimal investment levels for each party involved in the production of a variety  $i$  of a final good producer with productivity  $\theta$  are:

$$h_k^{l,*}(\theta) = x_{h,k}^{l,*}(\theta) = \frac{\alpha \beta_k^l \eta}{w^N} r_k^{l,*}(\theta) \quad ; \quad m_k^{l,*}(\theta) = x_{m,k}^{l,*}(\theta) = \frac{\alpha(1 - \beta_k^l)(1 - \eta)}{w^l} r_k^{l,*}(\theta) \quad (8)$$

with  $k = O, V_H, V_M$ ,

$$r_k^{l,*}(\theta) \equiv \alpha^{\sigma-1} \theta^{\sigma-1} (\gamma E)^\sigma Q^{1-\sigma} \left[ \left( \frac{\beta_k^l}{w^N} \right)^\eta \left( \frac{1 - \beta_k^l}{w^l} \right)^{1-\eta} \right]^{\sigma-1} \quad (9)$$

and the output level of the variety  $i$  corresponding to these investment levels is:

$$q_k^{l,*}(\theta) = \alpha^\sigma \theta^\sigma (\gamma E)^\sigma Q^{1-\sigma} \left[ \left( \frac{\beta_k^l}{w^N} \right)^\eta \left( \frac{1 - \beta_k^l}{w^l} \right)^{1-\eta} \right]^\sigma \quad (10)$$

### 3.1.3 Organisational choice.

If instead of a discrete set of organisational choices, the final good producer is available to choose  $\beta$  from a continuum set, then the optimal choice is illustrated in Figure 5 as  $\beta^*$  as a function of  $\eta$ . However, given the discrete nature of the set, she chooses the organisational type that approximates the most to  $\beta^*$ <sup>22</sup>. I characterise this decision and the trade-off involved below.

Given the upfront payment, the final good producer choose the organisational structure that max-

<sup>21</sup> Although the investments in  $h(i)$  always take place in the North by using northern labour, the magnitude depends on the location of the supplier and the chosen organisational type.

<sup>22</sup> For derivation of the function  $\beta^*(\alpha, \eta)$  see Antràs and Helpman (2004).

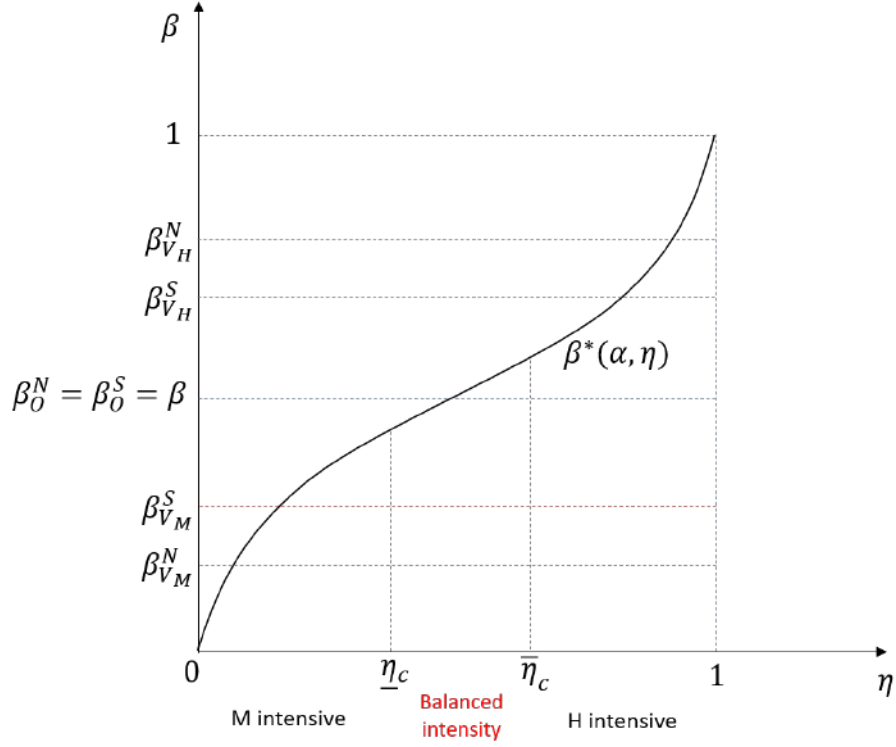


Figure 5: Optimal  $\beta$  and discrete organisational choices. Sectoral classification.

imises the overall profits. This program configures a discrete choice:

$$\max_{\beta_k^l} \pi_k^l(\theta, Q, \eta) = \theta^{\sigma-1} (\gamma E)^\sigma Q^{1-\sigma} \psi_k^l(\eta) - w^N f_k^l \quad \text{with } k = O, V_H, V_M \text{ and } l = N, S \quad (11)$$

with

$$\psi_k^l(\eta) = \left[ \frac{1 - \alpha[\beta_k^l \eta + (1 - \beta_k^l)(1 - \eta)]}{\alpha^{1-\sigma}} \right] \left[ \left( \frac{\beta_k^l}{w^N} \right)^\eta \left( \frac{1 - \beta_k^l}{w^l} \right)^{1-\eta} \right]^{\sigma-1}$$

Motivated from the transaction costs approach, I assume that the higher organisational complexity involved under integration, relative to the management of two independent specialised firms, imposes additional managerial or governance costs (Coase, 1937; Williamson, 1979, 1985; Grossman and Helpman, 2002). This implies that the organisational fixed costs of any type of integration in  $l$  cannot be smaller than the fixed costs of outsourcing in that same location, i.e.  $f_O^l < f_{V_H}^l$  and  $f_O^l < f_{V_M}^l$ . Additionally, I assume that overseas (or international) business operations require a larger management structure relative to fully domestic supply chains. Both conditions together lead to assumption A.2.



**Assumption A. 2** (Ranking in organisational fixed costs).

$$\begin{cases} f_O^N < f_{V_H}^N < f_O^S + (1 - \lambda)s^r < f_{V_H}^S + (1 - \lambda)s^r \\ f_O^N < f_{V_M}^N < f_O^S + (1 - \lambda)s^r < f_{V_M}^S + (1 - \lambda)s^r \end{cases}$$

The optimisation program defined by (11) balances a trade-off that the final good producers face when they must choose the organisational form from the discrete set of organisational types. They can realise gains from integration by allocating the residual rights on the party that has the highest contribution to the relationship, but at the cost of facing higher organisational fixed costs due to the higher complexity of the organisation.

In the case of  $H$ -intensive sectors, i.e. when  $\eta \geq \bar{\eta}_c$ , backward integration minimises the hold up by transferring the residual rights on all the assets to the final good producer. However, I show in section 3.2 that for some final good producers those gains are surpassed by the higher fixed costs of integration. Moreover, it is easy to see that the final good producer's revenue share is increasing in  $\eta$ , as predicted by Antràs and Helpman (2004), and in  $\delta_{V_H}^l$ . Thus, the critical level  $\bar{\eta}_c$  is increasing in  $\delta_{V_H}^l$ .

Intuitively, when the disruption on routines caused by the replacement of the manager of  $M$  is very low ( $\delta_{V_H} \rightarrow 1$ ), or in other words, when the routines are easily assimilated by a new manager of  $M$ , the efficiency losses in the manufacturing of the intermediate input are lower. Therefore, the outside option of  $H$  improves pushing up the share  $\beta_{V_H}$  for a given  $\eta$ , and thus increases the critical level  $\bar{\eta}_c$ .

In the case of  $M$ -intensive or component-intensive sectors, i.e. when  $\eta \leq \underline{\eta}_c$ , forward integration minimises the hold up by transferring all the residual rights on all the assets to the manufacturer  $M$ . However, for some final good producers, those gains cannot compensate the higher organisational fixed costs. The revenue share  $\beta_{V_M}^l$  is still increasing in  $\eta$  but decreasing in  $\delta_{V_M}^l$ . Thus, the critical level  $\underline{\eta}_c$  is decreasing in  $\delta_{V_M}^l$ .

The intuition refers to a mirror situation from the case above. When the routines in the final good production facilities can be easily assimilated by a new manager ( $\delta_{V_M} \rightarrow 1$ ), the efficiency losses from firing the manager of  $H$  are smaller. Therefore, the outside option of  $M$  increases, the share  $\beta_{V_M}$  for a given  $\eta$  diminishes, and thus the critical level  $\underline{\eta}_c$  becomes smaller.

In the case of the sectors with a balanced intensity between the two parties, i.e. when  $\underline{\eta}_c < \eta < \bar{\eta}_c$ , outsourcing dominates any type of integration. Therefore, the only active dimension in the decision of the final good producer is the location of the supplier.

**Corollary 1.** *The lower the role played by the tacit routines and non-codifiable knowledge in the effi-*

ciency of the production of the potentially integrated party, the higher is the prevalence of outsourcing over any type of integration in the sectoral organisational structures.

### 3.2 Perfect information steady state

The characterisation of the perfect information equilibrium is closely related to Antràs and Helpman (2004). The main departure comes from the possibility of forward integration as an organisational type, which is not considered in the latter. In this sense, the approach is closer to Grossman and Hart (1986) and Hart and Moore (1990). As I showed above, the possibility of forward integration leads to the emergence of a third type of sector (*balanced intensity*) and a different organisational structure of the component-intensive industries compared to the characterisation in Antràs and Helpman (2004).

**H-intensive sectors.** Forward integration is strictly dominated by the other two organisational types. Thus, the trade-off between the optimal allocation of property rights and the organisational fixed costs results in a sectoral structure with four organisational types.<sup>23</sup>

The most productive final good producers in the market choose FDI- $V_H$ , i.e. foreign backward integration or backward FDI. The respective productivity cutoff,  $\theta_{V_H}^S$ , is defined by the indifferent firm between this organisational type and arm's length trade,  $O^S$ . Therefore, this cutoff is defined by the condition:<sup>24</sup>

$$\pi_{V_H^S/O^S}^{prem}(\theta) \equiv \pi_{V_H}^S(\theta) - \pi_O^S(\theta) \Rightarrow \pi_{V_H^S/O^S}^{prem}(\theta_{V_H}^S) = 0$$

Figure 6a illustrates with the light shaded area the profit premium of FDI- $V_H$  with respect to  $O^S$ .

The final good producers with a relative lower productivity find it more difficult to afford the higher fixed costs of foreign integration, but they are productive enough to afford the fixed costs of foreign outsourcing. Thus, the most productive among the middle size firms opt instead for an independent southern supplier ( $O^S$ )<sup>25</sup>. The arm's length trade productivity cutoff  $\theta_O^S$ , which also represents the offshoring productivity cutoff, is defined by the final good producer that obtains a discounted offshoring profit premium high enough to cover the offshoring sunk cost  $w^N s^r$ .

$$\pi_{O^S/V_H^N}^{prem}(\theta) \equiv \pi_O^S(\theta) - \pi_{V_H}^N(\theta) \Rightarrow \pi_{O^S/V_H^N}^{prem}(\theta_O^S) = (1 - \lambda)w^N s^r$$

<sup>23</sup>See Appendix A.3 for proofs and explicit expressions for the productivity cutoffs in  $H$ -intensive sectors.

<sup>24</sup>In other words, the productivity cutoff is defined by the final good producer for whom the profit premium of backward FDI with respect to foreign outsourcing is zero. The offshoring profit premium of those under FDI- $V_H$  is the sum of both coloured areas, for a productivities higher than or equal to the FDI- $V_H$  productivity cutoff, i.e. for  $\theta \geq \theta_{V_H}^S$ . Furthermore, the offshoring profit premium of those producers under FDI- $V_H$  is the sum of both coloured areas for  $\theta \geq \theta_{V_H}^S$ .

<sup>25</sup>This takes place when the gains from a lower marginal costs,  $w^S < w^N$ , overcompensate the losses coming from a "misallocation" of property rights.

Finally, the domestic integration productivity cutoff,  $\theta_{V_H}^N$ , is defined by  $\pi_{V_H/O}^{prem}(\theta) = 0$ , while the market productivity cutoff,  $\underline{\theta}$ , is given by the condition  $\pi_O^N(\theta) = 0$ .

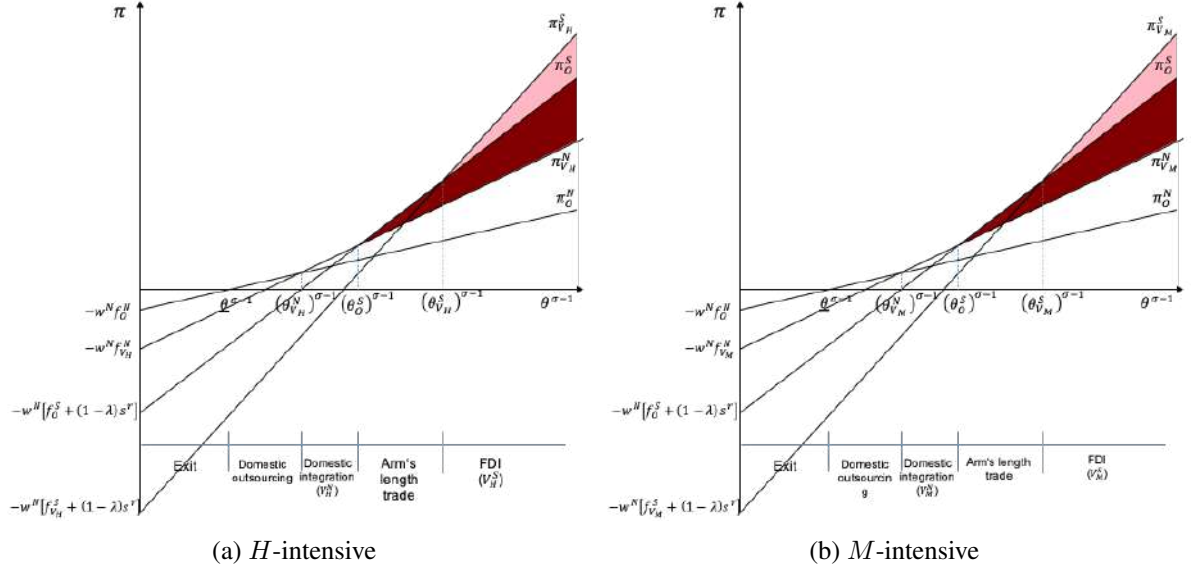


Figure 6: Perfect information steady states by sectors type

**M-intensive sectors.** The allocation of rights under the manufacturer's control minimises the hold up, while backward integration is strictly dominated by the other two organisational types. As in the case of *H*-intensive industries, four organisational types emerge under equilibrium.<sup>26</sup>

The most productive final good producers in the market find it optimal to allocate all the residual rights to a foreign supplier, i.e. they find it optimal to choose foreign forward integration or forward FDI, FDI- $V_M$ . The productivity cutoff,  $\theta_{V_M}^S$ , is defined by:

$$\pi_{V_M/O}^{prem}(\theta) \equiv \pi_{V_M}^S(\theta) - \pi_O^S(\theta) \Rightarrow \pi_{V_M/O}^{prem}(\theta_{V_M}^S) = 0$$

where  $\pi_{V_M/O}^{prem}(\theta)$  denotes the profit premium of FDI- $V_M$  relative to foreign outsourcing.<sup>27</sup>

The offshoring productivity cutoff is defined by the least productive firm under arm's length trade. At this cutoff, the final good producer obtains a discounted offshoring profit premium high enough to recover the offshoring sunk cost  $w^N s^r$ .

$$\pi_{O^S/V_M}^{prem}(\theta) \equiv \pi_O^S(\theta) - \pi_{V_M}^N(\theta) \Rightarrow \pi_{O^S/V_M}^{prem}(\theta_O^S) = (1-\lambda)w^N s^r$$

<sup>26</sup>See Appendix A.4 for proofs and explicit expressions for the productivity cutoffs in *M*-intensive sectors.

<sup>27</sup>The offshoring profit premium of those under FDI- $V_M$  is the sum of both coloured areas, with a productivity higher than or equal to the FDI- $V_M$  productivity cutoff, i.e.  $\theta \geq \theta_{V_M}^S$ .

with  $\pi_{OS/V_M^N}^{prem}(\theta)$  as the profit premium of arm's length trade relative to domestic forward integration.

To conclude, the domestic integration productivity cutoff,  $\theta_{V_M^N}^N$ , is defined by  $\pi_{V_M^N/O^N}^{prem}(\theta) = 0$ , while the market productivity cutoff,  $\underline{\theta}$ , is given by the condition  $\pi_O^N(\theta) = 0$ .

**Balanced-intensity sectors.** Outsourcing strictly dominates any type of integration when the contribution of each party to the total output is relatively balanced. Therefore, only two organisational forms are observed in these industries: *domestic outsourcing* and *arm's length trade*.<sup>28</sup>

The sectoral organisational structure under equilibrium is illustrated by Figure 7. The offshoring profit premium, i.e. the premium realised by those final good producers that contract a foreign independent supplier, is represented by the shaded area.

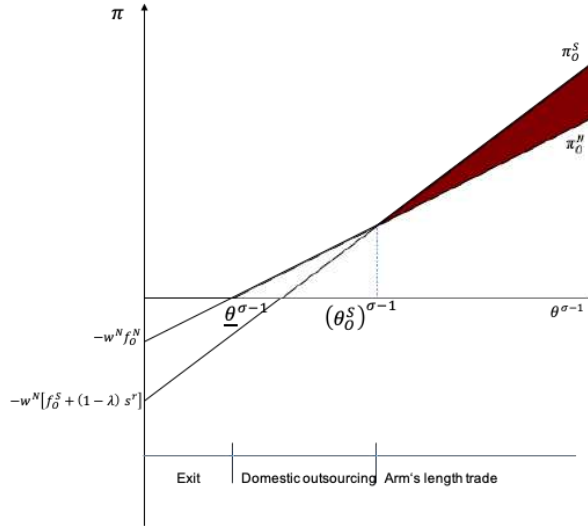


Figure 7: Balanced intensity sectors - Perfect information steady states

The offshoring productivity cutoff,  $\theta_O^S$ , is defined by the final good producer that realises a discounted offshoring profit premium high enough to recover the offshoring sunk cost.

$$\pi_{OS/O^N}^{prem}(\theta) \equiv \pi_O^S(\theta) - \pi_O^N(\theta) \Rightarrow \pi_{OS/O^N}^{prem}(\theta_O^S) = (1 - \lambda)w^N s^r$$

As in the previous sectors, the market productivity cutoff,  $\underline{\theta}$ , is defined by the condition  $\pi_O^N(\theta) = 0$ .

Using data for the US manufacturing industries, the following section shows evidence in favour of higher integration at both extremes of the  $H$ -intensity distribution. Nevertheless, the characterisation and conclusions of the dynamic model with uncertainty defined in section 4 are robust to only one type of integration (i.e. backward integration) as in Antràs and Helpman (2004).

<sup>28</sup>See Appendix A.5 for proofs and explicit expressions for the productivity cutoffs in balanced-intensity sectors.

### 3.3 Empirical model: determinants of the organisational choices

For the determinants of the sectoral component-intensity  $\eta$ , I build on the works of Yeaple (2006); Nunn (2007); Nunn and Trefler (2013) and Antràs (2015). However, one first departure from them comes from the quadratic functional form that I introduce in those variables. I test for the non-linear relation derived in the theoretical model above, that comes from the expanded organisational set with respect to Antràs and Helpman (2004).

As a complement to the cited literature, I build also a synthetic measure of  $\eta$  by two alternative approaches: *Factor Analysis (FA)* and *Principal Component Analysis (PCA)*. From these methods, I am able to reduce the multidimensionality of the previous models to a unique index for  $\eta$ .

Second, I introduce a novel measure for the tacit knowledge and routines at the management level for  $H$  and  $M$ . As described in section 3.1.1, they motivate the effects of  $\delta_{V_H}$  and  $\delta_{V_M}$ , respectively, on the organisational choices. The more important the tacit knowledge and routines in the potentially integrated party, the higher the efficiency losses (i.e. lower  $\delta_V$ ) that would be faced if the controlled party is seized after the investments are executed. I explain in detail the construction of this measure in section 3.3.2.

Third, I divide the analysis in two samples. I consider a sample with "all countries" included, and I replicate the models for a second sample "excluding high income countries". The regression results for the latter can be found in Appendix B.1.

Following Yeaple (2006), the exclusion of the high income countries represents a closer identification of the decisions with respect to the type of sourcing characterised in the theoretical section above. In the model, the final good producers  $H$  look for suppliers  $M$  in countries where they can exploit the advantages of lower marginal costs.

Finally, I exploit the input-output matrices provided by the Bureau of Economic Analysis (BEA), in particular on the *Import matrix before redefinitions 2012*. I identify the final good producer sectors  $H$  by the user manufacturing industries in the matrix, while the supplier  $M$  sector is linked to the manufacturing industries of the imported commodity in the matrix. Both are classified by BEA code.

After a reclassification of the manufacturing survey and the related-trade party datasets to BEA code, I merge both to the mentioned matrix. The data from the manufacturing survey is used for the measures of the determinants of the component-intensity of the sector  $H$ . On the other hand, the related-trade party imports data allows me to identify the intermediate inputs (commodity by BEA code) imported by each industrial sector (industry by BEA code).<sup>29</sup>

Additionally, I build a differentiation measure based on Rauch (1999)'s classification for sectors  $H$

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<sup>29</sup>For a detailed exposition of the methodology, see Appendix B.1.

and  $M$ . Later, in a future version of the model, I will incorporate the contract-dependence measure from Nunn (2007) as control variable.

### 3.3.1 Data

I use Related-Trade Party imports data for the period 2002-2016<sup>30</sup>, provided by the US Census Bureau. The data covers the manufacturing sectors in the US, reported at sector level (NAICS 6 digits).

It allows for the distinction between imports of US firms from a related party (intra-firm trade) and from a non-related party (independent suppliers). The main drawback for testing the theoretical predictions of the model comes from the fact that the data is aggregated at the sector-level. Therefore, the empirical model is limited to test for the consistency of the sectoral results with the theoretical predictions of the model. A second limitation of the data refers to the lack of distinction between forward and backward integration, but instead it identifies whether the parties are related (in either way of the ownership relation) or independent.

I use the "liberal" criteria of Rauch (1999)'s classification of commodities: i) good traded on an organised exchange, ii) reference priced, and iii) differentiated. I define a variable *diff* which takes the value 0 if Rauch's category is "w", 0.5 if *r*, and 1 if it is a differentiated good ("d"). I build a concordance table between Rauch's product classification (SITC) and NAICS 2012, and merge the differentiation index with the imports dataset, and thus obtain for each sector in the imports dataset a *diff* index  $\in [0, 1]$ , increasing in the differentiation of the sector. As robustness, I take a subsample of only differentiated final good sectors, defined by those BEA codes with  $diff > 0.5$ .<sup>31</sup>

Finally, I merge the imports dataset with the input-output imports matrix and thus obtain for each sector the imports for each intermediate input classified by intra-firm and non-related parties. Therefore, the sectors  $H$ , i.e. the users of the intermediate inputs, as well as the sectors  $M$ , i.e. the industries of the suppliers, are classified by BEA codes.<sup>32</sup>

For the determinants of the component-intensity, I use data from the Census Bureau on: *capital expenditure*, *machinery expenditure*, *advertising expenditure*, and *total shipments* (total sales). The expenditure share in R&D comes instead from the Business R&D and Innovation Survey (BRDIS) survey

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<sup>30</sup>For the period 2005-2016, the data comes directly from the Census Bureau. For the years 2002-2004, I use the data of the Census Bureau provided in Antràs (2015).

<sup>31</sup>The hold up problem in terms of the property rights approach becomes relevant when the production of the goods requires investments in relationship specific assets. As expected, the predictions of the model are verified in particular for the case of more differentiated sectors, showing that these investments, and thus the hold-up problem, are more relevant in the differentiated than in the non-differentiated industries.

<sup>32</sup>The underlying assumption is that for each input  $M$  the intra-firm input share is constant across the industries  $H$  that import the respective input. However, there is variation in the intra-firm share across industries  $H$  due to the different composition of intermediate inputs  $M$  imported.

of the National Center for Science and Engineering Statistics (NCSES) of the National Science Foundation. For the classification of countries by income per capita, I use the World Bank classification.

Additionally, using the methods of factor analysis (FA) and principal component analysis (PCA), I build a direct measure for  $\eta$ . In the case of FA, I use as measure the first factor that comes from a factor analysis of all the determinants of  $H$ -intensity considered above. In the case of PCA, instead, the measure of  $\eta$  consists on the first component that results from an equivalent principal component analysis. The analysis of the eigenvalues of the respective approaches show that the first factor of the FA is a better measure for  $\eta$  than the respective first component of PCA.<sup>33</sup>

I build a novel measure of tacit knowledge and routines at the management level based on the O\*NET database together with the employment survey (OES) of the Bureau of Labor Statistics. I describe it in detail in section 3.3.2. This measure is built separately for the final good producer,  $H$ , and for the intermediate input supplier,  $M$ .

After the merge of the datasets mentioned above, I achieve a sample with a sectoral classification according to BEA code, for the manufacturing sectors (31-33)  $H$  and  $M$ .

The data on tariffs comes from World Integrated Trade Solutions (WITS), the Rule of Law institutional measures from the World Governance Indicators of the World Bank database, the data on GDP per capita and GDP from the World Development Indicator of the same institution, and the distance measures from CEPII. Finally, the data on FTA comes from “Mario Larch’s Regional Trade Agreements Database from Egger and Larch (2008)”.

### **3.3.2 Measure of tacit routines and non-codifiable knowledge**

I use the dataset on occupational classification: “Education, Training, and Experience” from the O\*NET database. In particular, I use the index “On the job training” for managers. The intuition is the following. The training time required for the manager “on the job” may represent the importance of knowledge acquired in that position, and the time required by a new manager to assimilate the tacit routines associated to her/his position in that facility. The more important is the tacit component of the routines in the firm, the higher the time required to adapt and assimilate it as a manager.

I focus on the managers because, according to the theoretical model above, they are those who are exposed to be fired after the investments in specific-assets are executed. I normalize the index to the range of  $[1, 10]$ , which is increasing in “on the job training” period. It is easy to observe that this measure capture the inverse of  $\delta_V$ , i.e. as the training period increases, the tacit knowledge and importance of

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<sup>33</sup>See figure 14 in Appendix B.1.

routines is higher, therefore the efficiency loss after firing the manager of the respective facility increases ( $\delta_V \rightarrow 0$ ).

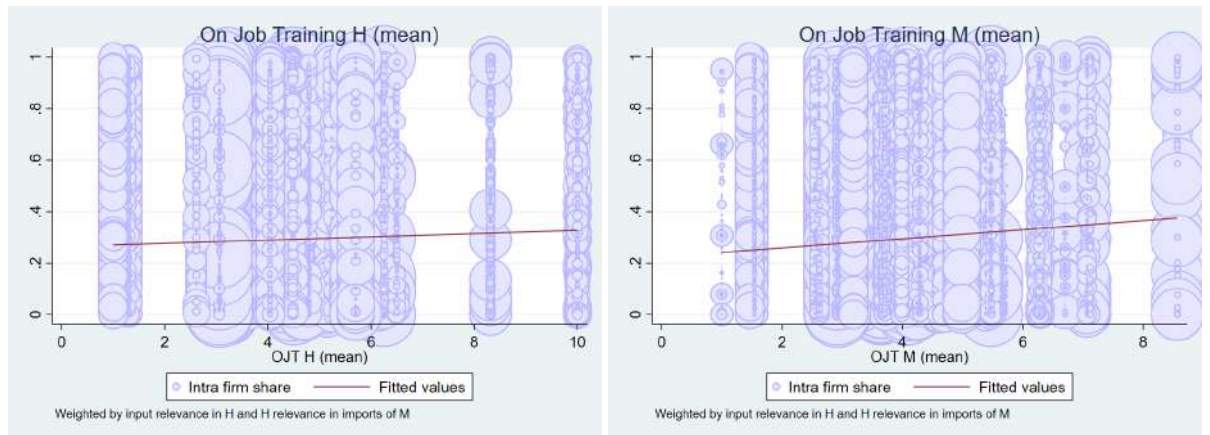
Regarding the construction of the index, using data from the O\*NET database, I compute first the index category "on the job training" (Element ID: 3.A.3, scale ID:  $OJ$ ) for each manager position in the O\*NET SOC code. Thus, the index for each O\*NET SOC code is given by:

$$OJT_{O^*NET\ SOC\ code} = \sum_{c=1}^9 c \times \frac{data_c}{100}$$

where  $OJT$  denotes the "on the job training" of general and operation managers,  $c$  refers to the category with  $c = 1, \dots, 9$ , the variable  $data_c$  indicates the data value for the category  $c$ , and 9 refers to the total number of categories for the scale ID  $OJ$ .

Second, using the cross-walk tables provided by O\*NET, I merge it with the OES database, and create an index by NAICS and year, i.e.  $OJT_{j,t}$ . Finally, I merge it with the input-output table by BEA codes for  $H$  and  $M$  industries, and re-scale the index to  $[1, 10]$ .

Figure 8 shows the tacit knowledge measure for manager in relation to the intra-firm import share. From the theory, a positive relation between these two variables are expected for both cases.



(a) On the Job Training  $H$

(b) On the Job Training  $M$

Figure 8: Intra-firm import share and tacit knowledge and routines.

I measure  $OJT M$  using data that comes from US manufacturing firms. However, it aims to capture the routines and knowledge in foreign sectors, i.e. suppliers  $M$ . The underlying assumption is that the relevance of routines and tacit knowledge is symmetric in US across countries for a given sector. In other words, it is a feature closer to technological determinants of the sector instead of geographical conditions.



### 3.3.3 Definition of other variables

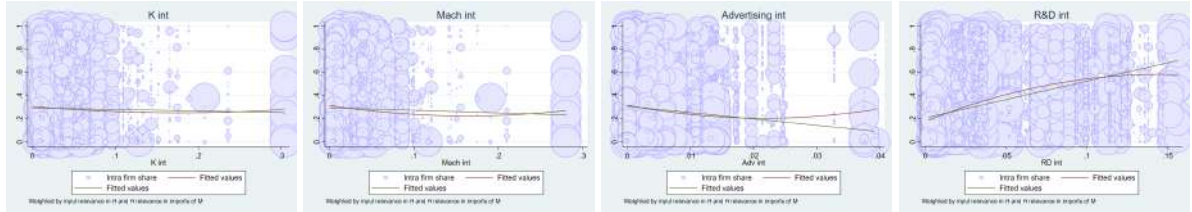
I build the main variables for the determinants of the capital intensity by following the previously cited empirical literature. From the manufacturing survey of the Census Bureau, I build the following intensity measures:

- Capital intensity:  $k\ int_{j,t} = \frac{\text{Total Capital Expenditure}_{j,t}}{\text{Total shipments}_{j,t}}$
- Machinery intensity:  $mach\ int_{j,t} = \frac{\text{Machinery Capital Expenditure}_{j,t}}{\text{Total shipments}_{j,t}}$
- Advertising intensity:  $adv\ int_{j,t} = \frac{\text{Advertising and Promotional Serv Exp.}_{j,t}}{\text{Total shipments}_{j,t}}$

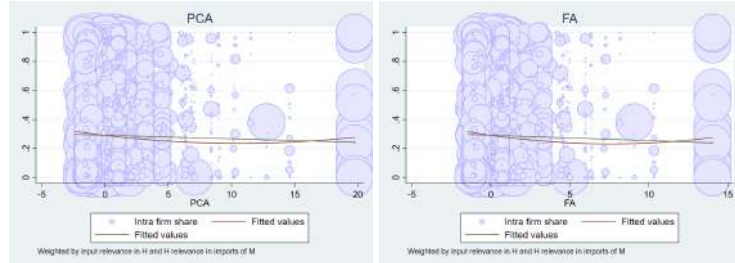
As a robustness, I use in every specification the machinery intensity as a substitute of the total capital intensity.

The R&D intensity measure is constructed from the Business R&D and Innovation Survey (BRDIS) survey of the National Center for Science and Engineering Statistics (NCSES) of the National Science Foundation, and it is defined as:  $rd\ int_{j,t} = \frac{\text{R\&D Expenditure}_{j,t}}{\text{Total Sales}_{j,t}}$

The figure 9 shows the linear and quadratic relationship between the  $H$ -intensity measures and the intra-firm import share<sup>34</sup>. As mentioned above, I also computed the index of the first component from a factor analysis (FA) and a principal component analysis (PCA) as alternative consolidated measures of  $H$ -intensity.<sup>35</sup>



(a) Individual measures.



(b) PCA and FA measures.

Figure 9: Intra-firm share and measures of  $\eta$

<sup>34</sup>See Appendix B.1.2 for alternative complementary measures.

<sup>35</sup>See Appendix B.1 for details.

### 3.3.4 The model

The input-out matrix structure allows me to exploit for the variation across inputs-intensity and supplier's countries across  $H$  sectors. Given the limitations that the data impose over a structural estimation for the predictions of the model above, I follow three complementary approaches to analyse the determinants of the integration decisions among offshoring firms. I call them the *H-perspective*, the *M-perspective*, and *no aggregation perspective*.

The *H-perspective* aggregates at  $H$  sector and country level the intra-firm import shares of each input and other control variables defined at  $M$  sector level, weighted by the relevance of the sector  $M$  in sector  $H$  imports according to the supplementary import matrix of the input-output matrix. On the other hand, the *M-perspective* aggregates at  $M$  sector and country level the  $H$ -sector determinants of the integration decision and other control variables defined at  $H$ -sector level, weighted by the relevance of  $H$ -sector in sector  $M$  imports according to the supplementary import matrix. Finally, the *no aggregation perspective* exploits the full variation of the data, weighting the observations by the relevance of  $H$  sector in sector  $M$  imports and the relevance of the  $M$  sector in sector  $H$  imports.

As a first step, instead of defining in favour of one measure for the  $H$ -intensity, I follow the previous literature and "I let the data talk" (Yeaple, 2006; Nunn and Trefler, 2013; Antràs, 2015). From a complementary perspective, as a second step I define two alternative measures of  $H$ -intensity of the sectors by using PCA and FA methods<sup>36</sup>.

Given the non-linear nature of the model, I estimate it by a fractional logit model:

$$\mathbb{E} \left[ IFshr_{m,j,l,t} \mid \mathbf{x} \right] = \frac{\exp(\mathbf{x}'_{m,j,l,t} \boldsymbol{\beta})}{1 + \exp(\mathbf{x}'_{m,j,l,t} \boldsymbol{\beta})} \quad (12)$$

with  $IFshr_{m,j,l,t}$  as the intra-firm import share in input  $M$  from country  $l$  in year  $t$  of sector  $j$ , and  $\mathbf{x}$  refers to the vector of explanatory and control variables.

$$\begin{aligned} \mathbf{x}'_{m,j,l,t} \boldsymbol{\beta} = & \beta_1 H OJT_{j,t} + \beta_2 M OJT_{m,t} + \beta_3 k int_{j,t} + \beta_4 k int_{j,t}^2 + \beta_5 rd int_{j,t} + \beta_6 rd int_{j,t}^2 \\ & + \beta_7 adv int_{j,t} + \beta_8 adv int_{j,t}^2 + other\ controls + \gamma_t + \gamma_l \end{aligned} \quad (13)$$

The first variable  $H OJT_{j,t}$  refers to the "on the job training" index for managers in the user (i.e. final good) sector  $j$  in year  $t$ . Instead,  $M OJT_{m,t}$  indicates the index in the supplier sector  $M$ . Given that it is increasing in the training time, a higher  $OJT$  in either case represent a lower  $\delta_V$ , i.e. a higher efficiency loss when the party with the control on the assets fires the manager of the controlled facilities.

<sup>36</sup>See Antràs (2015) for methodological approach.

The other control variables refer to the different determinants of the  $H$ -intensity that the literature has already identified, and they have been defined already in section 3.3.3. I control also for the relevance of the input  $M$  in the user sector among the imported inputs. I denote it as  $M\ tech\ shr_j$  and it measures the share of  $M$  in the user sector manufacturing imports.

I include also the degree of differentiation of the supplier industry,  $M\ diff \in [0, 1]$ , based on Rauch's classification. The intuition is that the higher differentiation of the supplier industry may be link to higher relationship-specific investments, and thus to a higher contract dependency of the relationship. This measure is equivalent to the contract dependence index for the supplier's industry of Nunn (2007). Additionally, I control for the  $H$  differentiation level based on Rauch's classification, with  $diff \in [0, 1]$ .

Finally,  $\gamma_t$  and  $\gamma_l$  indicate the year and sourcing country fixed effects. The respective estimation results and robustness checks are reported in Tables 7-9 in Appendix B.1.3. The results are robust to the exclusion of high income countries, which may represent a closer identification of the North-South type of offshoring relationship characterised above.

For the specification with PCA or FA, the vector  $\mathbf{x}$  is thus given by:

$$\begin{aligned} \mathbf{x}'_{m,j,l,t}\boldsymbol{\beta} &= \beta_1 H\ OJT_{j,t} + \beta_2 M\ OJT_{m,t} + \beta_3 FA_{j,t} + \beta_4 FA_{j,t}^2 + \gamma_t + \gamma_l \\ \mathbf{x}'_{m,j,l,t}\boldsymbol{\beta} &= \beta_1 H\ OJT_{j,t} + \beta_2 M\ OJT_{m,t} + \beta_3 PCA_{j,t} + \beta_4 PCA_{j,t}^2 + \gamma_t + \gamma_l \end{aligned} \quad (14)$$

Table 1 shows the estimation results of the determinants of the organisational choices for all countries in the sample. We can observe that the tacit knowledge of the supplier has a significant and positive effect on the intra-firms shares for the  $H$ -perspective sample, as predicted by theory, while the effects of  $H\ OJT$  seem to contradict the predictions of the model. As the time on the job training increases, the efficiency losses from firing the manager increase (lower  $\delta_V$ ).

The Tables 7-9 in Appendix B.1.3 show that  $M\ OJT$  has a positive effect in most of the alternative specifications, especially when I use the explanatory variables according to equation (13). Furthermore, in the negative effect of  $H\ OJT$  vanishes in many of those cases or take a positive value, as expected from theory. Nevertheless, in the later the data does not allow to confirm nor reject the sectoral level consistency with the prediction of the role  $H\ OJT$ .

Second, most of the measures for  $H$ -intensity show a non-linear relationship (U-shaped) as predicted by the theory<sup>37</sup>. Moreover, the PCA and FA measures show support for the non-linear "U-shaped" relation of the intra-firm import share with the  $H$ -intensity, as predicted by the theory. In other words, it is consistent with higher integration observed in both extremes of the  $H$ -intensity range, i.e. when one

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<sup>37</sup>See tables 7-9 in Appendix B.1.3.

of the two parties in the relationship is relatively more important.

Table 1: Organisational choices in offshoring decisions

All countries: Fractional logit						
	H perspective		M perspective		No aggregation	
	(1)	(2)	(3)	(4)	(5)	(6)
	$IFshr_{j,l,t}$	$IFshr_{j,l,t}$	$IFshr_{m,l,t}$	$IFshr_{m,l,t}$	$IFshr_{m,j,l,t}$	$IFshr_{m,j,l,t}$
$PCA_{j,t}$	0.000360 (0.00408)		-0.0255*** (0.00407)		-0.0189*** (0.00355)	
$PCA_{j,t}^2$	-0.0000889 (0.000213)		0.00346*** (0.000869)		0.00105*** (0.000234)	
$FA_{j,t}$		-0.00305 (0.00570)		-0.0356*** (0.00572)		-0.0288*** (0.00498)
$FA_{j,t}^2$		0.0000842 (0.000418)		0.00634*** (0.00177)		0.00222*** (0.000464)
$H OJT_{j,t}$	-0.0113** (0.00540)	-0.0115** (0.00548)	-0.0201*** (0.00497)	-0.0208*** (0.00500)	-0.00895** (0.00413)	-0.00974** (0.00414)
$M OJT_{m,t}$	0.0427*** (0.00883)	0.0425*** (0.00891)	-0.00420 (0.00522)	-0.00408 (0.00523)	0.00680 (0.00496)	0.00657 (0.00495)

Other controls: tariffs, technological relevance of input  $m$  in sector  $H$ ,  $H$  differentiation,  $M$  differentiation.

Country and year fixed effects included. Average marginal effects. Standard errors in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

To conclude, the data shows some evidence in favour to the organisational characterisation of the sectors defined above, but not conclusive. In particular, the data provides evidence of a U-shaped" relation intra-firm share with the  $H$ -intensity, although it does not allow to distinguish the direction of the ownership relation. While a structural estimation of the model would require for firm-level data, a higher disaggregation of sectoral-level data relative to the publicly available data may provide stronger evidence.

As a final remark, the characterisation of the firm and sectoral dynamics with uncertainty developed in the following sections, as well as the results and predictions derived from the model, are robust to a situation where only backward integration is allowed, as in Antràs and Helpman (2004). In other words, the model with the two types of integration decisions is a generalisation that includes the model defined by Antràs and Helpman (2004) as a particular case.

## 4 Uncertainty in organisational fixed costs in South: model setup

The initial conditions are defined as the steady state economy with non-tradable intermediate inputs (*n.t.i.*). This case represents a situation where institutional fundamentals in the South are so weak that offshoring strategies are not feasible for the northern final good producers.

Given the higher marginal costs in the North, the sector initially experiences a higher price index,  $P^{n.t.i.}$ , which translates into a lower intensity in the competition in the final goods market. Therefore, the market shows that final good producers with a lower productivity are able to remain active in the market after entry. On the other hand, the offshoring barrier impacts in a lower initial welfare achieved by the consumers, which is expressed by a lower aggregate consumption index  $Q^{n.t.i.}$ .

Given equation (6) and assumption A.2, the most productive final good producers in the  $H$ -intensive [ $M$ -intensive] sectors choose domestic backward [forward] integration, while the least productive producers opt instead for domestic outsourcing. On the other hand, in the balanced-intensity sectors, the final good producers source only from independent domestic suppliers. Denoting with  $*$  the perfect information equilibrium variables, the initial conditions are:

- $H$ -intensive sectors:  $\underline{\theta}^{n.t.i.} < \underline{\theta}^*$  ;  $\theta_{V_H}^{N,n.t.i.} < \theta_{V_H}^{N,*}$  ;  $P^{n.t.i.} > P^*$  ;  $Q^{n.t.i.} < Q^*$
- $M$ -intensive sectors:  $\underline{\theta}^{n.t.i.} < \underline{\theta}^*$  ;  $\theta_{V_M}^{N,n.t.i.} < \theta_{V_M}^{N,*}$  ;  $P^{n.t.i.} > P^*$  ;  $Q^{n.t.i.} < Q^*$
- Balanced-intensity sectors:  $\underline{\theta}^{n.t.i.} < \underline{\theta}^*$  ;  $P^{n.t.i.} > P^*$  ;  $Q^{n.t.i.} < Q^*$

An institutional reform takes place in the South in  $t = 0$ , but the weak credibility of the southern government produce that northern final good producers do not fully believe about the true features of the new institutional regime. Thus, the northern final good producers build prior beliefs about the conditions in South, based on how credible is the announcement of the southern government. In consequence, uncertainty emerge about the per-period fixed costs for each organisational type that involve a foreign supplier, i.e.  $f_O^S, f_{V_H}^S, f_{V_M}^S$ . The final good producers' priors at  $t = 0$  about institutional conditions post-reform in the South are:

$$\begin{aligned}
 f_O^S &\sim Y(f_O^S) & \text{with} & & f_O^S &\in [f_O^S, \bar{f}_O^S] \\
 f_{V_H}^S &\sim Y(f_{V_H}^S) & \text{with} & & f_{V_H}^S &\in [f_{V_H}^S, \bar{f}_{V_H}^S] \\
 f_{V_M}^S &\sim Y(f_{V_M}^S) & \text{with} & & f_{V_M}^S &\in [f_{V_M}^S, \bar{f}_{V_M}^S]
 \end{aligned} \tag{15}$$

The final good producers' organisational choice is modelled as a recursive Markov decision process and a Bayesian learning mechanism. Based on the priors, each final good producer must decide whether to explore her offshoring potential or wait. If the final good producer chooses to explore, she must contract an offshoring consulting service that involves a market research and feasibility study to set up a supply chain abroad, which consists in the analysis of the alternative organisational structures of offshoring from the South. Thus, after paying the offshoring sunk cost  $w^N s^r$ , she discovers the organisational fixed costs in South for all the alternative types, i.e.  $f_O^S, f_{V_H}^S, f_{V_M}^S$ .

After the discovery of the true conditions, the final good producer must choose the optimal organisational form with certainty<sup>38</sup>. She offers a contract to the potential suppliers, which also includes an upfront payment. The suppliers apply to the contract and she chooses one. Each party decide simultaneously their respective investments in the relationship-specific assets, and they use those assets for the production of the respective inputs  $x_h, x_m$ . The output is produced and sold, and the revenues distributed according to a Nash bargaining.

If instead, she decides to wait, she does it by sourcing for one more period with a domestic supplier under the previously chosen organisational structure ( $k^N$ ). Both northern parties decide simultaneously on their respective investments in the relationship-specific assets. The respective inputs are produced. The output is produced and sold, and the revenues distributed according to a Nash bargaining. At the beginning of the next period, the final good producers that decided to wait can update their prior beliefs by observing the behaviour of their competitors in the final good market. In particular, they can observe the chosen organisational type of the final good producers that explored their offshoring potential in the previous period. With this new information, they decide first whether to leave the market or remain active. If they stay active, they decide whether to explore their offshoring potential or wait one more additional period sourcing from a domestic supplier as before.

In the following sections, I introduce the information externalities and the learning mechanism. Then, I characterise the exploration decisions of the initial explorers (at  $t = 0$ ) and the followers at any period  $t > 0$ . Figure 10 illustrates the timing of event of this recursive Markov decision process.

#### 4.1 Informational externalities and learning.

As in Larch and Navarro (2021), the learning mechanism involves the interaction of two states: the *beliefs* state and the *physical* state. While the latter refers to the information externalities produced by the offshoring final good producers, the first state defines the mechanism through which the final good producers under domestic sourcing can update their beliefs.

**Physical state: information externalities.** I define the maximum affordable fixed cost for a final good producer under organisational form  $k^S = O^S, V_H^S, V_M^S$  in period  $t$  as:

$$\pi_{k^S/k^N,t}^{\text{prem}}(\theta) = 0 \Rightarrow f_k^S(\theta) = \frac{r_k^N(\theta, Q_t)}{\sigma w^N} \left[ \left( \frac{w^N}{w^S} \right)^{(1-\eta)(\sigma-1)} - 1 \right] + f_{k^N}^N \quad (16)$$

<sup>38</sup>An important feature of the exploration action is that it sets the final good producer in an absorbing state of the Markov process. After exploration, there is no remaining uncertainty to the final good producer.

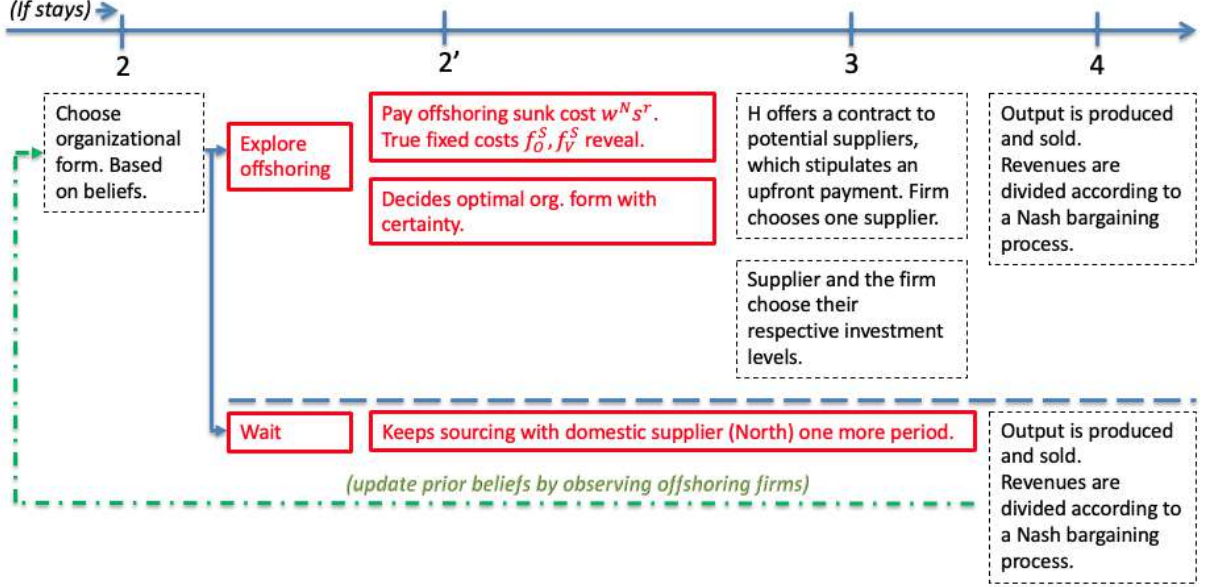


Figure 10: Timing of events - Uncertainty

where  $k^{IN}$  indicates  $V_H^N$  in the case of  $H$ -intensive sectors,  $V_M^N$  for  $M$ -intensive, and  $O^N$  for the industries with balanced intensity<sup>39</sup>. It is easy to see that if  $f_k^S > f_k^S(\theta) \forall k^S$ , the final good producer  $\theta$  does not find it profitable to offshore under any type. Thus, after discovering her offshoring potential in South, she decides to remain sourcing domestically under the previous organisational type  $k^{IN}$ .

I define  $\theta_{k,t}^S$  as the least productive final good producer doing offshoring under type  $k$  in period  $t$ , and  $\tilde{\theta}_t^S$  as the least productive producer that has explored the offshoring potential in  $t - 1$ . Based on this, I introduce a new notation:  $f_{k,t}^S \equiv f_k^S(\theta_{k,t}^S)$  denotes the maximum affordable fixed cost under type  $k$  for the final good producer  $\theta_{k,t}^S$  in  $t$ , and  $\tilde{f}_{k,t}^S \equiv f_k^S(\tilde{\theta}_{k,t}^S)$  indicates the maximum affordable fixed cost under type  $k$  for final good producer  $\tilde{\theta}_{k,t}^S$  in  $t$ .

**Beliefs state: learning.** The initial state of the beliefs is defined by the initial prior distributions in equation (15), and they evolve according to the learning mechanism described below. Intuitively, the final good producers that have not explored yet their offshoring potential can learn by observing the other producers' behaviour (*physical state*). In particular, I assume that the final good producers can observe the productivity  $\theta$  of their competitors<sup>40</sup> and the organisational type chosen by each of them<sup>41</sup>.

The posterior beliefs at the beginning of any period  $t > 0$  for each organisational type  $k = O, V_H, V_M$

<sup>39</sup>See appendix D.6 for derivation of this function.

<sup>40</sup>Alternatively, if they can observe the total size of the final good market and the respective market shares of the competitors, together with the chosen organisational type, they can infer the productivity level.

<sup>41</sup>In the appendix D.6, I define the learning process for the situation in which the ownership structure is unobservable when offshoring, but they can still observe the location from where the other final good producers are sourcing.

are given by:

$$f_k^S \sim \begin{cases} Y(f_k^S) & \text{if } f_{k,t}^S = f_{k,t-1}^S = \bar{f}_k^S \\ Y(f_k^S | f_k^S \leq f_{k,t}^S) = \frac{Y(f_k^S | f_k^S \leq f_{k,t-1}^S)}{Y(f_{k,t}^S | f_k^S \leq f_{k,t-1}^S)} & \text{if } \tilde{f}_{k,t}^S = f_{k,t}^S < f_{k,t-1}^S \\ f_{k,t}^S & \text{if } \tilde{f}_{k,t}^S < f_{k,t}^S \end{cases} \quad (17)$$

The first line indicates that the posterior beliefs for type  $k$  remains as the prior, when no final good producer has offshored yet under that type. The second line indicates a truncation of the prior uncertainty, exploiting the information that emerged from the new offshoring final good producers under type  $k$ . As a result of applying the Bayes rule, the distribution progressively truncates from the right, while the lower bound of the prior remains constant<sup>42</sup>. To simplify and with a little abuse of notation, I removed the lower bound in the conditional of the distribution.

Finally, the third line indicates the moment in which the true value is revealed, and thus the uncertainty distribution collapses in the maximum affordable fixed cost of the least productive firm that offshores under type  $k$ . This takes place if, after exploring the offshoring potential in type  $k$ , at least one final good producer returns to the previous domestic sourcing type. I characterise these events in detail for each sector type in section 5.

## 4.2 Exploration decision of the offshoring potential

The final good producer must decide whether to explore her offshoring potential under type  $k$  or wait sourcing domestically under its current organisational type.

$$\mathcal{V}_{k,t}(\theta; \theta_t^S) = \max\{V_{k,t}^o(\theta; \theta_t^S); V_{k,t}^w(\theta; \theta_t^S)\}; \text{ for } k = O, V_H, V_M$$

with  $\theta_t^S = \{\theta_{O,t}^S, \theta_{V_H,t}^S, \theta_{V_M,t}^S\}$  denoting the state of the sector in period  $t$ .

The value of exploring the offshoring potential for a final good producer  $\theta$  under type  $k^S = O^S, V_H^S, V_M^S$  is given by the expected discounted profit premium of that type  $k^S$  with respect to the current domestic sourcing organisational type  $k'^N$ , net of the offshoring sunk cost  $w^N s^r$ :

$$V_{k,t}^o(\theta; \theta_t^S) = \mathbb{E}_t \left[ \max \left\{ 0; \sum_{\tau=t}^{\infty} \lambda^{\tau-t} \pi_{k^S/k'^N, \tau}^{\text{prem}}(\theta) \right\} \middle| f_k^S \leq f_{k,t}^S \right] - w^N s^r$$

The final good producers, based on their posterior beliefs at  $t$ , can compute this expected value of off-

<sup>42</sup>For a similar Bayesian learning process see Rob (1991); Segura-Cayuela and Vilarrubia (2008); Larch and Navarro (2021)



shoring for each alternative type,  $k^S = O^S, V_H^S, V_M^S$ .

The value of waiting is defined as:

$$\mathcal{V}_{k,t}^w(\theta; \theta_t^S) = 0 + \lambda \mathbb{E}_t[\mathcal{V}_{k,t+1}(\theta; \theta_{t+1}^S)]$$

which is computed, based on posterior beliefs at  $t$ , by the producers for each type  $k^S = O^S, V_H^S, V_M^S$ .

The Bellman's equation for each offshoring type takes the form:

$$\mathcal{V}_{k,t}(\theta; \theta_t^S) = \max \{V_{k,t}^o(\theta; \theta_t^S); \lambda \mathbb{E}_t[\mathcal{V}_{k,t+1}(\theta; \theta_{t+1}^S)]\} \quad (18)$$

By assumption A.3<sup>43</sup>, it can be proved that the One-Step-Look-Ahead (OSLA) rule is the optimal policy rule. In other words, in expectation at  $t$ , waiting for one period and exploring the offshoring potential in the next period dominates waiting for any longer periods<sup>44</sup>.

**Assumption A. 3.** *Information flow decreases in the upper bound:*

$$\frac{\partial [f_{k,t}^S - E(f_k^S | f_k^S \leq f_{k,t}^S)]}{\partial f_{k,t}^S} > 0$$

Therefore, the Bellman's equation becomes  $\mathcal{V}_{k,t}(\theta; \theta_t^S) = \max \{V_{k,t}^o(\theta; \theta_t^S); V_{k,t}^{w,1}(\theta; \theta_t^S)\}$ . From this expression, I derive the trade-off function (19) for each offshoring type  $k = O^S, V_H^S, V_M^S$ .

$$\mathcal{D}_{k,t}(\theta; \theta_t^S, \tilde{\theta}_{t+1}^S) = V_{k,t}^o(\theta; \theta_t^S, \tilde{\theta}_{t+1}^S) - V_{k,t}^{w,1}(\theta; \theta_t, \tilde{\theta}_{t+1}) \quad (19)$$

where the first argument of the function refers to the final good producer  $\theta$  taking the decision, the second argument indicates the state of the system at the moment of the decision  $\theta_t^S$ , and the third argument denotes the expected state of the system one period after,  $\tilde{\theta}_{t+1}^S$ .

When the value of offshoring is higher than the value of waiting, the final good producer finds profitable to explore the offshoring potential under type  $k$  in  $t$ . On the other hand, when it is negative, it finds optimal to wait for one period. When the trade-off function is zero, the final good producer is indifferent between exploring and waiting. In the last case, I assume that she chooses to explore.

$$\mathcal{D}_{k,t}(\theta; \theta_t^S, \tilde{\theta}_{t+1}^S) \begin{cases} \geq 0 & \text{Explores offshoring potential in South under type } k \text{ in } t \\ < 0 & \text{Wait one period sourcing under } k^N \end{cases}$$

<sup>43</sup>This assumption implies that the information revealed is decreasing in time.

<sup>44</sup>See Appendix D.6 for proofs.

After paying the offshoring sunk cost  $w^N s^r$ , the final good producer discovers the value of the fixed costs in South for all the offshoring organisational types. Therefore, she decides to explore her offshoring potential whenever the trade off function is non-negative for at least one type  $k = O^S, V_H^S, V_M^S$ . However, after discovering all the values, she may opt for a different organisational offshoring structure than the type that triggered the exploration decision. In section 5, I characterise the decisions for each sector.

Substituting the value of offshoring and the value of waiting for one period with the respective expressions into equation (19), I obtain<sup>45</sup>:

$$\mathcal{D}_{k,t}(\theta; \theta_t^S, \tilde{\theta}_{t+1}^S) = \max \left\{ 0; \mathbb{E}_t \left[ \pi_{k^S/k^N,t}^{\text{prem}}(\theta) \mid f_k^S \leq f_{k,t}^S \right] \right\} - w^N s^r \left[ 1 - \lambda \frac{Y(f_{k,t+1}^S)}{Y(f_{k,t}^S)} \right] \quad (20)$$

From this expression, it is possible to derive a first property of the equilibrium path. Consistently with Larch and Navarro (2021), the proposition 1 shows that the exploration of the offshoring potential in the South is led by most productive final good producers in the market.

**Proposition 1** (Sequential offshoring). *The final good producers with higher productivity have an incentive to explore the offshoring potential in earlier periods.*

$$\frac{\partial \mathcal{D}_{k,t}(\theta; \theta_t^S, \tilde{\theta}_{t+1}^S)}{\partial \theta} \geq 0$$

Furthermore, the trade-off function is strictly increasing in  $\theta$  for those final good producers that are facing a real trade-off. In other words, for those with a positive value of offshoring.

Finally, the assumption A.4 establishes that at least the most productive final good producer in the market, denoted by  $\bar{\theta}$ , finds profitable at  $t = 0$  to explore the offshoring potential in at least one organisational form  $k = O, V_H, V_M$ . This is a necessary condition to trigger the sequential exploration of the offshoring potential in South.<sup>46</sup>

**Assumption A. 4.**  $\mathcal{D}_{k,t=0}(\bar{\theta}; \bar{\theta}, \bar{\theta}) > 0$  for at least one  $k = O, V_H, V_M$ , where  $\bar{\theta}$  refers to the most productive final good producer in the market.

## 5 Uncertainty in organisational fixed costs: Sectoral equilibrium paths

The paper focuses in the characterisation of the disintegration trends in the sectoral organisational structure that results from an endogenous increase in competition. For that reason, I concentrate in this section

<sup>45</sup>See Appendix D.3 for derivation of equation (20).

<sup>46</sup>If the distribution  $G(\theta)$  is unbounded on the right, i.e.  $\bar{\theta} \rightarrow \infty$ , then the assumption A.4 holds for any distribution  $Y(f_k^S)$  with a finite expected value.

in the analysis of the equilibrium paths for the industries in which those trends emerge, i.e. the  $M$ - and  $H$ -intensive sectors<sup>47</sup>. The analysis of the equilibrium paths of the Balanced-intensity sectors can be found in Appendix D.4.

Both industries,  $H$ - and  $M$ -intensive, face similar equilibrium paths, with the main difference that the integration type that emerge in the first case is backward, i.e.  $V_H$ , while in the second case is forward,  $V_M$ . Therefore, I characterise the equilibrium paths for both sectors together, where  $V$  refers to  $V_H$  for a  $H$ -intensive sector, and it indicates  $V_M$  for a  $M$ -intensive sector.

### 5.1 $H$ - and $M$ -intensive sectors: The trade-off function.

The final good producers may find optimal to offshore by either arm's length trade or FDI. When they must decide whether to explore their offshoring potential or wait, they compare the profits under domestic integration with the expected profit under those two offshoring types<sup>48</sup>.

The trade-off function is thus given by:

$$\mathcal{D}_{k,t}(\theta; \theta_t^S, \tilde{\theta}_{t+1}^S) = \max \left\{ 0; \mathbb{E}_t \left[ \pi_{k^S/V^N,t}^{prem}(\theta) \mid f_k^S \leq f_{k,t}^S \right] \right\} - w^N s^r \left[ 1 - \lambda \frac{Y(f_{k,t+1}^S)}{Y(f_{k,t}^S)} \right] \quad (21)$$

with  $k = O, V$ . From this trade-off function, it is easy to see that a final good producer with productivity  $\theta$  explores the offshoring potential in period  $t$  when  $\mathcal{D}_{k,t}(\theta; \theta_t^S, \tilde{\theta}_{t+1}^S) \geq 0$  for at least one  $k = O^S, V^S$ .

However, after exploring the final good producer may choose a different offshoring type than the  $k$  for which the trade-off function is positive. Once she has paid the offshoring market research sunk cost  $w^N s^r$ , all the values  $f_O^S, f_{V_H}^S, f_{V_M}^S$  reveal to her. In consequence, she chooses the organisational type that maximises her profits, independently of the type  $k$  that triggered the exploring decision.<sup>49</sup>

The offshoring exploration productivity cutoff, i.e. the least productive final good producer exploring the offshoring potential, at any period  $t$  is defined in Proposition 2.

**Proposition 2** (Per-period offshoring exploration productivity cutoff). *The offshoring exploration productivity cutoff at any period  $t$ , denoted as  $\tilde{\theta}_{t+1}^S$ , is given by:*

$$\tilde{\theta}_{t+1}^S = \min \left\{ \tilde{\theta}_{O,t+1}^S; \tilde{\theta}_{V,t+1}^S \right\}$$

<sup>47</sup>All the proofs and derivations can be found in Appendix D.5.

<sup>48</sup>In the case of  $H$ -intensive sectors  $V$  refers to  $V_H$ . Forward integration is strictly dominated by the other organisational types. Therefore, it is not considered as a potentially profitable alternative. Instead, in  $M$ -intensive sectors,  $V$  indicates  $V_M$ . Backward integration is strictly dominated by the other types. Thus, it is not considered as a potentially profitable alternative.

<sup>49</sup>I analyse the final good producer's choice of the offshoring type after discovering both fixed costs (see Proposition 3), after I characterise the exploration decision and the associated evolution of the offshoring productivity cutoff over time.

where  $\tilde{\theta}_{O,t+1}^S$  and  $\tilde{\theta}_{V,t+1}^S$  are defined by the fixed points:

$$\begin{aligned} \mathcal{D}_{V,t}(\tilde{\theta}_{V,t+1}^S; \theta_t^S, \tilde{\theta}_{t+1}^S) = 0 &\Rightarrow \mathbb{E}_t \left[ \pi_{V^S/V^N,t}^{prem}(\tilde{\theta}_{V,t+1}^S) \mid f_V^S \leq f_{V,t}^S \right] = w^N s^r \left[ 1 - \lambda \frac{Y(f_{V,t+1}^S)}{Y(f_{V,t}^S)} \right] \\ \mathcal{D}_{O,t}(\tilde{\theta}_{O,t+1}^S; \theta_t^S, \tilde{\theta}_{t+1}^S) = 0 &\Rightarrow \mathbb{E}_t \left[ \pi_{O^S/V^N,t}^{prem}(\tilde{\theta}_{O,t+1}^S) \mid f_O^S \leq f_{O,t}^S \right] = w^N s^r \left[ 1 - \lambda \frac{Y(f_{O,t+1}^S)}{Y(f_{O,t}^S)} \right] \end{aligned}$$

Solving these expressions for  $\tilde{\theta}_{O,t+1}^S$  and  $\tilde{\theta}_{V,t+1}^S$ :

$$\begin{aligned} \tilde{\theta}_{O,t+1}^S &= (\gamma E)^{\frac{\sigma}{1-\sigma}} \tilde{Q}_t \left[ \frac{w^N \left[ \mathbb{E}(f_O^S \mid f_O^S \leq f_{O,t}^S) - f_V^N + s^r \left( 1 - \lambda \frac{Y(f_{O,t+1}^S)}{Y(f_{O,t}^S)} \right) \right]}{\psi_O^S(\eta) - \psi_V^N(\eta)} \right]^{\frac{1}{\sigma-1}} \\ \tilde{\theta}_{V,t+1}^S &= (\gamma E)^{\frac{\sigma}{1-\sigma}} \tilde{Q}_t \left[ \frac{w^N \left[ \mathbb{E}(f_V^S \mid f_V^S \leq f_{V,t}^S) - f_V^N + s^r \left( 1 - \lambda \frac{Y(f_{V,t+1}^S)}{Y(f_{V,t}^S)} \right) \right]}{\psi_V^S(\eta) - \psi_V^N(\eta)} \right]^{\frac{1}{\sigma-1}} \end{aligned}$$

As mentioned above, the offshoring productivity cutoff, i.e. the least productive firm that explores her offshoring potential in period  $t$ , is defined by the minimum of these two values.

After paying the offshoring market research sunk cost, the final good producer discovers  $f_O^S, f_{V_H}^S, f_{V_M}^S$ . With this information, she must choose the most profitable organisational structure among the offshoring types and domestic integration. This decision is characterised by Proposition 3.

**Proposition 3** (Organisational choice after exploration). *After paying  $w^N s^r$  in period  $t$ , the final good producer discovers the true values of  $f_O^S, f_{V_H}^S$  and  $f_{V_M}^S$ , and she must choose an organisational type.*

*The final good producer with productivity  $\theta$  chooses FDI,  $V$ , when:*

$$\pi_{V^S/O^S,t}^{prem}(\theta) = \pi_{V,t}^S(\theta) - \pi_{O,t}^S(\theta) \geq 0$$

*She chooses arm's length trade when:*

$$\pi_{O^S/V^N,t}^{prem}(\theta) = \pi_{O,t}^S(\theta) - \pi_{V,t}^N(\theta) \geq 0 \quad \text{and} \quad \pi_{V^S/O^S,t}^{prem}(\theta) < 0$$

*Otherwise, she remains under domestic integration.*

From Proposition 3, it is possible to derive the FDI productivity cutoff in period  $t$ , i.e. the least

productive final good producer that has chosen FDI after paying the sunk cost in period  $t$ :

$$\theta_{V,t+1}^S = \max \left\{ \tilde{\theta}_{t+1}^S; \theta_{V,t+1}^{S,\bullet} \right\} \quad (22)$$

with

$$\pi_{V^S/O^S,t}^{prem}(\theta_{V,t+1}^{S,\bullet}) = 0 \Rightarrow \theta_{V,t+1}^{S,\bullet} = (\gamma E)^{\frac{\sigma}{1-\sigma}} \tilde{Q}_t \left[ \frac{w^N [f_V^S - f_O^S]}{\psi_V^S(\eta) - \psi_O^S(\eta)} \right]^{\frac{1}{\sigma-1}} \quad (23)$$

## 5.2 H- and M-intensive sectors: Long-run properties of the trade-off function.

Let's define  $\hat{t}$  as the earliest period in which:  $\tilde{\theta}_{\hat{t}+1}^S \leq \theta_{V,\hat{t}+1}^{S,\bullet}$ . For any  $t > \hat{t}$ , the FDI- $V$  productivity cutoff is given by equation (23).

Simultaneously, at any  $t > \hat{t}$ , the offshoring productivity cutoff  $\tilde{\theta}_{t+1}^S$  is given by  $\tilde{\theta}_{O,t+1}^S$ , with

$$\Rightarrow \tilde{\theta}_{t+1}^S = (\gamma E)^{\frac{\sigma}{1-\sigma}} \tilde{Q}_t \left[ \frac{w^N \left[ \mathbb{E}(f_O^S | f_O^S \leq f_{O,t}^S) - f_V^N + s^r \left( 1 - \lambda \frac{Y(f_{O,t+1}^S)}{Y(f_{O,t}^S)} \right) \right]}{\psi_O^S(\eta) - \psi_V^N(\eta)} \right]^{\frac{1}{\sigma-1}}$$

**Proposition 4** (Convergence of offshoring productivity cutoff). *The sector converges asymptotically to the perfect information equilibrium,  $\theta_t^S \xrightarrow{t \rightarrow \infty} \theta^{S,*} = \theta_O^{S,*}$ , when:*

$$\text{Case I: } f_O^S = \underline{f}_O^S \Rightarrow f_{O,\infty}^S = \underline{f}_O^S$$

$$\text{Case II: } \underline{f}_O^S + (1 - \lambda)s^r < f_O^S$$

*Hysteresis takes places, i.e. convergence leads to some "excess" of offshoring, when:*

$$\text{Case III: } \underline{f}_O^S + (1 - \lambda)s^r = f_O^S \Rightarrow \theta_t^S \xrightarrow{t \rightarrow \infty} \theta_O^{S,-r}$$

$$\text{Case IV: } \underline{f}_O^S + (1 - \lambda)s^r > f_O^S > \underline{f}_O^S \Rightarrow \theta_t^S \xrightarrow{t \rightarrow \infty} \theta_{O,\infty}^S$$

with  $\theta_O^{S,*} > \theta_{O,\infty}^S > \theta_O^{S,-r}$ , and  $\theta_O^{S,-r}$  denoting the case where the marginal firms obtain zero per period offshoring profit premium by doing arm's length trade, i.e. firms who cannot recover  $w^N s^r$ .

Figure 11a illustrates the cases characterised in Proposition 4. Depending on the optimistic level of the priors,  $\hat{t}$  may take place right in the first period, i.e.  $\hat{t} = 0$ , or in any finite period after the initial one. Under Case II,  $\hat{t}$  takes place necessary before the period in which the convergence stops. This is a natural consequence of the sequential offshoring process.

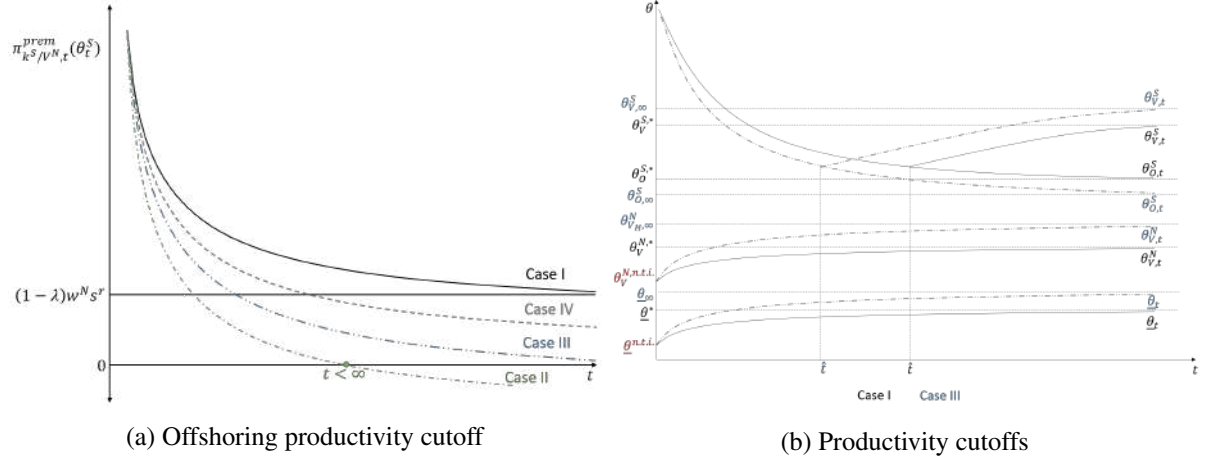


Figure 11:  $H$ - and  $M$ -intensive sectors. Equilibrium paths

### 5.3 $H$ - and $M$ -intensive sectors: Competition effect and the disintegration dynamics.

As more firms explore their offshoring potential the offshoring productivity cutoff converges to the perfect information steady state, and thus the price index and the aggregate consumption converges to their respective perfect information equilibrium states.

#### 5.3.1 Effect on the smallest and least productive firms in the market.

The decreasing price index intensifies the competition in the final good market, pushing sequentially the least productive final good producers out of the market. Formally, as  $P_t \downarrow P^*$  and  $Q_t \uparrow Q^*$ , the market productivity cutoff  $\underline{\theta}_t \uparrow \underline{\theta}^*$ .

#### 5.3.2 Effects on offshoring firms: regime change and sequential disintegration.

Recall the definition of  $\hat{t}$  as the earliest period in which  $\tilde{\theta}_{t+1}^S \leq \theta_{V,\hat{t}+1}^{S,\bullet}$ . Therefore, equation (23) defines the FDI productivity cutoff at the end of period  $t$  for any  $t > \hat{t}$ . It is straightforward to see that as  $P_t \downarrow P^*$ , the FDI- $V$  productivity cutoff converges, after  $\hat{t}$ , from below to the perfect information steady state:  $\theta_{V,t}^S \uparrow \theta_V^{S,*}$ .

Some of the early offshoring final good producer have chosen FDI- $V$  as a temporal organisational form. However, as the competition intensifies, they find optimal to separate into two independent specialised firms and switch to arm's length trade<sup>50</sup>.

This reflects a non-monotonic behaviour of the FDI productivity cutoff over time. It manifests itself as a regime change or a reorganisation of the supply chain in the least productive final good producers

<sup>50</sup>For simplicity, I assume that there are zero cost of reorganisation of the supply chain when they switch from FDI to foreign outsourcing. The introduction of a sunk cost of disintegration would simply shift upwards the productivity level defined by conditions in the period  $\hat{t}$ .

that have initially chosen FDI.

The increasing competition in the final good market shrinks the total revenues, and through this effect it diminishes the outside options of the bargaining stage of the final good producer under integration. The latter effect impacts directly into a reduction of the revenue share of the final good producer under integration. Therefore, a subset of final good producer under FDI face that the gains from integration cannot compensate the higher managerial costs of that organisational type. This generates an incentive in those final good producers to sequentially shift the regimen from FDI towards arm's length trade.

### 5.3.3 Effects on middle size firms: sequential disintegration of domestically integrated.

Is it easy to observe that the decreasing price index induces a sequential disintegration of the supply chains of the domestically integrated final good producers. In other words, the more intense competition in the final good market leads to an increment in the productivity cutoff for domestic integration, i.e.  $\theta_{V,t}^N \uparrow \theta_V^{N,*}$ .

As before, due to the effect of the increasing competition on the revenues, some domestically integrated final good producers discover that the gains from integration can no longer compensate for the larger managerial or governance costs. Thus, they sequentially shift the organisation of their supply chain towards independent northern manufacturers.

The domestic integration productivity cutoff for any period  $t$  is defined by the condition:

$$\pi_{V^N/O^N}^{prem}(\theta_{V,t+1}^N) = \pi_V^N(\theta_{V,t+1}^N) - \pi_O^N(\theta_{V,t+1}^N) = 0$$

with the respective productivity cutoff given by:

$$\theta_{V,t+1}^N = (\gamma E)^{\frac{\sigma}{1-\sigma}} \tilde{Q}_t \left[ \frac{w^N [f_V^N - f_O^N]}{\psi_V^N(\eta) - \psi_O^N(\eta)} \right]^{\frac{1}{\sigma-1}}$$

**Proposition 5** (Convergence properties of domestic productivity cutoffs). *As the offshoring productivity cutoff converges to the steady state defined by Proposition 4, the intensified competition*

1. *pushes sequentially the least productive final good producers out of the market.*

$$\left\{ \begin{array}{ll} \text{Cases I and II: } \underline{\theta}_t \uparrow \underline{\theta}^* & \text{if } \theta_t^S \downarrow \theta^{S,*} \\ \text{Case III: } \underline{\theta}_t \uparrow \underline{\theta}^{-r} & \text{if } \theta_t^S \downarrow \theta^{S,-r} \\ \text{Case IV: } \underline{\theta}_t \uparrow \underline{\theta}_\infty \in (\underline{\theta}^*; \underline{\theta}^{-r}) & \text{if } \theta_t^S \downarrow \theta_\infty^S \in (\theta^{S,-r}; \theta^{S,*}) \end{array} \right.$$

2. induces a sequential vertical disintegration of final good producers sourcing domestically.

$$\left\{ \begin{array}{ll} \text{Cases I and II: } \theta_{V,t}^N \uparrow \theta_V^{N,*} & \text{if } \theta_t^S \downarrow \theta^{S,*} \\ \text{Case III: } \theta_{V,t}^N \uparrow \theta_V^{N,-r} & \text{if } \theta_t^S \downarrow \theta^{S,-r} \\ \text{Case IV: } \theta_{V,t}^N \uparrow \theta_{V,\infty}^N \in (\theta_V^{N,*}; \theta_V^{N,-r}) & \text{if } \theta_t^S \downarrow \theta_\infty^S \in (\theta^{S,-r}; \theta^{S,*}) \end{array} \right.$$

Figure 11b illustrates the equilibrium path of the domestic and offshoring productivity cutoffs in the long run for the Case I (*solid line*) and the Case III (*dashed line*). The Case IV can be represented by any path between I and III.

## 6 Multiple countries: Supply chain relocation, competition intensity and disintegration

Assume now that the world economy has three countries: East ( $E$ ), North ( $N$ ) and South ( $S$ ). The production of the services  $x_h$  is still only possible in the North, but the the intermediate inputs  $x_m$  can be supplied by manufacturers in any location.

The main goal is to extend the previous analysis and characterise the relocation dynamics across offshoring locations after an institutional reform in one foreign country (the East). Under such conditions, I study the consequences of the competition effect on the ownership structure.

I assume that East have lower marginal costs that South, but the institutional fundamentals are better in the last location<sup>51</sup>. In consider other cases in appendix E. Additionally to assumption A.2, the assumption A.5 defines formally the marginal costs differences and the institutional fundamental conditions in foreign countries<sup>52</sup>.

**Assumption A. 5.** *Wages are higher in the South than in the East, but institutional fundamentals are better in South for each organisational type. Furthermore, I assume the ranking of foreign organisational fixed costs:*

$$w^E < w^S < w^N \quad ; \quad f_O^S < f_V^S < f_O^E < f_V^E \quad \text{with } V = V_H, V_M$$

However, the condition on institutional fundamentals is unknown to the final good producers when I introduce uncertainty in section 6.2.

<sup>51</sup>If  $f_k^E \leq f_k^S$ , no final good producer finds optimal to offshore from South under any organisational type. Therefore, only offshoring types  $O^E, V^E$  are observable in perfect information equilibrium.

<sup>52</sup>An additional simplifying assumption is that the offshoring sunk cost  $w^N s^r$  is homogeneous across countries.



The focus below is on the  $M$ - and  $H$ - intensive sectors' dynamics and, as before, I analyse both industries together.

Given assumptions A.2 and A.5, together with the assumption that  $\psi_O^E(\eta) > \psi_V^S(\eta)$ <sup>53</sup>, the sectoral organisational equilibrium under perfect information is represented by:

$$\underline{\theta}^* < \theta_V^{N,*} < \theta_O^{S,*} < \theta_V^{S,*} < \theta_O^{E,*} < \theta_V^{E,*} \quad (24)$$

## 6.1 Perfect information equilibrium

The lower wage in the East compared to the South allows the most productive producers in the market to realise higher gains from offshoring by reducing further down their marginal costs. This leads to differences in the perfect information equilibrium sectoral variables of the case where only offshoring from South is possible (section 3.2) compared to the situation where offshoring is feasible from both countries.

$$P^{(S)} > P^* \quad ; \quad Q^{(S)} < Q^* \quad (25)$$

where  $(S)$  denotes the value of the variables of the equilibrium in Section 3.2, and  $*$  denotes now the perfect information equilibrium conditions for this multiple-countries model.

The impact on the productivity cutoffs of the higher competition intensity in the final good market ( $P^{(S)} > P^*$ ), is represented by<sup>54</sup>:

$$\underline{\theta}^{(S)} < \underline{\theta}^* \quad ; \quad \theta_V^{N,(S)} < \theta_V^{N,*} \quad ; \quad \theta_O^{S,(S)} < \theta_O^{S,*} \quad ; \quad \theta_V^{S,(S)} < \theta_V^{S,*} \quad (26)$$

## 6.2 Institutional reform in East: Model setup and initial conditions

I assume that the economy starts from the steady state of a world economy where offshoring is only possible from the South, and there is no uncertainty about the institutional conditions in this country.

There is an institutional reform in  $t = 0$  in the East, but the northern final good producers have uncertainty about the scope of those reforms. In consequence, the final good producers build some priors based on the credibility of the announcement of the eastern government. As before, the prior uncertainty

<sup>53</sup>The assumption  $\psi_O^E(\eta) > \psi_V^S(\eta)$  implies that the gains from the lower marginal costs in the East with respect to South compensates the loss from a less efficient allocation of property rights of vertical integration in South with respect to East. If the gains from the lower marginal costs are not large enough, the ranking of organisational types is still as depicted in equation (24), but without observing any producer under  $O^E$ .

<sup>54</sup>In the case of  $(S)$  equilibrium conditions, there is no offshoring from East under any organisational type, i.e.  $\theta_k^{E,(S)} \rightarrow \infty$  for  $k = O, V_H, V_M$ . Therefore,  $\theta_O^{E,(S)} > \theta_O^{E,*}$  and  $\theta_V^{E,(S)} > \theta_V^{E,*}$ .

is given by:

$$\begin{aligned}
f_O^E &\sim Y(f_O^E) & \text{with} & & f_O^E &\in [f_O^E, \bar{f}_O^E] \\
f_{V_H}^E &\sim Y(f_{V_H}^E) & \text{with} & & f_{V_H}^E &\in [f_{V_H}^E, \bar{f}_{V_H}^E] \\
f_{V_M}^E &\sim Y(f_{V_M}^E) & \text{with} & & f_{V_M}^E &\in [f_{V_M}^E, \bar{f}_{V_M}^E]
\end{aligned} \tag{27}$$

and the learning mechanism is defined as in section 4.1, but instead with respect to the organisational fixed costs in East.

### 6.3 Exploration decision of offshoring potential in East: Relocation and competition

Each final good producer, who have not explored yet the offshoring potential in East, must decide whether to explore or wait one more period under her current organisational form  $k'$ . Notice that  $k'$  may denote a domestic sourcing type ( $O^N, V^N$ ) or an offshoring type from South ( $O^S, V^S$ ). The producer  $\theta$  decision for type  $k$  in  $t$  is defined by:

$$\mathcal{V}_{k,t}(\theta; \theta_t^E) = \max\{V_{k,t}^o(\theta; \theta_t^E); V_{k,t}^w(\theta; \theta_t^E)\}; \text{ for } k = O^E, V_H^E, V_M^E$$

with  $\theta_t^E = \{\theta_{O,t}^E, \theta_{V_H,t}^E, \theta_{V_M,t}^E\}$  denoting the state of the sector in period  $t$ .

The value of exploring the offshoring potential of a final good producer  $\theta$  in  $t$  under type  $k$  is given by the expected discounted profit premium of that type  $k$  with respect to its current organisational type  $k'$ , net of the offshoring sunk cost  $w^N s^r$ :

$$V_{k,t}^{o;E}(\theta; \theta_t^E) = \mathbb{E}_t \left[ \max \left\{ 0; \sum_{\tau=t}^{\infty} \lambda^{\tau-t} \pi_{k/k',\tau}^{\text{prem}}(\theta) \right\} \middle| f_k^E \leq f_{k,t}^E \right] - w^N s^r$$

The respective value of waiting is defined as:

$$\mathcal{V}_{k,t}^w(\theta; \theta_t^E) = 0 + \lambda \mathbb{E}_t[\mathcal{V}_{k,t+1}(\theta; \theta_{t+1}^E)]$$

The Bellman's equation for each offshoring type  $k$  from East for a producer  $\theta$  in  $t$  takes the form:

$$\mathcal{V}_{k,t}(\theta; \theta_t^E) = \max \{ V_{k,t}^o(\theta; \theta_t^E); \lambda \mathbb{E}_t[\mathcal{V}_{k,t+1}(\theta; \theta_{t+1}^E)] \} \tag{28}$$

By an equivalent assumption to A.3, it is possible to derive the following trade-off function:

$$\mathcal{D}_{k/k',t}(\theta; \theta_t^E, \tilde{\theta}_{t+1}^E) = \max \left\{ 0; \mathbb{E}_t \left[ \pi_{k/k',t}^{\text{prem}}(\theta) \middle| f_k^E \leq f_{k,t}^E \right] \right\} - w^N s^r \left[ 1 - \lambda \frac{Y(f_{k,t+1}^E)}{Y(f_{k,t}^E)} \right] \tag{29}$$

The trade-off function results in an exploration that is led by the most productive final good producers in the market<sup>55</sup>. Therefore, the sector shows a sequential offshoring path towards East that starts as a relocation process. The final good producers, who are originally offshoring from South, start sequentially to relocate their supply chain to the East<sup>56</sup>.

**Relocation and competition effect: disintegration.** As more final good producers explore their offshoring potential in East, they sequentially relocate their supply chain to this country. The relocation allows the final good producer to exploit the lower marginal costs offered by contracting eastern suppliers, driving the price index further down as the sequential offshoring flow continues. Thus, the aggregate consumption index increases and the competition in the final good market intensifies.

The increase in competition from the relocation phase of the dynamic equilibrium path has direct effects on the other productivity cutoffs in the market.

As  $\theta_{O,t}^E \downarrow \theta_O^{E,*}$  and  $\theta_{V,t}^E \rightarrow \theta_V^{E,*}$  :<sup>57</sup>

$$\underline{\theta}_t \uparrow \underline{\theta}^* \quad ; \quad \theta_{V,t}^N \uparrow \theta_V^{N,*} \quad ; \quad \theta_{O,t}^S \uparrow \theta_O^{S,*} \quad ; \quad \theta_{V,t}^S \uparrow \theta_V^{S,*} \quad (30)$$

In other words, the increase in competition induces a sequential disintegration of domestic producers and producers offshoring from South. It also generates the exit of the least productive producers from the market. An additional effect is a potential reshoring decision of the least productive producers offshoring from South. However, I describe in section 6.4 a case where this reshoring may not be observed.

#### 6.4 Additional considerations on equilibrium paths: Sequential institutional shocks

If the institutional reform in the East takes place before the sector reaches the steady state defined in section 5 and denoted here as ( $S$ ), it may be possible that the reshoring characterised above is not observed<sup>58</sup>.

The main condition is that the institutional reform in the East takes place at a period  $t$  where  $\theta_t^S > \theta_O^{S,*}$ , i.e. when the offshoring exploration cutoff to South is still above the new steady state level of the offshoring productivity cutoff in South. A second condition is that the priors beliefs about conditions in the East must be optimistic enough such that the offshoring exploration of the East is faster than the

<sup>55</sup>Regarding the properties of the trade-off function and the sectoral equilibrium path, the Propositions 1 to 5 still hold. For proofs see Appendix E.

<sup>56</sup>As before, I assume that at least the most productive final good producer in the market finds profitable to explore the offshoring potential in the East under at least one type  $k$ , i.e.  $\mathcal{D}_{k/k',t=0}(\bar{\theta}; \bar{\theta}, \bar{\theta}) > 0$

<sup>57</sup>Recall that the FDI productivity cutoff shows a non-monotonic equilibrium path. See section 5.3.2 and appendix E.

<sup>58</sup>I describe here one case. For a complete analysis of the multiple equilibria with simultaneous institutional reforms, see Larch and Navarro (2021).

exploration flow to the South. Under such conditions, the convergence of the relocation from South to East takes place before the offshoring exploration flow to South finishes.

## 7 FTA and organisational dynamics under uncertainty

In this section I develop a simple extension of the model to characterise a role that free trade agreements may play in order to trigger a sequential exploration of a new location. I highlight additional effects that may emerge when the agreements are analysed in a context of uncertainty about the general institutional conditions in the partner country.

I define now the marginal cost for a northern producer of a intermediate input source from  $l$  as  $c_t^l = \tau_{m,t}^l w^l$ , where  $\tau_{m,t}^l$  captures the associated trade costs relative to the location  $l = N, E, S$ . I define  $\tau_{m,t}^l = 1$  when the tariffs are zero with respect to the country  $l$ . Therefore,  $\tau_{m,t}^N = 1 \forall t$ .

### 7.1 Two-country model: North-South FTA

The sectoral initial conditions are defined by a situation where there is free trade in the final goods, but a positive tariff in the intermediate inputs, i.e.  $\tau_{m,t}^S > 1$  for any  $t < 0$ . In  $t = 0$  a FTA between North and South takes place, and thus all the tariffs are removed. Therefore  $\tau_{m,t}^S = 1 \forall t \geq 0$ . I consider an extreme case where the FTA is limited to a tariff reduction, and has no implications in terms of institutional reforms. Therefore, with this assumption, the priors about the southern institutions are not directly affected by the agreement.

It is easy to see that if the tariffs in intermediate inputs previous to the FTA are large enough, such that  $c_t^S > c_t^N$ , no final good producer find it profitable to offshore from the South independently of the existence of uncertainty about southern institutions. In other words,  $\theta_O^S > \bar{\theta}$  and  $\theta_V^S > \bar{\theta}$ .

However, when initial tariffs are small enough such that  $c_t^S < c_t^N$ , it may be possible that under perfect information some final good producers may find it profitable to offshore from the South, i.e.  $\theta_O^S < \bar{\theta}$  and/or  $\theta_V^S < \bar{\theta}$ . However, the prior beliefs may constrain all the northern final good producers to explore their offshoring potential in the South, when they are very pessimistic about the prevailing conditions in that country. This situation takes place when the following condition holds for any  $t < 0$  at the pre-agreement tariffs.

$$\mathcal{D}_{k,t}(\bar{\theta}; \bar{\theta}, \bar{\theta}, \tau_{m,t}^S) < 0 \quad \text{for all } k = O, V_H, V_M$$

and  $\bar{\theta}$  indicates the most productive final good producer in the differentiated sector. A necessary condition

is that the support of the distribution  $G(\theta)$  is bounded to the right, i.e.  $\bar{\theta} < \infty$ .

If the FTA reduces sufficiently the marginal cost for northern producer to contract with a southern supplier, it is possible that the reduction in tariffs induce an offshoring exploration at the given prior about southern institutions, i.e. at  $t = 0$ :

$$\mathcal{D}_{k,t=0}(\bar{\theta}; \bar{\theta}, \bar{\theta}, \tau_{m,t}^S) \geq 0 \quad \text{for at least one } k = O, V_H, V_M$$

## 7.2 Multicountry-model: North-East FTA

I define the initial conditions as a situation where offshoring is only profitable from the South. At any  $t < 0$ , there is free trade in the final goods, but the northern country sets positive tariffs on intermediate inputs, i.e.  $\tau_{m,t}^S = \tau_{m,t}^E > 1$ . In order to avoid a taxonomy of cases, I assume that at the current tariffs, the marginal costs of the intermediate inputs for the final good producers from each location are:  $c_t^E < c_t^S < c_t^N$ . As I have already shown above, under perfect information some final good producers may find it profitable to offshore from the East (see section 6.1) under such conditions.

However, when the prior beliefs about eastern institutions are pessimistic enough, no final good producer may find it attractive to explore the offshoring potential from the East at the given tariffs. Formally, this situation is represented by the condition below for any  $t < 0$ :

$$\mathcal{D}_{k/k',t}(\bar{\theta}; \bar{\theta}^E, \bar{\theta}^E, \tau_{m,t}^E, \tau_{m,t}^S) < 0 \quad \text{for all } k = O, V_H, V_M$$

In  $t = 0$  the FTA between North and East takes place, and the tariffs on intermediate inputs are removed for eastern suppliers, i.e.  $\tau_{m,t}^E = 1$ . As before, I assume that the FTA is limited to an agreement on tariffs, with no implications in institutional terms. Therefore, the prior beliefs about eastern institutions are not directly affected.

If the change in tariffs induces a large enough reduction in the marginal cost  $c_t^E$  relative to  $c_t^S$ , such at the most productive final good producer currently offshoring from South find it profitable to explore East for a potential supply chain relocation. Formally,

$$\mathcal{D}_{k/k',t=0}(\bar{\theta}; \bar{\theta}^E, \bar{\theta}^E, \tau_{m,t}^E, \tau_{m,t}^S) \geq 0 \quad \text{for at least one } k = O, V_H, V_M$$

To conclude, I showed that the changes in tariffs associated to a FTA or a preferential trade agreement may have some additional effect relative to those directly associated to the tariff change. In particular, when institutional uncertainty is present, small reductions in intermediate input tariffs may create enough

incentives for the most productive final good producers in the market to explore the offshoring potential in those locations, and thus trigger the sequential offshoring equilibrium path characterised above.

Moreover, when the FTA comprehends institutional bindings<sup>59</sup> additional to the tariffs reductions, the agreement have thus a direct impact on the prior beliefs about the institutional conditions in the partner country. Therefore, the tariffs reduction together with the institutional bindings boosts the offshoring exploration of that country with the potential relocation of supply chains towards that location.

## 8 Empirics: dynamic model

Using the US manufacturing sector-level data for the period 2002-2016 described above, I test for the consistency of the empirical sectoral dynamics with the theoretical predictions of the dynamic model with uncertainty.

The main theoretical predictions, in particular those related to the effects of competition intensity on disintegration decisions, are analysed in section 8.1. I focus in both mechanisms identified above: i) the effect of the increase in offshoring activity that results from the sequential offshoring exploration; ii) the effect of relocation of the offshoring supply chains towards other foreign locations with lower marginal costs. In section 8.2, I show supporting evidence for the predictions from Proposition 3, i.e. the organisational choices dynamics at the initial exploration periods. Section 8.3 analyses the effects of different types of institutional shocks in the exploration decision of new locations. The latter aims for capturing the effects of institutional shocks on prior beliefs, which potentially trigger the sequential exploration of a new country.<sup>60</sup>

### 8.1 Competition effect: sequential offshoring and relocation

I begin with the description of stylised facts and general evidence. Later, in section 8.1.2, I introduce the empirical model for the competition effect and the respective results.

#### 8.1.1 Stylised facts and main empirical trends

Figure 12a<sup>61</sup> shows that both types of supplier industries have experienced a positive trend in total imports. This behaviour is consistent with the increasing offshoring activity of US firms shown in Feenstra

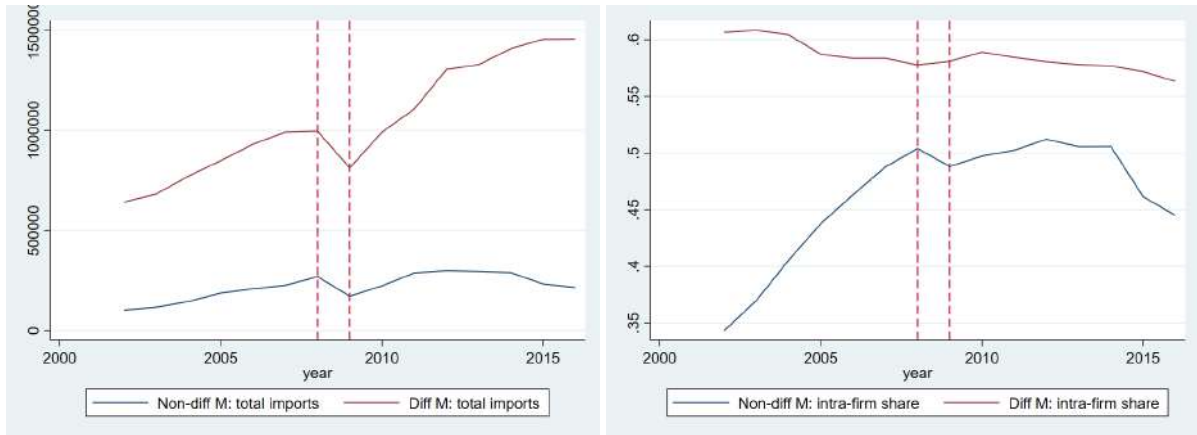
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<sup>59</sup>With institutional bindings I refer to regulatory agreements that define a lower bound for the institutional quality of each country member. Therefore, the FTA may not induce a change in fundamentals when the country's institutions are already within the bounds defined in the agreement. This bindings impact in our model through a reduction in the upper bound of the prior distribution of the fixed organisational costs relative to the members in the FTA.

<sup>60</sup>For a structural estimation of the learning mechanism, see Larch and Navarro (2021).

<sup>61</sup>The vertical lines indicate the global financial crisis shock.

(1998). Additionally, Figure 12b illustrates a positive trend in the participation of independent suppliers in US imports, in particular in the differentiated supplier's industries<sup>62</sup>, which may be explained by a progressive vertical disintegration of the value chains among the offshoring firms (Feenstra, 1998).



(a) Total imports, millions USD: by  $M$  sector type

(b) Intra-firm import share: by  $M$  sector type

Figure 12: US imports by input-sector type

From the perspective of the dynamic model with uncertainty, the sequential offshoring equilibrium path increases the intensity of competition in the final good markets, and thus it eventually leads to a sequential vertical disintegration of the offshoring firms. From a broad perspective offered by Figure 12, the positive trend in total imports in the differentiated sectors, as well as with the negative trend in the share of intra-firm imports, are consistent with the sectoral equilibrium path characterised in Section 5.

**Institutional reform: Access of China to WTO.** The access of China to the WTO in December 2001 has had a deep impact on the global organisation of supply chains. In that context, Handley and Limão (2017) showed that the membership of China in WTO impacted in the reduction of the tariffs' uncertainty in US for Chinese products, which resulted in an increase in the exports flows from China to the US. In other words, the authors show that after controlling for tariffs changes, a significant share of the export growth is explained by the reduction in the uncertainty about future tariffs.

However, Figure 13 shows a slow and progressive increase in the imports from China relative to other foreign locations, which may reflect a remaining effect of a residual uncertainty beyond the tariffs dimension addressed by Handley and Limão (2017). In this sense, the low market share of China in 2002 and its progressive increase in the years following the WTO membership is in line with the sequential offshoring exploration dynamics and the sequential relocation predicted by the theoretical model above. In particular, a sequential offshoring exploration and relocation towards China results in a progressive

<sup>62</sup>There is a more stable behaviour pattern in the sense that the trend shows a consistently negative trend all over the period, except during the financial crisis. During the crisis it showed a small increase, but it returned quickly to the decreasing trend.

increase of the market share of China over time. Figure 13 shows that the aggregate market share of China in the US imports is growing up to 10 years after the reform. However, although China's market share has increased in both sectors, the Chinese products show a higher and more dynamic penetration in differentiated supplier's industries. In this sense, the model complements the findings in Handley and Limão (2017).

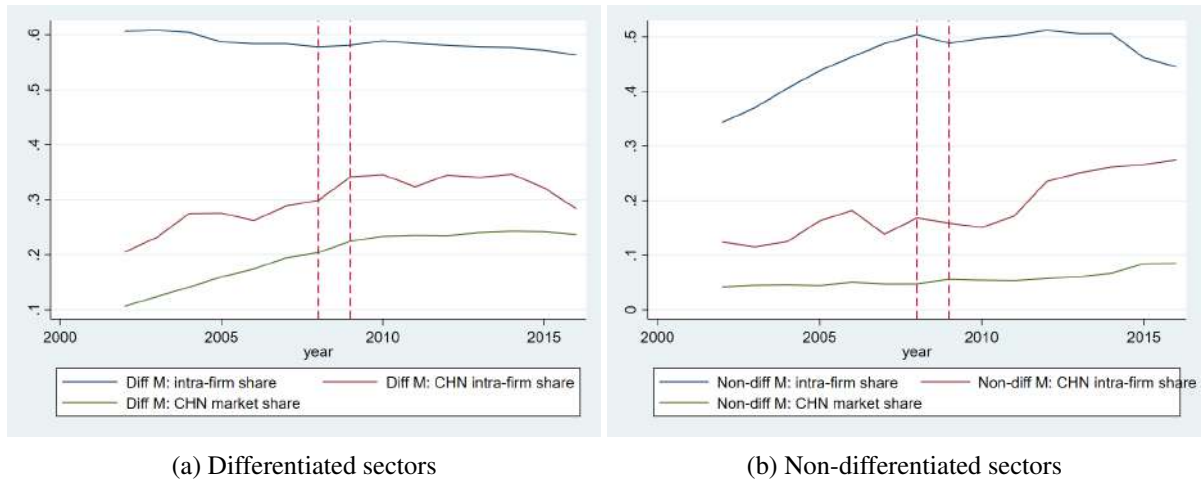


Figure 13: Intra-firm shares and China market-share, by  $M$  sector type

The period covered by the data on imports imposes limitations for a direct control of the Chinese institutional shock. Nevertheless, it may still shed light on the sectoral dynamics predicted by the model of section 6, in particular about the effect of the relocation channel of the competition effect on vertical disintegration.<sup>63</sup>

I focus the analysis in how this institutional reform may have created incentives for the US firms to begin a sequential exploration of the offshoring potential from China. I will test for both channels of this exploration: i) the exploration of domestic sourcing firms, which should be reflected by an increase in the offshoring share, and ii) the exploration driven by a relocation process of foreign suppliers.

Figure 13a shows a possible theory-consistent relation between the penetration of China in the US market and the total intra-firm imports. In particular, the negative trend in the total intra-firm trade may be a response to increasing competition in the final-good markets, which comes from the relocation of suppliers towards a location with lower marginal costs (China) compared to the previous configuration of the supply chain.

<sup>63</sup>In a future version of the paper, I will introduce WTO access and institutional shocks for other potential locations, as well as a direct measure of the marginal costs gains from relocation towards those countries.



### 8.1.2 Identification of the empirical model and estimation results.

Given the non-linear nature of the model, I estimate the effects on the intra-firm import share by a fractional logit model. The main specification is thus given by:

$$\mathbb{E} \left[ IFshr_{m,j,l,t} \mid \mathbf{x} \right] = \frac{\exp(\mathbf{x}'_{m,j,l,t} \boldsymbol{\rho})}{1 + \exp(\mathbf{x}'_{m,j,l,t} \boldsymbol{\rho})} \quad (31)$$

with  $IFshr_{m,j,l,t}$  as the intra-firm import share in input  $m$  from country  $l$  in year  $t$  of sector  $j$ , and  $\mathbf{x}$  refers to the vector of explanatory variables.

$$\mathbf{x}'_{m,j,l,t} \boldsymbol{\rho} = \rho_1 \text{ offshr } shr_{j,t} + \rho_2 \text{ CHN mrkt } shr_{m,t} + \text{ other controls} + \rho_l + \rho_t \quad (32)$$

The effect that comes from the sequential offshoring activity is proxied by  $\text{offshr } shr_{j,t}$ . The offshoring share is defined as:

$$\text{offshr } shr_{j,t} = \frac{\text{sectoral total input imports}_{j,t}}{\text{sectoral total sales}_{j,t}}$$

The effect coming from the relocation of suppliers among foreign locations, in particular relocation of suppliers to China, is capture by  $\text{CHN mrkt } shr_{m,t}$ , which represents the market share of China in US imports in input  $M$  in year  $t$ . Finally,  $\rho_{l,t}$  refers to country-year fixed effects.

Among the other controls, I include the degree of differentiation of the supplier industry,  $M \text{ diff} \in [0, 1]$ , based on Rauch's classification. The intuition is that the higher differentiation of the supplier industry may be link to higher relationship-specific investments, and thus to a higher contract dependency of the relationship. As already mentioned, this measure is equivalent to the contract dependence index for the supplier's industry of Nunn (2007). Additionally, I control for the  $H$  differentiation level based on Rauch's classification, with  $\text{diff} \in [0, 1]$ .

Finally, I control for the mean tariffs of sector  $M$  for each year with respect to each foreign location.

**H-perspective.** This perspective aggregates the data at the final good producer sectors level. Therefore, the empirical model is given by:

$$\mathbb{E} \left[ IFshr_{j,l,t} \mid \mathbf{x} \right] = \frac{\exp(\mathbf{x}'_{j,l,t} \boldsymbol{\rho})}{1 + \exp(\mathbf{x}'_{j,l,t} \boldsymbol{\rho})} \quad (33)$$

where  $IFshr_{j,l,t}$  indicates the intra-firm import share of sector  $j$  from country  $l$  in year  $t$ . The vector of explanatory variables is defined by:

$$\mathbf{x}'_{j,l,t}\boldsymbol{\rho} = \rho_1 \text{ offshr } shr_{j,t} + \rho_2 \text{ CHN mrkt } shr_{j,t} + \text{ other controls} + \rho_l + \rho_t \quad (34)$$

where  $\text{CHN mrkt } shr_{j,t}$  indicates the weighted mean of China market share in inputs imported by sector  $j$  in year  $t$ .

**M-perspective.** This perspective aggregates the data at the supplier sector level. The empirical model is given by:

$$\mathbb{E} \left[ IFshr_{m,l,t} \mid \mathbf{x} \right] = \frac{\exp(\mathbf{x}'_{m,l,t}\boldsymbol{\rho})}{1 + \exp(\mathbf{x}'_{m,l,t}\boldsymbol{\rho})} \quad (35)$$

where  $IFshr_{j,l,t}$  indicates the intra-firm import share in input  $m$  from country  $l$  in year  $t$ . The vector of explanatory variables is defined by:

$$\mathbf{x}'_{m,l,t}\boldsymbol{\rho} = \rho_1 \text{ offshr } shr_{m,t} + \rho_2 \text{ CHN mrkt } shr_{m,t} + \text{ other controls} + \rho_l + \rho_t \quad (36)$$

where  $\text{offshr } shr_{m,t}$  indicates the weighted mean of the offshoring share in year  $t$  of the final good producer sectors that use input  $m$ .

Table 2: Effects on intra-firm imports shares, differentiated sectors.

	Fractional logit: all countries					
	H perspective		M perspective		No aggregation	
	(1)	(2)	(3)	(4)	(5)	(6)
	$IFshr_{j,l,t}$	$IFshr_{j,l,t}$	$IFshr_{m,l,t}$	$IFshr_{m,l,t}$	$IFshr_{m,j,l,t}$	$IFshr_{m,j,l,t}$
$\ln(\text{offshr } shr)_{j,t}$	-0.00495*	-0.00631**	-0.0108***	-0.0130***	-0.00815***	-0.0102***
	(0.00286)	(0.00302)	(0.00209)	(0.00225)	(0.00221)	(0.00231)
$\ln(\text{CHN market } shr)_{m,t}$		0.00196		-0.0105***		-0.00767***
		(0.00326)		(0.00233)		(0.00226)
$\ln(1 + \text{tariff})_{m,l,t}$	-0.00649***	-0.00626***	-1.837***	-1.685***	-1.518***	-1.462***
	(0.00181)	(0.00179)	(0.228)	(0.229)	(0.219)	(0.217)

Other controls:  $H$  differentiation,  $M$  differentiation. Country and year fixed effects included.

Average marginal effects. Standard errors in parentheses.

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

**Regression results.** Table 2 shows a consistent negative effect of the offshoring activity in the intra-firm import share, which is consistent with the theoretical prediction of the model. As the offshoring activity increases, the competition intensity in the final good markets increases, leading to a progressive disintegration of the offshoring firms.

Regarding the second channel of the competition effect, i.e. the increase in the competition intensity caused by the sequential relocation decisions towards lower marginal costs countries<sup>64</sup>, the table shows that the market share of China has a significant negative impact on the intra-firm import share. Therefore, assuming that the relocation of supply chains to China is driven by the marginal costs advantages that this country offers to the offshoring firms, the increasing relocation of firms to China pushes the competition intensity further up, leading to a stronger vertical disintegration of the supply chains. The relocation to China of already offshoring supply chains is captured by the increasing market share of China after controlling for the sector offshoring share from any location.

## 8.2 Organisational choice after exploration and organisational sectoral convergence

The theoretical model predicts that the more productive final good producers in the market lead the offshoring exploration and the relocation decisions towards new foreign countries. As defined by Proposition 3, after discovering the institutional conditions in a foreign country, the final good producer choose the organisational form. While integration prevails in the initial periods, as more firms explore their offshoring potential, the offshoring activity under outsourcing increases and thus the intra-firm import share decreases.

I test for sectoral dynamics that are consistent with the theoretical predictions of the initial exploration periods, and the convergence to the steady state sectoral organisational structure. First, I show that the initial intra-firm share is higher relative to the steady state situation. Second, I analyse evidence that supports that the intra-firm import shares are higher at the period of a first time exploration of a country for  $H$ -intensive and  $M$ -intensive sectors relative to balanced-intensity sectors.

For the first analysis, I define the relative intra-firm import share in input  $m$  in period  $t$  from country  $l$  for the sector  $j$  as  $rel\ IFshr_{m,j,l,t}$ , which expressed in natural logarithm is given by:

$$\ln(rel\ IFshr)_{m,j,l,t} \equiv \ln \left[ \frac{IFshr_{m,j,l,t}}{IF\bar{shr}_{m,j,l}} \right]$$

where  $IF\bar{shr}_{m,j,l}$  is the mean intra-firm import share in input  $m$  from country  $l$  for the sector  $j$ . When the period since first exploration is sufficiently long, ceteris paribus, the latter approximates to the long-term sectoral organisational structure, i.e. a steady-state condition. According to the predictions of the model, the ratio is expected to be higher in the initial periods and progressively converge from above to the

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<sup>64</sup>The exploration of new countries to exploit the advantages from lower marginal costs, and the consequential relocation decision and reorganisation of the supply chain, is consistent with the model developed by Antras et al. (2017).

steady state intra-firm import share. The empirical model is given by:

$$\ln(\text{rel } IFshr)_{m,j,l,t} = \gamma_0 + \gamma_1 \ln(\text{years since expl})_{m,j,l,t} + \gamma_2 H \text{ int}_j + \gamma_3 M \text{ int}_j + \gamma_t + \gamma_l + \varepsilon_{m,j,l,t} \quad (37)$$

where *years since expl* indicates the years since the exploration for the first time in input *m* of country *l*, and *H int* and *M int* are dummy variables that indicate whether a sector is *H*-intensive or *M*-intensive. These dummies are defined as follows: first I compute the deciles of the  $\eta$  proxy defined by the mean value of the FA for each *H* sector. I define as *H*-intensive (*H int* = 1) those sectors in the 9th and 10th deciles, while *M*-intensive (*M int* = 1) are those in the 1st and 2nd deciles. Finally, the *B*-intensive sector (*B int*=1) are those in the 5th and 6th deciles. The other sectors are excluded from the sample when these dummies controls are included.

**H-perspective.** Considering the aggregation of the data at the final good producer sectors level, the empirical model is given by:

$$\ln(\text{rel } IFshr)_{j,l,t} = \gamma_0 + \gamma_1 \ln(\text{years since expl})_{j,l,t} + \gamma_2 H \text{ int}_j + \gamma_3 M \text{ int}_j + \gamma_t + \gamma_l + \varepsilon_{j,l,t} \quad (38)$$

where *rel IFshr*<sub>*j,l,t*</sub> indicates the respective ratio from country *l* in year *t* for the sector *j*, and *years since expl*<sub>*j,l,t*</sub> indicates the years since the sector *j* has imported for the first time from country *l* at least one input.

**M-perspective.** Considering the aggregation of the data at the supplier sector level, the empirical model is given by:

$$\ln(\text{rel } IFshr)_{m,l,t} = \gamma_0 + \gamma_1 \ln(\text{years since expl})_{m,l,t} + \gamma_2 H \text{ int}_m + \gamma_3 M \text{ int}_m + \gamma_t + \gamma_l + \varepsilon_{m,l,t} \quad (39)$$

where *years since expl*<sub>*m,l,t*</sub> indicates the years since the input *m* has been imported for the first time from country *l*. The dummy variables *H int*<sub>*m*</sub>, *M int*<sub>*m*</sub> and *B int*<sub>*m*</sub> are defined as above, but after computing the weighted mean FA at the input *m* level.

**Regression results.** Table 3 shows that the ratio is decreasing in the years since entry, which indicates that the intra-firm import share is larger at the initial period relative to its mean, and it converges progressively from above to the long-term equilibrium.

Regarding the coefficients associated to the dummies, they show the expected effects only for the *H*-perspective specification. When one of the parties is relative more important, i.e. when a sector at the

Table 3: Intra-firm shares since entry, relative to steady state organisational structure.

	All countries					
	H perspective		M perspective		No aggregation	
	(1)	(2)	(3)	(4)	(5)	(6)
$\ln(\text{years since expl})$	-0.781*** (0.0206)	-0.764*** (0.0262)	-0.0790*** (0.0118)	-0.0933*** (0.0165)	-0.0575*** (0.00352)	-0.0612*** (0.00490)
$H \text{ int}_j$		0.155*** (0.0412)		-0.0297 (0.0344)		0.00318 (0.00677)
$M \text{ int}_j$		0.141*** (0.0403)		-0.0209 (0.0413)		0.00407 (0.00656)

Other controls: technological relevance of input  $m$  in sector  $H$ ,  $H$  differentiation,  $M$  differentiation. Standard errors in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

extremes of the domain of the FA distribution is considered, the higher is the initial ratio relative to its mean. This is consistent with the model, given that integration would be observed only at the extremes of the domain of the FA.

As one step further in the identification of the last effect, I consider the following model in order to capture the relative prevalence of integration at the first exploration period, by sector type. As before, I consider the ratio relative to the long-term intra-firm share. The estimation results are reported in columns (5)-(8) of Table 4. As a complementary approach, I also compute the intra-firm share at the exploration period relative to the mean of the contemporaneous intra-firm shares from other locations. The ratio is defined by equations (40) and (42) for the  $H$ - and  $M$ -perspectives, respectively. The empirical models are defined by equations (41) and (43). The results for this model are reported in columns (1)-(4) of the same table.

$$\ln(\text{rel } \tilde{IFshr})_{j,l,t} \equiv \ln \left[ \frac{IFshr_{j,l,t}}{S^{-1} \sum_{l=1}^S IFshr_{j,l,t}} \right] \quad (40)$$

$$\ln(\text{rel } \tilde{IFshr})_{j,l,t} = \gamma_0 + \gamma_1 H \text{ int}_j + \gamma_2 M \text{ int}_j + \gamma_t + \gamma_l + \varepsilon_{j,l,t} \quad (41)$$

$$\ln(\text{rel } \tilde{IFshr})_{m,l,t} \equiv \ln \left[ \frac{IFshr_{m,l,t}}{S^{-1} \sum_{l=1}^S IFshr_{m,l,t}} \right] \quad (42)$$

$$\ln(\text{rel } \tilde{IFshr})_{m,l,t} = \gamma_0 + \gamma_1 H \text{ int}_m + \gamma_2 M \text{ int}_m + \gamma_t + \gamma_l + \varepsilon_{m,l,t} \quad (43)$$

**Regression results.** In both cases, I consider as robustness check a more extreme definition of the  $H$  and  $M$  intensive sectors, where  $H \text{ intensive} = 1$  if the sector is in the 10th decile, while  $M \text{ intensive} = 1$  if the sector is in the 1st decile of the FA domain. The definition of  $B$ -intensive sector remains the same

as before. Although the results do not contradict the theoretical predictions, the table 4 shows a very weak supporting evidence.

Table 4: Intra-firm shares at first exploration period of country  $l$  in input  $m$ .

	All countries							
	Relative to contemporaneous share				Relative to long term share			
	H perspective		M perspective		H perspective		M perspective	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	$\ln(\text{rel } \tilde{IFshr})_{j,t}$	$\ln(\text{rel } \tilde{IFshr})_{j,t}$	$\ln(\text{rel } \tilde{IFshr})_{j,t}$	$\ln(\text{rel } \tilde{IFshr})_{j,t}$	$\ln(\text{rel } \tilde{IFshr})_{j,t}$	$\ln(\text{rel } \tilde{IFshr})_{j,t}$	$\ln(\text{rel } \tilde{IFshr})_{j,t}$	$\ln(\text{rel } \tilde{IFshr})_{j,t}$
$H \text{ int}_j$	0.132 (0.0949)		0.108 (0.0769)		0.0914 (0.0707)		0.00183 (0.0393)	
$M \text{ int}_j$	0.207** (0.0929)		0.143 (0.0879)		0.107 (0.0703)		0.0237 (0.0481)	
$H \text{ intensive}_j$		0.309** (0.125)		0.198** (0.0912)		0.0380 (0.0936)		0.0124 (0.0489)
$M \text{ intensive}_j$		0.0575 (0.111)		0.111 (0.123)		0.200** (0.0856)		-0.00565 (0.0742)

Other controls: technological relevance of input  $m$  in sector  $H$ ,  $H$  differentiation,  $M$  differentiation. Standard errors in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

### 8.3 Institutional shocks and the determinants of exploration decisions

I analyse now the influence of institutional shocks in the probability and timing of the offshoring exploration decision of those locations that have experienced an institutional reform and have not been explored yet by US final good producers.

I identify the announcement of an institutional reform from three sources: i) the access of countries to the WTO, ii) the signature of a FTA of each country with the US, iii) the signature of a FTA of the country with other third countries where the US is not a member of the agreement. All those shocks may influence the beliefs that US firms possess about those potential locations, and thus incentivize the exploration of the offshoring potential from those countries.

The access of a country to WTO reveals information regarding regulations that country members of the organisation must follow. Thus, the access of a country to the WTO may affect the prior beliefs that US firms possess with respect to the institutional conditions in that location. I capture this effect by a dummy variable that takes the value one in the year  $t$  if the country becomes a member of WTO in that year ( $WTO \text{ shock}_{l,t}$ ), and a second variable that captures the time (years) since the shock has taken place ( $\text{yrs } WTO \text{ shock}_{l,t}$ ). I account only for those accessions during the sample period.<sup>65</sup>

After controlling for tariffs, the signature of a FTA with the US may reveal additional information about the prevailing institutional conditions in that foreign country, given that this types of agreement most often involve additional regulations related to contract enforcement and dispute resolutions, non-

<sup>65</sup>Given the very limited number of countries that have become a member of WTO since 2002, in a future version of the model I will extend the sample to previous years and capture the effect of WTO accession. I expect that this will improve the identification of the WTO shock in the offshoring exploration decision of US firms.

discriminatory policies, and other institutional conditions. I capture this effect by a dummy  $US\ shock_{l,t}$ , which takes value one when the country  $l$  signs a FTA with the US. As before, I add also a variable that captures the time since the agreement has been signed. I account only for those FTAs signed during the sample period.

Finally, in a similar way as above, the FTAs signed among third countries, where the US is not involved, may also reveal information to the US firms about the institutional conditions in the countries involved in the agreement. I capture this effect by a variable that takes the value of the mean institutional quality of the countries involved in the agreement (mean rule of law) in the year in which the country  $l$  became part of the agreement. This is represented by the variable  $inst\ shock_{l,t}$ . I also introduce a variable to capture the time (years) since the shock has taken place.<sup>66</sup>

### 8.3.1 Conditional probability

**M-perspective.** The probability of exploring the offshoring potential from country  $l$  in input  $m$  in period  $t$  for inputs that have not been imported from country  $l$  up to period  $t - 1$  is defined by:

$$\Pr\left(\text{offshr}\ stat_{m,l,t} = 1 \mid \text{offshr}\ stat\ cum_{m,l,t-1} = 0\right) = \Phi\left(\ln(1 + \text{tariff}_{m,l,t})\gamma_1, US\ shock_{l,t}\gamma_2, \right. \\ \ln(\text{yrs}\ US\ shock_{l,t})\gamma_3, \text{inst}\ shock_{l,t}\gamma_4, \ln(\text{yrs}\ \text{inst}\ shock_{l,t})\gamma_5, \\ \text{WTO}\ shock_{l,t}\gamma_6, \ln(\text{yrs}\ \text{WTO}\ shock_{l,t})\gamma_7, \text{Rule of law}_{l,t}\gamma_8, \\ \left. \text{other controls}, \gamma_m, \gamma_t\right) \quad (44)$$

where  $\text{offshr}\ stat_{m,l,t}$  is a dummy variable that denotes the offshoring status in input  $m$  from country  $l$  in period  $t$ , while the dummy variable  $\text{offshr}\ stat\ cum_{m,l,t-1}$  indicates the respective offshoring status up to period  $t - 1$ . The results for the model defined in equation (44), which represents the  $M$ -perspective, are reported in columns (1)-(3) of Table 5.

After controlling for tariffs, the estimated coefficients show that when a country signs a FTA with the US, it increases the probability that US firms explore the offshoring potential in that country in that year. Furthermore, the probability increases further in the years following the signature of the agreement.

About the institutional shock defined by the information revealed from FTAs among third countries, the table shows that it does not have a direct effect in the year that the country become a member of the agreement. However, the coefficient associated to  $\text{yrs}\ inst\ shock_{j,t}$  shows that agreement increases the probability that the US firms explore the offshoring potential in that country in the following years.

<sup>66</sup>The data on FTAs comes from “Mario Larch’s Regional Trade Agreements Database from Egger and Larch (2008)”.

The Rule of law index of the country has the expected positive and significant effect in all specifications. Finally, the WTO shock has an unexpected effect that may be explained by the fact that only a small number of countries have access to the WTO during the sample period.

**H-perspective.** The probability of exploring the offshoring potential from country  $l$  in period  $t$  for sector  $j$  in at least one input, for sectors that have not imported from country  $l$  up to period  $t - 1$  is defined by:

$$\Pr \left( \text{offshr stat}_{j,l,t} = 1 \mid \text{offshr stat cum}_{j,l,t-1} = 0 \right) = \Phi \left( \ln(1 + \text{tariff}_{j,l,t})\gamma_1, \text{US shock}_{l,t}\gamma_2, \right. \\ \ln(\text{yrs US shock}_{l,t})\gamma_3, \text{inst shock}_{l,t}\gamma_4, \ln(\text{yrs inst shock}_{l,t})\gamma_5, \\ \text{WTO shock}_{l,t}\gamma_6, \ln(\text{yrs WTO shock}_{l,t})\gamma_7, \text{Rule of law}_{l,t}\gamma_8, \\ \left. \text{other controls}, \gamma_j, \gamma_t \right) \quad (45)$$

where  $\text{offshr stat}_{j,l,t}$  is a dummy variable that denotes the offshoring status of sector  $j$  from country  $l$  in period  $t$ , while the dummy variable  $\text{offshr stat cum}_{j,l,t-1}$  indicates the respective offshoring status up to period  $t - 1$ . Columns (4)-(6) of Table 5 reports the estimation results for the  $H$ -perspective.

Table 5: Conditional probability model

All countries: Conditional probability model						
	M perspective			H perspective		
	(1)	(2)	(3)	(4)	(5)	(6)
	$\text{offshr stat}_{m,l,t}$	$\text{offshr stat}_{m,l,t}$	$\text{offshr stat}_{m,l,t}$	$\text{offshr stat}_{j,l,t}$	$\text{offshr stat}_{j,l,t}$	$\text{offshr stat}_{j,l,t}$
$\text{US shock}_{l,t}$	0.191*** (0.0240)		0.173*** (0.0240)	0.318*** (0.0157)		0.293*** (0.0157)
$\ln(\text{yrs US shock}_{l,t})$		0.134*** (0.0183)	0.120*** (0.0185)		0.133*** (0.0105)	0.109*** (0.0106)
$\text{inst shock}_{l,t}$	0.0641 (0.117)		0.0978 (0.117)	-0.265*** (0.0723)		-0.234*** (0.0721)
$\ln(\text{yrs inst shock}_{l,t})$		0.0922* (0.0484)	0.0968** (0.0481)		0.0726* (0.0425)	0.0806* (0.0422)
$\text{WTO shock}_{l,t}$	-0.358** (0.163)		-0.400** (0.162)	0.226*** (0.0615)		0.182*** (0.0617)
$\ln(\text{yrs WTO shock}_{l,t})$		-0.0261 (0.0237)	-0.0364 (0.0241)		0.0260 (0.0197)	0.0237 (0.0196)
$\text{Rule of law}_{l,t}$	0.221*** (0.0154)	0.243*** (0.0153)	0.199*** (0.0165)	0.211*** (0.0109)	0.251*** (0.0106)	0.192*** (0.0112)
M sector FE	YES	YES	YES	NO	NO	NO
H sector FE	NO	NO	NO	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES

Other controls: distance, mean income per capita, market thickness (mean GDP). Standard errors in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$



The results regarding the establishment of a FTA with the US remain robust relative to the  $M$ -perspective model. The FTAs among third countries shows a negative contemporaneous effect. It may be capturing the trade diversion effects of the FTA among third countries, as identified by the trade literature. However, the years following the agreements have a positive effect in the probability of the US firms exploring offshoring potential in those locations. As before, the Rule of law index of the country has the expected positive effect in all specifications.

### 8.3.2 Transition analysis

In order to estimate the respective transition rate in the offshoring status, I follow a similar approach to Larch and Navarro (2021), as well as Bergstrand et al. (2016) and the general literature in transition or survival analysis (Lancaster, 1990; Jenkins, 2005; Cameron and Trivedi, 2005; Wooldridge, 2010).

Due to the grouped nature of the data and time-varying covariates, the complementary log-logistic distribution (cloglog) is a standard choice for the modelling of the baseline hazard. Regarding the general time-trend, I consider two alternative specifications: a logarithmic form defined as  $\gamma_t = \psi \ln(t)$ , and a non-parametric approach that is defined by the year fixed effects.

**M-perspective.** I estimate the transition rate from a non-offshoring status in location  $l$  in input  $m$  to offshoring status in that input from that location in period  $t$ . Thus, the hazard rate to transition from non-offshoring status from country  $l$  in input  $m$  to offshoring status is given by:

$$\Lambda_{m,l,t}(t) \Big|_{\text{offshr stat cum}_{m,l,t-1}=0} = 1 - \exp[\exp(\mathbf{x}'_{m,l,t}\boldsymbol{\gamma} + \gamma_t)] \quad (46)$$

where  $\gamma_t$  refers to the general time-trend, and

$$\begin{aligned} \mathbf{x}'_{m,l,t}\boldsymbol{\gamma} = & \gamma_0 + \gamma_1 \ln(1 + \text{tariff}_{m,l,t}) + \gamma_2 \text{US shock}_{l,t} + \gamma_3 \ln(\text{yrs US shock}_{l,t}) + \gamma_4 \text{inst shock}_{l,t} \\ & + \gamma_5 \ln(\text{yrs inst shock}_{l,t}) + \gamma_6 \text{WTO shock}_{l,t} + \gamma_7 \ln(\text{yrs WTO shock}_{l,t}) \\ & + \gamma_8 \text{Rule of law}_{l,t} + \text{other controls} + \gamma_m \end{aligned}$$

The columns (1)-(4) of table 6 show the estimation results for the  $M$ -perspective specified in equation (46). As expected, when a country signs a FTA with the US, it accelerates the transition to offshoring status of US firms from that country in those inputs where US firms have not explored their offshoring potential yet. Furthermore, the positive and significant coefficient associated to the variable related to the years since the agreement shows that the transition accelerates in the subsequent years. This result

may introduce additional evidence on the sequential dynamic of exploration of a new location.

Regarding the FTA among third countries, the coefficient shows no significant effect. However, when I consider the years following the agreement, I observe a positive effect of those agreements in the specification with the non-parametric time-trend. Although it is a weak evidence, it shows that those FTAs where US is not a member may still impact on the prior beliefs of US firms, and thus accelerate the exploration of the offshoring potential from those locations.

Finally, the Rule of law of country  $l$  has a positive effect, as expected, in all specifications.

Table 6: Transition analysis: Institutional effects on hazard rate

All countries: Transition analysis. Estimation of hazard rate								
	M perspective				H perspective			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	$\Lambda_{m,l,t}$	$\Lambda_{m,l,t}$	$\Lambda_{m,l,t}$	$\Lambda_{m,l,t}$	$\Lambda_{j,l,t}$	$\Lambda_{j,l,t}$	$\Lambda_{j,l,t}$	$\Lambda_{j,l,t}$
$\ln(t)$	0.0411 (0.0350)		-0.328*** (0.0591)		-0.178*** (0.0204)		-0.415*** (0.0281)	
$\ln(1 + tariff_{.,l,t})$	-0.194*** (0.0290)	-0.196*** (0.0297)	-0.186*** (0.0290)	-0.188*** (0.0296)	-0.00610 (0.00919)	-0.000539 (0.00939)	0.00335 (0.00913)	0.00828 (0.00934)
$US\ shock_{l,t}$	0.422*** (0.0594)	0.450*** (0.0597)	0.379*** (0.0589)	0.407*** (0.0592)	0.542*** (0.0318)	0.541*** (0.0319)	0.497*** (0.0316)	0.498*** (0.0316)
$\ln(yrs\ US\ shock_{l,t})$			0.334*** (0.0477)	0.316*** (0.0473)			0.250*** (0.0213)	0.233*** (0.0220)
$inst\ shock_{l,t}$	0.165 (0.282)	0.168 (0.289)	0.234 (0.283)	0.254 (0.290)	-0.417*** (0.137)	-0.287** (0.139)	-0.357*** (0.138)	-0.233* (0.139)
$\ln(yrs\ inst\ shock_{l,t})$			0.0549 (0.0382)	0.274** (0.116)			-0.0568 (0.0353)	0.267** (0.107)
$WTO\ shock_{l,t}$	-0.716* (0.409)	-0.928** (0.411)	-0.831** (0.409)	-1.041** (0.412)	0.576*** (0.117)	0.580*** (0.118)	0.463*** (0.117)	0.477*** (0.118)
$\ln(yrs\ WTO\ shock_{l,t})$			-0.119** (0.0571)	-0.120** (0.0568)			-0.0400 (0.0428)	-0.0346 (0.0430)
$Rule\ of\ law_{l,t}$	0.517*** (0.0370)	0.514*** (0.0368)	0.455*** (0.0405)	0.452*** (0.0405)	0.349*** (0.0204)	0.353*** (0.0205)	0.302*** (0.0211)	0.309*** (0.0212)
M sector FE	YES	YES	YES	YES	NO	NO	NO	NO
H sector FE	NO	NO	NO	NO	YES	YES	YES	YES
Year FE	NO	YES	NO	YES	NO	YES	NO	YES

Other controls: distance, mean income per capita, market thickness (mean GDP). Standard errors in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

**H-perspective.** I estimate the transition rate from a non-offshoring status from location  $l$  of sector  $j$  to offshoring status of that sector from that location in period  $t$ . The hazard rate to transition from

non-offshoring status from country  $l$  in in sector  $j$  to offshoring status is given by:

$$\Lambda_{j,l,t}(t) \Big|_{\text{offshr stat cum}_{j,l,t-1}=0} = 1 - \exp[\exp(\mathbf{x}'_{j,l,t}\boldsymbol{\gamma} + \gamma_t)] \quad (47)$$

where

$$\begin{aligned} \mathbf{x}'_{j,l,t}\boldsymbol{\gamma} = & \gamma_0 + \gamma_1 \ln(1 + \text{tariff}_{j,l,t}) + \gamma_2 \text{US shock}_{l,t} + \gamma_3 \ln(\text{yrs US shock}_{l,t}) + \gamma_4 \text{inst shock}_{l,t} \\ & + \gamma_5 \ln(\text{yrs inst shock}_{l,t}) + \gamma_6 \text{WTO shock}_{l,t} + \gamma_7 \ln(\text{yrs WTO shock}_{l,t}) \\ & + \gamma_8 \text{Rule of law}_{l,t} + \text{other controls} + \gamma_j \end{aligned}$$

Columns (5)-(8) of Table 6 show the estimation results for the  $H$ -perspective given by equation (47). The table shows that the final good sectors in US accelerate the exploration of countries when the country  $l$  signs a FTA with the US. Thus, conclusions remain robust to this alternative perspective.

Regarding the FTAs among third countries, the table shows now a negative contemporaneous effect. However, although these FTAs reduces the speed of the transition in the short-run, the coefficient associated to the time after the FTA shows support to a later acceleration effect of the shock. Finally, as before, the Rule of law of country  $l$  has a positive effect in all specifications.

## 9 Conclusions

I introduce in the model a more general space for the organisation choices of the final good producers. As characterised by Grossman and Hart (1986), integration is the optimal allocation of rights in sectors with asymmetric relevance of inputs. This extension of the decision space results in a new sectoral classification which shows integrated firms in both extremes of the component-intensity range of technology.

Regarding the bargaining stage, I introduce a new characterisation of the efficiency losses that the residual claimant must face when decides to seize the control of the facilities from the manager. I relate this efficiency loss to the disruption of idiosyncratic routines and potential destruction of tacit knowledge when the manager is fired.

I introduce a novel measure for the relevance of this managerial knowledge and routines at sectoral level, and I test for the organisational structure. In particular, I focus in the effect of the tacit knowledge on the intra-firm import shares, and in the non-linear (U-shaped) relationship between the component-intensity of the sector and the intra-firm import share, and I find sectoral patterns that support the extension of the organisational space introduced in the theoretical model.

I extend the model by introducing uncertainty in the institutional conditions in foreign countries. I first did it in two-country setup (North-South) and I extended it later to multiple countries.

I characterised the learning mechanism and the trade-off decisions that the final good producers face when they must decide whether to explore their offshoring potential in a foreign location or wait under their current sourcing type. The distinctive feature of this model is that it focused the attention in the dynamic allocation of property rights, instead of the location dimension of the offshoring decisions. In this sense, this model complements the approach in Larch and Navarro (2021)

As in the latter, I show that the sectoral dynamic results in a sequential offshoring path led by most productive final good producers<sup>67</sup>. Furthermore, the increasing offshoring activity increases the competition intensity in the final good markets, and leads towards a sequential reorganisation in the ownership structure of the supply chains: vertical disintegration.

As the competition in the final good markets intensifies, the final good producers under domestic sourcing progressively disintegrate their supply chains. *Pari passu*, the foreign integration decisions show a non-monotonic behaviour over time. The productivity cutoff of foreign integration reduces progressively over time, as more final good producers explore their offshoring potential, until a moment where the least productive final good producers among those under FDI decide to sequentially disintegrate their supply chains, i.e. they redefine their sourcing strategy from FDI to arm's length trade.

With the extension to multiple countries, I introduce a second channel for the increase in the competition intensity in the final good markets. When the final good producers that are already under offshoring decide to explore new locations with lower marginal costs, they may trigger a sequential relocation of the supply chains towards the last countries. Therefore, the lower marginal costs in the new sourcing location push the sectoral price index further down, reinforcing the disintegration trend that comes from the first channel.

Finally, using sectoral-level data for the US manufacturing sectors, I find empirical sectoral dynamics that support the main theoretical predictions of the model.

**Next steps and further extensions.** In terms of the empirical model, in a future version of the paper I will finish the description of the methodological approach and consider additional specifications as robustness tests. I also consider the expansion of sample to consider the effects of years following the institutional shocks that have taken place in years previous to the sample period.

Finally, in terms of the theoretical model, I consider for an upcoming version the extension to partially

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<sup>67</sup>Due to data limitations, I do not test for the sequential offshoring dynamic in the empirical model. Nevertheless, using firm level data of Colombian manufacturing firms, Larch and Navarro (2021) shows empirical support for this theoretical prediction.

contractible investments as in Antràs and Helpman (2008). In such a case, the uncertainty would be related to the degree of contractibility of the supplier's investments when the location of the supplier is abroad. This extension focuses in the uncertainty about a very specific type of institutions (quality of the court system for contract enforcement), instead of the general institutional conditions captured by the model above. A second possible extension for future work consists in a model with multiple intermediate inputs.

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## A Perfect information model

Under perfect information, I eliminate the time index to simplify the notation.

### A.1 Consumer's problem

To obtain the variety  $i$  demand function  $q_j(i)$ , the representative consumer maximize the utility subject to the following budget constraint:

$$p_0 q_0 + \sum_{j=1}^J \int_{i \in I_j} p_j(i) q_j(i) di \leq E$$

From the FOCs for two different varieties  $i, i'$  in the differentiated sector:

$$\left[ \frac{q_j(i)}{q_j(i')} \right]^{\alpha_j - 1} = \frac{p_j(i)}{p_j(i')} \Leftrightarrow q_j(i) = \left[ \frac{p_j(i')}{p_j(i)} \right]^{\frac{1}{1 - \alpha_j}} q_j(i')$$

Given the Cobb-Douglas utility function,  $\gamma_j E$  refers to the expenditure in varieties of the differentiated sector  $j$ . Plugging the expression above for  $q_j(i)$  into the budget constraint:

$$\gamma_j E = \int_{i \in I_j} p_j(i) q_j(i) di \Leftrightarrow q_j(i') = \frac{\gamma_j E}{P_j} \left[ \frac{p_j(i')}{P_j} \right]^{-\sigma_j}$$

This expression holds for any variety  $i$  in sector  $j$ , thus

$$q_j(i) = \frac{\gamma_j E}{P_j} \left[ \frac{p_j(i)}{P_j} \right]^{-\sigma_j}$$

Or equivalently, from the FOCs, I can obtain:

$$q_j(i) = \left[ \gamma_j E Q_j^{-\alpha_j} p_j(i)^{-1} \right]^{\sigma_j}$$

To conclude, the demand for homogenous good  $q_0$  is given by:  $q_0 = \frac{\gamma_0 E}{p_0}$ .

### A.2 Nash Bargaining

The revenues are computed by using equations (3) and (5) into  $r(i) = p(i)q(i)$ . Plugging the equation (3) into the expression for revenues:

$$r(i) = \gamma E Q^{-\alpha} q(i)^{\alpha-1} q(i)$$

Replacing with the production level of variety with the production technology (5):

$$r(i) = \gamma E Q^{-\alpha} \theta^\alpha \left[ \left( \frac{x_h(i)}{\eta} \right)^\eta \left( \frac{x_m(i)}{1 - \eta} \right)^{1 - \eta} \right]^\alpha$$

The Nash equilibrium bargaining equilibrium comes from the solution to the following problem:

$$\arg \max_z \Omega = [zr(i) - \omega_h]^\beta [(1-z)r(i) - \omega_m]^{1-\beta}$$

From solving the FOC, I get:

$$z = \beta + \frac{(1-\beta)\omega_h - \beta\omega_m}{r(i)}$$

Therefore, the outside options under outsourcing are  $\omega_h = \omega_m = 0$ , and the equilibrium shares are defined by  $z = \beta$ .

Under integration  $V_H$ , the outside options are  $\omega_m = 0$  and  $\omega_h = (\delta_{V_H}^l)^{\alpha(1-\eta)}r(i)$ . Thus, the final good producer receives in the bargaining the revenue share:

$$z = \beta + (\delta_{V_H}^l)^{\alpha(1-\eta)}$$

Finally the outside options under integration  $V_M$  are  $\omega_h = 0$  and  $\omega_m = (\delta_{V_M}^l)^{\alpha\eta}r(i)$ . Therefore, the final good producer receives in the bargaining the revenue share:

$$z = \beta[(1 - \delta_{V_M}^l)^{\alpha(1-\eta)}]$$

### A.3 $H$ -intensive sectors: productivity cutoffs

The market entry productivity cutoff,  $\underline{\theta}^*$ , is defined by the zero profit condition  $\pi_O^N(\underline{\theta}^*) = 0$ . Solving for the market productivity cutoff:

$$\underline{\theta}^* = (\gamma E)^{\frac{\sigma}{1-\sigma}} Q \left[ \frac{w^N f_O^N}{\psi_O^N(\eta)} \right]^{\frac{1}{\sigma-1}} \quad (48)$$

Final good producers doing domestic backward integration realise an additional per-period profit with respect to domestic outsourcing, which is defined by the following condition:

$$\begin{aligned} \pi_{V_H^N/O^N}^{prem}(\theta) &= \pi_{V_H}^N(\theta) - \pi_O^N(\theta) \\ &= \theta^{\sigma-1} (\gamma E)^\sigma Q^{1-\sigma} [\psi_{V_H}^N(\eta) - \psi_O^N(\eta)] - w^N (f_{V_H}^N - f_O^N) \end{aligned}$$

Thus, the productivity cutoff for domestic backward integration is defined by the following condition:

$\pi_{V_H^N/O^N}^{prem}(\theta) = 0$ . The respective productivity cutoff is defined by:

$$\theta_{V_H}^{N,*} = (\gamma E)^{\frac{\sigma}{1-\sigma}} Q \left[ \frac{w^N [f_{V_H}^N - f_O^N]}{\psi_{V_H}^N(\eta) - \psi_O^N(\eta)} \right]^{\frac{1}{\sigma-1}} \quad (49)$$

The arm's length trade profit premium for final good producers with productivity  $\theta$ ,  $\pi_{OS/V_H^N}^{prem}(\theta)$ , is defined as the difference between the profits that she obtains under arm's length trade ( $O^S$ ) and the profits she would obtain under domestic integration ( $V_H^N$ ). Formally,

$$\begin{aligned}\pi_{OS/V_H^N}^{prem}(\theta) &= \pi_O^S(\theta) - \pi_{V_H^N}^N(\theta) \\ &= \theta^{\sigma-1}(\gamma E)^\sigma Q^{1-\sigma} [\psi_O^S(\eta) - \psi_{V_H^N}^N(\eta)] - w^N(f_O^S - f_{V_H^N}^N)\end{aligned}$$

The foreign outsourcing productivity cutoff is defined by the final good producer  $\theta_O^{S,*}$  that is indifferent between domestic vertical backward integration and foreign outsourcing, i.e.  $\pi_{OS/V_H^N}^{prem}(\theta) = w^N(1-\lambda)s^r$ . Thus, the respective productivity cutoff  $\theta_O^{S,*}$  is given by:

$$\theta_O^{S,*} = (\gamma E)^{\frac{\sigma}{1-\sigma}} Q \left[ \frac{w^N[f_O^S + (1-\lambda)s^r - f_{V_H^N}^N]}{\psi_O^S(\eta) - \psi_{V_H^N}^N(\eta)} \right]^{\frac{1}{\sigma-1}} \quad (50)$$

The FDI- $V_H$  profit premium obtained by the final good producers opting for this sourcing strategy with respect to domestic integration is:

$$\begin{aligned}\pi_{V_H^S/V_H^N}^{prem}(\theta) &= \pi_{V_H^S}^S(\theta) - \pi_{V_H^N}^N(\theta) \\ &= \theta^{\sigma-1}(\gamma E)^\sigma Q^{1-\sigma} [\psi_{V_H^S}^S(\eta) - \psi_{V_H^N}^N(\eta)] - w^N(f_{V_H^S}^S - f_{V_H^N}^N)\end{aligned}$$

The profit premium obtained by the final good producers doing FDI compared the premium they would realise under arm's length trade offshoring is defined as:

$$\begin{aligned}\pi_{V_H^S/O^S}^{prem}(\theta) &= \pi_{V_H^S}^S(\theta) - \pi_O^S(\theta) \\ &= \theta^{\sigma-1}(\gamma E)^\sigma Q^{1-\sigma} [\psi_{V_H^S}^S(\eta) - \psi_O^S(\eta)] - w^N(f_{V_H^S}^S - f_O^S)\end{aligned}$$

The FDI productivity cutoff ( $\theta_{V_H^S}^{S,*}$ ) is defined by the indifferent final good producer between arm's length trade and FDI,  $\pi_{V_H^S/O^S}^{prem}(\theta_{V_H^S}^{S,*}) = 0$ . Solving for  $\theta_{V_H^S}^{S,*}$ , the respective productivity cutoff is:

$$\theta_{V_H^S}^{S,*} = (\gamma E)^{\frac{\sigma}{1-\sigma}} Q \left[ \frac{w^N[f_{V_H^S}^S - f_O^S]}{\psi_{V_H^S}^S(\eta) - \psi_O^S(\eta)} \right]^{\frac{1}{\sigma-1}} \quad (51)$$

#### A.4 $M$ -intensive sectors: productivity cutoffs

The characterisation of the productivity cutoffs in these sectors is similar to  $H$ -intensive sectors, with the difference that instead of backward integration, in this case the control resides on the supplier  $M$ .

The market entry productivity cutoff,  $\underline{\theta}^*$ , is defined by the zero profit condition  $\pi_O^N(\underline{\theta}^*) = 0$ . Solving for the market productivity cutoff:

$$\underline{\theta}^* = (\gamma E)^{\frac{\sigma}{1-\sigma}} Q \left[ \frac{w^N f_O^N}{\psi_O^N(\eta)} \right]^{\frac{1}{\sigma-1}} \quad (52)$$

The per-period profit premium of  $V_M$  with respect to domestic outsourcing is given by:

$$\begin{aligned} \pi_{V_M^N/O^N}^{prem}(\theta) &= \pi_{V_M}^N(\theta) - \pi_O^N(\theta) \\ &= \theta^{\sigma-1} (\gamma E)^\sigma Q^{1-\sigma} [\psi_{V_M}^N(\eta) - \psi_O^N(\eta)] - w^N (f_{V_M}^N - f_O^N) \end{aligned}$$

Thus, the respective productivity cutoff is defined by  $\pi_{V_M^N/O^N}^{prem}(\theta) = 0$ , and it is given by:

$$\theta_{V_M}^{N,*} = (\gamma E)^{\frac{\sigma}{1-\sigma}} Q \left[ \frac{w^N [f_{V_M}^N - f_O^N]}{\psi_{V_M}^N(\eta) - \psi_O^N(\eta)} \right]^{\frac{1}{\sigma-1}} \quad (53)$$

The arm's length trade profit premium is defined as the difference between the profits that she obtains under arm's length trade ( $O^S$ ) and the profits she would obtain under domestic forward integration ( $V_M^N$ ).

Formally,

$$\begin{aligned} \pi_{O^S/V_M^N}^{prem}(\theta) &= \pi_{O^S}^S(\theta) - \pi_{V_M}^N(\theta) \\ &= \theta^{\sigma-1} (\gamma E)^\sigma Q^{1-\sigma} [\psi_{O^S}^S(\eta) - \psi_{V_M}^N(\eta)] - w^N (f_{O^S}^S - f_{V_M}^N) \end{aligned}$$

The foreign outsourcing productivity cutoff is defined by the indifferent final good producer between domestic vertical forward integration and foreign outsourcing, i.e.  $\pi_{O^S/V_M^N}^{prem}(\theta) = w^N (1 - \lambda) s^r$ . Thus, the respective productivity cutoff  $\theta_{O^S}^{S,*}$  is given by:

$$\theta_{O^S}^{S,*} = (\gamma E)^{\frac{\sigma}{1-\sigma}} Q \left[ \frac{w^N [f_{O^S}^S + (1 - \lambda) s^r - f_{V_M}^N]}{\psi_{O^S}^S(\eta) - \psi_{V_M}^N(\eta)} \right]^{\frac{1}{\sigma-1}} \quad (54)$$

The FDI- $V_M$  profit premium with respect to domestic integration is:

$$\begin{aligned} \pi_{V_M^S/V_M^N}^{prem}(\theta) &= \pi_{V_M}^S(\theta) - \pi_{V_M}^N(\theta) \\ &= \theta^{\sigma-1} (\gamma E)^\sigma Q^{1-\sigma} [\psi_{V_M}^S(\eta) - \psi_{V_M}^N(\eta)] - w^N (f_{V_M}^S - f_{V_M}^N) \end{aligned}$$

The profit premium obtained by the final good producers doing forward FDI with respect to arm's

length trade offshoring is defined as:

$$\begin{aligned}\pi_{V_M^S/O^S}^{prem}(\theta) &= \pi_{V_M^S}^S(\theta) - \pi_O^S(\theta) \\ &= \theta^{\sigma-1}(\gamma E)^\sigma Q^{1-\sigma} [\psi_{V_M^S}^S(\eta) - \psi_O^S(\eta)] - w^N(f_{V_M^S}^S - f_O^S)\end{aligned}$$

The FDI- $V_M$  productivity cutoff is defined by the indifferent final good producer between arm's length trade and FDI,  $\pi_{V_M^S/O^S}^{prem}(\theta_{V_M^S}^{S,*}) = 0$ . Solving for  $\theta_{V_M^S}^{S,*}$ , the respective productivity cutoff is:

$$\theta_{V_M^S}^{S,*} = (\gamma E)^{\frac{\sigma}{1-\sigma}} Q \left[ \frac{w^N[f_{V_M^S}^S - f_O^S]}{\psi_{V_M^S}^S(\eta) - \psi_O^S(\eta)} \right]^{\frac{1}{\sigma-1}} \quad (55)$$

### A.5 Balanced-intensity sectors: productivity cutoffs

The market entry productivity cutoff,  $\underline{\theta}^*$ , is defined by the zero profit condition:  $\pi_O^N(\underline{\theta}^*) = 0$ . Thus, the expression for the market productivity cutoff:

$$\underline{\theta}^* = (\gamma E)^{\frac{\sigma}{1-\sigma}} Q \left[ \frac{w^N f_O^N}{\psi_O^N(\eta)} \right]^{\frac{1}{\sigma-1}} \quad (56)$$

The offshoring profit premium for a final good producer with productivity  $\theta$  doing arm's length trade is defined as the difference in the profits she obtains under this sourcing type ( $O^S$ ) with respect to the profits she would earn under domestic outsourcing ( $O^N$ ). Formally, it is defined by the following condition:

$$\begin{aligned}\pi_{O^S/O^N}^{prem}(\theta) &= \pi_O^S(\theta) - \pi_O^N(\theta) \\ &= \theta^{\sigma-1}(\gamma E)^\sigma Q^{1-\sigma} [\psi_O^S(\eta) - \psi_O^N(\eta)] - w^N(f_O^S - f_O^N)\end{aligned}$$

The arm's length trade productivity cutoff,  $\theta_O^{S,*}$ , which is also the offshoring productivity cutoff, is defined by the final good producer indifferent between domestic and foreign outsourcing, i.e. by the final good producer with a productivity such that the discounted value of the offshoring premiums  $\pi_{O^S/O^N}^{prem}(\theta)$  is just enough to recover the offshoring market research sunk cost. Formally,

$$\pi_{O^S/O^N}^{prem}(\theta_O^{S,*}) = w^N(1-\lambda)s^r$$

leading to the following expression for the productivity cutoff:

$$\theta_O^{S,*} = (\gamma E)^{\frac{\sigma}{1-\sigma}} Q \left[ \frac{w^N[f_O^S + (1-\lambda)s^r - f_O^N]}{\psi_O^S(\eta) - \psi_O^N(\eta)} \right]^{\frac{1}{\sigma-1}} \quad (57)$$

## A.6 Price index and aggregate consumption index by sector type

Taking equation (10),

$$q_k^l(\theta) = \alpha^\sigma \theta^\sigma (\gamma E)^\sigma Q^{1-\sigma} \left[ \left( \frac{\beta_k^l}{w^N} \right)^\eta \left( \frac{1 - \beta_k^l}{w^l} \right)^{1-\eta} \right]^\sigma$$

$$[q_k^l(\theta)]^{1-\alpha} (\gamma E)^{-1} Q^\alpha = \alpha \theta \left( \frac{\beta_k^l}{w^N} \right)^\eta \left( \frac{1 - \beta_k^l}{w^l} \right)^{1-\eta}$$

$$[q_k^l(\theta)]^{\alpha-1} \gamma E Q^{-\alpha} = \alpha^{-1} \theta^{-1} \left[ \left( \frac{\beta_k^l}{w^N} \right)^\eta \left( \frac{1 - \beta_k^l}{w^l} \right)^{1-\eta} \right]^{-1}$$

Using equation (3), the price of a variety  $i$  produced by a final good producer with productivity  $\theta$  under organisational type  $k^l$  is:

$$p_k^{l,*}(\theta) = \alpha^{-1} \theta^{-1} \left[ \left( \frac{\beta_k^l}{w^N} \right)^\eta \left( \frac{1 - \beta_k^l}{w^l} \right)^{1-\eta} \right]^{-1}$$

Using the expression above, I can derive the prices for each organisational type for any  $\theta$ . The price of a variety  $i$  offered by a final good producer  $\theta$  who source the intermediate input from an independent domestic supplier is<sup>68</sup>:

$$p_O^{N,*}(\theta) = \frac{w^N}{\alpha \theta [\beta^\eta (1 - \beta)^{1-\eta}]}$$

For a final good producer  $\theta$  sourcing from an independent southern supplier, the price of variety  $i$  is:

$$p_O^{S,*}(\theta) = \frac{(w^N)^\eta (w^S)^{1-\eta}}{\alpha \theta [\beta^\eta (1 - \beta)^{1-\eta}]}$$

In the case of integrated final good producers, the respective prices depending on the location of the manufacturing facilities are:

$$p_V^{N,*}(\theta) = \frac{w^N}{\alpha \theta [(\beta_V^N)^\eta (1 - \beta_V^N)^{1-\eta}]} \quad \text{for } V = V_H, V_M$$

$$p_V^{S,*}(\theta) = \frac{(w^N)^\eta (w^S)^{1-\eta}}{\alpha \theta [(\beta_V^S)^\eta (1 - \beta_V^S)^{1-\eta}]} \quad \text{for } V = V_H, V_M$$

<sup>68</sup>Recall that  $\beta_O^N = \beta_O^S = \beta$ .

### A.6.1 $H$ -intensive sectors

The following ranking of prices of a variety produced by a final good producer with productivity  $\theta$  for each organisational type is a direct result of the setup of the model. Given that  $w^S < w^N$ :

$$\begin{aligned}
p_O^{S,*}(\theta) &= \left(\frac{w^S}{w^N}\right)^{1-\eta} p_O^{N,*}(\theta) && \Rightarrow p_O^{S,*}(\theta) < p_O^{N,*}(\theta) \\
p_{V_H}^{S,*}(\theta) &= \left(\frac{w^S}{w^N}\right)^{1-\eta} p_{V_H}^{N,*}(\theta) && \Rightarrow p_{V_H}^{S,*}(\theta) < p_{V_H}^{N,*}(\theta) \\
p_{V_H}^{N,*}(\theta) &= \left[ \frac{\beta^\eta (1-\beta)^{1-\eta}}{(\beta_{V_H}^N)^\eta (1-\beta_{V_H}^N)^{1-\eta}} \right] p_O^{N,*}(\theta) && \Rightarrow p_{V_H}^{N,*}(\theta) < p_O^{N,*}(\theta) \\
p_{V_H}^{S,*}(\theta) &= \left[ \frac{\beta^\eta (1-\beta)^{1-\eta}}{(\beta_{V_H}^S)^\eta (1-\beta_{V_H}^S)^{1-\eta}} \right] p_O^{S,*}(\theta) && \Rightarrow p_{V_H}^{S,*}(\theta) < p_O^{S,*}(\theta) \\
p_{V_H}^{S,*}(\theta) &= \left[ \frac{(\beta_{V_H}^N)^\eta (1-\beta_{V_H}^N)^{1-\eta}}{\beta^\eta (1-\beta)^{1-\eta}} \right] \left[ \frac{w^S}{w^N} \right]^{1-\eta} p_{V_H}^{N,*}(\theta) && \Rightarrow p_O^{S,*}(\theta) < p_{V_H}^{N,*}(\theta)
\end{aligned}$$

The last equation implicitly assumes that the gains from the lower marginal cost in the intermediate input overcome the losses from the hold-up.

To sum up,

$$p_{V_H}^{S,*}(\theta) < p_O^{S,*}(\theta) < p_{V_H}^{N,*}(\theta) < p_O^{N,*}(\theta)$$

The price index in the sector is given by:

$$\begin{aligned}
P^{1-\sigma} &= \int_{\underline{\theta}}^{\theta_{V_H}^N} p_O^N(\theta)^{1-\sigma} H \frac{g(\theta)}{1-G(\underline{\theta})} d\theta + \int_{\theta_{V_H}^N}^{\theta_O^S} p_{V_H}^N(\theta)^{1-\sigma} H \frac{g(\theta)}{1-G(\underline{\theta})} d\theta \\
&+ \int_{\theta_O^S}^{\theta_{V_H}^S} p_O^S(\theta)^{1-\sigma} H \frac{g(\theta)}{1-G(\underline{\theta})} d\theta + \int_{\theta_{V_H}^S}^{\infty} p_{V_H}^S(\theta)^{1-\sigma} H \frac{g(\theta)}{1-G(\underline{\theta})} d\theta
\end{aligned}$$

with  $H$  denoting the number of final good producers active in the market. Starting by a transformation of the third and fourth terms:

$$\begin{aligned}
P^{1-\sigma} &= H \left[ \int_{\underline{\theta}}^{\theta_{V_H}^N} p_O^N(\theta)^{1-\sigma} \frac{g(\theta)}{1-G(\underline{\theta})} d\theta + \int_{\theta_{V_H}^N}^{\theta_O^S} p_{V_H}^N(\theta)^{1-\sigma} \frac{g(\theta)}{1-G(\underline{\theta})} d\theta \right. \\
&\left. + \int_{\theta_O^S}^{\infty} p_O^S(\theta)^{1-\sigma} \frac{g(\theta)}{1-G(\underline{\theta})} d\theta + \chi_{V_H}^S \int_{\theta_{V_H}^S}^{\infty} [p_{V_H}^S(\theta)^{1-\sigma} - p_O^S(\theta)^{1-\sigma}] \frac{g(\theta)}{1-G(\theta_{V_H}^S)} d\theta \right]
\end{aligned}$$

with  $\chi_{V_H}^S = \frac{1-G(\theta_{V_H}^S)}{1-G(\underline{\theta})}$  referring to the share of final good producers under FDI- $V_H$ .



Transforming similarly the second and third terms:

$$P^{1-\sigma} = H \left[ \int_{\underline{\theta}}^{\theta_{V_H}^N} p_O^N(\theta)^{1-\sigma} \frac{g(\theta)}{1-G(\underline{\theta})} d\theta + \int_{\theta_{V_H}^N}^{\infty} p_{V_H}^N(\theta)^{1-\sigma} \frac{g(\theta)}{1-G(\underline{\theta})} d\theta \right. \\ \left. + \chi_O^S \int_{\theta_O^S}^{\infty} [p_O^S(\theta)^{1-\sigma} - p_{V_H}^N(\theta)^{1-\sigma}] \frac{g(\theta)}{1-G(\theta_O^S)} d\theta + \chi_{V_H}^S \int_{\theta_{V_H}^S}^{\infty} [p_{V_H}^S(\theta)^{1-\sigma} - p_O^S(\theta)^{1-\sigma}] \frac{g(\theta)}{1-G(\theta_{V_H}^S)} d\theta \right]$$

with  $\chi_O^S = \frac{1-G(\theta_O^S)}{1-G(\underline{\theta})}$  denoting the share of final good producers under offshoring. In other words, it denotes the share of  $H$  under foreign outsourcing and backward FDI. Therefore, the share of final good producers under foreign outsourcing is  $\chi_O^S - \chi_{V_H}^S$ .

Finally, with the first and second terms:

$$P^{1-\sigma} = H \left[ \int_{\underline{\theta}}^{\infty} p_O^N(\theta)^{1-\sigma} \frac{g(\theta)}{1-G(\underline{\theta})} d\theta + \chi_{V_H}^N \int_{\theta_{V_H}^N}^{\infty} [p_{V_H}^N(\theta)^{1-\sigma} - p_O^N(\theta)^{1-\sigma}] \frac{g(\theta)}{1-G(\theta_{V_H}^N)} d\theta \right. \\ \left. + \chi_O^S \int_{\theta_O^S}^{\infty} [p_O^S(\theta)^{1-\sigma} - p_{V_H}^N(\theta)^{1-\sigma}] \frac{g(\theta)}{1-G(\theta_O^S)} d\theta + \chi_{V_H}^S \int_{\theta_{V_H}^S}^{\infty} [p_{V_H}^S(\theta)^{1-\sigma} - p_O^S(\theta)^{1-\sigma}] \frac{g(\theta)}{1-G(\theta_{V_H}^S)} d\theta \right]$$

with  $\chi_{V_H}^N = \frac{1-G(\theta_{V_H}^N)}{1-G(\underline{\theta})}$  denoting the share of final good producers that are under  $V_H^N \cup O^S \cup V_H^S$ . The share of  $H$  under  $V_H^N$  is  $\chi_{V_H}^N - \chi_O^S$ . On the other hand, the share of final good producers under domestic outsourcing is  $1 - \chi_{V_H}^N$ .

It is easy to see that the RHS of the last expression is increasing in the shares  $\chi_k^l$ , and thus the price index is decreasing in those shares. In particular, as more firms offshore, i.e.  $\chi_O^S \uparrow$ , the price index decreases. A similar effect has an increase in  $\chi_{V_H}^S$ .

To conclude, the aggregate consumption index is:

$$Q = \gamma E H^{\frac{1}{\sigma-1}} \left[ \int_{\underline{\theta}}^{\infty} p_O^N(\theta)^{1-\sigma} \frac{g(\theta)}{1-G(\underline{\theta})} d\theta + \chi_{V_H}^N \int_{\theta_{V_H}^N}^{\infty} [p_{V_H}^N(\theta)^{1-\sigma} - p_O^N(\theta)^{1-\sigma}] \frac{g(\theta)}{1-G(\theta_{V_H}^N)} d\theta \right. \\ \left. + \chi_O^S \int_{\theta_O^S}^{\infty} [p_O^S(\theta)^{1-\sigma} - p_{V_H}^N(\theta)^{1-\sigma}] \frac{g(\theta)}{1-G(\theta_O^S)} d\theta + \chi_{V_H}^S \int_{\theta_{V_H}^S}^{\infty} [p_{V_H}^S(\theta)^{1-\sigma} - p_O^S(\theta)^{1-\sigma}] \frac{g(\theta)}{1-G(\theta_{V_H}^S)} d\theta \right]^{\frac{1}{\sigma-1}}$$

## A.6.2 Balanced intensive sectors

$$p_O^{S,*}(\theta) = \left( \frac{w^S}{w^N} \right)^{1-\eta} p_O^{N,*}(\theta) \Rightarrow p_O^{S,*}(\theta) < p_O^{N,*}(\theta)$$

The price index in the sector is:

$$\begin{aligned}
P^{1-\sigma} &= \int_{\underline{\theta}}^{\theta_O^S} p_O^N(\theta)^{1-\sigma} H \frac{g(\theta)}{1-G(\underline{\theta})} d\theta + \int_{\theta_O^S}^{\infty} p_O^S(\theta)^{1-\sigma} H \frac{g(\theta)}{1-G(\underline{\theta})} d\theta \\
&= \int_{\underline{\theta}}^{\infty} p_O^N(\theta)^{1-\sigma} H \frac{g(\theta)}{1-G(\underline{\theta})} d\theta + \frac{1-G(\theta_O^S)}{1-G(\underline{\theta})} \int_{\theta_O^S}^{\infty} p_O^S(\theta)^{1-\sigma} H \frac{g(\theta)}{1-G(\theta_O^S)} d\theta \\
&\quad - \frac{1-G(\theta_O^S)}{1-G(\underline{\theta})} \int_{\theta_O^S}^{\infty} p_O^N(\theta)^{1-\sigma} H \frac{g(\theta)}{1-G(\theta_O^S)} d\theta \\
P^{1-\sigma} &= H \left[ \int_{\underline{\theta}}^{\infty} p_O^N(\theta)^{1-\sigma} \frac{g(\theta)}{1-G(\underline{\theta})} d\theta + \chi_O^S \int_{\theta_O^S}^{\infty} [p_O^S(\theta)^{1-\sigma} - p_O^N(\theta)^{1-\sigma}] \frac{g(\theta)}{1-G(\theta_O^S)} d\theta \right]
\end{aligned}$$

where  $H$  denotes the number of active final good producers in the market, and  $\chi_O^S \equiv \frac{1-G(\theta_O^S)}{1-G(\underline{\theta})}$  indicates the share of final good producers under foreign outsourcing.

It is easy to see that the second term in the brackets on the RHS is positive. Therefore, a higher share of final good producers under offshoring, i.e. a lower arms' length trade productivity cutoff, induces a reduction in the price index  $P$ . A second order effect that reinforces this adjustment is the increase in the market productivity cutoff due to an decrease in the price index (and thus an increase in the aggregate consumption index).

The aggregate consumption index is thence:

$$Q = \gamma E H^{\frac{1}{\sigma-1}} \left[ \int_{\underline{\theta}}^{\infty} p_O^N(\theta)^{1-\sigma} \frac{g(\theta)}{1-G(\underline{\theta})} d\theta + \chi_O^S \int_{\theta_O^S}^{\infty} [p_O^S(\theta)^{1-\sigma} - p_O^N(\theta)^{1-\sigma}] \frac{g(\theta)}{1-G(\theta_O^S)} d\theta \right]^{\frac{1}{\sigma-1}}$$

As expected, the aggregate consumption is decreasing in both, the southern wages and the arms' length trade productivity cutoff.

### A.6.3 $M$ -intensive sectors

$$\begin{aligned}
p_O^{S,*}(\theta) &= \left( \frac{w^S}{w^N} \right)^{1-\eta} p_O^{N,*}(\theta) && \Rightarrow p_O^{S,*}(\theta) < p_O^{N,*}(\theta) \\
p_{V_M}^{S,*}(\theta) &= \left( \frac{w^S}{w^N} \right)^{1-\eta} p_{V_M}^{N,*}(\theta) && \Rightarrow p_{V_M}^{S,*}(\theta) < p_{V_M}^{N,*}(\theta) \\
p_{V_M}^{N,*}(\theta) &= \left[ \frac{\beta^\eta (1-\beta)^{1-\eta}}{(\beta_{V_H}^N)^\eta (1-\beta_{V_M}^N)^{1-\eta}} \right] p_O^{N,*}(\theta) && \Rightarrow p_{V_M}^{N,*}(\theta) < p_O^{N,*}(\theta) \\
p_{V_M}^{S,*}(\theta) &= \left[ \frac{\beta^\eta (1-\beta)^{1-\eta}}{(\beta_{V_M}^S)^\eta (1-\beta_{V_M}^S)^{1-\eta}} \right] p_O^{S,*}(\theta) && \Rightarrow p_{V_M}^{S,*}(\theta) < p_O^{S,*}(\theta) \\
p_{V_M}^{S,*}(\theta) &= \left[ \frac{(\beta_{V_M}^N)^\eta (1-\beta_{V_M}^N)^{1-\eta}}{\beta^\eta (1-\beta)^{1-\eta}} \right] \left[ \frac{w^S}{w^N} \right]^{1-\eta} p_{V_M}^{N,*}(\theta) && \Rightarrow p_{V_M}^{S,*}(\theta) < p_{V_M}^{N,*}(\theta)
\end{aligned}$$

Summary of prices' ranking:

$$p_{V_M}^{S,*}(\theta) < p_O^{S,*}(\theta) < p_{V_M}^{N,*}(\theta) < p_O^{N,*}(\theta)$$

The price index can be derived with a similar procedure as in the case of  $H$ -intensive sector, and thus

I obtain:

$$P^{1-\sigma} = H \left[ \int_{\underline{\theta}}^{\infty} p_O^N(\theta)^{1-\sigma} \frac{g(\theta)}{1-G(\theta)} d\theta + \chi_{V_M}^N \int_{\theta_{V_M}^N}^{\infty} [p_{V_M}^N(\theta)^{1-\sigma} - p_O^N(\theta)^{1-\sigma}] \frac{g(\theta)}{1-G(\theta_{V_M}^N)} d\theta \right. \\ \left. + \chi_O^S \int_{\theta_O^S}^{\infty} [p_O^S(\theta)^{1-\sigma} - p_{V_M}^N(\theta)^{1-\sigma}] \frac{g(\theta)}{1-G(\theta_O^S)} d\theta + \chi_{V_M}^S \int_{\theta_{V_M}^S}^{\infty} [p_{V_M}^S(\theta)^{1-\sigma} - p_O^S(\theta)^{1-\sigma}] \frac{g(\theta)}{1-G(\theta_{V_M}^S)} d\theta \right]$$

and the aggregate consumption index is:

$$Q = \gamma E H^{\frac{1}{\sigma-1}} \left[ \int_{\underline{\theta}}^{\infty} p_O^N(\theta)^{1-\sigma} \frac{g(\theta)}{1-G(\theta)} d\theta + \chi_{V_M}^N \int_{\theta_{V_M}^N}^{\infty} [p_{V_M}^N(\theta)^{1-\sigma} - p_O^N(\theta)^{1-\sigma}] \frac{g(\theta)}{1-G(\theta_{V_M}^N)} d\theta \right. \\ \left. + \chi_O^S \int_{\theta_O^S}^{\infty} [p_O^S(\theta)^{1-\sigma} - p_{V_M}^N(\theta)^{1-\sigma}] \frac{g(\theta)}{1-G(\theta_O^S)} d\theta + \chi_{V_M}^S \int_{\theta_{V_M}^S}^{\infty} [p_{V_M}^S(\theta)^{1-\sigma} - p_O^S(\theta)^{1-\sigma}] \frac{g(\theta)}{1-G(\theta_{V_M}^S)} d\theta \right]^{\frac{1}{\sigma-1}}$$

The offshoring profit premium of a final good producer with productivity  $\theta$  that chooses arm's length trade, relative to domestic outsourcing, is:

$$\pi_{O^S/O^N}^{\text{prem}}(\theta) = \pi_O^S(\theta) - \pi_O^N(\theta) \\ = r_O^S(\theta) [1 - \alpha[\beta_O^S \eta + (1 - \beta_O^S)(1 - \eta)]] - w^N f_O^S - r_O^N(\theta) [1 - \alpha[\beta_O^N \eta + (1 - \beta_O^N)(1 - \eta)]] + w^N f_O^N$$

using  $\beta_O^S = \beta_O^N = \beta$ , and  $\frac{r_O^S(\theta)}{r_O^N(\theta)} = \left(\frac{w^N}{w^S}\right)^{(1-\eta)(\sigma-1)}$ , the expression above becomes:

$$\pi_{O^S/O^N}^{\text{prem}}(\theta) = r_O^N(\theta) \left[ \left(\frac{w^N}{w^S}\right)^{(1-\eta)(\sigma-1)} - 1 \right] [1 - \alpha[\beta \eta + (1 - \beta)(1 - \eta)]] - w^N [f_O^S - f_O^N] \quad (58)$$

The profit premium obtained by a producer  $\theta$  under FDI- $V$  with  $V = V_H, V_M$  with respect to a domestically integrated firm is:

$$\pi_{V^S/V^N}^{\text{prem}}(\theta) = \pi_V^S(\theta) - \pi_V^N(\theta) \\ = r_V^S(\theta) [1 - \alpha[\beta_V^S \eta + (1 - \beta_V^S)(1 - \eta)]] - w^N f_V^S - r_V^N(\theta) [1 - \alpha[\beta_V^N \eta + (1 - \beta_V^N)(1 - \eta)]] + w^N f_V^N$$

using  $\frac{r_V^S(\theta)}{r_V^N(\theta)} = \left[ \left(\frac{\beta_V^S}{\beta_V^N}\right)^\eta \left(\frac{1-\beta_V^S}{1-\beta_V^N}\right)^{1-\eta} \left(\frac{w^N}{w^S}\right)^{1-\eta} \right]^{\sigma-1}$ , the premium is thus given by:

$$\pi_{V^S/V^N}^{\text{prem}}(\theta) = r_V^N(\theta) \left[ \left[ \left(\frac{\beta_V^S}{\beta_V^N}\right)^\eta \left(\frac{1-\beta_V^S}{1-\beta_V^N}\right)^{1-\eta} \left(\frac{w^N}{w^S}\right)^{1-\eta} \right]^{\sigma-1} \right. \\ \left. \times [1 - \alpha[\beta_V^S \eta + (1 - \beta_V^S)(1 - \eta)]] - [1 - \alpha[\beta_V^N \eta + (1 - \beta_V^N)(1 - \eta)]] \right] - w^N [f_V^S - f_V^N] \quad (59)$$

Finally, the profit premium of a producer  $\theta$  doing arm's length trade relative to domestic integration is:

$$\begin{aligned}
\pi_{OS/VN}^{\text{prem}}(\theta) &= \pi_O^S(\theta) - \pi_V^N(\theta) \\
&= r_V^S(\theta) [1 - \alpha[\beta\eta + (1 - \beta)(1 - \eta)]] - w^N f_O^S - r_V^N(\theta) [1 - \alpha[\beta_V^N\eta + (1 - \beta_V^N)(1 - \eta)]] + w^N f_V^N
\end{aligned}$$

using  $\frac{r_O^S(\theta)}{r_V^N(\theta)} = \left[ \left( \frac{\beta}{\beta_V^N} \right)^\eta \left( \frac{1 - \beta}{1 - \beta_V^N} \right)^{1 - \eta} \left( \frac{w^N}{w^S} \right)^{1 - \eta} \right]^{\sigma - 1}$ , the premium is thus given by:

$$\begin{aligned}
\pi_{OS/VN}^{\text{prem}}(\theta) &= r_V^N(\theta) \left[ \left[ \left( \frac{\beta}{\beta_V^N} \right)^\eta \left( \frac{1 - \beta}{1 - \beta_V^N} \right)^{1 - \eta} \left( \frac{w^N}{w^S} \right)^{1 - \eta} \right]^{\sigma - 1} \right. \\
&\quad \left. \times [1 - \alpha[\beta\eta + (1 - \beta)(1 - \eta)]] - [1 - \alpha[\beta_V^N\eta + (1 - \beta_V^N)(1 - \eta)]] \right] - w^N [f_O^S - f_V^N]
\end{aligned} \tag{60}$$

## B Empirics

In section B.1, I describe the methodology for the static models, and present additional estimation results and robustness checks regarding the theoretical predictions of the static model. In particular, the focus relies in the determinants of the organisational choices among offshoring firms.

### B.1 Empirical model: determinants of the organisational choices

METHODOLOGY DESCRIPTION: TBC

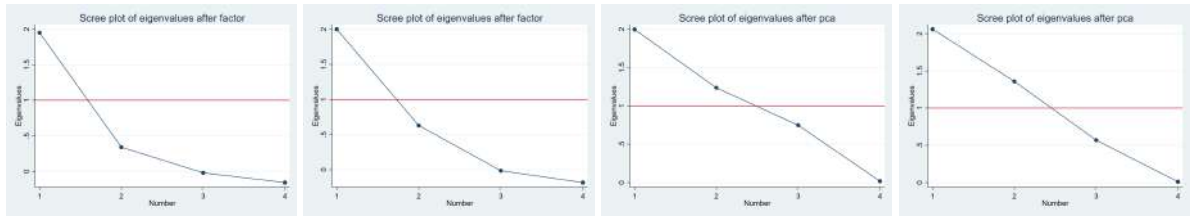
The section is organised as follows. Section B.1.1 shows the eigenvalues for the factor analysis and principal component analysis. Section B.1.2 shows complementary illustrations to sections 3.3.2 and 3.3.3 about the relationship of the intra-firm import share and the determinants of the organisational choices identified in the literature. Section B.1.3 shows the regression results for all the determinants of the organisational choices as identified in the literature, and reports additional robustness checks.

#### B.1.1 Eigenvalues for Factor Analysis and Principal Component Analysis

Figure 14 shows the values of the eigenvalues for each of the approaches. I use the first component of each method as a direct measure of  $\eta$ . From the graphs below, it is straightforward to see that the first component of the factor analysis is a better summary of the  $H$ -intensity. Nevertheless, I report the result for both measures.

#### B.1.2 Complementary graphs for $H$ -intensity measures

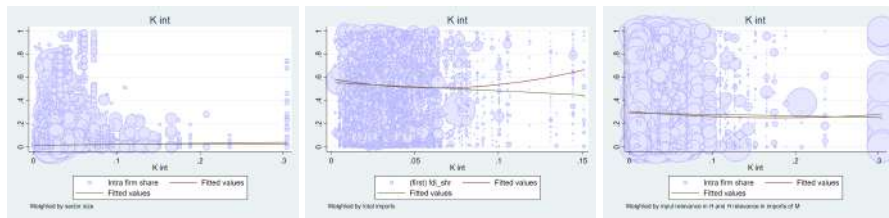
In the figures 15 to 18, I report the results from three complementary perspectives.  $H$ -sector perspective aggregates data at the  $H$ -sector level, while the  $M$ -sector perspective does the same at the  $M$ -sector



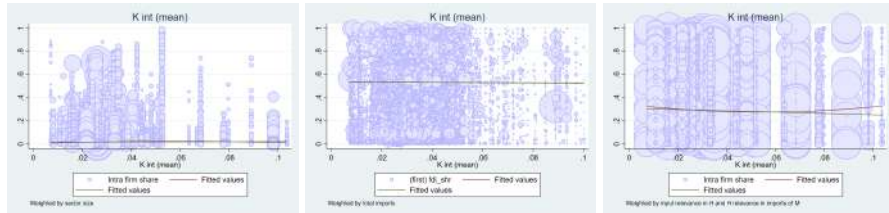
(a) Eigenvalues FA      (b) Eigenvalues mean FA      (c) Eigenvalues PCA      (d) Eigenvalues mean PCA

Figure 14: Eigenvalues: Factor analysis and principal component analysis

level. Finally, the no aggregation exploits both dimensions together.

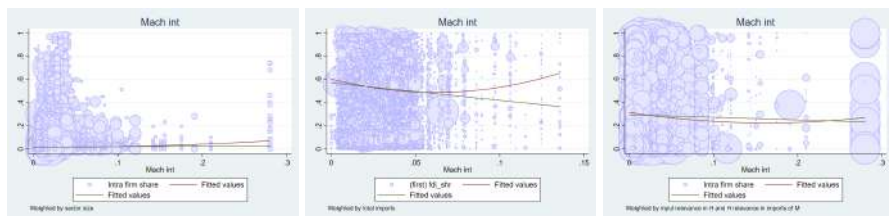


(a) K intensity: H sector perspective (left) - M sector perspective (center) - No aggregation (right).

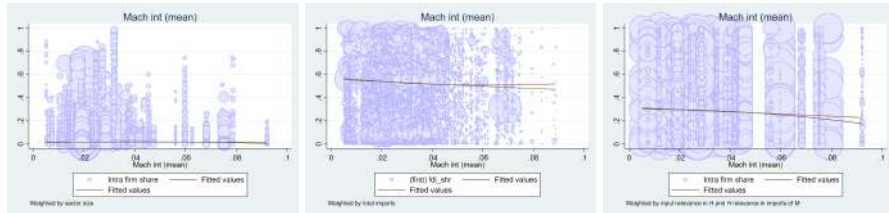


(b) K intensity (mean): H sector perspective (left) - M sector perspective (center) - No aggregation (right).

Figure 15: Intra-firm share and capital intensity

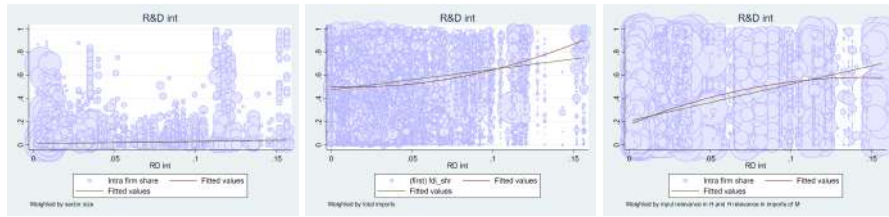


(a) Mach int: H sector perspective (left) - M sector perspective (center) - No aggregation (right).

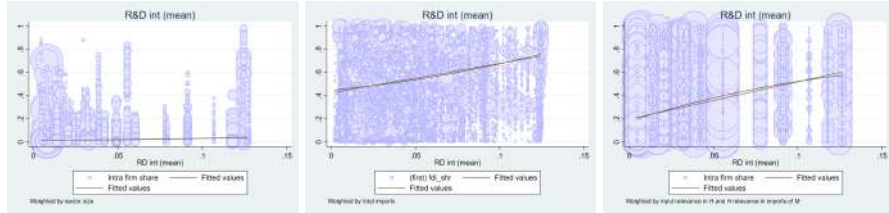


(b) Mach int (mean): H sector perspective (left) - M sector perspective (center) - No aggregation (right).

Figure 16: Intra-firm share and machinery intensity

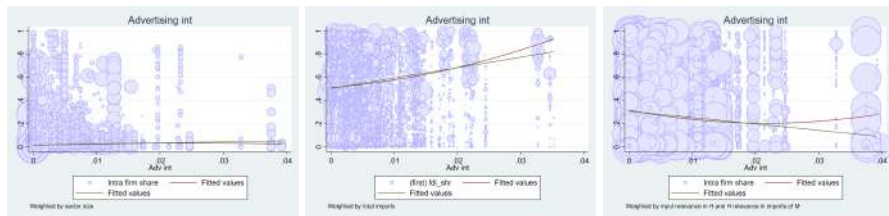


(a) R&D intensity: H sector perspective (left) - M sector perspective (center) - No aggregation (right).

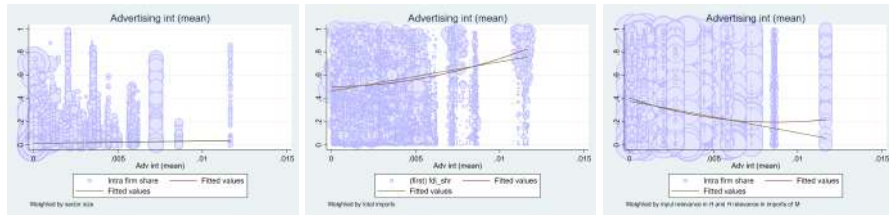


(b) R&D int (mean): H sector perspective (left) - M sector perspective (center) - No aggregation (right).

Figure 17: Intra-firm share and R&D intensity



(a) Adv intensity: H sector perspective (left) - M sector perspective (center) - No aggregation (right).



(b) Adv int (mean): H sector perspective (left) - M sector perspective (center) - No aggregation (right).

Figure 18: Intra-firm share and advertising intensity

### B.1.3 Robustness checks: Estimation results

Table 7: Organisational choices in offshoring decisions

	All countries: Fractional logit											
	H perspective				M perspective				No aggregation			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	$IFshr_{j,t}$	$IFshr_{j,t}$	$IFshr_{j,t,t}$	$IFshr_{j,t,t}$	$IFshr_{m,t}$	$IFshr_{m,t,t}$	$IFshr_{m,t,t}$	$IFshr_{m,t,t}$	$IFshr_{m,j,t,t}$	$IFshr_{m,j,t,t}$	$IFshr_{m,j,t,t}$	$IFshr_{m,j,t,t}$
$Kint_{j,t}$	0.189 (0.305)				-3.121*** (0.488)				-2.013*** (0.301)			
$Kint_{j,t}^2$	-1.402 (0.973)				14.85*** (4.247)				5.083*** (1.174)			
$MACHint_{j,t}$		0.203 (0.321)				-3.343*** (0.511)					-2.141*** (0.322)	
$MACHint_{j,t}^2$		-1.648 (1.114)				17.60*** (5.103)					5.904*** (1.366)	
$RDint_j$	1.474*** (0.440)	1.466*** (0.435)			3.520*** (0.390)	3.943*** (0.390)			3.405*** (0.393)	3.752*** (0.389)		
$RDint_j^2$	-4.445 (3.626)	-4.367 (3.593)			-8.239** (3.282)	-12.46*** (3.280)			-8.383** (3.305)	-11.90*** (3.266)		
$ADVint_{j,t}$	-8.188*** (1.788)	-8.151*** (1.762)			-18.17*** (2.065)	-18.33*** (2.066)			-18.90*** (1.860)	-19.03*** (1.857)		
$ADVint_{j,t}^2$	183.1*** (55.96)	182.1*** (55.36)			532.8*** (89.03)	545.3*** (88.84)			489.8*** (76.33)	498.3*** (76.09)		
$PCA_{j,t}$			0.000360 (0.00408)				-0.0255*** (0.00407)				-0.0189*** (0.00355)	
$PCA_{j,t}^2$			-0.0000889 (0.000213)				0.00346*** (0.000869)				0.00105*** (0.000234)	
$FA_{j,t}$				-0.00305 (0.00570)				-0.0356*** (0.00572)				-0.0288*** (0.00498)
$FA_{j,t}^2$				0.0000842 (0.000418)				0.00634*** (0.00177)				0.00222*** (0.000464)
$H OJT_{j,t}$	-0.00370 (0.00441)	-0.00369 (0.00443)	-0.0113** (0.00540)	-0.0115** (0.00548)	-0.00510 (0.00498)	-0.00616 (0.00500)	-0.0201*** (0.00497)	-0.0208*** (0.00500)	-0.00520 (0.00417)	-0.00559 (0.00419)	-0.00895** (0.00413)	-0.00974** (0.00414)
$M OJT_{m,t}$	0.0389*** (0.00735)	0.0389*** (0.00739)	0.0427*** (0.00883)	0.0425*** (0.00891)	0.0111** (0.00527)	0.0113** (0.00534)	-0.00420 (0.00522)	-0.00408 (0.00523)	0.0187*** (0.00519)	0.0191*** (0.00524)	0.00680 (0.00496)	0.00657 (0.00495)
$\ln(1 + tariff)_{m,t}$	-0.00169 (0.00174)	-0.00170 (0.00174)	-0.00686*** (0.00170)	-0.00684*** (0.00172)	-0.555*** (0.189)	-0.531*** (0.190)	-1.835*** (0.228)	-1.828*** (0.229)	-0.445** (0.194)	-0.402** (0.195)	-1.593*** (0.220)	-1.597*** (0.220)
$\ln(M shr in H)_{m,j,t}$	0.0103*** (0.00400)	0.0103*** (0.00401)	0.0141*** (0.00471)	0.0140*** (0.00471)	-0.0136*** (0.00246)	-0.0145*** (0.00244)	-0.00187 (0.00282)	-0.00111 (0.00282)	-0.00768*** (0.00251)	-0.00863*** (0.00250)	0.00376 (0.00277)	0.00455 (0.00277)
$H diff_{j,t}$	-0.0216 (0.0144)	-0.0221 (0.0146)	0.0233* (0.0131)	0.0252* (0.0130)	0.0274* (0.0155)	0.0305* (0.0157)	0.187*** (0.0158)	0.184*** (0.0158)	0.0398*** (0.0150)	0.0400*** (0.0151)	0.182*** (0.0152)	0.181*** (0.0152)
$M diff_{m,t}$	0.0671** (0.0301)	0.0675** (0.0304)	0.0682** (0.0330)	0.0695** (0.0331)	0.0920*** (0.0145)	0.0924*** (0.0146)	0.0781*** (0.0153)	0.0801*** (0.0153)	0.0759*** (0.0143)	0.0761*** (0.0143)	0.0501*** (0.0149)	0.0521*** (0.0148)

Country and year fixed effects included. Average marginal effects. Standard errors in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Table 8: Organisational choices in offshoring decisions: with additional controls

	All countries: Fractional logit											
	H perspective				M perspective				No aggregation			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	$IFshr_{j,t}$	$IFshr_{j,t}$	$IFshr_{j,t}$	$IFshr_{j,t}$	$IFshr_{m,t}$	$IFshr_{m,t}$	$IFshr_{m,t}$	$IFshr_{m,t}$	$IFshr_{m,j,t}$	$IFshr_{m,j,t}$	$IFshr_{m,j,t}$	$IFshr_{m,j,t}$
$Kint_{j,t}$	0.121 (0.301)				-3.717*** (0.503)				-2.218*** (0.303)			
$Kint_{j,t}^2$	-1.054 (0.962)				18.62*** (4.296)				5.846*** (1.182)			
$MACHint_{j,t}$		0.0793 (0.319)				-4.130*** (0.533)				-2.443*** (0.326)		
$MACHint_{j,t}^2$		-1.067 (1.112)				23.21*** (5.187)				7.082*** (1.378)		
$R\bar{D}int_j$	1.326*** (0.445)	1.317*** (0.439)			2.910*** (0.406)	3.376*** (0.402)			3.035*** (0.400)	3.404*** (0.394)		
$R\bar{D}int_j^2$	-3.755 (3.663)	-3.680 (3.629)			-5.613* (3.329)	-10.38*** (3.303)			-7.004** (3.319)	-10.82*** (3.269)		
$ADVint_{j,t}$	-7.110*** (1.805)	-7.067*** (1.788)			-17.17*** (2.048)	-17.28*** (2.049)			-17.97*** (1.847)	-18.08*** (1.844)		
$ADVint_{j,t}^2$	153.6*** (55.91)	152.4*** (55.48)			492.6*** (88.37)	504.7*** (88.12)			458.7*** (75.89)	467.0*** (75.59)		
$PCA_{j,t}$			-0.000812 (0.00381)				-0.0411*** (0.00404)				-0.0263*** (0.00351)	
$PCA_{j,t}^2$			0.00000861 (0.000200)				0.00531*** (0.000840)				0.00146*** (0.000231)	
$FA_{j,t}$				-0.00452 (0.00535)				-0.0620*** (0.00573)				-0.0402*** (0.00493)
$FA_{j,t}^2$				0.000266 (0.000395)				0.0110*** (0.00169)				0.00311*** (0.000458)
$H OJT_{j,t}$	-0.00116 (0.00461)	-0.00122 (0.00462)	-0.00614 (0.00518)	-0.00625 (0.00525)	0.000771 (0.00480)	-0.000496 (0.00484)	0.00466 (0.00501)	0.00300 (0.00503)	0.00106 (0.00420)	0.000712 (0.00422)	0.00916** (0.00437)	0.00819* (0.00436)
$M OJT_{m,t}$	0.0378*** (0.00720)	0.0377*** (0.00725)	0.0396*** (0.00813)	0.0392*** (0.00819)	0.0101* (0.00526)	0.0104* (0.00533)	-0.00267 (0.00533)	-0.00233 (0.00532)	0.0172*** (0.00517)	0.0177*** (0.00521)	0.00561 (0.00505)	0.00525 (0.00503)
$\ln(1 + tariff)_{m,t}$	-0.00142 (0.00173)	-0.00143 (0.00173)	-0.00565*** (0.00168)	-0.00561*** (0.00169)	-0.770*** (0.192)	-0.754*** (0.193)	-1.991*** (0.215)	-1.989*** (0.214)	-0.595*** (0.196)	-0.557*** (0.197)	-1.705*** (0.215)	-1.711*** (0.215)
$\ln(M shr in H)_{m,j}$	0.0106*** (0.00397)	0.0106*** (0.00398)	0.0138*** (0.00448)	0.0137*** (0.00447)	-0.00935*** (0.00254)	-0.0101*** (0.00251)	0.00504* (0.00277)	0.00687** (0.00279)	-0.00559** (0.00253)	-0.00647** (0.00252)	0.00589** (0.00270)	0.00698** (0.00271)
$H diff_{j,t}$	-0.0138 (0.0144)	-0.0135 (0.0145)	0.0308** (0.0122)	0.0323*** (0.0121)	0.0718*** (0.0167)	0.0785*** (0.0170)	0.259*** (0.0160)	0.259*** (0.0159)	0.0716*** (0.0155)	0.0737*** (0.0156)	0.232*** (0.0152)	0.232*** (0.0151)
$M diff_{m,t}$	0.0628** (0.0300)	0.0630** (0.0303)	0.0628** (0.0313)	0.0646** (0.0314)	0.0684*** (0.0144)	0.0677*** (0.0145)	0.0158 (0.0150)	0.0182 (0.0149)	0.0589*** (0.0141)	0.0584*** (0.0142)	0.0114 (0.0146)	0.0138 (0.0145)
$\ln(SKILLint)_{j,t}$	0.0254*** (0.00933)	0.0255*** (0.00938)	0.0474*** (0.00945)	0.0478*** (0.00950)	0.0609*** (0.00851)	0.0638*** (0.00861)	0.163*** (0.00818)	0.167*** (0.00824)	0.0476*** (0.00756)	0.0495*** (0.00758)	0.118*** (0.00743)	0.120*** (0.00745)

Country and year fixed effects included. Average marginal effects. Standard errors in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

## B.2 Empirical dynamic model

### B.2.1 Competition and relocation effects

TBC

### B.2.2 Institutional shocks and the determinants of exploration decisions



Table 9: Organisational choices in offshoring decisions: with additional controls - mean values

	All countries: Fractional logit - Explanatory variables in mean values											
	H perspective				M perspective				No aggregation			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	<i>IFshr<sub>j,l,t</sub></i>	<i>IFshr<sub>j,l,t</sub></i>	<i>IFshr<sub>j,l,t</sub></i>	<i>IFshr<sub>j,l,t</sub></i>	<i>IFshr<sub>m,l,t</sub></i>	<i>IFshr<sub>m,l,t</sub></i>	<i>IFshr<sub>m,l,t</sub></i>	<i>IFshr<sub>m,l,t</sub></i>	<i>IFshr<sub>m,j,l,t</sub></i>	<i>IFshr<sub>m,j,l,t</sub></i>	<i>IFshr<sub>m,j,l,t</sub></i>	<i>IFshr<sub>m,j,l,t</sub></i>
<i>Kint<sub>j</sub></i>	2.295*				-3.492**				-2.684***			
	(1.237)				(1.508)				(0.932)			
<i>Kint<sub>j</sub><sup>2</sup></i>	-30.71**				8.552				6.869			
	(12.74)				(21.39)				(11.12)			
<i>MACHint<sub>j</sub></i>		2.778**				-4.908***				-3.101***		
		(1.400)				(1.579)				(1.065)		
<i>MACHint<sub>j</sub><sup>2</sup></i>		-46.88***				28.23				11.03		
		(17.90)				(26.36)				(15.32)		
<i>RDint<sub>j</sub></i>	0.809	1.013**			1.871***	2.285***			1.753***	2.096***		
	(0.494)	(0.492)			(0.448)	(0.427)			(0.427)	(0.420)		
<i>RDint<sub>j</sub><sup>2</sup></i>	0.495	-1.029			0.721	-3.731			1.316	-2.301		
	(3.874)	(3.841)			(3.593)	(3.415)			(3.466)	(3.402)		
<i>ADVint<sub>j</sub></i>	-12.48**	-12.83**			-48.55***	-51.04***			-49.04***	-50.89***		
	(5.854)	(5.809)			(5.279)	(5.316)			(4.374)	(4.376)		
<i>ADVint<sub>j</sub><sup>2</sup></i>	-78.24	-17.47			3068.1***	3381.8***			2917.1***	3144.0***		
	(812.0)	(819.1)			(594.9)	(597.2)			(488.5)	(487.6)		
<i>PCA<sub>j</sub></i>			-0.00512				-0.0418***				-0.0280***	
			(0.00524)				(0.00404)				(0.00356)	
<i>PCA<sub>j</sub><sup>2</sup></i>			0.00109				0.0136***				0.00858***	
			(0.00130)				(0.00272)				(0.00134)	
<i>FA<sub>j</sub></i>				-0.0122*				-0.0729***				-0.0513***
				(0.00723)				(0.00590)				(0.00527)
<i>FA<sub>j</sub><sup>2</sup></i>				0.00114				0.0185***				0.0174***
				(0.00292)				(0.00663)				(0.00294)
<i>H OJT<sub>j</sub></i>	-0.0391***	-0.0412***	-0.0303***	-0.0349***	-0.0863***	-0.0942***	-0.0264**	-0.0500***	-0.0996***	-0.106***	-0.0367***	-0.0478***
	(0.0108)	(0.0109)	(0.00987)	(0.0102)	(0.0130)	(0.0135)	(0.0117)	(0.0126)	(0.0122)	(0.0124)	(0.0111)	(0.0113)
<i>M OJT<sub>j</sub></i>	0.0626***	0.0639***	0.0562***	0.0578***	0.0674***	0.0703***	0.0207	0.0343**	0.0842***	0.0883***	0.0494***	0.0501***
	(0.00832)	(0.00835)	(0.0104)	(0.0101)	(0.0143)	(0.0143)	(0.0155)	(0.0153)	(0.0139)	(0.0139)	(0.0149)	(0.0147)

Other controls: tariffs, technological relevance of input *m* in sector *H*, *H* differentiation, *M* differentiation, skill intensity.

Country and year fixed effects included. Average marginal effects. Standard errors in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Table 10: Conditional Probit: Institutional effects on probability of exploration

All countries: Conditional probability model						
	M perspective			H perspective		
	(1)	(2)	(3)	(4)	(5)	(6)
	<i>offshr stat</i> <sub><i>m,l,t</i></sub>	<i>offshr stat</i> <sub><i>m,l,t</i></sub>	<i>offshr stat</i> <sub><i>m,l,t</i></sub>	<i>offshr stat</i> <sub><i>j,l,t</i></sub>	<i>offshr stat</i> <sub><i>j,l,t</i></sub>	<i>offshr stat</i> <sub><i>j,l,t</i></sub>
<i>US shock</i> <sub><i>l,t</i></sub>	0.191*** (0.0240)		0.173*** (0.0240)	0.318*** (0.0157)		0.293*** (0.0157)
ln(yrs <i>US shock</i> <sub><i>l,t</i></sub> )		0.134*** (0.0183)	0.120*** (0.0185)		0.133*** (0.0105)	0.109*** (0.0106)
<i>inst shock</i> <sub><i>l,t</i></sub>	0.0641 (0.117)		0.0978 (0.117)	-0.265*** (0.0723)		-0.234*** (0.0721)
ln(yrs <i>inst shock</i> <sub><i>l,t</i></sub> )		0.0922* (0.0484)	0.0968** (0.0481)		0.0726* (0.0425)	0.0806* (0.0422)
<i>WTO shock</i> <sub><i>l,t</i></sub>	-0.358** (0.163)		-0.400** (0.162)	0.226*** (0.0615)		0.182*** (0.0617)
ln(yrs <i>WTO shock</i> <sub><i>l,t</i></sub> )		-0.0261 (0.0237)	-0.0364 (0.0241)		0.0260 (0.0197)	0.0237 (0.0196)
<i>Rule of law</i> <sub><i>l,t</i></sub>	0.221*** (0.0154)	0.243*** (0.0153)	0.199*** (0.0165)	0.211*** (0.0109)	0.251*** (0.0106)	0.192*** (0.0112)
ln(1 + <i>tariff</i> <sub><i>m,l,t</i></sub> )	-0.0728*** (0.0144)	-0.0696*** (0.0143)	-0.0694*** (0.0143)	0.000393 (0.00518)	0.00453 (0.00504)	0.00612 (0.00519)
ln( <i>dist</i> ) <sub><i>l</i></sub>	-0.137*** (0.0247)	-0.142*** (0.0237)	-0.122*** (0.0249)	-0.339*** (0.0139)	-0.322*** (0.0138)	-0.323*** (0.0140)
ln( <i>mean income pc</i> ) <sub><i>l</i></sub>	-0.109*** (0.0110)	-0.131*** (0.0112)	-0.120*** (0.0115)	-0.0555*** (0.00722)	-0.0764*** (0.00764)	-0.0656*** (0.00775)
ln( <i>mrkt thick</i> ) <sub><i>l</i></sub>	0.259*** (0.00598)	0.265*** (0.00575)	0.256*** (0.00604)	0.338*** (0.00517)	0.356*** (0.00511)	0.339*** (0.00522)
M sector FE	YES	YES	YES	NO	NO	NO
H sector FE	NO	NO	NO	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES

Standard errors in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Table 11: Transition analysis: Institutional effects on hazard rate

All countries: Transition analysis. Estimation of hazard rate								
	M perspective				H perspective			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	$\Lambda_{m,l,t}$	$\Lambda_{m,l,t}$	$\Lambda_{m,l,t}$	$\Lambda_{m,l,t}$	$\Lambda_{j,l,t}$	$\Lambda_{j,l,t}$	$\Lambda_{j,l,t}$	$\Lambda_{j,l,t}$
$\ln(t)$	0.0411 (0.0350)		-0.328*** (0.0591)		-0.178*** (0.0204)		-0.415*** (0.0281)	
$\ln(1 + \text{tariff}_{m,l,t})$	-0.194*** (0.0290)	-0.196*** (0.0297)	-0.186*** (0.0290)	-0.188*** (0.0296)	-0.00610 (0.00919)	-0.000539 (0.00939)	0.00335 (0.00913)	0.00828 (0.00934)
$US\ shock_{l,t}$	0.422*** (0.0594)	0.450*** (0.0597)	0.379*** (0.0589)	0.407*** (0.0592)	0.542*** (0.0318)	0.541*** (0.0319)	0.497*** (0.0316)	0.498*** (0.0316)
$\ln(\text{yrs } US\ shock_{l,t})$			0.334*** (0.0477)	0.316*** (0.0473)			0.250*** (0.0213)	0.233*** (0.0220)
$inst\ shock_{l,t}$	0.165 (0.282)	0.168 (0.289)	0.234 (0.283)	0.254 (0.290)	-0.417*** (0.137)	-0.287** (0.139)	-0.357*** (0.138)	-0.233* (0.139)
$\ln(\text{yrs } inst\ shock_{l,t})$			0.0549 (0.0382)	0.274** (0.116)			-0.0568 (0.0353)	0.267** (0.107)
$WTO\ shock_{l,t}$	-0.716* (0.409)	-0.928** (0.411)	-0.831** (0.409)	-1.041** (0.412)	0.576*** (0.117)	0.580*** (0.118)	0.463*** (0.117)	0.477*** (0.118)
$\ln(\text{yrs } WTO\ shock_{l,t})$			-0.119** (0.0571)	-0.120** (0.0568)			-0.0400 (0.0428)	-0.0346 (0.0430)
$Rule\ of\ law_{l,t}$	0.517*** (0.0370)	0.514*** (0.0368)	0.455*** (0.0405)	0.452*** (0.0405)	0.349*** (0.0204)	0.353*** (0.0205)	0.302*** (0.0211)	0.309*** (0.0212)
$\ln(dist)_l$	-0.248*** (0.0621)	-0.248*** (0.0623)	-0.208*** (0.0631)	-0.209*** (0.0632)	-0.610*** (0.0284)	-0.614*** (0.0283)	-0.567*** (0.0288)	-0.574*** (0.0288)
$\ln(\text{mean income } pc)_l$	-0.237*** (0.0261)	-0.238*** (0.0261)	-0.262*** (0.0269)	-0.262*** (0.0270)	-0.0760*** (0.0139)	-0.0774*** (0.0138)	-0.0975*** (0.0146)	-0.0996*** (0.0146)
$\ln(\text{mrkt thick})_l$	0.602*** (0.0134)	0.602*** (0.0134)	0.591*** (0.0135)	0.592*** (0.0136)	0.605*** (0.00866)	0.608*** (0.00870)	0.605*** (0.00868)	0.607*** (0.00872)
M sector FE	YES	YES	YES	YES	NO	NO	NO	NO
H sector FE	NO	NO	NO	NO	YES	YES	YES	YES
Year FE	NO	YES	NO	YES	NO	YES	NO	YES

Standard errors in parentheses

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ 

## C Initial conditions by sector type: Non-tradable intermediate inputs

When none of the offshoring types are available for the final good producers, the respective shares  $\chi_O^S = \chi_{V_H}^S = \chi_{V_M}^S = 0$ . Let's denote the steady state values for the economy under such a situation with superscript *n.t.i.*.

**Balanced intensity sectors.** The price index is given by:

$$(P^{n.t.i.})^{1-\sigma} = H^{n.t.i.} \int_{\underline{\theta}^{n.t.i.}}^{\infty} p_O^N(\theta)^{1-\sigma} \frac{g(\theta)}{1 - G(\underline{\theta}^{n.t.i.})} d\theta$$

and the aggregate consumption index is:

$$Q^{n.t.i.} = \gamma E(H^{n.t.i.})^{\frac{1}{\sigma-1}} \left[ \int_{\underline{\theta}^{n.t.i.}}^{\infty} p_O^N(\theta)^{1-\sigma} \frac{g(\theta)}{1-G(\underline{\theta}^{n.t.i.})} d\theta \right]^{\frac{1}{\sigma-1}}$$

Comparing this *n.t.i.* steady state conditions with the respective perfect information steady state with tradable intermediate inputs denoted by \*, it is easy to see that:

$$\underline{\theta}^{n.t.i.} < \underline{\theta}^* ; P^{n.t.i.} > P^* ; Q^{n.t.i.} < Q^*$$

**H-intensive sectors.** The price index is:

$$(P^{n.t.i.})^{1-\sigma} = H^{n.t.i.} \left[ \int_{\underline{\theta}^{n.t.i.}}^{\infty} p_O^N(\theta)^{1-\sigma} \frac{g(\theta)}{1-G(\underline{\theta}^{n.t.i.})} d\theta + \chi_{V_H}^{N,n.t.i.} \int_{\theta_{V_H}^{N,n.t.i.}}^{\infty} [p_{V_H}^N(\theta)^{1-\sigma} - p_O^N(\theta)^{1-\sigma}] \frac{g(\theta)}{1-G(\theta_{V_H}^{N,n.t.i.})} d\theta \right]$$

and the aggregate consumption index is:

$$Q^{n.t.i.} = \gamma E(H^{n.t.i.})^{\frac{1}{\sigma-1}} \left[ \int_{\underline{\theta}^{n.t.i.}}^{\infty} p_O^N(\theta)^{1-\sigma} \frac{g(\theta)}{1-G(\underline{\theta}^{n.t.i.})} d\theta + \chi_{V_H}^{N,n.t.i.} \int_{\theta_{V_H}^{N,n.t.i.}}^{\infty} [p_{V_H}^N(\theta)^{1-\sigma} - p_O^N(\theta)^{1-\sigma}] \frac{g(\theta)}{1-G(\theta_{V_H}^{N,n.t.i.})} d\theta \right]^{\frac{1}{\sigma-1}}$$

where

$$\underline{\theta}^{n.t.i.} < \underline{\theta}^* ; \theta_{V_H}^{N,n.t.i.} < \theta_{V_H}^{N,*} ; P^{n.t.i.} > P^* ; Q^{n.t.i.} < Q^*$$

**M-intensive sectors.** The price index is:

$$(P^{n.t.i.})^{1-\sigma} = H^{n.t.i.} \left[ \int_{\underline{\theta}^{n.t.i.}}^{\infty} p_O^N(\theta)^{1-\sigma} \frac{g(\theta)}{1-G(\underline{\theta}^{n.t.i.})} d\theta + \chi_{V_M}^{N,n.t.i.} \int_{\theta_{V_M}^{N,n.t.i.}}^{\infty} [p_{V_M}^N(\theta)^{1-\sigma} - p_O^N(\theta)^{1-\sigma}] \frac{g(\theta)}{1-G(\theta_{V_M}^{N,n.t.i.})} d\theta \right]$$

The aggregate consumption index is:

$$Q^{n.t.i.} = \gamma E(H^{n.t.i.})^{\frac{1}{\sigma-1}} \left[ \int_{\underline{\theta}^{n.t.i.}}^{\infty} p_O^N(\theta)^{1-\sigma} \frac{g(\theta)}{1-G(\underline{\theta}^{n.t.i.})} d\theta + \chi_{V_M}^{N,n.t.i.} \int_{\theta_{V_M}^{N,n.t.i.}}^{\infty} [p_{V_M}^N(\theta)^{1-\sigma} - p_O^N(\theta)^{1-\sigma}] \frac{g(\theta)}{1-G(\theta_{V_M}^{N,n.t.i.})} d\theta \right]^{\frac{1}{\sigma-1}}$$

and

$$\underline{\theta}^{n.t.i.} < \underline{\theta}^* \quad ; \quad \theta_{V_M}^{N,n.t.i.} < \theta_{V_M}^{N,*} \quad ; \quad P^{n.t.i.} > P^* \quad ; \quad Q^{n.t.i.} < Q^*$$

## D Uncertainty - Dynamic model: Sectoral equilibrium path

### D.1 Proofs: Bayesian learning mechanism

The characterisation of the learning mechanism is closely related to Larch and Navarro (2021); Rob (1991); Segura-Cayuela and Vilarrubia (2008).

From the "physical" state, final good producers in North receive information about  $\theta_{k,t}^S$  for  $k = O, V_H, V_M$ , i.e. the least productive producers sourcing under type  $k$ . With this information, they compute the respective  $f_{k,t}^S$ .

Using Bayes' rule, the posterior at period  $t$  for type  $k$  is given by:

$$Y(f_k^S | f_k^S \leq f_{k,t}^S) = \frac{Y(f_k^S | f_k^S \leq f_{k,t-1}^S) Y(f_{k,t}^S | f_k^S)}{Y(f_{k,t}^S | f_k^S \leq f_{k,t-1}^S)}$$

where  $Y(f_k^S | f_k^S \leq f_{k,t-1}^S)$  refers to the prior distribution at period  $t$ ,  $Y(f_{k,t}^S | f_k^S)$  denotes the likelihood functions, and the denominator is the scaling factor.

As it is shown in Larch and Navarro (2021), the likelihood function takes the form:

$$Y(f_{k,t}^S | f_k^S) = \begin{cases} 1 & \text{if } f_{k,t}^S \geq f_k^S \\ 0 & \text{if } f_{k,t}^S < f_k^S \end{cases}$$

Therefore, the posterior in  $t$  for type  $k$  becomes a truncation of the upper bound of the prior given by:

$$Y(f_k^S | f_k^S \leq f_{k,t}^S) = \frac{Y(f_k^S | f_k^S \leq f_{k,t-1}^S)}{Y(f_{k,t}^S | f_k^S \leq f_{k,t-1}^S)}$$

From equation (17), the producers hold the prior beliefs in type  $k$  as long as any producer offshore under that type. In other words, they are not able to update their priors if no new information is revealed by some of their competitors. Once at least one producer offshores under  $k$  new information reveals to the other still under domestic sourcing and the update of the prior beliefs follows the mechanism described above. The updating of type  $k$  stops once the true value  $f_k^S$  is revealed.

## D.2 Proof: OSLA rule as optimal policy

I follow the same procedure as Larch and Navarro (2021). Therefore, I will describe only the main steps of the proofs, and the aspects where they differ significantly from each other.

Consider the Bellman's equation (18). The goal of this section is to find the optimal waiting policy, i.e. how many periods is optimal to wait given the information set at  $t$ .

By policy iteration, I show that, in expectation at  $t$ , waiting for one period and exploring in the next one, i.e. the One-Step-Look-Ahead (OSLA) rule, dominates waiting for longer periods.

Let's define  $V_{k,t}^{w,1}(\theta; \cdot), \dots, V_{k,t}^{w,n}(\theta; \cdot)$  as the value of waiting in  $t$  for  $1, \dots, n$  periods, respectively. Let's define  $k'^N$  as the current organisational form of the producer taking the decision, i.e.  $k'^N = O^N, V_H^N, V_M^N$ .

The value of waiting is:

$$\begin{aligned}
 V_{k,t}^{w,1}(\theta; \theta_t, \theta_{t+1}) &= 0 + \frac{[Y(f_{k,t}^S) - Y(f_{k,t+1}^S)]}{Y(f_{k,t}^S)} \lambda \mathbb{E}_t \left[ \max \left\{ 0; \frac{\pi_{k^S/k'^N}^{prem}(\theta)}{1-\lambda} - w^N s^r \right\} \middle| f_{k,t+1}^S < f^S \leq f_{k,t}^S \right] \\
 &\quad + \frac{Y(f_{k,t+1}^S)}{Y(f_{k,t}^S)} \lambda \left[ \mathbb{E}_t \left[ \max \left\{ 0; \sum_{\tau=t+1}^{\infty} \lambda^{\tau-t-1} \pi_{k^S/k'^N, \tau}^{prem}(\theta) \right\} \middle| f_k^S \leq f_{k,t+1}^S \right] - w^N s^r \right] \\
 &\quad \vdots \\
 V_{k,t}^{w,n}(\theta; \theta_t, \theta_{t+n}) &= 0 + \frac{[Y(f_{k,t}^S) - Y(f_{k,t+n}^S)]}{Y(f_{k,t}^S)} \lambda^n \mathbb{E}_t \left[ \max \left\{ 0; \frac{\pi_{k^S/k'^N}^{prem}(\theta)}{1-\lambda} - w^N s^r \right\} \middle| f_{k,t+n}^S < f_k^S \leq f_{k,t}^S \right] \\
 &\quad + \frac{Y(f_{k,t+n}^S)}{Y(f_{k,t}^S)} \lambda^n \left[ \mathbb{E}_t \left[ \max \left\{ 0; \sum_{\tau=t+n}^{\infty} \lambda^{\tau-t-n} \pi_{k^S/k'^N, \tau}^{prem}(\theta) \right\} \middle| f_k^S \leq f_{k,t+n}^S \right] - w^N s^r \right]
 \end{aligned}$$

If the waiting period goes to infinity:

$$\lim_{n \rightarrow \infty} V_{k,t}^{w,n}(\theta; \theta_t, \theta_{t+n}) = 0$$

As in Larch and Navarro (2021), I concentrate the analysis in the case where there is a trade-off in the decision. In other words, in the case of producers with a non-negative value of offshoring under type  $k$  in period  $t$ <sup>69</sup>. Therefore, the value of waiting for these producers for any period  $n = 1, \dots, \infty$  is non-negative, i.e.  $V_{k,t}^{w,n}(\theta; \cdot) \geq 0 \forall n \geq 1$ .

As in Segura-Cayuela and Vilarrubia (2008); Larch and Navarro (2021), consider the marginal producer for type  $k$  who compares the value of exploring the offshoring potential under  $k$  with the value of waiting for one period and explore in the next one, i.e.  $\mathcal{D}_{k,t}(\theta; \cdot) = V_{k,t}^o(\theta; \cdot) - V_{k,t}^{w,1}(\theta; \cdot) = 0$ . The intuition of the proof is as follows and makes use of assumption A.3.

<sup>69</sup>When the value of offshoring is negative, the producer does not face any trade-off in the decision.

The value of waiting for  $n$  periods before exploring the offshoring potential under type  $k$  falls at a rate  $\lambda^n$  for producers that weakly prefer exploring now than waiting for one period. Since  $\lambda < 1$ , waiting for any number of periods  $n > 1$  is dominated by waiting for one period. In other words, if in expectation at  $t$  waiting for one period does not convince a producer to wait, waiting for two or more periods is less preferred, as the new information revealed every further period is less. Therefore, the equilibrium path is defined by the final good producers deciding between exploring offshoring in  $k$  in  $t$  or waiting for one period.

Let's continue with the formal proof. I start by comparing the value of waiting for one period with the value of waiting for two periods, i.e.  $V_{k,t}^{w,1}(\theta; \cdot); V_{k,t}^{w,2}(\theta; \cdot)$ . As mentioned above, I focus the analysis in the marginal producer, i.e. the indifferent one between explore offshoring under  $k$  today or wait for one period.<sup>70</sup>,

$$\begin{aligned} \mathcal{D}_{k,t}(\theta; \theta_t, \tilde{\theta}_{t+1}) &= V_{k,t}^o(\theta; \theta_t) - V_{k,t}^{w,1}(\theta; \theta_t, \tilde{\theta}_{t+1}) = 0 \\ &= \max \left\{ 0; \mathbb{E}_t \left[ \pi_{k^S/k'^N,t}^{prem}(\theta) \mid f_k^S \leq f_{k,t}^S \right] \right\} - w^N s^r \left[ 1 - \lambda \frac{Y(f_{k,t+1}^S)}{Y(f_{k,t}^S)} \right] \\ &\quad + \frac{[Y(f_{k,t}^S) - Y(f_{k,t+1}^S)]}{Y(f_{k,t}^S)} \lambda \mathbb{E}_t \left[ \max \left\{ 0; \frac{\pi_{k^S/k'^N}^{prem}(\theta)}{1 - \lambda} \right\} \right] \\ &\quad - \max \left\{ 0; \frac{\pi_{k^S/k'^N}^{prem}(\theta)}{1 - \lambda} - w^N s^r \right\} \mid f_{k,t+1}^S < f_k^S \leq f_{k,t}^S \Big] = 0 \end{aligned}$$

Equivalently, the expression of the trade-off function for waiting for two periods is given by:

$$\begin{aligned} \mathcal{D}_{k,t}(\theta; \theta_t, \tilde{\theta}_{t+2}) &= V_{k,t}^0(\theta; \theta_t) - V_{k,t}^{w,2}(\theta; \theta_t, \tilde{\theta}_{t+2}) \\ &= \max \left\{ 0; \mathbb{E}_t \left[ \pi_{k^S/k'^N,t}^{prem}(\theta) + \lambda \pi_{k^S/k'^N,t+1}^{prem}(\theta) \mid f_k^S \leq f_{k,t}^S \right] \right\} - w^N s^r \left[ 1 - \lambda^2 \frac{Y(f_{k,t+2}^S)}{Y(f_{k,t}^S)} \right] \\ &\quad + \frac{[Y(f_{k,t}^S) - Y(f_{k,t+2}^S)]}{Y(f_{k,t}^S)} \lambda^2 \mathbb{E}_t \left[ \max \left\{ 0; \frac{\pi_{k^S/k'^N}^{prem}(\theta)}{1 - \lambda} \right\} \right] \\ &\quad - \max \left\{ 0; \frac{\pi_{k^S/k'^N}^{prem}(\theta)}{1 - \lambda} - w^N s^r \right\} \mid f_{k,t+2}^S < f_k^S \leq f_{k,t}^S \Big] \end{aligned}$$

I consider the case in which the third term of the RHS is zero for both trade-off functions<sup>71</sup>. There-

<sup>70</sup>I show the derivation of the trade-off function in the main part of the paper, and the respective proofs are in Appendix D.3.

<sup>71</sup>This assumption allows me to focus in the most restrictive condition. It can be easily shown that if value of waiting for one period is optimal in this case, it is also optimal in the other cases.

fore, the trade-off functions become:

$$\mathcal{D}_{k,t}(\theta; \theta_t, \tilde{\theta}_{t+1}) = \mathbb{E}_t \left[ \pi_{k^S/k'^N,t}^{prem}(\theta) \Big| f_k^S \leq f_{k,t}^S \right] - w^N s^r \left[ 1 - \lambda \frac{Y(f_{k,t+1}^S)}{Y(f_{k,t}^S)} \right]$$

$$\mathcal{D}_{k,t}(\theta; \theta_t, \tilde{\theta}_{t+2}) = \mathbb{E}_t \left[ \pi_{k^S/k'^N,t}^{prem}(\theta) + \lambda \pi_{k^S/k'^N,t+1}^{prem}(\theta) \Big| f_k^S \leq f_{k,t}^S \right] - w^N s^r \left[ 1 - \lambda^2 \frac{Y(f_{k,t+2}^S)}{Y(f_{k,t}^S)} \right]$$

If the value of waiting for one period dominates the value of waiting for two periods, thence:

$$V_t^0(\theta; \cdot) - V_t^{w,1}(\theta; \cdot) - \left[ V_t^0(\theta; \cdot) - V_t^{w,2}(\theta; \cdot) \right] \stackrel{!}{<} 0 \Leftrightarrow V_t^{w,2}(\theta; \cdot) - V_t^{w,1}(\theta; \cdot) \stackrel{!}{<} 0$$

By replacing with the respective trade-off functions in this last expression, I have:

$$\mathbb{E}_t \left[ \pi_{k^S/k'^N,t+1}^{prem}(\theta) \Big| f_k^S \leq f_{k,t}^S \right] \stackrel{!}{>} w^N s^r \left[ \frac{Y(f_{k,t+1}^S)}{Y(f_{k,t}^S)} - \lambda \frac{Y(f_{k,t+2}^S)}{Y(f_{k,t}^S)} \right]$$

From the marginal producer condition above, I know:

$$\mathbb{E}_t \left[ \pi_{k^S/k'^N,t}^{prem}(\theta) \Big| f_k^S \leq f_{k,t}^S \right] = w^N s^r \left[ 1 - \lambda \frac{Y(f_{k,t+1}^S)}{Y(f_{k,t}^S)} \right]$$

By Assumption A.3,

$$1 - \lambda Y(f_{k,t+1}^S | f_k^S \leq f_{k,t}^S) > Y(f_{k,t+1}^S | f_k^S \leq f_{k,t}^S) - \lambda Y(f_{k,t+2}^S | f_k^S \leq f_{k,t}^S)$$

and thus,

$$\mathbb{E}_t \left[ \pi_{k^S/k'^N,t+1}^{prem}(\theta) \Big| f_k^S \leq f_{k,t}^S \right] > w^N s^r \left[ \frac{Y(f_{k,t+1}^S)}{Y(f_{k,t}^S)} - \lambda \frac{Y(f_{k,t+2}^S)}{Y(f_{k,t}^S)} \right] \Rightarrow V_{k,t}^{w,2}(\theta; \cdot) - V_{k,t}^{w,1}(\theta; \cdot) < 0$$

From the result above, it is easy to see that  $V_{k,t}^{w,n}(\theta; \cdot) > V_{k,t}^{w,n+1}(\theta; \cdot)$  for any period  $n$ . Therefore,

$$V_{k,t}^{w,1}(\theta; \cdot) > V_{k,t}^{w,2}(\theta; \cdot) > \dots > V_{k,t}^{w,n}(\theta; \cdot)$$

In other words, for those producers in a trade-off condition, in expectation at  $t$ , waiting for one period dominates waiting for longer periods.<sup>72</sup>

<sup>72</sup>Following similar steps as Larch and Navarro (2021), it is possible to there is no degeneration in producers' choices when  $V_t^o(\theta; \cdot) < 0$ . In other words, there is no reversion of the trade-off function sign under this situation, so producers will never find optimal to explore offshoring under  $k$  in  $t$  when  $V_{k,t}^o(\theta; \cdot) < 0$ .



### D.3 Trade-off function

$$\mathcal{D}_{k,t}(\theta; \theta_t, \tilde{\theta}_{t+1}) = V_{k,t}^o(\theta; \theta_t, \tilde{\theta}_{t+1}) - V_{k,t}^{w,1}(\theta; \theta_t, \tilde{\theta}_{t+1})$$

Decomposing the value of offshoring,

$$\begin{aligned} V_{k,t}^o(\theta; \cdot) &= \max \left\{ 0; \mathbb{E}_t \left[ \pi_{k^S/k'^N,t}^{prem}(\theta) \mid f_k^S \leq f_{k,t}^S \right] \right\} - w^N s^r \\ &\quad + \frac{[Y(f_{k,t}^S) - Y(f_{k,t+1}^S)]}{Y(f_{k,t}^S)} \lambda \mathbb{E}_t \left[ \max \left\{ 0; \frac{\pi_{k^S/k'^N}^{prem}(\theta)}{1-\lambda} \right\} \mid f_{k,t+1}^S < f_k^S \leq f_{k,t}^S \right] \\ &\quad + \frac{Y(f_{k,t+1}^S)}{Y(f_{k,t}^S)} \lambda \mathbb{E}_t \left[ \max \left\{ 0; \sum_{\tau=t+1}^{\infty} \lambda^{\tau-t-1} \pi_{k^S/k'^N,\tau}^{prem}(\theta) \right\} \mid f_k^S \leq f_{k,t+1}^S \right] \end{aligned}$$

$\frac{[Y(f_{k,t}^S) - Y(f_{k,t+1}^S)]}{Y(f_{k,t}^S)}$  denotes the probability that  $f_k^S$  is revealed in period  $t$ , while  $\frac{Y(f_{k,t+1}^S)}{Y(f_{k,t}^S)}$  indicates the probability it is not revealed but the uncertainty reduces given the new information flow.

Introducing  $f_k^S(\theta)$ ,

$$\begin{aligned} V_{k,t}^o(\theta; \cdot) &= \max \left\{ 0; \mathbb{E}_t \left[ \pi_{k^S/k'^N,t}^{prem}(\theta) \mid f_k^S \leq f_{k,t}^S \right] \right\} - w^N s^r \\ &\quad + \frac{[Y(f_{k,t}^S) - Y(f_k^S(\theta))]}{Y(f_{k,t}^S)} \lambda 0 \\ &\quad + \frac{[Y(f_k^S(\theta)) - Y(f_{k,t+1}^S)]}{Y(f_{k,t}^S)} \lambda \mathbb{E}_t \left[ \frac{\pi_{k^S/k'^N}^{prem}(\theta)}{1-\lambda} \mid f_{k,t+1}^S < f_k^S \leq f_k^S(\theta) \right] \\ &\quad + \frac{Y(f_{k,t+1}^S)}{Y(f_{k,t}^S)} \lambda \mathbb{E}_t \left[ \max \left\{ 0; \sum_{\tau=t+1}^{\infty} \lambda^{\tau-t-1} \pi_{k^S/k'^N,\tau}^{prem}(\theta) \right\} \mid f_k^S \leq f_{k,t+1}^S \right] \end{aligned}$$

The probability of  $f_k^S$  being revealed above the maximum affordable fixed cost for the producer  $\theta$  is  $\frac{[Y(f_{k,t}^S) - Y(f_k^S(\theta))]}{Y(f_{k,t}^S)}$ , and the probability of being revealed below is  $\frac{[Y(f_k^S(\theta)) - Y(f_{k,t+1}^S)]}{Y(f_{k,t}^S)}$ .

$$\begin{aligned} \Rightarrow V_{k,t}^o(\theta; \cdot) &= \max \left\{ 0; \mathbb{E}_t \left[ \pi_{k^S/k'^N,t}^{prem}(\theta) \mid f_k^S \leq f_{k,t}^S \right] \right\} - w^N s^r \\ &\quad + \frac{[Y(f_k^S(\theta)) - Y(f_{k,t+1}^S)]}{Y(f_{k,t}^S)} \lambda \mathbb{E}_t \left[ \frac{\pi_{k^S/k'^N}^{prem}(\theta)}{1-\lambda} \mid f_{k,t+1}^S < f_k^S \leq f_k^S(\theta) \right] \\ &\quad + \frac{Y(f_{k,t+1}^S)}{Y(f_{k,t}^S)} \lambda \mathbb{E}_t \left[ \sum_{\tau=t+1}^{\infty} \lambda^{\tau-t-1} \pi_{k^S/k'^N,\tau}^{prem}(\theta) \mid f_k^S \leq f_{k,t+1}^S \right] \end{aligned}$$

Decomposition in an equivalent way the value of waiting one period,

$$\begin{aligned}
V_{k,t}^{w,1}(\theta; \cdot) &= 0 + \frac{[Y(f_{k,t}^S) - Y(f_{k,t+1}^S)]}{Y(f_{k,t}^S)} \lambda \mathbb{E}_t \left[ \max \left\{ 0; \frac{\pi_{k^S/k'^N}^{prem}(\theta)}{1-\lambda} - w^N s^r \right\} \middle| f_{k,t+1}^S < f_k^S \leq f_{k,t}^S \right] \\
&\quad + \frac{Y(f_{k,t+1}^S)}{Y(f_{k,t}^S)} \lambda \left[ \mathbb{E}_t \left[ \max \left\{ 0; \sum_{\tau=t+1}^{\infty} \lambda^{\tau-t-1} \pi_{k^S/k'^N,\tau}^{prem}(\theta) \right\} \middle| f_k^S \leq f_{k,t+1}^S \right] - w^N s^r \right] \\
\Rightarrow V_{k,t}^{w,1}(\theta; \cdot) &= \frac{[Y(f_k^S(\theta)) - Y(f_{k,t+1}^S)]}{Y(f_{k,t}^S)} \lambda \\
&\quad \times \mathbb{E}_t \left[ \max \left\{ 0; \frac{\pi_{k^S/k'^N}^{prem}(\theta)}{1-\lambda} - w^N s^r \right\} \middle| f_{k,t+1}^S < f_k^S \leq f_k^S(\theta) \right] \\
&\quad + \frac{Y(f_{k,t+1}^S)}{Y(f_{k,t}^S)} \lambda \left[ \mathbb{E}_t \left[ \sum_{\tau=t+1}^{\infty} \lambda^{\tau-t-1} \pi_{k^S/k'^N,\tau}^{prem}(\theta) \middle| f_k^S \leq f_{k,t+1}^S \right] - w^N s^r \right]
\end{aligned}$$

Replacing the value of offshoring and the value of waiting for one period in the trade off function gives the following equivalent expression,

$$\begin{aligned}
\mathcal{D}_{k,t}(\theta; \cdot) &= \max \left\{ 0; \mathbb{E}_t \left[ \pi_{k^S/k'^N,t}^{prem}(\theta) \middle| f_k^S \leq f_{k,t}^S \right] \right\} - w^N s^r \left[ 1 - \lambda \frac{Y(f_{k,t+1}^S)}{Y(f_{k,t}^S)} \right] \\
&\quad + \frac{[Y(f_k^S(\theta)) - Y(f_{k,t+1}^S)]}{Y(f_{k,t}^S)} \lambda \mathbb{E}_t \left[ \frac{\pi_{k^S/k'^N}^{prem}(\theta)}{1-\lambda} \right. \\
&\quad \left. - \max \left\{ 0; \frac{\pi_{k^S/k'^N}^{prem}(\theta)}{1-\lambda} - w^N s^r \right\} \middle| f_{k,t+1}^S < f_k^S \leq f_k^S(\theta) \right]
\end{aligned}$$

By Proposition 1, the probability of  $f_k^S$  being revealed below  $f_k^S(\theta)$  while producer  $\theta$  is waiting is zero. If it would not be zero, this means that a final good producer with a lower productivity (i.e.  $\tilde{\theta}_{t+1} < \theta$ ) has tried offshoring before the producer  $\theta$ , which is not possible due to Proposition 1.

Therefore, the trade off function becomes:

$$\mathcal{D}_{k,t}(\theta; \theta_t, \tilde{\theta}_{t+1}) = \max \left\{ 0; \mathbb{E}_t \left[ \pi_{k^S/k'^N,t}^{prem}(\theta) \middle| f_k^S \leq f_{k,t}^S \right] \right\} - w^N s^r \left[ 1 - \lambda \frac{Y(f_{k,t+1}^S)}{Y(f_{k,t}^S)} \right]$$

#### D.4 Balanced-intensity sectors: The trade-off function and equilibrium paths.

As mentioned above, outsourcing dominates integration for both domestic sourcing and offshoring firms. Thence, when the final good producers must decide whether to explore the offshoring potential or wait, they compare the profit they earn under domestic outsourcing with the expected profits under arm's length trade.

The trade-off function, which drives the offshoring exploration decision, is given by:

$$\mathcal{D}_{O,t}(\theta; \theta_t^S, \tilde{\theta}_{t+1}^S) = \max \left\{ 0; \mathbb{E}_t \left[ \pi_{OS/ON,t}^{prem}(\theta) \mid f_O^S \leq f_{O,t}^S \right] \right\} - w^N s^r \left[ 1 - \lambda \frac{Y(f_{O,t+1}^S)}{Y(f_{O,t}^S)} \right] \quad (61)$$

As mentioned, when  $\mathcal{D}_{O,t}(\theta; \theta_t^S, \tilde{\theta}_{t+1}^S) \geq 0$ , the final good producer with productivity  $\theta$  explore their offshoring potential in period  $t$ .

The least productive final good producer exploring the offshoring potential in period  $t$ , i.e.  $\tilde{\theta}_{t+1}^S = \tilde{\theta}_{O,t+1}^S$ , is defined by Proposition 6.

**Proposition 6** (Per-period offshoring exploration productivity cutoff). *The offshoring exploration productivity cutoff at any period  $t$ ,  $\tilde{\theta}_{t+1}^S = \tilde{\theta}_{O,t+1}^S$ , is defined as the fixed point in the trade-off function*

$$\mathcal{D}_{O,t}(\tilde{\theta}_{O,t+1}^S; \theta_t^S, \tilde{\theta}_{t+1}^S) = 0 \Rightarrow \mathbb{E}_t \left[ \pi_{OS/ON,t}^{prem}(\tilde{\theta}_{O,t+1}^S) \mid f_O^S \leq f_{O,t}^S \right] = w^N s^r \left[ 1 - \lambda \frac{Y(f_{O,t+1}^S)}{Y(f_{O,t}^S)} \right]$$

Solving the expression above, the offshoring exploration productivity cutoff in period  $t$  is given by:

$$\tilde{\theta}_{O,t+1}^S = (\gamma E)^{\frac{\sigma}{1-\sigma}} \tilde{Q}_t \left[ \frac{w^N \left[ \mathbb{E}(f_O^S \mid f_O^S \leq f_{O,t}^S) - f_O^N + s^r \left( 1 - \lambda \frac{Y(f_{O,t+1}^S)}{Y(f_{O,t}^S)} \right) \right]}{\psi_O^S(\eta) - \psi_O^N(\eta)} \right]^{\frac{1}{\sigma-1}}$$

#### D.4.1 Convergence: Long-run properties of the trade-off function.

The steady states of the sector characterised by Proposition 7 are the result of the fixed point of the trade-off function defined by:

$$\mathcal{D}_{O,\infty}(\theta_{O,\infty}; \theta_\infty, \theta_\infty) = 0 \Rightarrow \mathbb{E}_t \left[ \pi_{OS/ON}^{prem}(\theta_{O,\infty}^S) \mid f_O^S \leq f_{O,\infty}^S \right] = w^N s^r (1 - \lambda)$$

**Proposition 7** (Convergence of offshoring productivity cutoff). *The sector converges asymptotically to the perfect information equilibrium, i.e.  $\theta_{O,t}^S \xrightarrow{t \rightarrow \infty} \theta_{O,*}^S$ , when:*

$$\text{Case I: } f_O^S = \underline{f}_O^S \Rightarrow f_{O,\infty}^S = \underline{f}_O^S$$

$$\text{Case II: } \underline{f}_O^S + (1 - \lambda)s^r < f_O^S$$

Hysteresis takes places, i.e. convergence leads to some "excess" of offshoring , when:

$$\text{Case III: } \underline{f}_O^S + (1 - \lambda)s^r = f_O^S \Rightarrow \theta_{O,t}^S \xrightarrow{t \rightarrow \infty} \theta_O^{S,-r}$$

$$\text{Case IV: } \underline{f}_O^S + (1 - \lambda)s^r > f_O^S > \underline{f}_O^S \Rightarrow \theta_{O,t}^S \xrightarrow{t \rightarrow \infty} \theta_{O,\infty}^S$$

with  $\theta_O^{S,*} > \theta_{O,\infty}^S > \theta_O^{S,-r}$ , and  $\theta_O^{S,-r}$  denoting the case where the marginal final good producers obtain zero per period offshoring profit premium from arm's length trade, i.e. they cannot recover the offshoring sunk cost.

In conclusion, it is possible to observe that the steady state exists and it is unique. However, the resting point depends on how optimistic are the initial prior beliefs. The Figure 19a illustrates the cases characterised in Proposition 7.

#### D.4.2 Competition effect and welfare considerations.

The convergence in the offshoring productivity cutoff pushes simultaneously to a convergence in the market productivity cutoff. The least productive final good producers must leave the market as the competition in the final good market intensifies.

Proposition 8 characterises the steady state of the market productivity cutoff, and Figure 19b illustrates the equilibrium paths of the domestic and offshoring productivity cutoffs in the long run for the Case I (*solid line*) and the Case III (*dashed line*). On the other hand, the Case IV is represented as any path in between the paths I and III.

**Proposition 8** (Convergence properties of market productivity cutoff). *As the offshoring productivity cutoff converges to the steady state defined by Proposition 7, the intensified competition pushes sequentially the least productive final good producers out of the market.*

$$\left\{ \begin{array}{ll} \text{Cases I and II: } \underline{\theta}_t \uparrow \underline{\theta}^* & \text{if } \theta_{O,t}^S \downarrow \theta_O^{S,*} \\ \text{Case III: } \underline{\theta}_t \uparrow \underline{\theta}^{-r} & \text{if } \theta_{O,t}^S \downarrow \theta_O^{S,-r} \\ \text{Case IV: } \underline{\theta}_t \uparrow \underline{\theta}_\infty \in (\underline{\theta}^*; \underline{\theta}^{-r}) & \text{if } \theta_{O,t}^S \downarrow \theta_{O,\infty}^S \in (\theta_O^{S,-r}; \theta_O^{S,*}) \end{array} \right.$$

To conclude, by propositions 7 and 8 it is possible to show that  $P_t \downarrow P^*$  and  $Q_t \uparrow Q^{*73}$ , therefore the informational spillovers allow the economy to fully realise the welfare gains from offshoring in the long run in these type of sectors.

<sup>73</sup>The aggregate consumption may increase slightly above the perfect information equilibrium value due to the hysteresis described above in cases III and IV.

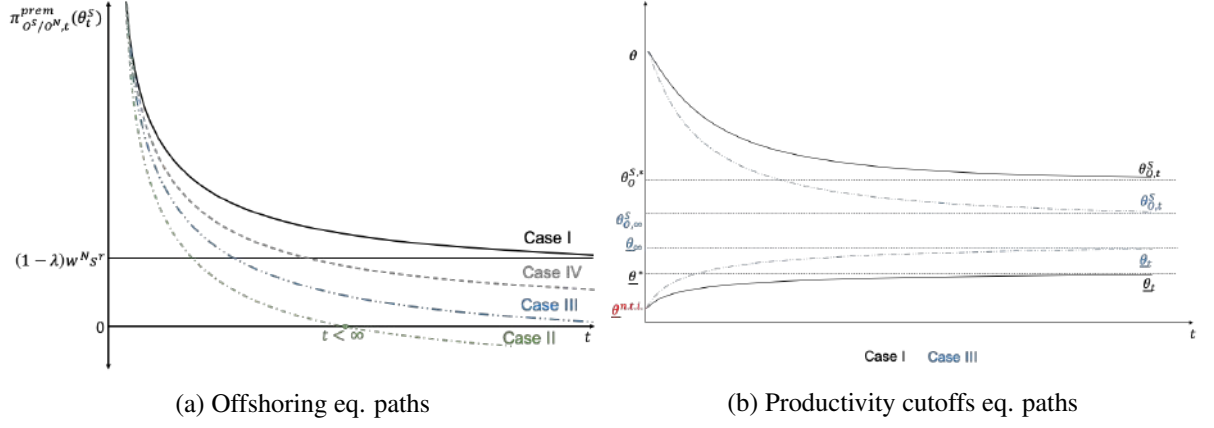


Figure 19: Balanced-intensity sectors

## D.5 Proofs of Propositions

### D.5.1 Proof of Proposition 1

The profit premium  $\pi_{k^S/k^N}^{prem}(\theta)$  is increasing in  $\theta$ . Therefore, it is easy to see that  $\frac{\partial \mathcal{D}_{k,t}(\theta; \theta_t, \tilde{\theta}_{t+1})}{\partial \theta} \geq 0$ . Furthermore, given that the producers facing a trade-off have a positive value of offshoring under  $k$  in  $t$ , the trade-off function is strictly increasing in  $\theta$  for those final good producers.

### D.5.2 Proof of Proposition 2

I start by characterizing the exploration cutoff productivities for the first period  $t = 0$ , and then I define them for any  $t > 0$ .

**Exploration in  $t = 0$ .** Although it is possible to characterise the exploration cutoff for any possible initial condition, I divide the analysis in three cases. Assuming a risk for repetition, the separation of the analysis helps in the understanding of the underlying decision.

Let's consider first the case where, given the priors  $Y(f_O^S), Y(f_V^S)$ , the final good producers find optimal to explore offshoring only under FDI- $V_k$ . In other words, given the priors, the trade-off function  $\mathcal{D}_{O,t=0}(\theta; \cdot) < 0$  for  $\theta \leq \bar{\theta}$ . Therefore, the exploration cutoff is defined by the fixed point below:

$$\begin{aligned} \mathcal{D}_{V,t=0}(\tilde{\theta}_{V,t=1}^S; \theta_{t=0}^S, \theta_{V,t=1}^S) &= 0 \\ \mathbb{E}_{t=0} \left[ \pi_{V^S/V^N,t=0}^{prem}(\tilde{\theta}_{V,t=1}^S) | f_V^S \leq \bar{f}_V^S \right] - w^N s^r \left[ 1 - \lambda \frac{Y(\tilde{f}_{V,t=1}^S)}{Y(f_V^S)} \right] &= 0 \end{aligned}$$

By replacing with the respective expressions, the exploration productivity cutoff in  $t = 0$  is given by:

$$\tilde{\theta}_{V,t=1}^S = (\gamma E)^{\frac{\sigma}{1-\sigma}} \tilde{Q}_{t=1} \left[ \frac{w^N \left[ \mathbb{E}_{t=0}(f_V^S | f_V^S \leq \bar{f}_V^S) - f_V^N + s^r \left( 1 - \lambda \frac{Y(\bar{f}_{V,t=1}^S)}{Y(\bar{f}_V^S)} \right) \right]}{\psi_V^S(\eta) - \psi_V^N(\eta)} \right]^{\frac{1}{\sigma-1}} \quad (62)$$

The second case takes place when the prior beliefs promote exploration only in foreign outsourcing, i.e.  $\mathcal{D}_{V,t=0}(\theta; \cdot) < 0$  for  $\theta \leq \bar{\theta}$ . Therefore, the exploration productivity cutoff is defined by the fixed point:

$$\mathcal{D}_{O,t=0}(\tilde{\theta}_{O,t=1}^S; \theta_{t=0}^S, \theta_{t=1}^S) = 0$$

Replacing with the expressions, the exploration productivity cutoff in  $t = 0$  is given by:

$$\tilde{\theta}_{O,t=1}^S = (\gamma E)^{\frac{\sigma}{1-\sigma}} \tilde{Q}_{t=1} \left[ \frac{w^N \left[ \mathbb{E}_{t=0}(f_O^S | f_O^S \leq \bar{f}_O^S) - f_V^N + s^r \left( 1 - \lambda \frac{Y(\bar{f}_{O,t=1}^S)}{Y(\bar{f}_O^S)} \right) \right]}{\psi_O^S(\eta) - \psi_V^N(\eta)} \right]^{\frac{1}{\sigma-1}} \quad (63)$$

Finally, the third case is defined as the situation where the prior beliefs drive exploration under both offshoring types,  $O^S$  and  $V_k^S$ . Therefore, the cutoff is defined by the fixed point of the following system of equations.

$$\begin{cases} \mathcal{D}_{V,t=0}(\tilde{\theta}_{V,t=1}^S; \theta_{t=0}^S, \theta_{t=1}^S) = 0 \\ \mathcal{D}_{O,t=0}(\tilde{\theta}_{O,t=1}^S; \theta_{t=0}^S, \theta_{t=1}^S) = 0 \end{cases}$$

Both equations are connected by the expected effects of the exploration flows in the price index and thus in  $\tilde{Q}_{t=1}$ . Replacing the trade-off function by the respective expressions:

$$\begin{cases} \mathbb{E}_{t=0} \left[ \pi_{V^S/V^N,t=0}^{prem}(\tilde{\theta}_{V,t=1}^S) | f_V^S \leq \bar{f}_V^S \right] - w^N s^r \left[ 1 - \lambda \frac{Y(\bar{f}_{V,t=1}^S)}{Y(\bar{f}_V^S)} \right] = 0 \\ \mathbb{E}_{t=0} \left[ \pi_{O^S/V^N,t=0}^{prem}(\tilde{\theta}_{O,t=1}^S) | f_O^S \leq \bar{f}_O^S \right] - w^N s^r \left[ 1 - \lambda \frac{Y(\bar{f}_{O,t=1}^S)}{Y(\bar{f}_O^S)} \right] = 0 \end{cases}$$

$$\begin{cases} (\tilde{\theta}_{V,t=1}^S)^{\sigma-1} (\gamma E)^\sigma \tilde{Q}_{t+1}^{1-\sigma} [\psi_V^S(\eta) - \psi_V^N(\eta)] = w^N \left[ \mathbb{E}_t(f_V^S | f_V^S \leq \bar{f}_V^S) - f_V^N + s^r \left( 1 - \lambda \frac{Y(\bar{f}_{V,t=1}^S)}{Y(\bar{f}_V^S)} \right) \right] \\ (\tilde{\theta}_{O,t=1}^S)^{\sigma-1} (\gamma E)^\sigma \tilde{Q}_{t+1}^{1-\sigma} [\psi_O^S(\eta) - \psi_V^N(\eta)] = w^N \left[ \mathbb{E}_t(f_O^S | f_O^S \leq \bar{f}_O^S) - f_V^N + s^r \left( 1 - \lambda \frac{Y(\bar{f}_{O,t=1}^S)}{Y(\bar{f}_O^S)} \right) \right] \end{cases}$$

The solution to this system is thus given by:

$$\begin{cases} \tilde{\theta}_{V,t=1}^S = (\gamma E)^{\frac{\sigma}{1-\sigma}} \tilde{Q}_{t=1} \left[ \frac{w^N \left[ \mathbb{E}_{t=0}(f_V^S | f_V^S \leq \bar{f}_V^S) - f_V^N + s^r \left( 1 - \lambda \frac{Y(\tilde{f}_{V,t=1}^S)}{Y(f_V^S)} \right) \right]}{\psi_V^S(\eta) - \psi_V^N(\eta)} \right]^{\frac{1}{\sigma-1}} \\ \tilde{\theta}_{O,t=1}^S = (\gamma E)^{\frac{\sigma}{1-\sigma}} \tilde{Q}_{t=1} \left[ \frac{w^N \left[ \mathbb{E}_{t=0}(f_O^S | f_O^S \leq \bar{f}_O^S) - f_V^N + s^r \left( 1 - \lambda \frac{Y(\tilde{f}_{O,t=1}^S)}{Y(f_O^S)} \right) \right]}{\psi_O^S(\eta) - \psi_V^N(\eta)} \right]^{\frac{1}{\sigma-1}} \end{cases}$$

and the exploration cutoff in  $t = 0$ ,  $\tilde{\theta}_{t=1}^S$ , is defined as:  $\tilde{\theta}_{t=1}^S = \min \left\{ \tilde{\theta}_{V,t=1}^S; \tilde{\theta}_{O,t=1}^S \right\}$ .

**Exploration in  $t > 0$ .** If after exploration in  $t = 0$  all the producers that have explored their offshoring potential have chosen FDI, then the offshoring exploration productivity cutoff is defined for any following period by condition below with  $k = V$ , up to the period in which after exploring, a producer chooses arm's length trade. From that period on, the exploration cutoff is given by the condition below for  $k = O$ .

Instead, if after exploration in  $t = 0$  at least one producer chooses foreign outsourcing, then for any  $t > 0$  the exploration cutoff is given by the condition below with  $k = O$ .

$$\begin{aligned} \mathcal{D}_{k,t}(\tilde{\theta}_{k,t}^S; \theta_t^S, \theta_{t+1}^S) &= 0 \\ \mathbb{E}_t \left[ \pi_{k^S/V^N,t}^{\text{prem}}(\tilde{\theta}_{k,t}^S) | f_k^S \leq \bar{f}_{k,t}^S \right] - w^N s^r \left[ 1 - \lambda \frac{Y(\tilde{f}_{k,t+1}^S)}{Y(f_{k,t}^S)} \right] &= 0 \end{aligned}$$

By replacing with the respective expressions, the exploration productivity cutoff in  $t$  is given by:

$$\tilde{\theta}_{k,t+1}^S = (\gamma E)^{\frac{\sigma}{1-\sigma}} \tilde{Q}_{t+1} \left[ \frac{w^N \left[ \mathbb{E}_t(f_k^S | f_k^S \leq \bar{f}_{k,t}^S) - f_V^N + s^r \left( 1 - \lambda \frac{Y(\tilde{f}_{k,t+1}^S)}{Y(f_{k,t}^S)} \right) \right]}{\psi_k^S(\eta) - \psi_V^N(\eta)} \right]^{\frac{1}{\sigma-1}} \quad (64)$$

### D.5.3 Proof of Propositions 4 and 5

By assumption A.4,

$$\mathcal{D}_{k,t}(\bar{\theta}; \bar{\theta}, \bar{\theta}) > 0 \quad \text{for at least one } k = O^S, V_H^S, V_M^S$$

Therefore, for the  $k$  where the condition above holds,

$$\mathbb{E} \left[ \pi_{k^S/V^N,t=0}^{\text{prem}}(\bar{\theta}) | f_k^S \leq \bar{f}_k^S \right] - w^N s^r (1 - \lambda) > 0$$

For exploration decision in  $t = 0$  and posterior dynamics, see appendix D.5.2.

I show now the convergence dynamics for vertical integration  $V$ , with  $V = V_H$  or  $V_M$ . Later I show the respective long-run dynamic conditions for  $O^S$ . Together, they define the long-run steady state of the differentiated sectors for  $H$  and  $M$  intensive industries.

Let's assume that the condition above holds for  $k = V^S$ .

$$\begin{aligned} & \mathbb{E} \left[ \pi_{V^S/V^N, t=0}^{\text{prem}}(\bar{\theta}) | f_V^S \leq \bar{f}_V^S \right] - w^N s^r (1 - \lambda) > 0 \\ & r_{V, t=0}^N(\bar{\theta}) B_V^S - w^N \mathbb{E}(f_V^S | f_V^S \leq \bar{f}_V^S) - w^N [s^r (1 - \lambda) - f_V^N] > 0 \end{aligned}$$

with

$$\begin{aligned} B_V^S \equiv & \left[ \left[ \left( \frac{\beta_V^S}{\beta_V^N} \right)^\eta \left( \frac{1 - \beta_V^S}{1 - \beta_V^N} \right)^{1-\eta} \left( \frac{w^N}{w^S} \right)^{1-\eta} \right]^{\sigma-1} \right. \\ & \left. \times [1 - \alpha[\beta_V^S \eta + (1 - \beta_V^S)(1 - \eta)]] - [1 - \alpha[\beta_V^N \eta + (1 - \beta_V^N)(1 - \eta)]] \right] \end{aligned}$$

Taking the limit of the trade-off function as  $t \rightarrow \infty$ ,

$$\mathcal{D}_{V^S, \infty}(\theta_\infty; \theta_\infty, \theta_\infty) = r_{V, \infty}^N(\theta_\infty) B_V^S - w^N \mathbb{E}(f_V^S | f_V^S \leq f_{V, \infty}^S) - w^N [s^r (1 - \lambda) - f_V^N]$$

By totally differentiating the trade-off function:

$$\frac{d\mathcal{D}_{V^S, \infty}(\theta_\infty; \theta_\infty, \theta_\infty)}{d\theta_\infty} = B_V^S \frac{\partial r_{V, \infty}^N(\theta_\infty)}{\partial \theta_\infty} - w^N \frac{\partial \mathbb{E}(f_V^S | f_V^S \leq f_{V, \infty}^S)}{\partial f_{V, \infty}^S} \frac{\partial f_{V, \infty}^S}{\partial \theta_\infty}$$

with

$$f_{V, \infty}^S \equiv \frac{r_{V, \infty}^N(\theta_\infty)}{w^N} B_V^S + f_V^N \Rightarrow \frac{\partial f_{V, \infty}^S}{\partial \theta_\infty} = \frac{B_V^S}{w^N} \frac{\partial r_{V, \infty}^N(\theta_\infty)}{\partial \theta_\infty}$$

Replacing this into the previous expression:

$$\frac{d\mathcal{D}_{V^S, \infty}(\theta_\infty; \theta_\infty, \theta_\infty)}{d\theta_\infty} = B_V^S \frac{\partial r_{V, \infty}^N(\theta_\infty)}{\partial \theta_\infty} \left[ 1 - \frac{\partial \mathbb{E}(f_V^S | f_V^S \leq f_{V, \infty}^S)}{\partial f_{V, \infty}^S} \right]$$

From this expression,  $\frac{\partial r_{V, \infty}^N(\theta_\infty)}{\partial \theta_\infty} > 0$  and  $B_V^S > 0$ . Also, from assumption A.3,

$$\frac{\partial [f_{V, t}^S - \mathbb{E}(f_V^S | f_V^S \leq f_{V, t}^S)]}{\partial f_{V, t}^S} > 0 \Rightarrow 1 - \frac{\partial \mathbb{E}(f_V^S | f_V^S \leq f_{V, t}^S)}{\partial f_{V, t}^S} > 0 \Rightarrow \frac{\partial \mathbb{E}(f_V^S | f_V^S \leq f_{V, t}^S)}{\partial f_{V, t}^S} < 1$$

Therefore,

$$\left[ 1 - \frac{\partial \mathbb{E}(f_V^S | f_V^S \leq f_{V, \infty}^S)}{\partial f_{V, \infty}^S} \right] > 0$$



Only in the limit, i.e. when the distribution collapses with the lower bound ( $f_{V,t}^S = \underline{f}_V^S$ ),

$$\frac{\partial \mathbb{E}(f_V^S | f_V^S \leq f_{V,t}^S)}{\partial f_{V,t}^S} = 1 \Rightarrow \frac{d\mathcal{D}_{V^S, \infty}(\theta_\infty; \theta_\infty, \theta_\infty)}{d\theta_\infty} = 0$$

Thus, this trade-off function has a unique fixed point. However, from proposition 3, the exploration driven by this fixed point stops at a period  $t < \infty$ , when after exploration the producers choose arm's length trade instead. From that date, the exploration is driven by the respective trade-off function. Therefore, I analyse below the convergence conditions of the later.

For any  $t > \hat{t}$ , with  $\hat{t}$  defined in section 5.2, the trade-off function that drives exploration is given by:

$$\begin{aligned} \mathcal{D}_{O^S, t}(\theta; \theta_t, \tilde{\theta}_{t+1}) &= \mathbb{E} \left[ \pi_{O^S/V^N, t}^{\text{prem}}(\theta) | f_O^S \leq f_{O,t}^S \right] - w^N s^r (1 - \lambda) \\ &= r_{V,t}^N(\theta) B_O^S - w^N \mathbb{E}(f_O^S | f_O^S \leq f_{O,t}^S) - w^N [s^r (1 - \lambda) - f_V^N] \end{aligned}$$

with

$$\begin{aligned} B_O^S &\equiv \left[ \left[ \left( \frac{\beta}{\beta_V^N} \right)^\eta \left( \frac{1 - \beta}{1 - \beta_V^N} \right)^{1-\eta} \left( \frac{w^N}{w^S} \right)^{1-\eta} \right]^{\sigma-1} \right. \\ &\quad \left. \times [1 - \alpha[\beta\eta + (1 - \beta)(1 - \eta)]] - [1 - \alpha[\beta_V^N\eta + (1 - \beta_V^N)(1 - \eta)]] \right] \end{aligned}$$

Taking the limit, as before, of the trade-off function as  $t \rightarrow \infty$ ,

$$\mathcal{D}_{O^S, \infty}(\theta_\infty; \theta_\infty, \theta_\infty) = r_{V, \infty}^N(\theta_\infty) B_O^S - w^N \mathbb{E}(f_O^S | f_O^S \leq f_{O, \infty}^S) - w^N [s^r (1 - \lambda) - f_V^N]$$

By totally differentiation of the trade off function,

$$\frac{d\mathcal{D}_{O^S, \infty}(\theta_\infty; \theta_\infty, \theta_\infty)}{d\theta_\infty} = B_O^S \frac{\partial r_{V, \infty}^N(\theta_\infty)}{\partial \theta_\infty} - w^N \frac{\partial \mathbb{E}(f_O^S | f_O^S \leq f_{O, \infty}^S)}{\partial f_{O, \infty}^S} \frac{\partial f_{O, \infty}^S}{\partial \theta_\infty}$$

with

$$f_{O, \infty}^S \equiv \frac{r_{O, \infty}^N(\theta_\infty)}{w^N} B_O^S + f_V^N \Rightarrow \frac{\partial f_{O, \infty}^S}{\partial \theta_\infty} = \frac{B_O^S}{w^N} \frac{\partial r_{V, \infty}^N(\theta_\infty)}{\partial \theta_\infty}$$

Replacing this into the previous expression:

$$\frac{d\mathcal{D}_{O^S, \infty}(\theta_\infty; \theta_\infty, \theta_\infty)}{d\theta_\infty} = B_O^S \frac{\partial r_{V, \infty}^N(\theta_\infty)}{\partial \theta_\infty} \left[ 1 - \frac{\partial \mathbb{E}(f_O^S | f_O^S \leq f_{O, \infty}^S)}{\partial f_{O, \infty}^S} \right]$$

From this expression,  $\frac{\partial r_{V,\infty}^N(\theta_\infty)}{\partial \theta_\infty} > 0$  and  $B_O^S > 0$ . As before, from assumption A.3, I get:

$$\left[ 1 - \frac{\partial \mathbb{E}(f_O^S | f_O^S \leq f_{O,\infty}^S)}{\partial f_{O,\infty}^S} \right] > 0$$

In the limit, i.e. when the distribution collapses with the lower bound ( $f_{O,t}^S = \underline{f}_O^S$ ),

$$\frac{\partial \mathbb{E}(f_O^S | f_O^S \leq f_{O,t}^S)}{\partial f_{O,t}^S} = 1 \Rightarrow \frac{d\mathcal{D}_{O^S,\infty}(\theta_\infty; \theta_\infty, \theta_\infty)}{d\theta_\infty} = 0$$

In conclusion, the setoral equilibrium path has at most one fixed point. Therefore, the fixed point defined by propositions 4 and 5 is unique.

#### D.5.4 Proof of Proposition 6

$$\mathcal{D}_{O,t}(\tilde{\theta}_{t+1}; \theta_t, \tilde{\theta}_{t+1}) = 0 \Rightarrow \mathbb{E}_t[\pi_{O^S/O^N,t}^{prem}(\tilde{\theta}_{t+1}) | f_O^S \leq f_{O,t}^S] = w^N s^r \left[ 1 - \lambda \frac{Y(\tilde{f}_{O,t+1}^S)}{Y(f_{O,t}^S)} \right]$$

The RHS represents the gains from waiting, while the LHS denotes the costs from waiting. Therefore, the offshoring exploration productivity cutoff is given by the indifferent producer.

Substituting  $\pi_t^{S,prem}(\tilde{\theta}_{t+1})$  with its expression,

$$\tilde{\theta}_{t+1}^{\sigma-1} (\gamma E)^\sigma \tilde{Q}_{t+1}^{1-\sigma} [\psi_O^S(\eta) - \psi_O^N(\eta)] = w^N \left[ \mathbb{E}_t(f_O^S | f_O^S \leq f_{O,t}^S) - f_O^N + s^r \left( 1 - \lambda \frac{Y(\tilde{f}_{O,t+1}^S)}{Y(f_{O,t}^S)} \right) \right]$$

$$\tilde{\theta}_{t+1} = (\gamma E)^{\frac{\sigma}{1-\sigma}} \tilde{Q}_{t+1} \left[ \frac{w^N \left[ \mathbb{E}_t(f_O^S | f_O^S \leq f_{O,t}^S) - f_O^N + s^r \left( 1 - \lambda \frac{Y(\tilde{f}_{O,t+1}^S)}{Y(f_{O,t}^S)} \right) \right]}{\psi_O^S(\eta) - \psi_O^N(\eta)} \right]^{\frac{1}{\sigma-1}}$$

#### D.5.5 Proof of Propositions 7 and 8

By Assumption A.4,

$$\mathbb{E}_t[\pi_{O^S/O^N,t}^{prem}(\bar{\theta}) | f_O^S \leq \bar{f}_O^S] - w^N s^r (1 - \lambda) > 0$$

$$\frac{r_{O,t}^N(\bar{\theta})}{\sigma} W - w^N \mathbb{E}_t(f_O^S | f_O^S \leq \bar{f}_O^S) - w^N [s^r (1 - \lambda) - f_O^N] > 0 \quad \text{with } W \equiv \left( \frac{w^N}{w^S} \right)^{(1-\eta)(\sigma-1)} - 1$$

Taking the limit of the trade off function as  $t \rightarrow \infty$ ,

$$\mathcal{D}_O(\theta_\infty; \theta_\infty, \theta_\infty) = \frac{r_O^N(\theta_\infty)}{\sigma} W - w^N \mathbb{E}(f_O^S | f_O^S \leq f_{O,\infty}^S) - w^N [s^r (1 - \lambda) - f_O^N]$$

Totally differentiating  $\mathcal{D}(\theta_\infty; \theta_\infty, \theta_\infty)$  with respect to each of its arguments:

$$\frac{d\mathcal{D}_O(\theta_\infty; \theta_\infty, \theta_\infty)}{d\theta_\infty} = \frac{W}{\sigma} \frac{\partial r_O^N(\theta_\infty)}{\partial \theta_\infty} - w^N \frac{\partial \mathbb{E}(f_O^S | f_O^S \leq f_{O,\infty}^S)}{\partial f_{O,\infty}^S} \frac{\partial f_{O,\infty}^S}{\partial \theta_\infty}$$

$f_{O,\infty}^S$  is given by:

$$f_{O,\infty}^S \equiv f_O^S(\theta_\infty) = \frac{r_O^N(\theta_\infty)}{\sigma w^N} \left[ \left( \frac{w^N}{w^S} \right)^{(1-\eta)(\sigma-1)} - 1 \right] + f_O^N$$

Therefore,

$$\begin{aligned} \frac{d\mathcal{D}_O(\theta_\infty; \theta_\infty, \theta_\infty)}{d\theta_\infty} &= \frac{W}{\sigma} \frac{dr_O^N(\theta_\infty)}{d\theta_\infty} - w^N \frac{W}{w^N \sigma} \frac{dr_O^N(\theta_\infty)}{d\theta_\infty} \frac{\partial \mathbb{E}(f_O^S | f_O^S \leq f_{O,\infty}^S)}{\partial f_{O,\infty}^S} \\ &= \frac{dr_O^N(\theta_\infty)}{d\theta_\infty} \frac{W}{\sigma} \left[ 1 - \frac{\partial \mathbb{E}(f_O^S | f_O^S \leq f_{O,\infty}^S)}{\partial f_{O,\infty}^S} \right] \end{aligned}$$

From this expression,  $\frac{dr_O^N(\theta_\infty)}{d\theta_\infty} > 0$  and  $\frac{W}{\sigma} > 0$ .

Taking Assumption A.3,

$$\frac{\partial [f_{O,t}^S - \mathbb{E}(f_O^S | f_O^S \leq f_{O,t}^S)]}{\partial f_{O,t}^S} > 0 \Rightarrow 1 - \frac{\partial \mathbb{E}(f_O^S | f_O^S \leq f_{O,t}^S)}{\partial f_{O,t}^S} > 0 \Rightarrow \frac{\partial \mathbb{E}(f_O^S | f_O^S \leq f_{O,t}^S)}{\partial f_{O,t}^S} < 1$$

Thence, the expression in brackets:

$$\left[ 1 - \frac{\partial \mathbb{E}(f_O^S | f_O^S \leq f_{O,\infty}^S)}{\partial f_{O,\infty}^S} \right] > 0$$

Only in the limit, when the distribution collapses with the lower bound,

$$\frac{\partial \mathbb{E}(f_O^S | f_O^S \leq f_{O,t}^S)}{\partial f_{O,t}^S} = 1 \Rightarrow \frac{d\mathcal{D}_O(\theta_\infty; \theta_\infty, \theta_\infty)}{d\theta_\infty} = 0$$

Therefore, it is possible to see that this problem has at most one fixed point. Therefore, the fixed point defined in Propositions 7 and 8 is unique.

## D.6 Alternative learning mechanism: the organisational type chosen by offshoring is unobservable

By the regularity condition A.6, the evolution of the foreign outsourcing type drives the offshoring equilibrium path. Thus, the learning mechanism does not require that firms observe the sourcing type chosen by the others.

**Assumption A. 6** (Regularity condition). *Final good producers know that the organisational fixed cost of arm's length trade cannot be larger than the fixed cost of any type of FDI. Furthermore, they also know that the offshoring organisational fixed costs cannot be smaller than the respective fixed costs of domestic sourcing.*

Therefore, the following results can be derived from this regularity condition:

$$f_V^N \leq \underline{f}_O^S \leq \underline{f}_V^S \quad \text{and} \quad f_{O,t}^S \leq f_{V,t}^S \quad \forall t \geq 0 \quad ; V = V_H, V_M$$

In this situation, define  $f_{V,t}^S$  as the maximum affordable fixed cost for the least productive firm offshoring from South in period  $t$ , under the assumption that the firm has chosen FDI. Also, define  $f_{O,t}^S$  in the same way but under the assumption that the firm has chosen arm's length trade, whenever  $f_{O,t}^S \leq \bar{f}_O^S$ . Thence, the learning mechanism is given by:

$$f_V^S \sim \begin{cases} Y(f_V^S | f_V^S \leq f_{\hat{V},t}^S) = \frac{Y(f_V^S | f_V^S \leq f_{\hat{V},t-1}^S)}{Y(f_{\hat{V},t}^S | f_V^S \leq f_{\hat{V},t-1}^S)} & \text{if } \tilde{f}_{\hat{V},t}^S = f_{\hat{V},t}^S < f_{\hat{V},t-1}^S \\ f_{\hat{V},t}^S & \text{if } \tilde{f}_{\hat{V},t}^S < f_{\hat{V},t}^S \\ \underline{f}_V^S & \text{if } f_{\hat{V},t}^S \leq \underline{f}_V^S \end{cases}$$

$$f_O^S \sim \begin{cases} Y(f_O^S) \text{ with } f_O^S \in [\underline{f}_O^S, \bar{f}_O^S] & \text{if } f_{\hat{O},t}^S \geq \bar{f}_O^S \\ Y(f_O^S | f_O^S \leq f_{\hat{O},t}^S) = \frac{Y(f_O^S | f_O^S \leq f_{\hat{O},t-1}^S)}{Y(f_{\hat{O},t}^S | f_O^S \leq f_{\hat{O},t-1}^S)} & \text{if } \tilde{f}_{\hat{O},t}^S = f_{\hat{O},t}^S < f_{\hat{O},t-1}^S \\ f_{\hat{O},t}^S & \text{if } \tilde{f}_{\hat{O},t}^S < f_{\hat{O},t}^S \end{cases}$$

It is straightforward to see that the true value  $f_O^S$  is revealed in the long run, while the  $f_V^S$  may not reveal itself. Firms that remain under domestic sourcing may end up with a wrong belief about the fixed costs of FDI. However, by condition A.6, this knowledge is irrelevant for defining the offshoring exploration equilibrium path.

## E Multiple countries

### E.1 Multiple countries: Proposition 1

The exploration of the offshoring potential in the East is led by the most productive final good producers in the market, i.e. Proposition 1 holds for the trade-off function (29).

## E.2 Multiple countries: Proposition 2

The offshoring exploration productivity cutoff in East in period  $t$  is:

$$\tilde{\theta}_{t+1}^E = \min \left\{ \tilde{\theta}_{O,t+1}^E; \tilde{\theta}_{V,t+1}^E \right\}$$

where  $\tilde{\theta}_{O,t+1}^E$  and  $\tilde{\theta}_{V,t+1}^E$  are defined by the fixed points:

$$\begin{aligned} \mathcal{D}_{V,t}(\tilde{\theta}_{V,t+1}^E; \theta_t^E, \tilde{\theta}_{t+1}^E) = 0 &\Rightarrow \mathbb{E}_t \left[ \pi_{VE/k',t}^{prem}(\tilde{\theta}_{V,t+1}^E) \mid f_V^E \leq f_{V,t}^E \right] = w^N s^r \left[ 1 - \lambda \frac{Y(f_{V,t+1}^E)}{Y(f_{V,t}^E)} \right] \\ \mathcal{D}_{O,t}(\tilde{\theta}_{O,t+1}^E; \theta_t^E, \tilde{\theta}_{t+1}^E) = 0 &\Rightarrow \mathbb{E}_t \left[ \pi_{OE/k',t}^{prem}(\tilde{\theta}_{O,t+1}^E) \mid f_O^E \leq f_{O,t}^E \right] = w^N s^r \left[ 1 - \lambda \frac{Y(f_{O,t+1}^E)}{Y(f_{O,t}^E)} \right] \end{aligned}$$

## E.3 Multiple countries: Proposition 3

After exploration, the final good producer discover all the organisational fixed costs of offshoring from East, and she must choose the one organisational type according to the following proposition.

**Proposition 9** (Organisational choice after exploration). *After paying  $w^N s^r$  in period  $t$ , the final good producer discovers the true values of  $f_O^E$ ,  $f_{V_H}^E$  and  $f_{V_M}^E$ , and she must choose an organisational type.*

*The final good producer with productivity  $\theta$  chooses FDI,  $V^E$ , when:*

$$\pi_{VE/OE,t}^{prem}(\theta) = \pi_{V,t}^E(\theta) - \pi_{O,t}^E(\theta) \geq 0$$

*She chooses arm's length trade in East,  $O^E$ , when:*

$$\pi_{OE/k',t}^{prem}(\theta) = \pi_{O,t}^E(\theta) - \pi_{k',t}^E(\theta) \geq 0 \quad \text{and} \quad \pi_{VE/OE,t}^{prem}(\theta) < 0$$

*Otherwise, she remains under her current organisational type  $k'$ .*

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