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Uncertainty in Global Sourcing
Learning, sequential offshoring, and selection patterns

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- Preliminary draft -

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Abstract

Institutions play an important role shaping the multinational firms' sourcing decisions worldwide. We analyse firms' sourcing decisions when they face uncertainty about institutional conditions abroad. In a North-South model, we find that firms exploit informational externalities, which allow them to better assess their offshoring potential by observing other firms' behaviour. A sequential offshoring equilibrium path drives the economy to the perfect information steady state, led by the most productive firms in the market. Finally, the extension to multiple countries shows multiple equilibria with implications in terms of welfare and allocation of production across countries. The prior beliefs and the informational spillovers drive the sectoral specialisation of countries, and thence become a source of their comparative advantages. Using firm-level data from Colombia, we build a direct measure for the informational spillovers, and test the main predictions of the model from two approaches. With a conditional probability model, we test for the determinants of the offshoring decisions and the location choices, while by a survival analysis approach we test for the timing dimension of those decisions.

Keywords: Multinational firms, global sourcing, supply chain, institutions, uncertainty, information externalities, spillovers, learning, sequential offshoring, selection patterns, comparative advantages, multiple equilibria, survival analysis.
JEL: D81, D83, F10, F14, F23

1 Introduction

Intermediate inputs explain a substantial share of global trade, revealing a deep transformation of the structure of international trade. The geographical vertical disintegration of the supply chains makes evident that sourcing strategies have become global, arousing the interest of many scholars to understand the determinants of the offshoring activity, the sourcing strategies of multinational firms, and their role in the organisation of international trade[1]. Recent literature has focused the attention on how institutions affect the firms' investment decisions, their organisational structures and technology choices (Helpman, 2006; Acemoglu et al., 2007; Antràs and Helpman, 2008; Antràs and Chor, 2013), as well as the institutional determinants of countries' comparative advantages (Costinot, 2009; Acemoglu et al., 2007; Nunn, 2007; Levchenko, 2007).

*Acknowledgements to be added.

[1] Hummels et al. (2001); Helpman (2006); Antràs and Helpman (2004, 2008); Grossman and Helpman (2005); Grossman and Rossi-Hansberg (2008); Alfaro and Charlton (2009); Nunn and Trefler (2008, 2013); Antràs and Yeaple (2014); Antras (2015); Ramondo et al. (2015); Antras et al. (2017)

However, while firms take usually their sourcing decisions under uncertainty, in particular about the prevailing conditions (e.g. institutions) in foreign countries, most of these studies characterise these decisions under perfect information. A clear case of uncertainty arises when firms consider sourcing from locations where they have never been active before[2]. But it may also emerge with respect to locations where firms have had some experience in the past. For instance, after the implementation of an ambitious institutional reform by a foreign government, firms may face doubts about the true scope of the reform, inducing uncertainty about the ex-post-reform prevailing institutional conditions.

The primary goal of this paper is to understand how the existence of prior uncertainty about the institutional fundamentals in foreign countries may affect the firms' sourcing decisions, in particular offshoring, and comprehend its implications in terms of the organisation of the firm and the supply chain, the sectoral specialisation of countries, and the respective welfare consequences.

The paper builds mainly from the literature on global sourcing with heterogeneous firms, in particular the models developed by Antràs and Helpman (2004, 2008), and complements the approaches of Grossman and Helpman (2005) and Antras et al. (2017) where the focus is on the location dimension of the offshoring decisions. The main departure from this literature consists in introducing institutional uncertainty as an ambiguous knowledge about the per-period offshoring organisational fixed costs. For simplicity, in order to focus in the location dimension of the sourcing decisions, we consider the case of complete contracts[3].

Up to our knowledge, this is the first paper in the global sourcing literature to introduce uncertainty in the form of a diffuse knowledge about conditions abroad, and to allow firms to learn about their offshoring potential by exploiting informational externalities obtained by observing the behaviour of the other firms.

There is a small but growing literature on uncertainty in global sourcing decisions, but the attention has centered on how the exposure to shocks affects firms' choices (Carballo, 2016; Kohler et al., 2018)[4]. In those cases, the firms optimise their sourcing strategy with a perfect knowledge of the distributions of shocks, i.e. the stochastic nature of the world. In our model, instead, the firms face an imperfect knowledge about the institutional fundamentals abroad, but they are able to progressively reduce their prior uncertainty by exploiting informational externalities.

There is a comparatively more extensive literature on export decisions under uncertainty, where firms may improve their prior knowledge by learning, and thus better assess their exporting potential [5]. The closest studies to our approach in this literature are Segura-Cayuela and Vilarrubia (2008), Albornoz et al. (2012) and Araujo et al. (2016), although applied to a different context.

We characterise the dynamics of the model as a Markov decision process, in which firms learn by a Bayesian recursive mechanism. In this regard, the closest references are Rob (1991) and Segura-Cayuela and Vilarrubia (2008), and the general literature on recursive methods and statistical decisions such as Stokey and Lucas (1989); DeGroot (2005); Sutton and Barto (2018)[6].

[2]Firms do not usually posses a sharp clear knowledge about the institutional quality of countries in which they have never been active before, in particular in areas such as: the reliability of the court system, expropriation risk, or complexity and costs associated to the regulatory or tax systems.

[3]The model could be easily extended to a context of incomplete contracts or partially contractible investments, without allowing firms to decide whether to integrate or outsource the production of intermediate inputs. The latter, as in Grossman and Helpman (2005), simplifies the model and allow us to center the attention in the location dimension of the sourcing decisions. This extension may be consider in a future version.

[4]Carballo (2016) examines how the various organisational types of global sourcing respond differently to demand shocks. Kohler et al. (2018), on the other hand, analyses the sourcing decisions when firms face shocks in demand (the size of the market) or in supply (supplier's productivity) conditions, and studies the role of labour market institutions (rigidity vs. flexibility) in those choices.

[5]Segura-Cayuela and Vilarrubia (2008); Albornoz et al. (2012); Nguyen (2012); Aeberhardt et al. (2014); Araujo et al. (2016).

[6]Rob (1991) introduces a model of market entry in which there is imperfect information about the demand conditions (the size of the market). Rob introduces a Bayesian learning process, which allows firms to progressively improve the information about the demand, characterizing a sequential entry into the market. Based on Rob (1991), Segura-Cayuela and Vilarrubia (2008) applies this same approach to a Melitz (2003)'s type model with uncertainty in fixed exporting costs, leading to sequential entry in the foreign markets.

We introduce in section 2 a model with two countries (North-South) and multiple sectors. One perfectly competitive sector, which produces a homogeneous good, and J differentiated sectors with monopolistic competition and a continuum of heterogeneous final good producers (firms). The production of the varieties in the differentiated sectors requires of the production of an intermediate input, which can be supplied to the final good producer by a domestic or a foreign manufacturer (supplier). The model characterises the dynamic equilibrium path where informational spillovers allow firms to learn about their offshoring potential in the foreign country[7]. The equilibrium path takes the form of a sequential offshoring process led by the most productive firms in the market. The latter results in an increasing offshoring activity that induces a progressive reduction in the sectoral price index and thus an increase in the competition intensity in the final-good market. Although this *competition effect* pushes the least productive firms out of the market, reducing the number of available varieties, the reduction in the price index results in aggregate welfare gains from offshoring. Moreover, the model shows that the initial welfare losses produced by the uncertainty vanish progressively as the sector converges to the perfect information steady state.

In section 3 we test the theoretical predictions of the model in section 2, by using firm-level Colombian data for the period 2004-2018. We follow two complementary empirical approaches. First, we build a conditional probability model to test for the determinants of the offshoring exploration decisions, as predicted by the theory. Second, given the dynamic nature of firms' choices and the equilibrium path, we use a transition (or survival) analysis approach to test for the timing dimension of the theoretical predictions. We discuss the identification of the models, and introduce a measure for the informational spillovers used by the firms, consistent with the learning mechanism defined in the theoretical model. We test whether these spillovers are part of the information set firms use when they decide whether to explore their offshoring potential as predicted by the theory, and present the main results. For the transition analysis, the closest reference is Bergstrand et al. (2016), and the general econometrics literature on the topic (Lancaster, 1990; Jenkins, 2005; Cameron and Trivedi, 2005; Wooldridge, 2010).

In order to analyse the effects of the information spillovers in the location dimension of the sourcing decisions, we extend the model to multiple countries in section 4. The extension shows how the informational spillovers conduce to multiple equilibria, characterising the different paths with the potential *relocation decisions* involved, and the respective welfare implications. When firms face uncertainty, the allocation of production across countries may differ from the optimal equilibrium defined by the institutional fundamentals. The model shows that, in such a case, prior beliefs and informational spillovers become a source of sectoral specialisation. In this sense, our model complements the literature on the role of institutions as determinants of countries' comparative advantages (Acemoglu et al., 2007; Costinot, 2009)[8], by showing the role that informational spillovers and learning play in the offshoring decisions under uncertainty, and its consequences on the allocation of production across countries. Acemoglu et al. (2007) and Costinot (2009) define the differences in the fundamentals of contractual institutions as the source of comparative advantages. On the other hand, our model remarks the importance of both dimensions (beliefs and fundamentals) in the definition of the countries' comparative advantages. In other words, not only the differences in institutional fundamentals matter. As key drivers of the offshoring flows, the firms' prior beliefs and the informational spillovers play an important role in defining the sectoral specialisation of countries.

In section 5 we test the theoretical predictions of the multi-country model. We follow the same two complementary empirical approaches as before, and we introduce also an instrumental variable approach for the conditional probability model. In the latter, the IV approach offers a more structural identification

[7]Firms are able to learn about the conditions abroad by their own experience, through the interaction with local agents and institutions, or by exploiting informational externalities, via observation of the behaviour of other firms who are active in those locations.

[8]Acemoglu et al. (2007) and Costinot (2009) analyse how institutions shape the countries' specialisation profile. The first concentrates in the sectoral specialisation of countries driven by the technology choices of firms. Instead, under a transaction costs approach, Costinot (2009) characterises the firms' choices on the complexity of the production processes, that depend on the existing institutional conditions in each country. A common feature of both models is that institutional fundamentals are the underlying factors defining the comparative advantages, and thence the sectoral specialisation of countries.

of the learning mechanism as characterised in the theoretical model, and it shows the importance of uncertainty in the offshoring decisions and how the effects of institutions are affected by ignoring the information spillovers and learning.

From a policy perspective, our model sheds light on situations where improvements in institutional fundamentals may not have the expected results as predicted by the models with perfect information. It brings new insights in the underlying determinants of the offshoring decisions, and characterises the conditions that must be considered by the governments when they implement reforms to promote the insertion of domestic suppliers in global value chains[9].

Finally, in order to analyse the general and input-specific dimensions of institutions and informational spillovers, we extend the model to multiple intermediate inputs 6.

We summarize the main conclusions in section 8, and briefly describe further possible extensions and next steps.

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 (ℓ). We assume that investments are fully contractible.

Preferences. They are represented by a per period Cobb-Douglas utility function

$$U = \gamma_0 \ln q_0 + \sum_{j=1}^{J} \gamma_j \ln Q_j \quad , \quad \sum_{j=0}^{J} \gamma_j = 1 \tag{1}$$

where q_0 is the per period consumption of a homogeneous good, and Q_j is an index of the per period aggregate consumption in the differentiated sectors $j = \{1, ..., J\}$.

All the goods are tradable in the world market, and there are no transport costs nor trade barriers, i.e. there is free trade in the final good markets and in intermediate inputs[10]. We assume also that consumers have identical preferences across countries.

The per-period aggregate consumption in a differentiated sector j is given by

$$Q_j = \left[\int_{i \in I_j} q(i)^{\alpha_j} di \right]^{1/\alpha_j} \quad , \quad 0 < \alpha_j < 1 \tag{2}$$

which consists of the aggregation of the consumed varieties $q_j(i)$ on the range of varieties i of sector j. The elasticity of substitution between any two varieties in this sector is $\sigma_j = 1/(1 - \alpha_j)$.

The inverse demand function for variety i in differentiated sector j is given by:

$$p_j(i) = \gamma_j E Q^{-\alpha_j} q_j(i)^{\alpha_j - 1} \tag{3}$$

where E denotes the per period total (world) expenditure, and the price index in each differentiated sector j is defined as:

$$P_j \equiv \left[\int_{i \in I} p_j(i)^{1-\sigma_j} di \right]^{\frac{1}{1-\sigma_j}} \tag{4}$$

[9]We show that when the economy converges to a "bad" steady state, the country which has better fundamentals but does not receive any offshoring flows must concentrate the reforms in the short-run in policies oriented to produce changes in the perceptions (beliefs) instead of improving fundamentals. On the other hand, the country with bad fundamentals but currently receiving the offshoring flows has an incentive to concentrate the efforts in improving the institutional fundamentals in the long-run.

[10]Trade costs in intermediate inputs can be easily introduced in the model, without any major consequences in the results and predictions of the model.

Technology and production in differentiated sectors ($j \in \{1, ...J\}$). The per period output of variety i is produced with a Cobb-Douglas technology:

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

where the respective inputs are the final good producer services, $x_{h,j}$, and the intermediate input, $x_{m,j}$. They are respectively supplied by the headquarter[11], H, and the intermediate input supplier, M.

$\eta_j \in (0, 1)$ is a technology parameter, which measures the headquarter-services intensity of the sector, and the parameter θ represents the firm's productivity level, which varies across firms.

Both inputs for each variety are produced with constant return technologies:

$$x_{k,j}(i) = \ell_{k,j}(i) \quad \text{with } k = h, m \tag{6}$$

As in Antràs and Helpman (2004), we assume that the final-good producers in the differentiated sectors are always located in the North.

Assumption A. 1. *The services $x_{h,j}$ and the final good varieties can be produced only by firms in the North.*

Entry cost and productivity draw. The process corresponds to a Melitz (2003)'s entry mechanism. Firms must pay a one-period market entry sunk cost $s_{e,j}$ in northern units of labour, i.e. $w^N s_{e,j}$. After the payment, they discover their productivity θ, which is drawn from a c.d.f. denoted by $G(\theta)$. This entry cost can be thought as the R&D expenditures that the firm has to afford in order to develop the variety she will commercialize.

Technology in homogenous sector ($j = 0$). We assume that the homogenous sector has a constant returns to scale technology:

$$q_0 = A_{0,l}\ell_0 \tag{7}$$

where $A_{0,l} > 0$ is a productivity parameter in country l.

Assumption A. 2. *The productivity of northern workers in the homogeneous good sector is higher than southern workers in the same sector, i.e. $A_{0,S} < A_{0,N}$. Therefore, $w^N > w^S$.*

We assume also that γ_0 is large enough such that the homogeneous good is produced in every country.

2.1 Perfect information equilibrium

In the remaining theoretical sections of the paper, the analysis focuses in the sectoral dynamics of one differentiated sector j. Therefore, for simplicity, we assume that there is only one differentiated sector, and thus drop the subscript j.

The equilibrium under perfect information characterised in this section plays an important role in the study of the transition path and the convergence properties of the dynamic model with uncertainty. This equilibrium is closely related to the Antràs and Helpman (2004)'s model with two main differences. First, as already mentioned, we assume perfectly contractible investments, instead of incomplete contracts[12]. Second, we introduce an offshoring market research sunk cost s^r in northern labour units, which must be paid in advance by those firms who want to offshore[13]. The offshoring sunk cost can be interpreted as the market research costs and feasibility studies that firms have to afford when search for potential suppliers in different locations.

The Figure 1 shows a schematic representation of the timing of events under perfect information. [14]

[11] We refer to the final-good producer alternatively as the firm, the headquarter, HQ, or H.

[12] This assumption reduces the sourcing decision directly to the location dimension. Nevertheless, we could relax it and introduce incomplete contracts as mentioned in the Introduction.

[13] The offshoring sunk cost s^r does not play an important role in the model with perfect information, but as we will show in section 2.2, it makes costly (and risky) for the firms to explore their offshoring potential under uncertainty.

[14] For a detailed solution of the model under perfect information see Appendix A.

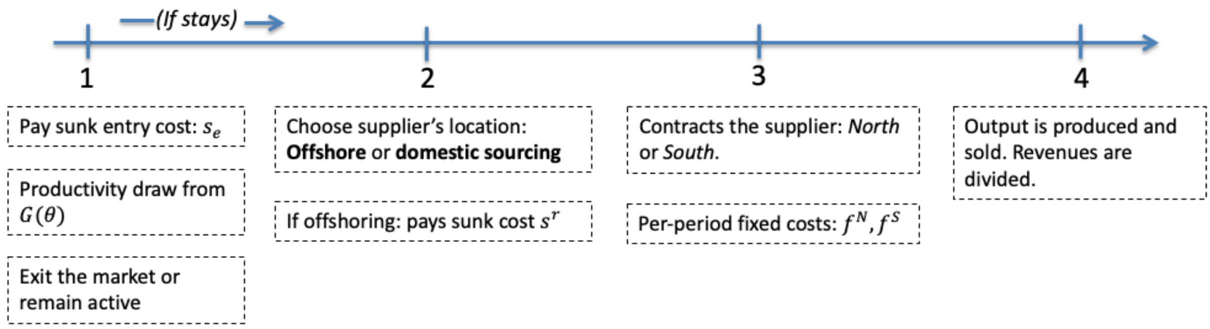


Figure 1: Timing of events.

Assumption A. 3. *The ranking of per-period fixed production costs is*

$$f^N < f^S + (1 - \lambda)s^r$$

with $\lambda \in (0, 1)$ denoting the per-period survival rate to an exogenous "death" shock that pushes the firm out of business.

The final good producer must choose whether she will source the intermediate input domestically or from a supplier in a foreign location. Thus, we define the *per-period offshoring profit premium* of a final good producer with productivity θ as:

$$\pi^{S,prem}(\theta) \equiv \pi^S(\theta) - \pi^N(\theta) = \frac{r^N(\theta)}{\sigma}\left[\left(\frac{w^N}{w^S}\right)^{(1-\eta)(\sigma-1)} - 1\right] - w^N\left[f^S - f^N\right] \tag{8}$$

The final good producers choose the sourcing location that maximizes their lifetime profits. Under perfect information, this is equivalent to choose the sourcing location that maximizes the per-period profits. Hence, using equation (8), they prefer to offshore whenever the per-period offshoring profit premium is higher than (or equal to) the discounted offshoring sunk cost.

$$\pi^{S,prem}(\theta) \begin{cases} < (1-\lambda)w^N s^r & \text{if } \theta < \theta^{S,*} \Rightarrow \text{ firm } \theta \text{ sources domestically} \\ = (1-\lambda)w^N s^r & \text{if } \theta = \theta^{S,*} \Rightarrow \text{ firm } \theta \text{ offshore} \\ > (1-\lambda)w^N s^r & \text{if } \theta > \theta^{S,*} \Rightarrow \text{ firm } \theta \text{ offshore} \end{cases} \tag{9}$$

with $\theta^{S,*}$ indicating the offshoring productivity cutoff [15]. The $*$ refers to the equilibrium values under perfect information.

Figure 2 illustrates the offshoring productivity cutoff ($\theta^{S,*}$) and the market entry productivity cutoff ($\underline{\theta}^*$) at equilibrium. The dark area in between the profit curves represent the per-period offshoring profit premium for each firm θ with a productivity above the offshoring productivity cutoff.

2.2 The North-South global sourcing dynamic model with uncertainty

We study now the sourcing decisions when firms face uncertainty about the per-period fixed costs of production in the South. However, they can exploit the informational spillovers, and thence progressively update their knowledge and thus reduce their prior uncertainty.

We define the initial conditions of the dynamic model as the steady state of an economy with non-tradable intermediate inputs ($n.t.i.$), i.e. a situation where the final-good producers can source only domestically, but the final goods are tradable in the world market. This may reflect a situation where pre-existing (beliefs about) institutions in the South make the cost of offshoring prohibitively high.

[15]The Antràs and Helpman (2004)'s model with complete contracts and no offshoring sunk cost would be represented as the case where the marginal offshoring firm earns $\pi^{S,prem}(\theta^{S,*}) = 0$, i.e. the offshoring cutoff firm obtains zero offshoring profit premium at equilibrium.

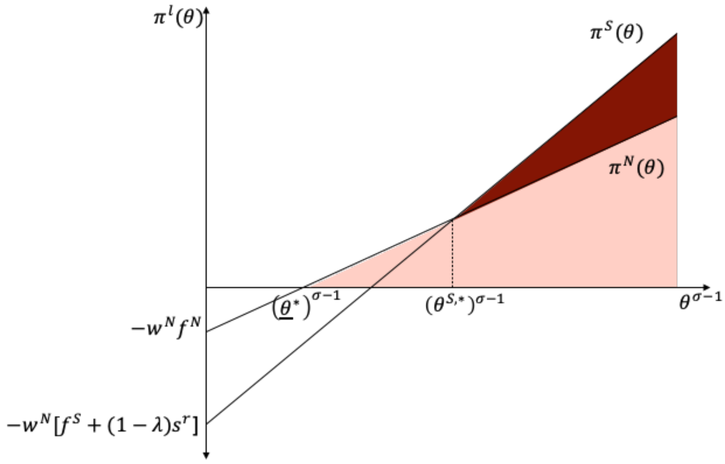


Figure 2: Per-period offshoring profit premium.

At $t = 0$, there is an unexpected shock that makes intermediate inputs potentially tradable. In other words, offshoring becomes feasible at least initially for some firms. It is possible to think about the shock at $t = 0$ as the moment in which the southern government annouces that it has implemented a deep institutional reform[16]. Nevertheless, northern firms do not fully believe in the announcement of the foreign government, but they know that some changes have been implemented. Therefore, the northern firms bluid a prior belief about the possible scope of these reforms, which may turn offshoring attractive at least to a subset of the firms. These prior beliefs manifest as a prior distribution about the southern institutions.

After the announcement, the adjustment under perfect information to the new equilibrium is instantaneous. However, in the following sections we show that under uncertainty the adjustment is sequential and led by the most productive firms in the market.

2.2.1 Timing of events

Figure 3 illustrates the timing of events after the intermediate inputs market opens up to trade. From $t = 0$ on, final good producers sourcing domestically can choose whether to explore their offshoring potential or wait for new information to be revealed. If the final good producer chooses to explore offshoring, then she pays the offshoring sunk cost $w^N s^r$ and discovers the true fixed cost f^S, which remains as private information. Thus, she can take the optimal sourcing decision with complete certainty for the rest of the periods. In terms of the Markov decision process, choosing to explore the offshoring potential by paying the sunk cost $w^N s^r$ is an absorbing state for the final good producer.

However, if the she decides to wait for more information to be revealed, then, while she is waiting, she keeps sourcing domestically with a northern supplier. In the following period, she must decide again whether to explore her offshoring potential or wait, but now under a reduced uncertainty given the new information revealed by observing the behaviour of the new offshoring firms, i.e. of those firms that have explored offshoring in the previous period.

Assumption A. 4. *Firms are risk neutral*

2.2.2 Initial conditions: non-tradable intermediate inputs (n.t.i.)

We characterise briefly the steady state of the n.t.i. economy, which defines the initial conditions for the dynamic model[17]. Given Assumption A.2, the prices charged by a firm θ under domestic sourcing are

[16] Consider this as a reform oriented to promote the insertion of local firms as intermediate input suppliers in global value chains.

[17] For details and proofs see Appendix B.

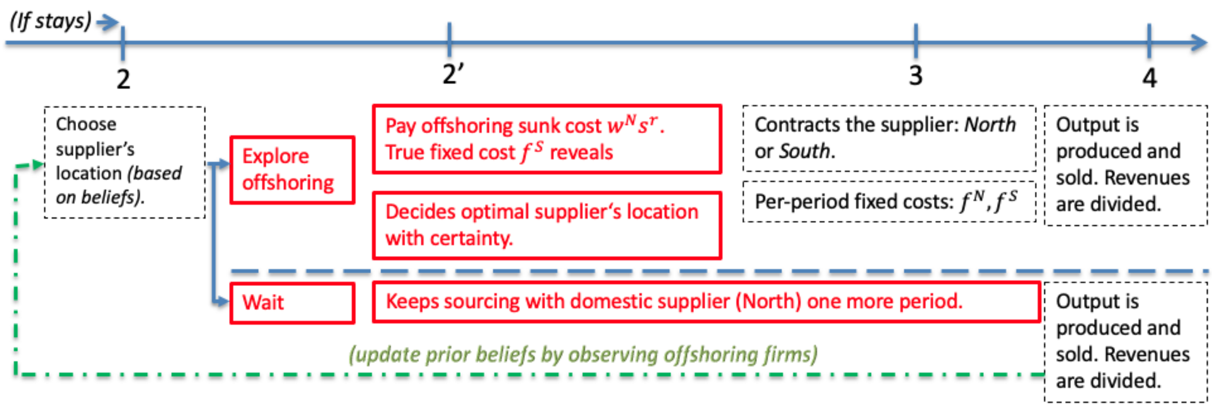


Figure 3: Timing of events - Uncertainty.

higher than under offshoring.

$$p(\theta) = \frac{w^N}{\alpha\theta} > \frac{(w^N)^\eta (w^S)^{1-\eta}}{\alpha\theta} = p^{\text{off}}(\theta)$$

Therefore, it is straightforward to see that[18]

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

where superscript $n.t.i.$ indicates the equilibrium value for the non-tradable intermediate inputs economy, and $*$ still refers to the equilibrium variables under perfect information with tradable intermediate inputs.

The higher initial price index allows the less productive firms to remain active in the market after entry, which is represented by a lower market productivity cutoff. However, when offshoring becomes feasible for the northern firms, the least productive firms in the market are not able to face the stronger competition that comes from the reduction in the price index, and therefore they must sequentially leave the market. The exit from the market of the least productive firms increases *pari passu* the offshoring productivity cutoff reduces.

Additionally, it is possible to observe a polarisation effect as in Melitz (2003), but of a different nature. The polarisation effect in our model comes, instead, from the cost advantages that firms doing offshoring can exploit by obtaining access to foreign intermediate input suppliers with lower marginal costs.

Welfare implications. The comparison between the $n.t.i.$ and the $*$ scenarios shows the welfare gains from offshoring. In the steady state, the economy $*$ reaches a lower price index and thus a higher aggregate consumption in the differentiated sectors. Those welfare gains are larger the higher is the share of offshoring firms. We can note that from the price index of the $*$ equilibrium in equation (10):

$$(P^*)^{1-\sigma} = \left(P^{\text{n.t.i.}}\right)^{1-\sigma} + \chi^* \left[\left(\frac{w^N}{w^S}\right)^{(1-\eta)(\sigma-1)} - 1 \right] \left(P^{\text{off|n.t.i.}}\right)^{1-\sigma} \tag{10}$$

where χ^* denotes the share of offshoring firms in the steady state of the economy, and $P^{\text{off|n.t.i.}}$ refers to the price index of the offshoring firms if they would be sourcing domestically[19]. Therefore, it is easy to observe that the price index P^* is decreasing in χ^*.

[18] Regarding the expressions of the Tradable Intermediate Inputs economy with perfect information, see Appendix C.

[19] $P^{\text{n.t.i.}}$ requires a careful interpretation in the context of the $*$ economy. As it is possible to observe in Appendix C, it corresponds to the n.t.i. price index but considering the cutoff productivity of the $*$ economy, i.e. $\underline{\theta}^*$. Nevertheless, when $\chi^* \to 0$, the market cutoff $\underline{\theta}^* \to \underline{\theta}^{n.t.i.}$ and $P^* \to P^{n.t.i.}$.

2.2.3 Dynamic model with uncertainty: tradable intermediate inputs

We continue with the description of the dynamic equilibrium path to the new steady state, after the institutional shock in the South in $t = 0$.[20]

We introduce uncertainty in the per-period organisational fixed cost in South, and the dynamic model is characterised as a Markov decision process in which firms learn by exploiting the informational externalities that emerge from other firms' behaviour.[21]

The state of the Markov process is characterised by a state with two dimensions: *"beliefs"* and *"physical"*. The first refers to the Bayesian learning mechanism by which firms update their knowledge and reduce their prior uncertainty, exploiting the new incoming data. The "physical" dimension corresponds to the data observed by the firms in the market, i.e. the per-period informational externalities produced by offshoring firms. Below, we define both state dimensions with more detail.

"Beliefs" state: Prior uncertainty and Bayesian learning. The institutional reform in the southern country in $t = 0$ allows northern firms to consider offshoring as a potentially feasible sourcing strategy. Nevertheless, as mentioned above, they do not fully believe in the announcement of the southern government. Thus, the northern firms build a prior (diffuse) knowledge about the scope of the reforms and the quality of the institutions abroad. Formally, this prior uncertainty translates as a prior distribution of the per-period organisational fixed costs in South represented by:

$$f^S \sim Y(f^S) \quad \text{with} \quad f^S \in [\underline{f}^S, \bar{f}^S]$$

where $Y(.)$ denotes the c.d.f. of the prior distribution.

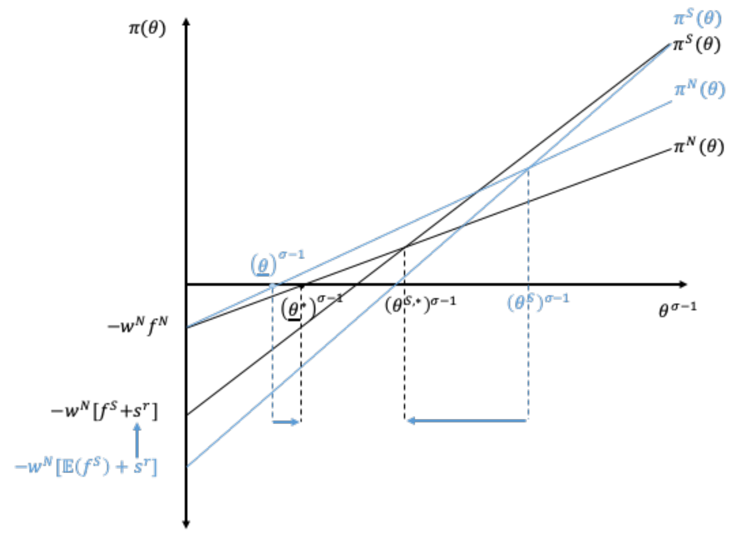


Figure 4: Perfect information and static equilibrium with uncertainty.

Figure 4 illustrates the perfect information equilibrium (*dark lines*) in comparison to the expected profits by sourcing type, given the initial prior uncertainty (*light lines*). The latter represents the equilibrium of a static model with uncertainty, where firms cannot learn from informational spillovers.

However, the dynamic approach captures the emergence of informational externalities and characterises the conditions under which the steady state converges progressively to the perfect information

[20]For details about the equilibrium of the tradable intermediate inputs sector under perfect information, and its comparison with the n.t.i. economy, see Appendix C.

[21]In particular, we assume that firms are able to observe the market's total revenues, the market share of every active firm, and the type of sourcing strategy chosen by each of her competitors. These elements, together with the known wages at each location, allow the firms to infer the productivity level of each of her competitors.

equilibrium[22]. The learning mechanism takes the form of a recursive Bayesian learning process, in which the posterior distribution at any $t > 0$ is given by:

$$f^S \sim \begin{cases} Y(f^S|f^S \leq f_t^S) = \frac{Y(f^S|f^S \leq f_{t-1}^S)}{Y(f_t^S|f^S \leq f_{t-1}^S)} & \text{if } \tilde{f}_t^S = f_t^S < f_{t-1}^S \\ f_t^S & \text{if } \tilde{f}_t^S < f_t^S \end{cases}$$

with f_t^S defined as the revealed upper bound in t, and $\tilde{f}_t^S$ as the expected revealed upper bound in t. We define both below in the "physical" state, as they are both related to the data (*informational externalities*) that firms observe.

Assumption A. 5. *The prior distribution satisfies the following condition:*

$$\frac{\partial[f_t^S - E(f^S|f^S \leq f_t^S)]}{\partial f_t^S} > 0$$

Intuitively, this assumption implies that the information flows are decreasing as the upper bound of the distribution reduces.

"Physical" state. Let's define $f^S(\theta)$ as the maximum affordable fixed cost in South for a firm with productivity θ. This implies that under this fixed cost, the firm θ would earn zero per-period offshoring profit premium offshoring from South, i.e.:

$$\pi^{S,prem}(\theta) = 0 \Rightarrow f^S(\theta) = \frac{r^{N,*}(\theta, Q_t)}{\sigma w^N}\left[\left(\frac{w^N}{w^S}\right)^{(1-\eta)(\sigma-1)} - 1\right] + f^N$$

We define θ_t as the least productive firm doing offshoring at the beginning of period t, i.e. that offshored in $t-1$. This implies that after paying the offshoring sunk cost $w^N s^r$, the firm θ_t realises a non-negative per-period offshoring profit premium, i.e. $\pi^{S,prem} \geq 0$, and thus remained sourcing from South. Therefore, f_t^S, i.e. the revealed upper bound at the beginning of period t, represents the maximum affordable fixed cost in South such that firm θ_t remains sourcing from abroad after paying the offshoring sunk cost in $t-1$. This bound is given by:

$$f_t^S \equiv f^S(\theta_t) = \frac{r^N(\theta_t, Q_t)}{\sigma w^N}\left[\left(\frac{w^N}{w^S}\right)^{(1-\eta)(\sigma-1)} - 1\right] + f^N \quad (11)$$

Finally, we define $\tilde{\theta}_t$ as the least productive firm trying offshoring in $t-1$. Therefore, $\tilde{f}_t^S \equiv f^S(\tilde{\theta}_t)$, i.e. the expected revealed upper bound in t, represents the maximum affordable fixed cost in South such that the firm $\tilde{\theta}_t$ would remain offshoring after paying the sunk cost in $t-1$.

Both, $\tilde{\theta}_t$ and θ_t are observable by the all the firms, and in particular by those firms that are waiting while sourcing domestically. Thus, $\tilde{f}_t^S$ and f_t^S can be easily computed by them. They are key elements defining the incoming data of the Bayesian learning mechanism in the "beliefs" dimension of the Markov state.

When both values $\tilde{f}_t^S$ and f_t^S coincide, the true fixed cost has not been revealed, but domestically sourcing firms can truncate their prior distribution according to the Bayesian rule shown above. However, when they differ, i.e. $\tilde{f}_t^S < f_t^S$, this implies that those firms in the range $\theta \in [\tilde{\theta}_t; \theta_t)$ have explored their offshoring potential in $t-1$ and after discovering f^S, they have decided to remain sourcing domestically. Such a situation reveals that the marginal offshoring firm which earns zero offshoring profit premium is θ_t, and thence the true value $f^S = f_t^S$. After this event, the learning process stops.

[22]In this regard, the informational externalities play a key role by allowing firms to progressively discover their offshoring potential and thence adjust optimally their sourcing strategy.

Offshoring decision. At any period t, a domestically sourcing firm must decide whether to discover her offshoring potential by paying the sunk cost, or wait for new information to be released.

The existence of informational externalities has two important consequences in the firms' exploration decision. First, some firms with a positive expected offshoring profit premium may decide to delay the offshoring exploration, in order to reduce the risk of the decision by the learning mechanism. Second, after that enough informational externalities have been generated, certain firms that initially had a negative expected offshoring profit premium, may now discover that it may be profitable for them to explore their offshoring potential. This trade-off "explore or wait" is a key element of the characterisation of firms' decisions. Formally, the decision process implies that the firm solves the value function $\mathcal{V}_t(\theta;\theta_t)$:

$$\mathcal{V}_t(\theta;\theta_t) = \max\left\{V_t^o(\theta;\theta_t); V_t^w(\theta;\theta_t)\right\}$$

with $V_t^o(\theta;.)$ and $V_t^w(\theta;.)$ denoting the value of offshoring and the value of waiting for a firm with productivity θ in t, respectively.

The value of offshoring in period t is given by the discounted expected total offshoring profit premium that the firm can earn starting from t minus the sunk cost s^r, or a loss equivalent to the sunk cost in the case that after paying it she finds out that the offshoring premium is negative. Thus, the value of offshoring in t for a firm θ is given by:

$$V_t^o(\theta;\theta_t) = \mathbb{E}_t\left[\max\left\{0; \sum_{\tau=t}^{\infty}\lambda^{\tau-t}\pi_\tau^{S,prem}(\theta)\right\}\middle| f^S \leq f_t^S\right] - w^N s^r$$

The value of waiting at period t for a firm θ is given by:

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

The first term of the RHS means that the firm remains doing domestic sourcing in t, and therefore earns zero offshoring profit premium in t. The second term on the RHS implies that she decides again in the following period whether to explore her offshoring potential or wait.

The Bellman's equation can be expressed as:

$$\mathcal{V}_t(\theta;\theta_t) = \max\left\{V_t^o(\theta;\theta_t); \lambda\mathbb{E}_t\left[\mathcal{V}_{t+1}(\theta;\theta_{t+1})\right]\right\}$$

By Assumption A.5, given the information set in t, the strategy of waiting for one period and explore offshoring in the following one, $V_t^{w,1}(.)$, dominates waiting for longer periods.

$$V_t^{w,1}(\theta;\theta_t,\theta_{t+1}) > V_t^{w,2}(\theta;\theta_t,\theta_{t+2}) > .... > V_t^{w,n}(\theta;\theta_t,\theta_{t+n})$$

Therefore, the One-Step-Look-Ahead (OSLA) rule is the optimal policy[23], and thus the Bellman's equation becomes:

$$\mathcal{V}_t(\theta;.) = \max\left\{\mathbb{E}_t\left[\max\left\{0; \sum_{\tau=t}^{\infty}\lambda^{\tau-t}\pi_\tau^{S,prem}(\theta)\right\}\middle| f^S \leq f_t^S\right] - w^N s^r; V_t^{w,1}(\theta;.)\right\} \tag{12}$$

By a further transformation of equation (12), we derived a *trade-off function*, which defines the offshoring exploration decision at any period t for any non-offshoring firm θ:

$$\mathcal{D}_t(\theta;\theta_t,\tilde{\theta}_{t+1}) = V_t^o(\theta;\theta_t,\tilde{\theta}_{t+1}) - V_t^{w,1}(\theta;\theta_t,\tilde{\theta}_{t+1}) \tag{13}$$

where the first argument of $\mathcal{D}_t(.)$ indicates the productivity of the firm taking the decision, the second argument refers to the state of the system at t, i.e. the productivity of the least productive offshoring firm in South, and the third argument denotes the expected new information that will be revealed at t, i.e. the least productive firm that will attempt offshoring in t.

[23]See Appendix D for proofs.

At any time t, firm's offshoring exploration decision is based on:

$$\mathcal{D}_t(\theta;.)\begin{cases}\geq 0 \Rightarrow & \text{pay the sunk cost and discover the offshoring potential.}\\ < 0 \Rightarrow & \text{remain sourcing domestically for one more period.}\end{cases}$$

By plugging the respective expressions of $V_t^o(\theta;.)$ and $V_t^{w,1}(\theta;.)$ in the trade-off function, it is possible to derive Proposition 1[24].

Proposition 1 (Sequential offshoring)**.** *Firms with higher productivity have an incentive to explore offshoring in early periods.*

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

Using Proposition 1[25], the trade-off function becomes :

$$\mathcal{D}_t(\theta;\theta_t,\tilde{\theta}_{t+1}) = \max\left\{0;\mathbb{E}_t\left[\pi_t^{S,prem}(\theta)\Big| f^S \leq f_t^S\right]\right\} - w^N s^r\left[1-\lambda\frac{Y(f_{t+1}^S)}{Y(f_t^S)}\right] \tag{14}$$

with $\frac{Y(f_{t+1}^S)}{Y(f_t^S)} \equiv Y(f_{t+1}^S | f^S \leq f_t^S)$.

Assumption A. 6. *At least the most productive firm in the market finds profitable to offshore, given the prior knowledge at $t = 0$.*

$$\mathcal{D}_{t=0}(\bar{\bar{\theta}};\bar{\bar{\theta}},\bar{\bar{\theta}}) > 0$$

where $\bar{\bar{\theta}}$ refers to the most productive firm in the market.

Intuitively, Assumption A.6 means that at least the most productive firm in the market must find profitable to explore offshoring in the initial period, given the prior uncertainty. This assumption is key in order to trigger the production of informational externalities[26].

Proposition 2 (Per-period offshoring cutoff)**.** *The offshoring productivity cutoff at any period t, $\tilde{\theta}_{t+1}$, is defined as the fixed point in the trade-off function*

$$\mathcal{D}_t(\tilde{\theta}_{t+1};\theta_t,\tilde{\theta}_{t+1}) = 0 \quad\Rightarrow\quad \mathbb{E}_t\left[\pi_t^{S,prem}(\tilde{\theta}_{t+1})\Big| f^S \leq f_t^S\right] = w^N s^r\left[1-\lambda\frac{Y(f_{t+1}^S)}{Y(f_t^S)}\right]$$

Thus, solving for $\tilde{\theta}_{t+1} \equiv \tilde{\theta}_{t+1}^S$, the offshoring productivity cutoff at the end of period t is:

$$\tilde{\theta}_{t+1}^S = [(1-\gamma_0)E]^{\frac{\sigma}{1-\sigma}}\,\tilde{Q}_{t+1}\left[\frac{w^N\left[\mathbb{E}_t(f^S|f^S\leq f_t^S) - f^N + s^r\left(1-\lambda\frac{Y(f_{t+1}^S)}{Y(f_t^S)}\right)\right]}{\psi^S-\psi^N}\right]^{\frac{1}{\sigma-1}}$$

where $\tilde{Q}_{t+1}$ refers to the aggregate consumption defined by $\tilde{\theta}_{t+1}$, i.e. $\tilde{Q}_{t+1} \equiv Q(\tilde{\theta}_{t+1})$.

Long-run properties (convergence analysis). We concentrate now in the characterisation of the steady state, and the conditions under which it converges to the perfect information equilibrium defined in section 2.1. The convergence to the latter holds, if any of the following conditions is satisfied:

$$f_t^S \xrightarrow{t\to\infty} f^S \quad ; \quad \theta_t^S \xrightarrow{t\to\infty} \theta^{S,*} \quad ; \quad \underline{\theta}_t \xrightarrow{t\to\infty} \underline{\theta}^*$$

First, it is easy to see that the learning mechanism collapses in the long-run in the lower bound of the prior distribution, unless the true fixed cost f^S is revealed and the updating process stops in a finite time.

[24] Appendix D for proofs.

[25] Another way to express the result coming from Proposition 1 is: *firms explore offshoring sequentially, led by the most productive ones in the market*. For proof of Proposition 1 see Appendix D.

[26] When the support of the productivity distribution $G(\theta)$ is $[\theta_{min},\infty)$, e.g. Pareto distribution, it is enough to assume that the prior distribution $Y(f^S)$ has a finite expected value.

- If $f^S = \underline{f}^S \Rightarrow$ The distribution collapses in the lower bound of the prior.
- If $f^S \in (\underline{f}^S, \bar{f}^S] \Rightarrow$ Updating stops sooner (true value revealed).

Finally, from the analysis of the trade-off function in the long-run (as $t \to \infty$), we show the conditions under which this function has a unique fixed point, which corresponds to the perfect information steady state[27].

$$\mathcal{D}(\theta_\infty; \theta_\infty, \theta_\infty) = 0 \quad \Rightarrow \quad \mathbb{E}_t \left[\pi^{S,prem}(\theta^S_\infty) \middle| f^S \leq f^S_\infty \right] = w^N s^r (1 - \lambda)$$

Proposition 3 (Convergence of offshoring productivity cutoff). *There is asymptotic convergence to the full information equilibrium, i.e.* $\theta^S_t \xrightarrow{t\to\infty} \theta^{S,*}$ *when:*

$$\textit{Case I: } f^S = \underline{f}^S \Rightarrow f^S_\infty = \underline{f}^S$$
$$\textit{Case II: } \underline{f}^S + (1-\lambda)s^r < f^S$$

Hysteresis takes places, i.e. the convergence produces some "excess" of offshoring, when:

$$\textit{Case III: } \underline{f}^S + (1-\lambda)s^r = f^S \Rightarrow \theta^S_t \xrightarrow{t\to\infty} \theta^{S,\neg r}$$
$$\textit{Case IV: } \underline{f}^S + (1-\lambda)s^r > f^S > \underline{f}^S \Rightarrow \theta^S_t \xrightarrow{t\to\infty} \theta^S_\infty$$

with $\theta^{S,*} > \theta^S_\infty > \theta^{S,\neg r}$*, and* $\theta^{S,\neg r}$ *denoting the case where the marginal firms obtain zero per period offshoring profit premium, i.e. firms who cannot recover the offshoring sunk cost.*

Proposition 3 shows that there are four possible cases of convergence. Although the steady state is unique, the convergence point depends on distance of the lower bound of the prior distribution with respect to the true value f^S.

In the Case I ($f^S = \underline{f}^S$), the sector converges to the perfect information equilibrium in infinite periods. The Case II is the other path in which the same steady state is achieved. The prior is initially "too optimistic", leading to the full revelation of the true fixed cost f^S in a finite number of periods. Therefore, although the offshoring productivity cutoff initially converges to $\theta^S_t \xrightarrow{t<\infty} \theta^{S,\neg r}$, the hysteresis is transitory. The exogenous death shock progressively vanishes the excess of offshoring firms, pushing the sector to the perfect information equilibrium in the long-run, $\theta^S_t \xrightarrow{t\to\infty} \theta^{S,*}$.

In the other two cases, the convergence paths drive to steady states with some excessive offshoring, i.e. the hysteresis remains in the long-run. Figure 5 illustrates these convergence points. The Case IV corresponds to any point between Case I and III, and the Case II to any point below Case III.

To conclude, the equilibrium path of the offshoring productivity cutoff defines the respective path of the market productivity cutoff. The increasing number of offshoring firms reduce the sectoral price index, increasing the competition intensity in the final good market, pushing the least productive firms progressively out of business.

Proposition 4 (Convergence properties of market productivity cutoff). *Convergence in the offshoring productivity cutoff implies the convergence in* P *and* Q*, leading thus to a convergence in the market productivity cutoff* $\underline{\theta}$*. Considering the taxonomy of cases from Proposition 3,*

$$\begin{cases} \textit{Cases I, II: } \underline{\theta}_t \to \underline{\theta}^* & \textit{if } \theta^S_t \to \theta^{S,*} \\ \textit{Case III: } \underline{\theta}_t \to \underline{\theta}^{\neg r} & \textit{if } \theta^S_t \to \theta^{S,\neg r} \\ \textit{Case IV: } \underline{\theta}_t \to \underline{\theta}_\infty \in (\underline{\theta}^*; \underline{\theta}^{\neg r}) & \textit{if } \theta^S_t \to \theta^S_\infty \in (\theta^{S,\neg r}; \theta^{S,*}) \end{cases}$$

Welfare considerations. We have shown that the transition from the initial conditions defined by the $n.t.i.$ equilibrium to the $*$ steady state presents potential welfare gains from offshoring. Propositions 3 and 4 show that in the long run, the informational spillovers allow the economy to achieve those welfare gains, as $P_t \downarrow P^*$ and thence $Q_t \uparrow Q^*$.

[27] See proof in Appendix D

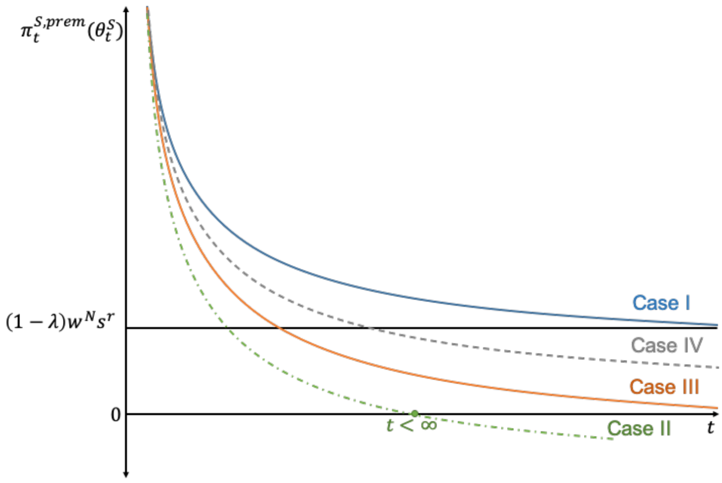


Figure 5: Convergence paths

3 Empirics: Two-country model

We test the predictions of our theoretical model from section 2. In particular, we focus the analysis mainly in the identification of the sequential dynamic equilibrium path of the offshoring activity led by the most productive firms in the market.

With the conditional probability models, we test for the determinants of the offshoring exploration decisions, i.e. the components of the information set considered by the firms when they face the trade-off and decide to explore their offshoring potential. In particular, we center the attention in the productivity of the firms and the effects of the informational spillovers as predicted by the theory. We this purpose, we identify the informational spillovers and learning mechanism by building two alternative measures. The main specification of the spillovers comes directly from the theory, and it is given by the productivity of the least productive offshoring firm in the same sector in the previous year. As an alternative measure, we use the standard deviation of the productivity of the offshoring firms in the same sector in the previous year. From the theoretical model, we expect that as more firms explore offshoring the lower is the upper bound of the uncertainty distribution, which is equivalent to an increase in the variance of the productivities of the offshoring firms. As measure for productivity, we use the *total assets* of the firm (in million USD) as proxy.[28]

From a complementary approach, we use survival analysis methods to identify the timing dimension of the exploration decisions characterised above. In particular, we focus in the determinants that induce firms to explore the offshoring potential in earlier periods[29]. Given the dynamic nature of the exploration decision, this approach drives us closer to a direct identification of the predictions of Proposition 1.

3.1 Data description and sample selection

We use data of Colombian manufacturing firms for the period 2004-2018. The dataset comes from two sources. The first consists of a firm-level dataset provided by the Superintendencia de Sociedades (SIREM) of Colombia, which consists of balance sheet information[30] and the sectoral classification of the firms by ISIC (4 digits). The second dataset is published by the National Statistics Office (Dirección Nacional de Estadística - DANE) and includes import data by firm at product level (10 digits)[31].

[28]Alternative proxies such as *Machinery assets*, and *Long-term assets* are considered for robustness.

[29]For the role of the information spillovers in the location choices, see the multi-country extension in sections 4 and 5.

[30]The variables include: firm tax ID (NIT), sector (ISIC at 4 digits), year, operational sales, assets (by types, short-term, machinery, long-term, total), liabilities (by type, short-term, long-term, total), profits, etc.

[31]The dataset includes: the importer identifier (NIT), name of firm, month, year, imports value CIF and FOB, quantity (kg and units), country of origin, country of purchase, city of exporter, product code (10 dig), etc.

The universe of firms is defined by manufacturing firms from the SIREM dataset. Both dataset are merged by firm ID (NIT) and year. When a firm in the SIREM dataset is not included in the DANE imports data, it is considered as non-importer, i.e. as a domestically sourcing firm. The product codes and ISIC codes are made compatible by concordance tables provided by DANE. We aggregate the product code (from now on we call them intermediate inputs) at 8 digits.

Finally, considering that the main goal of the model is to test for the effects of the informational spillover that arise from firms learning about offshoring conditions from other firms in the same sector, we drop all the sectors with less than 20 and 50 firms that have been active for at least one year during the entire sample period. Thus, the models below focus in Colombian manufacturing sectors with at least 50 firms and with at least 20 firms.

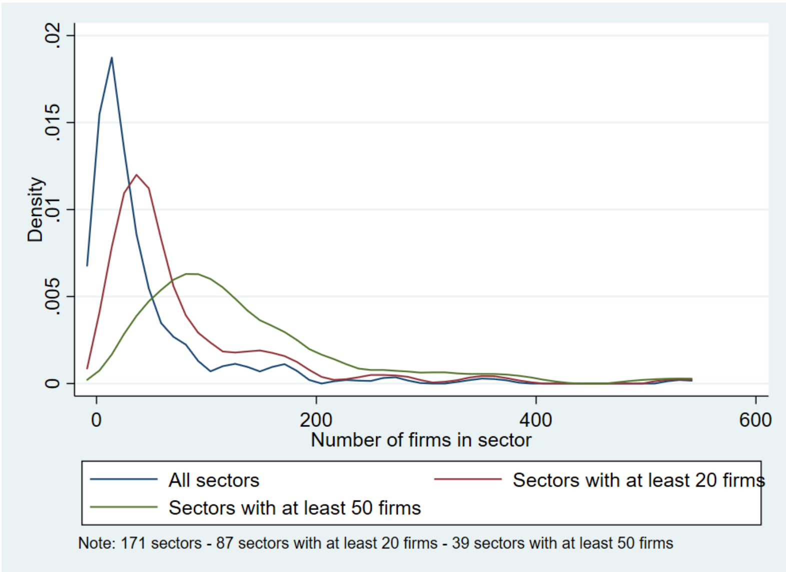


Figure 6: Kernel - Firms by sector

3.2 Conditional probability model

The North refers to Colombia, i.e. the location of the firm taking the sourcing decision, while South refers to the rest of the world.

We model the probability of exploring offshoring in period t of a domestically sourcing firm up to period $t-1$. In other words, we identify the offshoring decision for firms that explore their offshoring potential for the first time. Thus, the empirical model is given by:

$$\Pr\left(\textit{offshr status}_{i,j,t} = 1 \middle| \textit{offshr status cum}_{i,j,t-1} = 0\right) = \Phi\left(\ln(\textit{assets tot}_{i,t})\beta_1, \textit{info spillover}_{j,t}\beta_2, \gamma_j, \gamma_t\right)$$

where i, j denote the firm and sector, respectively. The variable *offshr status*$_{i,j,t}$ is a dummy variable that takes the value 1 if the firm i in sector j offshores in period t. The variable *offshr status cum*$_{i,j,t-1}$ is a dummy variable that takes the value 1 if the firm i in sector j has offshored up to period $t-1$ inclusive.

As already mentioned, we define the informational spillover measure in two alternative ways:

- Direct measure from theory: *info spillover*$_{j,t}$ = *min (assets tot offshr)*$_{j,t-1}$. It refers to the productivity of the least productive firm offshoring in previous year in the same sector.
- Alternative measure (theory-consistent): *info spillover*$_{j,t}$ = *sd(assets tot offshr)*$_{j,t-1}$. It refers to the standard deviation of the productivity among offshoring firms in previous year in the same sector.

Table 1: Regression results - Conditional Probability Model

Variable	*Exp. sign*	Sectors with at least 20 firms				Sectors with at least 50 firms			
		(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
		Linear	**Linear**	**Probit**	**Probit**	**Linear**	**Linear**	**Probit**	**Probit**
ln(assets tot)	+	0.0433***	0.0431***	0.313***	0.312***	0.0453***	0.0454***	0.307***	0.307***
		(0.00228)	(0.00228)	(0.0144)	(0.0144)	(0.00250)	(0.00250)	(0.0161)	(0.0161)
min(assets tot offshr)	-	-3.164**		-27.05**		-2.336		-7.792	
		(1.461)		(13.14)		(8.745)		(60.29)	
sd(assets tot offshr)	+		-0.108*		-0.427*		0.458***		2.901**
			(0.0632)		(0.225)		(0.174)		(1.212)
constant		0.373***	0.376***	0.629***	0.634***	0.382***	0.356***	0.553***	0.389**
		(0.0237)	(0.0238)	(0.150)	(0.150)	(0.0260)	(0.0262)	(0.164)	(0.169)
N		15203	15181	15203	15181	12072	12072	12072	12072
R-sq		0.052	0.052			0.050	0.051		
adj. R-sq		0.046	0.046			0.046	0.047		
pseudo R-sq				0.091	0.091			0.086	0.086

ISIC and Year FE included. Standard errors in parentheses. Robust standard errors.
* p<0.10, ** p<0.05, *** p<0.01

Table 1 shows that the probability of exploring the offshoring potential is increasing in the productivity of the firm, consistent with Proposition 1.

On the other hand, the coefficient associated to the main measure for informational spillovers has the expected sign in all specifications, although only significant (at the reported levels) for the sectors with at least 20 firms. This gives support to the prediction that the informational spillovers as defined by the model are part of the information set of the non-offshoring firms when they face the trade-off of exploring the offshoring potential or wait.

Regarding the alternative measure for spillovers, the associated coefficient shows the expected sign (and significant) for the sectors with at least 50 firms, but it has the opposite sign in the other cases. By using a discrete measure of firms' productivity (quintiles), we estimate the effect of the information spillovers separately for each productivity group. Table 13 in Appendix E reports the results of this last specification and it shows that *sd(assets tot offshr)* has the expected effect in particular for the group of non-offshoring firms with the highest productivity. According to the sequential offshoring exploration path, those are the firms facing the strongest trade-off situation between exploring offshoring and waiting, and thus have the highest potential learning gains from the information spillovers.

In summary, the conditional probability model for the North-South model with one intermediate input shows a strong support for Proposition 1, and give evidence in favour of domestic sourcing firms using the informational spillovers in their respective offshoring exploration decision.

3.3 Transition (or survival) analysis

Due to the grouped nature of the data[32] and the time-varying covariates, the complementary log-logistic distribution is a standard choice for the modelling of the baseline hazard. Thus, the hazard rate to transition from domestic sourcing to offshoring firm in period t is given by:

$$\Lambda_{i,j,t}(t) = 1 - \exp[-\exp(\mathbf{x}'_{i,j,t}\boldsymbol{\beta} + \delta_t)]$$

where δ_t indicates the general time-trend of the spell duration (years since entry),

$$\mathbf{x}'_{i,j,t}\boldsymbol{\beta} = \beta_0 + \beta_1 \ln(\textit{assets tot})_{i,t} + \beta_2 \textit{info spillover}_{j,t} + \beta_3 \textit{entry year}_i + \gamma_j$$

and the informational spillovers are defined by the two alternative measures described above. The variable δ_t controls for the general time-trend. We also introduce the variable *entry* to control for the year in which the firm enters the sample.

We considered two types of modelling of the general time-trend: a logarithmic form of the type $\delta_t = \alpha \ln(t)$, and a non-parametric approach. We observe that the results remain robust to both specifications.

[32] i.e. the underlying continuous process but with discrete time data collection.

Table 2: Regression results - Model 1: Survival Analysis

		Sectors with at least 20 firms		Sectors with at least 50 firms	
	Exp. Sign	**(1)**	**(2)**	**(3)**	**(4)**
		cloglog	**cloglog**	**cloglog**	**cloglog**
ln(t)		-0.512***	-0.503***	-0.539***	-0.624***
		(0.0754)	(0.0755)	(0.0844)	(0.0918)
ln(assets tot)	+	0.439***	0.438***	0.418***	0.418***
		(0.0275)	(0.0275)	(0.0307)	(0.0307)
min(assets tot offshr)	-	-69.14**		-139.4	
		(33.05)		(114.4)	
sd(assets tot offshr)	+		-0.921**		3.687*
			(0.388)		(2.016)
constant		2.021***	2.009***	1.904***	1.721***
		(0.267)	(0.266)	(0.285)	(0.290)
N		15203	15181	12072	12072

Standard errors in parentheses. ISIC and year of entry included. Robust standard errors.
* p<0.10, ** p<0.05, *** p<0.01

The estimation results in Table 2 support Proposition 1: *the most productive firms explore their offshoring potential earlier*. Therefore, from a temporal dimension, the offshoring equilibrium path is led by the most productive firms in the market (sector).

Regarding the information spillovers, the main measure $min($*assets tot offshr*$)$ shows a theory consistent coefficient in all specifications, indicating that the information revealed by the other firms' offshoring activity (i.e. information spillovers) are part of the information set considered by the non-offshoring firms when they decide whether to explore the offshoring potential or wait. An increase in the information revealed by the other firms accelerates the transition of the non-offshoring firms to the offshoring status.

The alternative measure, as before, shows a theory-consistent result only for sectors of at least 50 firms, but not in the case of at least 20 firms. However, Table 14 in Appendix E shows a clear positive effect for the most productive firms in the case of the sectors with at least 20 firms, as expected from the theory. As already mentioned in section 2, given that the exploration is sequential in productivity, those in the higher quintiles are the firms facing the trade-off in the decision, and thus derive a higher benefit from the use of the spillovers.

In summary, the transition analysis shows strong support for the leading role of the most productive firms in the offshoring exploration, as well as for the learning mechanism characterised in section 2. Firms use the informational spillovers to learn from other firms offshoring activity. As more information is revealed by the others, the sooner the firms transition to an offshoring status.

However, in order to achieve a more complete understanding of the role that information spillovers play in the offshoring decisions, and in particular in the location dimension, we extend the model to multiple countries in the next section.

4 The multi-country model

In a world with multiple countries, particularly one in which northern firms can offshore from have alternative foreign locations, two immediate questions arise: i) how is the allocation of intermediate inputs' suppliers across countries affected by the informational spillovers?; and ii) what are the welfare consequences of uncertainty in the steady state of the economy?

This section gives a step towards answering those questions. We assume a world economy with three countries: North (N), East (E), and South (S). The final-good producers of the differentiated sectors are still located in the North, but they can now choose the location of the intermediate input suppliers among: domestic sourcing (North), offshoring in East, or offshoring in South.

In order to discover their offshoring potential in the South or in the East, firms must pay the country-specific market research sunk cost $s^{r,S}$ or $s^{r,E}$, respectively. Both are expresed in northern labour units. For simplicity, we assume $s^{r,S} = s^{r,E} = s^r$. On the other hand, we assume that the fundamentals of southern institutions are better than the respective eastern ones. However, under uncertainty this is unknown to the firms.

Assumption A. 7. *Institutional fundamentals are better in South than in East.*

$$f^S < f^E$$

For simplicity, we assume identical wages across foreign countries, i.e. $w^E = w^S$. Therefore, the steady state under perfect information implies that firms will offshore only from the South.[33]

Assumption A. 8. *South and East have the same labour productivity in the homogeneous sector.*

$$A_{0,S} = A_{0,E} \Rightarrow w^S = w^E$$

Under uncertainty, the final good producers in the differentiated sector can reduce the risk of exploring their offshoring potential by learning while waiting. However, given that the informational externalities are country-specific[34], the behaviour of firms offshoring from one country does not affect firms' beliefs about institutions in the other foreign locations.

4.1 Multi-country model with symmetric wages

The steady state of the world economy, and furthermore the sectoral specialization of countries, depend on both the institutional fundamentals and the beliefs that firms have about the institutions in those countries. We show that the informational spillovers are key elements in defining the specialization patterns and thus the observed countries' comparative advantages. We characterise the multiple equilibria that emerge from the model, and their respective welfare consequences.

In the rest of this section we refer as convergence to the *"perfect information equilibrium"* or to the *"perfect information steady state"* to the situation in which the offshoring productivity cutoff in South converges to the steady state as defined in Proposition 3 in section 2.2.3 [35], and the firms doing offshoring are sourcing only from the South:

$$\theta_t^E \to \infty \text{ and } \theta_t^S \downarrow \theta^{S,*} \Rightarrow P_t \downarrow P^* \Rightarrow Q_t \uparrow Q^*$$

We characterise first the offshoring exploration decisions, and continue with the identification of the multiple equilibria under different assumptions on the beliefs: *symmetric* and *asymmetric* priors across countries.

4.1.1 Firms' offshoring decision

At any period t, firms sourcing in North decide whether to explore their offshoring potential or wait. If they decide to explore, they have two options: South or East. Therefore, the decision in t for any firm θ, who has never explored her offshoring potential in the past, takes the following form:

$$\begin{aligned} \mathcal{V}_t(\theta;.) &= \max\left\{V_t^{o,S}(\theta;.); V_t^{o,E}(\theta;.); \lambda \mathbb{E}_t\left[\mathcal{V}_{t+1}(\theta;.)\right]\right\} \\ &= \max\left\{\max\left\{V_t^{o,S}(\theta;); V_t^{o,E}(\theta;.)\right\}; \lambda \mathbb{E}_t\left[\mathcal{V}_{t+1}(\theta;.)\right]\right\} \end{aligned}$$

[33] For a model with heterogeneous wages, in particular $w^E < w^S < w^N$ see Appendix G and section 6.

[34] In the case where the informational spillovers are also sector-specific, this implies that the dynamics of each differentiated sector are separable. This may potentially imply that spillovers lead to sectoral specialisation of countries.

[35] Proposition 3 shows cases where excessive offshoring emerge. Therefore, we abuse on the terminology in order to simplify the description of all possible multiple equilibria analysed below. Given this warning about terminology and notation, we denote with $*$ any of the cases characterised in Proposition 3.

Assuming that $V_t^{o,l}(\theta;.)$ is the solution to the $\max\left\{V_t^{o,S}(\theta;);V_t^{o,E}(\theta;.)\right\}$, with $l=E$ or $l=S$, the decision becomes:

$$\mathcal{V}_t(\theta;.) = \max\left\{V_t^{o,l}(\theta;.);V_t^{w,1,l}(\theta;.)\right\}$$

with $V_t^{o,l}(\theta;.)$ as the value of exploring offshoring in country l in period t for firm θ, and $V_t^{w,1,l}(\theta;.)$ as the value of waiting one period and offshoring in country l in the next period.

From this expression, we derive the trade-off function:

$$\begin{aligned}\mathcal{D}_t^l(\theta;\theta_t^l,\tilde{\theta}_{t+1}^l) &= V_t^{o,l}(\theta;\theta_t^l,\tilde{\theta}_{t+1}^l) - V_t^{w,1,l}(\theta;\theta_t^l,\tilde{\theta}_{t+1}^l)\\ &= \max\left\{0;\mathbb{E}_t\left[\pi_t^{l,prem}(\theta)\middle|f^l\leq f_t^l\right]\right\} - w^N s^r\left[1-\lambda\frac{Y(f_{t+1}^l)}{Y(f_t^l)}\right]\end{aligned}$$

Intuitively, the process can be thought as a two-stage decision. In the first stage, the firms choose the preferred location (in expectation at t) among all the available foreign locations. In the second stage, the firms decide whether to explore offshoring in the chosen location or wait.

4.1.2 Case A: Equilibria with symmetric initial beliefs

We assume that both countries are fully symmetric in terms of beliefs[36]. Therefore, firms randomise their location choice at $t=0$. Due to the continuum of firms, the exploring firms are divided equally into East and South by the law of large numbers.

The exploration continues in both countries further periods as long as the symmetry in beliefs remains unbroken, i.e. until the true fixed cost in one of the locations is revealed. In particular, by Assumption A.7, the exploration in both locations continues until the fundamentals in the East are revealed. However, this event may not take place in a finite time.

Case A-I: Stable steady state with equally distributed offshore across foreign countries. Considering the results shown in Proposition 3, the transition path and the steady state of the economy depends on whether the prior beliefs about the eastern institutions are "optimistic" or "pessimistic". We describe both situations below.

Pessimistic beliefs. We define the priors as *pesismistic* when the lower bound of the distribution is close enough to the true value f^E. This corresponds to the Cases I, III and IV of Proposition 3, where the institutional fundamentals in East (f^E) are not revealed in any finite number of periods. Formally, this situation is defined by the following condition:

$$\underline{f} + (1-\lambda)s^r \geq f^E \geq \underline{f}$$

It implies that the difference in institutional fundamentals between South and East is relatively small, i.e. $0 < f^E - f^S \leq (1-\lambda)s^r$. Therefore, the offshoring flow continues indefinitely to both countries. The economy converges to a steady state in which both foreign economies receive offshoring flows, diverging from the optimal sectoral specialization defined by the fundamentals.

From a welfare perspective, the price index and agregate consumption index converge in the long run to the perfect information steady state of the economy. Therefore, welfare gains from offshoring are fully achieved in the long run, but with a very slow and costly transition phase.

$$\theta_t^S \downarrow \theta_\infty^S = \theta^{S,*} \text{ and } \theta_\infty^E < \infty \Rightarrow P_t \downarrow P^* \Rightarrow Q_t \uparrow Q^*$$

Optimistic beliefs. We consider now the situation in which the prior beliefs are relatively *optimistic* such that the institutional fundamentals in East are revealed in a finite time, i.e. the situation characterised by the Case II of the Proposition 3. Formally, the condition for optimistic beliefs is given by:

$$\underline{f} + (1-\lambda)s^r < f^E$$

First, we characterise the transition phase up to the revelation period, and then we define the conditions under which the relocation processes from one offshoring location to the other may take place.

[36]Symmetry in beliefs implies: $\underline{f}^S = \underline{f}^E = \underline{f}$ and $\bar{f}^S = \bar{f}^E = \bar{f}$ and in the distribution $Y(.)$.

Revelation period of eastern fixed cost. We define $\hat{t}$ as the period in which f^E is revealed, and $\theta^E_{\hat{t}}$ as the productivity level of the marginal firm that remains doing offshoring in East in $\hat{t}$.

From $\hat{t}+1$ on, the offshoring flow concentrates in South following a sequential dynamic path as the one described in section 2.2.3. From this result, we can already observe that the industry converges to a steady state in terms of the offshoring productivity cutoff, price index and aggregate consumption, consistent with the perfect information steady state. In other words, the welfare gains from offshoring are fully achieved in the long run.

$$\theta^S_t \downarrow \theta^{S,*} \Rightarrow P_t \downarrow P^* \Rightarrow Q_t \uparrow Q^*$$

From the perspective of the specialization of countries, it may be possible that some firms may keep sourcing from East for certain periods, even though the southern institutions have been already revealed as better than the eastern ones. Nevertheless, different types of relocation processes may take place as the share of offshoring firms increases. We analyse them below, and define the conditions under which these relocations take place.

Relocation dynamic of least productive firms offshoring in East. A relocation process of the least productive firms offshoring in East starts unfailingly as soon as the share of offshoring firms keeps increasing after $\hat{t}$. The offshoring sequential dynamic pushes the price index further down, driving the least productive firms offshoring from East to earn negative offshoring profit premiums if they remain sourcing from that country. Thence, starting by the least productive firms, they sequentially relocate their supply chain from the East to the South.

For any period $t > \hat{t}$, the industry shows $P_t < P_{\hat{t}}$ and $Q_t > Q_{\hat{t}}$, and therefore the offshoring productivity cutoff from the East at any period $t > \hat{t}$ is given by [37]:

$$\theta^E_t = [(1-\gamma_0)E]^{\frac{\sigma}{1-\sigma}} Q_t \left[\frac{w^N\left[f^E - f^N\right]}{\psi^E - \psi^N}\right]^{\frac{1}{\sigma-1}} > \theta^E_{\hat{t}}$$

As new firms keep exploring their offshoring potential in South, the "price index effect" pushes up the offshoring productivity cutoff in East. The convergence of the industry offshoring productivity cutoff is defined by the offshoring productivity cutoff in South θ^S_∞, which determines Q_∞ and P_∞, and thus the steady state level of θ^E_∞ [38]. Therefore, the offshoring productivity cutoff in East in the "steady state" of the industry[39] is given by:

$$\theta^E_\infty = [(1-\gamma_0)E]^{\frac{\sigma}{1-\sigma}} Q_\infty \left[\frac{w^N\left[f^E - f^N\right]}{\psi^E - \psi^N}\right]^{\frac{1}{\sigma-1}}$$

Considering this relocation decision of the least productive firms offshoring from East, the steady state is (temporarily[40]) characterised by the following expression, in which some firms remain sourcing from the East:

$$\theta^E_\infty < \infty \text{ and } \theta^S_t \downarrow \theta^{S,*} \Rightarrow P_t \downarrow P^* \Rightarrow Q_t \uparrow Q^*$$

However, as we show below, this is not the only relocation that can potentially take place.

Relocation decision of most productive firms offshoring in East. When the difference in institutional fundamentals is large enough to compensate the payment of the offshoring sunk cost in South, a second kind of relocation process from East to South may take place.

[37]For the expression of $\theta^E_{\hat{t}}$ see Appendix F.

[38]In this regard, the industry offshoring productivity cutoff θ^S_∞ is defined as in section 2.2.3, with the corresponding price index and aggregate consumption steady state levels $P_\infty \equiv P(\theta^S_\infty)$ and $Q_\infty \equiv Q(\theta^S_\infty)$.

[39]This characterisation considers only this relocation of the least productive firms in East. Therefore, it may not represent the true steady state of the industry. Below we incorporate another type of relocation that may arise in the industry, as well as the long run effect of the death shock.

[40]Temporarily in the sense explained in Footnote 39.

The firms offshoring from East with productivity $\theta > \theta_\infty^E$ will not be relocated by the mechanism described above. They still find more profitable to source from eastern suppliers than to relocate the supply chain to the South. However, these firms may consider to relocate and source from South when the following condition holds:

$$\mathbb{E}_t\left[\sum_{\tau=t}^{\infty}\lambda^{\tau-t}\pi_\tau^{S,prem}(\theta)|f^S \leq f_t^S\right] - \mathbb{E}_t\left[\sum_{\tau=t}^{\infty}\lambda^{\tau-t}\pi_\tau^{E,prem}(\theta)|f^S \leq f_t^S\right] - w^N s^r \geq 0$$

Intuitively, it means that the expected lifetime gains from relocation are large enough to recover the offshoring sunk cost in South, considering that the relocation of the supply chain involves the payment of the market research sunk cost s^r to discover the offshoring potential in the new location.

Solving this equation leads to the following condition:

$$f^E - \mathbb{E}_t\left[f^S|f^S \leq f_t^S\right] \geq (1-\lambda)s^r \tag{15}$$

The relocation takes place whenever this holds. It means that whenever the expected institutional quality in South is good enough compared to eastern institutional fundamentals, the remaining firms sourcing from East will change their suppliers' location to South[41].

We show below that there are two different transition phases depending on whether the second relocation process takes place or not. We define both of them below as *Case A-II* and *Case A-III*.

Case A-II: Transition phase without relocation. This refers to the situation in which differences in institutional fundamentals between South and East are not large enough, i.e.

$$f^E - f^S < (1-\lambda)s^r$$

Thus, the firms already offshoring in East with productivity $\theta > \theta_\infty^E$ will not relocate to South at any period t. The steady state of the industry, without condidering the exogenous death shock effect, is given by:

$$\theta_\infty^E < \infty \text{ and } \theta_t^S \downarrow \theta^{S,*} \Rightarrow P_t \downarrow P^* \Rightarrow Q_t \uparrow Q^*$$

Thus, the economy remains under a suboptimal sectoral specialization of countries. However, after the institutional fundamentals in East are revealed, the "death shock effect" pushes the industry to the optimal production allocation in the long run. Therefore, the steady state in the long run is finally achieved.

$$\theta_t^E \to \infty \text{ and } \theta_t^S \downarrow \theta^{S,*} \Rightarrow P_t \downarrow P^* \Rightarrow Q_t \uparrow Q^*$$

Case A-III: Transition phase with relocation. When differences in institutional fundamentals between South and East are large enough, i.e.

$$f^E - f^S \geq (1-\lambda)s^r$$

those firms already offshoring from East with productivity $\theta > \theta_\infty^E$ will relocate to South in a period $t < \infty$ defined by the following condition: $f^E - \mathbb{E}_t\left[f^S|f^S \leq f_t^S\right] = (1-\lambda)s^r$.

Thus, the economy converges to the perfect information equilibrium as defined in section 2.2.3, where firms only offshore from the South and welfare gains from offshoring are realised. The main difference with respect to the *Case A-II* is that here the optimal specialization is achieved in a finite period of time, while in the other case it is realised in the long run.

$$\theta_t^E \to \infty \text{ and } \theta_t^S \downarrow \theta^{S,*} \Rightarrow P_t \downarrow P^* \Rightarrow Q_t \uparrow Q^*$$

[41] A specific feature of the setting of the model is that this relocation is decided by all firms at the same time. This comes from the simplified illustration of the sourcing firms' problem. Nevertheless, the main features of this model are consistent with more complex scenarios. See section 6 for a more complex characterisation of sourcing decisions.

4.1.3 Equilibria with asymmetric initial beliefs

We characterise now the equilibria when the first movers coordinate in the "good equilibrium" or in the "bad equilibrium". For this, we introduce asymmetric beliefs about institutions in East and South, inducing an initial coordinated movement in favour of the exploration of the offshoring potential in one of the countries.

In order to analyse the strength of the path dependence process, we define the conditions under which the coordinated movement of the first explorers to the good or the bad equilibrium leads to a persistent flow into that initially chosen location. We also define the cases in which the industry equilibrium path pushes the offshoring flow out of the initially chosen location.

Case B: Coordination in the good equilibrium. We begin with the case in which the firms' beliefs about the southern institutions are better than the respective beliefs about the East. For simplicity, we assume that the lower bound of the prior uncertainty is the same across countries, i.e. $\underline{f}^S = \underline{f}^E = \underline{f}$, and thus the asymmetry comes from the difference in the upper bound of the prior distributions, i.e.

$$\underline{f}^S = \underline{f}^E = \underline{f} \text{ and } \bar{f}^S = \bar{f}^E - \delta;\ \text{with } \delta > 0 \quad \Rightarrow \quad E_{t=0}(f^S | f^S \leq \bar{f}^S) < E_{t=0}(f^E | f^E \leq \bar{f}^E)$$

In period $t = 0$, the favourable beliefs about the South induce the most productive firms to explore their offshoring potential in this location. In consequence, informational externalities emerge with respect to the southern country, while no new information about eastern institutions is revealed. Therefore, the beliefs about institutions in each country evolves in the following way:

$$f^E \sim Y(f^E) \text{ with } f^E \in [\underline{f}^E, \bar{f}^E]$$
$$f^S \sim \begin{cases} Y(f^S | f^S \leq f_t^S) & \text{if } \tilde{f}_t^S = f_t^S < f_{t-1}^S \\ f_t^S & \text{if } \tilde{f}_t^S < f_t^S \end{cases}$$

The decision at any period t of a non-offshoring firm θ is given by:

$$\mathcal{V}_t(\theta; .) = \max \left\{ V_t^{o,S}(\theta; .); V_t^{w,1,S}(\theta; .) \right\}$$

and the respective trade-off function is:

$$\mathcal{D}_t^S(\theta; \theta_t^S, \tilde{\theta}_{t+1}^S) = \max \left\{ 0; \mathbb{E}_t \left[\pi_t^{S,prem}(\theta) \Big| f^S \leq f_t^S \right] \right\} - w^N s^r \left[1 - \lambda \frac{Y(f_{t+1}^S)}{Y(f_t^S)} \right] \tag{16}$$

Due to the effect of informational externalities, the strategy of exploring the offshoring potential in the South increasingly dominates exploring it in the East. Therefore, the sequential offshoring equilibrium path concentrates in South, while East remains producing only the homogeneous good. This drives the industry to the perfect information steady state. However, whether the economy reaches the steady state in a finite or infinite time depends on the conditions defined by Proposition 3.

$$\theta_t^E \to \infty \forall t \text{ and } \theta_t^S \downarrow \theta^{S,*} \Rightarrow P_t \downarrow P^* \Rightarrow Q_t \uparrow Q^*$$

with $\theta_t^E \to \infty \forall t$ denoting the fact that no firm offshores in East in any period t.

To conclude, the specialization of each country is defined according to the perfect information steady state of the economy, and the welfare gains from offshoring are fully realised in the long run[42].

[42]There is a special case when δ is relatively close to zero and the prior beliefs about southern institutions are extremely optimistic, such that the true value f^S reveals in $t = 0$, i.e. when first explorers go to South. A subset of those firms that have failed in South may explore their offshoring potential in East in $t = 1$. Formally, this takes place if $\mathcal{D}_t^E(\theta_{t=1}^S; \bar{\bar{\theta}}^E, \bar{\bar{\theta}}^E) > 0$. Nevertheless, the explorers in the East will immediately discover that offshoring from that location is not profitable for them either, and they will remain sourcing domestically. In this situation, both fixed costs f^S and f^E are revealed in the first two periods, and still the steady state of the economy is defined by the perfect information steady state.

Case C: Coordination in the bad equilibrium. We assume now that firms believe that the eastern institutions are better than southern, i.e. $\delta < 0$.

$$\underline{f}^S = \underline{f}^E = \underline{f} \text{ and } \bar{f}^S = \bar{f}^E - \delta; \text{ with } \delta < 0 \quad \Rightarrow \quad E_{t=0}(f^S | f^S \leq \bar{f}^S) > E_{t=0}(f^E | f^E \leq \bar{f}^E)$$

The coordination in the bad equilibrium may be stable or unstable depending on the institutional fundamentals in the East, the size of δ and how optimistic are the prior beliefs of the eastern institutions with respect to the fundamentals. We characterise below all the possible cases.

Case C-I: *Stable bad equilibrium path.* Differences in how optimistic are the priors with respect to the fundamentals of eastern institutions push the economy to different transition phases and steady states. Using the definitions of *"pessimistic"* and *"optimistic"* beliefs from above, we show below the two possible paths.

Pessimistic beliefs. As mentioned above, this represents the situation in which the institutional fundamentals are not revealed in a finite time. Accordingly, the sequential offshoring process continues in the long run and it concentrates only in the eastern country. In consequence, the offshoring productivity cutoff, $\theta^E_\infty > \theta^{S,*}$, drives the economy to a steady state with a higher price index P_∞ and lower aggregate consumption index Q_∞.

$$\theta^S_t \to \infty \forall t \text{ and } \theta^E_t \downarrow \theta^E_\infty > \theta^{S,*} \Rightarrow P_t \downarrow P_\infty > P^* \Rightarrow Q_t \uparrow Q_\infty < Q^*$$

In other words, the economy converges to a bad steady state in which the supply chain is organised under a suboptimal allocation of production across countries[43], and the potential welfare gains from offshoring are not fully achieved in the long run.

Optimistic beliefs. The institutional fundamentals in the East will be revealed in a finite time. We define again $\hat{t}$ as the period in which the true value f^E is revealed[44]. Up to $\hat{t}$, the beliefs evolve according to:

$$f^S \sim Y(f^S) \text{ with } f^S \in [\underline{f}^S, \bar{f}^S]$$
$$f^E \sim \begin{cases} Y(f^E | f^E \leq f^E_t) & \text{if } \tilde{f}^E_t = f^E_t < f^E_{t-1} \\ f^E_t & \text{if } \tilde{f}^E_t < f^E_t \end{cases}$$

The decision at any period $t < \hat{t}$ of a non-offshoring firm θ is given by:

$$\mathcal{V}_t(\theta; .) = \max \left\{ V^{o,E}_t(\theta; .); V^{w,1,E}_t(\theta; .) \right\}$$

and the respective trade-off function is represented by:

$$\mathcal{D}^E_t(\theta; \theta^E_t, \tilde{\theta}^E_{t+1}) = \max \left\{ 0; \mathbb{E}_t \left[\pi^{E,prem}_t(\theta) \middle| f^E \leq f^E_t \right] \right\} - w^N s^r \left[1 - \lambda \frac{Y(f^E_{t+1})}{Y(f^E_t)} \right] \tag{17}$$

From period 0 up to $\hat{t}$, the strategy of exploring the offshoring potential in the East dominates the exploration in the South. Therefore, the offshoring flow concentrates in the East, while the South remains exclusively specialized in the production of the homogeneous good.

At $\hat{t}$, the beliefs about institutional conditions are:

$$f^S \sim Y(f^S) \text{ with } f^S \in [\underline{f}^S, \bar{f}^S]$$
$$f^E = f^E(\theta^E_{\hat{t}})$$

with $\theta^E_{\hat{t}}$ denoting the least productive firm offshoring from East in period $\hat{t}$.

[43] i.e. South remains producing only the homogeneous good while all the offshored production of intermediate inputs has been located in East.

[44] When $f^E - \underline{f}^E \leq (1-\lambda)s^r$, then $\hat{t} \to \infty$.

Consider $|\delta|$ is large enough[45] such that the following condition holds: $\mathcal{D}^S_{\hat{t}}(\theta^E_{\hat{t}}; \bar{\bar{\theta}}^S, \bar{\bar{\theta}}^S) < 0$. This means that the most productive firm doing domestic sourcing at $\hat{t}+1$ [46] does not find it attractive to explore her offshoring potential in the South. Therefore, no exploration of the South takes place that could trigger the sequential offshoring flow into that location. This drives the economy to an inefficient steady state where the specialisation of countries is suboptimal, and the welfare gains from offshoring are not fully realised.

$$\theta^S_t \to \infty \forall t \text{ and } \theta^E_t \downarrow \theta^E_\infty > \theta^{S,*} \Rightarrow P_t \downarrow P_\infty > P^* \Rightarrow Q_t \uparrow Q_\infty < Q^*$$

with $\theta^S_t \to \infty \forall t$ refering to the fact that no firm offshore in South at any period t.

Case C-II: *Early explorers shifting path.* There is a special case in which the economy starts in the bad path and it is pushed towards the good steady state. It arises when δ is relatively close to zero and the priors about eastern institutions are optimistic enough, such that f^E is revealed in the first period, i.e. some of the first explorers (in $t = 0$) find unprofitable to offshore in East after paying the sunk cost.

Too optimistic priors about eastern institutions implies that $f^E > f^E(\tilde{\theta}^E_{t=1}) \equiv \tilde{f}^E_{t=1}$, where $\tilde{\theta}^E_{t=1}$ indicates the least productive firm that have explored her offshoring potential in the East in period $t = 0$, and $\theta^E_{t=1}$ refers to the least productive firm that remained sourcing from East.

Those firms with productivity $\theta \in [\tilde{\theta}^E_{t=1}, \theta^E_{t=1})$, who have explored their offshoring potential in East in the period $t = 0$, discovered that it is not profitable for them to source from this country. In consequence, if $|\delta|$ is small enough such that firms $\theta \in [\tilde{\theta}^E_{t=1}, \theta^E_{t=1})$ find profitable to explore their offshoring potential in South in the period $t = 1$, a sequential offshoring process to the South is triggered by those firms. This takes place when: $\mathcal{D}_{t=1}(\theta^E_{t=1}; \bar{\bar{\theta}}^S, \bar{\bar{\theta}}^S) > 0$. Intuitively, this implies that at least the most productive firm among those who have failed offshoring from East, must find profitable to explore the offshoring potential in South.

Thence, after the initial period, the beliefs about the institutional conditions in both foreign countries at each period t is represented by:

$$\begin{aligned} &f^E = f^E_{t=1} \\ &f^S \sim \begin{cases} Y(f^S | f^S \leq f^S_t) & \text{if } \tilde{f}^S_t = f^S_t < f^S_{t-1} \\ f^S_t & \text{if } \tilde{f}^S_t < f^S_t \end{cases} \end{aligned}$$

and firm's decision at any period $t \geq 1$ is characterised by the trade-off function in equation (16).

Once the emergence of informational externalities in the South has been triggered, it leads the economy towards the perfect information steady state in which the welfare gains from trade are fully achieved in the long run. However, the transition phase can take two different paths, which we characterize below.

Case C-IIa: *Transition phase without relocation.* It refers again to the situation in which differences in institutional fundamentals between South and East are not large enough such that firms will have an incentive to relocate at some period t, i.e.: $f^E - f^S < (1-\lambda)s^r$. Thus, the firms already offshoring in East with productivity $\theta > \theta^E_{t=1}$ will not relocate to South at any period t. In consequence, the steady state of the industry, without considering the exogenous death shock effect, is given by:

$$\theta^E_\infty = \theta^E_{t=1} < \infty \text{ and } \theta^S_t \downarrow \theta^{S,*} \Rightarrow P_t \downarrow P^* \Rightarrow Q_t \uparrow Q^*$$

As shown above, although the economy remains temporarily under a suboptimal sectoral specialization of countries, the "death shock effect" pushes the industry to the optimal production allocation in the long run. Therefore, the steady state in the long run is finally characterised by:

$$\theta^E_t \to \infty \text{ and } \theta^S_t \downarrow \theta^{S,*} \Rightarrow P_t \downarrow P^* \Rightarrow Q_t \uparrow Q^*$$

[45] Equivalently, it is possible to consider that fundamentals in the East are good enough such that the true value does not reveal in the first period. Therefore, firms sourcing domestically, after the true value f^E is revealed, will not find profitable to explore their offshoring potential in South.

[46] i.e. the firm marginally less productive than the offshoring productivity cutoff in East.

Case C-IIb: Transition phase with relocation. When differences in institutional fundamentals between South and East are large enough, i.e. $f^E - f^S \geq (1-\lambda)s^r$, those firms already offshoring from East with productivity $\theta > \theta^E_{t=1}$ will relocate to South in a period $t < \infty$ defined by the following condition:

$$f^E - \mathbb{E}_t\left[f^S | f^S \leq f^S_t\right] = (1-\lambda)s^r$$

Thus, the sector converges to the perfect information steady state, where firms offshore exclusively from the South and welfare gains from offshoring are fully achieved in the long run. The main difference with respect to the previous transition phase consists that in this case the optimal specialization is achieved in a finite period of time, while in the other case it is realised in the long run.

$$\theta^E_t \to \infty \text{ and } \theta^S_t \downarrow \theta^{S,*} \Rightarrow P_t \downarrow P^* \Rightarrow Q_t \uparrow Q^*$$

4.2 Final consideration on the multi-country model and policy implications.

The extension to a multi-country world results in a multiple equilibria model, which shows the risks and costs faced by the firms when they explore their offshoring potential among several potential locations. The model shows the importance of the informational spillovers as drivers of the countries' *revealed* comparative advantages.

We have characterised above the cases where the sector reaches the perfect information steady state, the optimal allocation of production across countries according to the comparative advantages in fundamentals, and a full realisation of the welfare gains from offshoring.

But we have also defined and analysed the cases in which the industry converges to an inefficient steady state in which the welfare gains from offshoring are not fully achieved in the long run. Furthermore, we have shown the importance of the informational spillovers in the determination of the allocation of production across potential locations, and therefore in the definition of countries' comparative advantages.

Propositions 5 and 6 present the main results in terms of specialisation and welfare implications in the long run, respectively.

Proposition 5 (Countries' sectoral specialisation: multiple equilibria)**.** *The steady state of the economy converges*

1. *to the specialisation of countries according to fundamentals when*
   (a) *the prior beliefs are symmetric and "optimistic". This is achieved in a finite time when the relocation takes place, or in the long run when the relocation does not take place.*
   (b) *the prior beliefs are asymmetric and in favour of the country with the best fundamentals.*
   (c) *the prior beliefs are asymmetric and in favour of the country without the best fundamentals, but the prior beliefs are too optimistic about institutions in that country.*
2. *to an inefficient specialisation of countries when*
   (a) *the prior beliefs are symmetric and "pessimistic".*
   (b) *the prior beliefs are asymmetric and in favour of the country without the best fundamentals (except in the special case 1c).*

Proposition 6 (Welfare effects)**.** *In the long run, the welfare gains from offshoring*

1. *are fully achieved when*
   - *the prior beliefs are symmetric.*
   - *the prior beliefs are asymmetric and in favour of the country with best fundamentals.*
2. *are not fully realised when the prior beliefs are asymmetric and in favour of the country without the best fundamentals (except in the special case 1c of Proposition 5).*

Finally, in the cases of strong sector-specific institutions, or industries more dependent on institutional quality, the scope of the informational spillovers may extend only to an industry-specific effect, and thence it may lead to different sectoral specialisation paths in each industry. In other words, under this situation, the sequential offshoring process in one differentiated sector j is separable from the dynamic of other differentiated industries. However, when the scope of the spillovers is larger, i.e. the externalities spill across sectors, this may lead to a more extensive or across-sectors effect.

Policy implications. The model introduces some new questions in the discussion about the effectiveness of the institutional reforms. We show that a change in the fundamentals in a country may not have the expected results when firms do not fully believe in the scope of the reform, i.e. the prior beliefs are not sufficiently affected. In consequence, a high uncertainty prevails after the reform.

Furthermore, the informational spillovers produce an increasing differentiation between countries in terms of beliefs or perceptions. As this process advances, a successful reform requires a deeper change in (or larger impact on) firms' perceptions[47]. In other words, this pattern becomes harder to break by policy as the offshoring sequence progresses, and countries become increasingly differentiated.

Moreover, the goal of the institutional reforms may depend on the specific path in which the sector is involved, and the country implementing it.

For instance, in the cases of convergence to a "bad" equilibrium path, the country which has been hurt by the spillover effects but possesses better fundamentals, the entire orientation of the "reform" must lie on changing the beliefs that firms have about its institutions. Thence, it may be more effective for this country to introduce policies mainly defined as signals oriented to change firms' perception, i.e. signals that strongly affect the multinational firms' prior uncertainty about institutional quality in those country. [48]

On the other side, the countries receiving the offshoring flows under the bad equilibrium path, i.e. those who benefit from the spillovers, have an incentive to concentrate the effort on inducing reforms in the institutional fundamentals in the long run. The reforms must be oriented to avoid the stop of the offshoring inflows and the potential relocation processes.

5 Empirics: Multi-country model with one intermediate input

The empirical model is expanded now to multiple countries for the potential location of the supplier of the intermediate input. There are S foreign countries, with $S = 1, ..., s, ...S$[49]. Figure 7 shows the mean number of countries of origin by sector, for each of the samples defined.

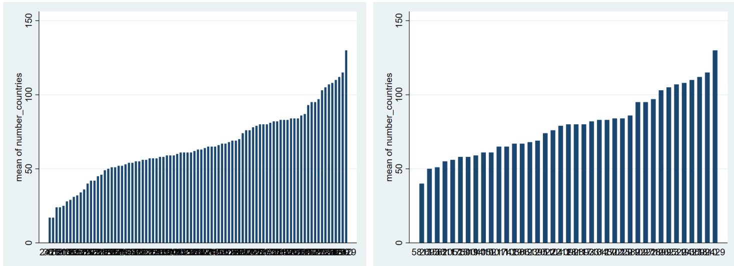
Complementary to the Colombian data already described, we use data from CEPII on distance (distance between capitals) and common language. Additionally, we incorporate data from World Bank on GDP and income per capita, and institutional measures such as *governance efficiency* and *rule of law* from the Worldwide Governance Indicators of the World Bank.

As controls, we use the mean income per capita as a proxy for wage level (marginal cost) in the foreign country, and the mean GDP as a measure of market thickness. The latter control is based on the model of Grossman and Helpman (2005), where the authors show that the thickness of the market is a driver of location choices for offshoring.

[47]In the case of sector-specific spillovers, the countries may exploit that in their favour and develop sector-specific institutions, especially those oriented to relatively new industries, in which informational spillovers have had only a weak effect by that moment.

[48]The access to and reputation of the countries at international institutions such as WTO or ICSID, the participation in RTA or FTA, or the introduction of dispute resolution mechanisms by international arbitration institutions, well known by multinational firms, and the enforcement of their resolutions, may work as strong signals to induce changes of the prior beliefs that multinational firms may have about those countries.

[49]The model defines a total of 182 foreign locations (countries).



(a) with at least 20 firms (b) with at least 50 firms

Figure 7: Suppliers' locations by sector

5.1 Conditional probability model

We estimate the probability of exploring the offshoring potential in country s in period t separately for:

- Non-offshoring firms: it refers to firms that up to $t-1$ have not offshored from any country, i.e. $\textit{offshr status cum}_{i,j,t-1} = 0$. In other words, it denotes the first time explorers.
- Offshoring firms: it indicates firms that up to $t-1$ have offshored from at least one other country $s' \in S$ with $s' \neq s$, i.e. $\textit{offshr status cum}_{i,j,t-1} = 1$ and $\textit{offshr stat country cum}_{i,s,j,t-1} = 0$. In other words, it refers to the firms that consider exploring a new location for a potential relocation.

Non-offshoring firms. These are the firms with a non-offshoring status up to $t-1$ $\forall s \in S$. It refers to the set of domestically sourcing firms that in period t must decide whether to explore their offshoring potential for the first time or wait.

The model aims to identify the determinants of the location choice for these firms that explore their offshoring potential for the first time. The main goal is to test for the theoretical prediction on selection patterns in the offshoring locations driven by the information spillovers. Given the prior beliefs, firms tend to explore offshoring in countries from which more information has been revealed about their institutional conditions.

$$\Pr\left(\textit{offshr stat country}_{i,s,j,t} = 1 \middle| \textit{offshr status cum}_{i,j,t-1} = 0\right) =$$
$$= \Phi\Big(\ln(\textit{assets tot}_{i,t})\beta_1, \ln(\textit{rel spillover})_{s,j,t}\beta_2, \gamma_j, \gamma_t\Big)$$

where i, s, j denote the firm, country and sector, respectively. The variable $\textit{offshr status cum}_{i,j,t-1}$ is a dummy variable that takes the value 1 if the firm i in sector j has offshored up to period $t-1$ inclusive from any country, while $\textit{offshr stat country}_{i,s,j,t}$ refers to the offshoring status of firm i from country s in period t.

Finally, the variable $\ln(\textit{rel spillover})_{s,j,t}$ refers to the information revealed with respect to country s relative to the rest of the potential locations. This allows us to consider the effect of information revealed on alternative competitive locations on the location choices. With this purpose, we develop three alternative indices for each spillover measure. For the main measure, the relative spillover indices used are:

$$\begin{aligned}
\ln(\textit{rel spillover MIN(minTA)})_{s,j,t} &\equiv \ln\left(\frac{\textit{min (assets tot offshr)}_{s,j,t-1}}{\min\left\{\forall s' \in S : \textit{min (assets tot offshr)}_{s',j,t-1}\right\}}\right) \\
\ln(\textit{rel spillover mean(minTA)})_{s,j,t} &\equiv \ln\left(\frac{\textit{min (assets tot offshr)}_{s,j,t-1}}{S^{-1}\sum_{s'=1}^{S} \textit{min (assets tot offshr)}_{s',j,t-1}}\right) \qquad (18) \\
\ln(\textit{rel spillover Wmean(minTA)})_{s,j,t} &\equiv \ln\left(\frac{\textit{min (assets tot offshr)}_{s,j,t-1}}{\sum_{s'=1}^{S} \textit{min (assets tot offshr)}_{s',j,t-1} \times \textit{InvDist}_{s'}}\right)
\end{aligned}$$

The first equation in (18) compares the information revealed in country s relative to the country s' with the highest information revealed. Instead the second equation compares it relative to the mean information revealed in all the locations. Finally, the third equation compares it relative to a weighted mean of the information revealed in all the locations, with the weights given by the normalised inverse of the distance to each location.

For the alternative measure *sd(assets tot offshr)*, we build equivalent indices given by:

$$\begin{aligned}
\ln(\textit{rel spillover sd TA})_{s,j,t} &\equiv \ln\left(\frac{\textit{sd(assets tot offshr)}_{s,j,t-1}}{\max\left\{\forall s' \in S : \textit{sd(assets tot offshr)}_{s',j,t-1}\right\}}\right) \\
\ln(\textit{rel spillover mean(sdTA)})_{s,j,t} &\equiv \ln\left(\frac{\textit{sd(assets tot offshr)}_{s,j,t-1}}{S^{-1}\sum_{s'=1}^{S} \textit{sd(assets tot offshr)}_{s',j,t-1}}\right) \\
\ln(\textit{rel spillover Wmean(sdTA)})_{s,j,t} &\equiv \ln\left(\frac{\textit{sd(assets tot offshr)}_{s,j,t-1}}{\sum_{s'=1}^{S} \textit{sd(assets tot offshr)}_{s',j,t-1} \times \textit{InvDist}_{s'}}\right)
\end{aligned} \tag{19}$$

Table 3 shows that the probability of exploring the offshoring potential in country s for non-offshoring firms is still increasing in productivity, as predicted by Proposition 1 and the multiple equilibria described in Section 4. The table reports the estimation results for the third equation only (weighted mean). The other cases are reported in Table 15 in Appendix E.

Table 3: Regression results: Cond. Prob. Model - Non-offshoring firms

		Non-offshoring firms			
		at least 20 firms		**at least 50 firms**	
	Exp. sign	**(1)** **Probit**	**(2)** **Probit**	**(3)** **Probit**	**(4)** **Probit**
ln(assets tot)	+	0.218*** (0.00771)	0.221*** (0.00803)	0.216*** (0.00843)	0.219*** (0.00867)
ln[rel sp Wmean(minTA)]	-	-0.101*** (0.00735)		-0.101*** (0.00822)	
ln[rel sp Wmean(sdTA)]	+		0.00313 (0.0117)		0.0138 (0.0128)
ln(market thickness)	+	0.236*** (0.00791)	0.280*** (0.00807)	0.240*** (0.00862)	0.283*** (0.00865)
ln[mean(income pc)]	-	-0.0830*** (0.00917)	-0.109*** (0.00943)	-0.0811*** (0.00992)	-0.107*** (0.0101)
common language	+	0.137*** (0.0304)	0.160*** (0.0315)	0.114*** (0.0335)	0.150*** (0.0341)
ln(distance capital)	-	-0.116*** (0.0207)	-0.141*** (0.0219)	-0.121*** (0.0227)	-0.143*** (0.0237)
N		628039	430768	558256	395526
pseudo R-sq		0.187	0.161	0.184	0.158

ISIC and Year FE included. Standard errors in parentheses. Robust standard errors.
* p<0.10, ** p<0.05, *** p<0.01

In relation to the spillovers effects, both indices are consistent with the theoretical predictions, although the alternative spillover measure is not significant at the reported levels in this specification of the model[50]. As more information from country s is revealed relative to the rest of the world, the higher the probability that non-offshoring firms will explore the offshoring potential in country s. In short, the informational spillovers drive the location choices of non-offshoring firms when they decide to explore their offshoring potential for the first time.

[50]In a future version of the model we will include the analysis by productivity quintile as before.

Offshoring firms Now the analysis relies in those firms that up to $t-1$ have offshored from other locations $s' \neq s$, i.e. *offshr status cum*$_{i,j,t-1} = 1$, but they have never explored their offshoring potential in the country s (i.e. *offshr stat country cum*$_{i,s,j,t-1} = 0$). The main idea is to capture the drivers for the exploration of a new potential location, and the consequential relocation of the supply chain [51].

$$\Pr\Big(\textit{offshr stat country}_{i,s,j,t} = 1 \Big| \textit{offshr stat country cum}_{i,s,j,t-1} = 0, \textit{offshr status cum}_{i,j,t-1} = 1\Big) =$$
$$= \Phi\Big(\ln(\textit{assets tot}_{i,t})\beta_1, \ln(\textit{rel spillover})_{s,j,t}\beta_2, \gamma_j, \gamma_t \Big)$$

where i, s, j denote the firm, country and sector, respectively. The variable *offshr status cum*$_{i,j,t-1}$ is a dummy variable that takes the value 1 if the firm i in sector j has offshored up to period $t-1$ inclusive from any country, while *offshr stat country*$_{i,s,j,t}$ refers to the offshoring status of firm i from country s in period t.

Table 4 shows, as predicted by the model, that firms with higher productivity among the offshoring firms lead the exploration of new locations. This is reflected by the positive effect of productivity on the probability of offshoring from country s, for firms that have already offshored from other locations. As before, the table reports the estimation results for the third equation only (weighted mean). The other cases are reported in Table 16 in Appendix E.

Table 4: Regression results: Cond. Prob. Model - Offshoring firms

		Offshoring firms from other locations			
		at least 20 firms		**at least 50 firms**	
	Exp. sign	**(1)**	**(2)**	**(3)**	**(4)**
		Probit	**Probit**	**Probit**	**Probit**
ln(assets tot)	+	0.243***	0.243***	0.245***	0.243***
		(0.00216)	(0.00243)	(0.00237)	(0.00260)
ln[rel sp Wmean(minTA)]	-	-0.0851***		-0.0889***	
		(0.00208)		(0.00227)	
ln[rel sp Wmean(sdTA)]	+		0.0142***		0.0141***
			(0.00358)		(0.00383)
ln(market thickness)	+	0.228***	0.253***	0.226***	0.256***
		(0.00267)	(0.00293)	(0.00291)	(0.00311)
ln[mean(income pc)]	-	-0.0241***	-0.0449***	-0.0210***	-0.0428***
		(0.00285)	(0.00318)	(0.00310)	(0.00339)
common language	+	0.162***	0.192***	0.161***	0.192***
		(0.0112)	(0.0118)	(0.0122)	(0.0128)
ln(distance capital)	-	-0.0404***	-0.0407***	-0.0425***	-0.0449***
		(0.00640)	(0.00693)	(0.00696)	(0.00740)
N		1317889	871851	1160882	796086
pseudo R-sq		0.142	0.121	0.142	0.119

ISIC and Year FE included. Standard errors in parentheses. Robust standard errors.
* p<0.10, ** p<0.05, *** p<0.01

In regard of the informational spillover effects, as before, they are consistent with the predictions of the theory. The more information is revealed about the location s relative to all the other alternative locations, the higher is the probability of exploring the offshoring potential in that location.

[51] For future specification, we may consider the probability of offshoring from s and stop offshoring from s'. This is more clearly a relocation than the current specification. This will be introduced in the next versions of the model 3. Nevertheless, it may be too restrictive for the one intermediate input model, but possibly feasible in the model 4 (multiple countries and multiple intermediate inputs).

5.2 Survival (or transition) analysis

The hazard rate to transition to offshoring status from country s is given by:

$$\Lambda_{i,s,j,t}(t)|. = 1 - \exp[-\exp(\mathbf{x}_{i,s,j,t}\boldsymbol{\beta} + \delta_t)]$$

where δ_t denotes the general time-trend, and

$$\mathbf{x}_{i,s,j,t}\boldsymbol{\beta} = \beta_0 + \beta_1 \ln(\textit{assets tot}_{i,t} + \beta_2 \ln(\textit{rel spillover})_{s,j,t} + \beta_3 \textit{entry year}_i + \gamma_j$$

with the variables related to the informational spillovers defined as before.

Non-offshoring firms This section estimates the hazard ratio for non-offshoring firms:

$$\Lambda_{i,s,j,t}(t)|\textit{offshr status cum}_{i,j,t-1} = 0$$

i.e. the transition rate to offshoring status from country s for firms with non-offshoring status up to $t-1$.

Table 5 shows that the most productive firms experience a transition to offshoring from s in earlier periods. In other words, among the non-offshoring firms, the most productive ones explore their offshoring potential from s earlier.

Table 5: Regression results: Survival Analysis Model 3 - Non-offshoring firms

		Non-offshoring firms			
		at least 20 firms		**at least 50 firms**	
	Exp. sign	**(1)**	**(2)**	**(3)**	**(4)**
		cloglog	**cloglog**	**cloglog**	**cloglog**
ln(t)		-0.926***	-1.006***	-0.939***	-0.939***
		(0.0680)	(0.0704)	(0.0750)	(0.0750)
ln(assets tot)	+	0.618***	0.615***	0.617***	0.617***
		(0.0205)	(0.0213)	(0.0226)	(0.0226)
ln[rel sp Wmean (minTA)]	-	-0.296***		-0.301***	-0.301***
		(0.0207)		(0.0231)	(0.0231)
ln[rel sp Wmean (sdTA)]	+		0.00342		
			(0.0339)		
ln(market thickness)	+	0.657***	0.775***	0.674***	0.674***
		(0.0227)	(0.0226)	(0.0248)	(0.0248)
ln[mean(income pc)]	-	-0.261***	-0.326***	-0.259***	-0.259***
		(0.0261)	(0.0264)	(0.0284)	(0.0284)
common language	+	0.263***	0.336***	0.196**	0.196**
		(0.0905)	(0.0936)	(0.0993)	(0.0993)
ln(distance)	-	-0.355***	-0.414***	-0.374***	-0.374***
		(0.0625)	(0.0657)	(0.0688)	(0.0688)
constant		-17.40***	-15.33***	-17.84***	-17.84***
		(0.657)	(0.807)	(0.724)	(0.724)
N		628039	430768	558256	558256

ISIC FE and year of entry included. Standard errors in parentheses. Robust standard errors.
* p<0.10, ** p<0.05, *** p<0.01

From the perspective of the location choice, the empirical model shows that the location decision is affected by the informational spillovers as predicted by the theory. The non-offshoring firms tend to explore their offshoring potential earlier in those locations with more revealed information.

Offshoring firms We consider now the hazard ratio to transition to offshore from s in t for firms already offshoring from other locations:

$$\Lambda_{i,s,j,t}(t)\Big|\textit{offshr stat country cum}_{i,s,j,t-1} = 0, \textit{offshr status cum}_{i,j,t-1} = 1$$

Table 6: Regression results: Survival Analysis Model 3 - Offshoring firms

		Offshoring firms from other locations			
		at least 20 firms		at least 50 firms	
	Exp. sign	(1)	(2)	(3)	(4)
		cloglog	cloglog	cloglog	cloglog
ln(t)		-0.536***	-0.663***	-0.533***	-0.655***
		(0.0135)	(0.0150)	(0.0148)	(0.0161)
ln(assets tot)	+	0.555***	0.545***	0.565***	0.552***
		(0.00506)	(0.00555)	(0.00567)	(0.00607)
ln[rel sp Wmean (minTA)]	-	-0.195***		-0.205***	
		(0.00479)		(0.00522)	
ln[rel sp Wmean (sdTA)]	+		0.0360***		0.0355***
			(0.00802)		(0.00860)
ln(market thickness)	+	0.521***	0.563***	0.520***	0.576***
		(0.00584)	(0.00631)	(0.00638)	(0.00673)
ln[mean(income pc)]	-	-0.0590***	-0.103***	-0.0520***	-0.0979***
		(0.00655)	(0.00705)	(0.00716)	(0.00758)
common language	+	0.301***	0.370***	0.305***	0.381***
		(0.0253)	(0.0265)	(0.0278)	(0.0288)
ln(distance)	-	-0.114***	-0.114***	-0.122***	-0.125***
		(0.0150)	(0.0161)	(0.0164)	(0.0173)
constant		-15.49***	-13.00***	-15.57***	-13.29***
		(0.178)	(0.231)	(0.192)	(0.246)
N		1317889	871851	1160882	796086

ISIC FE and year of entry included. Standard errors in parentheses. Robust standard errors.
* $p<0.10$, ** $p<0.05$, *** $p<0.01$

The results in Table 6 show that the most productive firms among the offshoring ones explore new locations earlier, which reflects a leading role in the exploration of new countries. This is consistent with the theoretical predictions of the model.

From the perspective of the location choices, the estimation results show that the location decision is affected by the informational spillovers as predicted by the theory. Firms tend to locate the supplier in a new country s earlier when more information about that country has been revealed, relative to the rest of the other potential locations.

5.3 IV model: Multi-country with one intermediate input

We go now one step further to the structural identification of the model. As already mentioned, we use the following institutional measures from the Worldwide Governance Indicators of the World Bank: *Government efficiency* and *rule of law*. For both cases, we use the estimate and the percentile rank measures.

Based on the fact that the cited measures capture perceptions about the institutional conditions in each country, we proxy the *prior* beliefs of the conditions in each location by these alternative institutional measures.

On the other hand, the informational spillover is the information received by each firm by observing the behaviour of the other firms in the market. In other words, the information spillovers capture the *physical state* used by the firms as part of the learning mechanism.

Therefore, based on Chapter 14 of Cameron and Trivedi (2009), we use an IV model to identify the learning mechanism. The instrumentation of the institutional measures by information spillovers captures the *posterior* of the learning process, which drives the offshoring decisions.

In order to capture the third country effects on offshoring location choices, we build relative institutional measures in an equivalent form as for the spillovers in equation (18). Thus, we have:

$$
\begin{aligned}
\ln(\textit{rel mean(inst. index)})_{s,j,t} &\equiv \ln\left(\frac{\textit{inst. index}_{s,j,t-1}}{S^{-1}\sum_{s'=1}^{S}\textit{inst. index}_{s',j,t-1}}\right)\\
\ln(\textit{rel Wmean(inst. index)})_{s,j,t} &\equiv \ln\left(\frac{\textit{inst. index}_{s,j,t-1}}{\sum_{s'=1}^{S}\textit{inst. index}_{s',j,t-1}\times \textit{InvDist}_{s'}}\right)
\end{aligned}
\tag{20}
$$

The tables 7 and 8 report the results for sectors with at least 20 firms, for each of the alternative institutional measures. Each row refers to a different specification of the model. The first column of each group of firms, shows the estimated coefficient for the institutional measure in the probit model, while the second column reports the coefficient of the IV probit model. Finally, the third column shows the estimated coefficient of the instrument in the reduced form. For the respective full tables see Appendix E.

Table 7: Regression results: IV Probit - Non-offshoring firms

Method	**Non-offshoring firms**		
	Probit	**IV: Weighted mean (minTA)**	
		Structural model	**Reduced form**
ln(rel Government Efficiency est)	-0.0736***	1.646***	-0.00166***
	(0.0129)	(0.00483)	(0.000628)
ln(rel Government Efficiency rank)	0.175***	3.090***	-0.00980***
	(0.0244)	(0.0248)	(0.000286)
ln(rel Rule of Law est)	-0.0759***	1.612***	-0.0113***
	(0.0168)	(0.0199)	(0.000648)
ln(rel Rule of Law rank)	0.0682***	1.842***	-0.0147***
	(0.0129)	(0.0127)	(0.000497)

Sectors with at least 20 firms.
Standard errors in parentheses. Robust standard errors. ISIC and Year FE included.
Other controls: ln(market thickness), ln(mean income pc), common language, ln(distance capital).
* p<0.10, ** p<0.05, *** p<0.01"

Table 8: Regression results: IV Probit - Offshoring firms

Method	**Offshoring firms from any location $s' \neq s$**		
	Probit	**IV: Weighted mean (minTA)**	
		Structural model	**Reduced form**
ln(rel Government Efficiency est)	0.0349***	1.492***	-0.0176***
	(0.00434)	(0.00833)	(0.000459)
ln(rel Government Efficiency rank)	0.421***	2.937***	-0.00998***
	(0.0104)	(0.0108)	(0.000203)
ln(rel Rule of Law est)	-0.162***	1.472***	-0.0203***
	(0.00346)	(0.0102)	(0.000471)
ln(rel Rule of Law rank)	0.222***	1.726***	-0.0185***
	(0.00590)	(0.00790)	(0.000348)

Sectors with at least 20 firms.
Standard errors in parentheses. Robust standard errors. ISIC and Year FE included.
Other controls: ln(market thickness), ln(mean income pc), common language, ln(distance capital).
* p<0.10, ** p<0.05, *** p<0.01"

From the comparison across columns, we observe that the estimation of the effects of institutions on the offshoring decisions suffer from a downward bias in all the cases. Moreover, we see in rows 1 and 3 that the bias may be strong enough such that the effect is reverted.

These results supports the uncertainty that firms face about institutional conditions in new locations, and the relevance of the informational spillovers and the learning mechanism in capturing the effects that institutions have in the global sourcing decisions.

6 Extension: Multiple intermediate inputs

We assume a world economy with three countries, as before: North (N), East (E) and South (S). Still the final good producers are located in the North, but they can choose the location of the supplier of each intermediate input $m = 1, ..., M_j$ among: domestic sourcing (northern supplier), offshoring from East (eastern supplier), and offshoring from South (southern supplier). Again, we focus the analysis in one differentiated sector, therefore for simplicity we drop subscript j.

We characterise briefly first the perfect information steady state, and then we follow with the dynamic model with uncertainty. The latter involves two cases called Scenario 1 and Scenario 2. The first case refers to the effects of a unilateral institutional reform in the East, and we focus the analysis in the potential relocation processes that may be triggered from South to East after this shock[52]. Instead, the second scenario refers to a simultaneous institutional reform in East and South[53]. In this case, the focus is as in section 4, in the identification of the multiple equilibria and the drivers of the selection patterns in the offshoring location decisions.

The Cobb-Douglas technology for a variety i produced by a final-good producer with productivity θ is defined by equation (21) as:

$$q_t(i) = \theta \left[\frac{x_{h,t}(i)}{\eta}\right]^{\eta} \left[\frac{X_{M,t}(i)}{1-\eta}\right]^{1-\eta} \tag{21}$$

where $q_t(i)$ indicates the quantity produced of variety i, and $X_{M,t}(i)$ indicates a composite input produced in period t by a Cobb-Douglas technology with a set M of $x_{m,t}$ intermediate inputs with $m = \{1, ..., M\}$, as defined by equation (22).

$$X_{M,t}(i) \equiv \prod_{m=1}^{M} [x_{m,t}(i)]^{\omega_m} \quad ; \quad \sum_{m=1}^{M} \omega_m = 1 \tag{22}$$

The marginal cost for the final good producer of an intermediate input m produced in location $l = \{N, S, E\}$ is:

$$c_m^l = \frac{w^l}{\phi_m^l} \quad \text{with } \phi_m^l \in (0, 1] \tag{23}$$

ϕ_m^l can be interpreted as the aggregation of the productivity level of country l in the production of input m and the associated input-specific trade costs from that location to the North. The lower ϕ_m^l is, the higher the marginal cost that the final good producer faces in that intermediate input m from country l. For simplicity, we consider assumption A.9 holds along this section.

Assumption A. 9.

$$\phi_m^N = 1 \Rightarrow c_m^N = w^N \quad \forall m = 1, ..., M \quad \textit{and} \quad w^N > w^S \geq w^E$$

6.1 Firms' profit maximisation problem

We solve it by backward induction in three steps.

[52] The access of China to the WTO is a potential case to be analysed under this framework.

[53] The access of multiple countries to the European Union in 2004 is a clear example of a simultaneous institutional shock in the new entrants. Another case, that will be analysed in a future version of this model is the Pacific Alliance agreement signed in 2012 by Chile, Colombia, Mexico and Peru.

6.1.1 Cost minimisation and unit cost function

First, we solve the cost minimisation problem for a given level of composite input $\bar{X}_M(i)$ and location set $\boldsymbol{l}$, with $\boldsymbol{l} = \{l_1, ..., l_m, ..., l_M\}$ indicating the location of each intermediate input supplier. Thus, we obtain the unit cost function of production of the composite input for a given $\boldsymbol{l}$.

$$\min_{\{x_{m,t}(i)\}_{m=1}^{M}} \sum_{m=1}^{M} c_m^{l_m} x_{m,t}(i) \quad \text{s.t.} \quad \bar{X}_{M,t}(i) = \prod_{m=1}^{M} [x_{m,t}(i)]^{\omega_m}$$

where l_m denotes the location of supplier of intermediate input m.

The optimal level of input m for each $m \in \{1, ..., M\}$ is given by:

$$x_{m,t}(i) = \frac{\omega_m}{c_m^{l_m}} \bar{X}_{M,t}(i) \prod_{m=1}^{M} \left(\frac{c_m^{l_m}}{\omega_m} \right)^{\omega_m}$$

and the respective unit cost function $c(\boldsymbol{l})$ is:

$$c(\boldsymbol{l}) = \prod_{m=1}^{M} \left(\frac{c_m^{l_m}}{\omega_m} \right)^{\omega_m} \tag{24}$$

6.1.2 Profit maximisation: optimal level of inputs

We find the optimal production levels of inputs $x_{h,t}(i), X_{M,t}(i)$ for a given $\boldsymbol{l}$.

$$\max_{x_{h,t}(i), X_{M,t}(i)} \pi_t(\theta, \boldsymbol{l}) = r_t(\theta, \boldsymbol{l}) - w^N x_{h,t}(\theta, \boldsymbol{l}) - c(\boldsymbol{l}) X_{M,t}(\theta, \boldsymbol{l}) - w^N f(\boldsymbol{l})$$

and the per-period fixed cost $f(\boldsymbol{l})$ is defined below in Assumption A.10.

Assumption A. 10. *The final-good producer faces intermediate input specific organisational costs that depend only on the respective location of each supplier m.*

$$f(\boldsymbol{l}) = \sum_{m=1}^{M} \mathbb{1}\{m \in M^N\} f_m^N + \sum_{m=1}^{M} \mathbb{1}\{m \in M^S\} f_m^S + \sum_{m=1}^{M} \mathbb{1}\{m \in M^E\} f_m^E$$

with $f_m^l = f^l + \epsilon_m^l$ and $\epsilon_m^l \sim iid \in [0, \bar{\epsilon}_m^l]$ [54]*. The number of inputs supplied from location l is denoted as M^l, with $M^N + M^S + M^E = M$.* [55]

Thus, the per-period profits for a final-good producer with productivity θ and a given $\boldsymbol{l}$ are:

$$\pi_t^*(\theta, \boldsymbol{l}) = \theta^{\sigma-1} [(1 - \gamma_0)E]^{\sigma} Q^{1-\sigma} \psi(\boldsymbol{l}) - w^N f(\boldsymbol{l}) \tag{25}$$

with

$$\psi(\boldsymbol{l}) = \frac{\alpha^{\sigma-1}}{\sigma[(w^N)^{\eta} c(\boldsymbol{l})^{1-\eta}]^{\sigma-1}} \tag{26}$$

The optimal investment levels in the inputs are given by:

$$x_{h,t}(\theta, \boldsymbol{l}) = \frac{\alpha\eta}{w^N} r_t^*(\theta, \boldsymbol{l}) \quad ; \quad X_{M,t}^*(\theta, \boldsymbol{l}) = \frac{\alpha(1-\eta)}{c(\boldsymbol{l})} r_t^*(\theta, \boldsymbol{l}) \tag{27}$$

with $r_t^*(\theta, \boldsymbol{l}) = \alpha^{\sigma-1} \theta^{\sigma-1} [(1 - \gamma_0)E]^{\sigma} Q^{1-\sigma} \left[(w^N)^{\eta} c(\boldsymbol{l})^{1-\eta} \right]^{1-\sigma}$.

[54] The general institutional fundamentals in country l are represented by f^l, while ϵ_m^l captures the input-specific institutional conditions in country l.

[55] If we assume that the per-period fixed cost is homogeneous across intermediate inputs, i.e. no input specific institutions, such that $f_m^l = f^l \; \forall m \in M$, we have: $f(\boldsymbol{l}) = M^N f^N + M^S f^S + M^E f^E$.

6.1.3 Profit maximisation: optimal location of intermediate inputs suppliers

Finally, firms choose the location set $\boldsymbol{l}$ that maximises profits. In other words, the final good producer decides the location of each intermediate input supplier m that maximises firm's profits.

$$\max_{\boldsymbol{l}} \Pi(\theta, \boldsymbol{l}) = \sum_{\tau=0}^{\infty} \lambda^{\tau} \pi^{*}(\theta, \boldsymbol{l}) = \frac{\pi^{*}(\theta, \boldsymbol{l})}{1-\lambda} - s^{r}(\boldsymbol{l})$$

$$\text{with } \pi^{*}(\theta, \boldsymbol{l}) = \theta^{\sigma-1}[(1-\gamma_0)E]^{\sigma} Q^{1-\sigma} \psi(\boldsymbol{l}) - w^{N} f(\boldsymbol{l})$$

We assume that the ranking in the institutional fundamentals is defined by Assumption A.11.

Assumption A. 11. $f_m^N < f_m^S < f_m^E \; \forall m \in M$

6.2 Offshoring (market) research costs: sunk cost per-input and location

The offshoring sunk cost is input-specific. This means that a firm that wants to discover the offshoring potential in an input m from a location l must pay an offshoring sunk cost, independently of the offshoring status of the firm in any of the other intermediate inputs. In general terms, the input-specific offshoring sunk cost for input m from country l is defined as $s_m^{r,l}$ with $l = S, E$. In consequence, the total offshoring sunk cost that a firm must pay for all the offshored inputs is[56]:

$$s^{r}(\boldsymbol{l}) = \sum_{m=1}^{M} \mathbb{1}\{m \in M^{S}\} s_m^{r,S} + \sum_{m=1}^{M} \mathbb{1}\{m \in M^{E}\} s_m^{r,E}$$

6.3 Perfect information equilibrium

There are two offshoring productivity cutoffs with respect to each intermediate input m to be defined: θ_m^S and θ_m^E. The first indicates the productivity cutoff for firms offshoring m from the South, while the second refers to the respective productivity cutoff of firms offshoring m from East [57].

6.3.1 Equilibrium offshoring productivity cutoffs

The offshoring productivity cutoff in South in input m is given by:

$$\theta_m^{S,*} = \begin{cases} [(1-\gamma_0)E]^{\frac{\sigma}{1-\sigma}} Q \left[\frac{w^N \left[f_m^S - f_m^N + (1-\lambda) s_m^{r,S} \right]}{\psi(l_m^S, \boldsymbol{l'}) - \psi(l_m^N, \boldsymbol{l'})} \right]^{\frac{1}{\sigma-1}} & \text{if } A_1 > 0 \wedge A_2 < 1 \\ \infty & \text{if } A_1 \leq 0 \vee A_2 \geq 1 \end{cases}$$

with

$$A_1 \equiv \psi(l_m = S, \boldsymbol{l'}) - \psi(l_m = N, \boldsymbol{l'})$$

$$A_2 \equiv \left[\frac{\psi(l_m^E, \boldsymbol{l'}) - \psi(l_m^N, \boldsymbol{l'})}{\psi(l_m^S, \boldsymbol{l'}) - \psi(l_m^N, \boldsymbol{l'})} \right]^{\frac{1}{\sigma-1}} \left[\frac{f_m^S + (1-\lambda) s_m^{r,S} - f_m^N}{f_m^E + (1-\lambda) s_m^{r,E} - f_m^N} \right]^{\frac{1}{\sigma-1}}$$

The condition defined as A_1 is positive when $c_m^S < w^N$. About A_2, it represents the trade-off between the marginal cost advantages of the East with respect to South, compared to the disadvantage of the first with respect to the latter in terms of institutions (i.e. fixed costs). The first bracket reflects the ratio of the relative slopes of the profit functions, while the second represents the relative intercepts.

[56] If we assume that the offshoring sunk cost is homogeneous across inputs m, i.e. $s_m^{r,l} = s^{r,l} \forall m \in M$, the expression simplifies to $s^r(\boldsymbol{l}) = M^S s^{r,S} + M^E s^{r,E}$. Furthermore, if we assume that the offshoring sunk cost is homogeneous across countries, i.e. $s^{r,E} = s^{r,S} = s^r$, we have: $s^r(\boldsymbol{l}) = (M^S + M^E) s^r$. We solve below the problem for a general case, i.e. $s_m^{r,l}$. However, it is straightforward to substitute and apply any of these simplifications.

[57] When no firm offshores input m from a location l, we denote this as $\theta_m^l \to \infty$ or $\theta_m^l > \bar{\bar{\theta}}$, where $\bar{\bar{\theta}}$ denotes the productivity of the most productive firm in the market. For the definition of the profit premiums and the conditions for the offshoring productivity cutoffs see Appendix H.1.

The offshoring productivity cutoff in East in input m, is given by:

$$\theta_m^{E,*} = \begin{cases} [(1-\gamma_0)E]^{\frac{\sigma}{1-\sigma}} Q \left[\frac{w^N \left[f_m^E - f_m^N + (1-\lambda) s_m^{r,E} \right]}{\psi(l_m^E, \boldsymbol{l'}) - \psi(l_m^N, \boldsymbol{l'})} \right]^{\frac{1}{\sigma-1}} & \text{if } A_2 \geq 1 \wedge A_3 > 0 \\ [(1-\gamma_0)E]^{\frac{\sigma}{1-\sigma}} Q \left[\frac{w^N \left[f_m^E - f_m^S + (1-\lambda)\left(s_m^{r,E} - s_m^{r,S} \right) \right]}{\psi(l_m^E, \boldsymbol{l'}) - \psi(l_m^S, \boldsymbol{l'})} \right]^{\frac{1}{\sigma-1}} & \text{if } A_2 < 1 \wedge A_4 > 0 \\ \infty & \text{if } A_3 \leq 0 \vee A_4 \leq 0 \end{cases}$$

with

$$A_3 \equiv \psi(l_m^E, \boldsymbol{l'}) - \psi(l_m^N, \boldsymbol{l'})$$
$$A_4 \equiv \psi(l_m^E, \boldsymbol{l'}) - \psi(l_m^S, \boldsymbol{l'})$$

The variable $A_3 > 0$ implies that $c_m^E < w^N$, while $A_4 > 0$ reflects the marginal cost advantage of East with respect to South in the intermediate input m, i.e. $c_m^E < c_m^S$.

Finally, the firms with productivity $\theta \in \left[\underline{\theta}^*, \min\{\theta_m^{S,*}, \theta_m^{E,*}\} \right)$ source the intermediate input m from domestic suppliers.

Offshoring productivity cutoff and the intermediate input relevance. It is easy to see that the offshoring productivity cutoffs are decreasing in the gains from offshoring that arise from the marginal cost advantage and the technological relevance of the inputs, for a given institutional differential (i.e. a given difference in the per-period fixed costs).

Formally, $\theta_m^{S,*}$ is smaller when $\psi(l_m^S, \boldsymbol{l'}) - \psi(l_m^N, \boldsymbol{l'})$ is higher. Equivalently, $\theta_m^{E,*}$ is lower for those inputs m for which $\psi(l_m^E, \boldsymbol{l'}) - \psi(l_m^N, \boldsymbol{l'})$ or $\psi(l_m^E, \boldsymbol{l'}) - \psi(l_m^S, \boldsymbol{l'})$ is larger, depending on which condition defines the input's offshoring productivity cutoff from East.

6.3.2 Import shares: extensive margin

The number of inputs sourced by a firm θ from each location is given by:

$$M^{N,*}(\theta) = \sum_{m=1}^{M} \mathbb{1}\{\theta < \theta_m^{S,*} \wedge \theta < \theta_m^{E,*}\}; \quad M^{S,*}(\theta) = \sum_{m=1}^{M} \mathbb{1}\{\theta_m^{S,*} \leq \theta < \theta_m^{E,*}\}; \quad M^{E,*}(\theta) = \sum_{m=1}^{M} \mathbb{1}\{\theta_m^{E,*} \leq \theta\}$$

The import shares (*input extensive margin*) from each country l of a firm θ, i.e. $\mu^l(\theta)$, are given by:

$$\frac{M^{N,*}(\theta)}{M} + \frac{M^{S,*}(\theta)}{M} + \frac{M^{E,*}(\theta)}{M} = 1 \quad \Rightarrow \quad \mu^{N,*}(\theta) + \mu^{S,*}(\theta) + \mu^{E,*}(\theta) = 1$$

An important results that can be easily derived from this expression is that the share of offshored intermediate inputs, i.e. $1 - \mu^{N,*}(\theta)$, is increasing in θ. In other words, the most productive firms in the market offshore a larger number of intermediate inputs.[58]

6.4 Uncertainty - Scenario 1: Institutional reform in East

The initial conditions correspond to the steady state of a world economy in which offshoring is only profitable from southern firms. Therefore, the final good producers can decide whether to source each input $m \in M$ from a domestic or southern supplier. In $t = 0$, an institutional reform takes place in the East.

[58] Integrating over the productivity distribution of active firms, we can obtain the average shares in the sector:

$$\bar{\mu}^{N,*} = \int_{\underline{\theta}^*}^{\bar{\bar{\theta}}} \mu^{N,*}(\theta) \frac{g(\theta)}{1 - G(\underline{\theta}^*)} d\theta; \quad \bar{\mu}^{S,*} = \int_{\underline{\theta}^*}^{\bar{\bar{\theta}}} \mu^{S,*}(\theta) \frac{g(\theta)}{1 - G(\underline{\theta}^*)} d\theta; \quad \bar{\mu}^{E,*} = \int_{\underline{\theta}^*}^{\bar{\bar{\theta}}} \mu^{E,*}(\theta) \frac{g(\theta)}{1 - G(\underline{\theta}^*)} d\theta$$

We show the case that refers to a small economy assumption, defined in section 6.4.1. It allows us to simplify the sectoral dynamics, keeping the focus on the sequentiality of the offshoring exploration in terms of firms' productivity and inputs' relevance. We do this simplification at the cost of shutting down the endogenous competition effect through the impact of the offshoring flow on the sectoral price index. We introduce some insights of the full sectoral general equilibrium case along this section and in Appendix H.5. However, a full description of the extension will be introduced in a future version.

6.4.1 Multiple northern countries: Small economy N assumption.

There are $\mathbb{N}$ countries in the North, with $N = 1, ..., \mathbb{N}$. We assume that the share of country N' firms in the world market is small[59]. Furthermore, we assume that the information spillovers in country N have no effect on firms' decisions from another country $N' \neq N$ and $N' \in \mathbb{N}$. Thence, the sectoral dynamic in N does not have an impact in the sectoral price index P and the aggregate consumption index Q.

6.4.2 Initial conditions:

We present a synthesis of the comparison of the initial conditions and the perfect information steady state under both cases.

- For small economy assumption: The absence of price index effects implies that the market productivity cutoff $\underline{\theta}$ is unaffected by the offshoring path. The analysis focuses exclusively in the movement of the offshoring cutoffs in East and South, i.e. in the underlying dynamics that explain the specialisation of countries under uncertainty.

$$\theta_m^{E,\text{initial}} \to \infty \quad \forall m \in M \quad ; \quad \theta_m^{S,\text{initial}} \leq \theta_m^{S,*}$$

- For general equilibrium analysis: The effects on the price index, due to the offshoring sequence, have a direct impact on the market productivity cutoff with welfare consequences. The analysis thus covers the convergence in:

$$\theta_m^{E,\text{initial}} \to \infty \quad \forall m \in M \quad ; \quad \theta_m^{S,\text{initial}} \leq \theta_m^{S,*} \quad ; \quad \underline{\theta}^{\text{initial}} < \underline{\theta}^{*}; P^{\text{initial}} > P^{*} \quad \text{and} \quad Q^{\text{initial}} < Q^{*}$$

6.4.3 Prior uncertainty and learning

In $t = 0$, after the reform takes place in the East, firms build an initial prior uncertainty about institutional conditions in that country. In general terms, the prior is defined as $f_m^E \sim Y(f_m^E)$ with $f_m^E \in [\underline{f}_m^E, \bar{f}_m^E]$. For simplicity, we assume that firms have a common prior across inputs:

$$f_m^E \sim Y(f_m^E) \text{ with } f_m^E \in [\underline{f}^E, \bar{f}^E]$$

The mechanism through which firms can learn about the fixed costs for an input m depends on the current offshoring status in the East of the respective firm. We characterise first the learning mechanism for those firms that have not explored their offshoring potential in the East for any intermediate input $m \in M$. We call this set of firms *Group I* or "*new entrants in East*". Then, we introduce the learning rule for the firms that have already explored their offshoring potential from the East in at least one intermediate input. As we show below, after the first exploration, firms are able to learn about the general institutional conditions in the country, and thence build a new prior about input-specific conditions for all the remaining unexplored intermediate inputs. We call these firms *Group II*.

[59]See Appendix H.2.1 for market share definition.

Learning of Group I: New entrants in East. The initial priors are updated through a Bayesian learning process by observing other firms' behaviour. The beliefs in period t of a firm in Group I are:

$$f_m^E \sim \begin{cases} Y(f_m^E) & \text{with } f_m^E \in [\underline{f}^E, \bar{f}^E] \text{ and } t = 0 \\ Y(f_m^E | f_m^E \leq f_{m,t}^E) & \text{if } \tilde{f}_{m,t}^E = f_{m,t}^E < f_{m,t-1}^E \text{ and } t > 0 \\ f_{m,t}^E & \text{if } \tilde{f}_{m,t}^E < f_{m,t}^E \text{ and } t > 0 \end{cases}$$

with the maximum affordable fixed cost, $f_{m,t}^E$, for the least productive firm offshoring m from East in t, $\theta_{m,t}^E$, defined as[60]:

$$f_{m,t}^E \equiv f_m^E(\theta_{m,t}^E) = \begin{cases} \frac{r_t(\theta; l_m^N, \boldsymbol{l_t'})}{w^N \sigma} \left[\left(\frac{c(l_m^N, \boldsymbol{l_t'})}{c(l_m^E, \boldsymbol{l_t'})} \right)^{(1-\eta)(\sigma-1)} - 1 \right] + f_m^N & \text{if } d_{m,t-1}^S(\theta_{m,t}^E) = 0 \\ \frac{r_t(\theta; l_m^N, \boldsymbol{l_t'})}{w^N \sigma} \left[\left(\frac{c(l_m^N, \boldsymbol{l_t'})}{c(l_m^E, \boldsymbol{l_t'})} \right)^{(1-\eta)(\sigma-1)} - \left(\frac{c(l_m^N, \boldsymbol{l_t'})}{c(l_m^S, \boldsymbol{l_t'})} \right)^{(1-\eta)(\sigma-1)} \right] + f_m^S & \text{if } d_{m,t-1}^S(\theta_{m,t}^E) = 1 \end{cases}$$

where $d_{m,t-1}^S(.)$ indicates the offshoring status from South in period $t-1$ in input m of the firm denoted in the argument of the function.

The firms in Group I cannot disentangle the components of f_m^E, i.e. f^E and ϵ_m^E, by observing other firms' behaviour. They can only update their overall beliefs in the inputs that are explored by other firms, but no information is released to them about the other intermediate input specific conditions nor about the general institutional framework in the East.

Learning of Group II: Already offshoring firms from East. These firms have already discovered the general institutional conditions in the East, i.e. f^E, when they explored the offshoring potential in East for the first time. After that first exploration, they remain uncertain about the input-specific institutional conditions for those inputs $m \in M$ that they have not explored. Therefore, they build new prior beliefs about the component ϵ_m^E for these inputs, that are given by:

$$\epsilon_m^E \sim Y(\epsilon_m^E) \quad \text{with } \epsilon_m^E \in [0, \bar{\epsilon}_m^E]$$

Therefore, considering a firm from Group II that has already discovered f^E and explored her offshoring potential in a set of intermediate inputs M_{t-1}^E, the beliefs in t for each input $m \notin M_{t-1}^E$ is:

$$f_m^E \sim Y(f_m^E) = \begin{cases} f^E + Y(\epsilon_m^E) & \text{with } \epsilon_m^E \in [0, \bar{\epsilon}_m^E] \\ f^E + Y(\epsilon_m^E | \epsilon_m^l \leq \epsilon_{m,t}^E) & \text{if } \tilde{\epsilon}_{m,t}^E = \epsilon_{m,t}^E < \epsilon_{m,t-1}^E \\ f^E + \epsilon_{m,t}^E & \text{if } \tilde{\epsilon}_{m,t}^E < \epsilon_{m,t}^E \end{cases}$$

with the upper bounds of the distribution, i.e. the maximum affordable fixed cost $f_{m,t}^E$ for the least productive firm offshoring m from E in t, defined as:

$$\begin{aligned} \pi_t^{\text{prem}}(\theta_{m,t}^E; l_m^{E/N}, \boldsymbol{l_t'}) \equiv & \pi_t(\theta; l_m^E, \boldsymbol{l_t'}) - \pi(\theta; l_m^N, \boldsymbol{l_t'}) = 0 \\ \Rightarrow f_{m,t}^E \equiv & f_m^E(\theta_{m,t}^E) = f^E + \epsilon_{m,t}^E = \frac{r_t(\theta; l_m^N, \boldsymbol{l_t'})}{w^N \sigma} \left[\left(\frac{c(l_m^N, \boldsymbol{l_t'})}{c(l_m^E, \boldsymbol{l_t'})} \right)^{(1-\eta)(\sigma-1)} - 1 \right] + f_m^N \end{aligned}$$

By comparing the beliefs between the two groups of unexplored intermediate inputs m, we observe that the upper bound of the distributions may differ. After at least one firm explores the offshoring potential in the input m, the upper bound of the distributions will converge to the same value in both groups. However, the distributions may still- and most likely will- differ between both groups due to the remaining differences in the lower bounds, given by $\underline{f}^E$ for Group I and f^E for Group II.

[60]See Appendix H.4 for details.

6.4.4 Firms' offshoring decision

The decision to explore the offshoring potential is fully separable[61] for each intermediate input m. Therefore, we can characterise the offshoring decision for one specific intermediate input m. After this, we define three types of intermediate inputs and the equilibrium paths of each of them.

Firms sourcing the input m from a domestic supplier or from the South must decide at any period t whether to explore the offshoring potential in East for that input or wait sourcing from the current location. This decision is defined by the maximum value between the value of offshoring in East and the value of waiting.

$$\mathcal{V}_{m,t}(\theta;\boldsymbol{\theta_t}) = \max\left\{V^{o,E}_{m,t}(\theta;\boldsymbol{\theta_t}); V^{w,E}_{m,t}(\theta;\boldsymbol{\theta_t})\right\}$$

with $\boldsymbol{\theta}_t$ indicating the state of the sector at the beginning of period t, and $\boldsymbol{\theta^l_t} = \{\theta^l_{1,t},...,\theta^l_{m,t},...,\theta^l_{M,t}\}$[62].

For a firm θ who has not yet explore the offshoring potential in input m from the East in a previous period, the value of offshoring input m from East in period t is given by:

$$V^{o,E}_{m,t}(\theta;\boldsymbol{\theta_t}) = \begin{cases} \mathbb{E}_t\left[\max\left\{0; \sum_{\tau=t}^{\infty}\lambda^{\tau-t}\pi^{\text{prem}}_{\tau}(\theta; l^{E/N}_m, \boldsymbol{l'_t})\right\}\middle|\mathcal{I}_t\right] - w^N s^{r,E}_m & \text{if } d^S_{m,t}(\theta)=0 \\ \mathbb{E}_t\left[\max\left\{0; \sum_{\tau=t}^{\infty}\lambda^{\tau-t}\pi^{\text{prem}}_{\tau}(\theta; l^{E/S}_m, \boldsymbol{l'_t})\right\}\middle|\mathcal{I}_t\right] - w^N s^{r,E}_m & \text{if } d^S_{m,t}(\theta)=1 \end{cases}$$

where $d^S_{m,t}(\theta)$ indicates the offshoring status from South in input m of the firm taking the decision, and $\mathcal{I}_t$ refers to the information set of this firm in t, which differs depending on the group the firm belongs to in t[63].

$$d^S_{m,t}(\theta) = \begin{cases} 0 & \text{if } \theta < \theta^S_{m,t} \\ 1 & \text{if } \theta \geq \theta^S_{m,t} \end{cases}$$

The value of waiting for the firm θ in t is $V^{w,E}_{m,t}(\theta;\boldsymbol{\theta_t}) = 0 + \lambda\mathbb{E}_t[\mathcal{V}_{m,t+1}(\theta;\boldsymbol{\theta_{t+1}})]$. Thus, the Bellman's equation takes the form:

$$\mathcal{V}_{m,t}(\theta;\boldsymbol{\theta_t}) = \max\left\{V^{o,E}_{m,t}(\theta;\boldsymbol{\theta_t}); \lambda\mathbb{E}_t\left[\mathcal{V}_{m,t+1}(\theta;\boldsymbol{\theta_{t+1}})\right]\right\}$$

Using the optimality of the OSLA rule as before, the Bellman's equation results in:

$$\mathcal{V}_{m,t}\left(\theta;\boldsymbol{\theta_t}, d^S_{m,t}(\theta)\right) = \max\left\{V^{o,E}_{m,t}\left(\theta;\boldsymbol{\theta_t}, d^S_{m,t}(\theta)\right); V^{w,1,E}_{m,t}\left(\theta;\boldsymbol{\theta_t}, d^S_{m,t}(\theta)\right)\right\} \tag{28}$$

Trade-off function for intermediate input m. By taking the difference between the first and second arguments of equation (28), we obtain the trade-off function $\mathcal{D}^E_{m,t}\left(\theta;\boldsymbol{\theta_t},\boldsymbol{\tilde{\theta}_{t+1}}, d^S_{m,t}(\theta)\right)$, which drives the offshoring exploration decision of firm θ in t for m:

$$\mathcal{D}^E_{m,t}(\theta;.) = \begin{cases} \max\left\{0;\mathbb{E}_t\left[\pi^{\text{prem}}_t(\theta; l^{E/N}_m, \boldsymbol{l'_t})\middle|\mathcal{I}_t\right]\right\} - w^N s^{r,E}_m\left[1-\lambda\frac{Y\left(f^E_{m,t+1}\right)}{Y\left(f^E_{m,t}\right)}\right] & \text{if } d^S_{m,t}(\theta)=0 \\ \max\left\{0;\mathbb{E}_t\left[\pi^{\text{prem}}_t(\theta; l^{E/S}_m, \boldsymbol{l'_t})\middle|\mathcal{I}_t\right]\right\} - w^N s^{r,E}_m\left[1-\lambda\frac{Y\left(f^E_{m,t+1}\right)}{Y\left(f^E_{m,t}\right)}\right] & \text{if } d^S_{m,t}(\theta)=1 \end{cases} \tag{29}$$

This trade off function holds the same properties as in the case of one intermediate input m.

Proposition 7 (Sequential offshoring in productivity)**.** *The firms with a higher productivity have an incentive to explore the offshoring potential in earlier periods for each input $m \in M$.*

$$\frac{\partial\mathcal{D}^E_{m,t}\left(\theta;\boldsymbol{\theta_t},\boldsymbol{\tilde{\theta}_{t+1}}\right)}{\partial\theta} \geq 0$$

[61] This property mainly comes from the specification of the offshoring sunk cost together with the small economy assumption.

[62] Given the full separability derived from the small economy assumption, we could replace the vector $\boldsymbol{\theta_t}$ by the state in the respective input $\theta_{m,t}$

[63] For the definition of groups I and II see section 6.4.3

6.4.5 Convergence analysis: small economy N

The main consequence of the small economy assumption[64] defined in section 6.4.1 is that the price index P and the aggregate consumption index Q are independent of the offshoring decisions of the firms in N. Therefore, we consider that P and Q are constant over time. The analysis is divided in three types of intermediate inputs, depending on the marginal cost ranking of each location with respect to each $m \in M$.

Type I inputs' set:= $\boldsymbol{\{m : m \in M; w^N < c^S_m; w^N < c^E_m\}}$. We denote this set of intermediate inputs as *non-tradables*. The trade frictions from $l = E, S$ for $m \in$ Type I are large enough, i.e. $\phi^l_m \to 0$, such that they turn over the advantages in terms of wages that the foreign locations presents with respect to N. Therefore, no firm finds it profitable to explore the offshoring potential from any foreign location $l = E, S$ in those inputs. In other words, we have:

$$\mathcal{D}^E_{m,t}\left(\bar{\bar{\theta}}; \boldsymbol{\theta_t}, \boldsymbol{\tilde{\theta}_{t+1}}\right) < 0 \quad \forall t$$

with $\bar{\bar{\theta}}$ as the most productive firm in N. Furthermore, no firm offshores either from South nor East any input $m \in$ Type I at any $t \geq 0$. Thence, the offshoring productivity cutoffs for inputs $m \in$ Type I remain at $\theta^l_m \infty$ $\forall t \geq 0$ with $l = E, S$, implying that all the firms in N source them domestically.

Type II inputs' set := $\boldsymbol{\{m : m \in M; (c^S_m < c^E_m < w^N) \vee (c^S_m < w^N \wedge c^E_m > w^N)\}}$. South shows a marginal cost advantage for the supply of the intermediate inputs $m \in$ Type II. Therefore, given assumption A.11, firms find offshoring appealing only from the South.

When the beliefs about eastern institutions are optimistic enough, some firms may find it profitable to explore their offshoring potential in that location. Nevertheless, they will find out immediately that it is not profitable for them to offshore from that country [65]. Formally, the exploration of the offshoring potential in East for Type II's inputs requires that the following condition holds for at least one firm θ:

$$\mathcal{D}^E_{m,t}\left(\theta; \boldsymbol{\theta_t}, \boldsymbol{\tilde{\theta}_{t+1}}\right) > 0 \quad \text{at a period } t \geq 0 \tag{30}$$

If such a situation takes place in any $t < \infty$, the true values f^E_m related to the explored intermediate inputs m are revealed in that period. In conclusion, no firm offshores from the East any $m \in$ Type II, i.e. $\theta^E_{m,t} \to \infty$, while the offshoring productivity cutoffs from South, $\theta^S_{m,t}$, remain constant at the initial levels, i.e. $\theta^S_{m,t} = \theta^S_{m,0}$ $\forall t$, with $\theta^S_{m,0} < \bar{\bar{\theta}}$ for some $m \in$ Type II.

Type III inputs' set := $\boldsymbol{\{m : m \in M; (c^E_m < c^S_m < w^N) \vee (c^E_m < w^N \wedge c^S_m > w^N)\}}$. East presents a marginal cost advantage with respect to both of the other locations for inputs $m \in$ Type III. However, under perfect information offshoring from East is only profitable for the most productive firms in N, given the relatively less appealing institutional fundamentals in the East. On the other hand, the least productive firms in N source domestically, while the middle productivity firms choose to offshore from the South instead. Only when the marginal cost advantage of the East is large enough to compensate the relatively worse institutions in this country with respect to South, i.e. $A_2 \geq 1$, firms will choose to offshore only from the East [66].

The emergence of the informational externalities that trigger the sequential offshoring equilibrium path towards the new steady state requires that Part 1 of assumption A.12 holds.

[64]This assumption also states that information externalities do not spread across northern countries. In other words, firms in country $N' \neq N$ do not observe the behaviour of firms in country N. Therefore, they cannot learn from other countries firms' behaviour.

[65]The ranking defined by assumption A.11 is unknown. Thus, some firms may have incentives to explore the offshoring potential in East for some $m \in$ Type II.

[66]For a full characterisation of the perfect information steady state of this set of inputs see section 6.3.

Assumption A. 12. *1. At least the most productive firm in N finds it profitable to explore her offshoring potential after the institutional reform in the East, in at least one intermediate input $m \in M$:*

$$\mathcal{D}^E_{m,t=0}\left(\bar{\bar{\theta}}; \boldsymbol{\theta_{t=0}}, \boldsymbol{\theta_{t=0}}\right) > 0 \textit{ for at least one } m \in M$$

2. After the first entrants learn general conditions f^E in $t=0$ and build their new prior about input-specific conditions in East[67]*, at least the most productive firm in N finds it profitable to explore in $t=1$ the offshoring potential in East in all $m \notin M_0^E$ and $m \in$ Type III.*

$$\mathcal{D}^E_{m,t=1}\left(\bar{\bar{\theta}}; \boldsymbol{\theta_{t=1}}, \boldsymbol{\tilde{\theta}_{t=2}}\right) > 0 \quad \forall m \in \textit{ Type III and } m \notin M_t^E$$

with $M_t^E(\theta)$ denoting the set of inputs explored up to t in East by firm θ, and M_t^E referring to the set of inputs m explored by at least one firm.

The assumption A.12-2 indicates the condition for all the inputs $m \in$ Type III being explored by at least one firm. This is a sufficient condition[68] for the convergence to the perfect information steady state[69].

Offshoring productivity cutoff from East for $m \in$ Type III in period t. The least productive firm exploring the offshoring potential in period t with respect to the input $m \in$ Type III, denoted as $\tilde{\theta}^E_{m,t+1}$, is defined by the fixed point:

$$\mathcal{D}^E_{m,t}\left(\tilde{\theta}^E_{m,t+1}; \boldsymbol{\theta}_t, \boldsymbol{\tilde{\theta}}_{t+1}\right) = 0$$

Thence, the offshoring productivity cutoff from East in input m in period t is given by:

$$\tilde{\theta}^E_{m,t+1} = \begin{cases} [(1-\gamma_0)E]^{\frac{\sigma}{1-\sigma}} Q \left[\frac{w^N\left[\mathbb{E}_t(f^E_m|\mathcal{I}_t) - f^N_m + s^{r,E}_m\left(1-\lambda\frac{Y\left(f^E_{m,t+1}\right)}{Y\left(f^E_{m,t}\right)}\right)\right]}{\psi\left(l^E_m, \boldsymbol{l'_t}\right) - \psi\left(l^N_m, \boldsymbol{l'_t}\right)}\right]^{\frac{1}{\sigma-1}} & \text{if } d^S_{m,t}(\tilde{\theta}^E_{m,t+1}) = 0 \\ [(1-\gamma_0)E]^{\frac{\sigma}{1-\sigma}} Q \left[\frac{w^N\left[\mathbb{E}_t(f^E_m|\mathcal{I}_t) - f^S_m + s^{r,E}_m\left(1-\lambda\frac{Y\left(f^E_{m,t+1}\right)}{Y\left(f^E_{m,t}\right)}\right)\right]}{\psi(l^E_m, \boldsymbol{l'}) - \psi(l^S_m, \boldsymbol{l'})}\right]^{\frac{1}{\sigma-1}} & \text{if } d^S_{m,t}(\tilde{\theta}^E_{m,t+1}) = 1 \end{cases} \tag{31}$$

with $\tilde{\theta}^E_{m,t+1} \to \infty$ for any period t in which the productivity cutoff is larger than $\bar{\bar{\theta}}$. By following an equivalent procedure as in the one intermediate input case[70], it is easy to show convergence $\theta^E_{m,t} \downarrow \theta^{E,*}_m$[71].

First entrants and exploration sequence in inputs. The first firms exploring the offshoring potential in the East are those with productivity $\theta \geq \tilde{\theta}^E_{m,t=1}$, as defined by the fixed points:

$$\mathcal{D}^E_{m,t=0}\left(\tilde{\theta}^E_{m,t=1}; \boldsymbol{\theta_{t=0}}, \boldsymbol{\tilde{\theta}_{t=1}}\right) = 0$$

[67] According to the learning mechanism defined for Group II.

[68] The necessary condition is that all the inputs with $\theta^{E,*}_m < \bar{\bar{\theta}}$ are explored.

[69] We define the convergence to the perfect information steady state disregarding the hysteresis effects as described in the North-South one intermediate input model. In other words, we call convergence to the perfect information steady state any of the four cases characterised in that version of the model.

[70] The main difference consists in the fact that the changes in Q as a result of the offshoring flows are not active.

[71] As already mentioned, with an abuse of notation we indicate the convergence point as the perfect information steady state, disregarding the effect of hysteresis due to sunk costs in the convergence point. Nevertheless, the cases identified in the one intermediate input case as convergence point are still valid under these circumstances.

The first inputs to be explored in the East are those $m \in$ Type III for which the assumption A.12-1 holds. From equation (31), we can easily observe that the offshoring productivity cutoff from East is decreasing in:

$$\begin{cases} \psi\left(l_m^E, \boldsymbol{l_t'}\right) - \psi\left(l_m^N, \boldsymbol{l_t'}\right) & \text{if } d_{m,t}^S(\tilde{\theta}_{m,t=1}^E) = 0 \\ \psi\left(l_m^E, \boldsymbol{l'}\right) - \psi\left(l_m^S, \boldsymbol{l'}\right) & \text{if } d_{m,t}^S(\tilde{\theta}_{m,t=1}^E) = 1 \end{cases}$$

In other words, given their beliefs about the eastern institutional conditions, firms explore the inputs that are more relevant in terms of the technology, ω_m, and with larger marginal cost advantages offered by the East with respect to their previous sourcing location.

The sequence in the exploration of intermediate inputs in the East is also led by the most productive firms in the market. These firms take the lead in entering the country as first explorers, but also leading the sequential exploration of inputs in that location. In general terms, the inputs offshored for the first time from the East in t are those inputs $m \notin M_{t-1}^E$ for which the following condition holds for at least the most productive firm in the market:

$$\mathcal{D}_{m,t}^E\left(\theta; \boldsymbol{\theta_t}, \boldsymbol{\tilde{\theta}_{t+1}}\right) \geq 0 \quad \text{for at least } \bar{\bar{\theta}} \tag{32}$$

Back to the intuition of the exploration after the first period. The condition defined by (32) with respect to the inputs $m \notin M_0^E(\theta)$ holds only for a subset of the firms that already explored offshoring from the East in $t = 0$, i.e. for a subset of $\theta \geq \tilde{\theta}_{m,t=1}^E$. The firms in N that did not find it profitable to explore their offshoring potential in $t = 0$ in any input $m \in M$, i.e. those with productivity $\theta < \tilde{\theta}_{m,t=1}^E$ $\forall m \in M_0^E$, have the same prior beliefs about any input $m \notin M_0^E$ in $t = 1$ [72]. Therefore, they still do not find it profitable to explore the offshoring potential in any input $m \notin M_0^E$ in $t = 1$. They will instead explore their offshoring potential in the inputs for which they have obtained new information, i.e. those explored by the first entrants in $t = 0$, $m \in M_0^E$. The same intuition applies for any other period t.

Proposition 8 (Offshoring sequentiality in inputs)**.** *Firms explore sequentially the intermediate inputs $m \in$ Type III, starting from those with larger values in $\psi(l_m^E, \boldsymbol{l'}) - \psi(l_m^S, \boldsymbol{l'})$ or $\psi(l_m^E, \boldsymbol{l'}) - \psi(l_m^N, \boldsymbol{l'})$, depending on their previous sourcing location, and given a set of initial prior beliefs.*

6.5 Uncertainty - Scenario 2: Simultaneous institutional reforms in East and South

We consider now a situation in which firms can initially source the intermediate inputs only domestically. In $t = 0$ an institutional reform is introduced simultaneously in the East and South. However, northern firms do not fully believe in the true scope of these reforms, and thus a prior uncertainty emerge about the institutional conditions in each of these foreign countries.

The Scenario 1 introduced in 6.4 allowed us to analyse the sequential offshoring dynamics in productivity and inputs, and characterise the convergence to the perfect information steady state. Instead, the Scenario 2 moves the model towards the multiple equilibria that emerge when firms face uncertainty about institutional conditions in several countries. In such a context, we study the path dependence of the countries sectoral specialisation, and the role of the informational spillovers as drivers of the sourcing decisions.

As before, we analyse first the scenario under the small economy assumption. The consideration of the sectoral general equilibrium effects remains for future a version of the model.

6.5.1 Initial conditions

The initial conditions are defined by the steady state of a world economy with non-tradable intermediate inputs, i.e. $n.t.i.$. In other words, all the firms are sourcing domestically the intermediate inputs $m = 1, ..., M$.

[72]Their beliefs about f_m^E for inputs $m \notin M_0^E$ did not change from the initial prior because no informational externalities have emerged with respect to those inputs.

- For small economy assumption: the analysis focuses exclusively in the movement of the offshoring productivity cutoffs in South and East.

$$\theta_m^{l,n.t.i.} \to \infty \quad \forall m \in M \quad ; \quad l = E, S$$

- For general equilibrium:

$$\theta_m^{l,n.t.i.} \to \infty \quad \forall m \in M; \quad l = E, S \quad ; \quad \underline{\theta}^{n.t.i.} < \underline{\theta}^* \quad ; \quad P^{n.t.i.} > P^* \quad \text{and} \quad Q^{n.t.i.} < Q^*$$

6.5.2 Prior uncertainty and learning

As before, we assume that the initial priors are defined over the same range for every intermediate input m for each location l. Therefore, the initial prior beliefs about institutional conditions in l for every intermediate input m are given by[73]

$$f_m^l \sim Y(f_m^l) \quad \text{with } f_m^l \in [\underline{f}^l, \bar{f}^l] \quad l = E, S$$

The beliefs and learning mechanism about location l differs depending on the offshoring status of the firm in location l. We characterise first the firms that have not explored in previous periods the offshoring potential from the location l for any intermediate input $m \in M$. We call these firms *"Group I"* or *"new entrants in country l"*. The group is fully integrated by domestic sourcing firms, and firms that may be already offshoring inputs from a different foreign location.

Then, we introduce the case of those firms that have already explored the offshoring potential from country l in at least one intermediate input. After the first exploration, these firms learned the general institutional conditions in that country, f^l, and remain with uncertainty regarding the input-specific component, ϵ_m^l. We call these firms *"Group II"*.

Learning of new entrants in country l (Group I). The beliefs in period t of a firm that has not explored the offshoring potential up to that moment in any intermediate input $m \in M$ from country l is:

$$f_m^l \sim \begin{cases} Y(f_m^l) & \text{with } f_m^l \in [\underline{f}^l, \bar{f}^l] \text{ and } t = 0 \\ Y(f_m^l | f_m^l \leq f_{m,t}^l) & \text{if } \tilde{f}_{m,t}^l = f_{m,t}^l < f_{m,t-1}^l \text{ and } t > 0 \\ f_{m,t}^l & \text{if } \tilde{f}_{m,t}^l < f_{m,t}^l \text{ and } t > 0 \end{cases}$$

The maximum affordable fixed costs for the least productive firms offshoring m from $l = E, S$ in t, $f_{m,t}^E$ and $f_{m,t}^S$, are defined as:

$$\begin{aligned} \pi_t^{\text{prem}}(\theta_{m,t}^E; l_m^{E/N}, \boldsymbol{l_t'}) \equiv& \pi_t(\theta; l_m^E, \boldsymbol{l_t'}) - \pi(\theta; l_m^N, \boldsymbol{l_t'}) = 0 \\ \Rightarrow f_{m,t}^E \equiv& f_m^E(\theta_{m,t}^E) = \frac{r_t(\theta; l_m^N, \boldsymbol{l_t'})}{w^N \sigma} \left[\left(\frac{c(l_m^N, \boldsymbol{l_t'})}{c(l_m^E, \boldsymbol{l_t'})} \right)^{(1-\eta)(\sigma-1)} - 1 \right] + f_m^N \\ \pi_t^{\text{prem}}(\theta_{m,t}^S; l_m^{S/N}, \boldsymbol{l_t'}) \equiv& \pi_t(\theta; l_m^S, \boldsymbol{l_t'}) - \pi_t(\theta; l_m^N, \boldsymbol{l_t'}) = 0 \\ \Rightarrow f_{m,t}^S \equiv& f_m^S(\theta_{m,t}^S) = \frac{r_t(\theta; l_m^N, \boldsymbol{l_t'})}{w^N \sigma} \left[\left(\frac{c(l_m^N, \boldsymbol{l_t'})}{c(l_m^S, \boldsymbol{l_t'})} \right)^{(1-\eta)(\sigma-1)} - 1 \right] + f_m^N \end{aligned}$$

with $\theta_{m,t}^E$ and $\theta_{m,t}^S$ denoting the productivities of the least productive firms offshoring m from East and South, respectively, at the beginning of period t.

Directly from the learning mechanism, we can observe that the firms in Group I are not able to disentangle the components of f_m^l, i.e. f^l and ϵ_m^l, by observing other firms' behaviour. They can only update the overall beliefs in those inputs explored by other firms in location l.

[73] In general terms, it is given by: $f_m^l \sim Y(f_m^l)$ with $f_m^l \in [\underline{f}_m^l, \bar{f}_m^l]$ and $l = E, S$.

Learning of already offshoring firms from l (Group II). This group includes the firms that have already discovered the general institutional conditions in country l, i.e. f^l, when they explored the offshoring potential in l for the first time. After that period, each firm in Group II remains uncertain about the input-specific component, ϵ^l_m, for every intermediate input m that she has not explored yet the offshoring potential in l.

Following the first time exploration of l, the firm builds a prior uncertainty about the input-specific institutional conditions. In other words, learning about the general institutions in l allows the firms to build new priors about all the remaining non-explored inputs from that location l. Therefore, the new priors with respect to l are thus given by:

$$\epsilon^l_m \sim Y(\epsilon^l_m) \quad \text{with } \epsilon^l_m \in [0, \bar{\epsilon}^l_m]$$

We define $M^l_{t-1}(\theta)$ as the set of intermediate inputs explored by firm θ in l at the beginning of period t. The beliefs in t about the location l for each input $m \notin M^l_{t-1}$ is:

$$f^l_m \sim Y(f^l_m) = \begin{cases} f^l + Y(\epsilon^l_m) & \text{with } \epsilon^l_m \in [0, \bar{\epsilon}^l_m] \\ f^l + Y(\epsilon^l_m | \epsilon^l_m \leq \epsilon^l_{m,t}) & \text{if } \tilde{\epsilon}^l_{m,t} = \epsilon^l_{m,t} < \epsilon^l_{m,t-1} \\ f^l + \epsilon^l_{m,t} & \text{if } \tilde{\epsilon}^l_{m,t} < \epsilon^l_{m,t} \end{cases}$$

with the upper bounds of the distributions, i.e. the maximum affordable fixed costs for the least productive firms offshoring m from $l = E, S$ in t, $f^E_{m,t}$ and $f^S_{m,t}$, defined as:

$$\begin{aligned} \pi^{\text{prem}}_t(\theta^E_{m,t}; l^{E/N}_m, \boldsymbol{l'_t}) \equiv& \pi_t(\theta; l^E_m, \boldsymbol{l'_t}) - \pi(\theta; l^N_m, \boldsymbol{l'_t}) = 0 \\ \Rightarrow f^E_{m,t} \equiv& f^E_m(\theta^E_{m,t}) = f^E + \epsilon^E_{m,t} = \frac{r_t(\theta; l^N_m, \boldsymbol{l'_t})}{w^N \sigma} \left[\left(\frac{c(l^N_m, \boldsymbol{l'_t})}{c(l^E_m, \boldsymbol{l'_t})} \right)^{(1-\eta)(\sigma-1)} - 1 \right] + f^N_m \\ \pi^{\text{prem}}_t(\theta^S_{m,t}; l^{S/N}_m, \boldsymbol{l'_t}) \equiv& \pi_t(\theta; l^S_m, \boldsymbol{l'_t}) - \pi_t(\theta; l^N_m, \boldsymbol{l'_t}) = 0 \\ \Rightarrow f^S_{m,t} \equiv& f^S_m(\theta^S_{m,t}) = f^S + \epsilon^S_{m,t} = \frac{r_t(\theta; l^N_m, \boldsymbol{l'_t})}{w^N \sigma} \left[\left(\frac{c(l^N_m, \boldsymbol{l'_t})}{c(l^S_m, \boldsymbol{l'_t})} \right)^{(1-\eta)(\sigma-1)} - 1 \right] + f^N_m \end{aligned}$$

As in section 6.4, the upper bound of the fixed cost f^l_m for an input m may differ between the two groups. After at least one firm explores the offshoring potential in the input m from l, the upper bound of the prior uncertainty converges to the same value for both groups. However, as before, the prior distribution may -and usually will- differ between both groups due to the difference in the lower bound of the distribution. A second and new feature is that a firm may belong to the first group with respect to one country while to the second group in relation to the other. This is the case when a firm has explored already the offshoring potential from the first location but not yet from the second one.

6.5.3 Firms' offshoring decision

We begin by characterising the offshoring decision for one intermediate input m in period t for the firms in either of the groups defined above. We consider first the case of firms that are still sourcing the intermediate input m domestically.[74]

At any period t, firms sourcing m domestically decide whether to explore their offshoring potential in one location l or wait. They have two potential locations to explore: *South* or *East*. Therefore, the decision in period t of any firm θ in such a situation takes the following form:

$$\begin{aligned} \mathcal{V}_{m,t}(\theta; \boldsymbol{\theta_t}) &= \max \left\{ V^{o,S}_{m,t}(\theta; \boldsymbol{\theta_t}); V^{o,E}_{m,t}(\theta; \boldsymbol{\theta_t}); V^w_{m,t}(\theta; \boldsymbol{\theta_t}) \right\} \\ &= \max \left\{ \max \left\{ V^{o,S}_{m,t}(\theta; \boldsymbol{\theta_t}); V^{o,E}_{m,t}(\theta; \boldsymbol{\theta_t}) \right\}; V^w_{m,t}(\theta; \boldsymbol{\theta_t}) \right\} \end{aligned} \tag{33}$$

where $\boldsymbol{\theta_t} = \{\boldsymbol{\theta^S_t}, \boldsymbol{\theta^E_t}\}$ and $\boldsymbol{\theta^l_t} = \left\{\theta^l_{1,t}, ..., \theta^l_{m,t}, ..., \theta^l_{M,t}\right\}$.

[74] In section 6.5.4, we show the relocation decisions from one foreign location to another that may take place in the equilibrium paths.

Value of offshoring and value of waiting. The value of exploring offshoring from a location $l = S, E$ in period t is given by:

$$V^{o,S}_{m,t}(\theta;\boldsymbol{\theta_t}) = \mathbb{E}_t\left[\max\left\{0;\sum_{\tau=t}^{\infty}\lambda^{\tau-t}\pi^{S,\text{prem}}_{\tau}(\theta;l^{S/N}_{m},\boldsymbol{l'_t})\right\}\middle|\mathcal{I}_t\right] - w^N s^{r,S}_m$$
$$V^{o,E}_{m,t}(\theta;\boldsymbol{\theta_t}) = \mathbb{E}_t\left[\max\left\{0;\sum_{\tau=t}^{\infty}\lambda^{\tau-t}\pi^{E,\text{prem}}_{\tau}(\theta;l^{E/N}_{m},\boldsymbol{l'_t})\right\}\middle|\mathcal{I}_t\right] - w^N s^{r,E}_m$$

with $\mathcal{I}_t = \left\{Y(f^S_m|f^S_m \leq f^S_{m,t}), Y(f^E_m|f^E_m \leq f^E_{m,t})\right\}$ denoting the information set the firm possesses in t.

The value of waiting with respect to a location l for firm θ in t is $V^{w}_{m,t}(\theta;\boldsymbol{\theta_t}) = 0 + \lambda\mathbb{E}_t[\mathcal{V}_{m,t+1}(\theta;\boldsymbol{\theta_{t+1}})]$. Thus, the Bellman's equation is given by:

$$\mathcal{V}_{m,t}(\theta;\boldsymbol{\theta_t}) = \max\left\{\max\left\{V^{o,S}_{m,t}(\theta;\boldsymbol{\theta_t}); V^{o,E}_{m,t}(\theta;\boldsymbol{\theta_t})\right\};\lambda\mathbb{E}_t[\mathcal{V}_{m,t+1}(\theta;\boldsymbol{\theta_{t+1}})]\right\}$$

Let's assume $V^{o,\dot{l}}_{m,t}(\theta;.)$ is the solution to $\max\left\{V^{o,S}_{m,t}(\theta;); V^{o,E}_{m,t}(\theta;.)\right\}$, with $\dot{l} = \{E \veebar S\}$ indicating the chosen location in t for this intermediate input m. The Bellman's equation becomes:

$$\mathcal{V}_{m,t}(\theta;\boldsymbol{\theta_t}) = \max\left\{V^{o,\dot{l}}_{m,t}(\theta;.);\lambda\mathbb{E}_t[\mathcal{V}_{m,t+1}(\theta;\boldsymbol{\theta_{t+1}})]\right\}$$

and using the optimality of the OSLA rule, we get that the firm θ decision in t is thus given by:

$$\mathcal{V}_{m,t}(\theta;\boldsymbol{\theta_t}) = \max\left\{V^{o,\dot{l}}_{m,t}(\theta;\boldsymbol{\theta_t}); V^{w,1,\dot{l}}_{m,t}(\theta;\boldsymbol{\theta_t})\right\}$$

with $V^{o,\dot{l}}_{m,t}(\theta;.)$ as the value of exploring offshoring in country $l = \dot{l}$ in period t for firm θ, and $V^{w,1,\dot{l}}_{m,t}(\theta;.)$ as the value of waiting one period and offshoring from country $l = \dot{l}$ in the next period.

Trade-off function. From the last expression, it is possible to derive the following trade-off function for the firm θ in t regarding the intermediate input m:

$$\begin{aligned}\mathcal{D}^{\dot{l}}_{m,t}\left(\theta;\boldsymbol{\theta_t},\boldsymbol{\tilde{\theta}_{t+1}}\right) &= V^{o,\dot{l}}_{m,t}\left(\theta;\boldsymbol{\theta_t},\boldsymbol{\tilde{\theta}_{t+1}}\right) - V^{w,1,\dot{l}}_{m,t}\left(\theta;\boldsymbol{\theta_t},\boldsymbol{\tilde{\theta}_{t+1}}\right)\\ &= \max\left\{0;\mathbb{E}_t\left[\pi^{\text{prem}}_t(\theta;l^{\dot{l}/N}_m,\boldsymbol{l'_t})\middle|\mathcal{I}_t\right]\right\} - w^N s^{r,\dot{l}}_m\left[1-\lambda\frac{Y\left(f^{\dot{l}}_{m,t+1}\right)}{Y\left(f^{\dot{l}}_{m,t}\right)}\right]\end{aligned}$$

This process can be thought as a two-stage decision. First the firm chooses the preferred location (in expectation at t), and in a second step she decides on the timing: explore or wait. The firm faces an equivalent trade-off function for each intermediate input m.

This trade off function holds the same properties as in the case of one intermediate input m.

Proposition 9 (Sequential offshoring in productivity)**.** *The firms with a higher productivity have an incentive to explore the offshoring potential in earlier periods for each input $m \in M$.*

$$\frac{\partial\mathcal{D}^{\dot{l}}_{m,t}\left(\theta;\boldsymbol{\theta_t},\boldsymbol{\tilde{\theta}_{t+1}}\right)}{\partial\theta} \geq 0$$

For simplicity, we assume that the offshoring sunk cost for a given input m is the same across countries, i.e.

Assumption A. 13. *The market research sunk cost are homogeneous across locations: $s^{r,E}_m = s^{r,S}_m = s^r_m$ for every $m \in M$.*

In general terms, the condition for the offshoring productivity cutoff in period t for the input m, i.e. $\tilde{\theta}^{l}_{m,t+1}$, is defined by the fixed point:

$$\mathcal{D}^{l}_{m,t}\left(\tilde{\theta}^{l}_{m,t+1};\boldsymbol{\theta_t},\boldsymbol{\tilde{\theta}_{t+1}}\right)=0$$

Solving this for the productivity cutoff $\tilde{\theta}^{l}_{m,t+1}$, we get:

$$\tilde{\theta}^{l}_{m,t+1}=[(1-\gamma_0)E]^{\frac{\sigma}{1-\sigma}}\tilde{Q}_{t+1}\left[\frac{w^N\left[\mathbb{E}_t(f^l_m|\mathcal{I}_t)-f^N_m+s^r_m\left(1-\lambda\frac{Y(f^l_{t+1})}{Y(f^l_t)}\right)\right]}{\psi(l^l_m,\boldsymbol{l'_t})-\psi(l^N_m,\boldsymbol{l'_t})}\right]^{\frac{1}{\sigma-1}}$$

From this expression, it is easy to see that given the prior beliefs, firms explore first their offshoring potential in the intermediate inputs for which $\psi(l^l_m,\boldsymbol{l'_t})-\psi(l^N_m,\boldsymbol{l'_t})$ is larger.

Proposition 10 (Sequential offshoring exploration in inputs)**.** *Given a set of beliefs, firms find profitable to explore first the intermediate inputs with a larger value in* $\psi(l^l_m,\boldsymbol{l'_t})-\psi(l^N_m,\boldsymbol{l'_t})$.

The assumption A.14 defines a necessary condition such that informational externalities emerge and push the sector to a new steady state.

Assumption A. 14. *At least the most productive firm in the market finds it profitable to explore in* $t=0$ *the offshoring potential in at least one intermediate input* $m\in M$ *from at least one location* l.

$$\mathcal{D}^{l}_{m,t=0}\left(\bar{\bar{\theta}};\boldsymbol{\theta_{t=0}},\boldsymbol{\theta_{t=0}}\right)>0\quad \textit{for at least one } m\in M \textit{ and } l=E\vee S$$

6.5.4 Convergence analysis: Multiple equilibria. Small economy N

Given the small economy assumption, the offshoring equilibrium path of the firms in country N has no effect on the sectoral price index P. Therefore, we assume that P and Q are constant over time.

The model results in a multiple equilibria situation, where the steady state depends on the priors and the differences in institutional fundamentals and marginal costs across countries. In order to illustrate the underlying dynamics, we characterise the equilibrium paths for the case in which initial prior beliefs are asymmetric and significantly in favour of eastern institutions[75].

The initial prior uncertainty for each intermediate input $m\in M$ with respect to each foreign location is given by:

$$f^l_m\sim Y(f^l_m)\quad\text{with } f^l_m\in[\underline{f}^l,\bar{f}^l]\quad;\quad l=E,S$$

For simplicity, we assume that the asymmetry in initial prior beliefs is defined by differences in the upper bound of the prior distributions, i.e. $\bar{f}^S>\bar{f}^E$ and $\underline{f}^S=\underline{f}^E$.

As before, the analysis is divided in the three types of intermediate inputs m.

Type I input's set $:=\left\{\boldsymbol{m:m\in M;w^N<c^S_m;w^N<c^E_m}\right\}$**.** This set represents the *non-tradable* intermediate inputs. The trade frictions, represented by ϕ^l_m for $l=E,S$, overcome the wage advantages of East and South with respect to the country N. Therefore, no firm finds it profitable to explore the offshoring potential in inputs $m\in$ Type I at any period $t\geq 0$. This is represented by:

$$\mathcal{D}^{l}_{m,t}\left(\bar{\bar{\theta}};\boldsymbol{\theta_t},\boldsymbol{\theta_{t+1}}\right)<0\quad\text{with } l=E,S$$

[75] Empirically, it is possible to think of this bias in the beliefs as the result of differences in cultural or historical relationships between North and each of these foreign countries.

with $\bar{\bar{\theta}}$ denoting the most productive firm in the market.[76] Thence, the offshoring productivity cutoffs for inputs $m \in$ Type I remain at $\theta^l_{m,t} \to \infty \forall t$ with $l = E, S$. In other words, all the firms in N source these inputs domestically.

Type II inputs' set $:= \boldsymbol{\{m : m \in M; (c^S_m < c^E_m < w^N) \vee (c^S_m < w^N \wedge c^E_m > w^N)\}}$**.** The marginal costs advantages of the South produce an incentive in this set of inputs that pushes the most productive firms in N to explore offshoring in the South. However, given the disadvantage of South in terms of institutional beliefs, we may have that no firm finds it profitable to explore offshoring in that location.

The exploration of South starts in $t = 0$ if, at least for the most productive firm in N, we have that both conditions below hold simultaneously:

$$\begin{aligned} V^{o,S}_{m,t=0}(\bar{\bar{\theta}}; \boldsymbol{\theta_{t=0}}) > V^{o,E}_{m,t=0}(\bar{\bar{\theta}}; \boldsymbol{\theta_{t=0}}) \\ \mathcal{D}^S_{m,t=0}\left(\bar{\bar{\theta}}; \boldsymbol{\theta_{t=0}}, \boldsymbol{\theta_{t=0}}\right) > 0 \quad \text{for at least one } m \in M \end{aligned} \tag{34}$$

For simplicity, we assume that the prior beliefs with respect to the South are bad enough such that even the most productive firm in N does not have incentives to explore the offshoring potential in South in any intermediate input[77], i.e.

Assumption A. 15. $\mathcal{D}^S_{m,t=0}\left(\bar{\bar{\theta}}; \boldsymbol{\theta_{t=0}}, \boldsymbol{\theta_{t=0}}\right) < 0 \; \forall m \in M.$

The exploration in South may still take place starting at a later period $t > 0$, if the condition defined by equation (37) holds. Let's define t^S as the moment in which firms explore offshoring potential in the South for the first time. Assuming that $t^S < \infty$[78], we characterise the offshoring productivity cutoff in input $m \in$ Type II in a period $t \geq t^S$.

Offshoring productivity cutoff from South for $m \in$ **Type II in period** t**.** The offshoring productivity cutoffs at the end of each period t for each input $m \in$ Type II are defined by the fixed points:

$$\mathcal{D}^S_{m,t}\left(\tilde{\theta}^S_{m,t+1}; \boldsymbol{\theta}_t, \tilde{\boldsymbol{\theta}}_{t+1}\right) = 0$$

$$\Rightarrow \begin{cases} \mathbb{E}_t\left[\pi^{\text{prem}}_t\left(\tilde{\theta}^S_{m,t+1}, l^{S/N}_m, \boldsymbol{l'_t}\right) \Big| \mathcal{I}_t\right] = w^N s^r_m \left[1 - \lambda \frac{Y(f^S_{t+1})}{Y(f^S_t)}\right] & \text{if } d^E_{m,t}(\tilde{\theta}^S_{m,t+1}) = 0 \\ \mathbb{E}_t\left[\pi^{\text{prem}}_t\left(\tilde{\theta}^S_{m,t+1}, l^{S/E}_m, \boldsymbol{l'_t}\right) \Big| \mathcal{I}_t\right] = w^N s^r_m \left[1 - \lambda \frac{Y(f^S_{t+1})}{Y(f^S_t)}\right] & \text{if } d^E_{m,t}(\tilde{\theta}^S_{m,t+1}) = 1 \end{cases}$$

Solving for the respective offshoring productivity cutoffs from South in input m in period t:

$$\tilde{\theta}^S_{m,t+1} = \begin{cases} [(1-\gamma_0)E]^{\frac{\sigma}{1-\sigma}} Q \left[\frac{w^N\left[\mathbb{E}_t(f^S_m|\mathcal{I}_t) - f^N_m + s^r_m\left(1 - \lambda\frac{Y(f^S_{t+1})}{Y(f^S_t)}\right)\right]}{\psi(l^S_m, \boldsymbol{l'_t}) - \psi(l^N_m, \boldsymbol{l'_t})}\right]^{\frac{1}{\sigma-1}} & \text{if } d^E_{m,t}(\tilde{\theta}^S_{m,t+1}) = 0 \\ [(1-\gamma_0)E]^{\frac{\sigma}{1-\sigma}} Q \left[\frac{w^N\left[\mathbb{E}_t(f^S_m|\mathcal{I}_t) - f^E_m + s^r_m\left(1 - \lambda\frac{Y(f^S_{t+1})}{Y(f^S_t)}\right)\right]}{\psi(l^S_m, \boldsymbol{l'_t}) - \psi(l^E_m, \boldsymbol{l'_t})}\right]^{\frac{1}{\sigma-1}} & \text{if } d^E_{m,t}(\tilde{\theta}^S_{m,t+1}) = 1 \end{cases} \tag{35}$$

[76] The underlying assumption is that firms know with certainty that the offshoring fixed costs from any location l cannot be smaller than the respective fixed costs of domestic sourcing, i.e. $f^l_m \geq f^N_m$ for $l = E, S$. Relaxing this assumption may lead to firms exploring the offshoring potential at some period t in these inputs, to immediately discover that it is not profitable for any firm to offshore these inputs $m \in$ Type I.

[77] As mentioned at the beginning, we do not aim to do a full taxonomy of all the multiple equilibria and the different equilibrium paths that drive to each of them. Thus, additionally to the asymmetric initial beliefs, the assumption A.15 reduces the number of paths to be considered. However, this simplification does not rule out the relocation decisions and the multiple equilibria as a function of the initial priors, with the respective consequences in terms of production allocation across countries (i.e. sectoral specialisation) and welfare.

[78] If the condition for exploration of the South defined by equation (37) does not hold, i.e. $t^S \to \infty$, no firm explores the offshoring potential in South at any period $t \geq 0$ in any input $m \in M$. Comparing with the perfect information steady state, this would lead to underoffshoring in all inputs $m \in$ Type II and in a subset of inputs $m \in$ Type III, and therefore to a non-optimal allocation of production across countries (non-optimal specialisation).

with $\tilde{\theta}^S_{m,t+1} \rightarrow \infty$ for any period t in which the productivity cutoff is larger than $\bar{\bar{\theta}}$.

Firms will explore South for the first time in those inputs for which the condition defined by equation (37) holds. After exploring their offshoring potential in those intermediate inputs, those firms are able to update their beliefs about the other intermediate inputs $m \in M$ from South, according to the learning mechanism of *Group II* described in section 6.5.2. At the same time, all the other firms in the market update their beliefs about South in those inputs explored by the first entrants in t^S, according to the respective learning procedure of *Group I*.

Necessary and sufficient condition for convergence to $\theta^{S,*}_m$ $\forall m \in$ Type II. After the discover of the general institutional environment f^S, at least one of the first entrants in S finds it profitable in t^S+1 to explore the offshoring potential in South in at least one input $m \in$ Type II, and finds it profitable to source them from that location. This reveals to all the firms with a higher productivity that offshoring input m from South is profitable for them with certainty, and thus they will explore the offshoring potential in South in t^S+2. After this exploration, they learn f^S and build new beliefs about input-specific conditions for every $m \in M$ in the South, according to the *Group II* mechanism.

If in $t+3$ we have that at least the most productive firm $\bar{\bar{\theta}}$ finds it profitable to explore the offshoring potential in South in every $m \in$ Type II for which $\theta^{S,*}_m < \bar{\bar{\theta}}$, i.e.

$$\mathcal{D}^S_{m,t=t^S+3}\left(\bar{\bar{\theta}}; \boldsymbol{\theta_{t=t^S+3}}, \boldsymbol{\tilde{\theta}_{t=t^S+4}}\right) > 0 \quad \forall m \in \text{ Type II } : \theta^{S,*}_m < \bar{\bar{\theta}} \tag{36}$$

The last part of this condition states that some firms must explore offshoring in intermediate input $m \in$ Type II for which there is offshoring from South under perfect information, such that the informational externalities about those inputs in S emerge, and thus the equilibrium path in the respective offshoring productivity cutoffs.

Type III inputs' set $:= \left\{\boldsymbol{m : m \in M; (c^E_m < c^S_m < w^N) \vee (c^E_m < w^N \wedge c^S_m > w^N)}\right\}$**.** The marginal costs advantages in the East, together with the initially favourable prior beliefs, lead the initial offshoring exploration towards this location for this set of inputs[79].

Under the conditions defined in this scenario, the assumption A.14 holds for exploration in East. In other words, we assume that at least the most productive firm in N finds it profitable to explore the offshoring potential in East in the initial period in at least one $m \in M$.

Offshoring productivity cutoff from East for $m \in$ Type III in period t. The offshoring productivity cutoff at the end t for each input $m \in$ Type III are defined by the fixed points:

$$\mathcal{D}^E_{m,t}\left(\theta^E_{m,t+1}; \boldsymbol{\theta}_t, \boldsymbol{\tilde{\theta}}_{t+1}\right) = 0 \quad \Rightarrow \quad \mathbb{E}_t\left[\pi^{\text{prem}}_t\left(\tilde{\theta}^E_{m,t+1}, l^{E/N}_m, \boldsymbol{l'_t}\right)\Big|\mathcal{I}_t\right] = w^N s^r_m\left[1 - \lambda\frac{Y(f^E_{t+1})}{Y(f^E_t)}\right]$$

Solving for the offshoring productivity cutoff from East in input m in period t:

$$\tilde{\theta}^E_{m,t+1} = [(1-\gamma_0)E]^{\frac{\sigma}{1-\sigma}} Q\left[\frac{w^N\left[\mathbb{E}_t(f^E_m|\mathcal{I}_t) - f^N_m + s^r_m\left(1 - \lambda\frac{Y(f^E_{t+1})}{Y(f^E_t)}\right)\right]}{\psi(l^E_m, \boldsymbol{l'_t}) - \psi(l^N_m, \boldsymbol{l'_t})}\right]^{\frac{1}{\sigma-1}}$$

First entrants and exploration sequence in inputs from East. Consistent with Proposition 10, firms explore initially those intermediate inputs $m \in$ Type III for which $\psi(l^E_m, \boldsymbol{l'_t}) - \psi(l^N_m, \boldsymbol{l'_t})$ is larger.

[79] Recall that under perfect information, the bad institutional conditions in East relative to the South implies that the middle productivity firms offshore from South. Only the most productive firms find East profitable as sourcing location. Only when the marginal cost advantage in East is large enough to compensate the higher fixed costs, i.e. $A_2 \geq 1$, firms will offshore only in East. For a full characterisation of the perfect information equilibrium see section 6.3

Necessary and sufficient condition for convergence to $\theta_m^{E,*}$ $\forall m \in$ Type III. For convergence in the offshoring productivity cutoffs to be triggered in each input $m \in$ Type III, the informational externalities must emerge with respect to each of them in East. This implies that at some period t at least the most productive firm must explore the offshoring potential in East for every input $m \in$ Type III for which $\theta_m^{E,*} < \bar{\bar{\theta}}$. Given the learning mechanisms for Group I and Group II, this condition may hold in $t = 0$, i.e. the most productive firm explores all these inputs in the first period, or in $t = 1$, after she learns f^E and builds new priors about input-specific conditions in that location. Formally:

$$\mathcal{D}^E_{m,t=0}\left(\bar{\bar{\theta}}; \boldsymbol{\theta_{t=0}}, \boldsymbol{\theta_{t=0}}\right) > 0 \quad \forall m \in \text{Type III}$$

or

$$\begin{cases} \mathcal{D}^E_{m,t=0}\left(\bar{\bar{\theta}}; \boldsymbol{\theta_{t=0}}, \boldsymbol{\theta_{t=0}}\right) > 0 & \text{for at least one } m \in \text{ Type III} \\ \mathcal{D}^E_{m',t=1}\left(\bar{\bar{\theta}}; \boldsymbol{\theta_{t=1}}, \boldsymbol{\tilde{\theta}_{t=2}}\right) > 0 & \forall m' \neq m; m' \in \text{ Type III} \end{cases}$$

Exploration in South. As before, let's define as $\hat{t}(m)$ the period in which the true value f_m^E reveals. With an abuse of notation, let's denote this period as $\hat{t}$, but it is nevertheless clear that the revelation period may vary across intermediate inputs m. If $\hat{t} < \infty$, this means that the true value reveals in a finite period of time, implying that firms with productivity $\theta \in [\tilde{\theta}^E_{m,\hat{t}}, \theta^E_{m,\hat{t}})$ found unprofitable to offshore m from East after exploring.

The firm $\theta^E_{m,\hat{t}}$ is defined as the firm that obtains a zero profit premium offshoring m from East. Thus, the productivity of this firm for each input m is given by:

$$\pi_t^{\text{prem}}(\theta^E_{m,\hat{t}}; l_m^{E/N}, \boldsymbol{l'_t}) = 0 \quad \Rightarrow \quad \theta^E_{m,\hat{t}} \equiv [(1-\gamma_0)E]^{\frac{\sigma}{1-\sigma}} Q \left[\frac{w^N\left[f_m^E - f_m^N\right]}{\psi(l_m^E, \boldsymbol{l'_t}) - \psi(l_m^N, \boldsymbol{l'_t})}\right]^{\frac{1}{\sigma-1}}$$

However, if the condition below holds for at least a subset of the firms in that productivity range, they will find it profitable to explore the offshoring potential in m from the South:

$$\mathcal{D}^S_{m,\hat{t}}\left(\theta; \boldsymbol{\theta}_{\hat{t}}, \boldsymbol{\theta}_{\hat{t}+1}\right) > 0 \quad \text{for at least one } \theta \in \left[\tilde{\theta}^E_{m,\hat{t}}, \theta^E_{m,\hat{t}}\right) \tag{37}$$

The period t^S defined above is defined as the earliest period in which a firm explores the offshoring potential in South, i.e. $t^S = \min\{\hat{t}(m)\}_1^M$. In such as situation, the most productive firms within $[\tilde{\theta}^E_{m,\hat{t}}, \theta^E_{m,\hat{t}})$ explore their offshoring potential from South in the period $\hat{t}$ for these intermediate inputs m. The productivity cutoff of the exploring firms in the South for an input m in this set is defined by the fixed point:

$$\mathcal{D}^S_{m,\hat{t}}\left(\tilde{\theta}^S_{m,\hat{t}+1}; \boldsymbol{\theta}_{\hat{t}}, \boldsymbol{\tilde{\theta}}_{\hat{t}+1}\right) = 0 \quad \Rightarrow \quad \mathbb{E}_{\hat{t}}\left[\pi_{\hat{t}}^{\text{prem}}\left(\tilde{\theta}^S_{m,\hat{t}+1}, l_m^{S/N}, \boldsymbol{l'_t}\right)\Big|\mathcal{I}_t\right] = w^N s_m^r \left[1 - \lambda\frac{Y(f^S_{\hat{t}+1})}{Y(f^S_{\hat{t}})}\right]$$

Solving for the offshoring productivity cutoff from South in input m in period t:

$$\tilde{\theta}^S_{m,\hat{t}+1} = [(1-\gamma_0)E]^{\frac{\sigma}{1-\sigma}} Q \left[\frac{w^N\left[\mathbb{E}_{\hat{t}}(f_m^S|\mathcal{I}_{\hat{t}}) - f_m^N + s_m^r\left(1 - \lambda\frac{Y(f^S_{\hat{t}+1})}{Y(f^S_{\hat{t}})}\right)\right]}{\psi(l_m^S, \boldsymbol{l'_t}) - \psi(l_m^N, \boldsymbol{l'_t})}\right]^{\frac{1}{\sigma-1}}$$

Relocation of suppliers from East to South. New information about f_m^S flows to firms sourcing m from a different location (North or East), as a result of the offshoring sequence of firms into South starting from $\hat{t}(m)$. If the following condition holds in any period $t > \hat{t}(m)$, the least productive firm offshoring from East in t, i.e. $\theta^E_{m,t}$ decides to explore the offshoring potential in South and, if she find it profitable, relocate the supplier to the latter location.

$$\mathcal{D}^S_{m,t}\left(\tilde{\theta}^E_{m,t};\boldsymbol{\theta}_t,\tilde{\boldsymbol{\theta}}_{t+1}\right)>0 \quad\Rightarrow\quad \mathbb{E}_t\left[\pi^{\text{prem}}_t\left(\tilde{\theta}^E_{m,t},l^{S/E}_m,\boldsymbol{l'_t}\right)\Big|\mathcal{I}_t\right]>w^N s^r_m\left[1-\lambda\frac{Y(f^S_{t+1})}{Y(f^S_t)}\right] \tag{38}$$

Therefore, the offshoring productivity cutoffs from East in m in $t>\hat{t}(m)$ is defined by:

$$\mathcal{D}^S_{m,\hat{t}}\left(\tilde{\theta}^E_{m,t+1};\boldsymbol{\theta}_t,\tilde{\boldsymbol{\theta}}_{t+1}\right)=0$$

Solving for the offshoring productivity cutoff, we get the expression in the second line of equation (35):

$$\tilde{\theta}^E_{m,t+1}=[(1-\gamma_0)E]^{\frac{\sigma}{1-\sigma}}Q\left[\frac{w^N\left[\mathbb{E}_t(f^S_m|\mathcal{I}_t)-f^E_m+s^r_m\left(1-\lambda\frac{Y(f^S_{t+1})}{Y(f^S_t)}\right)\right]}{\psi(l^S_m,\boldsymbol{l'_t})-\psi(l^E_m,\boldsymbol{l'_t})}\right]^{\frac{1}{\sigma-1}}$$

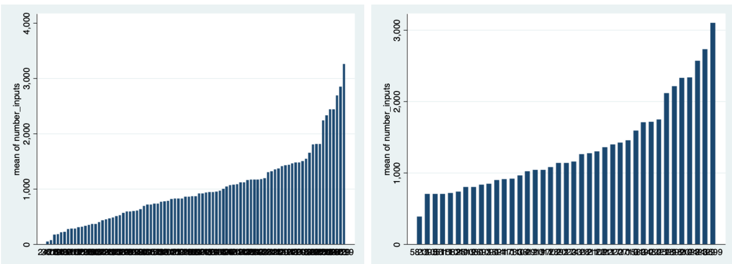
In conclusion, firms with productivity $\theta\in[\theta_{m,\hat{t}},...)$ sequentially relocate the supplier m from East to South, starting from period $\hat{t}(m)$.

7 Empirics: Two-country model with multiple intermediate inputs

This section is based on the extension to multiple intermediate inputs, but still hold the assumption of two-countries, i.e. the North-South world economy.

Production function. As in the theoretical model, we assume that the total set of intermediate inputs M_j is the same for all firms in the sector j, and empirically we define it by the set of inputs imported by the firms in the sector during the period 2004-2018. Thus, all the inputs that have been imported by any firm in the sector during that period are considered as an intermediate input. Once that set has been defined, we expand the sample such that every firm has an offshoring status in relation to each intermediate input in the sector.[80]

Figure 8 shows the mean number of inputs (8 digits) imported during the period 2004-2018 by each sector included in the sample, while Figure 9 shows the kernel density of the number of inputs by sector.



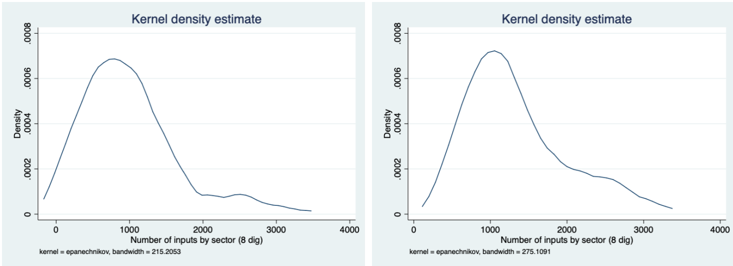
(a) with at least 20 firms (b) with at least 50 firms

Figure 8: Inputs by sector

7.1 Conditional probability model

The offshoring exploration decision in input m in period t is modelled separately for: i) firms that up to $t-1$ have not offshored any input $m\in M$ (i.e. non-offshoring firms); and ii) firms that up to $t-1$ have offshored at least one other input $m'\in M_j$ with $m'\neq m$. This distinction allows us to differentiate the decisions according to the information set possessed by each group of firms.

[80]This definition could be refined and improved by the use of a input-output matrix. Moreover, it would also allow to control for the technological relevance of the input, and test for the sequential exploration in technological relevance of the inputs as shown in Propositions 8 and 10.



(a) with at least 20 firms (b) with at least 50 firms

Figure 9: Kernel - Inputs by sector

Non-offshoring firms As mentioned, this section concerns to those firms with a non-offshoring status up to $t-1$ in any intermediate input $m \in M_j$, where M_j denotes the total set of inputs in the technology of the sector j. In other words, it refers to the domestically sourcing firms that in period t must decide whether to explore their offshoring potential for the first time or wait.

$$\Pr\left(\textit{offshr stat input}_{i,m,j,t} = 1 \middle| \textit{offshr status cum}_{i,j,t-1} = 0\right) = \\ = \Phi\Big(\ln(\textit{assets tot}_{i,t})\beta_1, \textit{info spillover}_{m,j,t}\beta_2, \gamma_j, \gamma_t\Big)$$

where i, m, j denote the firm, intermediate input and sector, respectively. The variable *offshr status cum*$_{i,j,t-1}$ is a dummy variable that takes the value 1 if the firm i in sector j has offshored up to period $t-1$ inclusive any intermediate input, while *offshr stat input*$_{i,m,j,t}$ refers to the offshoring status of firm i in input m in period t.

The measures for *info spillover*$_{m,j,t}$ are alternatively defined as:

- Direct measure from theory: *info spillover*$_{m,j,t}$ = *min (assets tot offshr)*$_{m,j,t-1}$. It refers to the least productive firm offshoring input m in previous year in the same sector j.
- Alternative measure (built based on theory): *info spillover*$_{m,j,t}$ = *sd(assets tot offshr)*$_{m,j,t-1}$. It refers to the standard deviation of the productivity among offshoring input m in previous year the same sector j.

Table 9: Regression results - Cond. Prob. Model - Non-offshoring firms

		Sectors with at least 20 firms		**Sectors with at least 50 firms**	
	Exp. Sign	**(1)**	**(2)**	**(3)**	**(4)**
		Probit	**Probit**	**Probit**	**Probit**
ln(assets tot)	+	0.0700***	0.0793***	0.0638***	0.0728***
		(0.00810)	(0.0102)	(0.00859)	(0.0105)
min(assets tot offshr)	-	-0.992***		-2.105***	
		(0.259)		(0.369)	
sd(assets tot offshr)	+		-0.0796		0.169
			(0.111)		(0.168)
constant		-2.513***	-2.186***	-2.474***	-2.238***
		(0.0836)	(0.105)	(0.0856)	(0.109)
N		995569	401447	929493	387490
pseudo R-sq		0.053	0.052	0.039	0.038

Standard errors in parentheses. ISIC and Year FE included. Robust standard errors.
* p<0.10, ** p<0.05, *** p<0.01

The sequential offshoring exploration in productivity is supported by the results in Table 9. In relation to the information spillovers, the main measure has the expected effects in all specifications.

About the coefficients associated to the alternative measure, they have no significant effect in any of the specifications in Table 9. However, Table 21 in Appendix E shows that the spillovers have the expected effect for the non-offshoring firms with higher productivity.

Offshoring firms This section focuses on firms that up to $t-1$ have offshored at least one other intermediate input $m' \in M_j$ with $m' \neq m$. In other words, it refers to the group of firms that already possess knowledge about the general conditions for offshoring, but remain uncertain about the input-specific conditions.

$$\Pr\Big(\textit{offshr stat input}_{i,m,j,t} = 1 \Big| \textit{offshr stat input cum}_{i,m,j,t-1} = 0, \textit{offshr status cum}_{i,j,t-1} = 1\Big) = \\ = \Phi\Big(\ln(\textit{assets tot}_{i,t})\beta_1, \textit{info spillover}_{m,j,t}\beta_2, \gamma_j, \gamma_t\Big)$$

The variable *offshr status cum*$_{i,j,t-1}$ is a dummy variable that takes the value 1 if the firm i in sector j has offshored up to period $t-1$ inclusive any intermediate input, *offshr stat input*$_{i,m,j,t}$ refers to the offshoring status of firm i in input m in period t, and *offshr stat input cum*$_{i,m,j,t-1}$ indicates whether this firm has offshored input m up to period $t-1$. The variable *info spillover*$_{m,j,t}$ has the two alternative measures defined above.

Table 10: Regression results - Cond. Prob. Model - Offshoring firms

		Sectors with at least 20 firms		**Sectors with at least 50 firms**	
	Exp. Sign	**(1)**	**(2)**	**(3)**	**(4)**
		Probit	**Probit**	**Probit**	**Probit**
ln(assets tot)	+	0.205***	0.213***	0.207***	0.216***
		(0.000769)	(0.00105)	(0.000836)	(0.00111)
min(assets tot offshr)	-	-0.365***		-0.874***	
		(0.0214)		(0.0212)	
sd(assets tot offshr)	+		0.111***		0.331***
			(0.0113)		(0.0227)
constant		-1.426***	-1.135***	-1.401***	-1.148***
		(0.00885)	(0.0124)	(0.00939)	(0.0129)
ISIC 4 dig FE		No	No	No	No
ISIC 2 dig FE		Yes	Yes	Yes	Yes
Year FE		Yes	Yes	Yes	Yes
N		19844059	8026509	18289452	7677984
pseudo R-sq		0.079	0.079	0.080	0.078

Standard errors in parentheses. Robust standard errors.
* p<0.10, ** p<0.05, *** p<0.01

The sequential offshoring exploration in productivity is supported by results in Table 10, and the information spillovers have the expected impact in both measures in all the specifications.

7.1.1 Survival (or transition) analysis

In this case, the conditional hazard rate to transition to an offshoring status in input m is given by:

$$\Lambda_{i,m,j,t}(t)|. = 1 - \exp[-\exp(\mathbf{x}_{i,m,j,t}\boldsymbol{\beta} + \delta_t)]$$

where δ_t denotes the general time-trend, and

$$\mathbf{x}_{i,m,j,t}\boldsymbol{\beta} = \beta_0 + \beta_1 \ln(\textit{assets tot}_{i,t} + \beta_2 \textit{info spillover}_{m,j,t} + \beta_3 \textit{entry year}_i + \gamma_j$$

and the informational spillovers are defined as above. The conditional denotes the two different group of firms considered below.

Non-offshoring firms The section concentrates in the hazard rate for non-offshoring firms, for the transition in the offshoring status with respect to input m. This hazard rate is denoted as:

$$\Lambda_{i,m,j,t}(t)\Big|\textit{offshr status cum}_{i,j,t-1} = 0$$

In other words, we estimate the transition rate to becoming an offshoring firm in input m, for firms that up to $t-1$ have never offshored any intermediate input, i.e. for first time explorers.

Table 11: Regression results - Survival analysis - Non-offshoring firms

		w/ at least 20 firms	
	Exp. sign	**(1)** **cloglog**	**(2)** **cloglog**
ln(t)		-0.124*	-0.276***
		(0.0637)	(0.0742)
ln(assets tot)	+	0.244***	0.264***
		(0.0275)	(0.0332)
min(assets tot offshr)	-	-3.656***	
		(0.929)	
sd(assets tot offshr)	+		-0.222
			(0.260)
constant		-4.398***	-3.322***
		(0.259)	(0.310)
N		995569	401375

Standard errors in parentheses
ISIC FE and year of entry included. Robust standard errors.
* p<0.10; ** p<0.05, *** p<0.01

As predicted by the theory in Propositions 7 and 9, the more productive firms explore their offshoring potential earlier in each input m. The coefficient associated to productivity is positive and highly significant in all the specifications.

In regard to the informational spillovers, the main measure shows also a theory consistent result. As more information is revealed about the offshoring conditions in one input m, the earlier the non-offshoring firms will explore their offshoring potential in that input. On the other hand, the coefficient associated to the alternative measure (*sd(assets tot)*) shows no significant effect at the reported levels.

Offshoring firms The hazard rate to transition in t to offshoring status in input m for firms already offshoring at least one other input $m' \in M_j$ with $m' \neq m$ is denoted as:

$$\Lambda_{i,m,j,t}(t)\Big|\textit{offshr stat input cum}_{i,m,j,t-1} = 0, \textit{offshr status cum}_{i,j,t-1} = 1$$

In other words, we estimate the transition rate to explore offshoring potential for the first time in input m, for firms that up to $t-1$ have already offshored other intermediate inputs, i.e. firms that already possess the information about the general offshoring cost, but must still learn the input-specific conditions.

As before the coefficient in Table 12 associated to productivity is positive and highly significant in all the specifications. This shows support for Propositions 7 and 9 with respect to the already offshoring firms. The most productive firms explore earlier the offshoring potential in inputs still not explored.

In regard to the informational spillovers, both measures show theory consistent results. As more information is revealed about the offshoring input-specific conditions in input m, the earlier the already offshoring firms (in other inputs) will explore their offshoring potential in m.

In sum, the sequential offshoring equilibrium path led by the most productive firms in the market is robustly confirmed in all the specifications of the Model 2. Furthermore, this feature is confirmed at the input level, as predicted by the theory in Propositions 7 and 9.

Table 12: Regression results - Survival analysis - Offshoring firms

		w/ at least 20 firms	
	Exp. sign	**(1)**	**(2)**
		cloglog	**cloglog**
ln(t)		-0.617***	-0.707***
		(0.00646)	(0.00847)
ln(assets tot)	+	0.592***	0.595***
		(0.00224)	(0.00287)
min(assets tot offshr)	-	-1.053***	
		(0.0622)	
sd(assets tot offshr)	+		1.203***
			(0.0600)
constant		-0.913***	-0.380***
		(0.0341)	(0.0477)
N		19844030	8026458

Standard errors in parentheses
ISIC FE and year of entry included. Robust standard errors.
* p<0.10; ** p<0.05, *** p<0.01

Finally, in relation to the learning mechanism through the use of the information spillovers, the models above show that they are part of the information set of both groups of firms when they face the trade-off of exploring the offshoring potential in input m or wait.

8 Conclusions, extensions and next steps

Institutions are key drivers of the multinational firms' sourcing decisions, and in consequence in the definition of the comparative advantages of countries and the allocation of production worldwide.

However, firms usually possess an uncertain knowledge about the institutional fundamentals in foreign countries, particularly about locations where they have never been active before, or countries that have implemented deep institutional reforms and the firms do not fully believe in the real scope of the changes announced by the foreign governments. In the latter sense, the institutional reforms induce also uncertainty about the true conditions in those locations.

In a model with two countries (North-South), we showed that firms can exploit informational externalities that emerge from other firms' behaviour, and thus better asses their offshoring potential and progressively adjust their sourcing strategies. These informational spillovers result in a sequential offshoring dynamic path led by the most productive firms in the market, which converges to the perfect information steady state of the economy. In consequence, informational externalities allow the economy to progressively overcome the initial inefficiencies produced by uncertainty, and thence fully achieve the welfare gains from offshoring in the long run.

Then we extended the model to multiple countries, in which northern firms can choose among different foreign locations for offshoring. We showed that a selection pattern emerges when firms do not posses perfect information about the true conditions in the foreign countries, with multiple equilibria driven by the informational spillovers. Therefore, the prior beliefs and the differences in institutional fundamentals across countries may drive the economy to the perfect information equilibrium, or may push the system to a non-optimal steady state. In the first case, the steady state is characterised by the perfect information welfare gains from offshoring and the optimal specialization of countries. On the other hand, in the second case the economy achieves a steady state with non-optimal specialisation of countries and welfare gains from offshoring that may not be fully achieved.

The latter shows how priors and informational spillovers drive the offshoring flows to certain locations becoming a source of the countries' *revealed* comparative advantages. In this regard, the model complements the literature on institutions and comparative advantages (Costinot, 2009; Acemoglu et al., 2007), which focuses on the importance of institutional fundamentals in the specialisation of countries.

The scope of the informational spillovers defines or drives the sectoral specialisation of each country. If the institutions (or the spillovers) are sector-specific, the sequential offshoring path narrows its effects to a sectoral dynamic, which may lead to a sectoral specialisation of the countries. However, if the scope of the spillovers is larger, i.e. externalities spill across sectors, it leads to a more extensive effect.

Finally, we tested the model using firm-level data of manufacturing Colombian firms, and we find support for the main predictions of the model. In particular, our empirical evidence support the learning mechanism and the sequential offshoring equilibrium path led by the most productive firms in the market, and the selection patterns in the location choices, driven by the informational spillovers.

Extensions of the model and next steps. We may extend the model in a future version to incorporate incomplete contracts or partially contractible investments[81], where in the latter the uncertainty relies in the degree of contractibility. In such a case, the definition of uncertainty would be narrowed down to a specific type of institutions: contractual institutions such as the quality or reliability of the court system.

Finally, in regard to the empirical model, we will go further into a full structural identification of the theoretical model, and analyse the theoretical predictions in the context of the conformation of the Pacific Alliance between Chile, Colombia Mexico and Peru in 2012 as the institutional shock.

[81] As in Grossman and Helpman (2005), we would limite the organisational choices of the firm such that the analysis concentrates in the location choices. In other words, the model would not allow firms to decide whether to integrate or outsource the intermediate inputs.

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A Perfect information model

A.1 Consumer's problem

To obtain the variety i demand function $q_j(i)$, we 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 sector j:

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

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

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

This expression holds for any variety i, thus

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

Or equivalently, from the FOCs, we can obtain:

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

To conclude, the demand for homogenous good q_0 is given by

$$q_0 = \frac{\gamma_0 E}{p_0}$$

A.2 Producers' problem

The per-period revenues of a firm producing a variety i is given by:

$$r_j(i) = p_j(i) q_j(i)$$

Plugging in the expression from equation (3), and replacing with the production function (5):

$$r_j(i) = \gamma_j E Q_j^{-\alpha} q_j(i)^{\alpha_j}$$
$$\Rightarrow r_j(i) = \gamma_j E Q_j^{-\alpha_j} \left[\theta \left(\frac{x_{h,j}(i)}{\eta_j}\right)^{\eta_j} \left(\frac{x_{m,j}(i)}{1-\eta_j}\right)^{1-\eta_j}\right]^{\alpha_j}$$

Solution to producer's problem. Given that all investments are contractible, the final good producer solves the following optimization problem.

$$\max_{x_{h,j}(i), x_{m,j}(i)} \pi_j = r_j(i) - w^N x_{h,j}(i) - w^l x_{m,j}(i) - w^N f_j^l$$

where $l = \{N, S\}$ refers to the location of the input's supplier.

By solving the FOCs,

$$x_{h,j}(i) = \frac{\alpha_j \eta_j}{w^N} r_j(i)$$

$$x_{m,j}(i) = \frac{\alpha_j(1-\eta_j)}{w^l} r_j(i)$$

Dividing the two equations above, and plugging them into the FOCs, the optimal HQ's investments are:

$$x^*_{h,j}(i) = \frac{\alpha_j \eta_j}{w^N} r_j^{l,*}(\theta) \tag{39}$$

with $r_j^{l,*}(\theta)$ given by:

$$r_j^{l,*}(\theta) \equiv \alpha_j^{\sigma_j - 1} \theta^{\sigma_j - 1} (\gamma_j E)^{\sigma_j} Q_j^{1-\sigma_j} \left[(w^N)^{\eta_j} (w^l)^{1-\eta_j} \right]^{1-\sigma_j} \tag{40}$$

Equivalently, the optimal supplier's investments are:

$$x^*_{m,j}(i) = \frac{\alpha_j(1-\eta_j)}{w^l} r_j^{l,*}(\theta) \tag{41}$$

Plugging the optimal investments into (5), we get the optimal production for a firm with productivity θ:

$$q^*_j(i) = \theta^{\sigma_j} \alpha_j^{\sigma_j} (\gamma_j E)^{\sigma_j} Q_j^{1-\sigma_j} \left[(w^N)^{\eta_j} (w^l)^{1-\eta_j} \right]^{-\sigma_j} \tag{42}$$

Consequently, the optimal price for a variety produced by a firm with productivity θ with a supplier from location l is:

$$p^*_j(i) = \theta^{-1} \alpha_j^{-1} (w^N)^{\eta_j} (w^l)^{1-\eta_j}$$

Finally, the profits realised by a firm with productivity θ for each sourcing strategy, i.e. domestic sourcing and offshoring, are:

$$\pi_j^l(\theta, Q_j, \eta_j, f_j^l, w^l) = r_j^{l,*}(\theta) - w^N x^*_{h,j}(i) - w^l x^*_{m,j}(i) - w^N f_j^l$$

Replacing with the expressions above for optimal investments:

$$\pi_j^l(\theta, .) = \frac{r_j^{l,*}(\theta)}{\sigma_j} - w^N f_j^l$$

Therefore, plugging the solution for revenues,

$$\pi_j^l(\theta, .) = \theta^{\sigma_j - 1} (\gamma_j E)^{\sigma_j} Q_j^{1-\sigma_j} \psi_j^l - w^N f_j^l \tag{43}$$

with $l = \{N, S\}$, and ψ_j^l is defined as:

$$\psi_j^l \equiv \frac{\alpha_j^{\sigma_j - 1}}{\sigma_j \left[(w^N)^{\eta_j} (w^l)^{1-\eta_j} \right]^{\sigma_j - 1}}$$

B Initial conditions: Non-tradable intermediate inputs ($n.t.i.$)

We focus the analysis on one differentiated sector. As mentioned above, we assume that there is only one differentiated sector, therefore we drop the subscript j.

The production, price and per-period profits for a firm with productivity θ in the steady state of the n.t.i. economy are given by:

$$q_t^{n.t.i.}(\theta) = \left(\frac{\theta \alpha (1-\gamma_0) E (Q^{n.t.i.})^{-\alpha_j}}{w^N} \right)^{\sigma} \tag{44}$$

$$p_t^{n.t.i.}(\theta) = \frac{w^N}{\alpha \theta} \tag{45}$$

$$\pi_t^N(.) = \theta^{\sigma - 1} [(1-\gamma_0)E]^{\sigma} (Q^{n.t.i.})^{1-\sigma} \psi^N - w^N f^N \tag{46}$$

with $\psi^N \equiv \sigma^{-1} \left[\frac{\alpha}{w^N} \right]^{\sigma - 1}$.

B.1 Sectoral price index

The price index can be represented as:

$$P^{n.t.i.} = \left[\int_{i\in I} p(i)^{1-\sigma} di\right]^{\frac{1}{1-\sigma}} \quad \Leftrightarrow \quad P^{n.t.i.} = \left[\int_0^\infty p(\theta)^{1-\sigma} H^{n.t.i.} \mu(\theta) d\theta\right]^{\frac{1}{1-\sigma}} \tag{47}$$

where $H^{n.t.i.}$ refers to the total number of final-good producers active in the market in this sector, and $\mu(\theta)$ denotes the ex-post distribution of firm productivities in the market.

$$\mu(\theta) = \begin{cases} \frac{g(\theta)}{1-G(\underline{\theta}^{n.t.i.})} & \text{if } \theta \geq \underline{\theta}^{n.t.i.} \\ 0 & \text{if } \theta < \underline{\theta}^{n.t.i.} \end{cases} \tag{48}$$

By plugging equation (45) into (47), we get the price index of the differentiated sector in terms of the average productivity in that sector.

$$P^{n.t.i.} = (H^{n.t.i.})^{\frac{1}{1-\sigma}} \frac{w^N}{\alpha} \left[\left(\int_0^\infty \theta^{\sigma-1} \mu(\theta) d\theta\right)^{\frac{1}{\sigma-1}}\right]^{-1}$$

Defining $\bar{\theta}^{n.t.i.}$ as the average productivity in the sector:

$$\bar{\theta}^{n.t.i.} \equiv \left(\int_0^\infty \theta^{\sigma-1} \mu(\theta) d\theta\right)^{\frac{1}{\sigma-1}} = \left(\frac{1}{1-G(\underline{\theta}^{n.t.i.})} \int_{\underline{\theta}^{n.t.i.}}^\infty \theta^{\sigma-1} g(\theta) d\theta\right)^{\frac{1}{\sigma-1}} \tag{49}$$

Replacing the equation (49) into the price index,

$$P^{n.t.i.} = (H^{n.t.i.})^{\frac{1}{1-\sigma}} \frac{w^N}{\alpha\bar{\theta}^{n.t.i.}} \quad \Rightarrow \quad P^{n.t.i.} = (H^{n.t.i.})^{\frac{1}{1-\sigma}} p(\bar{\theta}^{n.t.i.}) \tag{50}$$

B.2 Sectoral aggregate consumption

The aggregate consumption in terms of the quantities produced by the average active firm is given by

$$Q^{n.t.i.} = \left[\int_{i\in I} q(i)^{\alpha} di\right]^{1/\alpha} \quad \Leftrightarrow \quad Q^{n.t.i.} = \left[\int_0^\infty q(\theta)^{\frac{\sigma-1}{\sigma}} H^{n.t.i.} \mu(\theta) d\theta\right]^{\frac{\sigma}{\sigma-1}}$$

$$Q^{n.t.i.} = (H^{n.t.i.})^{\frac{\sigma}{\sigma-1}} \left[\frac{\alpha(1-\gamma_0)E}{w^N}\right]^{\sigma} (Q^{n.t.i.})^{1-\sigma} \left[\int_0^\infty \theta^{\sigma-1} \mu(\theta) d\theta\right]^{\frac{\sigma}{\sigma-1}}$$

$$Q^{n.t.i.} = (H^{n.t.i.})^{\frac{\sigma}{\sigma-1}} q(\bar{\theta}^{n.t.i.}) \quad \Rightarrow \quad Q^{n.t.i.} = (H^{n.t.i.})^{\frac{1}{\sigma-1}} \frac{\alpha(1-\gamma_0)E}{w^N} \bar{\theta}^{n.t.i.} \tag{51}$$

B.3 Zero Cutoff Profit Condition (ZCPC)

The firm's value function is:

$$v^{n.t.i.}(\theta) = \max\left\{0; v^{N,n.t.i.}(\theta)\right\}$$

with

$$v^{N,n.t.i.}(\theta) = \max\left\{0; \sum_{t=0}^{\infty} \lambda^t \pi^{N,n.t.i.}(\theta)\right\} = \max\left\{0; \frac{\pi^{N,n.t.i.}(\theta)}{1-\lambda}\right\}$$

where λ refers to the per period survival probability to an exogenous bad shock.

Thence, using the zero cutoff profit condition (ZCPC), the market productivity cutoff, denoted as $\underline{\theta}^*$, is implicitly defined by $\pi^{N,n.t.i.}(\underline{\theta}^{n.t.i.}) = 0$. Thus, solving this expression for $\underline{\theta}^{n.t.i.}$, we get:

$$\Pi^N = 0 \Leftrightarrow \frac{\pi_t^N}{1-\lambda} = 0 \Leftrightarrow \pi_t^N = 0$$

$$\Leftrightarrow \underline{\theta}^{n.t.i.} = [(1-\gamma_0)E]^{\frac{\sigma}{1-\sigma}} Q^{n.t.i.} \left[\frac{w^N f^N}{\psi^N}\right]^{\frac{1}{\sigma-1}} \tag{52}$$

Also, by using the (ZCPC), we get the revenue level for the cutoff productivity firm $r^{N,n.t.i.}(\underline{\theta}^{n.t.i.})$.

$$\pi_t^N(\underline{\theta}^{n.t.i.}) = 0 \quad \Rightarrow \quad r^N(\underline{\theta}^{n.t.i.}) = \sigma w^N f^N \tag{53}$$

Furthermore, the revenues of the average firm as a function of the cutoff firm revenues is given by:

$$\frac{r^N(\bar{\theta}^{n.t.i.})}{r^N(\underline{\theta}^{n.t.i.})} = \left(\frac{\bar{\theta}^{n.t.i.}}{\underline{\theta}^{n.t.i.}}\right)^{\sigma-1} \quad \Rightarrow \quad r^N(\bar{\theta}^{n.t.i.}) = \left(\frac{\bar{\theta}^{n.t.i.}}{\underline{\theta}^{n.t.i.}}\right)^{\sigma-1} r^N(\underline{\theta}^{n.t.i.}) \tag{54}$$

and the average revenues are:

$$\bar{r}^{n.t.i.} \equiv r^N(\bar{\theta}^{n.t.i.}) = \left(\frac{\bar{\theta}^{n.t.i.}}{\underline{\theta}^{n.t.i.}}\right)^{\sigma-1} \sigma w^N f^N \tag{55}$$

Finally, it is possible to obtain the profits of the average firm as:

$$\bar{\pi}^{n.t.i.} \equiv \pi^N(\bar{\theta}^{n.t.i.}) = \frac{r^N(\bar{\theta}^{n.t.i.})}{\sigma} - w^N f^N$$

Replacing with (55) and plugging the cutoff revenues from (53), we obtain the (ZCPC):

$$\bar{\pi}^{n.t.i.} \equiv \pi^N(\bar{\theta}^{n.t.i.}) = w^N f^N \left[\left(\frac{\bar{\theta}^{n.t.i.}}{\underline{\theta}^{n.t.i.}}\right)^{\sigma-1} - 1\right] \tag{56}$$

B.4 Free Entry Condition (FEC)

All the active final good producers, except for the cutoff firm $\underline{\theta}^{n.t.i.}$, earn positive profits. Therefore, $\bar{\pi}^{n.t.i.} > 0$. Given this expected positive profits, firms decide to sink the entry cost s_e and enter into the market.

The present value of a firm, conditional on sucessful entry, is:

$$\bar{v} = \int_{\underline{\theta}^{n.t.i.}}^{\infty} v(\theta)\mu(\theta)d\theta = \frac{\bar{\pi}^{n.t.i.}}{1-\lambda}$$

On the other hand, the net value of entry is given by:

$$v_e = p_{in}\bar{v} - w^N s_e = \frac{1 - G(\underline{\theta}^{n.t.i.})}{1-\lambda}\bar{\pi}^{n.t.i.} - w^N s_e$$

By (FEC): $v_e = 0$. Therefore,

$$\bar{\pi}^{n.t.i.} = \frac{(1-\lambda)s_e w^N}{1 - G(\underline{\theta}^{n.t.i.})} \tag{57}$$

B.5 Equilibrium: number of firms

From (ZCPC) and (FEC):

$$\bar{\theta}^{n.t.i.} = \left[\frac{(1-\lambda)s_e}{[1 - G(\underline{\theta}^{n.t.i.})]f^N} + 1\right]^{\frac{1}{\sigma-1}} \underline{\theta}^{n.t.i.} \tag{58}$$

The number of active firms is given by:

$$H^{n.t.i.} = \frac{R^{n.t.i.}}{\bar{r}^{n.t.i.}} \Leftrightarrow H^{n.t.i.} = \frac{(1-\gamma_0)E}{\bar{r}^{n.t.i.}}$$

Using $\bar{r}^{n.t.i.} = \sigma\left[\bar{\pi}^{n.t.i.} + w^N f^N\right]$, the number of active firms in sector j is:

$$H^{n.t.i.} = \frac{(1-\gamma_0)E}{\sigma\left[\bar{\pi}^{n.t.i.} + w^N f^N\right]}$$

and replacing $\bar{\pi}^{n.t.i.}$ with (ZCPC), the number of active firms is:

$$H^{n.t.i.} = \frac{(1-\gamma_0)E}{\sigma w^N f^N}\left(\frac{\underline{\theta}^{n.t.i.}}{\bar{\theta}^{n.t.i.}}\right)^{\sigma-1} \tag{59}$$

C Perfect information: tradable intermediate inputs

The revenues for a firm with productivity θ doing domestic sourcing is represented as $r^{N,*}(\theta)$. Instead, when the firm chooses offshoring the revenue is denoted as $r^{S,*}(\theta)$. Dividing both expressions:

$$\frac{r^{S,*}(\theta)}{r^{N,*}(\theta)} = \left(\frac{w^N}{w^S}\right)^{(1-\eta)(\sigma-1)} \Leftrightarrow r^{S,*}(\theta) = \left(\frac{w^N}{w^S}\right)^{(1-\eta)(\sigma-1)} r^{N,*}(\theta)$$

Substracting on both sides $r^{N,*}(\theta)$, we obtain the offshoring premium in revenues received by a firm with productivity θ, when the firm decides for offshoring:

$$r^{S,prem}(\theta) \equiv r^{S,*}(\theta) - r^{N,*}(\theta) = \left[\left(\frac{w^N}{w^S}\right)^{(1-\eta)(\sigma-1)} - 1\right] r^{N,*}(\theta) \tag{60}$$

Equivalently, the per period offshoring premium in profits for a firm with productivity θ (without considering the market research sunk cost) is given by:

$$\pi^{S,prem}(\theta) \equiv \pi^S(\theta) - \pi^N(\theta)$$

$$\pi^{S,prem}(\theta) = \frac{\alpha^{\sigma-1}\theta^{\sigma-1}[(1-\gamma_0)E]^{\sigma}Q^{1-\sigma}}{\sigma}\left[\frac{(w^N)^{(1-\eta)(\sigma-1)} - (w^S)^{(1-\eta)(\sigma-1)}}{\left[(w^S)^{(1-\eta)}w^N\right]^{(\sigma-1)}}\right] - w^N\left[f^S - f^N\right]$$

Thus, the per period offshoring premium in profits for a firm with productivity θ, without considering the market reserach sunk cost, can be equivalently expressed as[82]:

$$\Leftrightarrow \pi^{S,prem}(\theta) = \frac{r^{N,*}(\theta)}{\sigma}\left[\left(\frac{w^N}{w^S}\right)^{(1-\eta)(\sigma-1)} - 1\right] - w^N\left[f^S - f^N\right] \tag{61}$$

Let's define $\bar{\theta}^S$ as the average productivity of the firms doing offshoring. Formally,

$$\bar{\theta}^S \equiv \left[\frac{1}{1-G(\theta^{S,*})}\int_{\theta^{S,*}}^{\infty}\theta^{\sigma-1}g(\theta)d\theta\right]^{\frac{1}{\sigma-1}} \tag{62}$$

On the other hand, the variable $\bar{\theta}$ is still defined as:

$$\bar{\theta} \equiv \left(\int_0^{\infty}\theta^{\sigma-1}\mu(\theta)d\theta\right)^{\frac{1}{\sigma-1}} = \left(\frac{1}{1-G(\underline{\theta})}\int_{\underline{\theta}}^{\infty}\theta^{\sigma-1}g(\theta)d\theta\right)^{\frac{1}{\sigma-1}} \tag{63}$$

The *light* area of Figure 2, below the $\pi^N(\theta)$ function, can be computed in a similar way as in the case where domestic sourcing was the only available option:

$$\pi^N(\bar{\theta}) = w^N f^N\left[\left(\frac{\bar{\theta}}{\underline{\theta}^*}\right)^{\sigma-1} - 1\right]$$

On the other hand, the per period offshoring premium in profits, without considering the offshoring market research sunk cost, of the average productivity firm in offshoring is represented by:

$$\pi^{S,prem}(\bar{\theta}^S) \equiv \pi^S(\bar{\theta}^S) - \pi^N(\bar{\theta}^S)$$

[82] It is straightforward to see that this offshoring profit premium can be positive or negative depending on the productivity level of the firm.

with the aggregate offshoring profit premium if the *dark* area in Figure 2 between both profit functions.

Replacing in the previous equation with the respective profit equations evaluated at $\bar{\theta}^S$:

$$\Leftrightarrow \pi^{S,prem}(\bar{\theta}^S) = \frac{r^{N,*}(\bar{\theta}^S)}{\sigma}\left[\left(\frac{w^N}{w^S}\right)^{(1-\eta)(\sigma-1)} - 1\right] - w^N\left[f^S - f^N\right] \tag{64}$$

Therefore, the average per-period profits when the intermediate inputs become tradable are given by:

$$\begin{aligned}\bar{\pi} &= \pi^N(\bar{\theta}) + p_{\text{off}}\left[\pi^{S,prem}(\bar{\theta}^S) - (1-\lambda)w^N s^r\right]\\ &= w^N f^N\left[\left(\frac{\bar{\theta}}{\underline{\theta}^*}\right)^{\sigma-1} - 1\right] + \chi^*\left[\pi^{S,prem}(\bar{\theta}^S) - (1-\lambda)w^N s^r\right]\end{aligned} \tag{65}$$

with $\chi^* \equiv \frac{1-G(\theta^{S,*})}{1-G(\underline{\theta}^*)}$ denoting the share of offshoring firms. The first term of the RHS refers to the average profits obtained by the firms if they would all have choosen domestic sourcing, while the second term denotes the premium in profits received by those firms that decide to offshore adjusted by the share of offshoring firms among the active ones.

Equivalently, the average revenue is given by:

$$\begin{aligned}\bar{r} &= r^N(\bar{\theta}) + \chi^*\left[r^S(\bar{\theta}^S) - r^N(\bar{\theta}^S)\right]\\ &= r^N(\bar{\theta}) + \chi^*\left[\left(\frac{w^N}{w^S}\right)^{(\sigma-1)(1-\eta)} - 1\right] r^N(\bar{\theta}^S)\end{aligned} \tag{66}$$

Finally, the offshoring profit premium for the firm with the offshoring productivity cutoff:

$$\begin{aligned}&\pi^{S,prem}(\theta^{S,*}) - (1-\lambda)w^N s^r = 0\\ \Rightarrow &r^{N,*}(\theta^{S,*}) = \sigma w^N\left[f^S + (1-\lambda)s^r - f^N\right]\left[\left(\frac{w^N}{w^S}\right)^{(1-\eta)(\sigma-1)} - 1\right]^{-1}\end{aligned}$$

Dividing by the revenues of the firm at the market cutoff productivity level:

$$\frac{r^{N,*}(\theta^{S,*})}{r^{N,*}(\underline{\theta}^*)} = \left(\frac{f^S + (1-\lambda)s^r}{f^N} - 1\right)\left[\left(\frac{w^N}{w^S}\right)^{(1-\eta)(\sigma-1)} - 1\right]^{-1}$$

Also, by using the equivalent of equation (54), it is possible to show

$$\frac{r^{N,*}(\theta^{S,*})}{r^{N,*}(\underline{\theta}^*)} = \left(\frac{\theta^{S,*}}{\underline{\theta}^*}\right)^{\sigma-1} \tag{67}$$

Putting both equations together, and solving for the offshoring productivity cutoff:

$$\left(\frac{\theta^{S,*}}{\underline{\theta}^*}\right)^{\sigma-1} = \left(\frac{f^S + (1-\lambda)s^r}{f^N} - 1\right)\left[\left(\frac{w^N}{w^S}\right)^{(1-\eta)(\sigma-1)} - 1\right]^{-1}$$

$$\Rightarrow \theta^{S,*} = \left(\frac{f^S + (1-\lambda)s^r}{f^N} - 1\right)^{\frac{1}{\sigma-1}}\left[\left(\frac{w^N}{w^S}\right)^{(1-\eta)(\sigma-1)} - 1\right]^{\frac{1}{1-\sigma}}\underline{\theta}^* \tag{68}$$

C.1 Price index in sector j

The price of a variety i produced by a firm with productivity θ which sources only domestically is given by:

$$p(\theta) = \frac{w^N}{\alpha\theta} \tag{69}$$

Meanwhile the price of a variety i produced by a firm with productivity θ which offshores is:

$$p^{\text{off}}(\theta) = \frac{(w^N)^\eta (w^S)^{1-\eta}}{\alpha\theta} \tag{70}$$

By substracting equation (69) from (70), we get the price differential of an offshoring firm with productivity θ:

$$p^{\text{off}}(\theta) - p(\theta) = \frac{(w^N)^\eta \left[(w^S)^{1-\eta} - (w^N)^{1-\eta}\right]}{\alpha\theta} \tag{71}$$

If $w^S < w^N$, as defined by Assumption A.2, $p^{\text{off}}(\theta) - p(\theta) < 0$, i.e. offshoring firms can charge a lower price for a given productivity θ.

Moreover, the offshoring price of a firm with productivity θ as a function of its domestic sourcing price is given by:

$$p^{\text{off}}(\theta) = \left(\frac{w^S}{w^N}\right)^{1-\eta} p(\theta) \tag{72}$$

We define P^{off} as the price index of the firms doing offshoring, and $P^{\text{off}|n.t.i}$ as the price index of the same firm doing offshoring but computed under the cost structure of domestic sourcing. Formally, they are defined:

$$P^{\text{off}} \equiv \left[\int_{\theta^{S,*}}^{\infty} [p^{\text{off}}(\theta)]^{1-\sigma} H \frac{g(\theta)}{1 - G(\theta^{S,*})} d\theta\right]^{\frac{1}{1-\sigma}} \tag{73}$$

$$P^{\text{off}|n.t.i} \equiv \left[\int_{\theta^{S,*}}^{\infty} [p(\theta)]^{1-\sigma} H \frac{g(\theta)}{1 - G(\theta^{S,*})} d\theta\right]^{\frac{1}{1-\sigma}} \tag{74}$$

Finally, to obtain the sectoral price index:

$$P^{1-\sigma} = \int_{\underline{\theta}^*}^{\theta^{S,*}} p(\theta)^{1-\sigma} H \frac{g(\theta)}{1 - G(\underline{\theta}^*)} d\theta + \int_{\theta^{S,*}}^{\infty} [p^{\text{off}}(\theta)]^{1-\sigma} H \frac{g(\theta)}{1 - G(\underline{\theta}^*)} d\theta$$

$$\begin{aligned} P^{1-\sigma} = &\int_{\underline{\theta}^*}^{\infty} p(\theta)^{1-\sigma} H \frac{g(\theta)}{1 - G(\underline{\theta}^*)} d\theta \\ &+ \frac{1 - G(\theta^{S,*})}{1 - G(\underline{\theta}^*)} \int_{\theta^{S,*}}^{\infty} [p^{\text{off}}(\theta)]^{1-\sigma} H \frac{g(\theta)}{1 - G(\theta^{S,*})} d\theta \\ &- \frac{1 - G(\theta^{S,*})}{1 - G(\underline{\theta}^*)} \int_{\theta^{S,*}}^{\infty} p(\theta)^{1-\sigma} H \frac{g(\theta)}{1 - G(\theta^{S,*})} d\theta \end{aligned}$$

Therefore, the price index is

$$\Rightarrow P^{1-\sigma} = \left(P^{\text{n.t.i.}}\right)^{1-\sigma} + \chi^* \left[\left(P^{\text{off}}\right)^{1-\sigma} - \left(P^{\text{off}|\text{n.t.i.}}\right)^{1-\sigma}\right]$$

Furthermore, using equation (72), the sectoral price index for the tradable intermediate input economy, P, is given by the following expression:

$$P^{1-\sigma} = \left(P^{\text{n.t.i.}}\right)^{1-\sigma} + \chi^* \left[\left(\frac{w^N}{w^S}\right)^{(1-\eta)(\sigma-1)} - 1\right] \left(P^{\text{off}|\text{n.t.i.}}\right)^{1-\sigma} \tag{75}$$

The price index is increasing in southern wages, i.e. $\partial P / \partial w^S > 0$. Moreover, given $w^S < w^N$, the price index is increasing in the offshoring cutoff $\theta^{S,*}$. Therefore, reductions in the offshoring productivity cutoff, i.e. more firms choosing to offshore, leads to reductions in the price index of that sector.

Moreover, as $\theta^{S,*} \to \infty$, the share of offshoring firms goes to zero, i.e. $\chi^* \to 0$. Therefore, the second term of the RHS of the equation (75) vanishes and the first term shows $P^{n.t.i.}(\underline{\theta}^*) \uparrow P^{n.t.i}(\underline{\theta}^{n.t.i})$ and $\underline{\theta}^* \downarrow \underline{\theta}^{n.t.i.}$. In other words, $P \downarrow P^{n.t.i.}$, where the last term corresponds to the price index of the $n.t.i.$ model.

C.2 Aggregate consumption in sector j

Using the relation $Q = \frac{(1-\gamma_0)E}{P}$, [83]and the price index from equation (75), the sectoral aggregate consumption is:

$$Q = (1-\gamma_0)E\left[\left(P^{\text{n.t.i.}}\right)^{1-\sigma} + \chi^*\left[\left(\frac{w^N}{w^S}\right)^{(1-\eta)(\sigma-1)} - 1\right]\left(P^{\text{off|n.t.i.}}\right)^{1-\sigma}\right]^{\frac{1}{\sigma-1}} \tag{76}$$

As expected, the sectoral aggregate consumption is decreasing in both, southern wages and the offshoring productivity cutoff. As before, the latter implies that more firms choosing offshoring leads to a higher sectoral aggregate consumption.

C.3 Firm entry and exit

We derive now the (ZCPC) and (FEC) for the economy with tradable intermediate input.

C.3.1 Zero Cutoff Profit Condition (ZCPC)

The firm's value function is still represented by the same function:

$$v(\theta) = \max\left\{0; v^l(\theta)\right\}$$

with

$$v^l(\theta) = \max\left\{0; \sum_{t=0}^{\infty}\lambda^t\pi^l(\theta)\right\} = \max\left\{0; \frac{\pi^l(\theta)}{1-\lambda}\right\}$$

As before, the market productivity cutoff denoted as $\underline{\theta}^*$ is implicitly defined by the zero cutoff profit condition (ZCPC), $\pi^N(\underline{\theta}^*) = 0$. Solving this expression for $\underline{\theta}^*$, the market productivity cutoff is:

$$\underline{\theta}^* = [(1-\gamma_0)E]^{\frac{\sigma}{1-\sigma}} Q\left[\frac{w^N f^N}{\psi^N}\right]^{\frac{1}{\sigma-1}} \tag{77}$$

As before, from the (ZCPC) we get the same expression (53). Thence, dividing $\bar{r}$ from equation (66) by the cutoff firm's revenues (53), we can express the average revenues as a function of the cutoff firm's revenues:

$$\frac{\bar{r}}{r(\underline{\theta}^*)} = \frac{r^N(\bar{\theta})}{r(\underline{\theta}^*)} + \chi^*\left[\left(\frac{w^N}{w^S}\right)^{(\sigma-1)(1-\eta)} - 1\right]\frac{r^N(\bar{\theta}^S)}{r(\underline{\theta}^*)}$$

Replacing the first and second terms of the RHS by equivalent expressions from equation (54),

$$\frac{\bar{r}}{r(\underline{\theta}^*)} = \left(\frac{\bar{\theta}}{\underline{\theta}^*}\right)^{\sigma-1} + \chi^*\left[\left(\frac{w^N}{w^S}\right)^{(\sigma-1)(1-\eta)} - 1\right]\left(\frac{\bar{\theta}^S}{\underline{\theta}^*}\right)^{\sigma-1}$$

Solving for $\bar{r}$, and replacing $r(\underline{\theta}^*)$ with its expression from equation (53):

$$\bar{r} = \left[\left(\frac{\bar{\theta}}{\underline{\theta}^*}\right)^{\sigma-1} + \chi^*\left[\left(\frac{w^N}{w^S}\right)^{(\sigma-1)(1-\eta)} - 1\right]\left(\frac{\bar{\theta}^S}{\underline{\theta}^*}\right)^{\sigma-1}\right]\sigma w^N f^N \tag{78}$$

Taking the average profits from equation (65), and plugging it into equation (64):

$$\begin{aligned}
\bar{\pi} =& \pi^N(\bar{\theta}) + \chi^*\left[\pi^{S,prem}(\bar{\theta}^S) - (1-\lambda)w^N s^r\right] \\
=& w^N f^N\left[\left(\frac{\bar{\theta}}{\underline{\theta}^*}\right)^{\sigma-1} - 1\right] + \chi^*\frac{r^{N,*}(\bar{\theta}^S)}{\sigma}\left[\left(\frac{w^N}{w^S}\right)^{(1-\eta)(\sigma-1)} - 1\right] \\
& - \chi^* w^N\left[f^S + (1-\lambda)s^r - f^N\right]
\end{aligned}$$

[83]As we focus the analysis on one differentiated sector, we drop the subscript j. Therefore, the expenditure share in the differentiated sector under analysis is given by $1-\gamma_0$, i.e. by the expenditure that is not intended for consumption of the homogeneous good. This is a trivial assumption which we do in order to simplify notation.

Finally, replacing $r^{N,*}(\bar{\theta}^S)$, the (ZCPC) is given by:

$$\begin{aligned}\bar{\pi} =& w^N f^N \left[\left[\left(\frac{\bar{\theta}}{\underline{\theta}^*}\right)^{\sigma-1} - 1\right] + \chi^* \left[\left(\frac{w^N}{w^S}\right)^{(1-\eta)(\sigma-1)} - 1\right]\left(\frac{\bar{\theta}^S}{\underline{\theta}^*}\right)^{\sigma-1}\right] \\ &- \chi^* w^N \left[f^S + (1-\lambda)s^r - f^N\right]\end{aligned} \tag{79}$$

C.3.2 Free Entry Condition (FEC)

The (FEC) is given by the following expression:

$$v_e = p_{\text{in}} \frac{\bar{\pi}}{1-\lambda} - w^N s_e = 0 \quad \Rightarrow \quad \bar{\pi} = \frac{(1-\lambda) w^N s_e}{1 - G(\underline{\theta}^*)} \tag{80}$$

C.3.3 Sectoral equilibrium. Number of firms.

As before, putting the (ZCPC) and (FEC) together, we can obtain the sectoral equilibrium productivity cutoff and the average profits in the sector.

From the (ZCPC) and (FEC), we get:

$$w^N f^N \left[\left[\left(\frac{\bar{\theta}}{\underline{\theta}^*}\right)^{\sigma-1} - 1\right] + \chi^* W(.) \left(\frac{\bar{\theta}^S}{\underline{\theta}^*}\right)^{\sigma-1}\right] - \chi^* w^N f^N F(.) = \frac{(1-\lambda) w^N s_e}{1 - G(\underline{\theta}^*)}$$

with

$$\begin{aligned} W(w^N, w^S) &\equiv \left(\frac{w^N}{w^S}\right)^{(1-\eta)(\sigma-1)} - 1 \\ F(f^N, f^S, s^r) &\equiv \left(\frac{f^S + (1-\lambda)s^r}{f^N}\right) - 1 \end{aligned} \tag{81}$$

Solving for $\bar{\theta}$,

$$\Rightarrow \bar{\theta} = \left[\frac{(1-\lambda)s_e}{\left[1 - G(\underline{\theta}^*)\right] f^N} + \chi^* \left[F(.) - W(.) \left(\frac{\bar{\theta}^S}{\underline{\theta}^*}\right)^{\sigma-1}\right] + 1\right]^{\frac{1}{\sigma-1}} \underline{\theta}^* \tag{82}$$

Number of active firms. Finally, we obtain the number of active firms, i.e. the number of final good producers, in the differentiated sector. For this, we consider as before:

$$H^* = \frac{(1-\gamma_0)E}{\bar{r}}$$

Using $\bar{r}$ from equation (78),

$$H^* = \frac{(1-\gamma_0)E}{\left[\left(\frac{\bar{\theta}}{\underline{\theta}^*}\right)^{\sigma-1} + \chi^* \left[\left(\frac{w^N}{w^S}\right)^{(\sigma-1)(1-\eta)} - 1\right]\left(\frac{\bar{\theta}^S}{\underline{\theta}^*}\right)^{\sigma-1}\right] \sigma w^N f^N} \tag{83}$$

It is easy to see that when $w^N > w^S$, the number of active firms with tradable intermediate inputs is smaller than in the case when offshoring is not possible. This is due to the reduction of the price index induced by offshoring firms, and thus leads to a stronger competition in the final good market.

C.4 Offshoring productivity cutoff

The firm at the offshoring productivity cutoff is indifferent between offshoring and domestic sourcing. Therefore,

$$\frac{\pi^S(\theta^{S,*})}{1-\lambda} - w^N s^r = \frac{\pi^N(\theta^{S,*})}{1-\lambda}$$

The offshoring productivity cutoff is thus given by:

$$\theta^{S,*} = [(1-\gamma_0)E]^{\frac{\sigma}{1-\sigma}} Q \left[\frac{w^N \left[f^S - f^N + (1-\lambda)s^r \right]}{\psi^S - \psi^N} \right]^{\frac{1}{\sigma-1}} \tag{84}$$

Equivalently, the offshoring productivity cutoff can be expressed in terms of the market productivity cutoff:

$$\theta^{S,*} = \left(\frac{f^S + (1-\lambda)s^r}{f^N} - 1 \right)^{\frac{1}{\sigma-1}} \left[\left(\frac{w^N}{w^S} \right)^{(1-\eta)(\sigma-1)} - 1 \right]^{\frac{1}{1-\sigma}} \underline{\theta}^*$$

D Uncertainty - dynamic model: tradable intermediate inputs.

When a firm decides whether to explore her offshoring potential or remain active under domestic sourcing, she must compute the present value of the total offshoring profit premium that she expects to obtain, and compare it to the offshoring market research sunk cost s^r.

At time t, the present value of the expected offshoring profit premium for a firm with productivity θ, who is currently sourcing domestically, is given by:

$$\mathbb{E}_t \left[\Pi^{S,\text{prem}}(\theta) | f^S \leq f_t^S \right] = \mathbb{E}_t \left[\sum_{\tau=t}^{\infty} \lambda^{\tau-t} \pi_\tau^{S,\text{prem}} \left(\theta, f_\tau^S, Q(f_\tau^S), f^N, w^N, w^S \right) \Big| f^S \leq f_t^S \right]$$

From the equation above, it is clear that the expected profit premium flow depends on the expected offshoring fixed costs at the moment of the decision, and on the expected flow of new incoming information from the behaviour of other firms. The per period profits depend on the expected fixed costs at t and on the expected information flow. Therefore, they are affected by the effect that the increasing share of offshoring firms over time has on the sectoral price index, and thence in the sectoral aggregate consumption.

To simplify notation, we denote $\pi_t^{S,\text{prem}}(\theta, f_t^S, Q(f_t^S), f^N, w^N, w^S) \equiv \pi_t^{S,\text{prem}}(\theta)$, while $\pi^{S,prem}(\theta)$ refers to the per-period offshoring profit premium when there is no remaining uncertainty in the industry, i.e. when the true fixed cost has been revealed.

D.1 Proofs regarding Bayesian learning mechanism

After $t = 0$, firms sourcing domestically update their prior knowledge by observing the "physical state". By applying recursively Bayes rule, firms update every period their beliefs. The posterior distribution at time t is given by:

$$Y(f^S | f^S \leq f_t^S) = \frac{Y(f^S | f^S \leq f_{t-1}^S) Y(f_t^S | f^S)}{Y(f_t^S | f^S \leq f_{t-1}^S)}$$

where $Y(f^S | f^S \leq f_{t-1}^S)$ indicates the prior distribution at time t, $Y(f_t^S | f^S)$ refers to the likelihood function, and the denominator is the scaling factor.

The likelihood takes the following form:

$$Y(f_t^S | f^S) = \begin{cases} 1 & \text{if } f_t \geq f^S \\ 0 & \text{if } f_t < f^S \end{cases}$$

Therefore, the posterior distribution is represented by:

$$Y(f^S | f^S \leq f_t^S) = \frac{Y(f^S | f^S \leq f_{t-1}^S)}{Y(f_t^S | f^S \leq f_{t-1}^S)}$$

which is similar to the learning mechanisms characterized by Rob (1991) and Segura-Cayuela and Vilarrubia (2008).

On the other hand, if a firm who explored offshoring in the period $t-1$ is doing domestic sourcing during period t, then this reveals that this firm has made a mistake. After paying the sunk cost, this firm learned that the true fixed cost in South is too high for her, i.e. she would obtain negative per-period offshoring profit premiums.

Therefore, given the assumption of a continuum of firms, this situation implies that the true fixed cost in South has been revealed and it corresponds to the maximum affordable fixed cost in South of the least productive firm doing offshoring in t.

As a summary, the knowledge that firms have before taking the offshoring decision in period t is given by:

$$f^S \sim \begin{cases} Y(f^S) & \text{with } f^S \in [\underline{f}^S, \bar{f}^S] \text{ for } t=0 \\ Y(f^S | f^S \leq f_t^S) & \text{if } \tilde{f}_t^S = f_t^S < f_{t-1}^S \text{ for } t>0 \\ f_t^S & \text{if } \tilde{f}_t^S < f_t^S \text{ for } t>0 \end{cases} \tag{85}$$

D.2 Proof of the OSLA rule as optimal policy

The Bellman's equation takes the form:

$$\mathcal{V}_t(\theta;\theta_t) = \max\left\{V_t^o(\theta;\theta_t); \lambda_j \mathbb{E}_t\left[\mathcal{V}_{t+1}(\theta;\theta_{t+1})\right]\right\}$$
$$\mathcal{V}_t(\theta;\theta_t) = \max\left\{\mathbb{E}_t\left[\max\left\{0; \sum_{\tau=t}^{\infty}\lambda^{\tau-t}\pi_\tau^{S,prem}(\theta)\right\}\middle| f^S \leq f_t^S\right] - w^N s^r; \lambda\mathbb{E}_t\left[\mathcal{V}_{t+1}(\theta;\theta_{t+1})\right]\right\}$$

The goal is to find the optimal policy, which defines how many periods it is optimal to wait given the information set at t.

$$\begin{aligned} a \in \arg\max_{a\in\{0,1\}} \mathcal{V}_t(\theta;\theta_t) =& a\left[\mathbb{E}_t\left[\max\left\{0; \sum_{\tau=t}^{\infty}\lambda^{\tau-t}\pi_\tau^{S,prem}(\theta)\right\}\middle| f^S \leq f_t^S\right] - w^N s^r\right] \\ &+ (1-a)\lambda\mathbb{E}_t\left[\mathcal{V}_{t+1}(\theta;\theta_{t+1}, a')\right] \end{aligned}$$

where $a=1$ denotes the action of trying offshoring in period t, while $a=0$ refers to waiting.

Solution by policy iteration. By policy iteration, it is possible to prove that the One-Step-Look-Ahead (OSLA) rule is the optimal policy. In other words, that in expectation at t, waiting for one period dominates waiting for more periods.

At any given point in time, all the firms sourcing domestically have an expected flow of new information for every future period. According to this, the firms know they can obtain gains from waiting, by receiving new information and take the offshoring decision at a later period under a reduced uncertainty, or eventually with certainty if the true fixed cost has been revealed during the waiting period(s). However, the firms also face an opportunity cost of waiting, which is given by the offshoring profit premium that the firms can obtain by exploring the South in the current period and discovering their respective offshoring potential.

Let's define as $V_t^{w,1}(.), ..., V_t^{w,n}(.)$ the value of waiting in t for $1, ..., n$ periods, respectively.

$$\begin{aligned} V_t^{w,1}(\theta;\theta_t,\theta_{t+1}) =& 0 + \frac{\left[Y(f_t^S) - Y(f_{t+1}^S)\right]}{Y(f_t^S)}\lambda\mathbb{E}_t\left[\max\left\{0; \frac{\pi^{S,prem}(\theta)}{1-\lambda} - w^N s^r\right\}\middle| f_{t+1}^S < f^S \leq f_t^S\right] \\ &+ \frac{Y(f_{t+1}^S)}{Y(f_t^S)}\lambda\left[\mathbb{E}_t\left[\max\left\{0; \sum_{\tau=t+1}^{\infty}\lambda^{\tau-t-1}\pi_\tau^{S,prem}(\theta)\right\}\middle| f^S \leq f_{t+1}^S\right] - w^N s^r\right] \\ V_t^{w,2}(\theta;\theta_t,\theta_{t+2}) =& 0 + \frac{\left[Y(f_t^S) - Y(f_{t+2}^S)\right]}{Y(f_t^S)}\lambda^2\mathbb{E}_t\left[\max\left\{0; \frac{\pi^{S,prem}(\theta)}{1-\lambda} - w^N s^r\right\}\middle| f_{t+2}^S < f^S \leq f_t^S\right] \\ &+ \frac{Y(f_{t+2}^S)}{Y(f_t^S)}\lambda^2\left[\mathbb{E}_t\left[\max\left\{0; \sum_{\tau=t+2}^{\infty}\lambda^{\tau-t-2}\pi_\tau^{S,prem}(\theta)\right\}\middle| f^S \leq f_{t+2}^S\right] - w^N s^r\right] \\ &\vdots \end{aligned}$$

$$V_t^{w,n}(\theta;\theta_t,\theta_{t+n}) = 0 + \frac{\left[Y(f_t^S) - Y(f_{t+n}^S)\right]}{Y(f_t^S)}\lambda^n \mathbb{E}_t\left[\max\left\{0; \frac{\pi^{S,prem}(\theta)}{1-\lambda} - w^N s^r\right\}\Big| f_{t+n}^S < f^S \leq f_t^S\right]$$
$$+ \frac{Y(f_{t+n}^S)}{Y(f_t^S)}\lambda^n \left[\mathbb{E}_t\left[\max\left\{0; \sum_{\tau=t+n}^{\infty}\lambda^{\tau-t-n}\pi_\tau^{S,prem}(\theta)\right\}\Big| f^S \leq f_{t+n}^S\right] - w^N s^r\right]$$

It is straightforward to see:

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

The relevant analysis consists in the case when a firm θ faces a trade-off in her decision. This situation takes place when the value of offshoring for the firm θ in period t is non-negative, i.e. $V_t^o(\theta;.) \geq 0$, but nevertheless she can reduce the risk of exploring offshoring in t by waiting n periods for new incoming information[84]. In this situation, considering the decision characterised in section 2.2.3, the firm θ must decide what is the optimal number of periods for waiting and compare it to the value of offshoring in t in order to decide whether she will explore her offshoring potential or wait.

Therefore, if we narrow the analysis to the firms with a non-negative value of offshoring, i.e. $V_t^o(\theta;.) \geq 0$, thence it is easy to see that for each of these firms the value of waiting for any period $n = 1, ..., \infty$ is non-negative, i.e. $V_t^{w,n}(\theta;.) \geq 0 \forall n$.

So we go one step further in analysing this trade-off situation, and define the number of periods that, in expectation at t, a firm θ finds optimal to wait. In this regard, following a similar argument as Segura-Cayuela and Vilarrubia (2008), we begin with the case of the marginal firm which compares the value of exploring offshoring now with the value of waiting for one period and explore in the next one, i.e. $\mathcal{D}_t(\theta;.) = V_t^0(\theta;.) - V_t^{w,1}(\theta;.) = 0$.

The argument of the proof is as follows. The value of waiting for n periods before exploring the offshoring potential falls at a rate of λ^n for firms that weakly prefer exploring the offshore potential now than waiting for one period. Since $\lambda < 1$, waiting for any number of periods $n > 1$ is dominated by waiting for only one period. In other words, given Assumption A.5, if waiting for the information revealed in one period does not convince a firm to wait, waiting for two or more periods is less preferred, as the new information revealed every futher period is less. Therefore, to characterise the optimal equilibrium path it is only necessary to consider those firms who are deciding between exploring the offshoring potential in the current period or wait for one period.

We start by comparing the value of waiting for one period with the value of waiting for two periods, i.e. $V_t^{w,1}(\theta;.); V_t^{w,2}(\theta;.)$. As mentioned above, we focus the analysis in the marginal firm, i.e. the firm indifferent between explore offshoring today or wait for one period. Formally[85],

$$\mathcal{D}_t(\theta;\theta_t,\tilde{\theta}_{t+1}) = V_t^o(\theta;\theta_t) - V_t^{w,1}(\theta;\theta_t,\tilde{\theta}_{t+1}) = 0$$
$$= \max\left\{0; \mathbb{E}_t\left[\pi_t^{S,prem}(\theta)\Big| f^S \leq f_t^S\right]\right\} - w^N s^r\left[1 - \lambda\frac{Y(f_{t+1}^S)}{Y(f_t^S)}\right]$$
$$+ \frac{\left[Y(f_t^S) - Y(f_{t+1}^S)\right]}{Y(f_t^S)}\lambda\mathbb{E}_t\left[\max\left\{0; \frac{\pi^{S,prem}(\theta)}{1-\lambda}\right\}\right.$$
$$\left. - \max\left\{0; \frac{\pi^{S,prem}(\theta)}{1-\lambda} - w^N s^r\right\}\Big| f_{t+1}^S < f^S \leq f_t^S\right] = 0$$

[84] Otherwise, the firms who have a negative value of offshoring in t, i.e. $V_t^o(\theta;.) < 0$, are not facing any trade-off in their decisions. In other words, they do not confront any dilemma, given that exploring their offshoring potential in t is not attractive, therefore they do not face any opportunity cost from waiting.

[85] We show the derivation of the trade-off function in the main part of the paper, and the respective proofs are in Appendix D.3.

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

$$
\begin{aligned}
\mathcal{D}_t(\theta;\theta_t,\tilde{\theta}_{t+2}) &= V_t^o(\theta;\theta_t) - V_t^{w,2}(\theta;\theta_t,\tilde{\theta}_{t+2}) \\
&= \max\left\{0;\mathbb{E}_t\left[\pi_t^{S,prem}(\theta)+\lambda\pi_{t+1}^{S,prem}(\theta)\Big|f^S\le f_t^S\right]\right\} - w^N s^r\left[1-\lambda^2\frac{Y(f_{t+2}^S)}{Y(f_t^S)}\right] \\
&+ \frac{[Y(f_t^S)-Y(f_{t+2}^S)]}{Y(f_t^S)}\lambda^2\mathbb{E}_t\Bigg[\max\left\{0;\frac{\pi^{S,prem}(\theta)}{1-\lambda}\right\} \\
&- \max\left\{0;\frac{\pi^{S,prem}(\theta)}{1-\lambda}-w^N s^r\right\}\Big|f_{t+2}^S<f^S\le f_t^S\Bigg]
\end{aligned}
$$

We consider the case in which the third term of the RHS is zero for both trade-off functions[86]. Therefore, the trade-off functions become:

$$
\begin{aligned}
\mathcal{D}_t(\theta;\theta_t,\tilde{\theta}_{t+1}) &= \mathbb{E}_t\left[\pi_t^{S,prem}(\theta)\Big|f^S\le f_t^S\right] - w^N s^r\left[1-\lambda\frac{Y(f_{t+1}^S)}{Y(f_t^S)}\right] \\
\mathcal{D}_t(\theta;\theta_t,\tilde{\theta}_{t+2}) &= \mathbb{E}_t\left[\pi_t^{S,prem}(\theta)+\lambda\pi_{t+1}^{S,prem}(\theta)\Big|f^S\le f_t^S\right] - w^N s^r\left[1-\lambda^2\frac{Y(f_{t+2}^S)}{Y(f_t^S)}\right]
\end{aligned}
$$

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

$$
\begin{aligned}
&V_t^0(\theta;.)-V_t^{w,1}(\theta;.)-\left[V_t^0(\theta;.)-V_t^{w,2}(\theta;.)\right]\overset{!}{<}0 \\
\Leftrightarrow &V_t^{w,2}(\theta;.)-V_t^{w,1}(\theta;.)\overset{!}{<}0
\end{aligned}
$$

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

$$
\mathbb{E}_t\left[\pi_{t+1}^{S,prem}(\theta)\Big|f^S\le f_t^S\right]\overset{!}{>}w^N s^r\left[\frac{Y(f_{t+1}^S)}{Y(f_t^S)}-\lambda\frac{Y(f_{t+2}^S)}{Y(f_t^S)}\right]
$$

From the marginal firm condition above, we know:

$$
\mathbb{E}_t\left[\pi_t^{S,prem}(\theta)\Big|f^S\le f_t^S\right]=w^N s^r\left[1-\lambda\frac{Y(f_{t+1}^S)}{Y(f_t^S)}\right]
$$

By Assumtion A.5,

$$
1-\lambda Y\left(f_{t+1}^S|f^S\le f_t^S\right)>Y\left(f_{t+1}^S|f^S\le f_t^S\right)-\lambda Y\left(f_{t+2}^S|f^S\le f_t^S\right)
$$

and thus,

$$
\begin{aligned}
&\mathbb{E}_t\left[\pi_{t+1}^{S,prem}(\theta)\Big|f^S\le f_t^S\right]>w^N s^r\left[\frac{Y(f_{t+1}^S)}{Y(f_t^S)}-\lambda\frac{Y(f_{t+2}^S)}{Y(f_t^S)}\right] \\
\Rightarrow &V_t^{w,2}(\theta;.)-V_t^{w,1}(\theta;.)<0
\end{aligned}
$$

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

$$
V_t^{w,1}(\theta;.)>V_t^{w,2}(\theta;.)>....>V_t^{w,n}(\theta;.)
$$

In other words, for those firms in a trade-off condition, in expectation at t, waiting for one period domintates waiting for longer periods.

Given that our interest concentrates in modelling the "offshoring vs. waiting" trade-off and characterising the decision rule that drives the movements of the offshoring productivity cutoff at every period t, we consider it is sufficient to focus on the case for which $V_t^o(\theta;.)\ge 0$, i.e. when firms face a non-negative value of offshoring[87].

[86]This assumption allows us to focus in the most restrictive condition. It can be easily shown that if the value of waiting for one period is optimal in this case, it is also optimal in the other cases.

[87]We show here that there is no degeneration in firms' choices when $V_t^o(\theta;.)<0$. In other words, we show that there is no reversion of the trade-off function sign under this situation, so firms will never find it optimal to explore offshoring in t when

Thus, using the result that OSLA is the optimal rule under this condition, the optimal value function takes the following expression:

$$\mathcal{V}_t(\theta;\theta_t) = \max\left\{\mathbb{E}_t\left[\max\left\{0;\sum_{\tau=t}^{\infty}\lambda^{\tau-t}\pi_{\tau}^{S,prem}(\theta)\right\}\middle| f^S \leq f_t^S\right] - w^N s^r; V_t^{w,1}(\theta;\theta_t,\theta_{t+1})\right\}$$

and by the transformation explained in section 2.2.3, we obtain the trade-off function.

D.3 Derivation of the trade-off function

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

Decomposing the value of offshoring,

$$\begin{aligned} V_t^o(\theta;.) =& \max\left\{0;\mathbb{E}_t\left[\pi_t^{S,prem}(\theta)\middle| f^S \leq f_t^S\right]\right\} - w^N s^r \\ &+ \frac{[Y(f_t^S) - Y(f_{t+1}^S)]}{Y(f_t^S)}\lambda\mathbb{E}_t\left[\max\left\{0;\frac{\pi^{S,prem}(\theta)}{1-\lambda}\right\}\middle| f_{t+1}^S < f^S \leq f_t^S\right] \\ &+ \frac{Y(f_{t+1}^S)}{Y(f_t^S)}\lambda\mathbb{E}_t\left[\max\left\{0;\sum_{\tau=t+1}^{\infty}\lambda^{\tau-t-1}\pi_{\tau}^{S,prem}(\theta)\right\}\middle| f^S \leq f_{t+1}^S\right] \end{aligned}$$

Note that $\frac{[Y(f_t^S)-Y(f_{t+1}^S)]}{Y(f_t^S)}$ denotes the probability that the true fixed cost is revealed in period t, while $\frac{Y(f_{t+1}^S)}{Y(f_t^S)}$ is the probability that the true value is not revealed but the uncertainty will reduce given the new information flow.

Going one step further, by introducing the maximum affordable fixed cost of production in South for the firm, i.e. $f^S(\theta)$,

$$\begin{aligned} V_t^o(\theta;.) =& \max\left\{0;\mathbb{E}_t\left[\pi_t^{S,prem}(\theta)\middle| f^S \leq f_t^S\right]\right\} - w^N s^r \\ &+ \frac{[Y(f_t^S) - Y(f^S(\theta))]}{Y(f_t^S)}\lambda 0 \\ &+ \frac{[Y(f^S(\theta)) - Y(f_{t+1}^S)]}{Y(f_t^S)}\lambda\mathbb{E}_t\left[\frac{\pi^{S,prem}(\theta)}{1-\lambda}\middle| f_{t+1}^S < f^S \leq f^S(\theta)\right] \\ &+ \frac{Y(f_{t+1}^S)}{Y(f_t^S)}\lambda\mathbb{E}_t\left[\max\left\{0;\sum_{\tau=t+1}^{\infty}\lambda^{\tau-t-1}\pi_{j,\tau}^{S,prem}(\theta)\right\}\middle| f^S \leq f_{t+1}^S\right] \end{aligned}$$

The probability of true value revealed and above the maximum affordable fixed cost for the firm θ is $\frac{[Y(f_t^S)-Y(f^S(\theta))]}{Y(f_t^S)}$, and the probability of the fixed cost revealed below it is $\frac{[Y(f^S(\theta))-Y(f_{t+1}^S)]}{Y(f_t^S)}$.

$$\begin{aligned} \Rightarrow V_t^o(\theta;.) =& \max\left\{0;\mathbb{E}_t\left[\pi_t^{S,prem}(\theta)\middle| f^S \leq f_t^S\right]\right\} - w^N s^r \\ &+ \frac{[Y(f^S(\theta)) - Y(f_{t+1}^S)]}{Y(f_t^S)}\lambda\mathbb{E}_t\left[\frac{\pi^{S,prem}(\theta)}{1-\lambda}\middle| f_{t+1}^S < f^S \leq f^S(\theta)\right] \\ &+ \frac{Y(f_{t+1}^S)}{Y(f_t^S)}\lambda\mathbb{E}_t\left[\sum_{\tau=t+1}^{\infty}\lambda^{\tau-t-1}\pi_{\tau}^{S,prem}(\theta)\middle| f^S \leq f_{t+1}^S\right] \end{aligned}$$

$V_t^o(\theta;.) < 0$. If $V_t^{w,n}(\theta;.) \geq 0$, then the trade-off function $\mathcal{D}(\theta;.)$ is negative for any waiting period n with a positive value of waiting.

On the other hand, from a first sight it is possible to think that if $V_t^{w,n}(\theta;.) < 0$ this may result in a positive value for the trade-off function $\mathcal{D}(\theta;.)$. It is easy to see that in these cases $|V_t^o(\theta;.)| > |V_t^{w,n}(\theta;.)|$. Therefore, the trade-off function is still negative in all those cases.

In consequence, when the value of offshoring in t is negative, the trade-off function leads to a waiting decision. However, the number of periods that these firms find optimal to wait depends on the productivity level of each of them. Sufficiently low productive firms, for which $V_t^{w,n}(\theta;.) < 0 \forall n$, find it optimal to wait infinite periods. On the other hand, firms relatively more productive than the previous ones find it optimal to wait a finite number of periods, which is decreasing in the productivity of the firms.

On the other hand, with an equivalent decomposition for the value of waiting one period,

$$V_t^{w,1}(\theta;.) = 0 + \frac{\left[Y(f_t^S) - Y(f_{t+1}^S)\right]}{Y(f_t^S)}\lambda \mathbb{E}_t\left[\max\left\{0; \frac{\pi^{S,prem}(\theta)}{1-\lambda} - w^N s^r\right\}\Big| f_{t+1}^S < f^S \leq f_t^S\right]$$
$$+ \frac{Y(f_{t+1}^S)}{Y(f_t^S)}\lambda\left[\mathbb{E}_t\left[\max\left\{0; \sum_{\tau=t+1}^{\infty}\lambda^{\tau-t-1}\pi_\tau^{S,prem}(\theta)\right\}\Big| f^S \leq f_{t+1}^S\right] - w^N s^r\right]$$

$$V_t^{w,1}(\theta;.) = 0 + \frac{\left[Y(f_t^S) - Y(f^S(\theta))\right]}{Y(f_t^S)}\lambda 0 + \frac{\left[Y(f^S(\theta)) - Y(f_{t+1}^S)\right]}{Y(f_t^S)}$$
$$\times \lambda \mathbb{E}_t\left[\max\left\{0; \frac{\pi^{S,prem}(\theta)}{1-\lambda} - w^N s^r\right\}\Big| f_{t+1}^S < f^S \leq f_t^S\right]$$
$$+ \frac{Y(f_{t+1}^S)}{Y(f_t^S)}\lambda\left[\mathbb{E}_t\left[\sum_{\tau=t+1}^{\infty}\lambda^{\tau-t-1}\pi_\tau^{S,prem}(\theta)\Big| f^S \leq f_{t+1}^S\right] - w^N s^r\right]$$

$$\Rightarrow V_t^{w,1}(\theta;.) = \frac{\left[Y(f^S(\theta)) - Y(f_{t+1}^S)\right]}{Y(f_t^S)}\lambda$$
$$\times \mathbb{E}_t\left[\max\left\{0; \frac{\pi^{S,prem}(\theta)}{1-\lambda} - w^N s^r\right\}\Big| f_{t+1}^S < f^S \leq f^S(\theta)\right]$$
$$+ \frac{Y(f_{t+1}^S)}{Y(f_t^S)}\lambda\left[\mathbb{E}_t\left[\sum_{\tau=t+1}^{\infty}\lambda^{\tau-t-1}\pi_\tau^{S,prem}(\theta)\Big| f^S \leq f_{t+1}^S\right] - w^N s^r\right]$$

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

$$\mathcal{D}_t(\theta;.) = \max\left\{0; \mathbb{E}_t\left[\pi_t^{S,prem}(\theta)\Big| f^S \leq f_t^S\right]\right\} - w^N s^r\left[1 - \lambda\frac{Y(f_{t+1}^S)}{Y(f_t^S)}\right]$$
$$+ \frac{[Y(f_t^S) - Y(f_{t+1}^S)]}{Y(f_t^S)}\lambda \mathbb{E}_t\left[\max\left\{0; \frac{\pi^{S,prem}(\theta)}{1-\lambda}\right\}\right.$$
$$\left. - \max\left\{0; \frac{\pi^{S,prem}(\theta)}{1-\lambda} - w^N s^r\right\}\Big| f_{t+1}^S < f^S \leq f_t^S\right] \tag{86}$$

$$\mathcal{D}_t(\theta;.) = \max\left\{0; \mathbb{E}_t\left[\pi_t^{S,prem}(\theta)\Big| f^S \leq f_t^S\right]\right\} - w^N s^r\left[1 - \lambda\frac{Y(f_{t+1}^S)}{Y(f_t^S)}\right]$$
$$+ \frac{[Y(f(\theta)) - Y(f_{t+1}^S)]}{Y(f_t^S)}\lambda \mathbb{E}_t\left[\frac{\pi^{S,prem}(\theta)}{1-\lambda}\right.$$
$$\left. - \max\left\{0; \frac{\pi^{S,prem}(\theta)}{1-\lambda} - w^N s^r\right\}\Big| f_{t+1}^S < f^S \leq f^S(\theta)\right] \tag{87}$$

Proposition 1 implies that the probability of the true value being revealed below the maximum affordable fixed cost for the firm θ is zero. If it is not zero, this means that a firm with a lower productivity (i.e. $\tilde{\theta}_{t+1} < \theta$) has tried offshoring before the firm θ, which is not possible due to Proposition 1. In other words, given the sequential shape of the offshoring equilibrium path, led by the most productive firms in the market, a firm θ will discover her positive offshoring potential by waiting with probability zero.

Therefore, the trade off function becomes:

$$\mathcal{D}_t(\theta;\theta_t,\tilde{\theta}_{t+1}) = \max\left\{0; \mathbb{E}_t\left[\pi_t^{S,prem}(\theta)\Big| f^S \leq f_t^S\right]\right\} - w^N s^r\left[1 - \lambda\frac{Y(f_{t+1}^S)}{Y(f_t^S)}\right]$$

D.4 Proof of Proposition 1

From section 2.1, it is clear that the offshoring profit premium $\pi^{S,prem}(\theta)$ is increasing in θ.

Thence, taking the trade off function expression from equation (86), it is straightforward to see that $\frac{\partial \mathcal{D}_t(\theta;\theta_t,\tilde{\theta}_{t+1})}{\partial\theta} \geq 0$.

D.5 Proof of Proposition 2

$$\mathcal{D}_t(\tilde{\theta}_{t+1};\theta_t,\tilde{\theta}_{t+1}) = 0$$

$$\mathbb{E}_t[\pi_t^{S,prem}(\tilde{\theta}_{t+1})|f^S \leq f_t^S] - w^N s^r \left[1 - \lambda \frac{Y(\tilde{f}_{t+1}^S)}{Y(f_t^S)}\right] = 0$$

Replacing $\pi_t^{S,prem}(\tilde{\theta}_{t+1})$ with expressions for $\pi_t^S(\tilde{\theta}_{t+1})$ and $\pi_t^N(\tilde{\theta}_{t+1})$ from equation (43),

$$\tilde{\theta}_{t+1}^{\sigma-1}[(1-\gamma_0)E]^{\sigma}\tilde{Q}_{t+1}^{1-\sigma}[\psi^S - \psi^N] = w^N \left[E_t(f^S|f^S \leq f_t^S) - f^N + s^r \left(1 - \lambda \frac{Y(\tilde{f}_{t+1}^S)}{Y(f_t^S)}\right)\right]$$

$$\tilde{\theta}_{t+1} = [(1-\gamma_0)E]^{\frac{\sigma}{1-\sigma}}\tilde{Q}_{t+1} \left[\frac{w^N \left[E_t(f^S|f^S \leq f_t^S) - f^N + s^r \left(1 - \lambda \frac{Y(\tilde{f}_{t+1}^S)}{Y(f_t^S)}\right)\right]}{\psi^S - \psi^N}\right]^{\frac{1}{\sigma-1}}$$

D.6 Proofs of Propositions 3, 4 (long-run properties)

By *Assumption A.6*,

$$\mathcal{D}_t(\bar{\bar{\theta}};\bar{\bar{\theta}},\bar{\bar{\theta}}) > 0$$

$$\mathbb{E}_t[\pi_t^{S,prem}(\bar{\bar{\theta}})|f^S \leq \bar{f}^S] - w^N s^r(1-\lambda) > 0$$

$$\frac{r_t^{N,*}(\bar{\bar{\theta}})}{\sigma}W(.) - w^N E_t(f^S|f^S \leq \bar{f}^S) - w^N[s^r(1-\lambda) - f^N] > 0$$

Taking the limit of the trade off function as $t \to \infty$,

$$\mathcal{D}(\theta_\infty;\theta_\infty,\theta_\infty) = \frac{r^{N,*}(\theta_\infty)}{\sigma}W(.) - w^N E\left(f^S|f^S \leq f_\infty^S\right) - w^N\left[s^r(1-\lambda) - f^N\right]$$

Totally differentiating $\mathcal{D}(\theta_\infty;\theta_\infty,\theta_\infty)$ with respect to each of its arguments:

$$\frac{d\mathcal{D}(\theta_\infty;\theta_\infty,\theta_\infty)}{d\theta_\infty} = \frac{W(.)}{\sigma}\frac{\partial r^{N,*}(\theta_\infty)}{\partial\theta_\infty} - w^N \frac{\partial E(f^S|f^S \leq f_\infty^S)}{\partial f_\infty^S}\frac{\partial f_\infty^S}{\partial\theta_\infty}$$

By equation (11), f_∞^S is given by:

$$f_\infty^S \equiv f^S(\theta_\infty) = \frac{r^N(\theta_\infty)}{\sigma w^N}\left[\left(\frac{w^N}{w^S}\right)^{(1-\eta)(\sigma-1)} - 1\right] + f^N$$

Therefore,

$$\begin{aligned}\frac{d\mathcal{D}(\theta_\infty;\theta_\infty,\theta_\infty)}{d\theta_\infty} &= \frac{W(.)}{\sigma}\frac{dr^{N,*}(\theta_\infty)}{d\theta_\infty} - w^N\frac{W(.)}{w^N\sigma}\frac{dr^{N,*}(\theta_\infty)}{d\theta_\infty}\frac{\partial E(f^S|f^S \leq f_\infty^S)}{\partial f_\infty^S}\\ &= \frac{dr^{N,*}(\theta_\infty)}{d\theta_\infty}\frac{W(.)}{\sigma}\left[1 - \frac{\partial E(f^S|f^S \leq f_\infty^S)}{\partial f_\infty^S}\right]\end{aligned}$$

From this expression, $\frac{dr^{N,*}(\theta_\infty)}{d\theta_\infty} > 0$ and $\frac{W(.)}{\sigma} > 0$.

By *Assumption A.5*,

$$\frac{\partial[f_t^S - E(f^S|f^S \leq f_t^S)]}{\partial f_t^S} > 0 \Rightarrow 1 - \frac{\partial E(f^S|f^S \leq f_t^S)}{\partial f_t^S} > 0$$

$$\Rightarrow \frac{\partial E(f^S|f^S \leq f_t^S)}{\partial f_t^S} < 1$$

Thence, using this assumption, the expression in brackets

$$\left[1 - \frac{\partial E(f^S|f^S \leq f_\infty^S)}{\partial f_\infty^S}\right] > 0$$

Only in the limit, when the distribution collapses with the lower bound,

$$\frac{\partial E(f^S|f^S \leq f_t^S)}{\partial f_t^S} = 1 \Rightarrow \mathcal{D}(\theta_\infty;\theta_\infty,\theta_\infty) = 0$$

Therefore, it is possible to see that this problem has at most one unique fixed point. Therefore, the fixed point defined in Proposition 3 is unique.

E Empirical model

E.1 Two-country model with one intermediate input

Table 13 reports the results for the conditional productivity models with a discrete productivity measure (quintiles) and the interaction term between the latter and the information spillovers. On the other hand, Table 14 shows the respective results for the transition analysis model with an equivalent productivity measure and interaction terms.

Table 13: Regression results - Conditional Probability Model - Extension

	w/ at least 20 firms		w/ at least 50 firms	
	(1)	**(2)**	**(3)**	**(4)**
	Probit	**Probit**	**Probit**	**Probit**
assets tot (quintile 2)	0.497***	0.483***	0.506***	0.431***
	(0.0441)	(0.0439)	(0.0601)	(0.0688)
assets tot (quintile 3)	0.771***	0.768***	0.799***	0.748***
	(0.0481)	(0.0491)	(0.0663)	(0.0789)
assets tot (quintile 4)	0.931***	0.917***	0.983***	0.795***
	(0.0578)	(0.0563)	(0.0802)	(0.0867)
assets tot (quintile 5)	0.988***	0.884***	1.076***	1.108***
	(0.0918)	(0.0885)	(0.112)	(0.152)
min(assets tot offshr)	-26.41		44.30	
	(22.04)		(95.46)	
assets tot (quintile 2) * min(assets tot offshr)	-8.038		-7.465	
	(29.01)		(100.0)	
assets tot (quintile 3) * min(assets tot offshr)	1.256		-53.75	
	(29.62)		(109.0)	
assets tot (quintile 4) * min(assets tot offshr)	0.784		-187.6	
	(36.14)		(127.2)	
assets tot (quintile 5) * min(assets tot offshr)	-83.75		-230.4	
	(81.31)		(150.9)	
sd(assets tot offshr)		-0.714**		1.793
		(0.355)		(1.413)
assets tot (quintile 2) * sd(assets tot offshr)		0.250		1.931
		(0.353)		(1.359)
assets tot (quintile 3) * sd(assets tot offshr)		0.0778		0.797
		(0.436)		(1.652)
assets tot (quintile 4) * sd(assets tot offshr)		0.279		2.878*
		(0.337)		(1.606)
assets tot (quintile 5) * sd(assets tot offshr)		1.728***		-4.029
		(0.641)		(3.716)
constant	-2.112***	-2.094***	-2.164***	-2.258***
	(0.129)	(0.130)	(0.144)	(0.153)
N	15205	15183	12073	12073
pseudo R-sq	0.091	0.091	0.086	0.087

Standard errors in parentheses. ISIC and Year FE included. Robust standard errors.
* p<0.10, ** p<0.05, *** p<0.01

Table 14: Regression results - Model 1: Survival Analysis - Extension

	w/ at least 20 firms		w/ at least 50 firms	
	(1)	(2)	(3)	(4)
	cloglog	cloglog	cloglog	cloglog
ln(t)	-0.281***	-0.286***	-0.289***	-0.380***
	(0.0744)	(0.0741)	(0.0846)	(0.0877)
assets tot (quintile 2)	0.741***	0.696***	0.747***	0.581***
	(0.0940)	(0.0922)	(0.132)	(0.139)
assets tot (quintile 3)	1.081***	1.057***	1.139***	1.040***
	(0.0999)	(0.0993)	(0.142)	(0.155)
assets tot (quintile 4)	1.210***	1.207***	1.364***	1.018***
	(0.118)	(0.114)	(0.170)	(0.166)
assets tot (quintile 5)	1.318***	1.166***	1.383***	1.358***
	(0.175)	(0.153)	(0.214)	(0.254)
min(assets tot offshr)	-45.76		-96.49	
	(70.81)		(225.3)	
assets tot (quintile 2) * min(assets tot offshr)	-30.54		-24.05	
	(83.29)		(238.2)	
assets tot (quintile 3) * min(assets tot offshr)	4.803		-92.52	
	(83.56)		(251.6)	
assets tot (quintile 4) * min(assets tot offshr)	29.53		-326.7	
	(88.39)		(300.2)	
assets tot (quintile 5) * min(assets tot offshr)	-115.6		-263.4	
	(193.5)		(332.0)	
sd(assets tot offshr)		-0.755		1.307
		(0.817)		(2.367)
assets tot (quintile 2) * sd(assets tot offshr)		0.671		4.580*
		(0.854)		(2.672)
assets tot (quintile 3) * sd(assets tot offshr)		0.604		1.726
		(0.918)		(3.165)
assets tot (quintile 4) * sd(assets tot offshr)		0.383		5.774**
		(0.842)		(2.900)
assets tot (quintile 5) * sd(assets tot offshr)		2.367**		-3.072
		(0.953)		(5.952)
constant	-1.757***	-1.762***	-1.659***	-1.741***
	(0.169)	(0.167)	(0.208)	(0.197)
N	15205	15183	12073	12073

Standard errors in parentheses.ISIC 2 dig FE and year of entry included. Robust standard errors.
* $p<0.10$, ** $p<0.05$, *** $p<0.01$

E.2 Multi-country model with one intermediate input

The Table 15 shows the estimation results for the models with the alternative information spillover measures for those firms that are domestically sourcing, i.e. for the first time explorers. On the other hand, Table 16 shows the equivalent results for the firms already offshoring from different locations.

Table 15: Regression results: Conditional Probability Model - Non-offshoring firms

	Exp. sign	**Sectors with at least 20 firms**						**Sectors with at least 50 firms**					
		(1) **Probit**	**(2)** **Probit**	**(3)** **Probit**	**(4)** **Probit**	**(5)** **Probit**	**(6)** **Probit**	**(7)** **Probit**	**(8)** **Probit**	**(9)** **Probit**	**(10)** **Probit**	**(11)** **Probit**	**(12)** **Probit**
ln(assets tot)	+	0.218***	0.218***	0.218***	0.221***	0.221***	0.221***	0.216***	0.216***	0.216***	0.219***	0.219***	0.219***
		(0.00769)	(0.00773)	(0.00771)	(0.00803)	(0.00803)	(0.00803)	(0.00841)	(0.00846)	(0.00843)	(0.00867)	(0.00867)	(0.00867)
ln(rel spillover MIN(minTA)	-	-0.0897***						-0.0895***					
		(0.00729)						(0.00818)					
ln(rel spillover mean(minTA))	-		-0.0960***						-0.0971***				
			(0.00705)						(0.00780)				
ln(rel spillover Wmean(minTA))	-			-0.101***						-0.101***			
				(0.00735)						(0.00822)			
ln(rel spillover MAX(sdTA)	+				-0.00572						-0.000124		
					(0.0117)						(0.0127)		
ln(rel spillover mean(sdTA))	+					-0.00749						-0.00305	
						(0.0119)						(0.0129)	
ln(rel spillover Wmean(sdTA))	+						0.00313						0.0138
							(0.0117)						(0.0128)
ln(market thickness)	+	0.242***	0.239***	0.236***	0.281***	0.281***	0.280***	0.245***	0.241***	0.240***	0.283***	0.283***	0.283***
		(0.00791)	(0.00794)	(0.00791)	(0.00807)	(0.00807)	(0.00807)	(0.00864)	(0.00861)	(0.00862)	(0.00865)	(0.00864)	(0.00865)
ln(mean(income pc))	-	-0.0848***	-0.0838***	-0.0830***	-0.109***	-0.109***	-0.109***	-0.0826***	-0.0815***	-0.0811***	-0.107***	-0.107***	-0.107***
		(0.00914)	(0.00917)	(0.00917)	(0.00943)	(0.00943)	(0.00943)	(0.00990)	(0.00993)	(0.00992)	(0.0101)	(0.0101)	(0.0101)
common language	+	0.143***	0.139***	0.137***	0.159***	0.159***	0.160***	0.120***	0.115***	0.114***	0.148***	0.148***	0.150***
		(0.0305)	(0.0305)	(0.0304)	(0.0315)	(0.0315)	(0.0315)	(0.0336)	(0.0335)	(0.0335)	(0.0342)	(0.0342)	(0.0341)
ln(distance)	-	-0.117***	-0.117***	-0.116***	-0.141***	-0.141***	-0.141***	-0.122***	-0.122***	-0.121***	-0.143***	-0.143***	-0.143***
		(0.0207)	(0.0207)	(0.0207)	(0.0219)	(0.0219)	(0.0219)	(0.0227)	(0.0227)	(0.0227)	(0.0237)	(0.0237)	(0.0237)
constant		-6.080***	-6.344***	-7.442***	-6.853***	-6.852***	-6.806***	-6.155***	-6.402***	-7.510***	-6.929***	-6.931***	-6.765***
		(0.248)	(0.238)	(0.229)	(0.250)	(0.249)	(0.287)	(0.273)	(0.260)	(0.250)	(0.267)	(0.266)	(0.309)
N		628039	628039	628039	430768	430768	430768	558256	558256	558256	395526	395526	395526
pseudo R-sq		0.186	0.186	0.187	0.161	0.161	0.161	0.183	0.184	0.184	0.158	0.158	0.158

ISIC and Year FE included. Standard errors in parentheses. Robust standard errors.
* p<0.10, ** p<0.05, *** p<0.01

Table 16: Regression results: Conditional Probability Model - Offshoring firms

	Exp. sign	Sectors with at least 20 firms						Sectors with at least 50 firms					
		(1) **Probit**	**(2)** **Probit**	**(3)** **Probit**	**(4)** **Probit**	**(5)** **Probit**	**(6)** **Probit**	**(7)** **Probit**	**(8)** **Probit**	**(9)** **Probit**	**(10)** **Probit**	**(11)** **Probit**	**(12)** **Probit**
ln(assets tot)	+	0.243***	0.243***	0.243***	0.243***	0.243***	0.243***	0.245***	0.245***	0.245***	0.244***	0.244***	0.243***
		(0.00217)	(0.00216)	(0.00216)	(0.00243)	(0.00243)	(0.00243)	(0.00237)	(0.00237)	(0.00237)	(0.00260)	(0.00260)	(0.00260)
ln(rel spillover MIN(minTA)	-	-0.0781***						-0.0828***					
		(0.00200)						(0.00220)					
ln(rel spillover mean(minTA))	-		-0.0822***						-0.0859***				
			(0.00205)						(0.00223)				
ln(rel spillover Wmean(minTA))	-			-0.0851***						-0.0889***			
				(0.00208)						(0.00227)			
ln(rel spillover MAX(sdTA)	+				0.0159***						0.0168***		
					(0.00369)						(0.00392)		
ln(rel spillover mean(sdTA))	+					0.0137***						0.0142***	
						(0.00378)						(0.00402)	
ln(rel spillover Wmean(sdTA))	+						0.0142***						0.0141***
							(0.00358)						(0.00383)
ln(market thickness)	+	0.232***	0.230***	0.228***	0.253***	0.253***	0.253***	0.229***	0.227***	0.226***	0.255***	0.256***	0.256***
		(0.00267)	(0.00268)	(0.00267)	(0.00294)	(0.00294)	(0.00293)	(0.00290)	(0.00291)	(0.00291)	(0.00312)	(0.00312)	(0.00311)
ln(mean(income pc))	-	-0.0248***	-0.0243***	-0.0241***	-0.0450***	-0.0449***	-0.0449***	-0.0216***	-0.0211***	-0.0210***	-0.0430***	-0.0428***	-0.0428***
		(0.00285)	(0.00285)	(0.00285)	(0.00318)	(0.00318)	(0.00318)	(0.00310)	(0.00310)	(0.00310)	(0.00339)	(0.00339)	(0.00339)
common language	+	0.167***	0.164***	0.162***	0.192***	0.192***	0.192***	0.165***	0.163***	0.161***	0.192***	0.192***	0.192***
		(0.0112)	(0.0112)	(0.0112)	(0.0118)	(0.0118)	(0.0118)	(0.0123)	(0.0123)	(0.0122)	(0.0128)	(0.0128)	(0.0128)
ln(distance)	-	-0.0411***	-0.0409***	-0.0404***	-0.0407***	-0.0408***	-0.0407***	-0.0432***	-0.0429***	-0.0425***	-0.0447***	-0.0449***	-0.0449***
		(0.00641)	(0.00641)	(0.00640)	(0.00693)	(0.00693)	(0.00693)	(0.00697)	(0.00697)	(0.00696)	(0.00740)	(0.00740)	(0.00740)
constant		-6.337***	-6.586***	-7.511***	-6.777***	-6.793***	-6.634***	-6.252***	-6.526***	-7.494***	-6.839***	-6.857***	-6.700***
		(0.0852)	(0.0830)	(0.0805)	(0.0938)	(0.0935)	(0.105)	(0.0917)	(0.0894)	(0.0865)	(0.0993)	(0.0990)	(0.111)
N		1317889	1317889	1317889	871851	871851	871851	1160882	1160882	1160882	796086	796086	796086
pseudo R-sq		0.141	0.141	0.142	0.121	0.121	0.121	0.142	0.142	0.142	0.119	0.119	0.119

ISIC and Year FE included. Standard errors in parentheses. Robust standard errors.
* p<0.10, ** p<0.05, *** p<0.01

E.2.1 IV approach: multi-country model with one intermediate input

The Tables 17 and 18 show the estimation results for the probit models. We consider only sectors with at least 20 firms in all the specifications.

The columns labeled as full sample refer to the entire set of observations, while the columns named as reduced model consider only those observations included in the respective IV model, i.e. those for which there is a non-missing information spillover measure.

The Table 19 reports the estimation results for the IV model with measures weighted by the inverse of the distance. On the other hand, the Table 20 presents the estimations for the cases of the measures relative to the simple mean of the third countries' values.

We observe that the conclusions are robust to the comparison with respect to any of the samples considered, as well as to the different alternative institutional measures.

Table 17: Regression results: Probit - Non-offshoring firms

	Probit: Non-offshoring firms															
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Sample	**Full**	**Reduced**	**Full**	**Reduced**	**Full**	**Reduced**	**Full**	**Reduced**	**Full**	**Reduced**	**Full**	**Reduced**	**Full**	**Reduced**	**Full**	**Reduced**
ln(assets tot)	0.222***	0.225***	0.222***	0.225***	0.210***	0.216***	0.210***	0.216***	0.190***	0.233***	0.198***	0.233***	0.210***	0.216***	0.210***	0.216***
	(0.00833)	(0.00869)	(0.00833)	(0.00869)	(0.00718)	(0.00765)	(0.00718)	(0.00765)	(0.0113)	(0.00993)	(0.0103)	(0.00993)	(0.00718)	(0.00765)	(0.00718)	(0.00765)
ln(rel Wmean(G.E. est))	-0.0736***	-0.0952***														
	(0.0129)	(0.0145)														
ln(rel mean(G.E. est))			-0.0736***	-0.0956***												
			(0.0129)	(0.0144)												
ln(rel Wmean(G.E. rank))					0.175***	0.000905										
					(0.0244)	(0.0311)										
ln(rel mean(G.E. rank))							0.175***	-0.00477								
							(0.0244)	(0.0309)								
ln(rel Wmean(R.L. est))									-0.0759***	-0.0887***						
									(0.0168)	(0.0202)						
ln(rel mean(R.L. est))											-0.0850***	-0.0811***				
											(0.0129)	(0.0199)				
ln(rel Wmean(R.L. rank))													0.0682***	0.0126		
													(0.0129)	(0.0139)		
ln(rel mean(R.L. rank))															0.0682***	0.0113
															(0.0129)	(0.0138)
ln(market thickness)	0.309***	0.276***	0.309***	0.276***	0.331***	0.293***	0.331***	0.293***	0.447***	0.239***	0.343***	0.240***	0.335***	0.293***	0.335***	0.293***
	(0.00683)	(0.00834)	(0.00683)	(0.00834)	(0.00646)	(0.00747)	(0.00646)	(0.00748)	(0.0180)	(0.00959)	(0.00985)	(0.00958)	(0.00644)	(0.00742)	(0.00644)	(0.00742)
ln(mean(income pc))	-0.0262	0.00915	-0.0262	0.00943	-0.128***	-0.0993***	-0.128***	-0.0979***	-0.128***	0.0958***	0.00449	0.0871***	-0.108***	-0.104***	-0.108***	-0.103***
	(0.0189)	(0.0222)	(0.0189)	(0.0220)	(0.0109)	(0.0123)	(0.0109)	(0.0123)	(0.0347)	(0.0305)	(0.0252)	(0.0297)	(0.00965)	(0.0104)	(0.00965)	(0.0104)
common language	0.381***	0.372***	0.381***	0.373***	0.153***	0.176***	0.153***	0.176***	0.201***	0.434***	0.173***	0.431***	0.168***	0.174***	0.168***	0.174***
	(0.0421)	(0.0416)	(0.0421)	(0.0416)	(0.0328)	(0.0322)	(0.0328)	(0.0322)	(0.0481)	(0.0401)	(0.0489)	(0.0401)	(0.0326)	(0.0318)	(0.0326)	(0.0318)
ln(distance)	0.0339	0.0557	0.0339	0.0558	-0.225***	-0.140***	-0.225***	-0.138***	-0.337***	0.0480	-0.201***	0.0463	-0.208***	-0.145***	-0.208***	-0.145***
	(0.0334)	(0.0351)	(0.0334)	(0.0351)	(0.0222)	(0.0243)	(0.0222)	(0.0243)	(0.0360)	(0.0355)	(0.0327)	(0.0355)	(0.0224)	(0.0233)	(0.0224)	(0.0233)
constant	-10.80***	-10.68***	-9.729***	-9.752***	-5.664***	-7.348***	-7.588***	-7.391***	-10.73***	-10.19***	-9.082***	-9.350***	-7.258***	-7.122***	-8.006***	-7.267***
	(0.462)	(0.531)	(0.386)	(0.455)	(0.444)	(0.594)	(0.244)	(0.313)	(0.454)	(0.642)	(0.361)	(0.535)	(0.330)	(0.381)	(0.239)	(0.276)
N	1259910	454119	1259910	454125	2764215	627975	2764215	627975	1504533	396147	1398125	396159	2783087	628029	2783087	628029
pseudo R-sq	0.267	0.189	0.267	0.189	0.285	0.178	0.285	0.178	0.319	0.194	0.288	0.194	0.285	0.178	0.285	0.178

ISIC and Year FE included. Standard errors in parentheses. Robust standard errors.
* $p<0.10$, ** $p<0.05$, *** $p<0.01$

Table 18: Regression results: Probit - Offshoring firms

	Probit: Offshoring firms															
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**	**(13)**	**(14)**	**(15)**	**(16)**
Sample	**Full**	**Reduced**	**Full**	**Reduced**	**Full**	**Reduced**	**Full**	**Reduced**	**Full**	**Reduced**	**Full**	**Reduced**	**Full**	**Reduced**	**Full**	**Reduced**
ln(assets tot)	0.241***	0.248***	0.241***	0.248***	0.228***	0.239***	0.228***	0.239***	0.206***	0.251***	0.219***	0.251***	0.227***	0.239***	0.227***	0.239***
	(0.00210)	(0.00248)	(0.00210)	(0.00248)	(0.00176)	(0.00215)	(0.00176)	(0.00215)	(0.00281)	(0.00268)	(0.00246)	(0.00268)	(0.00175)	(0.00215)	(0.00175)	(0.00215)
ln(rel Wmean(G.E. est))	0.0349***	-0.0379***														
	(0.00434)	(0.00502)														
ln(rel mean(G.E. est))			0.0349***	-0.0356***												
			(0.00434)	(0.00500)												
ln(rel Wmean(G.E. rank))					0.421***	0.228***										
					(0.0104)	(0.0119)										
ln(rel mean(G.E. rank))							0.421***	0.227***								
							(0.0104)	(0.0119)								
ln(rel Wmean(R.L. est))									-0.162***	-0.00231						
									(0.00346)	(0.00584)						
ln(rel mean(R.L. est))											-0.0493***	0.00173				
											(0.00317)	(0.00577)				
ln(rel Wmean(R.L. rank))													0.222***	0.109***		
													(0.00590)	(0.00588)		
ln(rel mean(R.L. rank))															0.222***	0.109***
															(0.00590)	(0.00588)
ln(market thickness)	0.328***	0.270***	0.328***	0.270***	0.329***	0.278***	0.329***	0.278***	0.391***	0.253***	0.333***	0.253***	0.337***	0.280***	0.337***	0.280***
	(0.00208)	(0.00281)	(0.00208)	(0.00281)	(0.00194)	(0.00251)	(0.00194)	(0.00251)	(0.00403)	(0.00305)	(0.00279)	(0.00304)	(0.00193)	(0.00251)	(0.00193)	(0.00251)
ln(mean(income pc))	-0.107***	-0.0195***	-0.107***	-0.0221***	-0.110***	-0.0893***	-0.110***	-0.0888***	-0.0913***	-0.0163**	-0.00198	-0.0206***	-0.0712***	-0.0691***	-0.0712***	-0.0688***
	(0.00502)	(0.00660)	(0.00502)	(0.00655)	(0.00345)	(0.00417)	(0.00345)	(0.00415)	(0.00696)	(0.00798)	(0.00525)	(0.00788)	(0.00297)	(0.00351)	(0.00297)	(0.00351)
common language	0.248***	0.276***	0.248***	0.275***	0.239***	0.197***	0.239***	0.197***	0.451***	0.282***	0.294***	0.280***	0.272***	0.216***	0.272***	0.216***
	(0.0116)	(0.0132)	(0.0116)	(0.0131)	(0.00984)	(0.0113)	(0.00984)	(0.0113)	(0.0170)	(0.0142)	(0.0146)	(0.0142)	(0.00976)	(0.0111)	(0.00976)	(0.0111)
ln(distance)	-0.0937***	-0.0187**	-0.0937***	-0.0196**	-0.175***	-0.109***	-0.175***	-0.109***	-0.164***	0.00389	-0.131***	0.00340	-0.163***	-0.0950***	-0.163***	-0.0948***
	(0.00730)	(0.00906)	(0.00730)	(0.00906)	(0.00597)	(0.00715)	(0.00597)	(0.00715)	(0.00944)	(0.0101)	(0.00858)	(0.0101)	(0.00597)	(0.00691)	(0.00597)	(0.00691)
constant	-7.766***	-8.179***	-8.273***	-7.779***	-2.930***	-4.116***	-7.560***	-6.573***	-11.25***	-7.571***	-9.017***	-7.512***	-5.772***	-5.787***	-8.204***	-6.954***
	(0.114)	(0.152)	(0.0840)	(0.122)	(0.155)	(0.195)	(0.0678)	(0.0950)	(0.120)	(0.163)	(0.0971)	(0.136)	(0.107)	(0.126)	(0.0665)	(0.0872)
N	2709916	948832	2709916	948839	6133539	1317622	6133539	1317622	3471300	835926	3033728	835941	6164518	1317673	6164518	1317673
pseudo R-sq	0.214	0.135	0.214	0.135	0.249	0.136	0.249	0.136	0.280	0.127	0.233	0.127	0.248	0.136	0.248	0.136

ISIC and Year FE included. Standard errors in parentheses. Robust standard errors.
* p<0.10, ** p<0.05, *** p<0.01

Table 19: Regression results: IV Probit - Weighted mean

	Non-offshoring firms				Offshoring firms			
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
	IV	**IV**	**IV**	**IV**	**IV**	**IV**	**IV**	**IV**
ln(assets tot)	0.00807**	0.0659***	0.0606***	0.0592***	0.0913***	0.0865***	0.110***	0.0969***
	(0.00327)	(0.00519)	(0.00866)	(0.00482)	(0.00327)	(0.00258)	(0.00370)	(0.00259)
ln(rel Wmean(G.E. est))	1.646***				1.492***			
	(0.00483)				(0.00833)			
ln(rel Wmean(G.E. rank))		3.090***				2.937***		
		(0.0248)				(0.0108)		
ln(rel Wmean(R.L. est))			1.612***				1.472***	
			(0.0199)				(0.0102)	
ln(rel Wmean(R.L. rank))				1.842***				1.726***
				(0.0127)				(0.00790)
ln(market thickness)	0.193***	0.0840***	0.207***	0.135***	0.226***	0.101***	0.233***	0.189***
	(0.00372)	(0.00652)	(0.00746)	(0.00567)	(0.00293)	(0.00305)	(0.00300)	(0.00265)
ln(mean(income pc))	-1.702***	-0.954***	-1.633***	-0.747***	-1.483***	-0.899***	-1.531***	-0.674***
	(0.00367)	(0.00629)	(0.0215)	(0.00430)	(0.00754)	(0.00311)	(0.0106)	(0.00295)
common language	-0.600***	-0.303***	-0.754***	0.0171*	-0.303***	-0.239***	-0.609***	0.155***
	(0.00746)	(0.0123)	(0.0268)	(0.00955)	(0.00793)	(0.00666)	(0.0110)	(0.00506)
ln(distance)	-0.685***	-0.705***	-0.306***	-0.643***	-0.544***	-0.621***	-0.238***	-0.566***
	(0.00411)	(0.00808)	(0.0117)	(0.00660)	(0.00451)	(0.00360)	(0.00549)	(0.00329)
N	454119	627975	396147	628029	948832	1317622	835926	1317673
Reduced form								
ln(rel sp Wmean(minTA))	*-0.00166****	*-0.00980****	*-0.0113****	*-0.0147****	*-0.0176****	*-0.00998****	*-0.0203****	*-0.0185****
	(0.000628)	*(0.000286)*	*(0.000648)*	*(0.000497)*	*(0.000459)*	*(0.000203)*	*(0.000471)*	*(0.000348)*

Standard errors in parentheses. ISIC and Year FE included. Robust standard errors. * p<0.10, ** p<0.05, *** p<0.01

Table 20: Regression results: IV Probit - Simple mean

	Non-offshoring firms				**Offshoring firms**			
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
	IV	**IV**	**IV**	**IV**	**IV**	**IV**	**IV**	**IV**
ln(assets tot)	0.0172***	0.0707***	0.0747***	0.0642***	0.103***	0.0921***	0.119***	0.102***
	(0.00377)	(0.00545)	(0.0101)	(0.00511)	(0.00347)	(0.00268)	(0.00390)	(0.00269)
ln(rel mean(G.E. est))	1.623***				1.453***			
	(0.00529)				(0.00985)			
ln(rel mean(G.E. rank))		3.066***				2.917***		
		(0.0276)				(0.0119)		
ln(rel mean(R.L. est))			1.544***				1.424***	
			(0.0268)				(0.0115)	
ln(rel mean(R.L. rank))				1.830***				1.712***
				(0.0142)				(0.00858)
ln(market thickness)	0.199***	0.0898***	0.210***	0.141***	0.233***	0.108***	0.234***	0.194***
	(0.00423)	(0.00692)	(0.00849)	(0.00606)	(0.00305)	(0.00317)	(0.00313)	(0.00274)
ln(mean(income pc))	-1.675***	-0.945***	-1.555***	-0.741***	-1.442***	-0.890***	-1.476***	-0.667***
	(0.00419)	(0.00699)	(0.0285)	(0.00477)	(0.00898)	(0.00345)	(0.0119)	(0.00320)
common language	-0.580***	-0.297***	-0.701***	0.0207**	-0.283***	-0.232***	-0.581***	0.159***
	(0.00900)	(0.0131)	(0.0333)	(0.0103)	(0.00868)	(0.00690)	(0.0120)	(0.00527)
ln(distance)	-0.670***	-0.701***	-0.288***	-0.641***	-0.528***	-0.617***	-0.227***	-0.563***
	(0.00478)	(0.00860)	(0.0138)	(0.00712)	(0.00504)	(0.00377)	(0.00577)	(0.00349)
N	454125	627975	396159	628029	948839	1317622	835941	1317673
Reduced form								
ln(rel sp mean(minTA))	*-0.00329****	*-0.0100****	*-0.0136****	*-0.0152****	*-0.0196****	*-0.0104****	*-0.0218****	*-0.0191****
	(0.000626)	*(0.000284)*	*(0.000654)*	*(0.000493)*	*(0.000458)*	*(0.000203)*	*(0.000477)*	*(0.000347)*

Standard errors in parentheses. ISIC and Year FE included. Robust standard errors. * p<0.10, ** p<0.05, *** p<0.01

E.3 Two-country model with multiple intermediate inputs

Table 21: Regression results - Cond. Prob. Model - Non-offshoring firms - Extension

	Sectors with at least 20 firms				Sectors with at least 50 firms			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
	Linear	**Linear**	**Probit**	**Probit**	**Linear**	**Linear**	**Probit**	**Probit**
assets tot (quintile 2)	0.0000908	0.000188	0.0494*	0.0189	0.0000916	0.000110	0.00302	-0.00203
	(0.000127)	(0.000281)	(0.0261)	(0.0293)	(0.000125)	(0.000273)	(0.0306)	(0.0310)
assets tot (quintile 3)	0.0000741	0.000763*	0.0418	0.0132	0.000173	-0.000127	0.0634*	-0.00577
	(0.000139)	(0.000447)	(0.0294)	(0.0317)	(0.000151)	(0.000336)	(0.0342)	(0.0387)
assets tot (quintile 4)	0.000573***	0.000410	0.0872***	0.0508	0.000495**	0.000223	0.0624*	0.0553
	(0.000194)	(0.000483)	(0.0315)	(0.0393)	(0.000231)	(0.000481)	(0.0357)	(0.0401)
assets tot (quintile 5)	0.00614***	0.00998***	0.537***	0.562***	0.00401***	0.00581***	0.410***	0.436***
	(0.000675)	(0.00145)	(0.0362)	(0.0471)	(0.000652)	(0.00140)	(0.0497)	(0.0560)
min(assets tot offshr)	-0.00580***		-0.910**		-0.00732***		-2.553***	
	(0.000536)		(0.382)		(0.000709)		(0.803)	
assets tot (quintile 2) * min(assets tot offshr)	-0.00105		-0.825		0.000534		0.705	
	(0.000840)		(0.584)		(0.00101)		(0.981)	
assets tot (quintile 3) * min(assets tot offshr)	0.00148		-0.610		-0.00143		-2.227*	
	(0.000940)		(0.609)		(0.000907)		(1.330)	
assets tot (quintile 4) * min(assets tot offshr)	0.00382***		0.794*		0.00509*		2.526***	
	(0.00117)		(0.476)		(0.00292)		(0.872)	
assets tot (quintile 5) * min(assets tot offshr)	0.00123		0.859**		-0.00355		1.923*	
	(0.00110)		(0.386)		(0.00524)		(1.088)	
sd(assets tot offshr)		-0.00386*		-0.220		-0.00337*		-0.385
		(0.00218)		(0.234)		(0.00202)		(0.272)
assets tot (quintile 2) * sd(assets tot offshr)		0.00297		0.335		0.00378		0.520
		(0.00327)		(0.338)		(0.00333)		(0.380)
assets tot (quintile 3) * sd(assets tot offshr)		-0.00742		0.367		0.00704*		0.552
		(0.00711)		(0.271)		(0.00416)		(0.475)
assets tot (quintile 4) * sd(assets tot offshr)		0.0175**		1.274***		0.0204***		1.463***
		(0.00741)		(0.382)		(0.00741)		(0.404)
assets tot (quintile 5) * sd(assets tot offshr)		0.00862		0.521**		0.0371*		1.236***
		(0.0110)		(0.244)		(0.0197)		(0.438)
constant	0.00199***	0.00304***	-3.175***	-2.944***	0.00183***	0.00282***	-3.143***	-2.919***
	(0.0000804)	(0.000185)	(0.0471)	(0.0554)	(0.0000812)	(0.000170)	(0.0500)	(0.0559)
ISIC 4 dig FE	Yes	Yes	No	No	Yes	Yes	No	No
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	996275	402458	996275	402459	929493	387490	929493	387490
R-sq	0.003	0.005			0.001	0.003		
adj. R-sq	0.003	0.005			0.001	0.002		
pseudo R-sq			0.018	0.016			0.020	0.011

Standard errors in parentheses. Robust standard errors.
* p<0.10, ** p<0.05, *** p<0.01

F Uncertainty - multicountry model.

Let's consider the difference between offshoring profit premium with perfect information between firms sourcing from South and from East. For a firm with productivity θ, it is given by:

$$\begin{aligned}\pi^{S,prem}(\theta) - \pi^{E,prem}(\theta) = &\frac{r^N(\theta)}{\sigma}(w^N)^{(1-\eta)(\sigma-1)}\left[\frac{(w^E)^{(1-\eta)(\sigma-1)} - (w^S)^{(1-\eta)(\sigma-1)}}{(w^E w^S)^{(1-\eta)(\sigma-1)}}\right] \\ &- w^N\left[f^S - f^E\right]\end{aligned}$$

Under uncertainty, this expression for a firm θ currently sourcing in East in period t is given by:

$$\begin{aligned}\mathbb{E}_t[\pi^{S,prem}(\theta)|f^S \leq f_t^S] - \pi_t^{E,prem}(\theta) = &\frac{r^N(\theta, Q_t)}{\sigma}(w^N)^{(1-\eta)(\sigma-1)} \\ &\times \left[\frac{(w^E)^{(1-\eta)(\sigma-1)} - (w^S)^{(1-\eta)(\sigma-1)}}{(w^E w^S)^{(1-\eta)(\sigma-1)}}\right] \\ &- w^N\left[\mathbb{E}_t(f^S|f^S \leq f_t^S) - f^E\right]\end{aligned}$$

G Extension: multiple countries with heterogeneous wages and institutional fundamentals

We assume that East and South not only differ in institutional fundamentals, but also in their respective wages.

Assumption A. 16. *Institutions are better in the South but the wages are higher than in the East, i.e.:*

$$w^E < w^S < w^N \text{ and } f^N < f^S + (1-\lambda)s^r < f^E + (1-\lambda)s^r$$

Therefore, as before, profits are given by:

$$\pi^l(\theta, .) = \theta^{\sigma-1}[(1-\gamma_0)E]^\sigma Q^{1-\sigma}\psi^l - w^N f^l \tag{88}$$

with $l = \{N, S, E\}$, and ψ^l is defined as:

$$\psi^l \equiv \frac{\alpha^{\sigma-1}}{\sigma\left[(w^N)^\eta (w^l)^{1-\eta}\right]^{\sigma-1}}$$

Considering Assumption A.16, $\psi^N < \psi^S < \psi^E$, the perfect information equilibrium is represented by Figure 10.

In equilibrium the most productive firms supply the intermediate input from the country with the worst institutional fundamentals (higher fixed costs) exploiting the advantages that come from the lower marginal costs.

However, the firms with intermediate productivity cannot overcome the higher fixed costs with the marginal costs advantages of the East, choosing instead sourcing from the South.

Still, the least productive firms in the market source domestically.

Productivity cutoffs. The market productivity cutoff is still defined as above.

The productivity cutoff for firms offshoring from South, $\theta^{S,*}$, is defined by the condition below.

$$\begin{aligned}\pi^N(\theta^{S,*}) &= \pi^S(\theta^{S,*}) - w^N(1-\lambda)s^r \\ \theta^{S,*} &= [(1-\gamma_0)E]^{\frac{\sigma}{1-\sigma}} Q\left[\frac{w^N[f^S + (1-\lambda)s^r - f^N]}{\psi^S - \psi^N}\right]^{\frac{1}{\sigma-1}}\end{aligned} \tag{89}$$

However, when the marginal cost advantages are too large relative to the institutional disadvantages, no firm will offshore from South. Formally, define $\hat{\theta}^E$ as:

$$\begin{aligned}\pi^N(\hat{\theta}^E) &= \pi^S(\hat{\theta}^E) - w^N(1-\lambda)s^r \\ \hat{\theta}^E &= [(1-\gamma_0)E]^{\frac{\sigma}{1-\sigma}} Q\left[\frac{w^N[f^E + (1-\lambda)s^r - f^N]}{\psi^E - \psi^N}\right]^{\frac{1}{\sigma-1}}\end{aligned}$$

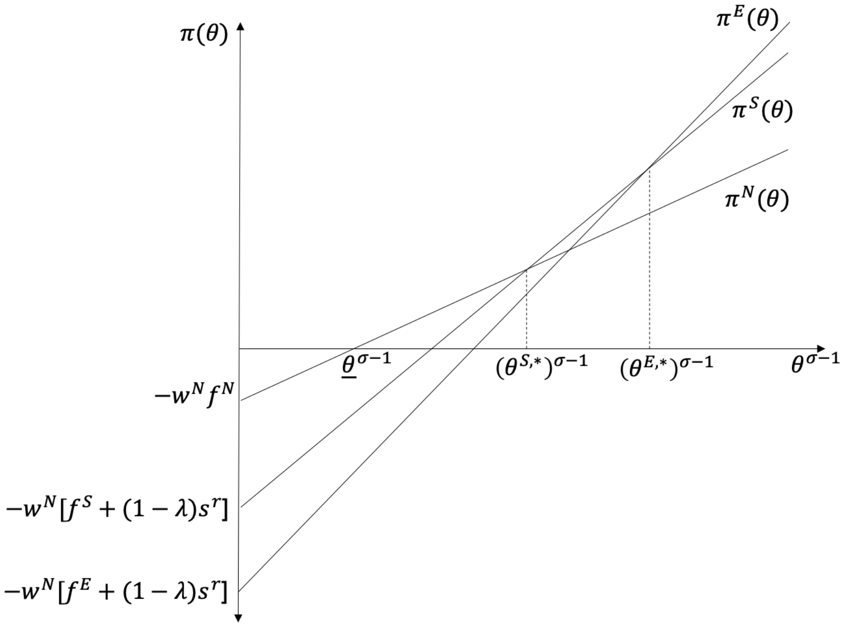

Figure 10: Perfect information equilibrium

Therefore, firm offshore from South, i.e. $\theta^{S,*} < \infty$ iff:

$$\theta^{S,*} < \hat{\theta}^E \Rightarrow \frac{\theta^{S,*}}{\hat{\theta}^E} < 1 \Rightarrow \left[\frac{\psi^E - \psi^N}{\psi^S - \psi^N}\right]^{\frac{1}{\sigma-1}} \left[\frac{f^S + (1-\lambda)s^r - f^N}{f^E + (1-\lambda)s^r - f^N}\right]^{\frac{1}{\sigma-1}} < 1$$

where given Assumption A.16 and A.7:

$$\left[\frac{\psi^E - \psi^N}{\psi^S - \psi^N}\right]^{\frac{1}{\sigma-1}} > 1 \quad \text{and} \quad \left[\frac{f^S + (1-\lambda)s^r - f^N}{f^E + (1-\lambda)s^r - f^N}\right]^{\frac{1}{\sigma-1}} < 1$$

Finally, assuming that $\theta^{S,*} < \hat{\theta}^E$, the offshoring productivity cutoff for firms offshoring from East is defined by:

$$\begin{aligned} \pi^S(\theta^{E,*}) &= \pi^E(\theta^{E,*}) \\ \theta^{E,*} &= [(1-\gamma_0)E]^{\frac{\sigma}{1-\sigma}} Q \left[\frac{w^N(f^E - f^S)}{\psi^E - \psi^S}\right]^{\frac{1}{\sigma-1}} \end{aligned} \tag{90}$$

H Extension: multiple countries and multiple intermediate inputs

H.1 Profit premiums and conditions for offshoring productivity cutoffs

H.1.1 Offshoring profit premium from location l.

We define the offshoring profit premium for each location l and input m. The per-period offshoring profit premium of input m for a firm with productivity θ and a supplier from the South is:

$$\begin{aligned} \pi^{\text{prem}}(\theta; l_m^{S/N}, \boldsymbol{l'}) &\equiv \pi(\theta; l_m^S, \boldsymbol{l'}) - \pi(\theta; l_m^N, \boldsymbol{l'}) \\ &= \frac{r^*(\theta; l_m^N, \boldsymbol{l'})}{\sigma} \left[\left(\frac{c(l_m^N, \boldsymbol{l'})}{c(l_m^S, \boldsymbol{l'})}\right)^{(1-\eta)(\sigma-1)} - 1\right] - w^N[f(l_m^S, \boldsymbol{l'}) - f(l_m^N, \boldsymbol{l'})] \\ &= \frac{r^*(\theta; l_m^N, \boldsymbol{l'})}{\sigma} \left[\left(\frac{c(l_m^N, \boldsymbol{l'})}{c(l_m^S, \boldsymbol{l'})}\right)^{(1-\eta)(\sigma-1)} - 1\right] - w^N[f_m^S - f_m^N] \end{aligned}$$

with $\boldsymbol{l'} = \boldsymbol{l} \setminus \{l_m\}$. In other words, $\boldsymbol{l'}$ is a set with $M-1$ elements and it denotes the given location of all the other intermediate inputs except m.

Equivalently, the per-period offshoring profit premium of input m for a firm with productivity θ and a supplier from the East is:

$$\begin{aligned}\pi^{\text{prem}}(\theta; l_m^{E/N}, \boldsymbol{l'}) &\equiv \pi(\theta; l_m^E, \boldsymbol{l'}) - \pi(\theta; l_m^N, \boldsymbol{l'}) \\ &= \frac{r^*(\theta; l_m^N, \boldsymbol{l'})}{\sigma}\left[\left(\frac{c(l_m^N, \boldsymbol{l'})}{c(l_m^E, \boldsymbol{l'})}\right)^{(1-\eta)(\sigma-1)} - 1\right] - w^N[f(l_m^E, \boldsymbol{l'}) - f(l_m^N, \boldsymbol{l'})] \\ &= \frac{r^*(\theta; l_m^N, \boldsymbol{l'})}{\sigma}\left[\left(\frac{c(l_m^N, \boldsymbol{l'})}{c(l_m^E, \boldsymbol{l'})}\right)^{(1-\eta)(\sigma-1)} - 1\right] - w^N[f_m^E - f_m^N]\end{aligned}$$

H.1.2 Conditions for offshoring productivity cutoffs

The condition for offshoring from South is defined by:

$$\pi\left(\theta, l_m^S, \boldsymbol{l'}\right) - w^N(1-\lambda)\, s^r\left(l_m^S, \boldsymbol{l'}\right) \geq \pi\left(\theta, l_m^N, \boldsymbol{l'}\right) - w^N(1-\lambda) s^r\left(l_m^N, \boldsymbol{l'}\right)$$

The cutoff θ_m^S is defined by the binding case of the condition above. Therefore:

$$\begin{aligned}\pi\left(\theta_m^S, l_m^S, \boldsymbol{l'}\right) - \pi\left(\theta_m^S, l_m^N, \boldsymbol{l'}\right) &= w^N(1-\lambda)\left[s^r\left(l_m^S, \boldsymbol{l'}\right) - s^r\left(l_m^N, \boldsymbol{l'}\right)\right] \\ \pi\left(\theta_m^S, l_m^S, \boldsymbol{l'}\right) - \pi\left(\theta_m^S, l_m^N, \boldsymbol{l'}\right) &= w^N(1-\lambda) s_m^{r,S}\end{aligned}$$

Solving for the productivity cutoff:

$$\theta_m^S = [(1-\gamma_0)E]^{\frac{\sigma}{1-\sigma}} Q\left[\frac{w^N\left[f(l_m^S, \boldsymbol{l'}) - f(l_m^N, \boldsymbol{l'}) + (1-\lambda)s_m^{r,S}\right]}{\psi(l_m^S, \boldsymbol{l'}) - \psi(l_m^N, \boldsymbol{l'})}\right]^{\frac{1}{\sigma-1}}$$

$$\Rightarrow \theta_m^S = [(1-\gamma_0)E]^{\frac{\sigma}{1-\sigma}} Q\left[\frac{w^N\left[f_m^S - f_m^N + (1-\lambda)s_m^{r,S}\right]}{\psi(l_m^S, \boldsymbol{l'}) - \psi(l_m^N, \boldsymbol{l'})}\right]^{\frac{1}{\sigma-1}}$$

Let's temporary define $\theta_m^{E,\bullet}$ as:

$$\begin{aligned}\pi\left(\theta_m^{E,\bullet}, l_m^E, \boldsymbol{l'}\right) - \pi\left(\theta_m^{E,\bullet}, l_m^N, \boldsymbol{l'}\right) &= w^N(1-\lambda)\left[s_m^r\left(l_m^E, \boldsymbol{l'}\right) - s_m^r\left(l_m^N, \boldsymbol{l'}\right)\right] \\ \pi\left(\theta_m^{E,\bullet}, l_m^E, \boldsymbol{l'}\right) - \pi\left(\theta_m^{E,\bullet}, l_m^N, \boldsymbol{l'}\right) &= w^N(1-\lambda) s_m^{r,E}\end{aligned}$$

$$\Rightarrow \theta_m^{E,\bullet} = [(1-\gamma_0)E]^{\frac{\sigma}{1-\sigma}} Q\left[\frac{w^N\left[f_m^E - f_m^N + (1-\lambda)s_m^{r,E}\right]}{\psi(l_m^E, \boldsymbol{l'}) - \psi(l_m^N, \boldsymbol{l'})}\right]^{\frac{1}{\sigma-1}}$$

Therefore, the offshoring productivity cutoff in South for input m is lower than in East when:

$$\frac{\theta_m^S}{\theta_m^{E,\bullet}} = \left[\frac{\psi(l_m^E, \boldsymbol{l'}) - \psi(l_m^N, \boldsymbol{l'})}{\psi(l_m^S, \boldsymbol{l'}) - \psi(l_m^N, \boldsymbol{l'})}\right]^{\frac{1}{\sigma-1}}\left[\frac{f_m^S + (1-\lambda)s_m^{r,S} - f_m^N}{f_m^E + (1-\lambda)s_m^{r,E} - f_m^N}\right]^{\frac{1}{\sigma-1}} < 1$$

Assuming the condition from above holds. The productivity condition for offshoring firms from East in input m, i.e. $\theta \geq \theta_m^E$, is given by:

$$\pi\left(\theta, l_m^E, \boldsymbol{l'}\right) - w^N(1-\lambda)\, s^r\left(l_m^E, \boldsymbol{l'}\right) \geq \pi\left(\theta, l_m^S, \boldsymbol{l'}\right) - w^N(1-\lambda)\, s^r\left(l_m^S, \boldsymbol{l'}\right)$$

Solving for the productivity cutoff in a similar way as before:

$$\theta_m^E = [(1-\gamma_0)E]^{\frac{\sigma}{1-\sigma}} Q\left[\frac{w^N\left[f_m^E - f_m^S + (1-\lambda)\left(s_m^{r,E} - s_m^{r,S}\right)\right]}{\psi(l_m^E, \boldsymbol{l'}) - \psi(l_m^S, \boldsymbol{l'})}\right]^{\frac{1}{\sigma-1}}$$

H.2 Scenario 1: Small open economy

H.2.1 Market share of country N' firms in world market

The aggregate consumption index in the differentiated sector in the world market is $Q = \left[\sum_{N=1}^{\mathbb{N}} \left[Q^N\right]^{\alpha}\right]^{\frac{1}{\alpha}}$, and the aggregate production of final-good producers from country N in is $Q^N = \left[\int_{i\in I^N} [q^N(i)]^{\alpha} di\right]^{\frac{1}{\alpha}}$. Therefore, the world market aggregate consumption index is:

$$Q = \left[\sum_{N=1}^{\mathbb{N}} \int_{i\in I^N} [q^N(i)]^{\alpha} di\right]^{\frac{1}{\alpha}}$$

Dividing both, we have the market share of the country N in the world market economy:

$$\left[\frac{Q_j^N}{Q_j}\right]^{\alpha_j} = \frac{\int_{i\in I_j^N} [q_j^N(i)]^{\alpha_j} di}{\sum_{N=1}^{\mathbb{N}} \int_{i\in I_j^N} [q_j^N(i)]^{\alpha_j} di} \quad \Rightarrow \quad \frac{Q_j^N}{Q_j} = \left[\frac{\int_{i\in I_j^N} [q_j^N(i)]^{\alpha_j} di}{\sum_{N=1}^{\mathbb{N}} \int_{i\in I_j^N} [q_j^N(i)]^{\alpha_j} di}\right]^{\frac{1}{\alpha_j}}$$

H.3 Profit function: slope's differences across locations for input m.

$$\begin{aligned}
\psi(l_m^S, \boldsymbol{l'}) - \psi(l_m^N, \boldsymbol{l'}) =& \frac{\alpha^{\sigma-1}}{\sigma} (w^N)^{\eta(1-\sigma)} \left[c(l_m^S, \boldsymbol{l'})^{(1-\eta)(1-\sigma)} - c(l_m^N, \boldsymbol{l'})^{(1-\eta)(1-\sigma)}\right] \\
=& \frac{\alpha^{\sigma-1}}{\sigma} (w^N)^{\eta(1-\sigma)} \prod_{\substack{m'=1 \\ m'\neq m}}^{M} \left(\frac{\omega_{m'}}{c_{m'}^{l_{m'}}}\right)^{\omega_{m'}(1-\eta)(\sigma-1)} \\
& \times \left[\left(\frac{\omega_m}{c_m^S}\right)^{\omega_m(1-\eta)(\sigma-1)} - \left(\frac{\omega_m}{w^N}\right)^{\omega_m(1-\eta)(\sigma-1)}\right]
\end{aligned}$$

Equivalently,

$$\begin{aligned}
\psi(l_m^E, \boldsymbol{l'}) - \psi(l_m^N, \boldsymbol{l'}) =& \frac{\alpha^{\sigma-1}}{\sigma} (w^N)^{\eta(1-\sigma)} \prod_{\substack{m'=1 \\ m'\neq m}}^{M} \left(\frac{\omega_{m'}}{c_{m'}^{l_{m'}}}\right)^{\omega_{m'}(1-\eta)(\sigma-1)} \\
& \times \left[\left(\frac{\omega_m}{c_m^E}\right)^{\omega_m(1-\eta)(\sigma-1)} - \left(\frac{\omega_m}{w^N}\right)^{\omega_m(1-\eta)(\sigma-1)}\right]
\end{aligned}$$

and

$$\begin{aligned}
\psi(l_m^E, \boldsymbol{l'}) - \psi(l_m^S, \boldsymbol{l'}) =& \frac{\alpha^{\sigma-1}}{\sigma} (w^N)^{\eta(1-\sigma)} \prod_{\substack{m'=1 \\ m'\neq m}}^{M} \left(\frac{\omega_{m'}}{c_{m'}^{l_{m'}}}\right)^{\omega_{m'}(1-\eta)(\sigma-1)} \\
& \times \left[\left(\frac{\omega_m}{c_m^E}\right)^{\omega_m(1-\eta)(\sigma-1)} - \left(\frac{\omega_m}{c_m^S}\right)^{\omega_m(1-\eta)(\sigma-1)}\right]
\end{aligned}$$

H.4 Learning

The maximum affordable fixed costs computed by the firms depend on the offshoring status of the least productive firm offshoring from East in the previous period.

The least productive firm sourcing from the East at the beginning of the period t is denoted as $\theta_{m,t}^E$. In the case that this firm previous sourcing location was a northern supplier, i.e. $d_{m,t-1}^S(\theta_{m,t}^E) = 0$, the maximum affordable fixed cost for that firm in order to remain sourcing from East is given by:

$$\begin{aligned}
\pi_t^{\text{prem}}(\theta_{m,t}^E; l_m^{E/N}, \boldsymbol{l_t'}) = \pi_t(\theta_{m,t}^E; l_m^E, \boldsymbol{l_t'}) - \pi_t(\theta_{m,t}^E; l_m^N, \boldsymbol{l_t'}) = 0 \\
f_{m,t}^E \equiv f_m^E(\theta_{m,t}^E) = \frac{r_t(\theta; l_m^N, \boldsymbol{l_t'})}{w^N \sigma} \left[\left(\frac{c(l_m^N, \boldsymbol{l_t'})}{c(l_m^E, \boldsymbol{l_t'})}\right)^{(1-\eta)(\sigma-1)} - 1\right] + f_m^N
\end{aligned}$$

On the other hand, if the firm $\theta^E_{m,t}$ previous sourcing location of input m was South, i.e. $d^S_{m,t-1}(\theta^E_{m,t}) = 1$, the maximum affordable fixed cost is define by the following condition:

$$\pi^{\text{prem}}_t(\theta^E_{m,t}; l^{E/S}_m, \boldsymbol{l'_t}) = \pi_t(\theta^E_{m,t}; l^E_m, \boldsymbol{l'_t}) - \pi_t(\theta^E_{m,t}; l^S_m, \boldsymbol{l'_t}) = 0$$

$$f^E_{m,t} \equiv f^E_m(\theta^E_{m,t}) = \frac{r_t(\theta; l^N_m, \boldsymbol{l'_t})}{w^N \sigma} \left[\left(\frac{c(l^N_m, \boldsymbol{l'_t})}{c(l^E_m, \boldsymbol{l'_t})} \right)^{(1-\eta)(\sigma-1)} - \left(\frac{c(l^N_m, \boldsymbol{l'_t})}{c(l^S_m, \boldsymbol{l'_t})} \right)^{(1-\eta)(\sigma-1)} \right] + f^S_m$$

with

$$\begin{aligned} \pi^{\text{prem}}_t(\theta^E_{m,t}; l^{E/S}_m, \boldsymbol{l'_t}) &= \pi_t(\theta^E_{m,t}; l^E_m, \boldsymbol{l'_t}) - \pi_t(\theta^E_{m,t}; l^S_m, \boldsymbol{l'_t}) \\ &= \frac{r_t(\theta; l^N_m, \boldsymbol{l'})}{\sigma} \left[\left(\frac{c(l^N_m, \boldsymbol{l'})}{c(l^E_m, \boldsymbol{l'})} \right)^{(1-\eta)(\sigma-1)} - \left(\frac{c(l^N_m, \boldsymbol{l'})}{c(l^S_m, \boldsymbol{l'})} \right)^{(1-\eta)(\sigma-1)} \right] - w^N[f^E_m - f^S_m] \end{aligned}$$

H.5 Convergence analysis: general equilibrium

We relax now the small economy assumption, and characterise the equilibrium path of the entire differentiated sector, considering that the firms modelled here represent the entire universe of firms in that sector. In other words, it is possible to think this section as the case in which there is only one country in North, or alternatively, a situation in which the informational externalities spreads perfectly to all the countries $N \in \mathbb{N}$.

The analysis can still be partially separated across inputs. However, there is a general equilibrium effect through the price index P that links all the sourcing decisions in each period t. Thus, the decisions are taken simultaneously and the solution can be characterised by finding the multidimensional fixed point of the system of equations.

This section builds on the results already obtained for the small economy in section 6.4.5, introducing the modifications implied by the GE effects.

The analysis starts by solving the offshoring productivity cutoffs for each type of inputs, taking $P_t, \tilde{P}_{t+1}$ and thus $Q_t, \tilde{Q}_{t+1}$ as given. Therefore, after the characterisation of the equilibrium path of each type of inputs, we show the general equilibrium sectoral dynamic path by characterising the fixed point of the system of equations that defines the vector of offshoring productivity cutoffs in each period t.

A first effect easy to observe due to the general equilibrium competition effect, already present in the simple model with one intermediate input, is that the market productivity cutoff increases over time $\underline{\theta}_t \uparrow \underline{\theta}^*$, as more firms explore their offshoring potential in the East.

Type I inputs' set:= $\{\boldsymbol{m : m \in M; w^N < c^S_m; w^N < c^E_m}\}$ As before, no firm among the active ones $\theta \geq \underline{\theta}_t$ at any period t find it profitable to explore the offshoring potential from any foreign location. Formally, we have:

$$\theta^{S,\text{initial}}_m = \theta^{S,*}_m \to \infty \; \forall t$$

$$\mathcal{D}^E_{m,t}\left(\bar{\bar{\theta}}; \boldsymbol{\theta_t}, \boldsymbol{\tilde{\theta}_{t+1}}\right) < 0 \; \forall t$$

with $\bar{\bar{\theta}}$ as the most productive firm in the market.

Type II inputs' set := $\{\boldsymbol{m : m \in M; (c^S_m < c^E_m < w^N) \vee (c^S_m < w^N \wedge c^E_m > w^N)}\}$ The exploration of eastern institutions may still take place under the conditions shown in section 6.4.5. However, additional dynamics emerge in relation to the offshoring productivity cutoff in the South, as a result of the increasing competition that comes from the progressively decreasing price index.

The initial offshoring productivity cutoff in input m from South is given by:

$$\theta^{S,\text{initial}}_m = \begin{cases} [(1-\gamma_0)E]^{\frac{\sigma}{1-\sigma}} Q^{\text{initial}} \left[\frac{w^N\left[f^S_m - f^N_m + (1-\lambda)s^{r,S}_m\right]}{\psi(l^S_m, \boldsymbol{l'}) - \psi(l^N_m, \boldsymbol{l'})} \right]^{\frac{1}{\sigma-1}} & \text{if } \leq \bar{\bar{\theta}} \\ \infty & \text{if } > \bar{\bar{\theta}} \end{cases}$$

In the second case, the productivity cutoff is above the productivity level of the most productive firm in the market[88], therefore $\theta^S_{m,t} = \theta^{S,*}_m \to \infty \ \forall t$[89]. In the first case, however, the initial offshoring productivity cutoff is smaller than the perfect information steady state condition, i.e. $\theta^{S,\text{initial}}_m < \theta^{S,*}_m$. Due to the initial lower competition in the market, the firms with productivity $\theta \in [\theta^{S,\text{initial}}_m, \theta^{S,*}_m)$ find it profitable to offshore m from South.

We know that the consumption price index is monotonically decreasing in the vector $\boldsymbol{\theta_t}$, and thus Q_t increases *pari passu*. Therefore, as more firms offshore any intermediate input $m \in M$, the decreasing price index generates that the marginal firms sourcing m from the South must sequentially relocate their supply chain to the North. This *reshoring* strategy is a direct result of the increasing competition in the final goods market.

Formally, the offshoring productivity cutoff in South at the beginning of period t is given by:

$$\theta^{S,\text{initial}}_m \leq \theta^S_{m,t} = [(1-\gamma_0)E]^{\frac{\sigma}{1-\sigma}} Q_t \left[\frac{w^N\left[f^S_m - f^N_m\right]}{\psi(l^S_m, \boldsymbol{l'}) - \psi(l^N_m, \boldsymbol{l'})}\right]^{\frac{1}{\sigma-1}}$$

The expected offshoring productivity cutoff of input $m \in$ Type II in South, as a result of the overall offshoring exploration in t, is denoted as:

$$\tilde{\theta}^S_{m,t+1} = [(1-\gamma_0)E]^{\frac{\sigma}{1-\sigma}} \tilde{Q}_{t+1} \left[\frac{w^N\left[f^S_m - f^N_m\right]}{\psi(l^S_m, \boldsymbol{l'}) - \psi(l^N_m, \boldsymbol{l'})}\right]^{\frac{1}{\sigma-1}}$$

with $\tilde{Q}_{t+1} = Q(\boldsymbol{\tilde{\theta}_{t+1}})$. The offshoring productivity cutoffs in the expression above represents the expected state of the system in $t+1$ for the respective inputs $m \in$ Type II.

Type III inputs' set $:= \left\{\boldsymbol{m : m \in M; (c^E_m < c^S_m < w^N) \vee (c^E_m < w^N \wedge c^S_m > w^N)}\right\}$ We assume that Assumption A.12 still holds. Thus, the offshoring productivity cutoff from East for $m \in$ Type III in period t is given by:

$$\tilde{\theta}^E_{m,t+1} = \begin{cases} [(1-\gamma_0)E]^{\frac{\sigma}{1-\sigma}} \tilde{Q}_{t+1} \left[\frac{w^N\left[\mathbb{E}_t(f^E_m|\mathcal{I}_t) - f^N_m + s^{r,E}_m\left(1-\lambda\frac{Y\left(f^E_{m,t+1}\right)}{Y\left(f^E_{m,t}\right)}\right)\right]}{\psi\left(l^E_m, \boldsymbol{l'_t}\right) - \psi\left(l^N_m, \boldsymbol{l'_t}\right)}\right]^{\frac{1}{\sigma-1}} & \text{if } d^S_{m,t}(\tilde{\theta}^E_{m,t+1}) = 0 \\ [(1-\gamma_0)E]^{\frac{\sigma}{1-\sigma}} \tilde{Q}_{t+1} \left[\frac{w^N\left[\mathbb{E}_t(f^E_m|\mathcal{I}_t) - f^S_m + s^{r,E}_m\left(1-\lambda\frac{Y\left(f^E_{m,t+1}\right)}{Y\left(f^E_{m,t}\right)}\right)\right]}{\psi(l^E_m, \boldsymbol{l'}) - \psi(l^S_m, \boldsymbol{l'})}\right]^{\frac{1}{\sigma-1}} & \text{if } d^S_{m,t}(\tilde{\theta}^E_{m,t+1}) = 1 \end{cases} \tag{91}$$

with $\tilde{\theta}^E_{m,t+1} \to \infty$ for any period t in which the productivity cutoff is larger than $\bar{\bar{\theta}}$.

Regarding the characterisation of the first entrants and the exploration sequence in inputs from East, it is still defined in an equivalent way as before, and Proposition 8 remains valid.

Competition effect and relocation of the supply chain. The initial offshoring productivity cutoff from South for inputs $m \in$ Type III are:

$$\theta^{S,\text{initial}}_m = \begin{cases} [(1-\gamma_0)E]^{\frac{\sigma}{1-\sigma}} Q^{\text{initial}} \left[\frac{w^N\left[f^S_m - f^N_m + (1-\lambda)s^{r,S}_m\right]}{\psi(l^S_m, \boldsymbol{l'}) - \psi(l^N_m, \boldsymbol{l'})}\right]^{\frac{1}{\sigma-1}} < \theta^{S,*}_m & \text{if } \leq \bar{\bar{\theta}} \wedge c^S_m < w^N \\ \infty & \text{if } > \bar{\bar{\theta}} \vee c^S_m \geq w^N \end{cases}$$

[88]This does not take place if the productivity distribution $G(\theta)$ is unbounded on the right, i.e. if $\bar{\bar{\theta}} \to \infty$.

[89]In general terms, $\theta^{S,\text{initial}}_m < \theta^{S,*}_m$ for every $m \in$ Type II. However, if the condition in the first line for an input $m \in$ Type II is larger than $\bar{\bar{\theta}}$, we observe from the initial conditions that input m is at its perfect information offshoring productivity cutoff level, i.e. no firm offshores the input m from South.

The reduction in the price index, and the consequent increasing competition, pushes upwards the offshoring productivity cutoff in South. Thence, the least productive firms initially offshoring from S sequentially move towards domestic suppliers (*reshoring*)[90].

The offshoring productivity cutoff from South at the beginning of period t is given by:

$$\theta_{m,t}^{S} = \begin{cases} [(1-\gamma_0)E]^{\frac{\sigma}{1-\sigma}} Q_t \left[\frac{w^N \left[f_m^S - f_m^N \right]}{\psi(l_m^S, \boldsymbol{l'}) - \psi(l_m^N, \boldsymbol{l'})} \right]^{\frac{1}{\sigma-1}} & \text{if } < \theta_{m,t}^{E} \\ \infty & \text{if } \geq \theta_{m,t}^{E} \end{cases}$$

and the expected offshoring productivity cutoff from South, as a result of the expected overall offshoring exploration in t, is given by:

$$\tilde{\theta}_{m,t+1}^{S} = \begin{cases} [(1-\gamma_0)E]^{\frac{\sigma}{1-\sigma}} \tilde{Q}_{t+1} \left[\frac{w^N \left[f_m^S - f_m^N \right]}{\psi(l_m^S, \boldsymbol{l'}) - \psi(l_m^N, \boldsymbol{l'})} \right]^{\frac{1}{\sigma-1}} & \text{if } < \tilde{\theta}_{m,t+1}^{E} \\ \infty & \text{if } \geq \tilde{\theta}_{m,t+1}^{E} \end{cases}$$

Finally, a sequential relocation of offshoring firms from East takes place for the least relevant inputs and the least offshoring productive firms. The Proposition 8 shows that firms explore the offshoring potential sequentially in inputs, starting from those with larger $\psi(l_m^E, \boldsymbol{l'}) - \psi(l_m^S, \boldsymbol{l'})$ or $\psi(l_m^E, \boldsymbol{l'}) - \psi(l_m^N, \boldsymbol{l'})$, depending on the previous sourcing location of the input.

However, as the competition effect intensifies, the least productive firms offshoring from East the relatively less relevant inputs realise that they are not productive enough to keep offshoring from that location. Therefore, they shift sequentially their supply chain in these inputs to their previous location.

[90] As $P_t \downarrow P^*$, and thus $Q_t \uparrow Q^*$, some inputs m with $\theta_m^{S,\text{initial}} < \bar{\bar{\theta}}$ may be fully reshored if the conditions $\theta_{m,t}^{S} > \bar{\bar{\theta}}$ and $\theta_{m,t}^{E} > \bar{\bar{\theta}}$ hold simultaneously as $t \to \infty$.

Contents