Productivity, Relationship-Specific Inputs and the Sourcing Modes of Multinationals ⋆

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Journal of Economic Behavior & Organization, forthcoming

Abstract

We investigate the roles of productivity and the specificity of inputs for the international sourcing strategy of firms which are part of a multinational network. We present a framework in which firms decide to import from a foreign independent supplier or from their related party abroad according to these two dimensions. We use a detailed survey that provides a detailed geographical breakdown of French firms' imports at the product level as well as the sourcing mode used for each transaction. The dataset also provides information to estimate the firms' productivity and their intensity in relationship-specific inputs. After controlling for countries of origin, products and sectors specific effects, the empirical results provide evidence that for the most productive multinationals the likelihood of trading through an independent supplier is higher especially if they use relationship-specific inputs intensively.

Keywords: Productivity, Incomplete Contracts, Intra-group Trade, Outsourcing.

JEL classification: F23, F14, L22, L23

⋆ A previous version of this paper was circulated under the title "Productivity and the Sourcing Modes of Multinational Firms: Evidence from French Firm-Level Data". We are really grateful to Pol Antràs, Andrew Bernard, Elhanan Helpman, Beata Javorcik, Philippe Martin, Thierry Mayer, Fergal McCann, Gianmarco Ottaviano, Peter Neary, Steve Redding, Frédéric Robert-Nicoud and Jean-Marc Siroen for helpful comments. Thanks to seminar participants at the universities of Aix-Marseille, ESSEC Business School, Strathclyde-Glasgow, Hohenheim University, London School of Economics, UCL-Louvain la Neuve, Oxford, Paris School of Economics, the annual meeting of the Royal Economic Society 2008 (Warwick), ESEM 2008 (Milan), ETSG 2008 (Warsaw) and Econometric Society 2009 (San Francisco).

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1 Introduction

According to the WTO (1996), one-third of world trade is intra-group, whereas another third involves the participation of multinationals in one of the two sides of the exchange. In this paper, we use a unique dataset on the trade activities of French Multinational companies (MNCs) which are part of a multinational network to understand how they organize their sourcing strategies from abroad. These firms may import their intermediate inputs from their network-based related-parties (intra-group trade) or from independent suppliers (outsourcing). As an illustration, consider the French "motor vehicle" industry which is largely globalized. In 1999, year of our observation, the median firm in this sector realizes 19 import transactions from 7 countries. All firms in this sector are part of an international network such as those of Renault, Peugeot-Citroën (PSA) or Deere & co. However, we observe large variations in their sourcing modes. About 8% of these firms import intermediate inputs exclusively from their foreign related parties, while 47% of them import exclusively from outside foreign suppliers. While firms like Iveco (Fiat trucks division) and Mercedes-Benz Molsheim (Mercedes-Benz trucks) import exclusively from related parties, Heuliez Bus (Renault Trucks) and Smart Car (Mercedes-Benz Cars division) exclusively rely on unrelated suppliers. In this paper, we empirically analyze the firm-level choice of multinationals between outsourcing and intra-group trade. [1]

While a vast theoretical literature has been established to examine the determinants of the boundaries of the firm [2], the majority of empirical studies

[1] While the literature usually refers to "intra-firm trade", we prefer the terminology "intra-group trade" which is more adapted for our purpose. To the best or our knowledge, all empirical studies on this question, including ours, consider data on international trade between related parties, without being able to distinguish between direct or indirect affiliations e.g. the US Census Bureau's Related Party Database.

have focused on sector and host country attributes. [3] The role of firm-specific characteristics in explaining the sourcing decision has been underemphasized. We explore how the total factor productivity of a MNC and the intensity of its production process in relationship-specific inputs (henceforth, RSI) affect its choice of organization.

We first develop a model that analyzes the input sourcing choice of MNCs. It builds on the incomplete contracts approach to the theory of the firm. This approach helps in predicting the prevalence of alternative sourcing strategies as a function of productivity variation across MNCs and their intensity in RSI. Our theoretical framework is borrowed from Antràs and Helpman (2004, 2008) from which we derive two empirical propositions. First, the firm's intensity in RSI increases the likelihood of importing an input from an independent supplier rather than from an affiliate. Second, we show that the decision depends on the combination of variation of productivity and variation in RSI across MNCs. Our model predicts that only the most productive MNCs would be able to outsource their intermediate inputs abroad while the least-productive MNCs will necessarily import from a foreign related party. In addition, the likelihood of importing through an independent supplier increases with the firm's productivity, especially if it uses relationship-specific inputs intensively. We use a firm-level survey that provides a detailed geographical breakdown of French firms' imports at product level and their sourcing modes – through outside suppliers and/or related parties. In our empirical analysis, we propose to investigate the links between the productivity and the RSI with the sourcing decision.

[2] Theoretical contributions include McLaren (2000), Antràs (2003, 2005), Antràs and Helpman (2004, 2008) and Grossman and Helpman (2002, 2003, 2005). See Spencer (2005), and Helpman (2006) for detailed surveys of the literature.
[3] See for instance, Yeaple (2006), Nunn and Trefler (2008), Bernard et al. (2010), Costinot et al. (2011) using aggregate sector or product-level data for the U.S.

The intensity in RSI has been found to positively affect the decision to import intermediate inputs from outside suppliers by Nunn and Trefler (2008) and Bernard et al. (2010) who use aggregate sector or product-level data for the U.S. Nunn (2007) and Nunn and Trefler (2008) identify inputs that require relationship-specific investments as those inputs that are neither bought and sold on an exchange nor reference priced. Bernard et al. (2010) approximate the products' contractibility based on the degree of intermediation. Our paper is taking one step forward by providing an alternative measure to the RSI intensity, which has the advantage to be firm specific and to be directly observable from the firm's balance sheet. We follow the French statistical institute (INSEE) and we define as relationship specific inputs the value of "*work based on plans*". It corresponds to inputs for which the MNC provides to the supplier all the technical specifications required for the production of the intermediate inputs he has ordered.[4] For instance, in the "motor vehicle" industry, it would includes inputs which required forging, cutting, stamping and foundry work based on plans provided by the car producers. In the "textile and clothing" industry, it would include the cutting of sheet of cloth based on plans and most of the textiles ennobling subsectors, whose main activity is to provide textile material with the suitable characteristics for their use as an intermediate product. The amounts reported in the balance sheet include the value of intermediate inputs bought from both independent suppliers and affiliates, purchased nationally and internationally. Hence, we can compute a direct measure of the share of relationship-specific inputs on the total value of total inputs. Our novel variable is different from that used in previous studies

[4] The amount reported in the accounting book refers to a juridical definition. This largely limits the possibility for the product classification to depend on the firm's ownership structure. That would be the case if, as suggested by Crémer et al. (2007), each firm has its own codification and intra-firm transactions required less detailed technical specification. However, the judicial definition is based on observable aspects of the production process, such as the use or not of an industrial mold.

because it does not rely on external information to classify the different type of inputs. We find a positive correlation between the intensity in RSI and the likelihood to outsource.

There is information in the data that allows to construct firm's total factor productivity (TFP). We analyze whether the variation of firm-level TFP across MNCs influences the choice of organization. We find that the prevalence of outsourcing is higher for firms that have higher productivity levels. For firms that are part of a multinational network, importing inputs from a related party seems less costly in terms of organization. As a consequence, importing from a foreign related party is more appropriate for low productive firms, which cannot incur the fixed organizational costs of outsourcing.[5] As we evaluate the productivity variation across MNCs, our empirical strategy is different from recent studies using samples that contain information on both independent firms and multinational firms (See Corcos et al., 2009, Kohler and Smolka, 2009 and Stefano, 2009).[6] By definition, intra-group trade can only occur among the group of multinational firms, which are known as being more productive than independent firms. Hence, the findings of these papers confirm that firms that are part of a multinational network, which are more

[5] The survey from which we base our empirical analysis shows that French MNCs perceive outsourcing to be related to higher fixed costs than intra-group trade (Service des études et des statistiques industrielles, *SESSI*, 1999). In his seminal book, Williamson (1985) considers that the fixed cost of organization under vertical integration is lower than the one associated with outsourcing because it amalgamates the coordination costs of two firms.

[6] Using French firm-level data, Corcos et al. (2009) find that intra-group trade occurs among the group of highly productive firms. A similar result is also found in a sample of Spanish firms by Kohler and Smolka (2009) and in a sample of Italian firms by Stefano (2009). These latter two papers also consider the case of national transactions. Both studies present evidence that the most productive firms are more likely to trade with a local affiliate than with local independent supplier. See also Tomiura (2007), who shows that Japanese *multinationals* that outsource internationally are more productive than domestic firms. The comparison of our results with Tomiura (2007) is difficult. In fact, the Japanese data do not report intra-group transactions. It only indicates if firms have a related party abroad or not. In our data, by definition, all firms have at least one related party abroad. However, not all firms rely on intra-group trade: 21.9% of the firms in our sample do not report a single transaction under intra-group trade.

productive than independent firms, can import within the group. However, the idea that most productive multinationals would always prefer to internalize their import transactions is at odd with the empirical evidence that many large firms import mostly from outside suppliers. Take the firms Renault and Peugeot-Citroën in 1999, more than 90% of the total number of their import transactions are bought from independent suppliers. [7] In this paper, we compare the TFP across firms that are part of a multinational network and argue that given the existence of a foreign related-party, the firm might still face the choice of organization. This choice is still guided by its productivity level. In line with the theoretical prediction of our model, we find that the firm' TFP increases the likelihood to outsource. For firms that are part of a multinational network, the choice between the different sourcing modes should imply a comparison between an already existing related-party and an outside supplier. For any given country, there may or may not be a foreign related party from which the firms can import the input. Once we control for the presence of a related party, we still find that the most productive firms outsource.

Despite the small number of MNCs, their international sourcing strategy is likely to alter the structure of international trade since they account for a large share of the world trade. Considering the French manufacturing sectors, firms which are part of a multinational network represent 83% of total French imports of industrial products. To further examine the role on MNCs on the volume of intra-group trade, we aggregate our data at the sector-product-country level. We compute the outsourcing share as the ratio of the value of imports from independent suppliers to the value of total imports. Using product and country specific effects, our empirical results support the idea that outsourcing is a prevalent mode of organization in RSI intensive sectors,

[7] We are considering the transactions of the firms themselves, not the transactions of their entire network of firms.

especially those which are composed by highly productive firms.

The remainder of this paper is structured as follows. Section 2 provides the theoretical background and the empirical implications of the model. Section 3 provides a thorough discussion of the data and discusses the empirical strategy. Section 4 proposes some stylized facts that can be constructed from the data. Section 5 contains our core empirical results and provides some robustness checks. Section 6 concludes.

2 Theoretical Background

In this section, we propose a theoretical framework which is borrowed from Antràs and Helpman (2004, 2008) but differs in two dimensions. First, we follow Williamson (1985) assuming that the fixed cost of organization of trading with a related party is lower than the one associated with outsourcing because it amalgamates the coordination costs of two firms. As a consequence, only the most productive MNCs would be able to outsource abroad their intermediate inputs while the least-productive MNCs will necessarily import from a foreign related party. Second, we assume that the RSI intensity is firm-specific and we analyze how the variation in RSI intensity influence a firm's sourcing choice. As a consequence, we show that the decision depends on the combination of firm's productivity and firm's RSI across MNCs.

We denote by v a firm that imports intermediate inputs from a foreign related party. We use the subscript o for a firm that imports these inputs from a foreign outside supplier.

2.1 Set-up

Each sector produces a differentiated good under monopolistic-competition.[8] The production of the final good requires the use of two specialized intermediate inputs, x^h and x^m. x^h is produced locally by headquarters, HQ, with a wage that is normalized to one. x^m is sourced from supplier, M, located in foreign country, l, where the wage is $w^l < 1$.[9] In addition, only a fraction μ_h and μ_m of the activities produced respectively by HQ and M are contractible. As in Antràs and Helpman (2004, 2008), we assume the output of variety i to be Cobb-Douglas:

$$Q_i = \theta \left[\frac{\left(x_c^h\right)^{\mu_h} \left(x_n^h\right)^{1-\mu_h}}{\eta} \right]^{\eta} \left[\frac{\left(x_c^m\right)^{\mu_m} \left(x_n^m\right)^{1-\mu_m}}{1-\eta} \right]^{1-\eta} \qquad 0 < \eta < 1 \qquad (1)$$

where η is the intensity in headquarter services and x_c and x_n are respectively the contractible and non-contractible activities involved in the production of each input. η and μ_h are assumed to be sector specific and would be captured by sector fixed effects in our empirical estimations. θ is the firm-specific productivity parameter. $\omega \equiv (1-\eta)(1-\mu_m)$ measures the importance of the non-contractible relationship-specific input (RSI) used in the production of the final good. We depart from Antràs and Helpman (2004, 2008) and assume firm-level heterogeneity in both θ and ω. After observing θ and ω, the headquarter, HQ, faces a choice when sourcing its inputs. It can decide to import inputs from an independent supplier or import them from a foreign related party.

[8] Consumers are assumed to share Dixit-Stiglitz preferences for differentiated products which generate the inverse demand function $p(i) = D.x(i)^{\alpha-1}$ for variety i in this sector. $p(i)$ is the price of this variety, $x(i)$ is the quantity demanded, D is an index of total demand for the output of this sector, and the elasticity of demand is equal to $1/(1-\alpha)$ and is larger than one. All final goods are freely traded with zero transport costs, so that D measures the world demand for the output of the sector.

[9] Throughout this paper, we rule out the possibility of sourcing x^m from a national supplier and focus on internationally fragmented production process.

Since our study focuses on firms that are part of a multinational network and have related parties abroad, an intra-group transaction does not imply to set-up an affiliate abroad. Hence, the model could be simplified by considering that the fixed costs associated with the set-up of a foreign network of related parties is $g = 0$. Nevertheless, different Ultimate Beneficial Owner (henceforth, UBO) may have different capacity to set-up affiliates in different countries. Assuming that each firm have a related party in each country is not binding in the data as we shall see in the empirical section. For any given country, the UBO may or may not have a foreign related party from which the firms of the group can import inputs intra-group. In the empirical section 5.2, we will consider a two step strategy where we first evaluate the likelihood of a UBO to have an affiliate in a given foreign country. We will be using the number of French firms owned by the UBO as an instrument, as it is likely to be correlated with the number of foreign related parties, but is exogenous to the international sourcing choice of a French firm own by the group. Given the existence of a foreign related party, the second step informs on the firm specific choice between importing from an already existing related-party or a foreign outside supplier.

However, the firm has to pay an additional fixed cost of organization F_o if it decides to import inputs from an outside supplier or F_v when it decides to import from its related party. We follow Williamson (1985) and assume that transactions with an outside supplier generate higher organization costs than transactions with an affiliate, i.e. $F_o > F_v$. In fact, intra-group trade may create economies of scope in the management of diverse activities, reducing the organization costs. In addition, the fixed costs of finding a suitable foreign partner, writing an international contract and managing cross-boarder transactions are likely to be lower within a network of related affiliates. Notably, Crémer et al. (2007) identify communication codification as an important determinant of firms' organization. Intra-group trade relies on internal codifications, which may translate in economize in communication cost and a lower fixed cost of communication for intra-group transactions. This assumption is widely used in the empirical literature on vertical integration (see Lafontaine and Slade, 2007). In line with this assumption, the survey from which we base our empirical analysis shows that French MNCs perceive outsourcing to be related to higher fixed costs than trade with affiliates (Service des etudes et des statistiques industrielles, *SESSI*, 1999).

The headquarter, HQ, writes a contract with the supplier, M, stipulating the required investment in the contractible activities x_c^h and x_c^m. However, the transaction between HQ and M involves incomplete contracts because, ex-ante the headquarter and the supplier cannot sign enforceable contracts specifying the required investment in the non-contractible relationship-specific activities x_n^h and x_n^m.[10] Since x_h and x_m are entirely customized and have no value outside the relationship, both firms face a hold-up problem. After the specific investment has been made, there is a renegotiation over the ex-post quasi-rents. Let β be the share of ex-post gain from trade obtained by the HQ.

Following the property-rights approach, the ex-post bargaining takes place both under outsourcing and under intra-group trade (Grossman and Hart (1986) and Hart and Moore (1990)). Once the HQ selects the organization form $k \in \{o, v\}$, the quantity of intermediate inputs is chosen by M to maximize $(1 - \beta_k)R(i) - w^l x_m$, while the quantity chosen by the HQ to maximize $\beta_k R(i) - w^N x_h$. However, the distribution of surplus is sensitive to the sourcing mode. Following Antràs and Helpman (2004), we assume $\beta_v > \beta_o$. Under this assumption, final good producers have a higher bargaining power when

[10] They also cannot specify the purchase of specialized intermediate inputs for a certain price or observe ex-ante the inputs' quality.

importing from a related party - directly affiliated or not. Even if the firm is not the UBO of the group, a final good producers is a major and influential actor of the group compared to a simple input supplier. Hence, final-good producers would hold some residual right of control over the supplier's production especially for inputs which production is based on plans owned by the final good producers. Hence, on the one hand, intra-group trade yields the headquarter with a higher share of the surplus than under outsourcing. On the other hand, the supplier's share of surplus is lower, and this decreases its incentive to invest. When choosing their sourcing mode, the headquarter faces a trade-off between having more control and inducing more investment from its supplier.

Ex-ante, the supplier pays a transfer T to the headquarter. It ensures its participation in the relationship and is equal to its profit.[11] The choice of ownership is chosen ex-ante by the headquarters to maximize its profit, which includes the transfer. Then, the headquarters' profit equals:

$$\pi_k(\omega, \theta) = \overline{\pi}_k(\omega)\theta^{\alpha/(1-\alpha)} - F_k \tag{2}$$

where $\overline{\pi}_k$ represents the variable profit for a final good producer with $\theta = 1$ that uses organizational form $k \in \{o, v\}$ and α is a parameter that determines the elasticity of demand. We obtain the empirical model by appending an unobserved zero-mean random variable, ϵ_k, to the profits under each mode of organization. Given its productivity level θ and its intensity in specific inputs ω, outsourcing will be chosen by the final-good producer if

$$\begin{aligned} \pi_o(\omega, \theta) + \epsilon_o &> \pi_v(\omega, \theta) + \epsilon_v \\ \Leftrightarrow \Delta = \pi_o(\omega, \theta) - \pi_v(\omega, \theta) &> \epsilon_o - \epsilon_v \end{aligned} \tag{3}$$

Finally, if $\epsilon_o - \epsilon_v$ has a cdf, F(.), the probability of outsourcing is defined as

[11] See Antràs (2003) for details.

follow:

$PROB\,[Outsourcing] = F(\Delta)$

As shown by Antràs and Helpman (2008), the optimal share of the revenue extracted by the Headquarter during the ex-post bargaining, β^*, is an decreasing function of ω. As a consequence, it exist a unique value $\overline{\omega}$, for which $\overline{\pi}_o > \overline{\pi}_v$ for any value $\omega > \overline{\omega}$ while $\overline{\pi}_o < \overline{\pi}_v$ for any value $\omega < \overline{\omega}$. We now translate this result in an testable proposition:

Proposition 1. *The likelihood of sourcing inputs through an independent supplier increases with the relationship-specific input intensity of the production.*

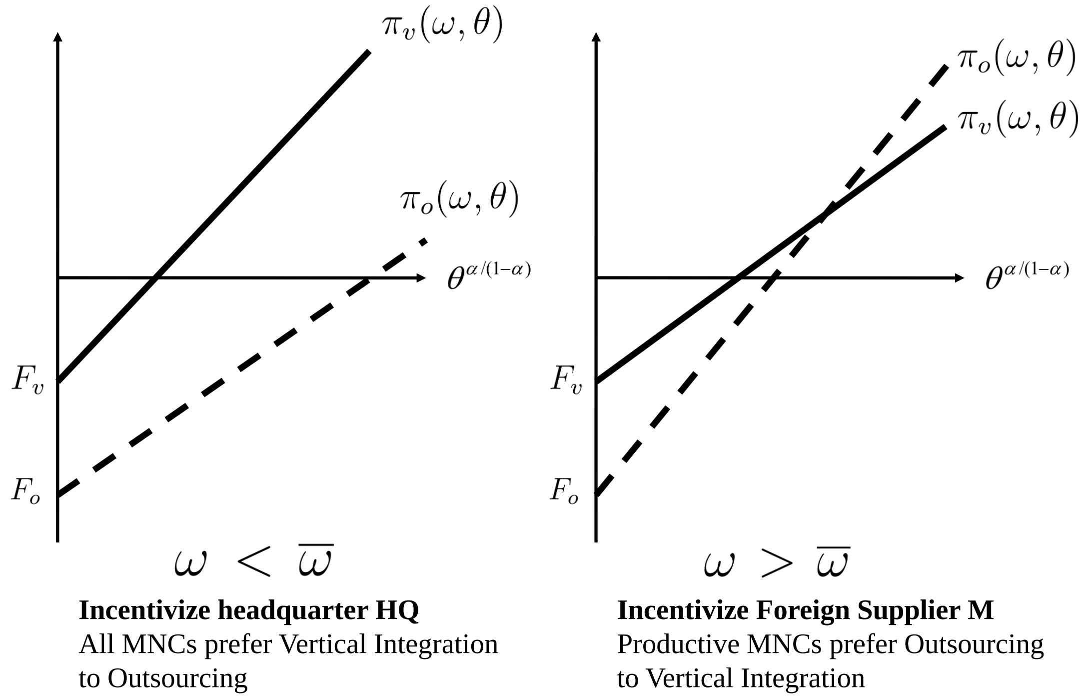
The supplier's RSI intensity affects the incentive the final good producer wants to give to the supplier. The more intensive the production is in RSI that are produced by the supplier, the larger is the share of revenue that the producer wants to give the supplier. This is possible under outsourcing where $\beta_o < \beta_v$.

Figure 1 illustrates the implication of the introduction of firms' heterogeneity and different fixed costs of organization. Below a threshold value $\overline{\omega}$, the likelihood of outsourcing would be equal to zero. Past this threshold value, for $\omega > \overline{\omega}$, the likelihood of outsourcing will become positive. Given $F_o > F_v$, firms that are above the threshold value $\overline{\theta}$ outsource. The most productive firms that rely intensively on specific inputs from the supplier, choose outsourcing. In addition, the prevalence of outsourcing will increase with ω as $\pi_o(\theta)$ becomes steeper and $\pi_v(\theta)$ becomes narrower.

Proposition 2. *The likelihood of sourcing inputs through an independent supplier increases with the productivity of the firm. This effect is magnified by the intensity in relationship specific inputs.*

As explained by Nunn and Trefler (2008, 2013), the mode of sourcing intermediate inputs depends on an interaction of θ with ω. The second empirical

Figure 1. Firm-level productivity, Relashionship-Specific Input intensity and sourcing modes



implication implies that outsourcing is chosen solely by firms that are simultaneously intensive in relationship-specific inputs and very productive. [12] Indeed, the willingness to pay the fixed organization cost associated with outsourcing increases with ω. Notice that this result depends on the ranking of fixed costs. Considering $F_v > F_o$, the most productive firms with a low RSI intensity would have preferred to import from a foreign related-party, as illustrated in

[12] Notice also that for sake of simplicity, we do not consider free-entry. However, Nunn and Trefler (2008) show that two simultaneous effects arise with an increase of ω when free-entry is taken into account. First, firms want to outsource more (this is our first empirical implication). Second, the less productive firms stop importing from the foreign market as the distortion associated with the incompleteness of contracts increases. Considering our ranking of fixed costs, the less productive firms are importing from their foreign related parties. Hence, the likelihood of sourcing through an independent supplier increases with ω through both mechanisms.

Nunn and Trefler (2013).

In the following section, we present the data and our estimation strategy. We then provide the empirical results showing a positive correlation between the TFP, the RSI and the probability for the firm to source its input through an independent supplier.

3 Data and Estimation Strategy

3.1 Data

This paper uses data on intra-group trade from a 1999 INSEE confidential firm-level survey on the foreign activities of French multinationals. [13] Looking at industrial sectors, the survey covers 83% of the French total imports of industrial products. [14] The survey was addressed to all French firms with trade worth more than 1 million Euro. The firm is part of, or is itself a group that controls at least 50% of the voting rights of a foreign firm. Hence, all the firms have at least one related party abroad and can be considered as multinational firms. A French intra-group transaction is thus defined as trade with a related party – directly affiliated or not – controlled by the group. [15]

The survey provides a detailed geographical breakdown of French firms' import at product level (HS4) and their sourcing modes – through outside suppliers and/or related parties. However, it has little information that is specific to the characteristics of the firm. We have obtained this information from the *EAE* database which contains the non-consolidated balance sheet and income statement of all firms located in France with more than 20 employees from

[13] *Échanges internationaux intra-groupe.*
[14] `www.insee.fr/fr/ffc/docs_ffc/IP936.pdf`, INSEE WP 936, Table 1.
[15] Some transactions are broken into two lines if the firm has to announce an amount larger than the one previously filled by the customs services. We have aggregated these lines.

1996 to 1999. The *EAE* provides firm-level information on sales, capital, labor and intermediates use, as well as the 4-digit *NAF700* sector classification of the firm.[16]

3.2 Endogenous Variable: Sourcing Modes

Our dependent variable, y_{isjl}, is the share of input j that is imported by a multinational i active in sector s from an independent supplier located in country l: $\frac{M^{o}_{isjl}}{\left(M^{o}_{isjl}+M^{v}_{isjl}\right)}$.[17] We take into account the country dimension because HS4 goods produced in low-income countries are very different from similar goods produced in high income countries (Schott (2004)). We restrict our analysis to manufacturing sectors. However, we do not consider the manufacture of food products, beverages and tobacco because there is no detailed firm-level information for these sectors from the *EAE*. We exclude firms which are active in the manufacture of coke, refined petroleum products and nuclear fuel since the sourcing modes in this industry are likely to be determined by factors such as national sovereignty (Antràs (2003)). This leaves us with 2394 firms in our baseline specification realizing 68590 transactions.

3.3 Main Explanatory Variables

3.3.1 Relationship-Specific Inputs

Nunn (2007) has identified the share of Relationship-Specific Inputs (RSI) at industrial level while our measure is at firm level.[18] To approximate the RSI

[16] *Nomenclature d'Activité Française*: nomenclature of French activities.
[17] Our dependent variable takes the value *zero* or *one* in 87% of the cases. Considering the strong binary nature of our dependent variable, we use a fractional logit model as in Papke and Wooldridge (2006) and interpret our results in terms of likelihood.
[18] The correlation of a Nunn index computed from a French IO table and our RSI variable aggregated at 2-digit industrial level is 0.73. This makes us confident that our measure is well related to relationship-specific inputs.

of firms, we rely on the value of inputs that are classified as “work based on plans”, i.e., where the firm provides the supplier with all the technical specifications required for the production of the input. As the production realized by the supplier must exactly comply with the instructions or technical specifications fixed by the firm, these invoices are necessarily specific to the production process of the firm. Therefore, we consider them as ”relationship-specific inputs” (RSI). Let us provide an example of how the French accounting regulation classifies inputs. When a firm buy metals, iron, steel of light metal and other non-ferrous metal, it enters into the firm accounting as purchased intermediate inputs but not as produced inputs based-on-plans. In fact, for these inputs, the firm does not need to provide any technical and exclusive specifications for the supplier to follow. However, casting production, which involves pouring a liquid metal into a mold, is likely to enter the firm accounting as purchases of based-on-plans inputs. In fact, the mold used by the supplier should comply with the instructions of the firm. Nevertheless, the use of a mold and of the casting technology is not a sufficient condition. For instance, most of the cast iron tubes are excluded from the based-on-plans category. In fact, this production is relatively standard and the technical and exclusive specifications fixed by the firm are rather limited. With limited changes, the same mold can be used to produce inputs which can enter the production process of various firms. In other words, the production of cast iron tubes is not relationship-specific.

The French accounting regulation states how inputs should be classified. In addition to comply with the instructions or technical specifications fixed by the firm, the products also need to directly integrate the firm’s final product. However, in most of cases, the product classification (HS4) does not depend on these criteria. Most of the products can be classified in either category depending on the level of requirement of the firm. Out of 215 different 4-digit manufacturing products, 206 have an additional digit to classify the produced inputs based-on-plans. Unfortunately, this additional information is not made public. Therefore, we rely on the balance sheet information which provides the value of inputs bought that are based on the firm' plans. The information is reported in the EAE and the firms' income statement and balance sheets are not consolidated. The model requires an approximation of ω_i, the share of relationship-specific inputs (RSI) provided by suppliers. We compute this share as follow:

$$\omega_i = \frac{Relashionship - Specific \ \ Inputs}{Total \ \ inputs \ \ used}$$

The EAE provides information on the total value of manufacturing inputs used as well as the value of manufacturing inputs that we consider as relationship-specific (RSI), i.e "work based on plans". In both case, the value reported is an accounting entry, which includes inputs purchased from the affiliates of the firms, the other affiliates of the group or any other independent suppliers. In fact, as mentioned previously, the income statement and balance sheet are consolidated at the firm level and not at the group level and do not include the firm's affiliates or related parties, which have separate accounting. Each firm reports the values of all the invoices from any other firm regardless of their location (in France or abroad), and independently of their financial ties with the multinational (being a related party or not).

3.3.2 Total Factor Productivity

We also use the EAE database to estimate the total factor productivity of each firm. The estimations have been realized for each of the 52 (3-digit) sectors. The TFP is estimated as the residual of the following three-factor

Cobb-Douglas production function:

$$Q_{it} = \lambda_0 + \lambda_K K_{it} + \lambda_L L_{it} + \lambda_M M_{it} + \theta_{it} + \epsilon_{it}$$

with labor (L_{it}), deflated values of capital (K_{it}), and material inputs (M_{it}) as production factors. θ_{it} denotes the productivity variable and ϵ_{it} stands for measurement error in output. Labor is the firm specific number of employees. The deflators are obtained from the national accounts system of the French statistical office (INSEE).[19] We use the Olley and Pakes (1996) (OP) semiparametric method to control the simultaneity bias that arises from the endogeneity of a firm's inputs selection. The bias exists if a firm responds to unobservable productivity shocks by adjusting its input choices. This response yields correlation between the stochastic error term and an explanatory variable in the estimation of the production function. The OP estimator corrects for this possible bias by using the firm's investment decision as a proxy for unobserved productivity shocks. The main assumption of the OP technique is the existence of a monotonic relationship between investment and firm-level unobserved heterogeneity.[20]

3.4 Other Control Variables

In order to account for possible within-sector heterogeneity in terms of headquarter services intensity, we include firms' specific factor intensities. We use the firm-level capital-labor ratio, (k/l), to proxy the firm's capital intensity and its spending per-employee on information technology, (s/l), to roughly control for the firm's skill intensity. The data on firm factor intensity are

[19] Nominal values of output are deflated using two-digit sectoral price indexes. Material inputs are deflated using two-digit sectoral price indexes for intermediate inputs published by the INSEE.
[20] See Section A of the online appendix with Supplementary Materials for details on the methodology.

taken from the EAE for the year 1999.

Table A.1 in Appendix 1 reports the descriptive statistics.

4 Descriptive Statistics

Table 1 reports the number of firms, transactions and countries for firms reporting intra-group trade and firms reporting outsourcing. The sample is composed of 2394 firms that import 1009 different types of SH4 products from 134 countries. The total number of observations is 68590. The number of firms that report outsourcing is about 1.5 times larger than the number of firms that report intra-group trade. The number of transactions reported by firms that outsource is larger than that reported by firms that import through their affiliates.

Table 1
Descriptive statistics on the full sample

	Full Sample	Firms reporting imports from	
Number of:		related party	independent supplier
– firms	2394	1489	2134
– countries	134	93	129
– products	1009	869	977
– transactions	68590	24353	54286
Mean of TFP	19.81	17.57	21.03
Mean of RSI	0.19	0.15	0.22

A crude look at the means of the TFP and RSI variables show that firms that report outsourcing are more productive and use more relationship specific inputs. We implement a two-sided Kolmogorov-Smirnov test on firms' TFP and RSI distribution in order to further investigate these results. [21] Table 2 show that the total factor productivity –and the labor productivity– distributions

Table 2
Kolmogorov-Smirnov test for equality of productivity and RSI distributions

	Difference	P-value	Corrected
Total Factor Productivity (Olley and Pakes, 1996)			
$TFP_o > TFP_v$	0.0406	0.229	
$TFP_o < TFP_v$	-0.0841	0.002	
Combined K-S	0.0841	0.004	0.003
Labor Productivity			
$LP_o > LP_v$	0.0038	0.987	
$LP_o < LP_v$	-0.1704	0.000	
Combined K-S	0.1704	0.000	0.000
Relationship Specific Inputs			
$RSI_o > RSI_v$	0.0054	0.974	
$RSI_o < RSI_v$	-0.0985	0.000	
Combined K-S	0.0985	0.000	0.000

are both statistically different at 1% level of significance.[22] Importantly, the two-sided test rejects the null hypothesis of higher productivities for firms importing from affiliates. However, it accepts the hypothesis that firms that outsource have higher productivities than those that import from their related parties. The KS-test on the RSI distribution shows a similar pattern. Firms that outsource are more intensive in relationship specific inputs than firms that import from their affiliates. The KS-test also rejects the null hypothesis of higher RSI intensity firms importing from foreign affiliates.

4.1 Estimation Strategy

Since our dependent variable is bounded between zero and one, the OLS linear regression is unsuitable because it cannot guarantee that the predicted values

[21] The KS-test has the advantage of making no assumption about the sample distribution. It determines whether two distributions differ significantly. Therefore, it calculates the largest difference between the observed and expected cumulative frequencies, which is called *D-statistics*. This statistic is compared against the critical D-statistic for that sample size. We run the tests at the firm level by aggregating the imports under both modes. A firm is classified under "outsourcing" if more than half of its imports are under this sourcing mode.

[22] Labor productivity is calculated as the production minus all the intermediate inputs used in the production, and then divided by the number of workers.

lie in the unit interval, like for binary data models. We use the fractional logit estimation method developed by Papke and Wooldridge (2006) to deal with fractional response variables bounded between zero and one. Since the unit of observation is a transaction, but none of our variables are measured at the transaction level–the finest being the firm level– we correct the standard errors by clustering by firm (Wooldridge, 1996).

We also correct for non-response in our sample survey by using specific weights that have been constructed by the SESSI. The weight coefficients correspond to the inverse probability that a multinational firm answers the survey. It is based on several characteristics. The SESSI methodology gives more weight to the answer of small firms in the survey. This correction for non-response is commonly used in all official releases. [23]

From our theoretical framework, the organizational choice is a function of firm's productivity θ_i and the RSI intensity ω_i. To estimate the predictions of the model, we also need to estimate how the relationship between the intensity in suppliers' inputs changes with the productivity. We add additional controls such as the capital-labor intensity $(k/l)_i$ and the skill intensity $(s/l)_i$.

All estimations include a set of specific effects at the French sector level, NAF_s, the imported product level, HS_j, and the country level, C_l. The baseline equation is reported below.

$$\begin{aligned} y_{isjl} = {} & \lambda_0 + \lambda_1 \theta_i + \lambda_2 \omega_i + \lambda_3 (\omega_i \times \theta_i) \\ & + \lambda_4 (k/l)_i + \lambda_5 (s/l)_i \\ & + NAF_s + HS_j + C_l + \nu_{isjl} \end{aligned} \tag{4}$$

The interpretation of interaction effects in non-linear models is complex. Ai and Norton (2003) argue that odds ratios have no meaningful interpretation

[23] The methodology used by SESSI to construct the weighted coefficient is presented in the Section B of the online appendix with Supplementary Materials.

for the interaction terms. We apply the Ai and Norton (2003) correction to our fractional logit estimations.

5 Estimation Results

The findings reported in this section do not represent, strictly speaking, a test of the theoretical hypothesis but show the correlation between the level of productivity and RSI and the sourcing choice. The theoretical model provides testable predictions on the effects a cross-variation in productivity and RSI on the incentives to outsource. Since our estimation is based on a cross-section of firms, we control for time invariant country, product and sector specific unobserved characteristics. We have moreover centered all variables around their respective means in order to interpret the coefficient of the interaction term. [24]

5.1 Baseline Specification

In the following Tables, we estimate a fractional logit model and present the marginal effects that are evaluated at sample means. We include a full set of country, product and sector specific effects to control for unobserved characteristics. The first three columns (S1-S3) of Table 3, present the results using the full sample of available transactions. Results from the application of the fractional logit estimations show the expected pattern of signs, and all estimated coefficients are statistically significant at the five percent level or better. [25] In specifications (S4) to (S6), we refine our estimation by using a sample composed of intermediate inputs. We follow the methodology devel-

[24] This explains the difference between the TFP and RSI averages in Tables 1 and A.

[25] In the Section C of the online appendix with Supplementary Materials, we also present the estimates based on a Linear Probability Model. The findings are qualitatively comparable.

oped by Feenstra and Hanson (1996), which identifies imported intermediate inputs as purchased inputs registered in another HS3-digit sector than that in which the French multinational reports its main activity.

Table 3
Baseline Results. Dependent variable: Y= share of outsourcing (marginal effects presented.)

		Full Sample			Intermediate Inputs		
	Label	(S1)	(S2)	(S3)	(S4)	(S5)	(S6)
Productivity	θ_i	0.006^a	0.005^a	0.007^a	0.006^a	0.006^a	0.006^a
		(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
RSI intensity	ω_i	0.136^a	0.157^a	0.166^a	0.170^a	0.192^a	0.200^a
		(0.052)	(0.043)	(0.044)	(0.058)	(0.049)	(0.049)
Interaction term	$\theta \times \omega_i$		0.009^b	0.010^b		0.010^b	0.010^b
			(0.003)	(0.003)		(0.004)	(0.004)
Skill intensity	$(s/l)_i$			-0.026^a			-0.026^a
				(0.009)			(0.009)
Capital-labor ratio	$(k/l)_i$			-0.001			0.006
				(0.009)			(0.011)
Observations		68590	68590	68590	49007	49007	49007
Log likelihood		-52767	-52659	-52465	-34911	-34850	-34702
Number of cluster		2394	2394	2394	2183	2183	2183

All regressions contain sector, product and country fixed effects. Robust standard error clustered at the firm level into brackets. ^{a}, ^{b} , ^{c} significantly different from 0 at 1%, 5% and 10% level, respectively.

The results of Table 3 provide support for our theoretical prediction. In particular, the most productive firms that intensively rely on specific inputs import from foreign independent suppliers. In both samples, a positive and significant marginal effect on TFP variable can be found. The size of the marginal effects is similar across columns. Their magnitudes are economically meaningful. The marginal effect associated with the productivity is 0.006. A standard deviation in the TFP variable is associated with an increase in the probability to outsource by about 8.6 percentage points.

There is also evidence that the share of relationship specific inputs affects the multinational sourcing mode. The marginal effect of the RSI intensity variable is positive and statistically significant. Moreover, it is estimated with a high level of precision. For a given productivity, we find that going from the lowest to the highest intensity in suppliers' input increases the share of outsourced inputs by 17 percentage points.[26]

The marginal effect of the interaction term on the other hand bears a positive sign and appears to be significant. The estimates are robust across specifications and confirm the second theoretical prediction of the model. Greater intensity in the RSI increases the marginal effect of the TFP variable on the likelihood to import from a foreign outside supplier.

As for the other control variables, The spending on information technology is negatively correlated with the outsourcing decision. Furthermore, we do not find any significant effect of the firm specific capital intensity on the sourcing mode.

5.2 Sourcing strategy, conditional on having a foreign related party

For any given country in the sample, there may or may not be an affiliate located there that imports a specific input. The choice between the different sourcing modes should imply a comparison between an already existing foreign related party and a foreign outside supplier. We need to correct this potential *selection* bias (Bernard et al. 2010).

To examine this issue, we identify the location of the firm's foreign related parties that supply the inputs. We use information from the LIFI data set which provides a survey on the financial links between firms. We construct a dummy variable, g_l, that takes the value of one if the Ultimate Beneficial Owner (UBO) of the firm reports a related party in a given foreign country. Otherwise, it takes the value of zero.

[26] The calculation is based on the subsample of intermediate inputs (Specification S4)

We address the selection issue by using the two following methodologies. First, we drop all transactions between a firm and any countries where the UBO of the firm has no related party. In other words, we drop all transactions for which our dummy variable takes the value of zero. The firm choice to import inputs is thus guided by the comparison between an existing related party and an independent supplier. This first procedure eliminates about one fifth of the total number of transactions in both the full and the intermediate inputs samples. The results shown in Table 4 still support our theoretical predictions (columns S1-S3 and S6-S8). A significant and positive correlation is found between the level of productivity and the outsourcing likelihood. Moreover, the positive effect of outsourcing is reinforced by the firm's intensity in RSI. The results are still economically significant. These findings are broadly consistent with our baseline results, but the estimated marginal effects are larger.

Second, we apply a two-step estimation procedure (columns S4-S5 and S9-S10 of Table 4). The equation to be estimated in the first stage is a probit equation using the related parties dummy variable as the dependent variable. The selection equation is identified by two variables: the number of related parties located in France owned by its UBO (from which we exclude the firm itself) and a dummy variable that identifies firms that are owned by a foreign group.

Instrumental variables are expected to have a positive impact on the likelihood of having a related party abroad. However, they should be exogenous to the firm's sourcing choice. As argued by Egger et al. (2011), multinational groups establish a network of affiliates in their home country, in parallel of a network of foreign affiliates abroad. We expect the size of the domestic network to predict the presence of a related party abroad. Our prior is that, the number of affiliates in France owned by the UBO, from which we exclude the firm

Table 4. Sample selection specifications

		Full sample					Intermediate inputs sample				
					Two stages equation					Two stages equation	
					1^{st}stage	2^{nd}stage				1^{st}stage	2^{nd}stage
		(S1)	(S2)	(S3)	(S4)	(S5)	(S6)	(S7)	(S8)	(S9)	(S10)
Productivity	θ_i	0.009^a	0.008^a	0.009^a	0.000	0.008^a	0.009^a	0.008^a	0.009^a	0.001	0.007^a
		(0.002)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.002)
RSI intensity	ω_i	0.163^b	0.201^a	0.209^a	-0.021^c	0.201^a	0.200^a	0.229^a	0.238^a	-0.027^a	0.231^a
		(0.068)	(0.052)	(0.053)	(0.011)	(0.045)	(0.073)	(0.058)	(0.059)	(0.010)	(0.049)
Interaction term	$\theta \times \omega_i$		0.013^c	0.014^b	-0.000	0.013^a		0.013^b	0.013^b	0.000	0.013^a
			(0.003)	(0.004)	(0.001)	(0.004)		(0.004)	(0.004)	(0.001)	(0.004)
Skill intensity	$(s/l)_i$			-0.024^b	0.014^a	-0.031^a			-0.024^b	0.012^a	-0.029^a
				(0.010)	(0.004)	(0.009)			(0.010)	(0.004)	(0.010)
Capital-labor ratio	$(k/l)_i$			-0.008	-0.002	-0.008			0.004	-0.001	0.002
				(0.015)	(0.006)	(0.014)			(0.017)	(0.005)	(0.015)
UBO-Number of related French parties	a_u				0.095^a					0.086^a	
					(0.006)					(0.006)	
UBO-Foreign group	$Foreign_u$				0.069^a					0.062^a	
					(0.013)					(0.013)	
Mills ratio	$Mills$					-0.862^a					-0.854^a
						(0.213)					(0.234)
Observations		58202	58202	58202	68117	57729	42366	42366	42366	48153	41512
Log likelihood		-46799	-46669	-46556	-20500	-45980	-45977	-31347	-31261	-13903	-30886
Number of firms		2247	2247	2247	2366	2219	2036	2036	2036	2148	2001

All regressions contain sector, product and country fixed effects Robust standard error clustered at the firm level into brackets. ^{a}, ^{b} , ^{c} significantly different from 0 at 1%, 5% and 10% level, respectively.

itself, is positively correlated with the number of affiliates abroad. A similar argument applies to the foreign ownership dummy. The foreign ownership status is likely to have a positive impact on the likelihood for the UBO to have affiliates in other foreign countries. From the point of view of the French affiliate which is part of the UBO network, the number of affiliate owned by the same UBO in France or the nationality of the UBO is exogenously determined and is independent on its own decision to outsource or not when importing inputs.

The equation to be estimated in the second stage is the one related to the sourcing choice. We estimate the fractional probit equation augmented by the inverse Mills' ratio. [27] The results are qualitatively similar. The inverse mills ratio is significant and negative indicating that the correction for selection bias reduces the outsourcing share. In Section D of the online appendix with Supplementary Materials, we show that our main findings are qualitatively similar when we take into account the product dimension in the construction of the related party dummy variable. [28]

5.3 Results from aggregate level data

We follow Yeaple (2006) and Bernard et al. (2010) and aggregate our data at 4-digit sector, 3-digit product and country level. We compute the outsourcing share as the ratio of the value of imports from independent suppliers to the value of total imports. Total imports have been computed as the sum of imports from affiliates plus imports from independent suppliers from the SESSI survey. Using the EAE database on all firms located in France with more than

[27] See Wooldridge (2007) for an example of a two step selection model with a fractional probit in the second stage.
[28] In this case, we use a more restrictive definition. We construct a dummy variable, g_{jl} which takes the value of 1 if the firm has a related party in a foreign country l that can provide a 3-digit input j. The results are qualitatively similar.

20 employees, we measure the extent of dispersion within an industry using the standard deviation of firms' TFP in that industry. We also compute the RSI intensity at the sectoral level, as the ratio of the value of relationship-specific inputs to the total inputs used in the sector. We also calculate the skill intensity and capital intensity for each sector.

Table 5
Results from the aggregated sample

	Full Sample			Intermediate Inputs		
	(S1)	(S2)	(S3)	(S4)	(S5)	(S6)
Sector productivity	0.010^a	0.010^a	0.009^b	0.010^a	0.010^a	0.009^b
dispersion	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Sector RSI intensity	0.281^a	0.222^c	0.290^b	0.277^a	0.209	0.294^b
	(0.109)	(0.128)	(0.138)	(0.107)	(0.127)	(0.139)
Interaction term		0.058^b	0.064^b		0.068^b	0.075^b
		(0.029)	(0.030)		(0.030)	(0.031)
Sector skill intensity			-0.005^b			-0.005^b
			(0.002)			(0.002)
Sector capital intensity			0.049			0.062^c
			(0.031)			(0.034)
Observations	22002	22002	22002	18312	18312	18312
Log likelihood	-11539	-11522	-11486	-9379	-9360	-9313
Number of sector	240	240	240	236	236	236

All regressions contain product and country fixed effects. Robust standard error clustered at the sector level into brackets. ^{a}, ^{b} , ^{c} significantly different from 0 at 1%, 5% and 10% level, respectively.

Table 5 reports the estimated marginal effects of fractional logit models. We control for product and country specific heterogeneity by using a set of products and country fixed effects. Robust standard-errors are clustered at the 4-digit sector level.

The results are in line with the predictions of our theoretical framework. The findings are qualitatively similar to those of the firm-level regressions of Table 3. We find a larger outsourcing share in industries that are intensive in relationship specific inputs. The share of intra-firm imports is lower in industry with a higher dispersion in productivity. This suggests a higher fixed organization cost under outsourcing than under intra-firm trade. Moreover, the productivity dispersion variable magnifies the effect of the RSI variable.

6 Conclusion

Since multinational firms account for a large share of the world trade, their international sourcing strategy is likely to change the structure of international trade. Understanding the choice of organization of multinational firms is important as it may have several implications on welfare. For instance, the structure of wages paid by firms in integrated or non-integrated units may be different, e.g. Egger and Kreickemeier (2011). In addition, in models featuring Nash-bargaining, such as the one considered in this paper, the choice of organisation is likely to affect firms' mark-up, and ultimately consumers' welfare. See Defever (2011) and Conconi et al. (2012).

In this paper, we use detailed French data on firms that are part of a multinational network to analyze how they organize their international production. There are multiple ways to organize its imports. Even being part of a multinational network, these firms might still face a choice between importing intermediate inputs from their related party abroad and/or from foreign outside suppliers. We analyze the determinants of the sourcing modes by focusing on the firm characteristics.

We build on the incomplete contracts approach to the theory of the firm and we identify two important determinant of this choice. We show that the decision to outsource depends on a combination between firms' total factor productivity and their intensity in RSI. Our model predicts that the most productive MNCs outsource abroad their intermediate inputs while the least-productive MNCs import from a foreign related party. In addition, the likelihood of importing through a foreign outside supplier increases with the firm's productivity, especially if it uses relationship-specific inputs intensively.

The data are sufficiently detailed to construct the share of relationship specific inputs that is used by firms. This is an important trait of the French firm-level database. It is compulsory for French firms to report in their balance sheet the value of inputs bought that are based-on plans and so, relationship specific. In combination to the firm-level productivity, we show empirically that the prediction of the model are borne out in the data. These results are robust to different specifications and samples.

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Appendices

A Descriptive Statistics

Table A.1
Summary statistics of variables

	Label	Mean	Std. Dev.	Obs.
Full Sample				
TFP	θ_i	0.000	14.400	68590
RSI	ω_i	0.000	0.384	68590
Firm Skill Intensity (Log)	$(s/l)_i$	0.910	7.140	68590
Firm Capital-Labor Ratio (Log)	$(k/l)_i$	1.944	1.200	68590
Interaction term 1	$\omega_i \times \theta_i$	0.662	0.936	68590
Intermediate inputs sample				
TFP	θ_i	0.000	14.171	49007
RSI	ω_i	0.000	0.367	49007
Firm Skill Intensity (Log)	$(s/l)_i$	0.817	6.708	49007
Firm Capital-Labor Ratio (Log)	$(k/l)_i$	1.963	1.211	49007
Interaction term 1	$\omega_i \times \theta_i$	0.676	0.942	49007