Productivity and the Sourcing Modes of Multinational Firms: Evidence from French Firm-Level Data ⋆

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November 2007

Abstract

We investigate the role of firm's total factor productivity in its decision to import from their affiliates rather than from independent input suppliers. We propose a slightly modified version of the Antràs and Helpman (2004) model. We assume higher fixed costs under outsourcing and a firm-specific production function. We use detailed French firm-level data that provides a geographical breakdown of French firms' import at product level and their sourcing modes in 1999. We find strong empirical support for the theoretical predictions of the model. In particular, high-productivity firms that have a production process intensive in suppliers' inputs source their inputs through independent foreign suppliers.

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

JEL classification: F23, F14, L22, L23

⋆ We are really grateful to Pol Antràs, Elhanan Helpman, Philippe Martin, Thierry Mayer, Gianmarco Ottaviano, Frédéric Robert-Nicoud and Jean-Marc Siroen for helpful comments. The author acknowledge financial support from the ACI - *Dynamiques de concentration des activités économiques dans l'espace mondial.*

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1 Introduction

Firms wishing to import intermediate inputs from foreign markets either require a local foreign partner, who acts as an independent input supplier or need to set up their own affiliates. The choice of sourcing modes plays a key role in strategic management decisions and has triggered considerable research effort into international organization of production. In a new body of work, trade theorists have started to bring modern theories of the firm into models of international trade.[1] Seminal contributions include McLaren (2000), Antràs (2003, 2005), Antràs and Helpman (2004) and Grossman and Helpman (2002, 2003, 2005).

Part of this literature focuses on contract incompleteness because firms cannot specify all possible contingencies, in particular when they operate in foreign markets. In Antràs (2003), a final good producer decides whether to source a specific intermediate input through an independent foreign supplier or to integrate it. Possible cost sharing for specific investments leads to a hold-up problem. As emphasized by Antràs (2003), a firm's organizational choice depends strongly on the share of intermediate inputs in the industry that requires the engagement of suppliers. In particular, the final-good producer can alleviate the hold-up problem by offering the supplier a larger share of revenue, by using outsourcing, when the industry is intensive in intermediate inputs produced by the supplier. If the share of inputs that are produced by the final-good producer is large enough, then it should keep the residual rights of control and should integrate the supplier.

An interesting extension of Antràs (2003) is made by Antràs and Helpman (2004) who consider heterogeneity in firm-level productivity. In particular,

[1] See Spencer (2005), and Helpman (2006) for detailed surveys of the literature

the final-good producer draws its productivity randomly from a common distribution and decides to produce only after paying a fixed cost of entry. Antràs and Helpman (2004) assume that the fixed cost of production abroad is lower under outsourcing than under vertical integration. Since the most productive firms can compensate the foreign affiliate set-up costs, the most productive firms in the headquarter-intensive sector will source their inputs internally. The assumption concerning the ranking of fixed costs is crucial and reversing it leads to opposite findings (Grossman et al., 2005).

When contracts are incomplete, cross-countries differences in the contracting environment might also explain the prevalence of sourcing modes. The idea that judicial quality of country influences the hold-up problem and the value of specific investment has been first developed by Nunn (2007). Thus, goods requiring substantial relationship-specific investments tend to be produced in countries with good contract-enforcement institutions. It is applied to the organizational choice by Antràs and Helpman (2008) who show final-good producers and suppliers will be unwilling to make relationship-specific investments in countries with poor contract enforcement institutions.

So far, empirical evidence using firm-level data on outsourcing is scarce. Tomiura (2007) uses detailed data on Japanese firms and shows that Japanese multinational firms that export through their affiliates are more productive than firms that outsource. This productivity ordering is robust even when firm size, factor intensity, and/or industry are controlled. In a related paper, Tomiura (2005), shows firms tend to outsource more of their activities overseas when their productivity is higher or when their products are more labor-intensive. Using French firm-level data, Raspiller and Sillard (2004) show that French multinational firms trade intermediate inputs through their affiliates when their production process use intensively advertising.

This study examines the role of firm's productivity and of its intensity in suppliers' input for its organizational choice. We build on a theoretical model that incorporates the main features of Antràs and Helpman (2004). We slightly change the model by introducing a production function that allows both the productivity and the cost share of input provided by suppliers to vary across firms. In addition, we consider only the case where the supplier's input is produced abroad. Our theoretical model offers three important predictions for the organizational choice that faces final-good producers. Assuming a higher fixed cost under outsourcing, we show that firms outsource when (i) they intensively use suppliers' inputs in their production process, (ii) they are simultaneously highly productive and intensively use suppliers' inputs in their production process, and (iii) they are highly productive and import inputs from countries that have a sound contracting environments.

This paper makes two specific contributions to the related empirical literature. First, we use a new data set at firm-level which contains superior information compared to previous studies. Second, our empirical specification follows directly from theory, especially in the case of the intensity in suppliers' inputs.

We use detailed French firm-level data to estimate the predictions of the model. The database provides a geographical breakdown of French firms' imports at product level (HS4) and their sourcing modes – through independent suppliers and/or affiliates – in 1999. This also data includes information that allows a distinction to be made between intermediate inputs and final goods. The survey, which has been carried out by the SESSI, includes French firms trading more than 1 million Euro and that are owned by manufacturing groups that control at least 50% of the equity capital of their foreign affiliate. These limitations sharply reduce the number of participants. However, the coverage remains significant. The survey covers 55% of French total imports and

61% of French total exports. In the present analysis, we focus on 2619 French importers which carry out 72391 transactions. However, the survey provides little information at firm-level. We retrieve this information from the *EAE* database on the balance sheet and income statement of all firms located in France that have more than 20 employees.[2] The data is annual from 1996 to 2002.

The previous literature has approximated the parameter of the headquarters intensity in the Cobb-Douglas production function by sector-specific variables such as capital and/or skill intensities (Antràs, 2003, Nunn and Trefler, 2008, Yeaple, 2006). We propose a measure of the intensity in suppliers' input which is directly mapped from theory. It is the total use of intermediate inputs from suppliers in French firm production process. This measure has the main advantage of being firm-specific and to be directly related to the cost share of input provided by suppliers of the Cobb-Douglas production function.

Contrary to the previous related literature, we have estimated firm's total factor productivity (TFP) using the Olley and Pakes (1996) methodology because it has two main advantages over the standard measures of productivity, such as value-added over employment. First, this methodology takes into account the selection bias that arises because we only observe firms that are included in the survey and which are likely to be the most productive. Second, it solves the endogeneity problem that arises because inputs are chosen by firms according to their productivity.

To test the prediction of the model, our empirical specifications take into account the non linear interaction term between the productivity, the intensity in suppliers' input and the contracting environment. We follow Ai and Norton (2003) and use their estimation methodology that allows interpreting

[2] EAE: *Enquête Annuelle d'Entreprises.*

multiplicative terms in logit models.

In line with the theoretical prediction, we find that firms that have a production process intensive in suppliers' inputs source through independent suppliers. Moreover, we find that the most productive firms source their inputs through independent suppliers. The higher the intensity of the production process in suppliers' inputs, the larger the effect. Contrary to our theoretical prediction, we find that a better contracting environment increases the likelihood of importing inputs from affiliates. This result is likely to be in line with the theoretical prediction of Antràs and Helpman (2008) model that allow inputs to be partially contractible. They show that if a better contracting environment reduces the non-contractible share of the suppliers' input, then the incentives required by the headquarters should increase.

The remainder of this paper is structured as follows. Section 2 provides the theoretical background and the testable implications of the model. Section 3 presents the data and discusses the empirical strategy. Section 4 proposes a first look at the data. Section 5 presents our main results and provides some robustness checks. Section 6 concludes.

2 Theoretical Background

In this section, we slightly modify the Antràs and Helpman (2004) model and review its core testable implication for firm-level data analysis. We denote by v a vertically integrated firm that sources inputs abroad through its affiliate. We use the subscript o for a firm that sources inputs abroad through an independent supplier. [3]

[3] As we consider only the case where the supplier's input is produced abroad, it should read "vertical integration offshore" and "outsourcing offshore" instead. Offshoring means that the production of the inputs is made in a *foreign country*.

2.1 Set-up

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

Each sector j produces a differentiated good under monopolistic-competition. 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 wages is $w^l < 1$. Throughout this paper, we rule out the possibility of sourcing x_m from a national supplier and focus on internationally fragmented production process. As in Antràs and Helpman (2004), we assume the output of variety i to be a Cobb-Douglas function of these inputs:

$$Q_i = \theta \left[\frac{x_h}{1-z}\right]^{1-z} \left[\frac{x_m}{z}\right]^{z} \qquad 0 < z < 1 \tag{1}$$

θ is the firm-specific productivity parameter. $(1-z)$ is the "*intensity in headquarters services*". We depart from Antràs and Helpman (2004) and assume that z is firm-specific. A higher z is associated with a more intensive use of the intermediate input from supplier M in production. z represents thus the *intensity in supplier's input.*

Upon paying a fixed cost f_k, which we label in national units of labor, and observing its productivity, θ, the headquarter, HQ, faces a choice when sourc-

ing its input. It can decide to import inputs from an independent supplier and pay a fixed cost f_o or import them from its affiliate and pay a fixed cost f_v. We assume that sourcing through an independent supplier generates a higher fixed cost than sourcing through an affiliate because vertical integration creates economies of scope in the management of diverse activities (Antràs and Helpman, 2004).

The transaction between HQ and M involves incomplete contracts because, ex-ante the headquarter and the supplier cannot sign enforceable contracts specifying the purchase of specialized intermediate inputs for a certain price. They also cannot observe ex-ante the inputs' quality.

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 renegotiation over how the ex-post quasi rents from the relationship will be shared.

Denote by β the share of ex-post gain from trade obtained by the headquarter. Following the property-rights approach, the ex-post bargaining will take place both under outsourcing and under vertical integration (Grossman and Hart, 1986 and Hart and Moore, 1990). However, the distribution of surplus is sensitive to the sourcing mode. More precisely, the outside option of the headquarter would be equal to zero under outsourcing, but would be equal to $\delta \in (0, 1)$ under integration. When it chooses to source inputs through its affiliate, the HQ owns the residual rights of control and seizes control of the unit of production. In that case, we assume that the headquarter receives a fraction δ of the amount of x_m, which translates into an outside option of $\delta^\alpha R_v$ assuming CES preferences and a constant markup $1/\alpha$. Along with Antràs and Helpman (2004), we think that δ is related to the protection of property rights or more generally to the contracting environment of the export country.

Given the bargaining framework, the headquarter receives the fraction β_o of the revenue $R(i)$ under outsourcing and the fraction $\beta_v = \delta^\alpha + \beta_o(1-\delta^\alpha)$ under vertical integration, hence $\beta_v > \beta_o$. Once the HQ selects the organization form k, 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 $\beta_k R(i) - w^N x_h$. Thus, on one hand, integration 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 incentives 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, which ensures its participation in the relationship which would be equal to its profit.[4] The choice of ownership is chosen ex-ante by the headquarters to maximize its profit, which includes the transfer. Then, headquarters profit equals:

$$\pi_k^l = D^{\frac{1}{1-\alpha}} \theta^{\alpha/(1-\alpha)} \psi_k^l - f_k^l \tag{2}$$

where

$$\psi_k^l = \frac{1 - \alpha[\beta_k^l(1-z) + (1-\beta_k^l)z]}{\left[\frac{1}{\alpha}\left(\frac{1}{\beta_k^l}\right)^{(1-z)}\left(\frac{w^l}{1-\beta_k^l}\right)^z\right]^{\alpha/(1-\alpha)}} \tag{3}$$

Given its productivity level θ, the final-good producer chooses the mode of sourcing and the location of production that maximizes equation (2). It exits when its productivity level is below a threshold θ, denoted $\underline{\theta}$, because its operating profit is negative. On the other hand, firms with $\theta \geq \underline{\theta}$ stay in the industry and choose their mode of sourcing inputs.

We denote by $\overline{\theta}$, the threshold productivity level of the firm that is indifferent between both sourcing modes. Thus, the firms having a larger productivity

[4] See Antràs (2003) for details

level than the productivity threshold $\overline{\theta}$, choose to import inputs from an independent supplier. Firms with a productivity between $\underline{\theta}$ and $\overline{\theta}$ will choose to import inputs from their affiliates. Under the threshold productivity value $\underline{\theta}$, firms exit. Using the free-entry condition, we derive the thresholds of productivity that can be expressed as in Equation (4).

$$\begin{aligned}\underline{\theta} &= D^{-1/\alpha}\left[\frac{f_v}{\psi_v(z)}\right]^{(1-\alpha)/\alpha}\\ \overline{\theta} &= D^{-1/\alpha}\left[\frac{(f_o - f_v)}{\psi_o(z) - \psi_v(z)}\right]^{(1-\alpha)/\alpha}\end{aligned} \tag{4}$$

In order to derive the probability that a firm chooses to source its inputs arm-length, we follow Helpman et al. (2004) and assume that that the producer of variety i in sector j draws a productivity level θ from a pareto distribution $G(\theta)$ with shape parameter κ.

$$G(\theta) = 1 - \left(\frac{b}{\theta}\right)^{\kappa} \quad for \quad \theta \geq b > 0 \quad , \tag{5}$$

We denote by σ_k the probability that a firm chooses the organization form k. Then, $\sigma_o = [1 - G(\overline{\theta})]/[1 - G(\underline{\theta})]$. Using the pareto distribution and the productivity threshold values, we derive the probability, $\sigma_o = (\underline{\theta}/\overline{\theta})^{\kappa}$, that a firm chooses to source inputs through an independent supplier:

$$\sigma_o = \left[\frac{\psi_o(z)}{\psi_v(z)} - 1\right]^{\kappa(1-\alpha)/\alpha}\left[\frac{f_v}{f_o - f_v}\right]^{\kappa(1-\alpha)/\alpha} \tag{6}$$

As shown in Antràs and Helpman (2004), this organizational choice will mostly depend on the intensity of supplier's input. Under the assumption of higher fixed cost under outsourcing, vertical integration yields higher profit than outsourcing for low enough intensities in supplier's input ($\frac{\psi_o^l}{\psi_v^l} < 1$), while only the most productive firms will outsource when the intensities in supplier's input are high enough ($\frac{\psi_o^l}{\psi_v^l} > 1$).

2.2 Testable Implications

The results of this model yield a set of testable predictions concerning the productivity level of the firm, the intensity in supplier's inputs and the contracting environment on the prevalence of each sourcing mode.

2.2.1 Supplier's Input Intensity, z

The supplier's input intensity affects the incentive that the final good producer wants to give a supplier. In particular, the more intensive the production is in intermediate inputs that are produced by the supplier, the larger the share of revenue it wants to give to the supplier. This is possible under outsourcing where $\beta_O < \beta_V$.

Testable implication 1. *The likelihood of sourcing through an independent supplier increases with the supplier's input intensity of the production.*

Notice that this result does not depend on the ranking of fixed costs or on the level of firm's productivity.

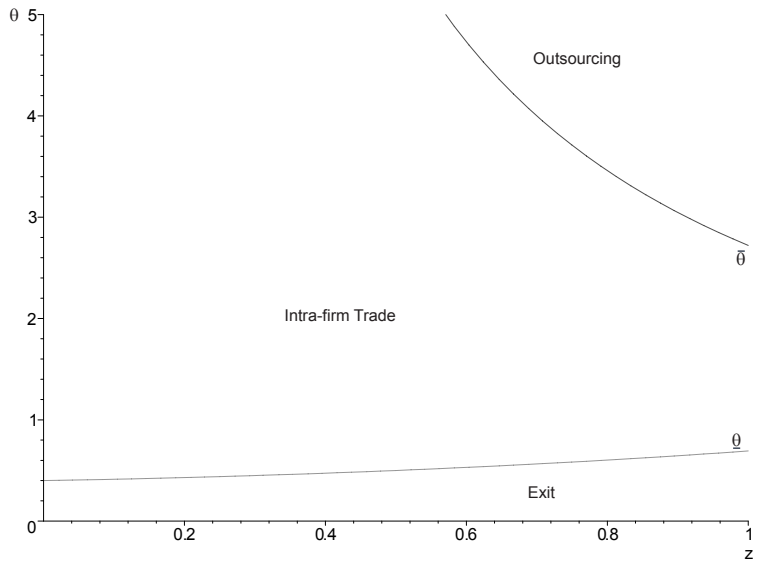
2.2.2 Productivity, θ.

In Figure 1, we show simulated levels of the critical productivity value and how they relate to the intensity in supplier's input. [5]

Outsourcing appears when a firm has simultaneously a high level of productivity and when its production process is relatively intensive in supplier's inputs. Notice that this result depends on the ranking of fixed costs. If the fixed cost under integration was higher than the one under outsourcing, then high-productivity firms that are intensive in headquarters input prefer vertical

[5] Notice that we carefully choose the value of w_l in order to obtain Figure 1. However, w_l does not affect the ratio $\psi_o(z)/\psi_v(z)$ in equation 6

Fig. 1. Firm-level productivity, supplier's input intensity and sourcing modes



Authors' computation assuming $\alpha = 0.5,\ w_l = 0.1,\ \beta_o = 0.9,\ f_o = 1,\ f_v = 0.2,\ \delta = 0.5.$

integration.

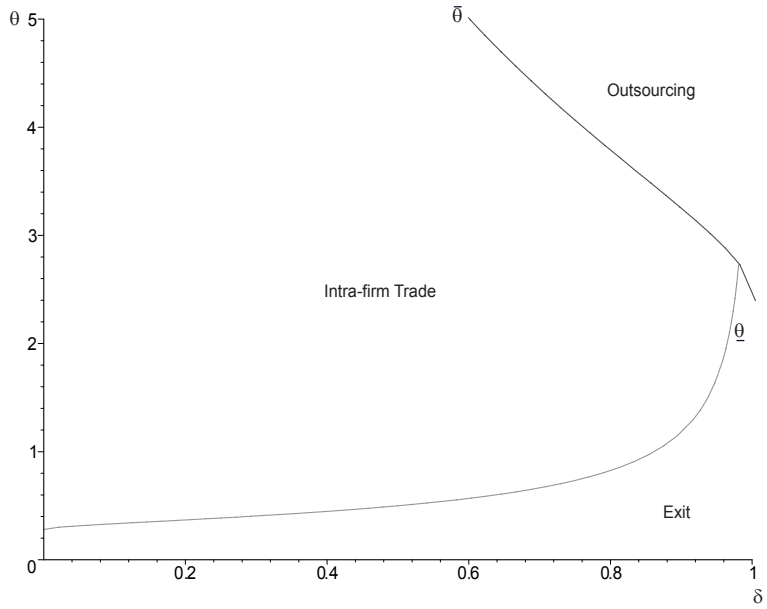
Testable implication 2. *The likelihood of sourcing inputs from an independent supplier increases with the supplier's input intensity of the production and with the productivity of the firm.*

2.2.3 Contracting Environment, δ_l

The model predicts an indirect relationship between the level of firm's productivity and the contracting environment of the export country. We show in Figure 2 the impact of the firm-level productivity and the contracting environment on the critical values of productivity.

Since $\beta_v = \delta^\alpha + \beta_o(1 - \delta^\alpha)$, a better contracting environment implies a large bargaining power, δ, for the final-good producer. Given the intensity in supplier's input, the final-good producer chooses to internalize for a low level of contracting environment. It gives more incentives to the supplier and chooses to outsource for a high level of contracting environment. Since the fixed cost under outsourcing is higher than under vertical integration, only the most

Fig. 2. Firm-level productivity, contracting environment and sourcing modes



Authors' computation assuming $\alpha = 0.5,\ w_l = 0.1,\ \beta_o = 0.9,\ f_o = 1,\ f_v = 0.2,\ z = 0.5.$

productive final good producer will be able to cover the fixed cost associated to outsourcing.

Testable implication 3. *The likelihood of sourcing inputs from an independent supplier increases with the productivity of the firm and the level of contracting environment of the export country.*

3 Data and Estimation Strategy

3.1 Data

This paper uses information from a confidential firm-level survey which provides information on the trade organization of French firms in 1999. [6] The data are provided by *SESSI* (Service des Études Statistiques Industrielles) The survey was addressed to all French firms trading more than 1 million Euro, owned by manufacturing groups that control at least 50% of the equity capital of an

[6] *Échanges internationaux intra-groupe*

foreign affiliate. This limitation sharply reduced the number of firms that answered the survey. However, the coverage remains significant. The data covers 55% of total French imports and 61% of total French exports. We focus on 4249 French importers which carried out 104947 transactions. The survey provides a detailed geographical breakdown of French firms' import and export at product level (HS4) and their sourcing modes – through independent suppliers and/or affiliates.[7] A French intra-firm transaction is defined as trade with an affiliate controlled by a single French entity with at least fifty percent of its equity capital. The *SESSI* defines two types of transaction with independent suppliers; formal contractual relationships that refer to alliances, franchising, joint-ventures, licensing agreements and informal relationships that involve transactions that use far less detailed contracts.[8]

This survey provides little information at firm level. We retrieve this information from the *EAE* database. It contains information on the balance sheet and income statement of all firms located in France that have more than 20 employees from 1996 to 2002. The *EAE* provides firm-level information on sales, capital, labor and intermediates use, fixed assets, as well as the 4-digit *NAF700*[9] sectoral classification of the firm.

3.2 Endogenous Variable: Sourcing Modes

Our first step is to distinguish firms that source their inputs through independent suppliers from those that source their input through affiliates. We use

[7] A transaction is defined as a specific product imported from a country by a firm. Some transactions were broken into two lines in cases where the firm had to announce an amount higher than the one previously filled by the customs services. We aggregate these lines.

[8] 15767 (21,8%) are intra-firm transaction, 45502 (62,9%) are informal outsourcing, 1099 (1,5%) are formal outsourcing and 10023 (13,8%) are mixed strategies (a combination of two sourcing modes).

[9] *Nomenclature d'Activité française*: nomenclature of French activities

the detailed HS4-digit classification to obtain the information as to whether goods have been imported through affiliates or through independent suppliers. The dependent variable, y_{ijl}, takes the value of one if firm i sources input j from country l through an independent supplier and 0 if the input is imported from an affiliate. 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).

$$y_{ijl} = \begin{cases} 1 \text{ if the transaction has been imported from an independent supplier} \\ \\ 0 \text{ if the transaction has been imported from an affiliate} \end{cases}$$

We restrict our analysis to manufacturing sectors but 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 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 2619 firms realizing 72391 transactions among which 15767 are imported from affiliates, 46954 are outsourced (formal and informal), and 9670 have been completed using both modes. For our empirical analysis, we exclude firms that import inputs from independent suppliers and from their affiliates simultaneously (mixed strategies).

3.3 Main Explanatory Variables

The model requires a careful approximation of the cost share of input provided by supplier, z. The EEA data set provides information on the total amount of inputs supplied to French firms by independent and affiliated suppliers,

irrespective of their location.[10] Using this information, we define z as the share of inputs from suppliers in French firms' output:

$$z = \frac{Input\ from\ suppliers}{Output}$$

We also use the EAE database to estimate firm level total factor productivity. The TFP is estimated as the residual of a three-factor Cobb-Douglas production function, with labor and deflated values of capital and material inputs as production factors. Labor is the firm-specific number of employees. The deflators are obtained from the national accounts system of the French statistical office (INSEE).[11] We estimate the production function using the Olley and Pakes (1996) methodology. The Olley and Pakes methodology control for the simultaneity bias that arise from the endogeneity of a firm's input selection, which will exist 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, thus leading to a biased OLS estimator. The Olley and Pakes estimator corrects for this possible bias by using the firm's investment decision as a proxy for unobserved productivity shocks. We present this methodology in appendix III.A.

We follow Nunn (2007) and capture the variation in contracting environments across countries using the *"rule of law"* variable for the year 2000 from the *Governance Matters VI* database (Kaufmann et al., 2006). This variable is established on the basis of polls of experts or surveys of businessmen/citizens. It is related to the perceptions of the effectiveness and predictability of the

[10] These inputs correspond to the materials and equipment, the small materials and some inputs from general sub-contracting.

[11] 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.

judiciary, and the enforceability of contracts. The variable is configured such that a higher value is associated with a better contracting environment.

3.3.1 Other Control Variables

The theoretical predictions of the model rely partially on the assumption that the fixed cost of sourcing intermediate inputs through an independent supplier is higher than the fixed cost of sourcing through an affiliate. We include the fixed costs of French firms in our baseline regression. The fixed costs have been defined as total physical assets scaled by sales.

We know from the model that β_o influences the sourcing choice and control for it in the empirical specification by including a firm's size variable. The idea that that firm's size confers a bargaining advantage has received some empirical support (Porter, 1974). The size of the firm is approximated by the number of its employees in 1999.

The organizational choice might also be influenced by country-specific endowment and firm-specific factor intensities. According to Antràs (2003), capital intensive goods are imported from affiliates located in countries that are relatively abundant in capital. We use data on countries' stock physical and human capital and on firm-level factor intensity to examine this relationship. The country-specific endowment data are taken from Trefler (2002). Capital endowment (K/L) is measured by the natural log of the ratio of the physical capital stock divided by the total labor force. Human capital endowment (H/L) is measured by the natural log of the ratio of workers completing high school to the total labor force. The data on firm factor intensity are taken from the EAE. We use the firm-level capital-labor ratio, k/l, to proxy the firm's capital intensity and its per-employee spending on information technology, s, to roughly control for firm's skill intensity.

3.4 Estimation Strategy

We analyze the choice between outsourcing and vertical integration using a logit model at the transaction level. From our theoretical framework, the organizational choice is a function of firm's fixed costs f, firm's productivity θ, the supplier's input intensity z, the primitive bargaining power β_o and the contracting environment of the exporting country, δ_l. In Equation (7), we denote by subscript i, firm-specific variable and by subscript l country-specific variable.

$$\begin{aligned} y_{ijl} = & \lambda_0 + \lambda_1 f_i + \lambda_2 z_i + \lambda_3 \theta_i + \lambda_4 \beta_{oi} + \lambda_5 \delta_l \\ & + NAF + HS + \epsilon_{ijl} \end{aligned} \tag{7}$$

where NAF and HS are the sets of sector and product specific fixed effects, respectively. ϵ_{ijl} is the stochastic error term. To estimate the empirical implication of the model, we also need to estimate how the relationship between the intensity in suppliers' inputs and the contracting environment evolves with the productivity. We therefore interact these explanatory variables with the productivity θ.

$$\begin{aligned} y_{ijl} = & \lambda_0 + \lambda_1 f_i + \lambda_2 z_i + \lambda_3 \theta_i + \lambda_4 \beta_{oi} + \lambda_5 \delta_l \\ & + \lambda_6 (z_i \times \theta_i) + \lambda_7 (\theta_i \times \delta_l) \\ & + NAF + HS + \epsilon_{ijl} \end{aligned} \tag{8}$$

The interpretation of interaction effects in non-linear models, such as logit is complex. Ai and Norton (2003) argue that odds ratios have no meaningful interpretation for the interaction effects. We follow Ai and Norton (2003) and compute the cross derivative of the expected value of the dependent variable and the statistical significance of the entire cross-derivative. The interaction effect is conditional on other independent variables. Because there are two additive terms, each of which can be positive or negative, the interaction

effect may have different signs for different values of covariates.[12] We discuss the correct interpretation of the interaction effects in the fifth section.

The logit model relies crucially on the assumption of homoskedasticity in the underlying latent variable model. We use the Huber-White method to correct for heteroscedasticity. Finally, because the model is non-linear in its parameters, the marginal effects are not constant and must be interpreted at some sample point. We choose the means of the independent variables for this evaluation. The descriptive statistics and a correlation table are shown in Appendix III.B (Table B.1 and B.2).

4 A First Look at the Data

4.1 Fixed Costs

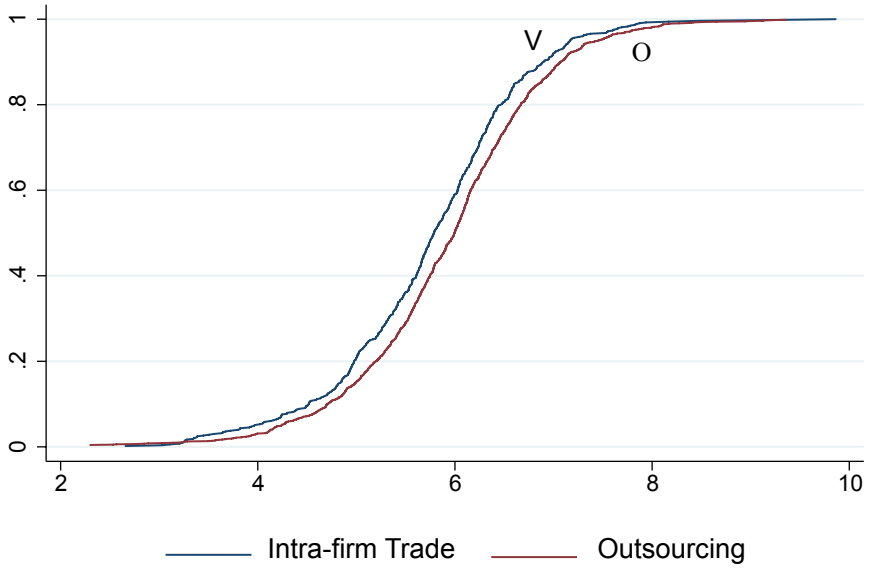
The organizational choice depends crucially on ranking of fixed costs. We first have a closer look at this ranking by comparing the cumulative distributions of firms' fixed costs in Figure 3. We only take into account firms that import at least 80% of their total import volumes either through outsourcing agreements, O, or through their affiliates, V.[13] The graph points to a first-order stochastic dominance of outsourcing with respect to fixed costs. Firms that source inputs through independent suppliers have higher fixed costs than firms that import through their affiliates.

We analyze systematic differences between both distribution using the non-parametric Kolmogorov-Smirnov two-sided test (KS-test). The KS-test has

[12] We have used the Stata command "inteff" to compute the marginal effect of the interaction terms. See Norton et al. (2004).

[13] We find qualitatively similar results when we modify the threshold value of 80%, in particular, when firms source entirely through either one of the modes. The drawback of using this latter approach is a loss of 53% in the total number of firms.

Fig. 3. Cumulative distribution of French firms' fixed costs, in logarithm



Source: EAE and SESSI's survey, authors' computation.

the advantage of making no assumption about the sample distribution. It determines if 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. The results of the KS-test are presented in Table 1.

Table 1
Kolmogorov-Smirnov test for equality of fixed cost distributions

	Difference	P-value	Corrected
$f_o > f_v$	0.0049	0.982	
$f_o < f_v$	-0.0948	0.001	
Combined K-S	0.0948	0.002	0.002

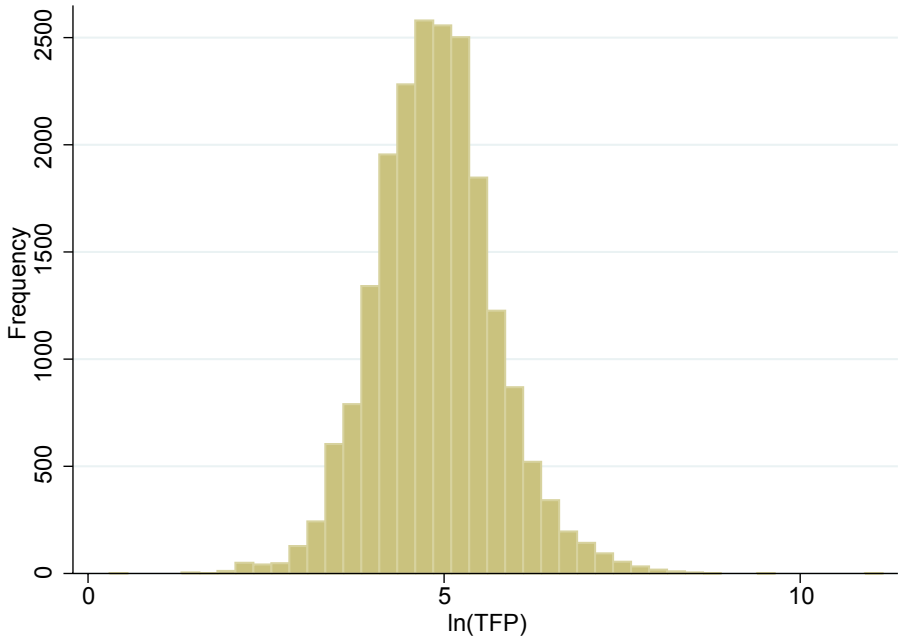
The largest difference between the distribution functions is 0.0948 which is statistically significant at 1%. Thus, the null hypothesis that both fixed costs distributions are equal is rejected. From the left-hand side of the KS test, we can reject the hypothesis that firms that source through their affiliates (V-type) have on average larger fixed costs than firms that source through in-

dependent suppliers (O-type). The largest difference between the distributions functions is 0.0049, which is not significant. From the right-hand side of the test, we accept the hypothesis that V-type are less productive than O-type firms.[14]

4.2 Productivity and the Choice between Sourcing Modes

We look at the distribution of French firms' TFP in Figure 4. The TFP distribution of French firms is not too far from log-normal even if it is slightly right-skewed. It seems that the TFP distribution of French firms does not differ from other firms' TFP distributions (Sutton, 1997, Cabral and Mata, 2003).

Fig. 4. Firm-level TFP, in logarithm



Source: EAE and SESSI's survey, authors' computation.

We have a closer look at firm heterogeneity in Table 2. It reports the number

[14] Note that increasing the threshold value of 80 % to 100% does not qualitatively change the results.

of transactions and the volume of imports according to the productivity distribution of French firms. In particular, it presents four quartiles that correspond to low (1st quartile), medium (2nd quartile), high (3rd quartile), and the most productive firms (4th quartile). Firms in the 4th quartile are on average 1.7% percent more productive than firms in the 1st quartile. [15]

Table 2
Quartile distribution of intra-firm trade and outsourcing (percentage of total in parentheses)

Quartile of TFP	Average TFP	Intra-Firm Trade	Outsourcing	Total
		Number of transactions		
First Quartile	3.67	6682	12812	19494
		(34.3)	(65.7)	
Second Quartile	4.57	4865	11039	15904
		(30.6)	(69.4)	
Third Quartile	5.09	6426	13721	20147
		(31.9)	(68.1)	
Fourth Quartile	6.11	7464	19052	26516
		(28.1)	(71.9)	
Total	4.86	25437	56624	82061
		Import Volume (1000 Euro)		
First Quartile	3.67	8853.3	8251.0	17104.3
		(51.8)	(48.2)	
Second Quartile	4.57	5209.0	4910.2	10119.1
		(51.5)	(48.5)	
Third Quartile	5.09	11774.1	8333.6	20107.7
		(58.6)	(41.4)	
Fourth Quartile	6.11	11143.1	21404.4	32547.5
		(34.2)	(65.8)	
Total	4.86	36979.5	42899.2	79878.7

Given productivity, firms that source through their foreign affiliates trade less both in terms of the number and the volume of transactions. We find a concentration of activities among the most productive firms.

In order to compare firms' productivity according to their sourcing mode, we

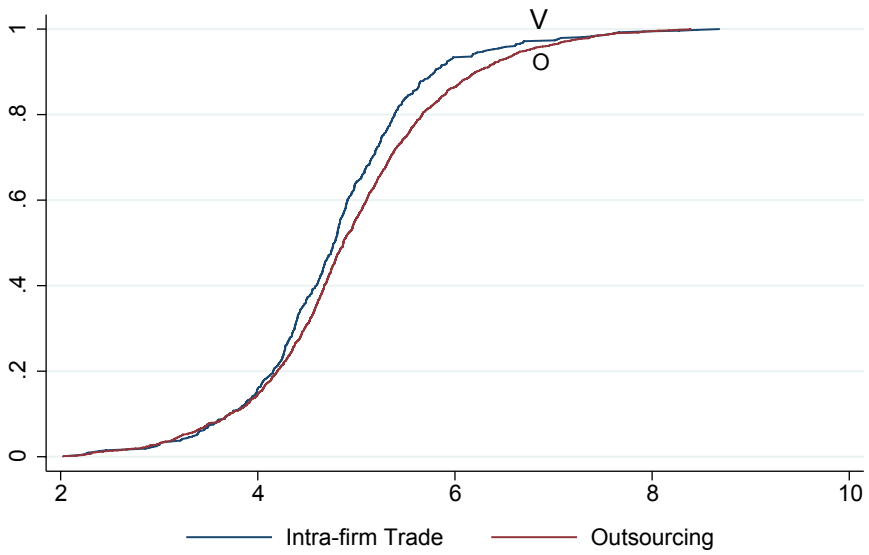
[15] Note that the number of total transactions is slightly higher than the total number of transactions presented in Table 4. This result is mainly driven by firms that have mixed strategies.

Table 3
Kolmogorov-Smirnov test for equality of productivity distribution

	Difference	P-value	Corrected
$TFP_o > TFP_v$	0.0124	0.890	
$TFP_o < TFP_v$	-0.0930	0.001	
Combined K-S	0.0930	0.003	0.002

compare their cumulative distributions of TFP in Figure 5. The graph points to a first-order stochastic dominance of outsourcing with respect to TFP. Firms that outsource are more productive than firms that import through their affiliates but not over the whole distribution.

Fig. 5. Cumulative distribution of French firm's TFP, in logarithm



Source: EAE and SESSI's survey, authors' computation.

The results of the two-sided KS-tests in table 3 confirm that the most productive firms import from independent suppliers. The KS-test shows that both distributions of TFPs are statistically different at 1% level of significance. Importantly, the two-sided test rejects the null hypothesis of higher TFPs under integration. However, it accepts the hypothesis that O-firms have higher TFPs than V-firms.

4.3 Suppliers' Input Intensity

Table 4 reports the sector-level aggregates figures concerning the intensity in suppliers' inputs, intra-firm trade and outsourcing. The suppliers' input intensity presented in Table 4 is expressed as the average intensity in suppliers' input within each sector.

For sake of simplicity, we aggregate the NAF700 sectors into 14 industries. We present the number of import transactions and their share as percentage of the total number of transaction. About 65% of the transactions are exchanged through outsourcing agreements while intra-firm import concerns only 22% of all transactions. The share of transactions that are imported through mixed strategies[16] concerns about 14% of the total number of transactions.

We also note from this table that about 42% of total imports' transactions are made in the industry of chemical, rubber and plastic products, machinery and equipment and electrical and optical equipment.

Inter-industry differences with respect to the sourcing modes at transaction level are also apparent in Table 4. Within the six industries with the higher share of outsourcing, four have high relative intensity in suppliers' input: leather products (77.9%), other transport equipment (77.3%), publishing and printing (72.8) and textile products (73.90%). A higher share of intra-firm import is found in the industries of other non-metallic mineral products (34.7%) and electrical components (32.5%). Both industries are relatively intensive in headquarter's services. This observation is in line with the findings of Antràs and Helpman (2004) that firms in headquarter intensive industries are importing mostly from their affiliates.

[16] A combination of both sourcing modes.

Table 4
Number of import transactions by sourcing modes (percentage of total into parentheses)

Industries	$\widetilde{z}^{\ddagger}$	Number of firms	Total	Intra-firm Import	Outsourcing	Mixed Strategies
Textiles, textile products	10.4	101	2462	380	1820	262
				(15.4)	(73.9)	(10.6)
Leather, leather products	14.9	66	3650	616	2845	189
				(16.9)	(77.9)	(5.2)
Wood, paper	2.1	165	3617	513	2895	209
				(14.2)	(80.0)	(5.8)
Publishing and printing	12.2	80	886	203	645	38
				(22.9)	(72.8)	(4.3)
Chemicals, rubber and plastic products	5.4	478	13814	3110	8904	1800
				(22.5)	(64.5)	(13.0)
Pharmaceutical products	6.7	168	4701	1026	3234	441
				(21.8)	(68.8)	(9.4)
Other non-metallic mineral products	3.7	128	2843	987	1699	157
				(34.7)	(59.8)	(5.5)
Basic metals and fabricated metal	6.2	314	5653	661	4397	595
				(11.7)	(77.8)	(10.5)
Machinery. equipment n.e.c.	13.0	408	9025	2110	5638	1277
				(23.4)	(62.5)	(14.1)
Electrical component	5.0	157	6177	2010	3140	1027
				(32.5)	(50.8)	(16.6)
Electrical equipment	10.5	206	7206	1806	3905	1495
				(25.1)	(54.2)	(20.7)
Motor vehicles	3.7	125	5279	851	3302	1126
				(16.1)	(62.5)	(21.3)
Other transport equipment	26.3	53	2039	200	1577	262
				(9.8)	(77.3)	(12.8)
Furniture	4.8	170	5039	1294	2953	792
				(25.7)	(58.6)	(15.7)
Total	7.9	2619	72391	15767	46954	9670
				(21.8)	(64.9)	(13.4)

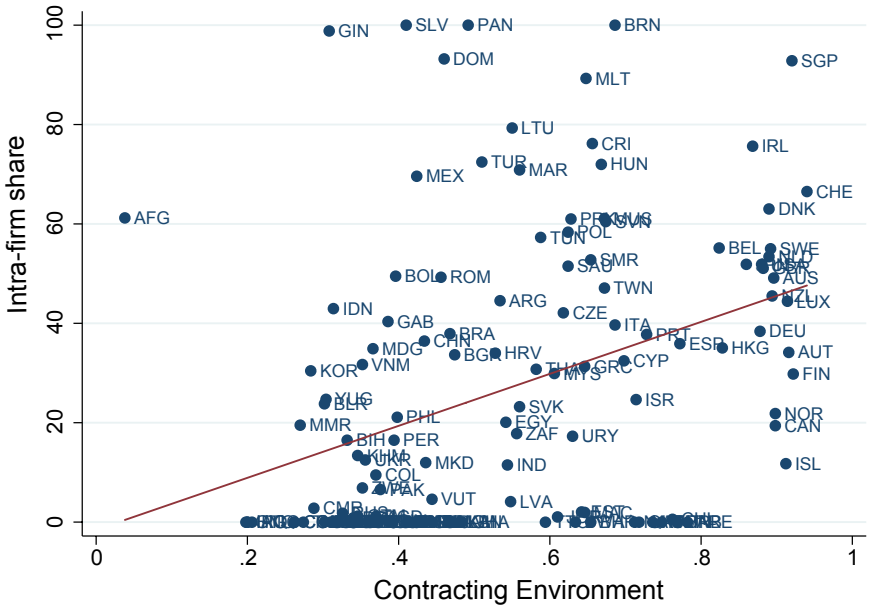
‡: $\widetilde{z}$ is the average intensity in suppliers' input within each sector

4.4 Contracting Environment and Sourcing Modes

In order to examine the relationship between the contracting environment and the sourcing mode of import, we create a country-specific variable that has information on the share of intra-firm import from a specific country. This variable is defined as the ratio between imports through foreign affiliates to total French imports: Intra-Firm Share $= \frac{M_v}{M_o+M_v}$, where M_v and M_o denote French imports through affiliates and French import through independent suppliers, respectively.

Figure 6 shows that country-specific contracting environment matters. We find a positive correlation between the intra-firm share and the rule of law

Fig. 6. Contracting environment and intra-firm share



Source: EAE and SESSI's survey, authors' computation.

variables.[17] This finding is similar to the one reported by Nunn and Trefler (2008) who show that the share of US intra-firm import is positively related to the exporting country's contracting environment. It is however not in line with our theoretical prediction, since a better contracting environment should increase the likelihood of outsourcing given the ranking of French firms' fixed costs. We investigate this result in Section 5.

4.5 Correlation between Sourcing Modes

As in Tomiura (2007), we look at the correlation between different international sourcing modes in Table 5. The upper panel (A) of this table shows the correlations at firm level. The inter-industry correlation between outsourcing and intra-firm imports is negative although insignificant. We find substitutability between mixed strategies and outsourcing or intra-firm imports.

[17] This result is robust to the exclusion of countries where France has less than 50 transactions.

Table 5
Correlation between sourcing modes (p-values into parentheses)

	Intra-firm Trade	Outsourcing	Mixed Strategies
	Panel (A): At the firm level		
Intra-firm trade	1		
Outsourcing	-0.15	1	
Mixed transaction	-0.23*	-0.93***	1
	Panel (B): At the transaction level		
Intra-firm trade	1		
Outsourcing	-0.84***	1	
Mixed transaction	-0.03	-0.52***	1

The correlation is for the share in the number of transaction across 239 industries
***,** ,*, significant at 1%, 5% and 10% level of significance, respectively.

Panel (B) shows stronger inter-industry correlation at product level. The correlation between intra-firm imports and outsourcing is negative and significant at 1% level of significance. The correlation between outsourcing and mixed strategies is also significant and negative at 1% level of significance. The inter-industry correlations suggest a substitutability between the different modes of sourcing at product level. This finding is consistent with our theoretical model.

Overall, these cross-industry correlations suggest that the level of the firm might not be best suited for our empirical analysis since a firm may import (different) goods using different sourcing modes from different countries.

5 Results

5.1 Baseline Specification

Table 6 presents the estimates of the marginal effects of the regressions at transaction level. We evaluate the marginal effect at the sample means, which measures the effect for a firm with characteristics equal to the sample averages.

In the fourth specification (S1-S4), we estimate the model as close as possible to the theoretical framework.[18] Note that all variables have been centered around their respective mean and that all specifications include a full set of French sector and product specific effects.

The first specification is an estimation of Equation 7. Except for the contracting environment whose coefficient has an unexpected sign, the marginal effects are in line with the theoretical predictions of the model and are significant at the 1% significance level.

Turning to the impact of the interaction terms on other covariates' effects, they do not qualitatively influence the results of the baseline regression. We use the Ai and Norton (2003) methodology to interpret the interaction effect whenever this effect varies widely across observations.

We show in specification (S1) that firms that have higher fixed costs choose to source their inputs through independent suppliers.[19] This is in line with our theoretical assumption. Consistent with this finding, we observe that firms that have a higher productivity level also have a higher probability of sourcing their input through independent suppliers. We find that a one percent increase in firm's TFP increases the probability of outsourcing by about 0.028 percentage point, holding the other explanatory variables constant. These results are significant at one percent level and robust across specifications.

Turning to the suppliers' input intensity, its marginal effect is positive and significant at 1%. Holding all other explanatory variables constant, we find that going from the lowest to the highest intensity in suppliers' input increases the probability to outsource by 30.7 percentage points. This finding supports

[18] Notice that the results remain robust to the exclusion of formal contractual relationships (alliances, franchising, joint ventures, licensing agreements). Only 1,5% of the transactions are formal outsourcing after the exclusion of mixed strategies.
[19] Notice that the results remain robust to the exclusion of the fixed costs and the primitive bargaining power variables.

Table 6
Dependent variable: Y=1 for outsourcing (marginal effects presented.)

	Label	(S1)	(S2)	(S3)	(S4)
Fixed Costs	f_i	0.034^a	0.034^a	0.034^a	0.034^a
		(0.002)	(0.002)	(0.002)	(0.002)
TFP	θ_i	0.028^a	0.030^a	0.028^a	0.030^a
		(0.002)	(0.002)	(0.002)	(0.002)
Supplier's Input Intensity	z_i	0.307^a	0.242^a	0.306^a	0.242^a
		(0.024)	(0.025)	(0.024)	(0.025)
Contracting Environment	δ_l	-0.105^a	-0.103^a	-0.107^a	-0.105^a
		(0.014)	(0.014)	(0.014)	(0.014)
Primitive Bargaining Power	β_{oi}	0.006^a	0.006^a	0.006^a	0.006^a
		(0.001)	(0.001)	(0.001)	(0.001)
Interaction term 1	$\theta_i \times z_i$		0.167^a		0.165^a
			(0.037)		(0.037)
Interaction term 2	$\theta_i \times \delta_l$			-0.034^b	-0.031^b
				(0.014)	(0.014)
French Sector Fixed Effects		Yes	Yes	Yes	Yes
Product Fixed Effects		Yes	Yes	Yes	Yes
Number of observation		62670	62670	62670	62670
Pseudo R^2		0.057	0.058	0.057	0.058
Log Likelihood		-33316	-33281	-33312	-33277

Robust standard error in brackets. ^{a}, ^{b} , ^{c} significantly different from 0 at 1%, 5% and 10% level, respectively.

the first implication of the model. The probability that firms import their input from independent suppliers increases with the suppliers' input intensity of the production.

In specification (S2), we introduce a multiplicative term between the suppliers' inputs intensity variable and the firm-level TFP variable in order to examine the second testable implication of the theoretical model. We find that the mean interaction effect is very significant and positive. This finding is robust across observations and confirms the theoretical prediction of the model. Greater intensity in suppliers' inputs increases the marginal effect of the TFP variable on the probability to source through an independent supplier.

We find that a better contracting environment has a significant and negative impact on the probability of sourcing inputs through an independent supplier

in specification (S1). Going from the lower to the upper bound of our "rule of law" variable decreases the probability to outsource by 10.5 percentage point in the first specification. However, the theoretical model does not offer any predictions concerning the intercept-shift effect of the contracting environment variable on the sourcing mode. Looking at the mean interaction effect in specification (S3), we find that a higher productivity strengthens the negative marginal effect of the contracting environment on the probability of sourcing inputs through an independent supplier. Whereas the magnitude and the sign of the interaction effect are robust across observations, the significance level is not. The marginal effect of the interaction term is positive but insignificant for all observations that have larger predicted values than 0.8. These findings are not consistent with the third testable implication of the model but is in line with the prediction of a recent study by Antràs and Helpman (2008). According to the authors, the foreign supplier and the final good producer produce intermediate inputs that are partially contractible. They show that if a better contracting environment reduces the non-contractible share of the supplier's input then the incentives required by the final-good producer increases. Thus increasing the foreign contracting environment increases the likelihood of sourcing inputs through affiliates. [20]

Finally, we find primitive bargaining power measured by the logarithm of the size of the firm is also positive and significant at 1% level in specification. Holding all explanatory variable constant, a one percent increase in the primitive bargaining power increases the probability of outsourcing by about 0.006 percentage point.

[20] Antràs and Helpman (2008) also show that a better contracting environment increase firms' entry. Considering our ranking of fixed costs, these new firms are less productive and import from affiliates.

5.2 Intermediate Inputs

We follow the methodology developed by Feenstra and Hanson (1996) to distinguish between imported final goods and imported intermediate inputs. For a sufficiently disaggregated level of sector classification, at HS3-level, we identify imported intermediate inputs as inputs purchased from each supplier registered in another sector as the sector in which the French firm reports its main activity. The results using imported intermediate inputs are reported in Table 7.

Table 7
Imported intermediate inputs' sample. Dependent variable: Y=1 for outsourcing (marginal effects presented.)

	Label	(I1)	(I2)	(I3)	(I4)
Fixed Costs	f_i	0.041^a	0.040^a	0.041^a	0.040^a
		(0.002)	(0.002)	(0.002)	(0.002)
TFP	θ_i	0.027^a	0.030^a	0.027^a	0.030^a
		(0.002)	(0.002)	(0.002)	(0.002)
Supplier's Input Intensity	z_i	0.372^a	0.282^a	0.371^a	0.281^a
		(0.029)	(0.030)	(0.029)	(0.030)
Contracting Environment	δ_l	-0.074^a	-0.072^a	-0.076^a	-0.074^a
		(0.016)	(0.016)	(0.016)	(0.016)
Primitive Bargaining Power	β_{oi}	0.008^a	0.008^a	0.008^a	0.008^a
		(0.002)	(0.002)	(0.002)	(0.002)
Interaction term 1	$\theta_i \times z_i$		0.276^a		0.274^a
			(0.041)		(0.041)
Interaction term 2	$\theta_i \times \delta_l$			-0.024	-0.017
				(0.016)	(0.017)
Sector Fixed Effects		Yes	Yes	Yes	Yes
Product Fixed Effects		Yes	Yes	Yes	Yes
Number of observation		45829	45829	45829	45829
Pseudo R^2		0.064	0.067	0.064	0.067
Log Likelihood		-22731	-22670	-22729	-22670

Robust standard error into brackets. ^{a}, ^{b} , ^{c} significantly different from 0 at 1%, 5% and 10% level, respectively.

The sign of the marginal effects and the magnitude of the standard errors remain in line with the one found using the whole sample. Using the intermediate inputs sample slightly decreases the contracting environment's effect

while it increases significantly the impact of the first interaction term. Notice that the Log likelihood is smaller when using the imported intermediate inputs sample. This is an indication that the sample of imported intermediate inputs fits the model better.

We find positive and very significant mean effects of the first interaction terms on the probability of sourcing inputs through an independent supplier. We also find these results to be robust across observations. This tends to confirm that the intermediate input sample is better suited for our analysis of the sourcing mode.

We find a negative albeit insignificant mean interaction effect of the contracting environment and firm's productivity level on the sourcing decision.

5.3 Factor Intensities and Factor Endowments

In Table 8, we consider the role of factor endowment and firm-level factor intensity in explaining the organizational choice. We show the results of estimations from the intermediate inputs sample in specifications (R1) to (R3). [21]

In specifications (R1), we find the countrys skill endowment and the firm-specific skill intensity to be important determinants of the organizational choice. The likelihood of sourcing intermediate inputs through an independent supplier decreases with the skill intensity of the firm's production process. This finding confirms earlier results at aggregate level by Antràs (2003), Yeaple (2006) and Nunn and Trefler (2008). Moreover, the probability of importing inputs through independent suppliers is lower in countries relatively skill-abundant. The mean interaction term between the skill intensity and

[21] We find similar results using the whole sample. These results are presented in Table C.1 of Appendix III.C

the skill endowment variable is negative and significant. The probability of sourcing inputs through affiliates is higher for high-skilled intensive firms that import from high-skilled abundant countries. The inclusion of the skill intensity and endowment variables sharply reduces the significance level of the marginal effect of the contracting environment variable. The role of the contracting environment is no longer important once we control for a country's specific skill endowment.

In specification (R2), we substitute the skill intensity and the skill endowment variables by the firm's and country's capital-labor ratio. The firm's capital intensity variable has a positive impact on the decision to source input through independent suppliers. This result is in line with Antràs (2003). We find however that the probability of sourcing through affiliates is higher, the higher the capital-labor ratio of the exporting country. In our database, the bulk of outsourcing is placed among European countries, USA and Canada. Among these countries, the largest recipients of outsourcing, Germany, Italy and Austria, have low skill endowments but high capital-labor ratios. The mean interaction term between the firm-level capital intensity and the country-level capital-labor ratio variables is positive and insignificant. We do not find any relationship between the capital intensities and the capital endowment.

6 Conclusion

Recent theoretical evidence have stressed the importance of firm's productivity for their mode of sourcing foreign intermediate inputs. In Antràs and Helpman (2004), the most productive firms can compensate the foreign affiliate set-up costs, and source their intermediate inputs internally in the headquarter-intensive sector. We propose a slight modification of the Antràs and Helpman

Table 8
Robustness check: Dependent variable: Y=1 for outsourcing (marginal effects presented)

		Intermediate Inputs		
	Label	(R1)	(R2)	(R3)
Fixed Costs	f_i	0.040^a	0.091^a	0.090^a
		(0.002)	(0.004)	(0.004)
TFP	θ_i	0.028^a	0.046^a	0.049^a
		(0.002)	(0.002)	(0.003)
Supplier's Input Intensity	z_i	0.394^a	0.372^a	0.281^a
		(0.031)	(0.030)	(0.031)
Contracting Environment	δ_l	-0.015	-0.184^a	-0.082^a
		(0.021)	(0.023)	(0.023)
Primitive Bargaining Power	β_{oi}	0.012^a	0.008^a	0.011^a
		(0.002)	(0.002)	(0.002)
Skill Endowment (Country)	H_l/L_l	-0.057^a		-0.053^a
		(0.005)		(0.005)
Skill Intensity (Firm)	s_i	-0.006^a		-0.005^a
		(0.001)		(0.001)
Capital-Labor Ratio (Country)	K_l/L_l		0.033^a	0.031^a
			(0.005)	(0.005)
Capital-Labor Ratio (Firm)	$(k/l)_i$		-0.065^a	-0.065^a
			(0.004)	(0.004)
Interaction term 1	$\theta_i \times z_i$			0.321^a
				(0.045)
Interaction term 2	$\theta_i \times \delta_l$			0.038^c
				(0.020)
Interaction term 3	$s_i \times H_l/L_l$	-0.014^a		-0.013^a
		(0.003)		(0.002)
Interaction term 4	$(k/l)_i \times K_l/L_l$		0.005	0.006^c
			(0.004)	(0.004)
Sector Fixed Effects		Yes	Yes	Yes
Product Fixed Effects		Yes	Yes	Yes
Number of observation		42123	42123	42123
Pseudo R^2		0.071	0.075	0.083
Log Likelihood		-20715	-20637	-20459

Robust standard error into brackets. ^{a}, ^{b} , ^{c} significantly different from 0 at 1%, 5% and 10% level, respectively.

(2004) model by considering a production function that is firm-specific. The model predicts that the likelihood to import from an independent supplier is increasing with (i) the production intensity in supplier's inputs, (ii) the final-good producer's productivity and its production intensity in supplier's input,

and (iii) its productivity and the contracting environment of the supplier's country.

We make several improvements to the previous empirical literature. First, we use firm-level data that have detailed information on the mode of sourcing at product-level and allow to distinguish between final goods and intermediate inputs. Second, the data have sufficient information to compute total factor productivity at firm-level using Olley and Pakes (1996) correction for endogeneity of input selection. Third, we create a measure of intensity of supplier inputs at firm-level, which is derived from the theory.

The data indicate that French firms that source their intermediate inputs trough independent suppliers have a higher fixed cost that firms that imports intermediate inputs from their affiliates. The results further show that greater intensity in suppliers' inputs increases the likelihood of outsourcing. This results is in line with the prediction of the model. We find moreover that highly productive firms that use suppliers' inputs intensively in their production process have a higher probability to outsource. However, the data indicate that firms tend to import their inputs from their affiliates located in countries that have better contracting environment. This might be explained by the level of contractibility of intermediate inputs as emphasized by Antràs and Helpman (2008). A careful examination of the contractibility hypothesis goes beyond the scope of our present analysis. Further research is needed to determine the exact nature of the relationship between contractibility and the sourcing mode of inputs.

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Appendices

A TFP Measurement

We use the Olley and Pakes (1996) (OP) semiparametric method to estimate firm-level TFP. This method allows robust estimation of the production function. It takes into account the endogeneity of some inputs, the exit of firms as well as the unobserved permanent differences among firms. The main assumption the OP technique relies on, is the existence of a monotonic relationship between investment and firm-level unobserved heterogeneity. Estimation have been realized for each one of the 52 sectors (3 digit).

We consider the following Cobb-Douglas production function

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

and denote the logarithm of output, capital, labor and intermediate inputs with Q_{it}, K_{it}, L_{it} M_{it}, respectively. Subscripts i and t stand for firm and time, θ_{it} denotes productivity, and ϵ_{it} stands for measurement error in output. It is assumed that θ_{it} follow an exogenous first order Markov process:

$$\theta_{it+1} = E[\theta_{it+1}|\theta_t] + \upsilon_{it+1}$$

where υ_{it} is uncorrelated with the productivity shock. The endogeneity problem stems from the fact that K_{it} and L_{it} are correlated with the θ_{it}. This makes λ_{OLS} to be biased and inconsistent. Given that investment is strictly monotonic, it can be inverted as:

$$\theta_{it} = h(I_{it}, K_{it})$$

and substituting this function in the production function leads to

$$Q_{it} = \lambda_L L_{it} + \lambda_M M_{it} + \Phi(I_{it}, K_{it}) + \epsilon_{it}$$

where $\Phi(I_{it}, K_{it}) = \lambda_0 + \lambda_K K_{it} + h(I_{it}, K_{it})$. Since the functional form of $\Phi(\cdot)$ is not known, we cannot estimate the coefficients of the capital and labor variable directly. Instead, we use a linear model that includes a series estimator using a full interaction term polynomial in capital and investment to approximate $\Phi(\cdot)$. From this first stage, the consistent estimates of the coefficients on labor and material inputs as well as the estimate of the polynomial in I_{it} and K_{it} are obtained.

The second stage takes into account the survival of firms. These probabilities are given by

$$\begin{aligned} Pr\{\chi_{t+1} = 1 | \underline{\theta}_{t+1}(K_{t+1}), Jt\} &= Pr\{\theta_{t+1} \geq \underline{\theta}_{t+1}(K_{t+1}) | \underline{\theta}_{t+1}(K_{t+1}), \theta_t\} \\ &= \varphi\{\underline{\theta}_{t+1}(K_{t+1}), \theta_t\} \\ &= \varphi(i_t, K_t) \\ &= P_t \end{aligned}$$

The probability that a firm survives at time $t+1$ conditional on its information set at time t, J_t and θ_{t+1}. This is equal to the probability that the firm's productivity is greater than a threshold, $\underline{\theta}_{t+1}$, which in turn depends on the capital stock. The survival probability can be written as a function of investment and capital stock at time t. Thus, we estimate a probit regression on a polynomial in investment and capital controlling for year specific effects. Now, consider the expectation $Q_{t+1} - \lambda_L L_{t+1}$ conditional on the information at time t and survival at $t+1$.

$$\begin{aligned} E[Q_{t+1} - \lambda_L L_{t+1} | K_{t+1}, \chi_{t+1} = 1] &= \lambda_0 + \lambda_K K_{t+1} + E[\theta_{t+1} | \theta_t, \chi_{t+1} = 1] \\ &= \lambda_K K_{t+1} + g(\underline{\theta}_{t+1}, \theta_t) \end{aligned}$$

θ_{it} follows an exogenous first-order Markov process. We substitute the productivity shock in the above equation using the result from the first stage.

$$Q_{t+1} - \lambda_L L_{t+1} = \lambda_K K_{t+1} + g(P_t, \Phi_t - \lambda_K K_t) + \upsilon_{t+1} + \epsilon_{it}$$

The third step takes the estimates from λ_L, Φ_t, and P_t and substitutes them for the true values. The series estimator is obtained by running a non-linear least squares on the equation

$$Q_{t+1} - \lambda_L L_{t+1} - \lambda_M M_{t+1} = c + \lambda_K K_{t+1} + \sum_{j=0}^{s-M} \sum_{M=0}^{s} \lambda_{Mj} (\hat{\phi}_t - \lambda_K K_t)^M \hat{P}_t^j + e_t$$

where s is the order of the polynomial used to estimate the coefficient on capital.

B Descriptive Statistics and Correlation Table

Table B.1
Summary statistics of variables

	Label	Mean	Std. Dev.	Obs.
Fixed Costs (Log)	f_i	-1.116	0.917	62670
TFP (Log)	θ_i	0.003	1.066	62721
Supplier's Input Intensity	z_i	0.001	0.097	62721
Firm Size (Log)	β_{oi}	-0.002	0.132	62721
Contracting Environment	δ_l	-0.085	1.414	62721
Country Skill Endowment (Log)	H_l/L_l	0.001	2.294	56912
Firm Skill Intensity (Log)	s_i	0.001	0.432	56912
Country Capital-Labor Ratio (Log)	K_l/L_l	0.001	0.966	56912
Firm Capital-Labor Ratio (Log)	$(k/l)_i$	0.001	0.524	56912
Interaction term 1	$z_i \times \theta_i$	0.026	0.115	62721
Interaction term 2	$\theta_i \times \delta_l$	-0.005	0.140	62721
Interaction term 3	$s_i \times H_l/L_l$	0.043	0.942	56912
Interaction term 4	$(k/l)_i \times K_l/L_l$	0.053	0.592	56912

Non-interacted variables have been centered around their mean.

Table B.2
Correlation matrix

	f_i	θ_i	z_i	β_0	δ_l	s_i	H_l/L_l	$(k/l)_i$	K_l/L_l
f_i	1.000								
θ_i	-0.164^a	1.000							
z_i	-0.205^a	0.253^a	1.000						
β_{0i}	0.126^a	0.198^a	-0.005	1.000					
δ_l	0.100^a	-0.039^a	-0.036^a	-0.016^a	1.000				
s_i	0.006^a	0.059^a	0.091^a	0.236^a	0.005^a	1.000			
H_l/L_l	0.016^a	0.013^a	0.011^a	0.059^a	0.454^a	0.044^a	1.000		
$(k/l)_i$	0.765^a	0.071^a	-0.152^a	0.150^a	0.104^a	0.076^a	0.050^a	1.000	
K_l/L_l	0.108^a	-0.067^a	-0.044^a	-0.021^a	0.584^a	-0.014^a	0.319^a	0.104^a	1.000

^{a}, significantly different from 0 at 1% level.

C Robustness Checks: Factor Intensities and Factor Endowments using the Whole Sample

Table C.1
Robustness check: Dependent variable: Y=1 for outsourcing (marginal effects presented)

		Whole Sample		
	Label	(R4)	(R5)	(R6)
Fixed Costs	f_i	0.034^a	0.095^a	0.096^a
		(0.002)	(0.003)	(0.004)
TFP	θ_i	0.028^a	0.049^a	0.051^a
		(0.002)	(0.002)	(0.002)
Supplier's Input Intensity	z_i	0.326^a	0.318^a	0.241^a
		(0.026)	(0.025)	(0.026)
Contracting Environment	δ_l	-0.035^c	-0.195^a	-0.106^a
		(0.018)	(0.020)	(0.021)
Primitive Bargaining Power	β_{oi}	0.010^a	0.006^a	0.008^a
		(0.002)	(0.001)	(0.001)
Skill Endowment (Country)	H_l/L_l	-0.056^a		-0.052^a
		(0.005)		(0.005)
Skill Intensity (Firm)	s_i	-0.006^a		-0.004^a
		(0.001)		(0.001)
Capital-Labor Ratio (Country)	K_l/L_l		0.029^a	0.032^a
			(0.004)	(0.004)
Capital-Labor Ratio (Firm)	$(k/l)_i$		-0.078^a	-0.078^a
			(0.003)	(0.003)
Interaction term 1	$z_i \times \theta_i$			0.221^a
				(0.040)
Interaction term 2	$\theta_i \times \delta_l$			0.017
				(0.017)
Interaction term 3	$s_i \times H_l/L_l$	-0.010^a		-0.010^a
		(0.002)		(0.002)
Interaction term 4	$(k/l)_i \times K_l/L_l$		0.020^a	0.020^a
			(0.004)	(0.004)
Sector Fixed Effects		Yes	Yes	Yes
Products Fixed Effects		Yes	Yes	Yes
Number of observation		56912	56912	56912
Pseudo R^2		0.061	0.068	0.072
Log Likelihood		-30161	-29967	-29809

Robust standard error into brackets. ^{a}, ^{b} , ^{c} significantly different from 0 at 1%, 5% and 10% level, respectively.