Market Power in Input Markets:

Theory and Evidence from French Manufacturing*

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Abstract

This paper investigates the empirical size of market power in input trade, and its impact on aggregate output and productivity. I employ longitudinal data on trade and production of French manufacturing firms from 1996-2007, and provide evidence that in a large number of industries, larger and more productive firms spend a less-than-optimal amount of resources on foreign intermediate inputs, consistent with the exercise of buyer power. Based on this empirical evidence, I embed buyer power in an otherwise standard model of production, and analytically show that it induces allocative inefficiencies in production. When the buyer power is counterfactually removed, I calculate static gains in aggregate TFP of 6%, and in aggregate output of about 1%. My results imply that the productivity gains associated with input trade might be lower than what usually thought.

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1 Introduction

The relationship between trade openness and productivity features prominently in studies of international economics. A recent body of work has emphasized the importance of trade in intermediate inputs for enhancing economic performance: by allowing firms to access novel, cheaper or higher quality inputs from abroad, input trade has been shown to generate both static and dynamic gains (Goldberg et al., 2010; Topalova and Khandelwal, 2011; Halpern et al., 2015; Blaum et al., 2018).

The literature has so far remained largely silent about the economic environment where importers operate, a key determinant of both welfare and distributional consequences of international trade (e.g. Bhagwati, 1971; Harrison, 1994). What we know is based on the premise that importers act as price takers in foreign input markets. While it is recognized that international trade largely takes place in less-than competitive environments (Dixit, 1984), and that countries have market power in imports (Broda et al., 2008), little is known about the importance of input market power at the microeconomic level. Yet large individual importers are aware of their dominant buyer position, and might act to profit from it. The exercise of buyer power in international markets could in turn impair the efficiency of the production process and aggregate outcomes, and it ultimately matters in important ways for our understanding of the gains from input trade.

This paper takes a first step towards filling this empirical and theoretical gap by investigating both the empirical size of market power in foreign input trade, and its effects on aggregate variables, using data from a large open economy: France. The analysis proceeds in two steps. I first provide novel empirical evidence that the type of competition prevailing in French input trade is largely consistent with the buyer power of domestic importers. To do so, I extend the econometric reduced-form production model with imperfect product and labor markets in Dobbelaere and Mairesse (2013), and show that input market power can be identified as an efficiency wedge in the firm's first order condition for the foreign input, which can be estimated jointly with the parameters of the production function of firms. One important contribution of this paper is to combine modern econometric techniques with detailed micro level data, to consistently estimate measures of input market power in imports while addressing several biases in production function estimation.

Motivated by the empirical evidence, in the second part of the paper I embed buyer power in a standard model of production with heterogeneous firms, and characterize its effects on the aggregate economy. I show that the exercise of buyer power induces large allocative inefficiencies in production, and substantially lowers both aggregate output and TFP. In the case of France, the estimated wedges on the foreign input imply losses in aggregate output of 0.6–2%, and losses in TFP of 6%, as compared to a counterfactually competitive benchmark. To the best of my knowledge, my analysis is the first to shed light on the aggregate consequences of input market power in a standard macroeconomic framework.

One key empirical challenge in estimating the production function of firms is that data on physical units of inputs and output are usually not observed, such that the researcher has to resort to industry-wide price deflators to capture price movements common across firms from nominal variables. This procedure leads to well-known biases in estimation, due to firm-specific demand shocks, and/or market power (cf. Katayama et al., 2009; Foster et al., 2008; De Loecker, 2011a). Accounting for input and output price bias in production function estimation is particularly important in this context, given that the estimation of input market power requires measures of the *physical* output elasticities. To address this issue, I exploit customs data on import and export unit values to construct firm-level price deflators, which I then use to eliminate the price effects from the relevant nominal variables. This approach dispenses with parametric assumptions on demand and/or market structure of the foreign input market, consistent with the application of the paper.

I apply my methodology using French longitudinal firm-level data on trade and production over the period 1996-2007. I find that both the mean and median value of the foreign intermediate input wedges are significantly above unity in almost all sectors, even with substantial heterogeneity. Seen through the lens of the theoretical framework, this means that domestic importers decide to spend on foreign inputs a share of resources that is below competitive levels, consistent with the exercise of buyer power in foreign input markets. My estimates are robust to different specifications of the production function, and to different methodologies to estimate input market power.

Sector and firm-level analyses corroborate the interpretation of the wedges as buyer power, while alternative explanations based on trade or adjustment costs are ruled out. Across industries, market imperfections are large in sectors which are highly concentrated, highly productive, and with a high share of multinational firms. Regression analysis further shows that large and productive firms are relatively more distorted than smaller, unproductive firms.

Motivated by these findings, in the second part of the paper I incorporate buyer power in an otherwise standard general equilibrium model of a production economy with heterogeneous firms, in the spirit of Melitz (2003) and Hsieh and Klenow (2009). I assume that a differentiated variety of a foreign intermediate input is used by each firm to produce a differentiated variety of a final good. Foreign markets are horizontally segmented, and each domestic firm only competes with a finite number of foreign firms abroad. In the model, input market power arises due to the existence of rents in foreign markets, and atomistic buyers.

The benefit of focusing on a simple model of production is twofold. First, it allows me to investigate the specific channels through which buyer power affects the production decisions of firms. Second, the model yields an analytical characterization of the static aggregate equilibrium distortions. I show that at the individual firm level, buyer power raises the marginal revenue product of the foreign intermediate input, leading to an inefficient substitution of the inputs in production, and to an inefficient firm size. From an aggregate standpoint, such allocative inefficiencies result in lower TFP, and lower aggregate output, compared to a counterfactual economy where all firms are price takers in the input markets.

A particularly interesting feature of the model is that, given parameters, the first and second moments of the distribution of the foreign input wedges are *sufficient statistics* for quantifying the losses in aggregate output and TFP due to buyer power. When I plug the estimated wedges in the relevant model equations, I find that by hypothetically eliminating the buyer power of French importers, and its dispersion thereof, aggregate efficiency would increase by 6%, while aggregate output would increase by about 1%.

These findings contribute in important ways to the discussion on the relationship between trade, competition, and productivity. First, a large body of work has studied the relationship between input trade and productivity, largely finding positive effects (see Amiti and Konings, 2007; Gopinath and Neiman, 2014; Topalova and Khandelwal, 2011; Halpern et al., 2015 and Muendler, 2004, for an exception). My results suggest that opening up to trade could increase a country's exposure to input market distortions, and to allocative inefficiencies in production. It follows that the productivity gains of input trade could potentially be lower - by at least 6% - than what traditional studies assert.

A separate, but related, literature in international trade has studied the effect of international trade on firm-level markups and product market power (Harrison, 1994; Konings et al., 2001; Chen et al., 2009; De Loecker and Warzynski, 2012; De Loecker et al., 2016; Arkolakis et al., 2015). These studies focus on exports and product market power, and emphasize a tradeoff in the relationship between trade and competition. Unlike these papers, here I focus on imports, and input market power. The finding that input trade is associated with the market power of importers and production distortions is consistent with the narrative that international trade could potentially have negative effects on the overall level of competition in an economy.

This study belongs to a growing literature aimed at understanding the determinants and implications of market power in input markets. Until now studies have mostly focused on the market of labor (see Dobbelaere and Mairesse, 2013; Azar et al., 2017; Nesta et al., 2018; Dobbelaere and Kiyota, 2018; MacKenzie, 2019). The findings of this paper emphasize that input market power could be an important economic issue even beyond the labor markets.

My work is also related to the literature on market power and misallocation (Epifani and Gancia, 2011; Holmes et al., 2014; Edmond et al., 2015; Peters, 2016; Asker et al., 2018). I study the effect of heterogenous *buyer* power on the equilibrium allocation of resources, while pointing out a new type of productivity loss through misallocation, which had not yet been addressed by the literature. More generally, input market frictions had received some implicit attention in the misallocation literature, but little explicit modeling.

Finally, the findings of this paper speak to the current debate on the importance of market power of firms in the modern economy (De Loecker and Eeckhout, 2017, 2018; Gutiérrez and Philippon, 2017; Syverson, 2019; Eggertsson et al., 2018). While I focus on the specific setting of foreign input markets, both my econometric framework and the theoretical model can be easily extended to think about buyer power in a more general sense.

The remainder of the paper is organized as follows. I introduce the conceptual framework and estimation routine in Section 2. In Section 3 I describe the empirical exercise, the data sources, and main results. In Section 4 I describe the theoretical model, the main theoretical results, and the counterfactual exercise. Section 5 concludes.

2 Empirical Model: A Framework to Estimate Input Market Power

This section describes my methodology for consistently estimating input market power at the firm level. I build on the econometric framework to estimate product and labor market imperfections in Dobbelaere and Mairesse (2013), and similarly Hall (1986) and De Loecker and Warzynski (2012), while extending their theoretical framework to think about imperfect competition in foreign input markets. I derive the relationship between input market imperfections, data, and output elasticities in Section 2.1. In Section 2.2, I describe my production function estimation procedure to obtain consistent estimates of the output elasticities.

2.1 Deriving an Expression for Input Market Power

A firm i produces output in each period according to the following technology:

$$Q_{it} = Q(\mathbf{V}_{it}, \mathbf{K}_{it}; \Theta_{it}), \tag{1}$$

where $\mathbf{V}_{it}$ is the vector of variable inputs in production, which the firm can flexibly adjust in each period, and $\mathbf{K}_{it}$ is the vector of "dynamic" inputs, such as capital and labor, which are subject to adjustment costs or time-to-build. Given the application of this paper, I assume that each firm uses exactly two variable inputs in production, namely a *domestic* intermediate input, which I denote by M_{it}; and a *foreign* intermediate input, which I denote by X_{it}.[1] I restrict to well-behaved production technologies, and assume that $Q(\cdot)$ is twice continuously differentiable with respect to its arguments.

In each period firms minimize short-run costs taking as given output quantity and state variables. In order to allow for non-competitive buyer behavior, I consider the following mapping between input price and input demand of firm i:

$$W_{it}^{v} = W\left(V_{it}; \mathbf{G}_{it}^{v}\right) \ \forall \ v = m, x, \tag{2}$$

where W_{it}^{v} is the input v's unit price, and $\mathbf{G}_{it}^{v}$ are other exogenous variables affecting prices, such as location. Equation (2) nests several price setting models in input markets, and can be reconciled with a number of models of imperfect competition in the market of input v. When markets are competitive, the buyer behaves as a price taker, and $\frac{\partial W_{it}^{v}}{\partial V_{it}} = 0$. Conversely, when the buyer has input market power, $\frac{\partial W_{it}^{j}}{\partial V_{it}^{j}} \neq 0$.

Let $\mathcal{L}(M_{it}, X_{it}, \mathbf{K}_{it}; \lambda_{it}) = W_{it}^{M} M_{it} + W_{it}^{X} X_{it} + \sum_{j=1}^{J} r_{it}^{J} K_{it}^{j} + \lambda_{it}\left(Q_{it} - Q_{it}(\cdot)\right)$ denote the Lagrangean function associated with the cost-minimization problem of firm i. The first-order condition for any variable input V_{it} is given by:

[1] This choice is without loss of generality. The discussion can be easily extended to the general case with $N \geq 2$ variable inputs.

$$\frac{\partial \mathcal{L}}{\partial V_{it}} \equiv W_{it}^{v} + \frac{\partial W_{it}^{v}}{\partial V_{it}} V_{it} - \lambda_{it} \frac{\partial Q_{it}(\cdot)}{\partial V_{it}} = 0 \tag{3}$$

$$\Longrightarrow \lambda_{it} \frac{\partial Q_{it}(\cdot)}{\partial V_{it}} = W_{it}^{v} \left(1 + \frac{\partial W_{it}^{v}}{\partial V_{it}^{v}} \frac{V_{it}}{W_{it}}\right). \tag{4}$$

The term $\lambda_{it} = \frac{\partial \mathcal{L}}{\partial Q_{it}}$ is the shadow value of the constraint of the associated Lagrangian function, i.e. the marginal cost of output. Equation (4) thus says that the marginal cost of the input in equilibrium is equal to the unit price W_{it}^{v}, times a term which differs from one whenever $\frac{\partial W_{it}^{v}}{\partial V_{it}} \neq 0$. In other words, the existence of input market power generates a *wedge* between the marginal valuation of the input and its equilibrium price, which I denote by ψ_{it}^{v} and is equal to

$$\psi_{it}^{v} \equiv \left(1 + \frac{\partial W_{it}^{v}}{\partial V_{it}} \frac{V_{it}}{W_{it}^{v}}\right). \tag{5}$$

I consider ψ_{it}^{v} as a measure of firm i's input market power in the market of $v = \{m, x\}$. Let us denote firm-level markups, a measure of product market imperfections, as price over marginal costs, i.e. $\mu_{it} = P_{it}/\lambda_{it}$. We can now rearrange equation (4) to get the following expression:

$$\psi_{it}^{v} = \frac{\theta_{it}^{v}}{\alpha_{it}^{v}} (\mu_{it})^{-1}, \tag{6}$$

where $\theta_{it}^{v} \equiv \frac{\partial Q_{it} V_{it}}{\partial V_{it} Q_{it}}$ is the output elasticity of static input V_{it}, $\alpha_{it}^{v} \equiv \frac{W_{it}^{v} V_{it}}{P_{it} Q_{it}}$ is the share of expenditure on input v over total firm's revenues, for $v = m, x$. Equation (6) shows that the input market power of the firm can be expressed as a function of three objects: the output elasticity of the input, its share in total firm revenues, and firm-level markups. While it is relatively easy to obtain measures of the output elasticities, markups are usually unobserved. To make progress, notice that equation (6) holds for any static input $V_{it} \in \mathbf{V}_{it}$. In the case of two static inputs, i.e. $\mathbf{V}_{it} = \{X_{it}, M_{it}\}$, this would give us a system of two equations in three unknowns, namely ψ_{it}^{x}, ψ_{it}^{m} and μ_{it}. In my application, I will assume that firms behave as price takers in the domestic input markets, which implies that $\psi_{it}^{m} = 1$ for all i and t. Under the assumption of competitive domestic input markets, one can use (6) to derive firm-level markups as:

$$\mu_{it} = \frac{\theta_{it}^{m}}{\alpha_{it}^{m}}, \tag{7}$$

such that input market power in the market of X is identified as:

$$\psi_{it}^{x} = \frac{\theta_{it}^{x}}{\theta_{it}^{m}} \cdot \frac{\alpha_{it}^{m}}{\alpha_{it}^{x}}. \tag{8}$$

Equation (8) says that the input market power of firm i is estimated positive (negative), when the firm spends a lower(higher)-than-optimal share of revenues on input X relative to a benchmark competitive input, in light of the differences in their output elasticities.

Table I. Value of ψ^x_{it} and Input Market Structure

Value of ψ^x_{it}	$\psi^x_{it} > 1$	$\psi^x_{it} = 1$	$\psi^x_{it} < 1$
Type of Competition	Monopsony/ Oligopsony	Perfect Competition	Efficient Bargaining/ Quantity Discount

Discussion Equations (7) and (8) identify product and foreign input market imperfections under two important assumptions. The first is that the foreign intermediate input is a static input in production. This assumption needs to be justified, in light of the evidence of substantial fixed costs associated with input trade (Antràs et al., 2017). I reconcile this evidence by considering input X_{it} as static only at the intensive margin: firms decide first what products, and from which countries, they want to source. In the following period, conditional on this extensive margin, they can freely choose the optimal quantity of X. In the empirical analysis, I treat the extensive margin of imports as a state variable of the firm.

The second assumption is that firms are price takers in the market for the domestic input M, such that firm-level markups can be written as in equation (7).[2] As I will discuss more in detail in the next section, because data on prices of domestic intermediates are not available, this restriction is necessary in order to control for input price biases in production function estimation. I will consider several alternative methodologies to estimate firm-level markups in the empirical section, which allow me to test the robustness of my estimates, and indirectly, the validity of this assumption.

Interpreting the Input Efficiency Wedge The conceptual framework nests a number of models of imperfect competition in the input markets, and the interpretation of the wedge ψ^x_{it} can vary accordingly. In models of monopsonistic competition, the function in (2) corresponds to the inverse of the input supply function, which is typically characterized by a positive supply elasticity. This class of models therefore implies that $\psi^x_{it} \geq 1$.[3]

Values of $\psi^x < 1$ are also admissible. Dobbelaere and Mairesse (2013) show that this is the case in models of efficient bargaining, where equation (8) identifies ψ_{it} as a function of the relative bargaining power of firms. In Appendix A.1, I show that a model with second degree price discrimination (quantity discounts), and a model with two-part tariffs, also command values of ψ_{it} below unity.[4] Table 1 summarizes the relationship between the values of ψ^x_{it} and different models of competition in foreign input markets. Note that different firms might compete in different environments, and therefore belong to different competition regimes.

[2]Note that this is a standard assumption in empirical studies of markup estimation, that use equation (7) as the main estimating equation (e.g. De Loecker and Warzynski, 2012).

[3]In models of monopsony in the labor markets, the wedge ψ_{it} is often referred to as the "rate of exploitation" of workers (e.g. Pigou (1932)).

[4]More generally, this is the case whenever the input price decreases with the quantity purchased by the firm, i.e. whenever $\frac{\partial W^v_{it}}{\partial V_{it}} \frac{V_{it}}{W^v_{it}} < 0$.

Estimating Input Market Power We now have all the elements to summarize the empirical strategy to obtain estimates of input market power at the firm level. Given data on expenditure shares, one can use equations (7)-(8) to compute measures of markups and input market power in foreign input markets as:

$$\begin{cases} \hat{\psi^x_{it}} = \frac{\hat{\theta^x_{it}}}{\alpha^x_{it}} \cdot (\hat{\mu_{it}})^{-1} \\ \hat{\mu_{it}} = \frac{\theta^m_{it}}{\alpha^m_{it}} \end{cases}, \tag{9}$$

where $\hat{\theta}^v_{it}$ for $v = m, x$ are firm-level estimates of the output elasticities of the variable inputs. In the remainder of the Section, I describe my methodology to obtain consistent estimates of the output elasticities of the productive inputs.

2.2 Estimating the Output Elasticities

I consider the following class of production technologies for firm i at time t:

$$Q_{it} = \exp(\omega_{it} + \epsilon_{it})F_t(K_{it}, L_{it}, M_{it}, X_{it}; \beta), \tag{10}$$

where a firm i produces a unit of output Q_{it} at time t using capital (K_{it}), labor (L_{it}), domestic intermediate inputs (M_{it}), and foreign intermediate inputs (X_{it}), and where $F(\cdot)$ satisfies standard regularity conditions. The term ω_{it} reflects a firm-specific productivity shock, while ϵ_{it} captures measurement error and idiosyncratic shocks to production. Neither ω_{it} nor ϵ_{it} are observed by the researcher.

I specify the state variable vector as $\varsigma_{it} = \{\omega_{it,}K_{it}, L_{it}, G_i, \mathit{\Phi}_{it}\}$, where G_i denotes firms' observable characteristics that might affect material prices (such as firm location), and $\mathit{\Phi}_{it}$ is the firm's import sourcing strategy, i.e. a measure of the extensive margin of import in the spirit of Antràs et al. (2017). Including Φ_{it} in the state variables means that the foreign intermediate input X_{it} is considered flexible only *conditional* on the firm sourcing strategy.

Estimation of (11) requires dealing with several sources of biases: unobserved productivity ω_{it}, and lack of data on the quantity produced - as well as input used - by the firm.[5] The standard approach in the empirical literature to measure quantities of output and inputs has been to deflate firm-level sales and expenditures by industry wide producer and input price indices to eliminate the price effects. However, it is well-known that if output and input markets are less than competitive, failing to control for both the output and input price differences among firms would lead to severe output and input price biases in estimation (e.g. Syverson, 2004; Katayama et al., 2009; De Loecker and Goldberg, 2014). Existing approaches to control for unobserved input prices rely on imposing restrictions on the underlying nature of market competition (e.g. De Loecker et al., 2016). Ideally, one should dispense with this kind of restrictions in this case, where the nature of input market

[5]Both the price and simultaneity biases have received considerable attention in the literature. See Olley and Pakes (1996); Levinsohn and Petrin (2003); Ackerberg et al. (2015); Blundell and Bond (2000) for a discussion of the simultaneity bias related to unobserved TFP; and see De Loecker and Goldberg (2014); Syverson (2004); Katayama et al. (2009); De Loecker et al. (2016); De Loecker (2011b) for theoretical treatments (and applications) of the input and especially the output price bias in production function estimation.

competition is the object of analysis. My approach to deal with input price bias is to exploit custom information on prices of imports to construct measures of firm-level deviations from industry prices. This approach dispenses with assumptions on the nature of competition in the foreign input market, consistent with the application of the paper.

I introduce my estimation procedure in Section 2.2.1, where I describe the estimation biases and my bias-correction approach. I then discuss extensions of the baseline model in Section 2.2.2. I describe all the details of the estimation biases and my estimation strategy in section A.2 of the Appendix.

2.2.1 Estimation Procedure

I consider a production function of the following form:

$$q_{it} = f(l_{it}, k_{it}, m_{it}, x_{it}) + \omega_{it} + \epsilon_{it}, \tag{11}$$

where β contains all the relevant coefficients. As it is standard in the production function estimation literature, I consider flexible approximations to $f(\cdot)$. The advantage of using this class of production functions is that one can rely on proxy methods suggested by Olley and Pakes (1996); Levinsohn and Petrin (2003); Ackerberg et al. (2015) and De Loecker et al. (2016) to obtain consistent estimates of the technology parameters β.

In my baseline empirical specification, I consider a Cobb-Douglas production function (hereafter, CD) that implies that $f(\cdot)$ is approximated by a first-order polynomial in all its inputs. I will discuss advantages and disadvantages of this specification at the end of this Section. To ease exposition, in what follows I will explicitly write equation (11) in its CD form. All the results can be easily extended to more flexible approximations of $f(\cdot)$.

Output Price Bias When information on the quantity produced by the firm is not available, the standard approach in the empirical literature has been to define output as $\tilde{Q}_{it} = R_{it}/P_{It}$, where R_{it} is firm-level sales and P_{It} is an industry-wide producer price deflator. Using this definition, one can rewrite equation (11), in logs, as

$$\tilde{q}_{it} = \beta_l l_{it} + \beta_k k_{it} + \beta_m m_{it} + \beta_x x_{it} + (p_{it} - p_{It}) + \omega_{it} + \epsilon_{it} \tag{12}$$

The term $(p_{it} - p_{It})$ is unobserved, and generates an *output price bias* whenever it differs from zero in a way that is correlated with input choice. Market power is potentially a source of such bias: firms who charge high markups sell less, and thus buy less inputs.

My approach to control for output price bias involves two main steps. First, I construct a measure $\hat{p_{it}}$ of the average firm deviation from the industry-level price of different products. I do so by exploiting information on export unit values at the firm-product-destination country level, available from international trade data. Then, I use this measure to construct a firm-level price deflator of output as

$$P_{it} = P_{It} \cdot \hat{p_{it}}, \tag{13}$$

which I use instead of the standard P_{It} to deflate revenues.[6] As a result, the term $(p_{it} - p_{It})$ in the RHS of equation (12) disappears, up to an error term which is absorbed by ε_{it}, and which I assume uncorrelated with the inputs.

Input Price Bias Similar problems arise when input quantities at the firm level are not observed, and input-specific industry price indices are used to deflate input expenditures. In my setting, this is the case for domestic material and capital inputs, M_{it} and K_{it}, and for the foreign intermediate input X_{it}. When measures of physical inputs are constructed as expenditures deflated by an industry price index of the input, i.e. $\tilde{V}_{it} = E^V_{it}/W^V_{It}$, an input price bias arises when firm-level prices for the input systematically deviates from the industry deflator, namely $W^V_{it} \neq W^V_{It}$ for some i (De Loecker and Goldberg, 2014).

Let us first consider M_{it} and K_{it}. By substituting the observed deflated expenditures in equation (11), we get:

$$q_{it} = \beta_l l_{it} + \beta_k \tilde{k}_{it} + \beta_m \tilde{m}_{it} + \beta_x x_{it} + B(\mathbf{\bar{w}_t} - \mathbf{w_{it}}, \boldsymbol{\beta}) + \omega_{it} + \epsilon_{it}. \tag{14}$$

The term $B(\mathbf{\bar{w}_t} - \mathbf{w_{it}}, \boldsymbol{\beta})$ captures the input price bias.[7] Because I do not observe prices of either K_{it} or M_{it}, in order to control for this bias I follow the approach developed in De Loecker et al. (2016), and impose the following assumption:

Assumption 1 *The markets of* k_{it} and m_{it} *are competitive, and firms take their prices as given.*

Under Assumption 1, it is possible to write the term $B(\mathbf{\bar{w}_t} - \mathbf{w_{it}}, \boldsymbol{\beta})$ as a generic function of output prices p_{it} and market share ms_{it}, which I can measure from export data, as well as exogenous factors (such as location) $\mathbf{G}_i$. In other words, we can write[8]

$$B(\mathbf{\bar{w}_t} - \mathbf{w_{it}}, \boldsymbol{\beta}) = \tilde{B}(p_{it}, ms_{it}, \mathbf{G}_i). \tag{15}$$

Note that because the input control function approach works under the assumption of perfectly competitive input markets, it cannot be used to control for firm-level differences in the price index for input X_{it}, whose market structure is what we want to estimate.

Foreign Intermediate Inputs I obtain a physical measure of the imported intermediate X_{it}, by using a procedure similar to the one I used for the output variable. I define a firm-level import

[6] I discuss the details of the construction of this measure when I introduce the data in Section 3. Another option that has been explored in empirical work is to construct a firm-level price index p_{it} using observed within firm-product price changes, and use it instead of p_{It} to deflate revenues (e.g. Eslava et al., 2004; Smeets and Warzynski, 2013). This approach relies on a choice of an underlying demand system and market structure in both the home and foreign markets, and is thus suboptimal for this study.

[7] In the CD case, $B(\mathbf{\bar{w}_t} - \mathbf{w_{it}}, \boldsymbol{\beta}) \equiv \beta_k \left(\bar{w_t}^k - w^k_{it}\right) + \beta_m \left(\bar{w_t}^m - w^m_{it}\right).$

[8] The reader should refer to De Loecker et al. (2016) for more details. I discuss the construction of measures of p_{it} and ms_{it} in Section 3.

price deflator as

$$W_{it}^{X} = W_{It}^{X} \cdot \hat{w_{it}^{X}}, \tag{16}$$

where W_{It}^{x} is an import price index at the industry level, which is observed, and $\hat{w_{it}^{X}}$ is a measure of the average firm deviation from the industry-level price of different foreign inputs, which I can construct from international trade data. Then, I construct a measure of X_{it} by deflating total expenditure on foreign intermediate inputs E_{it}^{X} by this firm level import price deflator W_{it}^{x}. In doing so, I take into account average differences in prices for the intermediate input among firms, such that concerns about input price bias for input X_{it} are bypassed.

Unobserved Input Quality One potential concern of using deflated nominal variables is that if there are unobserved differences in quality among differentiated inputs, we might attribute variation in quality to variation in buyer power, potentially biasing the results. For example, suppose that two firms buy the same amount of inputs, but firm 1 pays twice as much as firm 2 for each unit of input. The price difference could be due to the fact that firm 1 buys a lower quality input, or to firm 1 exercising buyer power in foreign markets. Understanding the source of price variation is important in this case, since in the former case the firm is behaving efficiently, while in the latter the firm is buying a less-than-competitive amount of inputs. Moreover, the output elasticities might be different for firms that use different quality of inputs.

Note that the input control function in equation (15) can alleviate the concern of quality bias. This function controls for the unobserved variation in input prices across firms due to quality, using information on output prices and market shares. The intuition is that the latter variables contain information on both quality of inputs and output, and input prices.

Simultaneity bias The last source of bias in equation (11) is the unobserved productivity term ω_{it}. I deal with the well-known associated simultaneity problem by relying on a control function for productivity based on the demand equations of the static inputs, building on the work by Ackerberg et al. (2015). As I show in the Appendix A.2.1, the unobserved term ω_{it} can be written as a nonparametric function of observables as:

$$\omega_{it} = h_t(\tilde{k}_{it}, l_{it}, \tilde{m}_{it}, x_{it}, \hat{w_{it}^{x}}, \hat{p_{it}}, m\hat{s}_{it}, \mathit{\Phi}_{it}, G_i). \tag{17}$$

This expression can be used in equation (11) to control for firm's productivity.

Estimation We now can put all pieces together and write the estimating equation as

$$\begin{aligned} q_{it} =& \beta_l l_{it} + \beta_k \tilde{k_{it}} + \beta_m \tilde{m_{it}} + \beta_x x_{it} + \tilde{B}(\hat{p_{it}}, m\hat{s}_{it}, \mathbf{G}_i; \beta) \\ &+ h_t(\tilde{k}_{it}, l_{it}, \tilde{m}_{it}, \tilde{x}_{it}, \hat{w_{it}^{x}}, \hat{p_{it}}, m\hat{s}_{it}, G_i, \mathit{\Phi}_{it}) + \epsilon_{it}. \end{aligned} \tag{18}$$

To estimate (18), I follow the 2-steps GMM procedure in Ackerberg et al. (2015). For my baseline estimation, I run the GMM procedure on a sample of firms that source their foreign inputs from at least three countries. This choice addresses the concern that fixed entry costs are an empirically relevant determinant of both the extensive and intensive margin of a firm's imports (Antràs et al., 2017). Intuitively, I focus on firms that are far from the threshold of entry into foreign input markets. I thus implement a selection correction to address the potential selection bias stemming from the use of large importers in estimation. All the standard errors are obtained by block-bootstrapping.

2.2.2 Discussion and Extensions

The choice of a CD specification of the production function $f(\cdot)$ has several advantages, including the fact that it involves the estimation of a low number of parameters. Choosing the more flexible translog (TL) specification, which involves a second or higher order polynomial approximation of $f(\cdot)$, is not feasible in this case, due to the fact that the high number of inputs implies a very large number of coefficients to be estimated, i.e. 20, which can lead to serious collinearity concerns. In the empirical section, I will show results of production function estimation both for the CD case and for the TL case, while pointing out the main problems associated with the TL.

Choosing a CD production function can raise two main concerns. The first concern is that since the output elasticities are restricted to be constant among firms within an industry, we could be attributing variation in technology across firms to variation in market power, potentially biasing the results. In the empirical application, I will consider an array of exercises to test the robustness of my estimates to variation in technology among firms.

The second (related) concern is that the CD exhibits a unit elasticity of substitution among all inputs. This feature of the CD could potentially bias the results in case of important substitutabilities among foreign and domestic intermediates. The next paragraph shows how one can extend the baseline framework to think about such non-linearities in the production function.

Nested Cobb-Douglas with CES Intermediate Bundle I consider the following specification of the production function:

$$Q_{it} = L_{it}^{\beta_l} K_{it}^{\beta_k} Z_{it}^{\beta_z} \exp(\omega_{it} + u_{it}), \tag{19}$$

with

$$Z_i = \left(M_{it}^{\frac{1-\rho}{\rho}} + B_{it} X_{it}^{\frac{1-\rho}{\rho}} \right)^{\frac{\rho}{1-\rho}}. \tag{20}$$

In (19), the intermediate good Z_{it} is assembled from a combination of a foreign and domestic variety, where $\rho > 1$ is the elasticity of substitution among the two intermediate inputs. This is the standard specification of the technology in studies of input trade (Gopinath and Neiman, 2014; Halpern et al., 2015; Blaum et al., 2018). Note that in this scenario, the output elasticities of intermediate inputs are allowed to vary across firms.[9]

[9] The output elasticities of the foreign and domestic input are given in this case by:

$$\theta_{it}^{x} = \beta_z B_{it} \left(X_{it}/Z_{it} \right)^{\rho/(\rho-1)}, \quad \text{and} \quad \theta_{it}^{m} = \beta_z \left(M_{it}/Z_{it} \right)^{\rho/(\rho-1)}$$

Under assumption 1, and when the production function is given by (19), one can write input market power as:

$$\psi_{it}^{x} = \frac{\gamma \cdot \mu_{it}^{-1} - (\alpha_{it}^{k} + \alpha_{it}^{L} + \alpha_{it}^{m})}{\alpha_{it}^{x}}, \tag{21}$$

where γ is the return to scale parameter, i.e. $\gamma = \beta_l + \beta_k + \beta_z$, and μ_{it} is firm-level markups.[10] Equation (21) relates the input market power to the expenditure shares of all inputs, estimates of the return to scale parameter, and estimates of firm-level markups.

Due to non-linearities, we cannot use standard proxy methods to estimate the coefficients of (19), such that it is not possible to jointly estimate measures of input market power, markups and return to scale as in the CD or TL case.[11] In the empirical analysis, I will plug standard estimates of γ and μ_{it} into (21), and discuss how results change under this more common specification of the production function with multiple types of intermediate inputs.

[10] See section A.3 of the Appendix for derivations.

[11] While a few studies have dealt with the estimation of a production function similar to (19) (e.g. Halpern et al., 2015; Grieco et al., 2016), these techniques cannot be applied to the current study, nor can easily adapted, as they crucially rely on the assumption of perfect competition in all the intermediate input markets.

3 Market Power in Foreign Input Markets

I rely on the empirical framework to analyze the nature of competition prevailing in input trade, for firms operating in a large open economy. Furthermore, I am interested in understanding how distortions interact with firm-level characteristics. To answer this, I correlate measures of input market power at the firm level with variables such as size, productivity, and MNE status, while controlling for input use, and the extensive margin of imports. I further explain my empirical model in detail once I have introduced the data and discussed the information I can rely on.

Almost the entirety of the literature on input trade relies on the assumption of perfectly competitive input markets.[12] The evidence provided in this paper complement the existing empirical findings, and it also provides new insights for theoretical work.

3.1 Data

I employ two longitudinal datasets covering the activity of the universe of French manufacturing firms during the period 1996 - 2007. The first dataset contains the full company accounts, including nominal measures of output and different inputs in production, such as capital, labor, and intermediate inputs, at the firm level. The second dataset comes from official files of the French custom administration, and includes exhaustive records of export and import flows of French firms. Trade flows are reported at the firm-product-country level, with products defined at the 8-digit (NC8) level of aggregation.[13] I describe the construction of the main variables in the Data Appendix.

I select all manufacturing firms that engage in both import and export activities in a given year.[14] These are the firms for which price information is available, and I will refer to them as "international firms". To address the concern that a firm's optimal choice of foreign inputs might be constrained, I run the estimation procedure on a subset of international firms that source their imports from at least three countries, which I refer to as "super-international" firms.[15] The idea is that firms that are large enough to afford to import from many sourcing countries are less likely to be affected by trade costs and/or capacity constraints.

Table 2 provides summary statistics for the selected firms. As expected, both the international and especially the super-international firms are bigger, sell more, and are more productive than the average manufacturing firm in France (cf. Bernard et al., 2007a,b, 2009). International firms are about 46% of the population of manufacturing firms in France, and they account for about 80% of total manufacturing value added. Both international and super-international firms heavily rely on foreign intermediates, which account for 26% and 33% of total material expenditure, respec-

[12] See Antràs et al. (2017) for a theory of the extensive margin of imports, and Halpern et al. (2015); Gopinath and Neiman (2014); Blaum et al. (2018) for theories of the intensive margin of imports.

[13] The reader should refer to Blaum et al. (2018) for a detailed description of the data sources.

[14] I classify a firm as "manufacturing" if its main reported activity belongs to the NACE2 industry classes 15 to 35. Manufacturing firms account for 19% of the population of French importing firms and 36% of total import value (average across the years in the sample).

[15] The choice is due to the fact that the 25th percentile of the distribution of number of sourcing countries among international firms is 3.

Table II. Summary Statistics (2005)

	International	Super International*
# Firms	14,206	8,258
(% of total)	46%	27%
(% in total value added)	80%	75%
(log) sales premium $^{(a)}$	0.62	1.12
(log) wage premium	0.04	0.08
(log) TFP premium$^{(b)}$	0.10	0.17
Belongs to a MNE$^{(c)}$	50%	62%

Source: Author's calculations. Notes: The number of manufacturing firms in a given year is, after basic cleaning, 30,840.$^{(a)}$ The (log) premium of variable x is computed as the percentage difference in the average x in the selected sample (i.e. all international or super-international) relative to the average x in the full sample of manufacturers. $^{(b)}$ TFP is computed as real value-added per worker. $^{(c)}$ Benchmark (All firms): 35% A firm is classified as MNE if it belongs to either a French private, or a Foreign private business group.

tively. The final sample includes around 14 thousands firms per year, spread across 18 two-digit manufacturing sectors.[16]

Table 3 summarizes the means, standard deviations and quartile values of the revenue share of all inputs, as well as of measures of extensive and intensive margin of imports. As expected for firm-level data, the dispersion of all these variables across firms is large, as it can be seen from the different interquartile ranges. Compared to the average manufacturing firm, the average *international* firm uses a lower share of labor, and a larger share of material inputs in production. This is consistent with the disintegration of the production process of global firms (global value chain), and with a parallel increase in the use of intermediates in production (cf. Feenstra, 1998; Hummels et al., 2001; Yi, 2003).

Firm heterogeneity is particularly dramatic when it comes to import behavior, as it can be seen from the 10/90 gap of almost all the import variables. This implies that there is large heterogeneity in the use of foreign inputs in production, which is a feature I will take into account later on when I discuss the robustness of my main results.

Domestic Intermediate Inputs The computation of input market power in the market of foreign intermediate inputs relies on the existence of a second variable input in production, which is needed to purge the foreign input wedge from the variation due to the common markup component. I focus on the domestic intermediate input as my second input of interest, while imposing price taking behavior of firms in this market, due to a lack of data on prices of domestic intermediates.

[16] I define sectors using the NACE rev.1 industry classification, which is similar to the ISIC industry classification in the US. The level of aggregation is presented in Table A1 in the Data Appendix

Table III. Distribution Quantiles

Variable	1996-2007				
	Mean	Std Dev	p10	p50	p90
Revenue Shares of Inputs					
Labor α_{it}^{L}	.19	.08	.09	.18	.30
Capital α_{it}^{K}	.07	.06	.02	.06	.15
Domestic Materials α_{it}^{M}	.28	.15	.10	.26	.48
Imported Materials α_{it}^{X}	.1	.09	.01	.06	.23
Extensive Margin of Imports					
No. of sourcing countries	5.8	4.5	1	5	11
No. of sourcing markets[a]	22	31	2	12	51
Intensive Margin of Imports					
Imported Share of Intermediates	.26	.2	.04	.21	.57

Notes: Numbers are averaged across time and sectors, and refer to the full baseline sample of international firms. Number of observations: 129,787. [a]A sourcing market is defined as a country-NC8 product combination.

This assumption is consistent with lower barriers to entry in the domestic market, and also with the fact that the varieties of intermediates that firms source domestically, such has energy or electricity, have on average lower scope for input market power.

Note that in principle, the gross output production function setting allows for multiple variable inputs to compute markups. In particular, if labor is a static input in production, one can learn about markups from the optimal labor demand decisions. However, labor markets in France are highly regulated and adjustment costs of labor are high, especially for large firms, which are the focus of my analysis.[17] Due to large adjustment costs, labor is better thought as a dynamic input in production, and therefore is not a good candidate for the study of market power.[18]

Firm-level Prices of Output and Imported Input Equations (13) and (16) define firm-level price deflators of output and imported input as $P_{it} = P_{It} \cdot \hat{p_{it}}$, and $W_{it}^{X} = W_{It}^{X} \cdot \hat{w_{it}^{X}}$, respectively, where P_{It} and W_{It}^{X} are the 2-digit industry output and import deflators. In order to construct the output $(\hat{p_{it}})$ and imported input $\left(\hat{w_{it}^{x}}\right)$ terms that allows me to generate firm-level variation in the industry deflators, I run the following regression:

$$\log\left(uv^{j}{}_{iknt}\right) = \theta_{it}^{j} + c_{knt}^{j} + \epsilon_{iknt},$$

[17]See evidence in Abowd and Kramarz, 2003; Kramarz and Michaud, 2010; Garicano et al., 2016

[18]Note that the main results are robust when considering the labor input as the second variable input.

where i indexes firms, k indexes NC8 digit products, n indexes destination or source country, and t indexes years. Finally, j is an index for either exports ($j = EX$) or imports ($j = IM$). I define uv^{j}_{iknt} the unit value that firm i charges (pays) for product k sold in (sourced from) country n in year t, calculated as expenditures divided by units of physical quantity. I regress the log of the unit values on firm-time fixed effects (θ^{j}_{it}), and product-country-time fixed effects (c^{j}_{nct}), where ϵ_{inct} is a mean-zero error term. The product-country-time fixed effects (c^{j}_{nct}) capture the average price of a particular product in a particular market across firms in a given year. Therefore, the firm-year effects θ^{j}_{it} measure firm-level average prices purged of effects due to the composition of products. I define firm-level average relative input prices to be equal to these OLS estimates, namely $\hat{p_{it}} = \hat{\theta}^{EX}_{it}$, and $\hat{w^{x}_{it}} = \hat{\theta}^{IM}_{it}$.[19] Table A1 in the Appendix summarizes the means, standard deviations and quartile values of the relative price distribution. There is substantial variation in the relative price of exports and imports across firms. Moreover, firm-level price differences seem to be significantly correlated with both material inputs, and output. This evidence suggests that both input and output price bias are potentially important concerns for production function estimation.

3.2 Empirical Results

I first analyze the results of production function estimation.Table 4 reports the estimated output elasticities when production function is CD across different sectors together with standard errors, which I obtain by block bootstrapping over the entire procedure. Consistent with the extensive global sourcing of large international firms, the labor and capital coefficients are smaller, and the two material coefficients larger, than what is traditionally found by using the full sample of manufacturing firms.

I show the results of the estimation when the production function is TL in the Appendix. Table A2 shows results when I specify the TL as a function of four inputs, whereas in Table A3 I combine foreign and domestic intermediates in a single intermediate input, which corresponds to a more standard specification of the gross output production function (e.g. Ackerberg et al., 2015). In both cases, I duly adjust the procedure to account for price and simultaneity bias in estimation. While the coefficients of domestic material, labor and capital are broadly on range and fairly stable, the one on the foreign intermediate input is extremely noisy, consistent with the existence of collinearity problems when the number of inputs is large, as well as with the large variation in the import data.[20] This explains why I focus on the CD case for my baseline procedure.

The most important limitation of using a CD production is that the output elasticities are constant across firms and over time. This leads to concerns when computing measures of market power from these elasticities, since if differences in technology exist and are large, we could be attributing variation in technology across firms to variation in market power, potentially biasing the results.

[19] A similar procedure has been used by Bastos et al. (2018) to construct firm-level intermediate input prices using Portuguese data.

[20] Note that when I consider only three inputs in Table A2, the elasticities are on range, and in line with studies in the literature.

Table IV. Output Elasticities, Cobb-Douglas, By Sector

	Industry	β_K	β_L	β_M	β_X	Return to Scale
15	Food Products and Beverages	0.10	0.20	0.52	0.10	0.92
		(0.02)	(0.05)	(0.01)	(0.01)	
17	Textiles	0.11	0.21	0.39	0.22	0.94
		(0.02)	(0.03)	(0.02)	(0.02)	
18	Wearing Apparel, Dressing	0.32	0.19	0.34	0.24	1.09
		(0.04)	(0.04)	(0.03)	(0.03)	
19	Leather, and Products	0.12	0.32	0.32	0.25	1.01
		(0.05)	(0.09)	(0.02)	(0.04)	
20	Wood, and Products	0.01	0.31	0.48	0.12	0.92
		(0.04)	(0.05)	(0.05)	(0.03)	
21	Pulp, Paper, & Products	0.10	0.34	0.40	0.16	1.00
		(0.02)	(0.06)	(0.02)	(0.02)	
22	Printing and Publishing	0.07	0.57	0.33	0.17	1.14
		(0.04)	(0.05)	(0.04)	(0.04)	
24	Chemicals, and Products	0.09	0.32	0.34	0.18	0.93
		(0.02)	(0.03)	(0.02)	(0.02)	
25	Rubber, Plastics, & Products	0.19	0.39	0.40	0.12	1.10
		(0.02)	(0.02)	(0.02)	(0.02)	
26	Non-metallic mineral Products	0.30	0.41	0.32	0.12	1.15
		(0.05)	(0.06)	(0.01)	(0.03)	
27	Basic Metals	0.14	0.32	0.38	0.17	1.01
		(0.15)	(0.05)	(0.01)	(0.02)	
28	Fabricated Metal Products	0.13	0.37	0.39	0.11	1.00
		(0.02)	(0.03)	(0.01)	(0.03)	
29	Machinery and Equipment	0.06	0.45	0.35	0.12	0.98
		(0.02)	(0.03)	(0.01)	(0.01)	
31	Electrical machinery & App.	0.04	0.28	0.40	0.15	0.87
		(0.03)	(0.04)	(0.01)	(0.02)	
32	Radio and Communication	0.16	0.29	0.42	0.15	1.02
		(0.07)	(0.06)	(0.02)	(0.03)	
33	Medical, Precision, Optical Instr.	0.08	0.47	0.32	0.13	1.00
		(0.03)	(0.04)	(0.01)	(0.02)	
34	Motor Vehicles, Trailers	0.03	0.41	0.38	0.16	0.98
		(0.05)	(0.06)	(0.01)	(0.02)	
35	Other Transport Equipment	0.07	0.22	0.36	0.20	0.85
		(0.13)	(0.16)	(0.04)	(0.05)	

Notes: The table reports the output elasticities when the production function is Cobb-Douglas. Cols 2–4 report the average estimated output elasticity with respect to each factor of production. Standard errors are obtained by block-bootstrapping, and are in parentheses. Col. 5 reports the returns to scale, which is the sum of the preceding 4 columns.

The large variation in the import share of total costs and revenues observed in the data suggests that firms are very heterogeneous in their use of foreign inputs, such that firms on different locations of the import size distribution are more likely to have different production technologies. Therefore, as a test of potential biases stemming from the use of a CD, I split the baseline sample into three groups - of small, medium and large importers - and run the estimation procedure separately for each of these three groups. Table A4 in the Appendix shows how the elasticities change when I run the procedure on these three different samples. Large firms have on average higher elasticities of foreign inputs and lower elasticities of labor compared to smaller firms, although results are overall similar to the baseline case, which implies that the baseline estimates are largely reliable.

Finally, Table A5 in the Appendix shows results of production function estimation with and without correction for the price and selection biases, both for the CD and the TL case. Results are quite stable across specifications, with the exceptions again of the foreign intermediate input. The stability of the coefficients suggests that the input price bias is not a big concern for the French manufacturing data. The stability of the coefficient estimates with and without selection correction for the unbalanced panel suggests that the use of the unbalanced panel of large importing firms likely alleviates most of the concerns about the selection bias.

3.2.1 Markups

I now turn to the analysis of market power estimates. I first report my baseline estimates for markups. Recall that under assumption 1, markups are identified as

$$\hat{\mu_{it}} = \frac{\theta^m_{it}}{\tilde{\alpha}^m_{it}},$$

where I normalized the observed expenditure shares by the residual of the first stage regression as $\tilde{\alpha}^m_{it} = \frac{W^m_{it} M_{it}}{P_{it} Q_{it}/\hat{\epsilon}_{it}}$, in order to purge revenue shares from variation unrelated to technology or market power (De Loecker and Warzynski, 2012).

I list the median markup, averaged across sectors, using a wide set of specifications to compare my results to standard methodologies used in the literature. More specifically, I compute markups under the following specifications of the production function. **I**: Gross output under CD; **II**: Gross output under CD, run separately on samples of small, medium and large importers; **III**: Gross output under TL, with four inputs; **IV**: Gross output under TL, with three inputs, namely labor, capital and and intermediates (domestic + foreign). The latter specification follows the methodology in De Loecker and Warzynski, 2012 (DLW hereafter), and can thus be considered a benchmark specification. Finally, I also report accounting markups, which I compute as total revenues divided by total accounting costs.

Table 5 reports the median markup in the various specifications. Results are robust across different methodologies.[21] I obtain markups in the range of 1.22-1.52, with results overall similar

[21]Note that the correlation of my baseline markups and the DLW markups across firms and sectors is high, and equal to 0.61. This implies that in spite of the CD specification of the production function, my baseline procedure

TABLE V. MARKUPS - ESTIMATES

	METHODOLOGY	MARKUP
	Accounting	1.54 (0.5)[b]
Specification		
	I (Cobb-Douglas)	1.52 (0.06)[a]
	II (Extended Cobb-Douglas)	1.47 (0.1)[a]
	III (Translog, Four Inputs)	1.22 (0.5)[b]
	IV (Translog, Three Inputs, DLW)	1.40 (0.37)[b,c]

Notes: The table reports the median sectoral markup, averaged across sectors. [a] Standard errors in parentheses are obtained with the Delta method. [b] Standard deviation in parentheses. [c] I specify the Translog as a function of capital, labor and total intermediate inputs. Here, I consider both labor and intermediates as static inputs, following the baseline specification in De Loecker and Warzynky (2012)

across the different specifications, with the exception of specification **III**, which gives lower estimates of markups. The difference between specification **III** and the other specifications might have to do with the collinearity problems of estimating a TL production function in four inputs.

Finally, notice that the estimated markups are lower than accounting markups, which implies that the latter are potentially biased upward. I will interpret this result in the next section, in light of my findings on input market power.

3.2.2 Input Market Power across Industries

I now have all the elements to compute input market power in the foreign input market given equation (8). Table 6 presents the median estimated input market power in the baseline specification, together with standard errors, and the industry estimated competition regime, defined in Table 1. I classify an industry as belonging to the monopsony regime, (MO), if the lower bound of the 95% CI of the median sectoral input market power is above one. Similarly, I classify industries as belonging to the efficient bargaining/quantity discount regime (EB/QD), if the upper bound of the 95% CI of the median input market power is below one. I classify an industry as perfectly competitive (PC), if it cannot be classified neither as MO, nor as EB/QD, at the 90% CI.

My results shows that in a large number of sectors, both mean and median input market power are estimated significantly above one, which means that they can be classified under the monopsony regime. More specifically, when I use the conceptual framework to interpret the evidence, I find that the median French importer pays on average 36% less than the competitive price (i.e. value of marginal product of the input) for its imported intermediate inputs, and that it does so by distorting downward the optimal share of foreign intermediates in total revenues.

To verify the robustness of my results, I also compute measures on input market power using alternative specifications and/or methodologies. I first obtain median estimates jointly with the production function coefficients, when the production function is gross output under CD, run

yields accurate estimates of market power even across firms.

Table VI. Input Market Power, by Sector

Sector	$\psi^x{}_{it}$ Median	Std Err	Regime
15 Food and Beverages	1.43	0.08	MO
17 Textiles	0.97	0.04	PC
18 Wearing Apparel	0.97	0.08	PC
19 Leather Products	1.35	0.1	MO
20 Products of Wood	1.23	0.14	MO[a]
21 Pulp and Paper Products	0.89	0.04	EB/QD
22 Printing and Publishing	1.78	0.19	MO
24 Chemical Products	1.39	0.05	MO
25 Rubber Products	0.99	0.05	PC
26 Non-metallic minerals	1.66	0.17	MO
27 Basic Metals	1.27	0.07	MO
28 Fabricated Metal Products	1.08	0.07	MO[a]
29 Machinery and Equipment	1.64	0.08	MO
31 Electrical Machinery	1.37	0.09	MO
32 Radio and Communication	1.61	0.21	MO
33 Medical Instruments	1.52	0.12	MO
34 Motor Vehicles, Trailers	1.69	0.15	MO
35 Other Equipment	1.72	0.40	MO[a]
Average	1.36	0.12	MO

Notes: Standard errors are obtained with the Delta Method. The average standard deviation in each industry is about 3. I trim observations with ψ that are above and below the 3^{rd} and 97^{th} percentiles within each sector. [a]True at the 90% confidence interval. I classify an industry as MO, if the lower bound of the 95% CI of the median sectoral input market power is above one.

separately on samples of small, medium and large importers (**II**), and gross output under TL (**III**).

I then consider equation (6), and obtain estimates of input market power under alternative measures of markups: the DLW markups (**IV**), and the accounting markups (**V**). Specifications **IV** and **V** aim to address the concern that the baseline measures in **I** are biased due to lack of variation in both the foreign and domestic output elasticities.

I then report estimates of input market power when the production function is a nested CD, with a CES intermediate input. As explained in Section 2.2, in this case I cannot obtain estimates of ψ^x_{it} jointly with estimates of the nested CES production function. I thus consider different measures of markups and return to scale parameter to compute input market power from equation (21): those obtained when the production function is CD (**VI**), and when the production function is TL in three inputs, as in DLW (**VII**).

Finally, I construct input market power from a calibration exercise. I consider the definition of input market power in equation (8): $\psi^x_{it} = 1+\frac{\partial W^x_{it}}{\partial X_{it}}\frac{X_{it}}{W^x_{it}}$, and rearrange it as $\psi^x_{it} = 1+\frac{\partial W^x_{it}}{\partial X_t}\frac{X_t}{W^x_{it}}\cdot\frac{\partial X_t}{\partial X_{it}}\cdot\frac{X_{it}}{X_t}$, where $X_t = \sum_j X_{jt}$ is aggregate demand of foreign input. Under the assumption that $\frac{\partial X_t}{\partial X_{it}} = 1$, namely that aggregate demand moves one-to-one with individual firm demand, I can write input

Table VII. Input Market Power - Robustness

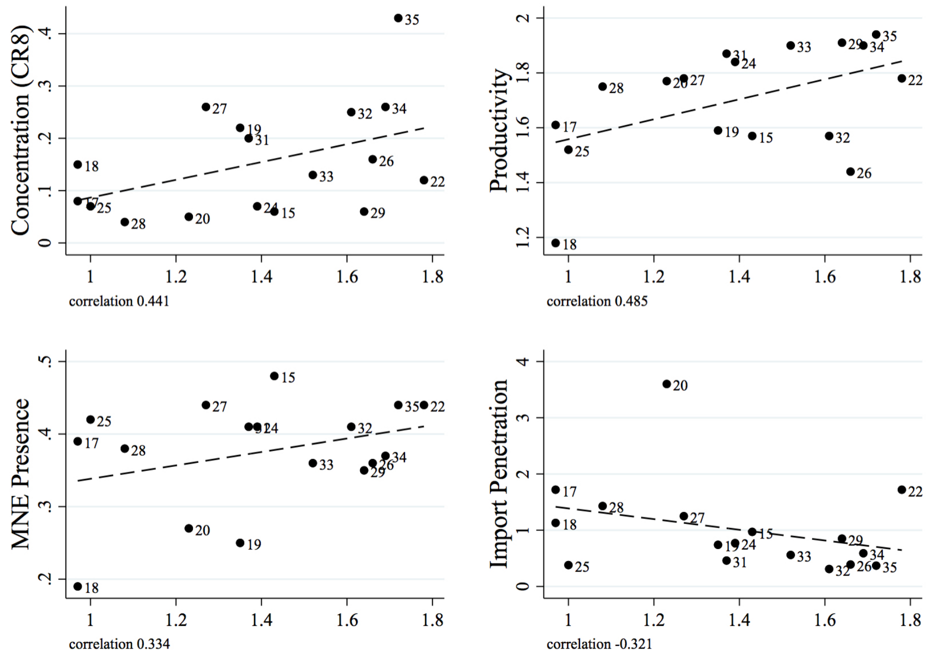
Methodology	Input Market Power
Production Function Approach	
Baseline	
I (Cobb-Douglas)	1.36 (0.23)[a]
II (Extended Cobb-Douglas)	1.31 (0.4)[a]
III (Translog, four inputs)	1.20 (23.98)[b]
Computing markups from alternative specification	
IV (w/ DLW markups)	1.35 (2.18)[b]
V (w/ accounting markups)	1.13 (2.1) [b]
Cobb-Douglas w/CES Intermediate Input	
VI (w/ baseline markups)	1.69 (0.19)[b]
VII (w/ DLW markups)	2.07 (0.18)[b]
Calibration Approach	
VIII (Broda et al. (2008) Elasticities)	1.16 (0.4)[b]

Notes: [a] Standard errors in parentheses are obtained with the Delta method. [b] Standard deviations in parentheses

market power as $\psi^x_{it} = 1 + s^x_{it} \cdot \eta^x$, that is a function of the input market share of firm i, $s^x_{it} = \frac{X_{it}}{X_t}$, and the inverse of the foreign supply elasticity $\eta^x_{it} \equiv \frac{\partial W^x_{it}}{\partial X_t}\frac{X_t}{W^x_{it}}$. In specification **VIII,** I compute input market power using this formula. I first compute firm-product estimates of the input share s^x_{ipt} as the firm share of total imports of an NC8-country product (product p), which I compute from customs data, times the share of France in the world imports of the same NC8-country product, which I obtain from UN Comtrade data. I obtain estimates of the foreign export supply elasticities of product p, at the HS4 level, from Broda et al. (2008). With this data at hand, I can construct firm-product level estimates of input market power as $\psi^x_{ipt} = 1 + s^x_{ipt} \cdot \eta^x_p$. I finally compute a firm-level measure of input market power as $\psi^x_{it} = N^{-1}_{ipt} \cdot \sum_{p \in \Omega_{ipt}} \psi^x_{ipt}$, that is, as the firm-level simple average of the firm-product level measures.

Table 7 presents the median input market power of the various methodologies. The median input market power ranges from 1.13-1.36 across the main specifications. The median estimated input market power is considerably higher when I assume a nested CD production function, around 1.7-2. Note that when using accounting markups in specification **V**, I obtain lower estimates of input market power (1.13). This is consistent with the existence of buyer power in the data: when foreign input markets are characterized by monopsonistic/oligopsonistic competition, the effective total costs of output $\lambda_{it}Q_{it}$ will be higher than the true cost to the firm, i.e. $\lambda_{it}Q_{it} > \textit{Total Accounting Costs}_{it}$, such that the accounting markups are expected to be larger, and input market power lower than the true ones.

Figure 1: Buyer Power Across Sectors



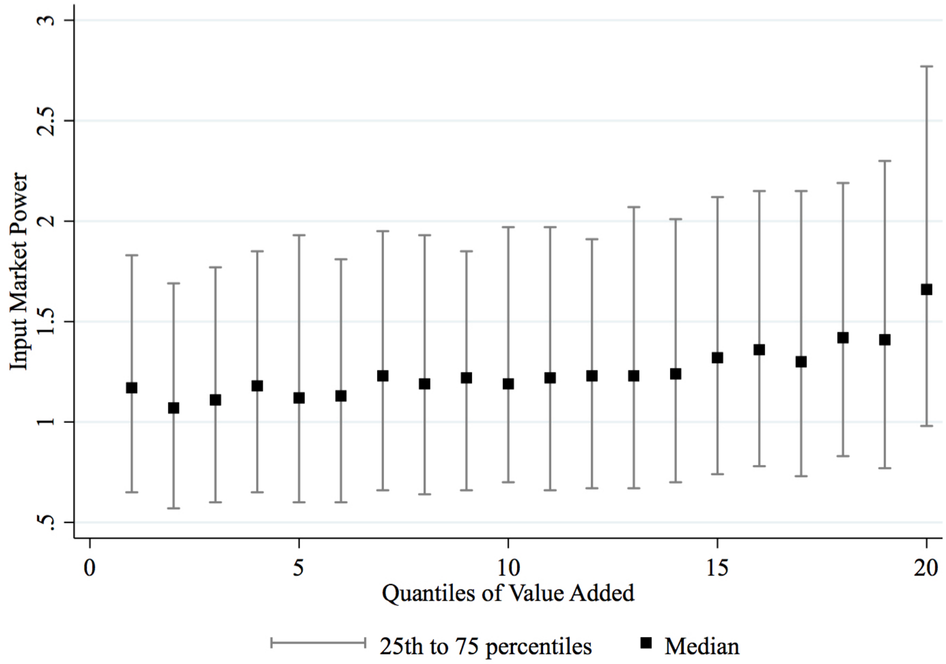
The low number (but still significantly above one) in specification **VIII** is also consistent with (downward) measurement bias: the share s^x_{ipt} is computed as if firm i competes with all the other firms in the world for product p. In this sense, it most likely underestimates the true firm input share, and ultimately ψ^x_{ipt}. Therefore, estimates of ψ^x_{it} in specification **VIII** can be considered as lower bounds of the true input market power.

Industry Analysis My estimates shows substantial sectoral heterogeneity in input market power. Not only different industries are classified under different competition regimes, but even among those industries classified as monopsony/oligopsony the median estimated input market power ranges from 1.08-1.78.

In this section I aim to validate the plausibility of the interpretation of the wedge as buyer power by tying the sectoral estimates to industry observable that are plausibly correlated with the existence of input market power: the industry concentration ration, average firm productivity, share of firms that belong to a MNEs, and import penetration ratio.[22] Consistent with our prior, Figure 1 shows a positive correlation between sectoral buyer power and industry concentration, productivity, and MNEs presence. Note that the figure also shows a strong negative correlation between buyer power and import penetration ratio. This last piece of evidence suggests that in sectors whose demand is largely satisfied by imports, firms are less willing to distort their import choice.

[22] I exclude industry 21, namely "Pulp, Paper, & Products" from the remainder of the analysis because it is the only one classified as EB/QD.

Figure 2: Dispersion in Buyer Power



Notes: Figure plots the size distribution of the residuals of $\hat{\psi}^x_{it}$, after purging from industry-time fixed effects and controls for extensive margin of imports

3.2.3 Firm-level Analysis

Finally, I investigate how estimates of buyer power relate to firm characteristics. Figure 2 shows the distribution of input market power for different value added quantiles, after purging out industry-year fixed effects, and controlling for the extensive margin of imports. Large firms seem to have larger buyer power, even with substantial heterogeneity.

I confirm this result by means of regression analysis. I consider the following regression:

$$\log \hat{\psi}^x_{it} = \beta_0 + \beta_1 \log size_{it} + \beta_2 \log \hat{\omega}_{it} + \beta_3 \text{MNE}_{it} + \mathbf{z}_{it} + \gamma_{st} + \varepsilon_{it}, \tag{22}$$

where $size_{it}$ is firm size, as measured by total sales, $\hat{\omega_{it}}$ is the estimate of firm-level TFP which I obtain from the estimation of the production function, MNE_{it} is a dummy equal to 1 if the firm belongs to a French multinational corporation, and $\mathbf{z}_{it}$ includes controls for the main reported activity of the firm, the extensive margin of imports (total number of sourcing countries and of imported products), and the share of imports in total intermediates. By controlling for the vector $\mathbf{z}_{it}$, I aim to control for unobserved differences in technology across firms. Finally, γ_{st} are industry-time fixed effects. The coefficient of interest are $\hat{\beta}_i$, with $i = 1, 2, 3$.

Table 8 presents the results from estimating (22), where the standard errors are obtained by block-bootstrapping. Column 1-3 shows results when ψ^x_{it} is obtained with the baseline methodology and specification, while columns 4-6 use the measure of ψ^x_{it} in specification **IV**, where markups are obtained using the standard DLW methodology, and so they account for differences in technology

Table VIII. Market Power And Firm Characteristics

	I. Baseline			IV. DLW Markups		
	(1)	(2)	(3)	(4)	(5)	(6)
$\log size_{it}$	0.17***		0.16***	0.06***		0.05***
	(0.002)		(0.002)	(0.001)		(0.005)
$\log \hat{\omega}_{it}$		0.14***	0.04***		0.05***	0.01**
		(0.004)	(0.004)		(0.003)	(0.003)
MNE			0.01***			0.0001
			(0.003)			(0.002)
Fixed Effects						
Industry (2 digits) -Time	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.77	0.76	0.77	0.81	0.81	0.81
No. Observations	112,898	112,898	112,898	104,391	104,391	104,391

Notes: The regressions exclude outliers in the top and bottom 3rd percentile of the distribution of input market power. The standard errors are obtained by block bootstrapping. *** denotes significance at the 10% level, ** 5% and *** 1%.

across firms. Input market power is positively and significantly correlated with size, measured productivity, and MNE status of the firm. A 1% increase in firm size correspond to a 17% higher buyer power in the baseline specification. Similarly, a 1% increase in firm tfp corresponds to a 4% increase in buyer power, even after controlling for size. Results are robust to all the different specifications of input market power described in Table 5. Therefore, my results are largely consistent with larger and more productive firms being more distorted in foreign markets, where they seem to enjoy large degree of buyer power. The fact that larger, more productive firms have higher estimated wedges rules out alternative interpretation of the wedges based on trade costs, or capacity constraints.

4 Buyer Power and the Aggregate Economy

The results presented in Section 3 are largely consistent with the existence of imperfect competition in input trade, and in particular with the monopsony or oligopsony power of large French manufacturing importers. The goal of this Section is to understand the effect of a noncompetitive foreign environment on the aggregate gains associated with intermediate inputs trade, an important step for evaluating the welfare and redistributive implications of trade policies (Harrison, 1994; Hallak and Levinsohn, 2007). A large theoretical and empirical literature has evaluated the aggregate effects of improved access to imported intermediate inputs. Studies have used evidence from a large number of countries, and have found - although with some exceptions - large positive effects of foreign inputs on productivity. Importantly, all the existing firm-based import models are based on the assumption that input markets are perfectly competitive. The results presented in this Section are thus complementary to existing studies.

I build an heterogeneous firms model as in Hsieh and Klenow (2009), extended to incorporate buyer power in the market of an intermediate input, which the firms source from a foreign country. The model is deliberately simple, and based on a number of simplifying assumptions that allow me to obtain an analytical characterization of the aggregate equilibrium, and to highlight the main forces at play. Most importantly, I show how this simple framework allows me to use the estimates in the first part of the paper to quantify the effect of buyer power on aggregate output and efficiency.

4.1 Environment

I consider a simplified economy consisting of a Home country (France), and a Foreign country (Rest of the World), and focus on the equilibrium in the Home country. A representative consumer inelastically supplies L units of labor, and consumes a final good. In addition to earning an income from her labor supply, the consumer also owns claims to the profits of the domestic firms.

The final good Q is produced by a representative firm in a competitive final output market. The final good is a CD aggregate of the output of S manufacturing sectors, denoted by Q_s, with $s = 1, .., S$,

$$Q = \prod_{s=1}^{S} Q_s^{\theta_s}, \text{ where } \sum_{s=1}^{S} \theta_s = 1. \tag{23}$$

Cost minimization implies that θ_s is also the fraction of revenues spent on each sectoral output Q_s, i.e. $\frac{P_s Q_s}{PQ} = \theta_s$, $\forall\, s$. I assume that the final good is the numeraire, so that $P = 1$.

In each sector there is a continuum of measure M_s of firms, each producing a differentiated product. I focus on the equilibrium where entry is restricted, and M_s is exogenous.[23] Individual varieties are combined to produce the industry output, according to a CES technology:

$$Q_s = \left(\int_{i \in M_s} {q_{si}}^{\rho_s} di \right)^{\frac{1}{\rho_s}}, \quad \sigma_s > 1, \tag{24}$$

where I allow the elasticity of substitution between goods to vary across industries.

Consumer optimization yields to the standard CES demand for variety i in sector s:

$$q_{s,i} = \left(\frac{p_{si}}{P_s} \right)^{-\frac{1}{1-\rho_s}} Q_s, \tag{25}$$

where P_s is the industry price index, defined as $P_s = \left(\int_{i \in M_s} {p_{si}}^{-\frac{\rho_s}{1-\rho_s}} di \right)^{\frac{1-\rho_s}{\rho_s}}$. Because total sectoral spending is exogenous, in order to ease the exposition I focus hereafter on the analysis of a single sector, and drop the s subscript unless necessary.

Technology Firms in each sector differ in their efficiency level $\phi \in (0, \infty)$. Production of the differentiated variety requires both local and foreign inputs according to the following constant

[23] This choice is motivated by our primary interest in the effect of buyer power on firm-level and aggregate outcomes. In this sense, restricted entry may be interpreted as the description of a short-run equilibrium in which entry has not taken place yet and exit is never optimal (Epifani and Gancia, 2011).

returns CD structure:[24]

$$q_i = \phi_i {x_i}^{\beta} {l_i}^{1-\beta}, \tag{26}$$

where x denotes foreign inputs and l denotes domestic primary factors, which I am going to refer to as labor.[25] Firms can hire any amount of labor at a unitary wage W^l.

Each firm uses a horizontally differentiated variety of the input x for the production of its differentiated final variety. For example, different varieties of x in the Food manufacturing sector can be cattle for a beef processor, or raw organic milk for packaged organic milk producers. Consistent with the empirical results in Section 3, I allow the structure of the market of input x to depart from the traditional benchmark of inelastic supply and perfect competition. In the next paragraph I describe how input market power can be embedded in the model in a tractable way.

The Market of the Foreign Intermediate Input It is assumed that each firm i buys its differentiated variety of input x_i from a different seller (or market) in the Foreign country, with different markets being horizontally segmented by the product characteristics. In the foreign market, each buyer from Home competes with a fringe of competitive buyers from Foreign, but never with other buyers from Home, such that a Home firm's input demand does not depend on the price paid by another Home firm, and we can exclude general equilibrium effects of the price paid by i on the demand of other domestic firms. Let us denote total demand by foreign competitors as $X_{-i} \in [0, \infty)$. I assume that X_{-i} varies across firms, and is exogenous. Total input demand in market i is thus given by $X_i = x_i + X_{-i}$, with $\partial X_i / \partial x_i = 1$. The assumption that X_{-i} is exogenous rules out strategic interactions across a Home firm i and its Foreign competitors.

There exist economic rents on the Foreign markets, which arise owing to decreasing returns in production of the intermediate input varieties.[26] Each foreign seller supplies X_i units of the good according to the following (inverse) supply function

$$W_i^x = \left(\frac{x_i + X_{-i}}{a_i + X_{-i}} \right)^{\eta}. \tag{27}$$

where $\eta \equiv \frac{\partial W_i}{\partial X_i} \frac{X_i}{W_i} > 0$ represents the elasticity of intermediate input price to total demand, which is positive due to the assumption of decreasing returns, and is constant across firms. The denominator $\gamma_i \equiv (a_i + X_{-i})^{-\eta}$ reflects market conditions in the Foreign market for input i, which are taken as given by the firm, and act as a normalizing factor.

[24]The CRS assumption guarantees tractability, yet none of the qualitative results below relies on it. In Section 3 I showed that CRS is a good approximation for a large number of French manufacturing sectors (See Table 3).

[25]As in Blaum et al. (2018), I consider a single primary factor l for notational simplicity. The production structure is consistent with the CD estimating equation in Section 2, with l defined as a constant return to scale aggregator of l_i for $i = 1, .., N$ primary factors, including labor, capital, and domestic intermediate. In the empirical application below, I set $\beta = \beta_X$ and $1 - \beta = 1 - \beta_X$, where β_X is the output elasticity of foreign intermediates estimated in Section 3.

[26]Let X denote total demand of an input variety, and $C(X)$ denote total costs of producing it. Decreasing returns imply that marginal costs $C'(X)$ are increasing in X, i.e. $C^{''} > 0$. In equilibrium, the (unique) price of the intermediate input X_i equal marginal costs, and is higher than the average cost of production. These "excess returns" for the input represent the rents accruing to the seller, and often referred to as *Ricardian rents*.

An important object for the derivation of the firm-level equilibrium is the marginal *expenditure* on input x_i. This is given by

$$\frac{\partial(W_i^x x_i)}{\partial x_i} \equiv W_i^x \left(1 + \frac{\partial W_i}{\partial X_i}\frac{X_i}{W_i} \cdot \frac{\partial X_i}{\partial x_i}\frac{x_i}{X_i}\right) = W_i^x \left(1 + \eta \cdot s_i^x\right), \tag{28}$$

where s_i^x is defined as $s_i^x \equiv \frac{x_i}{x_i + X_{-i}} \in (0,1)$ and is the input market share of firm i. We can now define buyer power of Home firm i in the Foreign market as the gap between the marginal expenditure and the marginal cost of the input, which in the model is given by:

$$\psi_i = 1 + \eta s_i^x \geq 1. \tag{29}$$

The expression in (29) correspond to the wedge in equation (5), with the only difference that the former has a structural interpretation. Note that in the model, two conditions are necessary for buyer power to emerge: *(i)* the firm must be large compared to its competitors, namely $s_i^x > 0$, and *(ii)* the foreign export supply is elastic, i.e. $\eta > 0$.[27]

The model nests the special cases of pure monopsony and perfect competition in a tractable way. When the Home firm is small compared to its competitors in Foreign (i.e. $X_{-i} \to \infty$ and $s_i^x \to 0$), as in the case of perfect competition, then $\psi_i = 1$ and $W_i^x = W^x = 1$. On the contrary, when the Home firm is the only buyer in the market for the differentiated input variety X_i, as in the case of monopsony, then $X_{-i} \to 0$ and $s_i^x \to 1$, such that $\psi_i = 1 + \eta > 1$ and $W_i^x = \left(\frac{x_i}{a_i}\right)^\eta$. I normalize a_i for each firm i to be equal to the counterfactual competitive level of input $a_i = \bar{x}_i$, such that if the firm optimally chooses to buy the competitive quantity, i.e. $x_i = \bar{x}_i$, the price of the input will be equal to the competitive price.

4.2 Firm-Level Equilibrium

The problem of the firm with productivity ϕ_i and foreign competition X_{-i} is to choose inputs so as to maximize profits, subject to demand (25), technology (26) and input supply (27), and taking aggregate variables (i.e. W^l) as given. Formally, profits are given by

$$\pi_i = p_i q_i - W^x(x_i, X_{-i})x_i - W^l l_i,$$

where $W_i^x = W^x(x_i, X_{-i})$ is given by (27). The first order conditions can be written as:

$$\frac{\beta}{\alpha_i^x} = \frac{1}{\rho}\psi_i \tag{30}$$

$$\frac{1-\beta}{\alpha_i^l} = \frac{1}{\rho} \tag{31}$$

[27] This feature of the model is akin to a well-known results in GE models of oligopsonistic competition, where the firm markups increase in both the market share of the firm, and the demand elasticities (e.g. Atkeson and Burstein, 2008).

where $\alpha_i^v \equiv \frac{W_i^v v_i}{p_i q_i}$ for $v = x, l$ are the share of expenditure on input v, and where ρ^{-1} is the markup on on the final good variety, constant due to the assumption of a CES final demand. Note that these expressions coincides with equation (6) in the first part of the paper.

I can summarize the firm-level equilibrium as follows:

$$x_i \propto \phi_i^{\frac{\rho}{1-\rho}} \psi_i^{-\frac{1-\rho(1-\beta)}{1-\rho+\eta(1-\rho(1-\beta))}} \tag{32}$$

$$\frac{l_i}{x_i} \propto \psi_i^{\frac{1-\rho}{1-\rho+\eta(1-\rho(1-\beta))}} \tag{33}$$

$$q_i \propto \phi_i^{\frac{1}{1-\rho}} \psi_i^{-\frac{\beta}{1-\rho+\eta(1-\rho(1-\beta))}}. \tag{34}$$

The allocation of resources across firms depend *both* on firm TFP levels (i.e. ϕ_i), and on the degree of foreign competition (i.e. X_{-i}). Interestingly, equations (32)-(34) show that buyer power ψ_i is a *sufficient statistic* for the effect of foreign competition on firm-level variables, such that we can characterize the equilibrium as a function of ϕ_i, ψ_i and aggregate variables.

Buyer power in foreign markets generate three sources of inefficiency. First, output in the monopsonised market is too low compared to the competitive equilibrium, which corresponds to the case $\psi_i = 1$ (equation (32)). Second, firms with high level of ψ engage in inefficient substitution of the domestic input for the monopsonised input in producing the final product (equation (33)). Third, the final good will be smaller than optimal, causing final goods prices to be higher than would be the case in the absence of monopsony (equation (34)).

The previous discussion can be summarized by looking at the marginal revenue product of the two inputs in production:

$$\text{MRPL}_i \equiv \frac{\partial p_i q_i}{\partial l_i} = W^l \tag{35}$$

$$\text{MRPX}_i \equiv \frac{\partial p_i q_i}{\partial x_i} = W_i^x \psi_i = \psi_i^{\frac{1-\rho}{1-\rho+\eta(1-\rho(1-\beta))}}. \tag{36}$$

Buyer power drives a wedge between the marginal revenue product of the foreign input, and its price. A standard result in the misallocation literature is that the existence of such wedges generates misallocation of resources, and production inefficiencies. In this case, given that the competitive price of X_i is normalized to one, the fact that $\psi_i \geq 1$ and $\text{MRPX}_i \geq 1$ implies that buyer power always makes firm smaller than optimal. I summarize the firm-level equilibrium in the following proposition:

Proposition 1: *Buyer power in foreign markets raises the marginal revenue product of foreign inputs of the firm, making it smaller than optimal. In particular, firms with high buyer power buy less inputs (both foreign and domestic), have a higher labor-to-intermediate ratio, produce less output, and have a higher revenue productivity.*

4.3 Buyer Power and the Aggregate Economy

I now have all the elements I need to derive an aggregate equilibrium. Given the focus of this paper, I focus the analysis on the effect of buyer power on aggregate efficiency, and aggregate output.

4.3.1 Aggregate Productivity

I first ask what happens to aggregate TFP in presence of buyer power. To do so, I restore sector notation, and follow the derivations in Hsieh and Klenow (2009) (hereafter HK) to obtain an expression isomorphic to equation (15) in their paper. Aggregate TFP is given by

$$\text{TFP}_s = \left(\int_0^{M_s} \phi_{si}^{\frac{\rho_s}{1-\rho_s}} \left(\frac{\text{MRPX}_s}{\text{MR}\bar{\text{P}}\text{X}_{si}} \right)^{\beta \frac{\rho_s}{1-\rho_s}} di \right)^{\frac{1-\rho_s}{\rho_s}} \tag{37}$$

where $\text{MR}\bar{\text{P}}\text{X}_s$ is the harmonic mean of the marginal revenue product of intermediates in the sector, with weights equal to the market share of the firm, and $\text{MRPX}_{s,i}$ is defined in (36).[28]. Equation (37) reveals that sectoral TFP is homogeneous of degree zero in buyer power: multiplying all $\psi_{s,i}$, and MRPX_{si} thereof, by any positive constant leaves sectoral TFP unaffected. In other words, the average buyer markups does not matter for aggregate productivity.

I can make further progress if I assume - as it is standard in the misallocation literature - that ϕ ($\equiv$ TFPQ) and ψ are jointly log-normally distributed. I can then write (37) as:

$$\log \text{TFP}_s = \log \left(\int_0^{M_s} \phi_{si}^{\frac{\rho_s}{1-\rho_s}} di \right)^{\frac{1-\rho_s}{\rho_s}} - \kappa_{1,s} \text{var} \log \psi_s^x, \tag{38}$$

where $\kappa_{1,s} \equiv \left(\frac{1-\rho_s}{1-\rho_s+\eta(1-\rho_s(1-\beta))} \right)^2 \left(\frac{\beta_s^2}{2(1-\rho_s)} + \frac{\beta_s(1-\beta_s)}{2} \right)$. Equation (38) shows that dispersion in buyer power reduces aggregate efficiency. As in HK, this happens because buyer power induces misallocation of resources across heterogeneous firms. For an intuition, consider the ratio of labor allocation between two firms, i and j :

$$\frac{l_{si}}{l_{sj}} = \left(\frac{\phi_{si}}{\phi_{sj}} \right)^{\frac{\rho_s}{1-\rho_s}} \left(\frac{\psi_{si}}{\psi_{sj}} \right)^{-\frac{\rho_s \beta_s}{1-\rho_s+\eta_s(1-\rho_s(1-\beta_s))}}. \tag{39}$$

When $\psi_{si} = \psi_{sj} = \psi$, namely when there is no dispersion in buyer power, more labor is allocated to the more productive firm, leading to an efficient allocation of resources. On the contrary, when buyer power is heterogeneous, labor is (inefficiently) reallocated from the more to the less distorted firm: conditional on ϕ, $l_{si} > l_{sj} \iff \psi_{si} < \psi_{sj}$.

The cost of this misallocation of resources is higher the higher the output markup (low ρ_s), the higher the output share of intermediates, the lower the inverse supply elasticity η. Note that a higher value of η raises the average buyer power in the economy for a given distribution of X_{-i}. Intuitively,

[28] $\text{MR}\bar{\text{P}}\text{X}_s = \int_{i \in M_s} \text{MRPX}_{si}^{-1} \frac{p_{si} q_{si}}{P_s Y_s} = \int_{i \in M_s} \psi_{si}^{-\frac{1-\rho}{1-\rho+\eta(1-\rho(1-\beta))}} \frac{p_{si} q_{si}}{P_s Y_s}$

the probability that a firm has buyer power below the mean increases with the dispersion in ψ, the more so the higher the average level of distortions, or equivalently the higher η. I summarize this result in the following proposition:

Proposition 2: *Heterogeneity in buyer power introduces an intrasectoral misallocation, whereby firms with below-average buyer power overproduce, and industries with above-average buyer power underproduce. The efficiency cost of buyer power induced misallocation are inversely proportional to the inverse supply elasticity of the foreign input.*

4.3.2 Aggregate Output

I now explore the effect of buyer power on sectoral output and welfare. I follow Epifani and Gancia (2011) and define welfare in this economy as aggregate consumption, i.e.

$$W = \prod_{s=1}^{S} Q_s^{\theta_s}, \tag{40}$$

where the sectoral output Q_s is defined in (24). I show in the Appendix that sectoral output can be written as:

$$Q_s = \Gamma \cdot \left(\int_{i \in M_s} \phi_{si}^{\frac{\rho_s}{1-\rho_s}} \psi_{si}^{-\frac{\rho_s \beta_s}{1-\rho_s+\eta_s(1-\rho_s(1-\beta_s))}} di \right)^{\frac{1-\rho_s}{\rho_s}}, \tag{41}$$

where $\Gamma \equiv \left(\frac{W^l}{1-\beta_s}\right)^{\beta_s} \left(\frac{1}{\beta_s}\right)^{-\beta_s} L_s$ summarizes the effect of aggregate variables. When ϕ and ψ are jointly log-normally distributed, output (and welfare) can be written as:

$$\log Q_s \propto \log \left(\int_0^{M_s} \phi_{si}^{\frac{\rho_s}{1-\rho_s}} \right)^{\frac{1-\rho_s}{\rho_s}} - \kappa_{2,s} \mathbb{E} \log \psi_s + \kappa_{3,s} \mathrm{var} \log \psi_s, \tag{42}$$

where $\kappa_{2,s} \equiv \frac{(1-\rho_s)\beta_s}{1-\rho_s+\eta(1-\rho_s(1-\beta_s))} > 0$ and $\kappa_{3,s} \equiv \left(\frac{1-\rho_s}{2\rho_s}\right)\left(\frac{\rho_s\beta_s}{1-\rho_s+\eta(1-\rho_s(1-\beta_s))}\right)^2 > 0$. Equation (42) shows that both first and second moments of the distribution of ψ determine the sectoral output Q_s. In particular, output *decreases* with the average level of ψ but, unlike TFP, it *increases* with the dispersion of ψ across firms. To interpret this seemingly counterintuitive result, let us write aggregate output as

$$Q_s = \mathrm{TFP}_s X_s^{\beta_s} L_s^{1-\beta_s}, \tag{43}$$

and let us consider a world where there is no heterogeneity in buyer power, such that $\psi_i = \psi_j = \psi$ for any pair of firms $i, j \in M_s$. We know from Proposition 2 that in this world TFP_s is at its efficient level. However, because aggregate foreign input X_s is supplied elastically, it will decrease with the average level of ψ. Therefore, even if firms are producing efficiently, the existence of buyer power makes aggregate output smaller than optimal. What happens when we introduce heterogeneity in buyer power? On the one hand, Proposition 2 tells us that there will be resource misallocation, which lowers aggregate TFP. On the other hand, because less distorted firms overproduce in this world, more resources will be employed in the economy, increasing X_s. Equation (42) says that the increase in X_s more than offset the decrease in TFP_s, leading to an overall positive effect of heterogeneity on aggregate output. Proposition 3 summarizes this finding:

Proposition 3: *Output is inefficiently low in an economy where firms have buyer power. A mean-preserving spread of the distribution of buyer power increases both output and welfare, by inducing a larger number of low buyer power firms overproduce, albeit inefficiently.*

4.4 Aggregate Cost of Buyer Power in Foreign Markets

I finally aim to quantify the costs of buyer power in foreign markets for the French economy. To do so, I compare aggregate output and TFP in the distorted economy to their values in a counterfactually efficient scenario where all firms are price takers in foreign input markets.

For any given variable X, I denote as $\hat{X} \equiv \log X^{DIS} - \log X^{EFF}$ the log-difference between the value in the distorted economy and the counterfactually efficient value. After some algebra, it is possible to show that the efficiency cost of buyer power $\hat{\text{TFP}}$ is given by:

$$\hat{\text{TFP}} = \sum_{s=1}^{S} \theta_s \hat{\text{TFP}}_s = -\sum_{s=1}^{S} \theta_s \kappa_{1s} \text{var} \log \psi_s^x. \tag{44}$$

Similarly, the output cost of buyer power $\hat{Q}$ can be written as:

$$\hat{Q} = \frac{1}{1 - \sum_{s=1}^{S} \theta_s \beta_s} \left[-\sum_{s=1}^{S} \theta_s \kappa_{2,s} \mathbb{E} \log \psi_s + \sum_{s=1}^{S} \theta_s \kappa_{3,s} \text{var} \log \psi_s \right]. \tag{45}$$

Inspection of equations (44) and (45) reveals a striking result: for a given set of parameters, the only thing we need to know in order to quantify the efficiency and output cost of buyer power is $\mathbb{E} \log \psi_s$ and $\text{var} \log \psi_s$. In other words, first and second moment of the sectoral distribution of ψ are sufficient statistics for the effect of imperfect competition in the aggregate economy.

The next paragraph shows how all the elements necessary to quantify equations (44) and (45) can be derived from the estimates in Section 3.

Model Calibration In order to compute the right-hand side of equations (44) and (45), one needs estimates of the parameters θ_s, ρ_s, β_s and η_s, as well as values of both $\mathbb{E} \log \psi_s$ and $\text{var} \log \psi_s$ for each sector. The latter can be derived from the mean and variance of the distribution of input efficiency wedge in Section 3, by using the properties of the lognormal distribution.[29] Values of θ_s reflect the sectoral share of total manufacturing output, directly observed from firm-level data. The demand elasticities ρ_s can be inferred from the baseline estimates of average markup at the

[29] In particular, under the assumption that ψ is distributed lognormal, i.e. $\psi \sim \log \mathcal{N}(\mu_{xs}, \sigma_{xs}^2)$, the following relationships hold: $\mathbb{E} \log \psi_s = \mu_{xs}$ and $\text{var} \log \psi_s = \sigma_{xs}^2$. The values μ_{xs} and σ_{xs}^2 solve the following system of equations:

$$\begin{cases} \mathbb{E}(\psi_s) = & \exp\left(\mu_{xs} + \frac{\sigma_{xs}^2}{2}\right) \\ \text{var}(\psi_s) = & \left[\exp\left(\sigma_{xs}^2\right) - 1\right] \exp\left(2\mu_{xs} + \sigma_{xs}^2\right) \end{cases}$$

Table IX. Aggregate Cost of Buyer Power

		Robustness			
	$\eta_s^{\text{BLW (2008)}}$	$\eta_s = 1$	$\eta_s = 2$	$\eta_s = 3$	$\eta_s = 4$
Δ%TFP	-5.92% (0.002)	-6.4%	-6.1%	-6%	-6%
$\Delta\%Q$	-0.63% (0.001)	-2.3%	-1.6%	-1.2%	-1%

Notes: The table reports the losses in TFP and Q using alternative choices for η. Standard errors in parentheses are obtained by block bootstrapping.

sector level, while the CD parameters β_s correspond to the sectoral output elasticities of the foreign intermediate input, which I summarized in Table 4.

The choice of the foreign supply elasticity η_s is less straightforward, as it cannot easily be mapped to any of the production function parameters. I thus consider several options: first, I set the value of η_s equal to an estimate of the sectoral inverse export supply elasticity, which I obtain by averaging the product-level estimates in Broda et al. (2008) at the sector level. Then, I show the sensitivity of my results to the choice of this specific parameter by letting it vary arbitrarily.

Results Table 9 summarizes the results, while Table A6 in the Appendix breaks down the results by sector. Columns (1) reports the TFP and output losses when η is constructed from the Broda et al. (2008) export supplies elasticities. The value of η_s in this case ranges from 1.36 to 93.14, as shown in Table A6 in the Appendix. Columns (2)-(5) consider different values of η, respectively equal to 1,2,3 and 4. The results show that the cost of buyer power is substantial: aggregate efficiency is reduced by 6%, on average, while the cost in terms of aggregate output varies across specification, and ranges from 0.6%-2%.

The efficiency cost of buyer power does not vary much with the value of η. However, the cost in terms of output is lower the higher the value of the elasticity. A high value of η_s implies that even small deviations of the quantity demanded from its efficient counterpart can substantially reduce the input price, such that even if the price is very much below competitive levels, the quantity is not.

4.5 Foreign Inputs and Aggregate Productivity - Linking Back to the Literature

The results in this Section suggest that opening up to trade could increase a firm's scope of buyer power, and simultaneously increase a country's exposure to input market distortions, and inefficiencies. Yet a robust finding in the international literature is that trade in intermediate inputs is associated with large productivity gains, stemming from improved access to high quality or highly differentiated inputs.[30] How can we reconcile these two seemingly opposite messages?

[30] SeeAmiti and Konings (2007) for Indonesia, Muendler (2004); Schor (2004) for Brazil; Kasahara and Rodrigue (2008) for Chile, Goldberg et al. (2010); Topalova and Khandelwal (2011) for India, Gopinath and Neiman (2014) for Argentina, and Halpern et al. (2015) for Hungary.

Note that the model laid out in this Section takes as given the fact that firms use a foreign input in production. In this sense, it is not a good model to think about a counterfactual economy under autarky. However, we can still make progress by considering the following thought exercise. Under autarky, a representative firm produces using the following technology: $q = \phi^A f(k, l, m)$, where ϕ^A is aggregate efficiency, and k, l and m denotes capital, labor and domestic intermediate inputs. After a trade liberalization, the firm starts using foreign intermediates in production, such that technology can now be described as $q = \phi^{FT} g(k, l, m, x)$, where ϕ^{FT} is aggregate efficiency under free trade, and $g(\cdot)$ is now a function of four inputs, where it is understood that the output elasticities of the different inputs might have changed as a result of the trade liberalization.

Let us decompose ϕ^{FT} as $\phi^{FT} = \phi^{FT,C} + \hat{\phi}$, where $\phi^{FT,C}$ is aggregate TFP in a *counterfactual* competitive economy under free trade, and $\hat{\phi}$ is the deviation of the *actual* aggregate TFP in free trade from its counterfactually competitive value. The term $\hat{\phi}$ corresponds to the quantity in equation (44). The productivity gains from input trade can be written as: $GT^I = \phi^{FT} - \phi^A = \left(\phi^{FT,C} - \phi^A\right) + \hat{\phi}$. The term in parentheses represents the gains from trade, conditional on input markets being competitive before and after the trade liberalization. This is what traditional studies aim to quantify. The term $\hat{\phi}$ indicates the effect of a noncompetitive environment on aggregate efficiency.

My results say that the value of $\hat{\phi}$ is about -6%, and therefore that the gains of trade are 6% lower than they would be if markets were perfectly competitive. This would also imply that the gains of trade are 6% lower than what traditional studies assert, conditional on traditional estimates being unbiased. However, it is easy to show that neglecting the role of input market power in foreign input markets generates a positive bias in standard estimates of the gains from input trade, which reflect the increase in profitability over and above the increase in efficiency. In this sense, standard estimates could be inflated by even more than 6%. A fruitful direction for future research would be to analyze gains and losses associated with foreign sourcing in a unified framework.

5 Conclusions

This paper studies imperfect competition in the context of imported input trade, using data for the French manufacturing sector. The paper makes two contributions. On the methodological side, I show that the input market power in foreign input markets can be consistently estimated from standard firm-level production and trade data. On the theoretical side, I characterize both qualitatively and quantitatively the aggregate implications of buyer power of firms in a standard macroeconomic framework.

This study raises a number of questions, which could be further investigated in future research. An increasing body of work aims to understand the source of market power of firm, which is a key determinant of firm and industry performance (Blonigen and Pierce, 2016; De Loecker and Eeckhout, 2017; Syverson, 2019). The finding that input market power is large and relevant for aggregate variables suggests that to learn about the market power of firms one should look at the supply side of the economy, and not just to the demand side.

My analysis further suggests that the buyer power of importers should be an important target of trade and antitrust policy, as it could significantly hamper the economic performance not only of foreign countries, but also of domestic ones through its effect on the efficiency and scale of production. Even so, a better understanding of the actual sources of foreign market segmentation is necessary to formulate appropriate recommendations. The nature of the "barriers to entry" into foreign markets - be it search or information costs, or limited scope of substitution of foreign sellers - will determine the feasibility and effectiveness of such policies. One limitation of the current study is that I am not able to pin down the sources of buyer power in foreign input markets.

This study could be extended in many fruitful directions. On the methodological side, input market power is identified as a wedge in the first order condition of firms, under the assumption that firm-level markups can be identified from a (competitive) static input in production. Future research could exploit increasingly available information on prices of intermediate inputs to relax, or test the validity of, this assumption. On the theoretical side, my model is very simple, and most importantly, static. It is important to relate the static welfare gains or losses associated with buyer power to dynamic aggregate outcomes, such as entry, R&D and innovation, to better assess the economic importance of input market power.

Table A1. Firm Relative Export and Import Prices

Variable	1996-2007				
	Mean	Std Dev	p10	p50	p90
(Relative) output price $\hat{p}_{it}$	-0.06	.48	-.55	-0.5	.41
(Relative) imported input price $\hat{w}^x_{it}$	-0.03	.38	-.42	-0.03	.34

Panel B. Correlation with Main PF Variables

	$\hat{p}_{it}$	$\hat{w}^x_{it}$
$Corr(\cdot, Y_{it})$	-.41	-.02
$Corr(\cdot, L_{it})$	0	.08
$Corr(\cdot, M_{it})$	-.06	.03
$Corr(\cdot, X_{it})$	-.11	-.2

Notes: Numbers are averaged across time and sectors, and refer to the full baseline sample of international firms. Number of observations: 129,787. [a]A sourcing market is defined as a country-NC8 product combination.

Table A2. Average Output Elasticities, Tranlog, By Sector

	Industry	β_L	β_K	β_M	β_X	Return to Scale
15	Food Products and Beverages	0.03	0.14	0.44	-0.89	0.64
		(0.14)	(0.09)	(0.16)	(0.33)	
17	Textiles	0.18	0.16	0.35	0.81	0.85
		(0.17)	(0.10)	(0.18)	(0.25)	
18	Wearing Apparel, Dressing	0.46	0.25	0.35	0.76	1.57
		(0.14)	(0.12)	(0.23)	(0.23)	
19	Leather, and Products	-0.01	0.15	0.16	-1.16	0.28
		(.16)	(0.06)	(0.15)	(0.38)	
20	Wood, and Products	0.56	0.03	0.47	-2.03	1.63
		(.12)	(0.11)	(0.25)	(0.57)	
21	Pulp, Paper, & Products	0.4	0.14	0.4	-0.72	1.33
		(0.07)	(0.08)	(0.14)	(0.31)	
22	Printing and Publishing	0.31	0.06	0.25	-0.8	0.94
		(0.29)	(0.09)	(0.17)	(0.25)	
24	Chemicals, and Products	0.11	0.1	0.28	1	0.58
		(0.20)	(0.08)	(0.21)	(0.38)	
25	Rubber, Plastics, & Products	0.16	0.22	0.35	1.11	0.88
		(0.10)	(0.09)	(0.15)	(0.39)	
26	Non-metallic mineral Products	-0.04	0.32	0.24	0.22	0.46
		(0.20)	(0.15)	(0.12)	(0.07)	
27	Basic Metals	0.36	0.10	0.34	0.18	1.11
		(0.17)	(0.10)	(0.17)	(0.09)	
28	Fabricated Metal Products	0.46	0.15	0.38	-0.35	1.45
		(0.11)	(0.10)	(0.12)	(0.15)	
29	Machinery and Equipment	0.35	0.1	0.33	0.03	1.11
		(0.22)	(0.05)	(0.19)	(0.07)	
31	Electrical machinery & App.	0.4	0.09	0.43	-0.08	1.31
		(0.11)	(0.06)	(0.16)	(0.13)	
32	Radio and Communication	0.08	0.15	0.29	0.17	0.62
		(0.25)	(0.10)	(0.22)	(0.14)	
33	Medical, Precision, Optical Instr.	0.41	0.10	0.32	0.73	1.23
		(0.23)	(0.08)	(0.23)	(0.24)	
34	Motor Vehicles, Trailers	0.16	0.11	0.37	1.26	0.79
		(0.17)	(0.09)	(0.18)	(0.52)	
35	Other Transport Equipment	0.05	0.08	0.18	1.80	0.36
		(0.30)	(0.15)	(0.18)	(0.79)	

Notes: The table reports the output elasticities when the production function is translog. Standard deviations (not standard errors) are in parentheses. Cols 2–4 report the average estimated output elasticity with respect to each factor of production. Median values are similar. Col. 5 reports the average returns to scale.

Table A3. Average Output Elasticities, Tranlog 3 Inputs, By Sector

	Industry	β_L	β_K	β_M	Return to Scale
15	Food Products and Beverages	0.28	0.12	0.61	1.01
		(0.11)	(0.1)	(0.13)	
17	Textiles	0.29	0.14	0.58	1.01
		(0.18)	(0.09)	(0.21)	
18	Wearing Apparel, Dressing	0.20	0.24	0.54	0.98
		(0.1)	(0.11)	(0.12)	
19	Leather, and Products	0.28	0.13	0.56	0.97
		(0.07)	(0.05)	(0.07)	
20	Wood, and Products	0.32	0.00	0.51	0.83
		(0.09)	(0.08)	(0.2)	
21	Pulp, Paper, & Products	0.31	0.12	0.54	0.97
		(0.07)	(0.08)	(0.1)	
22	Printing and Publishing	0.61	-0.01	0.47	1.07
		(0.32)	(0.11)	(0.18)	
24	Chemicals, and Products	0.40	0.09	0.55	1.04
		(0.17)	(0.07)	(0.17)	
25	Rubber, Plastics, & Products	0.37	0.20	0.51	1.08
		(0.08)	(0.09)	(0.12)	
26	Non-metallic mineral Products	0.33	0.34	0.45	1.12
		(0.18)	(0.15)	(0.12)	
27	Basic Metals	0.39	0.14	0.52	1.05
		(0.17)	(0.05)	(0.17)	
28	Fabricated Metal Products	0.41	0.12	0.47	1.00
		(0.1)	(0.09)	(0.14)	
29	Machinery and Equipment	0.47	0.08	0.43	0.98
		(0.22)	(0.04)	(0.17)	
31	Electrical machinery & App.	0.30	0.09	0.53	0.92
		(0.12)	(0.06)	(0.13)	
32	Radio and Communication	0.37	0.15	0.50	1.02
		(0.16)	(0.07)	(0.19)	
33	Medical, Precision, Optical Instr.	0.43	0.11	0.43	0.97
		(0.19)	0.120	(0.2)	
34	Motor Vehicles, Trailers	0.34	0.53	0.54	1.41
		(0.17)	(0.09)	(0.14)	
35	Other Transport Equipment	0.620	-0.070	0.420	0.97
		(0.22)	(0.08)	(0.18)	

Notes: The table reports the output elasticities when the production function is translog in three inputs. Material here is defined as Total Material Inputs, which include domestic and foreign intermediates. Cols 2–3 report the average estimated output elasticity with respect to each factor of production. Standard deviations (not standard errors) are in parentheses. Col. 4 reports the average returns to scale, which is the sum of the preceding 4 columns.

Table A4. Firm Relative Export and Import Prices

Sample of Importers		β_k	β_l	β_m	β_x
	Small	0.11 (0.08)	.39 (0.09)	.34 (0.03)	.12 (0.02)
	Medium	0.09 (0.06)	.34 (0.07)	.39 (0.02)	.14 (0.02)
	Large	0.11 (0.05)	.31 (0.06)	.37 (0.02)	.17 (0.01)

Notes: The reported elasticities are averaged across sectors. In parenthesis I report the average industry standard error. Class of importers are drawn based on terciles of extensive margin distribution of imports.

Table A5. Firm Relative Export and Import Prices

Prod. Fun.	*Specification*	β_k	β_l	β_m	β_x
	Baseline	0.11 (0.04)	.34 (0.05)	.38 (0.01)	.16 (0.01)
CD	No Price Bias	0.11 (0.03)	.34 (0.04)	.37 (0.01)	.17 (0.01)
	No Selection Bias	0.11 (0.03)	.35 (0.03)	.38 (0.01)	.15 (0.01)
		θ_{it}^k	θ_{it}^l	θ_{it}^m	θ_{it}^x
	Baseline	0.14 (0.09)	0.25 (0.17)	0.33 (0.18)	0.11 (0.29)
TL[a]	No Price Bias	0.12 (0.09)	0.31 (0.18)	0.34 (0.19)	0.01 (0.29)
	No Selection Bias	0.13 (0.08)	0.27 (0.16)	0.34 (0.17)	0.22 (0.25)

Notes: The reported elasticities are averaged across sectors. In parenthesis I report the average industry standard error. [a]Standard deviations (no standard errors) in parantheses.

TABLE A6. AGGREGATE COST OF BUYER POWER IN FOREIGN MARKETS

	PARAMETERS				MOMENTS		COUNTERFACTUALS	
	DATA	PF ESTIMATION					EQ. (47)-(48)	
SECTOR	θ_s	β_s	η_s	ρ_S	$\mathbb{E}\log\psi_s^x$	$\text{var}\log\psi_s^x$	ΔTFP_s	ΔQ_s
15 Food and Beverages	0.15	0.11	2.1	.8	0.58	0.96	-0.05	-0.01
17 Textiles	0.03	0.22	23.7	.56	0.07	1.09	-0.09	-0.0004
18 Wearing Apparel	0.01	0.24	4.63	.57	0.23	1.11	-0.1	-0.007
19 Leather Products	0.01	0.25	4.18	.71	0.36	1	-0.1	-0.01
20 Products of Wood	0.02	0.12	4.2	.7	0.43	0.98	-0.05	-0.007
21 Pulp and Paper Products	0.05	0.16	1.36	.68	0.05	1.03	-0.07	0.0007
22 Printing and Publishing	0.05	0.17	22.86	.63	0.75	0.971	-0.07	-0.004
24 Chemical Products	0.14	0.18	8.27	.78	0.40	0.935	-0.07	-0.005
25 Rubber Products	0.08	0.12	2.03	.70	0.17	0.969	-0.05	-0.004
26 Non-metallic minerals	0.04	0.12	4.92	.76	0.68	0.946	-0.05	-0.01
27 Basic Metals	0.05	0.17	7.45	.73	0.36	0.974	-0.07	-0.005
28 Fabricated Metal Products	0.10	0.10	7.92	.60	0.23	0.94	-0.04	-0.002
29 Machinery and Equipment	0.10	0.12	17.86	.8	0.64	0.932	-0.05	-0.003
31 Electrical Machinery	0.05	0.15	6.9	.7	0.49	0.99	-0.06	-0.007
32 Radio and Communication	0.02	0.15	20.23	.68	0.62	1	-0.06	-0.003
33 Medical Instruments	0.03	0.13	30.76	.74	0.60	1	-0.06	-0.002
34 Motor Vehicles, Trailers	0.05	0.16	10.6	.92	0.66	1	-0.07	-0.003
35 Other Equipment	0.02	0.15	93.14	.69	0.74	1	-0.06	-0.008
CHANGES IN AGGREGATE VARIABLES					$\Delta\%\text{TFP} = \left(\sum_{s=1}^{S}\theta_s\hat{\text{TFP}}_s\right)\times 100$		-5.92%	
					$\Delta\%Q = \left(\sum_{s=1}^{S}\theta_s\hat{Q}_s\right)\times 100$			-0.6%[a]

Notes: The table reports estimates of main parameters, and estimates necessary to compute equation (47)-(48), together with the main results. All parameters are computed on the baseline sample, as described in Section 3. The ρ_s are calculated as $\rho_s = \mu_s^M$, where μ_s^M is the median markup in sector $s = 1, .., S$. The η_s are calculated as $\eta_s = \psi_s(p90) - 1$, where $\psi_s(p90)$ is the solution to $\Pr(\psi < \psi_s(p90)) = .9$, where $\psi \sim \log\mathcal{N}(\mu_{xs}, \sigma_{xs}^2)$. [a] This is decomposed as -0.69% due to a mean term, and +0.06% due to a variance ter.

A Appendix

A.1 Models of Imperfect Competition in the Input Markets

In this Section, I consider two particular models of price discrimination in the input markets, and discuss their implications for the input efficiency wage ψ_{it}^{x} . I first consider a model of second degree price discrimination with quantity discounts, and then a model with two-part pricing. The choice of these particular models is based on their saliency in the literature of international trade and industrial organization.

A.1.1 A Model with Quantity Discounts

Let us consider the following price (cost) schedule for the firm demand of input j. For orders less than 500 units, the supplier charges a price W_{it}^{j} equal to a_1 per unit, for orders of 500 or more but fewer than 1000 units, it charges a_2 per unit, and for orders of 1000 or more, it charges a_3 per unit, with $a_1 > a_2 > a_3$. The discount schedule is applied to all units purchased, so that there is a unique price per order. The unit cost function can thus be described as:

$$W(V_{it}^{j}) = \begin{cases} a_1 & \text{for } 0 < V_{it}^{j} < 500 \\ a_2 & \text{for } 500 < V_{it}^{j} < 1000 \\ a_3 & \text{for } V_{it}^{j} \geq 1000 \end{cases} .$$

Note that the function $W(\cdot)$ can be rewritten as:

$$W(V_{it}^{j}) = a(V_{it}^{j})V_{it}^{j},$$

where $a(V_{it}^{j}) = a_1 1\left(V_{it}^{j} \in [0, 500)\right) V_{it}^{j} + a_2 1\left(V_{it}^{j} \in [500, 1000)\right) V_{it}^{j} + a_3 1\left(V_{it}^{j} \in [1000, \infty)\right) V_{it}^{j}$. In the limit case where the function $a(\cdot)$ is continuous, we have $a' < 0$, and $\epsilon_{it}^{j} \equiv \underbrace{\frac{\partial W_{it}^{j}}{\partial V_{it}^{j}}}_{-} \underbrace{\frac{V_{it}^{j}}{W_{it}^{j}}}_{+} < 0$, which would imply $\psi_{it}^{j} \equiv 1 + \epsilon_{it}^{j} < 1$.

A.1.2 Non-linear pricing - Two-part Tariff

Let us now consider the case where the firm has to pay a "fee" to buy imports (such as an import license for entry), after which it can buy intermediates at a fixed unit cost a. The total price of V_{it}^{j} units of the inputs is

$$C(V_{it}^{j}) \equiv W(V_{it}^{j})V_{it}^{j} = F + aV_{it}^{j}$$

If the firm takes the fee into account (the fee is not sunk from the firm's point of view), then

$$W(V_{it}^j) = \frac{F + aV_{it}^j}{V_{it}^j},$$

which implies that $\frac{\partial W_{it}^j}{\partial V_{it}^j} = -\frac{F}{V_{it}^{j2}} < 0$,and therefore $\psi_{it}^j \leq 1$. Otherwise, if fee is considered a sunk cost, $W(V_{it}^j) = a$ and the firm behaves as a price taker in the input market, such that $\psi_{it}^j = 1$.

A.2 Production Function Estimation

A.2.1 Simultaneity bias

Let us consider a setting where heterogeneous firms produce output using two variable inputs: domestic intermediates m_i, and foreign intermediates x_i. The market for domestic material is competitive, such that firms take price w_i^m as given. The price w_i^m is allowed to vary by firms due to quality differences across firms. The market for x_i is not perfectly competitive, and I let ψ_i denote the degree of firms buyer power in the market for foreign intermediates. This environment is similar to the one I consider for the theoretical model in section 4, and the reader should refer to that section for the derivation of the main equations. In particular, it can be shown that the demand for the two productive inputs (conditional on state variables) is given by

$$x_i = f(\omega_i, \psi_i, w_i^x, w_i^m | \varsigma_i) \tag{46}$$

$$m_i = g(\omega_i, \psi_i, w_i^x, w_i^m | \varsigma_i), \tag{47}$$

where ω_i is unobserved firm productivity, w_i^v with $v = x, m$ are the variable input prices, and ς is the vector of state variables. Since the competitive input m_i is monotonically decreasing in ψ_i, the second expression can be inverted to write:

$$\psi_i = \tilde{g}(\omega_i, w_i^x, w_i^m, m_i). \tag{48}$$

We can now write $m_i = \tilde{m}_i - (w_i^m - \bar{w}^m)$, where $\bar{w}^m$ is the material deflator in the relevant industry, and we can further write, as argued in the main text, $(w_i^m - \bar{w}^m) = w(p_i, G_i)$, given the assumption that the domestic market is perfectly competitive. Putting all pieces together, the demand for intermediate can be written as:

$$x_i = x(\omega_i, \tilde{m}_i, w_i^x, p_i, G_i | \varsigma_i), \tag{49}$$

such that productivity ω_i is the only unobserved *scalar* entering the input demand. Since imported input demand is monotonically increasing in firm TFP, we can invert (49) to get

$$\omega_i = h\left(x_i, \tilde{m}_i, w_i^x, p_i, G_i | \varsigma_i\right). \tag{50}$$

In order to account for model misspecifications, and other unobservables, I generalize the previous expression (in terms of observables) as:

$$\omega_{it} = h_t(\tilde{k}_{it}, l_{it}, \tilde{m}_{it}, x_{it}, \hat{w^x_{it}}, \hat{p_{it}}, \hat{ms}_{it}, G_i, \Phi_{it}). \tag{51}$$

I substitute equation (51) in (11) to control for firm's productivity.

A.2.2 Estimation

I put all the pieces together and write the estimating equation as:

$$\begin{aligned} q_{it} =& \beta_l l_{it} + \beta_k \tilde{k_{it}} + \beta_m \tilde{m_{it}} + \beta_x x_{it} + \hat{p_{it}} + \tilde{B}(\hat{p_{it}}, \hat{ms}_{it}, \mathbf{G}_i; \beta) \\ &+ h_t(\tilde{k}_{it}, l_{it}, \tilde{m}_{it}, x_{it}, \hat{w^x_{it}}, \hat{p_{it}}, \hat{ms}_{it}, G_i, \Phi_{it}) + \epsilon_{it}, \end{aligned} \tag{52}$$

which corresponds to equation (18) in the text. To estimate (52), I follow the 2-steps GMM procedure in Ackerberg et al. (2015). First, I run OLS on a non-parametric function of the dependent variable on all the included terms. Specifically, I run OLS of $\tilde{q_{it}}$ on a third order polynomial of $(l_{it}, \tilde{k_{it}}, \tilde{m_{it}}, x_{it}, p_{it}, w^X_{it}, G_i)$:

$$q_{it} = \phi_t(l_{it}, \tilde{k_{it}}, \tilde{m_{it}}, \tilde{x_{it}}, \hat{w^x_{it}}, \hat{p_{it}}, \hat{ms}_{it}, G_i, \Phi_{it}) + \epsilon_{it}. \tag{53}$$

The goal of this first stage is to identify the term $\hat{\phi_{it}} \equiv \hat{q_{it}} - \hat{\epsilon}_{it}$, which is output net of unanticipated shocks and/or measurement error. The second stage identifies the production function coefficients from a GMM procedure. Let the law of motion for productivity be described by:

$$\omega_{it} = g(\omega_{it-1}) + \xi_{it}, \tag{54}$$

where I approximate $g(\cdot)$ as a second order polynomial in all its arguments. Using (52) and (53) we can express ω_{it} as

$$\omega_{it}(\beta) = \hat{\phi}_{it} - \left(\beta_l l_{it} + \beta_k \tilde{k_{it}} + \beta_m \tilde{m_{it}} + \beta_x x_{it} - \tilde{B}(\hat{p_{it}}, \hat{ms}_{it}, \mathbf{G}_i; \rho)\right). \tag{55}$$

We can now substitute (55) in (54) to derive an expression for the innovation in the productivity shock $\xi_{it}(\beta)$ as a function of only observables and unknown parameters β. Given $\xi_{it}(\beta)$, we can write the moments identifying conditions as:

$$\mathbb{E}\Big(\ \xi_{it}(\beta)\ \ \mathbf{Y}_{it}\Big) = 0, \tag{56}$$

where $\mathbf{Y}_{it}$ contain lagged domestic and foreign materials, current capital and labor, lagged output prices, market shares, and their higher order and interaction terms. The identifying restrictions are that the TFP innovations are not correlated with current labor and capital, which are thus assumed to be dynamic inputs in production, and with last period domestic and imported materials, and prices. These moment conditions are fully standard in the production function estimation literature (e.g. Levinsohn and Petrin (2003); Ackerberg et al. (2015)). I run the GMM procedure on a sample of firms that simultaneously import and export for two consecutive years. In particular, I follow the procedure suggested in Wooldridge (2009) that forms moments on the joint error term $(\xi_{it} + \epsilon_{it})$.

A.3 Input market imperfections with a more general production function

We now consider the case when the production function is CES in the two intermediate varieties, such that the output elasticities of intermediate inputs vary across firms. We follow a large literature in foreign input trade and posit that the production function can be written as:

$$Q_{it} = \exp(\omega_{it} + u_{it}) L_{it}^{\beta_l} K_{it}^{\beta_k} Z_{it}^{\beta_z},$$

where

$$Z_{it} = (M_{it}^{\rho} + X_{it}^{\rho})^{\frac{1}{\rho}}$$

In this scenario, the output elasticities of the two variable inputs are given by:

$$\begin{aligned}
\theta_{it}^{x} &= \frac{\partial Q_{it}}{\partial X_{it}} \frac{X_{it}}{Q_{it}} = \beta_z \left(\frac{X_{it}}{Z_{it}} \right)^{\rho} \\
\theta_{it}^{m} &= \frac{\partial Q_{it}}{\partial M_{it}} \frac{M_{it}}{Q_{it}} = \beta_z \left(\frac{M_{it}}{Z_{it}} \right)^{\rho}
\end{aligned}$$

Note that the CES case implies a linear relationship between the output elasticities of domestic and foreign intermediates:

$$\begin{aligned}
\theta_{it}^{m} &= \beta_z \left(\frac{M_{it}}{Z_{it}} \right)^{\rho} = \beta_z \left(\frac{\theta_{it}^{m}}{\theta_{it}^{m} + \theta_{it}^{x}} \right) \\
\implies \frac{\theta_{it}^{x}}{\theta_{it}^{m}} &= \beta_z \left(\theta_{it}^{m}\right)^{-1} - 1. \qquad (57)
\end{aligned}$$

We can now use the FOCs:

$$\frac{\theta_{it}^{x}}{\theta_{it}^{m}} = \psi_{it}^{x} \frac{\alpha_{it}^{x}}{\alpha_{it}^{m}}$$

and

$$\theta_{it}^{m} = \mu_{it} \alpha_{it}^{m}$$

together with equation (57) to get:

$$\psi_{it}^{x} = \frac{\beta_z \mu_{it}^{-1} - \alpha_{it}^{m}}{\alpha_{it}^{x}}.$$

Estimating β_z To make progress, assume that production function is constant returns, so that $\beta_z = 1 - (\beta_x + \beta_l) = 1 - \left(\frac{W_{it}^{k} K_{it} + W_{it}^{l} L_{it}}{\lambda Y_i} \right) = 1 - \left(\frac{\alpha_{it}^{k} + \alpha_{it}^{l}}{\mu_{it}^{-1}} \right)$. Therefore, we can write $\beta_z \mu_{it}^{-1} =$

$\mu_{it}^{-1} - (\alpha_{it}^k + \alpha_{it}^L)$ such that:

$$\psi_{it}^x = \frac{\mu_{it}^{-1} - (\alpha_{it}^k + \alpha_{it}^L + \alpha_{it}^m)}{\alpha_{it}^x},$$

which means that ψ_{it}^x can be easily derived given observable shares, up to a measure of firm-level markups. Note that in the more general case, if we knew the return to scale γ, we would have $\beta_z = \gamma - \left(\frac{W_{it}^k K_{it} + W_{it}^l L_{it}}{\lambda Y_i}\right)$ such that:

$$\psi_{it}^x = \frac{\gamma \cdot \mu_{it}^{-1} - (\alpha_{it}^k + \alpha_{it}^L + \alpha_{it}^m)}{\alpha_{it}^x},$$

which is the equation in the main text.

A.4 Data Appendix

A.4.1 Variable Construction

To estimate the production function, we need firm-level output, labor, capital, and materials. Output is measured as total firm sales in a given year, deflated by the firm-level price deflator I define in Section 2.2.1. The industry-level output price deflator is taken from the STAN industry dataset. Labor is measured as the total number of "full-time equivalent" employees in a given year. The FICUS Dataset also includes a measure of firm-level cost of salaries, which I use to derive firm-level wages by dividing total cost of labor by total firm employment. I define total intermediate inputs as the total expenditure in raw materials by an enterprise in the process of manufacturing or transformation into product reported on the fiscal files. I construct the *foreign* intermediate input using information on all firm imports of intermediate inputs. First, I drop observations on the import of HS8 digit products which are both imported and exported by the firm in a given year (about 20% of the observations). Then, I drop those import poducts classified as "final goods" by the Broad Economic Classification (BEC). I finally construct total expenditures on intermediates as the sum of the imports at the firm year level of all residual products. Results are robust to using different definitions of the foreign intermediate input, including restricting the attention to those goods that the BEC classification classifies as intermediates.[31] To measure the expenditure on domestic inputs, I subtract the total value of imports of intermediates from the total expenditure on intermediate inputs. Capital is measured by gross fixed assets, which includes movable and immovable assets. As this value is reported at at the historical value, I infer a date of purchase from the installment quota given a proxy lifetime duration of Equipment (20 years) to obtain the current value of capital stock.[32] Results are robust to using an alternative measure of capital, which I construct using a perpetual inventory method, i.e. $K_t = (1 - \delta_s)K_{t-1} + I_t$. I consider the book value of capital on the

[31] I choose not to use this definition in the baseline estimation due to the the large number of hs8 products which are not classified neither as intermediates, nor as final good.

[32] I thank Claire Lelarge for this suggestion

first year of activity of the firm as the initial level, and take the values for the depreciation rate δ_s, where s indicates that i might vary by sector, from Olley and Pakes (1996).

All these variables are deflated by two-digit STAN input price indexes. For the foreign intermediate input, I construct a firm-level price deflator as described in Section 2.2.1, where I take the 2-digit import price deflator from INSEE data.

A.4.2 Classification of Industries

I consider 18 manufacturing industries, based on the ISIC (International Standard Industrial Classification) Rev. 3. Sectors 15-35 of the ISIC 3 are classified as manufacturing sectors. Among those, I drop sectors 16 ("Tobacco Products"), 23 ("Coke, Refined Petroleum Products") and 30 ("Office, Accounting and Computing Machinery") for insufficient number of observations in the selected sample. Table A1 presents the industry classification and the number of firms and observations for each industry $s \in \{1, .., 17\}$.

Table A.VIII Manufacturing Sectors, and Sample Size

	Industry	No of Obs. $^{(a)}$	No Firms	% Super Intl. Firms
C15	Food Products and Beverages	17,917	1506	0.66
C17	Textiles	11,620	989	0.49
C18	Wearing Apparel, Dressing and Dyeing Fur	10,046	860	0.43
C19	Leather, and Leather Products	3,741	321	0.51
C20	Wood and Products of Wood and Cork	6,727	573	0.68
C21	Pulp, Paper and Paper Products	6,053	508	0.56
C22	Printing and Publishing	8,236	693	0.70
C24	Chemicals and Chemical Products	13,656	1141	0.39
C25	Rubber and Plastic Products	14,632	1230	0.64
C26	Other non-metallic Mineral Products	6,200	520	0.60
C27	Basic Metals	4,359	364	0.53
C28	Fabricated Metal Products	25,479	2140	0.69
C29	Machinery and Equipment	21,092	1769	0.56
C31	Electrical machinery and Apparatus	6,634	555	0.39
C33	Medical, Precision and Optical Instruments	10,267	858	0.38
C34	Motor Vehicles, Trailers & Semi-Trailers	4,558	382	0.53
C35	Other Transport Equipment	2,736	229	0.39

Notes: The table reports the list of manufacturing sectors, the total number of observations and the total number of firms in each sector (average over 1996-2007). $^{(a)}$ The number of observation refers to the sample of ALL international firms.

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