Market Power in Input Markets:

Theory and Evidence from French Manufacturing*

Monica Morlacco†

University of Southern California

March 4, 2019

Abstract

I document the market power of large buyers in foreign input markets, and evaluate its effect on the aggregate economy. I develop an empirical methodology to consistently estimate buyer power at the firm level, and apply it using longitudinal data on trade and production of French manufacturing firms from 1996-2007. My results show that the buyer power of French importers is substantial, and it correlates with the size and productivity of the firm. I then incorporate heterogeneous buyer power in a general equilibrium model of production, and show analytically that it induces large distortionary effects on aggregate efficiency and welfare. When buyer power of French manufacturing importers is counterfactually removed, I calculate gains in aggregate TFP of 0.1–0.9%, and gains in aggregate output of 0.5–1.5%.

*Acknowledgments: I thank Costas Arkolakis, Penny Goldberg, Sam Kortum and Michael Peters for their invaluable guidance and support throughout my PhD. I would also like to thank Vittorio Bassi, Johannes Boehm, Lorenzo Caliendo, Giovanni Compiani, Colin Hottman, Anna Ignatenko, Ayumu Ken Kikkawa, Danial Lashkari, Clémence Lenoir, Jacques Mairesse, Isabelle Méjean, Giuseppe Moscarini, John Van Reenen, Marleen Renske, Pascual Restrepo, Alessandro Sforza, Valerie Smeets, Conor Walsh, Frederic Warzynski, Fabrizio Zilibotti for helpful comments and fruitful discussions. Special thanks go to Francis Kramarz, for support and making the data available. Funding from the Yale Economics Department and the Yale MacMillan Center International Dissertation Research Fellowship is gratefully acknowledged. All errors are mine.

†E-mail: morlacco@usc.edu.

1 Introduction

A long-standing question in international economics is the relationship between international trade and aggregate growth. A large body of work has shown that the increasing trend towards globalization and outsourcing (Feenstra, 1998; Yi, 2003a), together with the associated boom in trade in intermediate inputs (Johnson and Noguera, 2012), has played a central role over the past few decades in generating both static and dynamic gains from trade (Amiti and Konings, 2007; Goldberg et al., 2010; Halpern et al., 2015).

One aspect that has been often overlooked in this literature is the role of market imperfections. Market imperfections are potentially large in international markets, due to formal and informal trade barriers generating important obstacles to firm entry (Greif, 1992; Allen, 2014; Startz, 2017). Not surprisingly, large corporations have become major players in international markets (Bernard et al., 2007a), achieving a dominant buyer position, which they could potentially use to extract inefficiently low prices. Buyer power in international markets is thus a potentially important economic issue - yet largely underexplored in the literature - with implications for trade, production, and ultimately growth.

This paper uses longitudinal data from France to document the market power of firms in the market for imported intermediates, and quantify its effect for the aggregate economy. The contributions of this study are twofold: (1) I combine modern econometric techniques with rich micro data to consistently estimate the buyer power of firms; (2) I incorporate buyer power in a general equilibrium model of a production economy, and characterize its effect on aggregate variables, both qualitatively and qualitatively.

I first lay out a methodology to estimate input market imperfections at the firm level. I consider the cost-minimization problem of firms that choose the optimal quantity of two static inputs. The conceptual framework builds on existing work in the literature of markup estimation (e.g. De Loecker and Warzynski, 2012), while allowing for imperfect competition in input markets.[1] In this framework, the existence of input market imperfections generates an input efficiency wedge in the first order condition of firms. Values of the wedge larger than unity are consistent with models of buyer power in input markets. In such models, the input efficiency wedge corresponds to the *buyer markup*, i.e. the gap between the competitive price and the price paid by the firm. I show that the input efficiency wedge can be written as a function of the revenue shares and output elasticities of two static inputs. This is useful for estimation, insofar as the revenue shares can be observed, and the output elasticities can be obtained from production function estimation.

[1] In so doing, my exercise is closer to Dobbelaere and Mairesse (2013). See the Literature Review for a discussion.

I specify the production function as a function of capital, labor, domestic and foreign intermediates. The two intermediate inputs are the static inputs of interest. Throughout the analysis, I maintain the assumption that firms are price takers in the domestic market.

I estimate the output elasticities using techniques from the industrial organization literature (e.g. Ackerberg et al., 2015; De Loecker et al., 2016). The lack of data on physical units of inputs and output can present an important challenge here. A well-known problem associated with using *nominal* instead of *physical* variables is the existence of severe price biases in estimation, due to demand shocks, and/or market power (cf. Foster et al., 2008; Katayama et al., 2009; De Loecker and Goldberg, 2014). To address this issue, I construct firm-level price indices for output and the imported input from observed export and import unit values at the firm-product-country level. In doing so, I dispense with assumptions on the foreign market structure, consistent with the application of the paper.

I use longitudinal data on firm trade and production for the French manufacturing sector for the period 1996-2007, and apply this methodology to study imperfect competition in the market for imported intermediates. I find that the efficiency wedges of foreign inputs are large in almost all sectors, which is consistent with firms exercising buyer power in international markets. At the industry level, I find that buyer power is large in highly concentrated sectors, in sectors where the share of imports from low-income countries is large, and in sectors characterized by large transportation or storage costs (e.g. food, iron ore). These distinctive characteristics have often been associated with monopsony power (e.g. Rogers and Sexton, 1994; Bergman and Brännlund, 1995). Firm-level analysis further shows that input market distortions are positively and significantly correlated with measures of firm size and productivity. The finding that large and productive firms are relatively more distorted in foreign markets corroborates the interpretation of the wedges as buyer power, by ruling out alternative explanations based on trade or adjustment costs, supposedly smaller for larger firms.

In order to investigate the role of market imperfections in foreign input markets for aggregate variables, in the second part of the paper I incorporate buyer power in an heterogeneous firm model à la Melitz (2003). I assume that differentiated varieties of an intermediate input are supplied elastically from different foreign sellers, which I assume to be price takers. Foreign markets are horizontally segmented, such that each domestic firm faces limited competition abroad. The extent of foreign competition is exogenous, and I let it vary across firms. In this model, input market power arises due to the existence of rents and limited competition in foreign markets.

I show that buyer power generates equilibrium distortions along several channels. At the individual firm level, buyer power raises the marginal revenue product of the distorted input, leading to an inefficient substitution of the inputs in production, and to an inefficient firm size.

From an aggregate standpoint, I show analytically that both the first and second moment of the distribution of buyer power affects aggregate output and TFP. An interesting finding is the role of heterogeneity in this context. Heterogeneity in buyer power induces less distorted firms to overproduce. One the one hand, this induces misallocation of resources across heterogenous firms, reducing aggregate TFP (i.e. a *misallocation* channel).[2] On the other hand, it implies that relatively more resources are employed in the economy, increasing total output (i.e. a *resource* channel). My theoretical results show that with a Cobb-Douglas production function with constant returns to scale, the resource channel more than compensate for the misallocation channel, such that a mean preserving spread in the distribution of buyer power is positive from an output (and welfare) point of view.

Finally, I aim to quantify the aggregate effect of buyer power on the French economy. The tractability of the model allows me to analytically characterize the counterfactual aggregate losses from buyer power. I show that, given parameters, the first and second moment of the sectoral distribution of buyer power are sufficient statistics for the effect of imperfect competition in foreign markets on the aggregate economy. This is important, since buyer power in the model maps to the input efficiency wedge in the first part of the paper, whose relevant moments have been already estimated. Counterfactual analysis shows that when I hypothetically eliminate the buyer power of French importers, and its dispersion thereof, aggregate efficiency increases by 0.1-0.9%, while aggregate output increases by 0.5-1.5%.

My analysis seems to suggest that to the extent that barriers to entry into foreign markets can be overcome by means of policy instruments, trade policy should foster import market participation and make a larger number of buyers available to foreign sellers, in order to enhance the economic performance of a country. Nevertheless, a better understanding of the actual sources of foreign market segmentation are necessary to formulate more appropriate recommendations for trade and antitrust policy.

Literature Review This paper builds on prevailing related literature. Despite its prominence, market power of buyers has been under-explored in the economic literature, which has mostly focused on the market power among sellers of goods.[3] This paper contributes

[2]This market power-induced misallocation is qualitatively similar to (but not isomorphic to) the effect of capital distortions in Hsieh and Klenow (2009). It is also reminiscent of the effect of markups heterogeneity on aggregate efficiency (e.g. Epifani and Gancia, 2011; Edmond et al., 2015; Peters, 2016).

[3]The ability of large buyers to lower prices below competitive levels has been raising concerns among competition authorities and policymakers. See, e.g. *American Antitrust Institute (AAI)'s Transition Report on*

to the rather limited empirical literature on input market imperfections, which has mostly focused on labor markets (Azar et al., 2017; Crépon et al., 2005; Dobbelaere and Mairesse, 2013; Nesta et al., 2018). In particular, I extend the framework of Dobbelaere and Mairesse (2013) to study to market imperfections in international trade. One important contribution of this paper is to address several econometric issues in estimation, most notably the endogeneity of input choice with respect to unobserved input and output market power.[4]

This paper also contributes to the relatively small theoretical literature on input market power in international trade. Existing work includes Markusen, 1984; Feenstra, 1980; McCulloch and Yellen, 1980, who study monopsony in an otherwise standard H-O framework. These studies show that in presence of monopsony, the Stolper-Samuelson theorem does not hold and autarky may yield higher welfare than trade. Unlike these papers, I study buyer power in an heterogeneous firms model à la Melitz (2003).[5] The findings of my model are consistent with negative gains from trade, to the extent that the welfare losses associated with the misallocation and resource channels highlighted here are higher than the (well-known) gains associated with quality or variety of foreign intermediate inputs (e.g. Halpern et al., 2015).

My work also speaks to the literature on gains from foreign input trade, which finds large and positive aggregate effects of increased access to foreign intermediate inputs (Amiti and Konings, 2007; Goldberg et al., 2010; Gopinath and Neiman, 2014; Halpern et al., 2015; Blaum et al., 2018). In these papers, imported intermediate inputs raise productivity via learning, variety, and quality effects. This paper suggests that the existence of buyer power can lower the gains from foreign input trade. Moreover, I show that failing to account for buyer power in international trade can generate an omitted variable bias in current studies, such that aggregate gains from foreign input trade could be exaggerated.

As an economic issue, the market power of large corporations has recently received renewed attention, since it has been associated to a number of important macroeconomic outcomes, such as low business dynamism and low economic growth overall, especially in rich countries (Barkai (2016); Blonigen and Pierce (2016); De Loecker and Eeckhout (2017); Zingales (2017)). The contribution of this paper to this discussion is twofold. First, this paper provides evidence that input market power is an economically important problem and can harm a country's economic performance. By increasing firm profits and low-

Competition Policy (2008) - Chapter 3

[4]In this sense, my approach is similar to De Loecker and Warzynski (2012), who combined the Hall's framework with modern econometric tools to consistently estimate markups of firms.

[5]A recent paper that takes a similar modeling framework is Macedoni (2018), who studies the effects of international trade on firms markups and buyer power.

ering aggregate efficiency, buyer power could discourage entry, and hamper economic growth. Second, it suggests that input and output market power have potentially different macroeconomic implications, and that a better understanding of the nature of market power would be necessary to identify the root of the overall economic slowdown.

Last, but not least, my work relates to an extensive literature on market power and misallocation (Epifani and Gancia, 2011; Holmes et al., 2014; Edmond et al., 2015; Peters, 2016). This paper is the first to study the effect of heterogenous *buyer* power on the equilibrium misallocation of resources, and points out a potentially important asymmetry between heterogeneous input and output market power. To the extent that this result is robust to alternative specification of the model, this result could have far-reaching normative implications for anti-trust policy (Noll, 2004).

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 A Framework to Estimate Input Market Power

This section describes my methodology for consistently estimating input market power at the firm level. In Section 2.1, I use a simple conceptual framework to derive input market imperfections as a function of data, and measures of production elasticities of two static inputs, building on Dobbelaere and Mairesse (2013). In Section 2.2, I describe my approach to production function estimation that allows me to obtain consistent estimates of the output elasticities. I build on a large literature in the industrial organization literature (Ackerberg et al., 2015; De Loecker et al., 2016). Unlike existing work in this literature, I can relax the assumption that all input markets are perfectly competitive. More precisely, because I observe prices of imported inputs, I can allow for market power in the market of foreign intermediate inputs, consistent with the application of the paper.

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 $\mathbf{V}_{it} = \{V_{it}^{m}, V_{it}^{x}\}$ are the 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.[6] 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:

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

where W_{it}^{j} is the input j's unit cost, and $\mathbf{A_{it}}^{j}$ are other exogenous variables affecting prices, such as location. Equation (2) encompasses models of both perfect and imperfect competition in input markets. When markets are competitive, the firm takes prices as given, and $\frac{\partial W_{it}^{j}}{\partial V_{it}^{j}} = 0$. Conversely, under imperfect competition the buyer takes into account the effect that her demand has on input prices, such that $\frac{\partial W_{it}^{j}}{\partial V_{it}^{j}} \neq 0$.

The first-order condition for any variable input V_{it}^{j} with $j = \{m, x\}$ is:

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

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

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. The left hand side of equation (4) thus represents the shadow value of an additional unit of V_{it}^{j} , or the *effective* marginal cost of the input. Equation (4) says that in this general setting, the marginal cost of the input in equilibrium is equal to the unit price W_{it}^{j}, times a term which differs from one whenever $\frac{\partial W_{it}^{j}}{\partial V_{it}^{j}} \neq 0$, namely whenever the input market is less than competitive. In other words, the existence of input market power generates a *wedge* between the marginal valuation of the input and

[6] In what follows, I assume that each firm uses exactly two variable inputs in production, namely a *domestic* intermediate input, which I denote by V_{it}^{m}; and a *foreign* intermediate input, which I denote by V_{it}^{x}. This choice is driven by the application and data used in this paper, and can be easily generalized to any number of variable inputs.

its equilibrium price, equal to

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

The wedge ψ_{it}^{j} represents an *efficiency wedge* in the first order condition of the input, insofar as it captures how much the equilibrium price W_{it}^{j} departs from its efficient counterpart due to market imperfections. I consider ψ_{it}^{j} as the measure of firm i's input market power in the market of $j = \{m, x\}$.

Rearranging terms and multiplying both sides of (4) by $\frac{V_{it}^{j}}{P_{it}Q_{it}}$ gives:

$$\frac{\partial Q_{it}(\cdot)}{\partial V_{it}^{j}} \frac{V_{it}^{j}}{Q_{it}} = \frac{P_{it}}{\lambda_{it}} \cdot \psi_{it}^{j} \cdot \frac{W_{it}^{j} V_{it}^{j}}{P_{it} Q_{it}} \tag{6}$$

Let us now denote the output elasticity of input V_{it}^{j} as $\beta_{it}^{j} \equiv \frac{\partial Q_{it} V_{it}^{j}}{\partial V_{it}^{j} Q_{it}}$, and let $\alpha_{it}^{j} \equiv \frac{W_{it}^{j} V_{it}^{j}}{P_{it} Q_{it}}$ denote the share of expenditure on input V_{it}^{j} for $j = m, x$ over total firm's revenues. Using these definitions, I can conveniently rewrite equation (6) for $j = x, m$ as:

$$\beta_{it}^{x} = \frac{P_{it}}{\lambda_{it}} \cdot \alpha_{it}^{x} \cdot \psi_{it}^{x}, \tag{7}$$

and

$$\beta_{it}^{m} = \frac{P_{it}}{\lambda_{it}} \cdot \alpha_{it}^{m} \cdot \psi_{it}^{m}. \tag{8}$$

We can divide (8) by (7) to write

$$\frac{\psi_{it}^{x}}{\psi_{it}^{m}} = \frac{\beta_{it}^{x} / \alpha_{it}^{x}}{\beta_{it}^{m} / \alpha_{it}^{m}}. \tag{9}$$

Equation (9) shows that the relative input market power of the firm in the two variable input markets can be expressed as a function of two objects: the output elasticities of the inputs, and their revenue shares. This expression is at the core of my methodology to estimate input market power from production data: the output elasticities can be estimated from standard production function estimation, while the revenue shares are directly observed in most production datasets.

This result has two main implications. First, it says that if all markets were perfectly competitive, we should observe $\frac{\beta_{it}^{x}/\alpha_{it}^{x}}{\beta_{it}^{m}/\alpha_{it}^{m}} = 1$. Therefore, equation (9) provides a simple test of the assumption of perfect competition in all input markets, which is maintained in the prevailing literature. Second, equation (9) suggests that by normalizing the value of ψ_{it}^{m}

in the market for input M, one could pin down the *level* of input market power in market X from standard firm-level data. In particular, in the extreme case where the domestic market is assumed competitive, one could set $\psi_{it}^{m} = 1$, and write input market power in the market of foreign intermediates as:

$$\psi_{it}^{x} = \frac{\beta_{it}^{x}}{\beta_{it}^{m}} \cdot \left(\frac{\alpha_{it}^{x}}{\alpha_{it}^{m}} \right)^{-1} . \tag{10}$$

To show the workings of equation (10), let us suppose that the output elasticity of the foreign input was twice as large as the output elasticity of the domestic input, i.e. $\frac{\beta_{it}^{x}}{\beta_{it}^{m}} = 2$. Equation (10) says that absent any distortions in the foreign market (i.e. if $\psi_{it}^{x} = 1$), the firm would optimally spend twice as much on the foreign input as it does on the domestic one. Input market power is thus estimated positive (negative), when we observe the firm spending a lower(higher)-than-optimal share of revenues on the foreign intermediate input compared to the domestic input, in light of the differences in their output elasticities.

Interpreting the Input Efficiency Wedge The framework set forth in this section encompasses a number of models of imperfect competition in the input markets, and the structural interpretation of the wedge ψ_{it}^{x} varies depending on which underlying model is assumed.

In models of monopsonistic or oligopsonistic competition, the price function in (2) corresponds to the inverse of the input supply function, and is characterized by a positive elasticity to individual demand, such that $\psi_{it}^{x} \geq 1$. In those models, the wedge ψ_{it}^{x} represents the degree of buyer power of firm i in the market for input X, which is higher the more the input price varies with individual demand.[7]

Values of $\psi^{x} < 1$ are also admissible. Dobbelaere and Mairesse (2013) show that in a model of efficient bargaining in the labor markets, the labor wedge ψ_{it}^{l} is lower than unity, and is proportional to the bargaining power of buyers. In Section A.1 in the Appendix, I consider a model with second degree price discrimination (quantity discounts) and a model with two-part tariff, and show that even in these settings the input efficiency wedge is predicted lower than unity. More generally, this is the case whenever the input price is inversely proportional to the quantity purchased by the firm, and therefore whenever $\frac{\partial W_{it}^{j}}{\partial V_{it}^{j}} \frac{V_{it}^{j}}{W_{it}^{j}} < 0$.

The strength of the empirical analysis in this paper, is that I am able to estimate values

[7] In the labor literature, the labor wedge $\psi^{l} > 1$ is sometimes referred to as the "rate of exploitation" (e.g. Pigou (1932)), since it measures how much buyers (firms) are able to push prices (wages) below the marginal product.

of ψ^x_{it} across industries, and therefore to see which model better fit the data, without taking a stand ex ante on the underlying model of competition in the market of input X. Based on the findings that across sectors, values of ψ^x seem to be consistently greater than one, in the second part of the paper I then build a model of monopsonistic competition in the market of X, and discuss its implications for the aggregate economy.

Firm-level Markups The discussion so far has abstracted from output market considerations, despite having many elements in common with existing studies of markups (e.g. Hall 1988; De Loecker and Warzynski 2012; De Loecker et al. 2016). To see how my approach relates to this literature, let us define markups μ_{it} as output prices over marginal costs, i.e. $\mu_{it} = \frac{P_{it}}{\lambda_{it}}$. The first order condition in (6) can be rewritten as:

$$\frac{\beta^j_{it}}{\alpha^j_{it}} = \mu_{it} \cdot \psi^j_{it}, \text{ for } j = \{m, x\}. \tag{11}$$

Equation (11) shows that in a general setting, the ratio between the output elasticity and revenue share of an input reflects *both* input and output market power of a firm. Only when input markets are perfectly competitive, such that $\psi^j_{it} = 1$, does the ratio correctly identify markups as

$$\mu_{it} = \frac{\beta^j_{it}}{\alpha^j_{it}}. \tag{12}$$

However, if input market power is mistakenly overlooked, existing approaches would over- or under- estimate the true level of markups, depending on whether $\psi^j_{it} \gtrless 1$. Note finally that under the normalization $\psi^m = 1$, one can set $j = m$ in equation (12) and identify *both* input and output market power using both equations (10) and (12).

2.2 Empirical Strategy and Output Elasticities

In this section I describe how one could obtain unbiased estimates of the output elasticities, when input markets are allowed to depart from perfect competition. To ease the exposition, I assume a Cobb-Douglas specification of the production technology, which means that I can write the production function in (1) as

$$q_{it} = \beta_l l_{it} + \beta_k k_{it} + \beta_m m_{it} + \beta_x x_{it} + \omega_{it} + \varepsilon_{it}, \tag{13}$$

where lower-case letters denote logs. Note that all the results I derive in this section are applicable to more general production functions. I let q_{it} denote the log of physical output of firm i at time t, $m_{it} \equiv \log V_{it}^{m}$ and $x_{it} \equiv \log V_{it}^{x}$ denote the log of the domestic and foreign material inputs, respectively, l_{it} denotes log labor, and k_{it} is the log of physical capital. I denote by ω_{it} the shock component that is unobserved by the econometrician but is correlated with the inputs, which notably include the (log) productivity of the firm, and I denote with ε_{it} the component of the shock that is orthogonal to inputs, such as idiosyncratic measurement error.

I specify the state variable vector as follows:

$$\varsigma_{it} = \{\omega_{it,} k_{it}, l_{it}, G_i, \Phi_{it}\}, \tag{14}$$

where G_i denotes firms' observable characteristics that might affect material prices such as firm location, and Φ_{it} is the firm's import sourcing strategy, i.e. a measure of the extensive margin of import. Including Φ_{it} in the state variables means that the imported material input x_{it} is considered flexible only *conditional* on the firm sourcing strategy.

Estimation of the production function in (13) requires dealing with three major sources of bias, which are due to unobserved productivity ω_{it}, unobserved physical inputs and unobserved physical output. Correcting for the associated simultaneity and price biases is important in this context, given that the approach relies on measures of *physical* output elasticities. A large body of work in the industrial organization literature has dealt with the simultaneity bias.[8] Similarly, many studies have addressed the output price bias in production function estimation.[9] On the contrary, the input price bias has often been overlooked, and the few studies that deal with it do it by assuming perfect competition in all input markets (De Loecker et al., 2016). Because I allow some input markets to be imperfectly competitive, existing approaches to control for input prices are not entirely suitable in this context. My approach to deal with input and output price bias is to exploit information on import and export prices included in commonly available custom records to construct a firm-level price deflator for foreign intermediate inputs and output, respectively, which I then use to construct quantity measures of the relevant variables. This approach does not rely on any assumption on the nature of competition in the output or foreign input markets, and is therefore robust to the application of this paper.

In what follows, I first discuss the estimation biases, and my bias-correction approach. I then describe the identification strategy and the moment identifying condition I employ to obtain estimates of the output elasticities of importing firms.

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[8] See, for example, Olley and Pakes (1996); Blundell and Bond (2000); Levinsohn and Petrin (2003); Ackerberg et al. (2015)

[9] Studies that deal with output price bias in production function estimation include Foster et al. (2008); De Loecker (2011); De Loecker et al. (2016), among others.

2.2.1 Output Price Bias

Let p_{it} denote the log of the output price, and $\bar{p}_t$ denote an industry-wide price deflator, that is a measure of average output price within the industry where firm i operates. In most production datasets, neither q_{it} nor p_{it} are usually available. Measures of physical output q_{it} are usually obtained by deflating the log of total firm revenues r_{it} by the industry-wide price deflator, namely $\tilde{q}_{it} = r_{it} - \bar{p}_t = q_{it} - (\bar{p}_t - p_{it})$, where $\tilde{q_{it}}$ is *deflated* revenues, and where I used the definition $r_{it} \equiv p_{it} + q_{it}$ to derive the second expression. We can substitute $q_{it} = \tilde{q_{it}} + (\bar{p}_t - p_{it})$ in equation (13) and write:

$$\tilde{q}_{it} = \beta_l l_{it} + \beta_k k_{it} + \beta_m m_{it} + \beta_x x_{it} + (p_{it} - \bar{p}_t) + \omega_{it} + \varepsilon_{it}. \tag{15}$$

If differences in firm-level prices exist, i.e. $\exists\ (i,t)$ s.t. $(p_{it} - \bar{p}_t) \neq 0$, and if they are correlated with input demand, then there is an *output price bias*. Market power is potentially a source of such bias: firms who charge high markups sell less, and thus buy less inputs.

In order to address the output price bias, I exploit export unit values at the firm-product-country level to construct a measure of firm-level output price deflator, which I then use to directly control for $(p_{it} - \bar{p}_t)$ in (15). The key idea is that export data contain information about the price of a firm relative to the industry average within each product-destination country, and therefore can be used to construct a measure of firm average deviation from the industry average price.

2.2.2 Input Price Bias

Let us define the log expenditure of firm i on input V as $v^E_{it} = v_{it} + w^v_{it}$, where $v_{it} = \log V_{it}$ is the log quantity of input V, and w^v_{it} is the log unit price of the input. Let $\bar{w}^v_t$ denote the industry deflator of input V. Due to lack of firm-level data on input prices, physical units of input V are typically measured as total expenditures deflated by an industry wide deflator, namely $\tilde{v}_{it} = v^{EXP}_{it} - \bar{w}^V_i = v_{it} + \left(w^V_{it} - \bar{w}^V_t\right)$. If differences in input prices exist, i.e. $\exists\ (i,t)$ s.t. $\left(w^V_{it} - \bar{w}^V_t\right) \neq 0$ for $V = K, M, L, X$, and they are correlated with input demand, then there is an *input price bias*. Existing methods to deal with the input price bias try to control for unobserved price deviations with observable variables, but they only work under the assumption that all input markets are perfectly competitive. Because the focus of this paper is to estimate input market power in the market of input X, such approach cannot be used for this particular input.

To deal with this issue, let us assume that firm-level input prices can be constructed, both for the labor input and the foreign intermediate input, i.e. we have information on w^l_{it} and w^x_{it}, while data on w^k_{it} and w^m_{it} are not available. If this was the case, then we can substitute $\tilde{v}_{it}$ in (15) for $V = M, K$, and obtain:

$$\tilde{q}_{it} = \beta_l l_{it} + \beta_k \tilde{k}_{it} + \beta_m \tilde{m}_{it} + \beta_x x_{it} + (p_{it} - \bar{p}_t) + B(\mathrm{w}, \boldsymbol{\beta}) + \omega_{it} + \varepsilon_{it}, \tag{16}$$

where $B(\mathrm{w}, \boldsymbol{\beta}) \equiv \beta_k \left(\bar{w}_t{}^k - w_{it}^k\right) + \beta_m \left(\bar{w}_t{}^m - w_{it}^m\right)$ is the unobserved input price term, which generates an input price bias. To control for $B(\mathrm{w}, \boldsymbol{\beta})$, I follow the control function approach developed by De Loecker et al. (2016).[10] The idea behind their control function approach to input price bias is that, if firms are price takers in the input markets, firm-specific input price deviations from the industry average can arise either because local input prices differ, and/or due to variation in input quality. Because high quality inputs produce high quality output, and because output quality is correlated with output prices and market shares, one could use the latter to control for differences in input prices. I therefore 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, De Loecker et al. (2016) show that one could write unobserved differences in input prices as a function of output prices p_{it}, market share ms_{it} and exogenous factors (such as location) $\mathbf{G}_i$, i.e.

$$B(\mathrm{w}, \boldsymbol{\beta}) = B(p_{it}, ms_{it}, \mathbf{G}_i) \equiv -(\beta_k + \beta_m) b(p_{it}, ms_{it}, \mathbf{G}_i), \tag{17}$$

where measures of firm average market shares, as well as output prices, can be constructed from custom-level data.

2.2.3 Simultaneity bias

The last source of bias in equation (13) 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). Because I allow for input market power in foreign input markets, the demand of static inputs are affected by two unobservables, which are firm-level TFP, and input market power. I thus consider the static demand functions for both the imported and domestic input, x_{it} and m_{it}. In Section A.2 in the Appendix I show that given these demand functions, one can derive a system of two equations in two unknowns, which means that one could solve for ω_{it} as a function of observables only:

$$\omega_{it} = h_t(\tilde{k}_{it}, l_{it}, G_i, \Phi_{it}, w_{it}^x, p_{it}, \tilde{m}_{it}, x_{it}). \tag{18}$$

[10] I refer to the paper for a complete discussion of the approach.

I substitute equation (18) in (13) to control for firm's productivity.

2.2.4 Estimation

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

$$
\begin{aligned}
q_{it} =& \beta_l l_{it} + \beta_k \tilde{k_{it}} + \beta_m \tilde{m}_{it} + \beta_x x_{it} + B(p_{it}, ms_{it}, \mathbf{G}_i; \mathbf{fi}) \\
&+ h_t(\tilde{k}_{it}, l_{it}, G_i, \Phi_{it}, w^x_{it}, p_{it}, \tilde{m}_{it}, x_{it}). + \epsilon_{it}.
\end{aligned} \tag{19}
$$

To estimate (19), I follow the 2-steps GMM procedure in Ackerberg et al. (2015), which I describe in Section A.3 of the Appendix. For my baseline estimation, I run the GMM procedure on a sample of firms that source their foreign inputs from at least three countries outside the EU. This choice addresses the concern that foreign intermediate choice is affected by adjustment costs. I thus implement a selection correction to address the potential selection bias stemming from the use of large importers in estimation.

I adopt a Cobb-Douglas specification of the technology $f(\cdot)$ because it involves a lower number of parameters to be estimated, and thus it keeps the estimation more tractable. The dimensionality problem associated with choosing a more flexible specification of the production function is a particularly important issue in my case, due to the large number of inputs I consider.[11] The choice of a Cobb-Douglas production function has the disadvantage that the output elasticities are constrained to be the same across years and firms within an industry. While this is a limitation of my approach, it is still the case that I can obtain consistent estimates of the *average* level of input market power within an industry, which is the primary object of interest. In Section 3 I am going to discuss how this choice affects the distribution of market power across firms, and how one can still learn about correlates of market power even in this context. Finally, the standard errors on the coefficients are obtained using block-bootstrapping, where I draw an entire firm time series.

3 Market Power in the Market for Imported Intermediates

In this section, I apply the methodology set forth in Section 2 to study imperfect competition in foreign input markets for French manufacturing importers.

[11] For example, by adopting the more flexible Translog specification of $f(\cdot)$ the GMM procedure would involve a non-linear search over about 20 parameters.

The market of foreign intermediates has features that may lead to imperfect competition among firms, and thus it represents a good setting for a study of buyer power. On the one hand, imports are dominated by large firms (e.g. Bernard et al., 2007b), and large firms plausibly enjoy a dominant buyer position, especially in small, isolated input markets. On the other hand, substantial search and information costs related to trade (e.g. Allen, 2014; Startz, 2017) and other entry barriers (e.g. Greif, 1992) can lead to the existence of market power both downstream and upstream.

Theoretical work in import trade and imperfect competition has recently focused on models of bargaining between importers and exporters, motivated by the empirical relevance of micro-level trade relationship and bargaining (e.g. Heise et al., 2016; Monarch and Schmidt-Eisenlohr, 2016; Krolikowski and McCallum, 2016; Eaton et al., 2016). This paper contributes to prevailing literature by providing new direct evidence on the nature and magnitude of market distortions in foreign input markets.

3.1 Data Description

I employ two longitudinal datasets covering the activity of the universe of French manufacturing firms during the period 1996 - 2007. The first dataset comes from fiscal files and 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.[12] 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.

Sample Selection Due to the focus of the exercise, I select all manufacturing firms that engage in both import and export activities in a given year.[13] These are the firms for which input and output prices are available, and I will refer to them as "international firms". To address the concern that a firm's optimal choice of foreign intermediates might be affected by significant fixed costs, and thus that foreign intermediates is not a variable input for the firm, for my baseline estimation I run the procedure on a subset of international firms that source their imports from at least three countries outside the EU, which I refer to as "super-international" firms, while implementing a selection correction to address the

[12] I refer to Blaum et al. (2018) for a more detailed description of the data sources.

[13] 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).

potential selection bias stemming from the use of large importers in estimation.[14] The idea behind my selection criterion is that firms that are large enough to afford to import from distant sources are less likely to be affected by things like trade costs and/or capacity constraints.

Table 1 provides summary statistics for the selected firms. As expected, both the international and especially the super-international firms have superior performance (cf. Bernard et al., 2007b,c, 2009). These firms are bigger, sell more, and are more productive than the average manufacturing firm in France. International firms are about 8% of the entire population of manufacturing firms in France, and they account for about 59% of total manufacturing value added. Note that both international and super-international firms heavily rely on foreign intermediates for production, with imported intermediates accounting for 29% and 35% of total material expenditure, respectively. The final sample includes around 12 thousands firms per year, spread across 18 two-digit manufacturing sectors.

Firm-level Prices of Output and Imported Input The estimation procedure in Section 2.2 relies on the existence of measures of prices of output and of the foreign input at the firm-level. Because price information are not available at the production-line level, I exploit information on exports and imports at the firm-product-country-year level in order to construct a firm price index for output (p_{it}) and imported input $\left(w^x_{it}\right)$.

I construct these prices by running the following regression:

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

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 input prices to be equal to these OLS estimates, namely

[14] The choice is due to the fact that the median importers sources from 3 countries outside the EU. Results are not substantially affected by this choice.

$p_{it} = \hat{\theta}^{EX}_{it}$, and $w^x_{it} = \hat{\theta}^{IM}_{it}$.[15]

Note that in order to use import/export prices to infer information about average prices, I am implicitly assuming that the marginal cost of goods does not systematically vary by destination markets.[16]

Foreign and Domestic Intermediate Inputs The main input of interest is the foreign intermediate input. I construct my measure of physical units of the foreign intermediate input by deflating total firm expenditure on imported intermediates by the firm-level input price w^x_{it}. Note that my approach to construct price and quantity information on the foreign intermediate input does not rely on any a priori assumption on the nature of competition in this market, which is consistent with the application of this paper.[17]

The computation of buyer power relies on the existence of two variable inputs in production. Together with foreign intermediates, I focus on domestic intermediates as my second input of interest. Throughout the analysis, I consider firms as price takers in domestic input markets. As discussed in Section 2.2.2, the lack of data on prices of domestic intermediates forces us to impose restrictions on the nature of competition in the market in order to consistently estimate the production function coefficients. The assumption of perfect competition in domestic input markets is standard in the literature on markup estimation (cf. De Loecker and Warzynski, 2012; De Loecker et al., 2016). One can rationalize this assumptions by arguing that barriers to entry are lower domestically, or that firms choose to source domestically only those varieties of intermediates that have little scope for buyer power, such has electricity.

The choice of domestic materials is also dictated by the fact that among all the inputs I observe, it is the one that most likely satisfies the requirement of short-run flexibility. One could use labor, in alternative to domestic materials. 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 (e.g. Abowd and Kramarz, 2003; Kramarz and Michaud, 2010; Garicano et al., 2016). To the extent that adjustment costs are an important factor in firms' labor decisions, the first-order condition of labor compounds the effects of market power and other unobserved factors, such as the expected stream of future profits, which implies that the methodology cannot be implemented.[18]

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

[16] This assumption is standard in the literature of pricing-to-market (e.g. Burstein and Gopinath (2014)).

[17] In the Data Appendix, I discuss the construction of all remaining variables.

[18] As a robustness check, I also perform the analysis using the labor input; under these conditions, the main results that buyer power in foreign markets is large does not change.

(Data on) Revenue Shares To construct the input's revenue shares ($\{\alpha_{it}^{j}\}_{j=l,k,m,k}$), I divide the firm nominal expenditure on each of the inputs by the firm nominal value of production. Table 2 reports the means, standard deviations and quartile values of these variables. These shares are fairly stable over the period 1996–2007. 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 full sample of manufacturing firms, the international manufacturing firms are less labor intensive, and use a lower share of domestic material input in production and a larger share of foreign material inputs. This is consistent with the disintegration of the production process of global firms across borders (global value chain), and with a parallel increase in the use of intermediates in production (cf. Feenstra, 1998; Hummels et al., 2001; Yi, 2003b).

3.2 Empirical Results

Table III reports the estimated output elasticities across different sectors together with standard errors, which I obtain by block bootstrapping over the entire procedure.[19] Consistent with the extensive global sourcing of large international firms, the labor and capital coefficients are typically smaller, and the two material coefficients larger, than what one would find by using a more representative subset of manufacturing firms.[20] Table 3B in the Appendix repeat the production function estimation without implementing the correction for the unobserved input price variation discussed in Section 2.2.2 (Columns 1-5), and without implementing the correction for sample selection (Columns 6-11). The uncorrected procedure yields quite different estimates of the production function the output elasticities, which shows the importance of input and output price bias in production function estimation. 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.

Given the estimates of elasticities and measures of input revenue shares, I derive the overall efficiency wedges for domestic and foreign intermediate inputs. Recall that equation (11) says that one could derive a measure of overall (average) market distortions for each variable input $j = \{x, m\}$ as the ratio of output elasticity and revenue share of the

[19] 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

[20] See for example Dobbelaere and Mairesse (2013) for a study of output elasticities for French manufacturing.

input, i.e.

$$\Xi^m \equiv \frac{\hat{\beta^m}}{\bar{\alpha}^m} = \bar{\mu} \cdot \bar{\psi^m} \tag{20}$$

$$\Xi^x \equiv \frac{\hat{\beta^x}}{\bar{\alpha}^x} = \bar{\mu} \cdot \bar{\psi^x}. \tag{21}$$

Because the markup term $\bar{\mu}$ is common to both equations, by looking at the differences between Ξ^m and Ξ^x one can get a sense of the differences in the structure of the two input markets. In particular, if all variable input markets were perfectly competitive, as it is often assumed in economics, we should observe $\Xi^m = \Xi^x$.

Table 4 reports the mean and median value of Ξ^j for $j = m, x$.[21] Across sectors, we observe large differences between Ξ^m and Ξ^x, which means that the level of competition in the domestic and foreign input market differs markedly. In particular, the foreign market seems to be much more "distorted" than the domestic one. Note that under the assumption of perfectly competitive domestic market, the wedge Ξ^m coincides with the average markup of French international firms, i.e. $\Xi^m = \bar{\mu}$. From Table 4 we can infer that the average sectoral markup is, on average, 13%. These numbers are consistent with the results of De Loecker and Warzynski (2012) who find, using similar methods for the Slovenian manufacturing sector, an average markup of around 22%.

Note that if one assumed perfect competition in foreign input markets, it would derive the average markup as $\bar{\mu} = \Xi^x$ and conclude that firms charge on average a price which is 166% above marginal costs!

3.2.1 Input Market Power across Industries

I now have all the elements to compute input market power in the foreign input market given equation (10). Table 5 reports mean, median and standard deviation of ψ^x across sectors.[22]

The evidence indicates that in a large number of sectors, both the mean and median input efficiency wedge ψ^x are consistently greater than one, which is consistent with French importers having substantial buyer power in the market of imported intermediates, even

[21] Due to the Cobb-Douglas specification of the production function, the output elasticities are constant within sectors and over time so that they represent a measure of "average" elasticity in a sector. I thus compare these elasticities with mean and median value of revenue share of the input to get a sense of average distortions.

[22] Note that because I use a Cobb-Douglas specification of the production function, the output elasticity is restricted to be constant within a sector, and over time. Therefore, the standard deviation in Table 5 only reflects the dispersion in the observed input shares. This means that the true underlying heterogeneity in buyer power is potentially overestimated in this setting.

with some heterogeneity. According to my estimates, the average French importer would pay 165% less than the competitive price (i.e. value of marginal product of the input) for the imported intermediate input. The buyer markup of the median importer is significantly lower, at about 56% in the pooled sample.

My estimates shows substantial sectoral heterogeneity in input market power. For example, in the wood industry, French importers pay, on average, 300% less than the competitive price. Conversely, firms active in sectors such as leather or paper products are substantially less distorted, with an average buyer markup of 72 and 44%, respectively.

The large value of the estimates of the input efficiency wedges in the imported input market can raise the suspect than things other than market power can affect the results. In particular, the assumption that all firms in an industry are assumed to have the same technology (Cobb-Douglas technology) can play a large role for the estimates, to the extent that large international corporations have a very fragmented production structure, and have potentially different elasticities of foreign and domestic inputs.

For this reason, I aim to validate their interpretation as buyer power by means of regression analysis, both across firms and sectors. In Figure 1, I correlate the average value of buyer power in a sector with several variables which have been associated to higher monopsony power in the literature: average industry concentration, average firm productivity, average share of imports from low-income countries, and average share of imports of commodity inputs.[23]

Figure 1 confirms that more concentrated sectors, sector where firms are on average more productive and sectors with higher share of imports from developing countries have higher average buyer power.

3.2.2 Input Market Power across Firms

I now investigate how estimates of buyer power relate to firm characteristics. Using its definition (equation (10)), I write our measures of buyer power as:

$$\log \psi_{it}^{x} = \log\left(\frac{\beta_{it}^{x}}{\beta_{it}^{m}}\right) + \log\left(\frac{\alpha_{it}^{m}}{\alpha_{it}^{x}}\right).$$

[23]This choice is consistent with the focus of an extended body of empirical literature that emerged during the eighties and nineties, which aimed to measure the extent of buyer power in those sectors concerned over market monopsonisation due to rising concentration, large economies of scale downstream, and a large number of atomistic sellers upstream. See Just and Chern (1980); Schroeter (1988); Azzam and Pagoulatos (1990) for studies in in the Food and meatpacking industry; and Murray (1995) and Bergman and Brännlund (1995) for studies of the Wood and Pulp industry.

Note that under the Cobb-Douglas specification, the term $\log\left(\frac{\beta^x_{it}}{\beta^m_{it}}\right)$ is an industry constant, such that all the within industry variation in buyer power is driven by differences in revenue shares across firms. The concern is that differences in buyer power might also be related to unobserved differences in technology across firms, which I rule out in production function estimation. However, note that in the regression analysis, I can control for variables that are likely to be correlated by production choices of firms.

I therefore run the following regression:

$$\log\left(\frac{\alpha^m_{it}}{\alpha^x_{it}}\right) = \beta_0 + \beta_1 \log size_{it} + \beta_2 \log \hat{\omega}_{it} + \gamma' \mathbf{z}_{it} + \gamma_{st} + \varepsilon_{it}, \tag{22}$$

where the dependent variable is the ratio of revenue share of domestic and foreign intermediates, $size_{it}$ is a measure of firm size, such as total sales or employment, $\hat{\omega}_{it}$ is the estimate of firm-level TFP which I can obtain from the estimation of the production function, 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 a dummy equal to 1 if the firm belongs to an international business group. Finally, γ_{st} are industry-time fixed effects. The coefficient of interest are $\hat{\beta}_i$, with $i = 1, 2$.

Note that the wedge ψ^x_{it} is estimated high whenever firms spend a lower-than-optimal share of revenues in the foreign input X. One might be concerned that a low share of foreign intermediates has to do with trade costs or other constraints, rather than input market distortions. Because smaller firms are more likely to be affected by those constraints, if the wedges were driven by things such as trade costs or financial constraints we should observe small firms having very large buyer power.

Table 6 presents the results from estimating (22), where the standard errors are obtained by block-bootstrapping. The first two columns report the result without adding the "production" control vector $\mathbf{z}_{it}$, which is instead included in column (3)-(6). Column (6) restrict the sample to only the largest importers, namely firms which import from more than 3 countries outside the European Union. The results in Table 6 confirm that input market distortions are positively and significantly correlated with the size and measured productivity of the firm. A 1% increase in firm size correspond to a 16% higher buyer power. Similarly, a 1% increase in firm tfp corresponds to a 6% increase in buyer power.

Note that I use $\log\left(\frac{\alpha^m_{it}}{\alpha^x_{it}}\right)$, rather than $\log \hat{\psi}_{it}$, as the dependent variable. This choice is motivated by the fact that variation in input market power due to the output elasticities are captured by the industry fixed effects (if technology is Cobb-Douglas) and by $\mathbf{z}_{it}$, for a more general technology. The firm level analysis is thus robust to any misspecification of the estimation of the production function. The difference in the coefficients of column (1) vs. (3), and (2) vs. (4), respectively, suggest that accounting for differences in technology is an important determinant of buyer power, and that the estimates in Table 5 are good only to a first order approximation.

3.2.3 Robustness - Constant Elasticity of Substitution Technology

I now consider a more general production function where the firm combines an intermediate input bundle Z with primary factors L and K, in a Cobb-Douglas fashion, but where Z is a Constant Elasticity of Substitution (CES) composite of a domestic variety M, and a foreign variety X. This is the production technology considered in prevailing studies of input trade (Gopinath and Neiman (2014); Halpern et al. (2015); Blaum et al. (2018)). I can write this technology as

$$Y_{it} = L_{it}^{\beta_L} K_{it}^{\beta_K} \left(M_{it}^{\rho} + X_{it}^{\rho} \right)^{\frac{1}{\rho}}, \tag{23}$$

where $\frac{1}{1-\rho}$ is the inverse of the elasticity of substitution between foreign and domestic intermediates.

Let $\beta_{it}^{j} \equiv \frac{\partial \log Y_{it}}{\partial \log J_{it}}$ denote the output elasticity of intermediate input J, with $J = M, X$. The ratio of output elasticities of foreign and intermediate input in this setting is:

$$\frac{\beta_{it}^{x}}{\beta_{it}^{m}} = \left(\frac{X_{it}}{M_{it}} \right)^{\rho}, \tag{24}$$

which means that buyer power in a model with CES technology can be written as:

$$\psi_{it}^{x,CES} \equiv \left(\frac{\beta_{it}^{x}}{\beta_{it}^{m}} \right) \left(\frac{\alpha_{it}^{m}}{\alpha_{it}^{x}} \right) = \left(\frac{X_{it}}{M_{it}} \right)^{\rho} \left(\frac{\alpha_{it}^{m}}{\alpha_{it}^{x}} \right). \tag{25}$$

Because I have constructed quantity measures of X_{it} and M_{it}, I can construct $\psi_{it}^{x,CES}$ from available data, while taking values of ρ from Blaum et al. (2018), since they use my same datasets for estimation.

In Table 7 I report mean and median value of buyer power obtained in the CES case, obtained from equation (25). The results show that even when I account for potential differences in output elasticities across firms, the estimated buyer power is still high and positive for a large number of industries, while it becomes less than one in a small number of sectors.

Firm-level analysis confirm my results at baseline. I run a similar regression than (22) while substituting $\log \psi_{it}^{x,CES}$ as the dependent variable:

$$\log \psi_{it}^{x,CES} = \beta_0 + \beta_1 \log size_{it} + \beta_2 \log \hat{\omega}_{it} + \gamma' \mathbf{z}_{it} + \gamma_{st} + \varepsilon_{it} \tag{26}$$

In Table 8 shows that even with this more flexible production technology, measures of distortions are positively and strongly related to measures of firm size and productivity.

Therefore, my results are consistent with larger and more productive firms being more distorted in foreign markets, where they seem to enjoy large degree of buyer power.

4 Buyer Power and the Aggregate Economy

The results in Section 3 highlight that in the majority of manufacturing industries, firms seem to be substantially distorted in the market for foreign intermediate inputs, and that such distortions are consistent with the existence of monopsony or oligopsony power.

In this Section, I aim to investigate the impact of buyer power in foreign input markets on the aggregate economy. 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.[24] The standard theoretical explanation is that foreign inputs improve both quality and variety of intermediates, lowering firms' unit cost of production and ultimately consumer prices. Importantly, all the existing firm-based import models are based on the assumption that input markets are perfectly competitive.

This Section aims to understand the effect of the noncompetitive foreign environment on our estimates and understanding of the aggregate gains associated with intermediate inputs trade, an important step for evaluating the welfare and redistributive implications of trade policies (Hallak and Levinsohn, 2007). To do so, I first build an heterogeneous firms model as in Melitz (2003) extended to incorporate buyer power in foreign input markets. I impose several simplifying assumptions that allow me to obtain an analytical characterization of the aggregate equilibrium and to highlight the main forces at play. I then show how the estimates in the first part of the paper can be used to quantify the effect of buyer power on aggregate output and efficiency. Finally, I consider two relevant examples of existing quantitative studies of firm-based import and show how the presence of buyer power can bias the estimates of aggregate gains from input trade.

[24]See, among others: Amiti 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 and Gopinath and Neiman (2014) for Argentina.

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 Cobb-Douglas aggregate of the output of S manufacturing sectors, denoted by Q_s, with $s = 1, .., S$,

$$Q = \prod_{s=1}^{S} Q_s^{\theta_s}, \text{ where } \sum_{s=1}^{S} \theta_s = 1. \tag{27}$$

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.[25] Individual varieties are combined to produce the industry output, according to a CES technology:

$$Q_s = \left(\int_{i \in M_s} {q_{si}}^{\rho_s} di \right)^{\frac{1}{\rho_s}}, \quad \sigma_s > 1, \tag{28}$$

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:

$$q_{s,i} = \left(\frac{p_{si}}{P_s} \right)^{-\frac{1}{1-\rho_s}} Q_s, \tag{29}$$

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

[25]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).

Constant Return to Scale Cobb-Douglas structure:[26]

$$q_i = \phi_i {x_i}^{\beta} {l_i}^{1-\beta}, \tag{30}$$

where x denotes foreign inputs and l denotes domestic primary factors, which I am going to refer to as labor.[27] Firms can hire any amount of labor at a unitary wage W^l.

I assume that 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. Most importantly, I assume that firms buy their intermediate inputs from the Foreign market, as detailed in the next section.

The main assumption here (and throughout the paper) is that foreign and domestic inputs are related by a unit elasticity of substitution. Standard models of firm-based imports allow for higher elasticities of substitutions (e.g. Gopinath and Neiman (2014); Halpern et al. (2015); Blaum et al. (2018)). I choose a Cobb-Douglas aggregator both because it is internally consistent with my functional form restrictions for the estimation in Section 2, and because it allows me to obtain analytical expressions for the aggregate equilibrium.[28]

The Market of the Intermediate Input I assume 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 $\partial X_i / \partial x_i = 1$.[29]

[26] 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).

[27] As in Blaum et al. (2018), I consider a single primary factor l for notational simplicity. However, the production structure is consistent with the estimating equation in (13), with l defined as a constant return to scale aggregator of l_i for $i = 1, .., N$ primary factors, including notably 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.

[28] However, the qualitative results do not depend on this functional form assumption. In Section 4.5. I to discuss that the same conclusions can be reached when foreign and domestic intermediates are considered as CES substitutes.

[29] The assumption that X_{-i} is exogenous further implies that I am ruling out strategic interactions across

There exist economic rents on the Foreign markets, which arise owing to decreasing returns in production of the intermediate input varieties.[30] I assume that *i's* Foreign seller supplies X_i units of the good according to the following (inverse) supply function

$$W_i^x = \left(\frac{x_i + X_{-i}}{\bar{x}_i + X_{-i}} \right)^{\eta}. \tag{31}$$

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 $\gamma_i \equiv (\bar{x}_i + X_{-i})^{-\eta}$ reflects market conditions in the Foreign market for input i, and is taken as given by the firm.

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

$$\frac{\partial (W_i^x x_i)}{\partial x_i} \equiv W_i^x \left(1 + \frac{\partial W_i}{\partial X_i} \frac{X_i}{W_i} \cdot \frac{\partial X_i}{\partial x_i} \frac{x_i}{X_i} \right) = W_i^x \left(1 + \eta s_i^x \right), \tag{32}$$

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 is given by:

$$\psi_i \equiv \frac{\partial (W_i^x x_i) / \partial x_i}{W_i^x} = 1 + \eta s_i^x \geq 1. \tag{33}$$

Note that the expression in (33) represents the same object I estimated in Section 3, with the only difference that now I can attribute a structural interpretation to it. Equation (33) implies that in the model, two conditions are necessary for buyer power to emerge: *(i)* the firm must be large compared to its competitors (i.e. $s_i^x > 0$); and *(ii)* the (inverse) input supply is elastic (i.e. $\eta > 0$).[31]

The model encompasses the cases of monopsony and perfect competition in the foreign input market in a tractable way. When the Home firm is small compared to its com-

a Home firm i and its Foreign competitors.

[30] 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*.

[31] 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).

petitors 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 $X_{-i} \to 0$ and $s_i^x \to 1$ as in the case of monopsony, $\psi_i = 1 + \eta > 1$ and $W_i^x = \left(\frac{x_i}{\bar{x}_i}\right)^{\eta}$. I set $\bar{x}_i$ equal to the "competitive" quantity of input x for firm i, such that if the firm optimally chooses $x_i = \bar{x}_i$, the price of the input is always equal to the competitive price.

In Figure 4, I show the equilibrium in the market of X_i for different values of X_{-i}. The demand curve is denoted by D and reflects the marginal revenue product of input x for firm i. The input supply curve is denoted by S, and it is upward sloping, according to (31). Curve ME represents the marginal expenditure on the input, and is given by equation (32). The firm sets marginal revenues (curve D) equal to the marginal expenditure. When markets are competitive, $s_i^x \to 0$, and the marginal expenditure and marginal cost curves coincide, such that the equilibrium price and quantity are given by W^* and x^*, respectively. Conversely, when the firm is large relative to the market, i.e. $s_i^x \to 1$, the marginal expenditure curve is steeper than S, and in equilibrium the firm will buy a lower quantity (i.e. $X' < X^*$), and pay a lower unit price ($W' < W^*$). This is due to the fact that the firm internalizes the effect of its input demand on the equilibrium input price not only of the marginal unit, but also of all the *infra*marginal ones. Our measure of buyer power ψ corresponds to the gap between the counterfactual competitive price W^*, and the equilibrium unit price of the firm $W^{'}$.

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 (29), technology (30) and input supply (31), 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 (31). The first order conditions can be written as:

$$\frac{\beta}{\alpha_i^x} = \frac{1}{\rho}\psi_i \tag{34}$$

$$\frac{1-\beta}{\alpha_i^l} = \frac{1}{\rho} \tag{35}$$

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. These expressions coincides with equations (7) and (8) in the first part of the paper.

In the Appendix I show that when X_{-i} is small enough (i.e. $X_{-i} \to 0$), and when $X_{-i} \to \infty$, the solution for x_i is given by:[32]

$$x_i = \bar{x}_i \left(1 + \eta \frac{x_i}{x_i + X_{-i}}\right)^{-\frac{1-\rho(1-\beta)}{1-\rho+\eta(1-\rho(1-\beta))}} = \bar{x}_i \psi_i^{-\frac{1-\rho(1-\beta)}{1-\rho+\eta(1-\rho(1-\beta))}}, \tag{36}$$

where $\bar{x}_i$ is the solution to the firm problem under perfect competition.[33] Equation (36) implicitly defines x_i as a function of X_{-i}, i.e. $x_i = x(X_{-i})$. Using the implicit function theorem, it is easy to show that $\frac{\partial x}{\partial X_{-i}} > 0$: firm input demand increases with foreign competition, and decreases with buyer power.I can summarize the firm-level equilibrium as follows:

$$x_i \propto \phi_i^{\frac{\rho}{1-\rho}} \psi_i^{-\frac{1-\rho(1-\beta)}{1-\rho+\eta(1-\rho(1-\beta))}} \tag{37}$$

$$\frac{l_i}{x_i} \propto \psi_i^{\frac{1-\rho}{1-\rho+\eta(1-\rho(1-\beta))}} \tag{38}$$

$$q_i \propto \phi_i^{\frac{1}{1-\rho}} \psi_i^{-\frac{\beta}{1-\rho+\eta(1-\rho(1-\beta))}}. \tag{39}$$

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 (37)-(39) 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 monopsonized market is too low compared to the competitive equilibrium, which corresponds to the case $\psi_i = 1$ (equation (37)). Second, firms with high level of ψ engage in inefficient substitution of the domestic input for the monopsonized input in producing the final product (equation (38)). 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 (39)).

Equations (37)-(39) look remarkably similar to the equilibrium in the model with cap-

[32]For X_{-i} large but finite, equation (36) correspond only to an approximation of the firm-level equilibrium.

[33]$\bar{x}_i \equiv A\phi_i^{\frac{\rho}{1-\rho}} \left(\frac{1}{\rho}\right)^{-\frac{1}{1-\rho}} \left(\frac{W^l}{1-\beta}\right)^{-\frac{\rho}{1-\rho}(1-\beta)} \left(\frac{1}{\beta}\right)^{-\frac{1-\rho(1-\beta)}{1-\rho}}$

ital distortions in Hsieh and Klenow (2009) (hereafter HK).[34] The effect of buyer power on the equilibrium allocation of resources is similar (but not equivalent) to the effect of capital distortions in HK. The difference is that distortions here are not exogenous, but arise endogenously due to the existence of market segmentation and elastic supply in foreign markets.[35] Most important, as with capital distortions in HK, buyer power drives differences in the marginal revenue product of foreign inputs, making firms smaller than optimal:

$$\text{MRPL}_i \equiv \frac{\partial p_i q_i}{\partial l_i} = W^l \tag{40}$$

$$\text{MRPX}_i \equiv \frac{\partial p_i q_i}{\partial x_i} = W_i^x \psi_i = \psi_i^{\frac{1-\rho}{1-\rho+\eta(1-\rho(1-\beta))}}. \tag{41}$$

Differences in firm MRPX will show up as differences in revenue productivity, namely:

$$\text{TFPR}_i = p_i \phi_i \propto \text{MRPX}_i^{\beta} = \psi_i^{\frac{\beta(1-\rho)}{1-\rho+\eta(1-\rho(1-\beta))}}. \tag{42}$$

In other words, the more firms are *distorted* in the foreign markets, the higher the revenue productivity. 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. To ease the comparison with existing work on the aggregate gains from intermediate input trade, I focus 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 HK to obtain an expression isomorphic to

[34] See equations (7)-(9) in HK.

[35] While in HK firms take input prices as given, here input prices and quantity are both endogenously chosen. This shows up as a different exponent to the distortion parameter.

equation (15) in their paper.[36] Aggregate TFP is given by

$$\text{TFP}_s = \left(\int_0^{M_s} \phi_{si}^{\frac{\rho_s}{1-\rho_s}} \left(\frac{\text{MRPX}_s}{\text{M\bar{R}PX}_{si}} \right)^{\beta \frac{\rho_s}{1-\rho_s}} di \right)^{\frac{1-\rho_s}{\rho_s}} \tag{43}$$

where $\text{M\bar{R}PX}_s$ 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 (42).[37]. Equation (43) reveals that sectoral TFP is homogeneous of degree zero in buyer power: multiplying all $\psi_{s,i}$ (or MRPX_{si}) 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. Under this restriction, I can rewrite (43) as:

$$\log \text{TFP}_s = \log \left(\int_0^{M_s} \phi_{si}^{\frac{\rho_s}{1-\rho_s}} di \right)^{\frac{1-\rho_s}{\rho_s}} - \kappa_{1,s} \text{var} \log \psi_s^x, \tag{44}$$

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 (44) clearly shows that high 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 :

$$\frac{l_{si}}{l_{sj}} = \left(\frac{\phi_{si}}{\phi_{sj}} \right)^{\frac{\rho_s}{1-\rho_s}} \left(\frac{\psi_{si}}{\psi_{sj}} \right)^{-\frac{\rho_s \beta_s}{1-\rho_s+\eta_s(1-\rho_s(1-\beta_s))}}. \tag{45}$$

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, the probability that a firm has buyer power below

[36] See Online Appendix for full derivations.

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

the 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

In this paragraph, I 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.

$$W = \prod_{s=1}^{S} Q_s^{\theta_s}, \tag{46}$$

where the sectoral output Q_s is defined in (28). I show in the Appendix that sectoral output can be written as:

$$Q_s = \Gamma \cdot \left(\int_{i \in M_s} \phi_{si}^{\frac{\rho_s}{1-\rho_s}} \psi_{si}^{-\frac{\rho_s \beta_s}{1-\rho_s+\eta_s(1-\rho_s(1-\beta_s))}} di \right)^{\frac{1-\rho_s}{\rho_s}}, \tag{47}$$

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:

$$\log Q_s \propto \log \left(\int_0^{M_s} \phi_{si}^{\frac{\rho_s}{1-\rho_s}} \right)^{\frac{1-\rho_s}{\rho_s}} - \kappa_{2,s} \mathbb{E} \log \psi_s + \kappa_{3,s} \text{var} \log \psi_s, \tag{48}$$

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 (48) shows that both first and second moments of the distribution of ψ determine aggregate (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

$$Q_s = \text{TFP}_s X_s^{\beta_s} L_s^{1-\beta_s}, \tag{49}$$

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 (48) 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.*

Input vs Output Market Power How does the aggregate effect of market power in input markets compare to the effect of market power in output markets? Understanding the nature and the implications of market power of firms is important for both positive and normative reasons, from taxation and redistribution to antitrust enforcement (De Loecker and Eeckhout, 2017). One standard result in the literature of output market power and misallocation is that with fixed entry, welfare is independent on the average level of markups and only depends on the dispersion across firms (e.g. Epifani and Gancia, 2011; Peters, 2016; Edmond et al., 2015).

What happens when there is market power in input markets? Proposition 2 establishes that just like output market power, heterogeneity in input market power reduces aggregate efficiency, by generating misallocation. However, Proposition 3 points out an important difference when it comes to output. Not only output (and welfare) decreases with average buyer power, but the overall welfare effect of heterogeneity is actually positive. This is true because when inputs are supplied elastically and firms have buyer power, too little resources are employed in the economy, and it is better, from a welfare point of view, to have less distorted firms overproduce, albeit inefficiently.

4.4 Aggregate Cost of Buyer Power in Foreign Markets

I finally use the theoretical results in Proposition 2 and 3 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.

First, for any given variable X, I denote as $\hat{X} \equiv \log X^{DIS} - \log X^{EFF}$ the log-difference between its value in the distorted economy relative to its value in the efficient economy. The model is tractable enough to allow for closed form solutions for the aggregate equilibrium. In the online Appendix, I show that one can compute the efficiency cost of buyer power $\hat{\text{TFP}}$ as

$$\hat{\text{TFP}} = \sum_{s=1}^{S} \theta_s \hat{\text{TFP}}_s = -\sum_{s=1}^{S} \theta_s \kappa_{1s} \text{var} \log \psi_s^x. \tag{50}$$

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

$$\hat{Q} = \frac{1}{1 - \sum_{s=1}^{S} \theta_s \beta_s} \left[-\sum_{s=1}^{S} \theta_s \kappa_{2,s} \mathbb{E} \log \psi_s + \sum_{s=1}^{S} \theta_s \kappa_{3,s} \text{var} \log \psi_s \right]. \tag{51}$$

Inspection of equations (50) and (51) 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 first and second moment of the distribution of ψ across sectors. In other words, these moments are sufficient statistics for the effect of imperfect competition in foreign markets in the aggregate economy. This is important, since the variable ψ in the model correspond to the "input efficiency wedge" in Section 2, whose distribution I have already estimated. In what follows, I describe how I calibrate the main parameters, and I discuss my results.

Estimation of ρ_s, β_s and η_s In order to compute the right-hand side of equations (50) and (51), I need to find estimates of the parameters θ_s, ρ_s, β_s and η_s. Values of θ_s reflect the sectoral share of total manufacturing output, and is something I can directly compute from firm-level data.

I can map the parameters ρ_s, β_s and η_s to quantities I have already estimated in Section 3. In particular, I back out values of ρ_s for each sector from my estimates of sectoral markups in Table 4B in the Appendix, using the relationship $\rho_s = \frac{\sigma_s - 1}{\sigma_s} = \mu_s^{-1}$. I choose β_s equal to the output elasticity of foreign intermediate inputs in Table 3. The choice of the foreign supply elasticity is less obvious, as it cannot easily be mapped to any of the parameters estimated alongside production function estimation. One possibility is to back out η_s using the model equilibrium relationship $\psi_{si} = 1 + \eta s_{si}^x$. This expression implies that η_s can be derived as $\eta_s = \bar{\psi}_s - 1$, where $\bar{\psi}_s = \psi_{si}$ of firm i with $s_{is}^x \to 1$. Ideally, the firm with the highest market share is the one with the highest observed buyer power, which means that which should choose $\bar{\psi}_s = \max_i \{\psi_{si}\}$. It is clear however that this implies that η_s is very sensitive to the existence of outliers in the distribution of ψ_s. In the baseline calibration, I choose $\bar{\psi}_s$ as the 75th percentile of the distribution of ψ_{si} in each given sector. This choice addresses concerns of noisy estimates of ψ_{si}. As I discuss below, this is a valid concern in our case.

Moments of the distribution of ψ_s Values of both $\mathbb{E} \log \psi_s$ and $\operatorname{var} \log \psi_s$ across sectors are derived from the mean and variance of the distribution of input efficiency wedge in Section 3, which in the model correspond to ψ. In particular, under the assumption that ψ is distributed lognormal, i.e. $\psi \sim \log \mathcal{N}(\mu_{xs}, \sigma^2_{xs})$, the following relationships hold: $\mathbb{E} \log \psi_s = \mu_{xs}$ and $\operatorname{var} \log \psi_s = \sigma^2_{xs}$. One can then use the property of the lognormal distribution to derive μ_{xs} and σ^2_{xs} given the estimates of the mean ($\mathbb{E}\psi_s$) and variance ($\operatorname{var} \psi_s$) of ψ, available from Table 4.[38]

Results Table 9 summarizes the results. Columns (1)-(4) reports the values of the parameters, columns (5)-(6) are the mean and variance of $\log \psi$, and columns (7)-(8) reports the counterfactual losses in TFP and output across sectors computed using equations (50) and (51), respectively. The cost of buyer power is substantial: aggregate efficiency is reduced by 0.35%, while aggregate output is reduced by 1.1% relative to a world where firms are price takers in all input markets.

These numbers can be largely determined by our choice of the inverse supply elasticity η, which is estimated very high in the baseline calibration. To the extent that the variation in the wedge ψ is driven by forces other than buyer power, it is very likely that they affect the variance (noise) of the distribution. Since η is a function of high percentiles of the distribution, it is very sensitive to the existence of outliers.

I consider alternative choices of η. First, to address the concerns of outliers in the distribution, I keep using the model implied relationship $\eta_s = \bar{\psi}_s - 1$, but choose $\bar{\psi}_s$ at the 60th, 80th, 95th percentile of the distribution of ψ_{si}. I then choose estimates outside the current studies. Benchmark values of the foreign supply elasticity are not very common in the literature, or at least much less common that its demand counterpart. One noteworthy exception is Broda et al. (2008). Their estimates of the (inverse) foreign export supply elasticity precisely correspond to η in our model. They estimate η at the HS4 product level, which I aggregate at the industry level. Table IX summarizes these alternative esti-

[38]Specifically, μ_{xs} and σ^2_{xs} solve the following system of equations:

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

mates of the inverse supply elasticity, and the corresponding values of aggregate cost of buyer power. The results confirm that the cost of buyer power is very sensitive to the foreign supply elasticity. The buyer power induced losses in TFP range from 0.1 to 0.9%%, while the output losses range from 0.5 to 1.5%.

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

The results in this Section suggest that access to foreign intermediate inputs could potentially have negative consequences for the domestic economy, to the extent that it allows domestic firms to monopsonize foreign markets. This statement seems to stand in contrast to what has become common sense of international economists, which is that there are gains from accessing foreign intermediate inputs, stemming from improved access to high quality or highly differentiated inputs (e.g. Goldberg et al. (2010); Halpern et al. (2015); Blaum et al. (2018)). The current study does not invalidate those studies, nor intends to do so. The economy could still gain as compared to a setting where there are no foreign intermediates. My model ignores this margin, by taking as given the fact that firms use both foreign and domestic inputs in production. The model does suggest, however, that the estimated gains from foreign intermediate inputs in existing studies could be potentially overestimated, as they ignore an important margin through which foreign inputs could lower productivity and welfare.

Let us take the example of Halpern et al. (2015). The authors estimate the gains from foreign intermediates as the difference in output between two firms, say Q_1 and Q_2, that have the same demand and TFP, but differ in the number of varieties they choose to import, n_1 and n_2. The authors find very large effect of foreign inputs for aggregate output and productivity. They estimate that of the 21% productivity growth in Hungary in the period 1993-2002, about 5.0% (one quarter) was due to improved access to imported inputs. Let us now use the model in this section and say that firm 2 buys less foreign inputs because it is exercising its buyer power, that is because $\psi_2 > \psi_1$. Buyer power is such that firm 2 produces an inefficient amount of output, and so that $Q_2 < Q_2^{EFF}$. This means that the existence of buyer power generates an upward bias in the productivity estimates of productivity.

Similarly, Blaum et al. (2018) find that a sufficient statistic for the gains from foreign intermediate is the domestic share of intermediates, i.e. $s_D \equiv \frac{W^m M_i}{W^m M_i + W^x X_i}$. In their (competitive) model, s_D is inversely proportional to the decrease in price associated with access to foreign intermediates. In the Appendix, I show that if firms where distorted in the foreign market, s_D no longer identifies the price effect of foreign inputs. On the contrary, a high value of s_D is observed both when aggregate domestic prices are high, and when buyer power is high. This again implies that by not considering buyer power one could overestimate the aggregate gains from foreign inputs.

4.6 Policy Implications

The main message of the model is that heterogeneous buyer power can lower aggregate efficiency and welfare. One straightforward implication of the model is that trade policy should foster foreign market integration, by means of import subsidies for example, so as to make more buyers accessible to foreign sellers and reduce the scope of distortions. Note that this conclusion rests on the assumption that there exist entry barriers to foreign markets - such as search or information costs - that can be overcome. In fact, the same policy would be ineffective if foreign markets were segmented due to relationship-specific investments that the foreign sellers had to bear in order to enter in the relationship with a particular buyer, or product characteristics. A deeper understanding of what is driving foreign market segmentation is thus needed in order to provide direction to trade or antitrust policy authorities.

5 Conclusions

This paper studies buyer power 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 of firms can be consistently estimated from standard production data. On the theoretical side, I show that input market power induces large distortions in the domestic economy. My paper raises a number of questions, which could be relevant for future research.

First, my theoretical results suggest that input and output market power could have substantially different implications in terms of aggregate distortions. On the one hand, this is important for normative reasons, as antitrust scholars sometimes dismiss the issue of buyer power as "symmetric" to output market power (Noll, 2004). On the other hand, my results suggest that understanding the nature of market power is potentially important to understand a number of macroeconomic outcomes (Barkai (2016); Blonigen and Pierce (2016); De Loecker and Eeckhout (2017); Zingales (2017)). A fruitful direction for future research is to analyze both qualitatively and quantitatively the generalizability of these results.

My paper also raises the issue that current estimates of the aggregate gains from intermediate input trade (e.g. Halpern et al., 2015; Blaum et al., 2018) could be biased upward, to the extent that part of the measured productivity gains are in fact profitability gains associated with input trade. Future research should investigate the relative importance of productivity gains associated with the use of foreign varieties, and increased distortions associated with the existence of buyer power in foreign markets.

This study has a number of limitations. On the methodological side, my results rely on the assumption that domestic markets are perfectly competitive. This assumption is not without loss of generality, and can bias the estimates of buyer power to the extent that market power in domestic input markets exists, and is in fact stronger than market power abroad. While this does not seem to be case in reality, future research could exploit increasingly available information on prices of domestic intermediate inputs to test the validity of this assumption. On the theoretical side, my model is deliberately simple. Future work could investigate whether more realistic assumptions on final demand, entry and the production function, qualitatively or quantitatively change the welfare results.

FIGURE 1: BUYER POWER ACROSS SECTORS

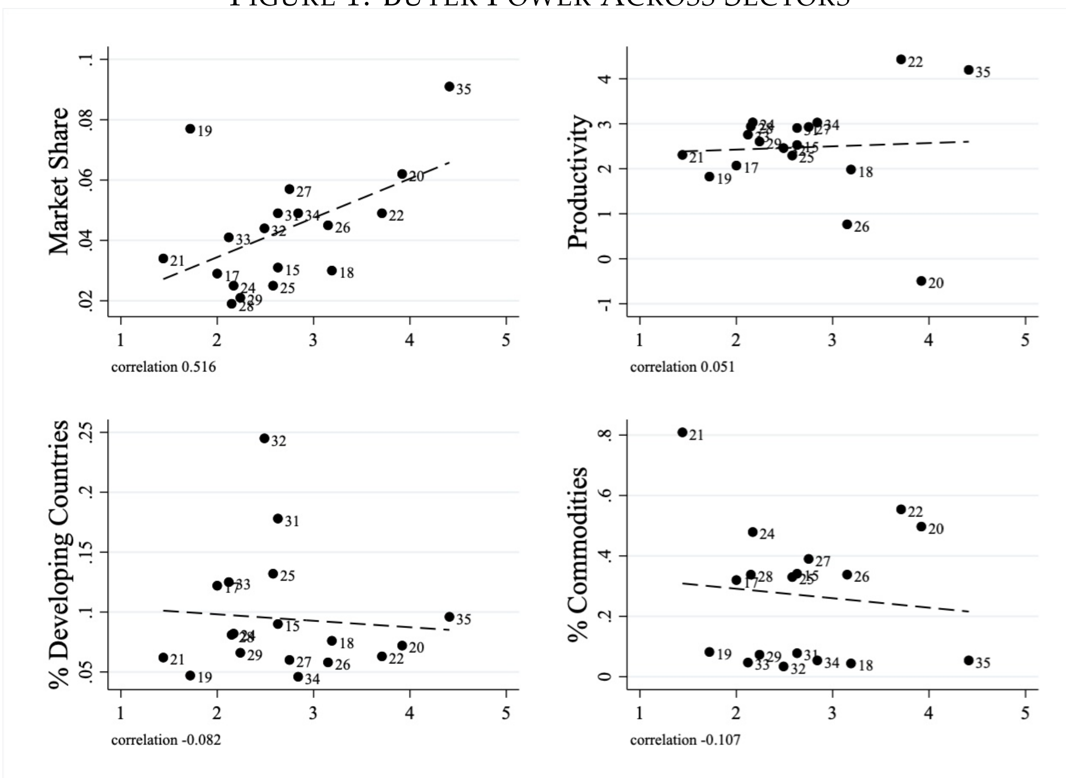

FIGURE 2: EQUILIBRIUM IN THE INTERMEDIATE INPUT MARKET

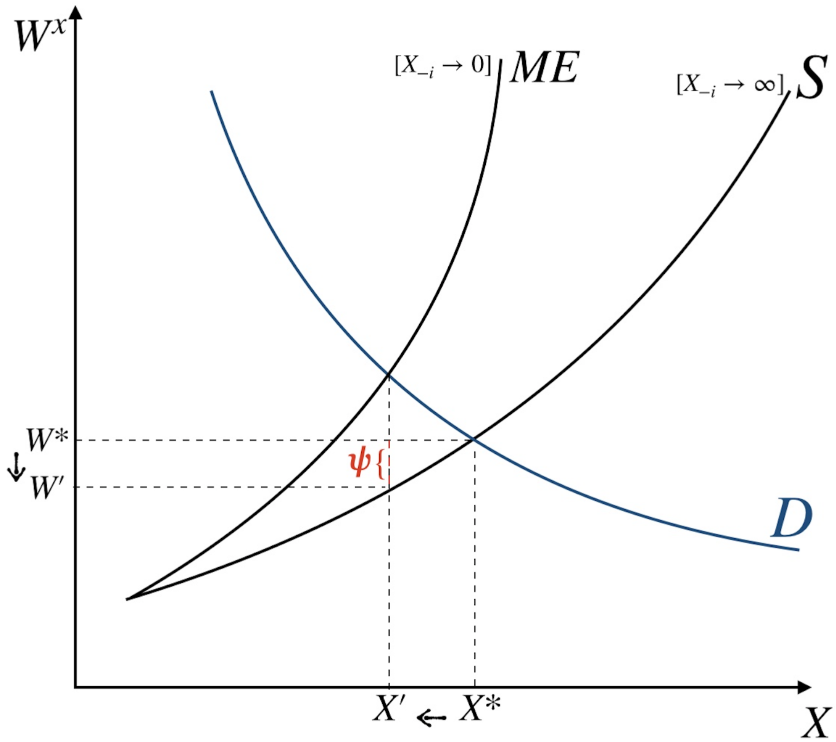

TABLE I. SUMMARY STATISTICS (2005)

	INTERNATIONAL	**SUPER INTERNATIONAL***
# Firms	11,916	6,489
(% of total)	7.7%	4.2%
(% in total value added)	59%	53%
(log) sales premium [a]	3.3	3.97
(log) wage premium	0.29	0.31
(log) TFP premium[b]	0.20	0.24
Belongs to a group[c]	74%	85%
% French imports	36%	34%
Imported share of intermediates	29%	35%

Source: Author's calculations. Notes: The number of *all* the manufacturing firms in 2005 is 166,175.[a] The (log) x premium 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): 13.4% A firm "belongs to a group" if it is classified as either French private, French public, foreign private (group).

TABLE II. REVENUE SHARES: DISTRIBUTION QUANTILES

Variable	1996-2007				
	Mean	Std Dev	p10	p50	p90
Labor α_{it}^{L}	.18	.08	.08	.17	.29
Capital α_{it}^{K}	.03	.04	.003	.02	.08
Domestic Materials α_{it}^{M}	.31	.15	.12	.30	.52
Imported Materials α_{it}^{X}	.2	.17	.03	.15	.43

Notes: The table reports the share of total revenues of different input expenditures, averaged across time and sectors. I consider the full sample of international firms. Number of observations: 133,921,123. Imported intermediates are defined as total imports. Accordingly, domestic materials are defined as Total materials (both raw materials and final goods) minus total imports.

TABLE III. AVERAGE OUTPUT ELASTICITIES, BY SECTOR

	INDUSTRY	NO. OBS.	β_L	β_K	β_M	β_X	RTS
C15	Food Products and Beverages	4502	0.20	0.06	0.67	0.11	1.03
			(0.02)	(0.01)	(0.01)	(0.005)	
C17	Textiles	4178	0.21	0.06	0.60	0.22	1.09
			(0.02)	(0.01)	(0.01)	(0.01)	
C18	Wearing Apparel, Dressing	2699	0.17	0.07	0.44	0.38	1.06
			(0.02)	(0.02)	(0.01)	(0.01)	
C19	Leather, and Products	751	0.26	0.14	0.48	0.25	1.12
			(0.06)	(0.04)	(0.02)	(0.01)	
C20	Wood, and Products	1010	0.38	0.25	0.54	0.18	1.36
			(0.05)	(0.05)	(0.01)	(0.01)	
C21	Pulp, Paper, & Products	2310	0.22	0.11	0.61	0.13	1.07
			(0.03)	(0.02)	(0.01)	(0.005)	
C22	Printing and Publishing	880	0.38	0.02	0.55	0.16	1.11
			(0.05)	(0.02)	(0.02)	(0.01)	
C24	Chemicals, and Products	5538	0.25	0.07	0.57	0.16	1.05
			(0.02)	(0.01)	(0.01)	(0.004)	
C25	Rubber, Plastics, & Products	4055	0.24	0.11	0.57	0.17	1.09
			(0.02)	(0.01)	(0.01)	(0.01)	
C26	Non-metallic mineral Products	1562	0.24	0.23	0.54	0.16	1.17
			(0.05)	(0.04)	(0.01)	(0.01)	
C27	Basic Metals	1671	0.27	0.07	0.56	0.18	1.09
			(0.04)	(0.03)	(0.01)	(0.01)	
C28	Fabricated Metal Products	4941	0.30	0.09	0.60	0.10	1.10
			(0.02)	(0.01)	(0.01)	(0.01)	
C29	Machinery and Equipment	5592	0.27	0.09	0.61	0.11	1.07
			(0.02)	(0.01)	(0.01)	(0.004)	
C31	Electrical machinery & App.	1803	0.26	0.05	0.58	0.17	1.06
			(0.03)	(0.02)	(0.01)	(0.01)	
C32	Radio and Communication	1644	0.27	0.04	0.60	0.16	1.07
			(0.03)	(0.02)	(0.01)	(0.01)	
C33	Medical, Precision, Optical Instr.	1952	0.29	0.08	0.57	0.12	1.06
			(0.03)	(0.02)	(0.01)	(0.01)	
C34	Motor Vehicles, Trailers	1666	0.14	0.06	0.59	0.20	0.98
			(0.04)	(0.02)	(0.01)	(0.01)	
C35	Other Transport Equipment	685	0.270	0.061	0.580	0.191	1.10
			(0.07)	(0.06)	(0.03)	(0.02)	

Notes: The table reports the output elasticities from production function estimation. Imported intermediates are defined as total imports. Accordingly, domestic materials are defined as Total materials (both raw materials and final goods) minus total imports. I perform the GMM procedure on a sample of super-international firms, while implementing a sample selection correction to address the potential selection bias stemming from the use of large importers in estimation. I follow the procedure suggested by Wooldridge (2009) that forms moments on the joint error term ($\xi_{it} + \epsilon_{it}$). Column 1 reports the number of observations for each production function estimation. Cols 2–4 report the estimated output elasticity with respect to each factor of production. Standard errors, obtained by block-bootstrapping, are reported in brackets. Col. 5 reports the average returns to scale, which is the sum of the preceding 4 columns.

TABLE IV. INPUT AND OUTPUT MARKET DISTORTIONS, BY SECTOR

SECTOR	Ξ^m		Ξ^x	
	MEAN	MEDIAN	MEAN	MEDIAN
15 Food and Beverages	1.05	1.00	2.43	1.40
17 Textiles	1.30	1.26	2.27	1.49
18 Wearing Apparel	1.11	1.01	2.61	1.78
19 Leather Products	1.24	1.16	1.79	1.34
20 Products of Wood	1.01	0.96	3.45	2.05
21 Pulp and Paper Products	1.21	1.15	1.52	0.94
22 Printing and Publishing	1.04	1.01	3.59	2.25
24 Chemical Products	1.10	1.06	2.15	1.39
25 Rubber Products	1.10	1.06	2.57	1.67
26 Non-metallic minerals	1.10	1.07	3.19	2.01
27 Basic Metals	1.09	1.05	2.72	1.77
28 Fabricated Metal Products	1.22	1.18	2.40	1.47
29 Machinery and Equipment	1.16	1.11	2.34	1.49
31 Electrical Machinery	1.19	1.15	2.79	1.62
32 Radio and Communication	1.24	1.19	2.81	1.85
33 Medical Instruments	1.24	1.20	2.35	1.48
34 Motor Vehicles, Trailers	1.10	1.04	2.80	1.77
35 Other Equipment	1.14	1.10	4.39	2.43
Average (Weighted)	1.13	1.08	2.66	1.64

Notes: The table reports the mean and median joint wedges Ξ^m and Ξ^x, for the domestic and foreign material input, respectively. Imported intermediates are defined as total imports. Accordingly, domestic materials are defined as Total materials (both raw materials and final goods) minus total imports. The average standard deviation of Ξ^m across industries is 0.3, with some (small) heterogeneity across sectors. The average standard deviation of Ξ^x across industries is 5.27, with some heterogeneity across sectors.

TABLE V. INPUT MARKET POWER, BY SECTOR

SECTOR	$\psi^x{}_{it}$		
	MEAN	MEDIAN	STD DEV
15 Food and Beverages	2.63	1.43	3.00
17 Textiles	2.00	1.21	2.20
18 Wearing Apparel	3.19	1.78	3.83
19 Leather Products	1.72	1.17	1.58
20 Products of Wood	3.92	2.12	4.43
21 Pulp and Paper Products	1.44	0.82	1.57
22 Printing and Publishing	3.71	2.31	3.73
24 Chemical Products	2.17	1.32	2.26
25 Rubber Products	2.58	1.58	2.60
26 Non-metallic minerals	3.15	1.94	3.22
27 Basic Metals	2.75	1.72	2.84
28 Fabricated Metal Products	2.15	1.27	2.29
29 Machinery and Equipment	2.24	1.35	2.33
31 Electrical Machinery	2.63	1.43	3.01
32 Radio and Communication	2.49	1.61	2.46
33 Medical Instruments	2.12	1.26	2.27
34 Motor Vehicles, Trailers	2.84	1.78	2.94
35 Other Equipment	4.41	2.32	5.11
Average	2.65	1.56	2.85

Notes: The table reports the mean, median and standard deviation of input market power by sector for the preferred sample over the period 1996-2007. Imported intermediates are defined as total imports. Accordingly, domestic materials are defined as Total materials (both raw materials and final goods) minus total imports. The average standard deviation across industries is 1.89, with some heterogeneity across sectors. Input market power is computed as the ratio between the "joint distortion wedge" Ξ^x for the foreign intermediate input and the markups, as obtained in Table 4. The table trims observations with ψ that are above and below the 3^{rd} and 97^{th} percentiles within each sector.

TABLE VI. MARKET POWER AND FIRM CHARACTERISTICS

	(1)	(2)	(3)	(4)	(5)	(6)
$\log size_{it}$	-0.09***		0.16***		0.16***	0.21***
	(0.003)		(0.005)		(0.005)	(0.006)
$\log \hat{\omega}_{it}$		0.112***		0.06***	0.06**	0.033***
		(0.01)		(0.009)	(0.009)	(0.013)
CONTROLS	No	No	Yes	Yes	Yes	Yes
FIXED EFFECTS						
Industry (2 digits) -Time	Yes	Yes	Yes	Yes	Yes	Yes
Industry (3 digits)	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.12	0.12	0.24	0.20	0.24	0.26
No. Observations	71,284	71,284	71,284	71,284	71,284	46,459

Notes: The table reports the estimates of OLS regressions on equation (22). The dependent variable is $\log\left(\frac{\alpha^m_{it}}{\alpha^x_{it}}\right)$. Measures of firm-level TFP $\log \hat{\omega}_{it}$ are obtained from production function estimation. The results are shown for the sample of all international firms, except in column (6), where I restrict to the sample of super-international firms. Imported intermediates are defined as total imports of the firm. Accordingly, domestic materials are defined as Total materials (raw materials and final goods) minus total imported materials. All regressions include Industry-Time Fixed Effects, where industry is either measured at the 2-digit Isic Rev. 3 level, or 3 digits NACE level. In Column (3)-(6) I include controls for the number of source countries in a given year, the number of sourced products, a dummy for which type of business group the firm belongs to, and dummies for the main reported activity of the firm. The regressions exclude outliers in the top and bottom 3rd percent of the markup distribution. The standard errors are bootstrapped *** denotes significance at the 10% level, ** at the 5% and *** at the 1%.

TABLE VII. INPUT MARKET POWER, CES TECHNOLOGY

SECTOR	$\psi^{x}{}_{it}$		
	MEAN	MEDIAN	STD DEV
15 Food Products and Beverages	1.79	1.51	1.10
17 Textiles	0.85	0.74	0.53
18 Wearing Apparel, Dressing	0.64	0.50	0.49
19 Leather, and Leather Products	0.80	0.70	0.51
20 Wood and Products of Wood	1.55	1.32	0.92
21 Pulp, Paper and Paper Products	1.05	0.91	0.59
22 Printing and Publishing	1.18	1.00	0.80
24 Chemicals and Chemical Products	1.02	0.92	0.61
25 Rubber and Plastic Products	1.21	1.08	0.67
26 Non-metallic mineral Products	1.11	0.94	0.75
27 Basic Metals	1.15	1.03	0.67
28 Fabricated Metal Products	1.27	1.09	0.80
29 Machinery and Equipment	1.49	1.27	0.95
31 Electrical machinery and Apparatus	1.30	1.08	0.84
32 Radio and Communication	1.17	1.01	0.74
33 Medical, Precision Instruments	0.99	0.81	0.73
34 Motor Vehicles, Trailers	1.38	1.24	0.77
35 Other Transport Equipment	1.09	0.83	0.85
Average (Weighted)	1.29	1.11	0.82

Notes: The table reports the mean and median input market power by sector for the preferred sample over the period 1996-2007, according to the relationship: $\psi^{x,CES}_{it} \equiv \left(\frac{\beta^{x}_{it}}{\beta^{m}_{it}}\right)\left(\frac{\alpha^{m}_{it}}{\alpha^{x}_{it}}\right) = \left(\frac{X_{it}}{M_{it}}\right)^{\rho}\left(\frac{\alpha^{m}_{it}}{\alpha^{x}_{it}}\right)$ which holds when production function is CES. Imported intermediates are defined as total imports. Accordingly, domestic materials are defined as Total materials (both raw materials and final goods) minus total imports.

TABLE VIII. MARKET POWER AND FIRM CHARACTERISTICS, CES TECHNOLOGY

	(1)	(2)	(3)	(4)	(5)	(6)
$\log size_{it}$	-0.08***		0.06***		0.06***	0.09***
	(0.003)		(0.004)		(0.004)	(0.005)
$\log \hat{\omega}_{it}$		0.197***		0.16***	0.155***	0.19***
		(0.008)		(0.007)	(0.007)	(0.011)
CONTROLS	No	No	Yes	Yes	Yes	Yes
FIXED EFFECTS						
Industry (2 digits) -Time	Yes	Yes	Yes	Yes	Yes	Yes
Industry (3 digits)	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R^2	0.13	0.12	0.18	0.18	0.19	0.20
No. Observations	81,292	81,292	81,292	81,292	81,292	46,816

Notes: The table reports the estimates of CES regressions on equation (25). The dependent variable is $\log \hat{\psi}_{it}$. Imported intermediates are defined as total imports of the firm. Accordingly, domestic materials are defined as Total materials (raw materials and final goods) minus total imported materials. The results are shown for the sample of all international firms. All regressions include Industry-Time Fixed Effects, where industry is either measured at the 2-digit Isic Rev. 3 level, or 3 digits NACE level. All regressions include controls for the number of source countries in a given year, the number of sourced products, a dummy for which type of business group the firm belongs to, and dummies for the main reported activity of the firm. The regressions exclude outliers in the top and bottom 3rd percent of the markup distribution. All regressions include firm–product fixed effects. The regressions use data from 1989–1997. The standard errors are bootstrapped and are clustered at the firm level. *** denotes significance at the 10% level, ** at the 5% and *** at the 1%.

TABLE IX. 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	$\mathbb{E}\log\psi_s^x$	$\text{var}\log\psi_s^x$	$\Delta\%\text{TFP}_s$	$\Delta\%Q_s$
15 Food and Beverages	0.19	0.11	2.21	0.95	0.55	0.83	-0.22	-1.06
17 Textiles	0.02	0.22	1.45	0.77	0.29	0.80	-1.23	-1.18
18 Wearing Apparel	0.01	0.38	2.86	0.90	0.71	0.89	-0.39	-1.36
19 Leather Products	0.01	0.25	1.15	0.80	0.24	0.61	-1.38	-1.21
20 Products of Wood	0.02	0.18	3.79	0.99	0.95	0.82	-0.03	-1.14
21 Pulp and Paper Products	0.03	0.13	0.80	0.83	0.08	0.57	-1.16	-1.08
22 Printing and Publishing	0.07	0.16	3.59	0.96	0.96	0.70	-0.08	-1.11
24 Chemical Products	0.07	0.16	1.67	0.91	0.40	0.74	-0.53	-1.11
25 Rubber Products	0.07	0.17	2.20	0.91	0.60	0.70	-0.33	-1.12
26 Non-metallic minerals	0.04	0.16	2.90	0.91	0.79	0.72	-0.20	-1.11
27 Basic Metals	0.04	0.18	2.40	0.92	0.65	0.72	-0.29	-1.13
28 Fabricated Metal Products	0.09	0.10	1.65	0.82	0.39	0.75	-0.48	-1.05
29 Machinery and Equipment	0.06	0.11	1.76	0.86	0.44	0.73	-0.43	-1.06
31 Electrical Machinery	0.04	0.17	2.21	0.84	0.55	0.84	-0.50	-1.12
32 Radio and Communication	0.03	0.16	2.09	0.81	0.57	0.68	-0.46	-1.12
33 Medical Instruments	0.08	0.12	1.61	0.81	0.37	0.76	-0.60	-1.07
34 Motor Vehicles, Trailers	0.09	0.20	2.51	0.91	0.68	0.73	-0.29	-1.15
35 Other Equipment	0.04	0.19	4.37	0.87	1.06	0.85	-0.15	-1.15

Changes in Aggregate Variables			
	$\Delta\%\text{TFP} = \left(\sum_{s=1}^{S}\theta_s \hat{\text{TFP}}_s\right)\times 100$	-0.35%	
	$\Delta\%Q = \left(\sum_{s=1}^{S}\theta_s \hat{Q}_s\right)\times 100$		-1.09%

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 $\psi \sim \log\mathcal{N}(\mu_{xs}, \sigma_{xs}^2)$.

TABLE X. THE ROLE OF THE INVERSE FOREIGN SUPPLY ELASTICITY - SENSITIVITY ANALYSIS

	MODEL IMPLIED η - ROBUSTNESS			BRODA ET AL. (2008)
	$\eta_s\|_{\bar{\psi}_s=\psi(p60)}$	$\eta_s\|_{\bar{\psi}_s=\psi(p80)}$	$\eta_s\|_{\bar{\psi}_s=\psi(p95)}$	η_s^{BLW}
SECTOR				
15 Food and Beverages	1.19	2.74	6.79	4.07
17 Textiles	0.68	1.84	4.82	3.72
18 Wearing Apparel	1.60	3.52	8.66	3.39
19 Leather Products	0.55	1.45	3.59	3.74
20 Products of Wood	2.27	4.57	10.54	3.56
21 Pulp and Paper Products	0.31	1.04	2.73	4.12
22 Printing and Publishing	2.23	4.28	9.35	3.73
24 Chemical Products	0.86	2.09	5.15	3.16
25 Rubber Products	1.25	2.68	6.21	3.83
26 Non-metallic minerals	1.73	3.49	7.85	2.98
27 Basic Metals	1.38	2.92	6.76	3.73
28 Fabricated Metal Products	0.84	2.07	5.16	3.07
29 Machinery and Equipment	0.92	2.18	5.34	4.12
31 Electrical Machinery	1.18	2.74	6.80	3.44
32 Radio and Communication	1.18	2.55	5.88	4.07
33 Medical Instruments	0.81	2.02	5.09	3.31
34 Motor Vehicles, Trailers	1.45	3.05	7.04	5.33
35 Other Equipment	2.64	5.27	12.15	5.54
Δ%TFP	-0.89%	-0.25%	-0.05%	-0.13%
Δ%Q	-1.53%	-0.94%	-0.47%	-0.74%

Notes: The table reports the counterfactual losses in TFP and Q using the alternative estimates of the foreign supply elasticity η. In the first three columns η_s are calculated using the model relationship $\eta_s = \bar{\psi}_s - 1$, where $\bar{\psi}_s$ is the buyer power of a firm with input market share $s_{is}^x \to 1$. I choose $\bar{\psi}_s$ at the 60th, 70th, and 80th percentiles of the sectoral distribution, respectively. Column 4 reports the estimates of η computed by Broda et al. (2008). I compute industry η_s as the median elasticity (HS4 product) in the industry.

TABLE IIIB. OUTPUT ELASTICITIES. INPUT PRICE CORRECTION AND SAMPLE SELECTION

		(A) NO INPUT PRICE CORRECTION					(B) NO SAMPLE SELECTION CORRECTION				
		β_L	β_K	β_M	β_X	RETURN TO SCALE	β_L	β_K	β_M	β_X	RETURN TO SCALE
	INDUSTRY										
15	Food Products and Beverages	0.21	0.07	0.56	0.14	0.99	0.29	0.08	0.52	0.10	0.99
17	Textiles	0.18	0.06	0.52	0.26	1.01	0.28	0.02	0.50	0.13	0.93
18	Wearing Apparel. Dressing	0.16	0.07	0.62	0.23	1.08	0.25	0.17	0.58	0.11	1.11
18	Leather. and Products	-0.09	0.25	0.50	0.15	0.81	0.21	0.22	0.54	0.04	1.01
20	Wood. and Products	0.34	0.22	0.51	0.13	1.20	0.32	0.30	0.46	0.11	1.20
21	Pulp. Paper. & Products	0.07	0.30	0.65	0.11	1.12	0.21	0.18	0.50	0.11	0.99
22	Printing and Publishing	1.12	0.00	0.26	0.38	1.76	0.77	-0.03	0.36	0.11	1.22
24	Chemicals. and Products	0.32	0.02	0.47	0.18	0.99	0.37	0.07	0.42	0.11	0.97
25	Rubber. Plastics. & Products	0.14	0.10	0.55	0.23	1.02	0.42	0.12	0.42	0.12	1.08
26	Non-metallic mineral Products	0.38	0.39	0.42	0.18	1.37	0.43	0.35	0.35	0.13	1.25
27	Basic Metals	0.04	0.14	0.40	0.22	0.81	0.41	0.07	0.42	0.15	1.05
28	Fabricated Metal Products	0.27	0.12	0.49	0.25	1.13	0.54	0.12	0.37	0.09	1.12
29	Machinery and Equipments	0.41	0.12	0.40	0.24	1.17	0.47	0.05	0.38	0.08	0.98
30	Electrical machinery & App.	0.13	0.01	0.57	0.30	1.01	0.38	0.04	0.45	0.10	0.98
31	Radio and Communication	-0.01	0.00	0.52	0.33	0.85	0.36	0.08	0.47	0.11	1.02
33	Medical. Precision. Optical Instr.	0.35	0.14	0.39	0.22	1.09	0.51	0.16	0.35	0.10	1.11
34	Motor Vehicles. Trailers	0.39	0.21	0.40	0.21	1.20	0.44	0.06	0.44	0.12	1.06
35	Other Transport Equipment	0.59	-0.09	0.19	0.23	0.93	0.61	-0.10	0.28	0.17	0.97

Notes: The table reports the output elasticities from production function estimation. In Columns (1)-(5), I report the results **O**f the 2 Steps GMM procedure on a sample of super-international firms, where I don't control for the unobserved price of domestic inputs (material input and capital). These coefficients are thus affected by the input price bias. Columns (6)-(11) reports the results of the procedure without correcting for sample selection. Column 5 and 11 reports the sectoral returns to scale.

TABLE IVB. MARKUPS, BY SECTOR

SECTOR	μ_{it}		
	MEAN	MEDIAN	STD DEV
15 Food and Beverages	1.05	1.00	0.26
17 Textiles	1.30	1.26	0.35
18 Wearing Apparel	1.11	1.01	0.46
19 Leather Products	1.24	1.16	0.40
20 Products of Wood	1.01	0.96	0.25
21 Pulp and Paper Products	1.21	1.15	0.27
22 Printing and Publishing	1.04	1.01	0.22
24 Chemical Products	1.10	1.06	0.25
25 Rubber Products	1.10	1.06	0.24
26 Non-metallic minerals	1.10	1.07	0.24
27 Basic Metals	1.09	1.05	0.26
28 Fabricated Metal Products	1.22	1.18	0.28
29 Machinery and Equipments	1.16	1.11	0.26
31 Electrical Machinery	1.19	1.15	0.27
32 Radio and Communication	1.24	1.19	0.28
33 Medical Instruments	1.24	1.20	0.31
34 Motor Vehicles, Trailers	1.10	1.04	0.27
35 Other Equipment	1.14	1.10	0.29
Average	1.15	1.10	0.29

Notes: The table reports the mean and median markups by sector for the preferred sample over the period 1996-2007. Markups are computed as the "joint distortion wedge" Ξ^m for the domestic material input. Imported intermediates are defined as total imports of the firm. Accordingly, domestic materials are defined as Total materials (raw materials and final goods) minus total imported materials. The table trims observations with markups that are above and below the 3^{rd} and 97^{th} percentiles within each sector.

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. The more extensive theoretical literature on price discrimination shows how suppliers may use nonlinear price schedules to price discriminate among different buyers, such that different buyers pay different prices for their inputs, consistent with the general equation (2). It is shown that both these models yield predictions for $\psi_{it}^{x} < 1$, and therefore are not compatible with the evidence for the French economy shown in Section 3.

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 Proxy Control Function for Unobserved Productivity

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

$$x_i = f(\omega_i, \psi_i, w_i^x, w_i^m | \varsigma_i) \tag{52}$$

$$m_i = g(\omega_i, \psi_i, w_i^x, w_i^m | \varsigma_i), \tag{53}$$

where ω_i is unobserved firm productivity, w_i^v with $v = x, m$ are the variable input prices, and **&** 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:

$$\psi_i = \tilde{g}(\omega_i, w_i^x, w_i^m, m_i). \tag{54}$$

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:

$$\begin{aligned} x_i &= x(\omega_i, m_i, w_i^x, w_i^m | \varsigma_i) && (55)\\ &= x(\omega_i, \tilde{m}_i, w_i^x, p_i, G_i | \varsigma_i), && (56) \end{aligned}$$

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 (56) to get

$$\omega_i = h\left(x_i, \tilde{m}_i, w_i^x, p_i, G_i | \varsigma_i\right), \tag{57}$$

which is equation (18) in the main text.

A.3 2 Steps GMM Estimation of the Production Function

In the main text, I derived the main estimating equation as:

$$\begin{aligned} q_{it} =& \beta_l l_{it} + \beta_k \tilde{k_{it}} + \beta_m \tilde{m}_{it} + \beta_x x_{it} + B(p_{it}, ms_{it}, \mathbf{G}_i; \mathbf{fi}) && (58)\\ &+ h_t(\tilde{k}_{it}, l_{it}, G_i, \Phi_{it}, w_{it}^x, p_{it}, \tilde{m}_{it}, x_{it}). + \epsilon_{it}. \end{aligned}$$

To estimate (58), 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 $(l_{it}, \tilde{k_{it}}, \tilde{m_{it}}, x_{it}, p_{it}, w_{it}^X, G_i)$:

$$q_{it} = \phi_t(l_{it}, \tilde{k_{it}}, \tilde{m_{it}}, x_{it}, p_{it}, w_{it}^X, G_i) + \epsilon_{it}. \tag{59}$$

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:

$$\omega_{it} = g(\omega_{it-1}) + \xi_{it}, \tag{60}$$

where I approximate $g(\cdot)$ as a second order polynomial in all its arguments. Using (58) and (59) we can express ω_{it} as

$$\omega_{it}(\mathbf{fi}) = \hat{\phi}_{it} - \left(\beta_l l_{it} + \beta_k \tilde{k_{it}} + \beta_m \tilde{m}_{it} + \beta_x x_{it} - (\beta_k + \beta_m) b(p_{it}, ms_{it}, \mathbf{G}_i)\right), \tag{61}$$

which we can substitute in (60) to derive an expression for the innovation in the productivity shock $\xi_{it}(\mathbf{fi})$ as a function of only observables and unknown parameters β. Given $\xi_{it}(\mathbf{fi})$, we can write the moments identifying conditions as:

$$\mathbb{E}\left(\ \xi_{it}(\beta) \ \mathbf{Y}_{it}\right) = 0, \tag{62}$$

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.4 Data Appendix

A.4.1 Variable Construction

Output is measured as total firm sales in a given year, deflated by the STAN industry output deflator. 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 derive (and try) two different measures of the capital input. For the first "rough" measure, I take the book value of capital reported at the historical value, infer a date of purchase from the installment quota given a proxy lifetime duration of Equipment, and then use deflators[39]. The second and preferred measure of capital is constructed 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 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

[39] I thank Claire Lelarge for this suggestion

(1996).

I construct the foreign intermediate input using information on all firm imports of intermediate inputs. In order to identify which imported product is used in production by the firm, I use the Broad Economic Classification (BEC) to identify NC8 digit products as intermediates, and restrict the attention to imports of intermediates only. My results are robust to using alternative definitions of foreign intermediates. Finally, to measure the expenditure on domestic inputs, I subtract the total value of imports of intermediates from the total expenditure on wares and inputs reported in the fiscal files (Blaum et al. (2018)).

A.4.2 Classification of Industries

I consider 17 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. I also drop sector 32 ("Radio, Television and Communication Equipment and Apparatus") for lack of precision in the production function estimation. 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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