Market Power in Input Markets:

Theory and Evidence from French Manufacturing

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Abstract

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

1   Introduction

Recent years have seen a fruitful debate on the impact of the rise of trade in intermediate inputs on a country's economic performance. A number of empirical studies have consistently shown that input trade benefits countries, by providing access to new products or varieties (Goldberg et al., 2009, 2010; Halpern et al., 2015; Blaum et al., 2018).

The literature has so far remained largely silent about the economic environment where importers operate, a key determinant of the effects of import activities on productivity and welfare (e.g. Raff and Schmitt, 2009; Bernard and Dhingra, 2019). What we know is based on the premise that importers act as price takers in foreign input markets. While it is recognized that international trade largely take place in less-than competitive environments (Dixit, 1984; Helpman and Krugman, 1989), there is surprisingly little evidence on the importance of imperfect competition in input trade at the microeconomic level, and on its macroeconomic implications.

Recent research based on micro data on firms and trade yet suggests that the market power of individual importers is potentially sizable. Large fixed costs of sourcing limit the ability of firms to select into importing (Antràs et al., 2017), effectively acting as barriers to competition. As a result, import activities are concentrated in a small number of large, highly performing firms (Bernard et al., 2007), who are likely aware of their dominant buyer position, and who might act to profit from it. The exercise of buyer power could in turn impair the efficiency of the production process and aggregate outcomes, and it ultimately affects in important ways the gains from input trade.

This paper takes a first step towards filling the empirical and theoretical gap by investigating both the empirical size of market power in foreign input trade, and its effects on aggregate variables. The main contributions of this study are twofold: (1) I combine modern econometric techniques with rich micro data to provide novel empirical evidence on the buyer power of importers; (2) I incorporate buyer power in a tractable heterogeneous firm model of production, and characterize its effect on aggregate variables, both qualitatively and quantitatively.

The starting point is a general reduced-form production framework that encompasses several models of imperfect competition and input trade. The analysis focuses on the optimal firm choice of foreign and domestic intermediate inputs. I define inputs as firm-level aggregates, and assume that, conditional on the extensive margin import decisions, firms can flexibly adjust both foreign and domestic intermediates in each period so as to minimize total variable costs. Importantly, I do not restrict competition in either the foreign or the domestic market.

I show that a measure of the firm's relative market power in the foreign input market, defined as the relative gap between the input price and its marginal revenue product, can be written as a function of two objects: the revenue shares of the two inputs, which are observed, and their output elasticities, which can be estimated jointly with the parameters of the production function. My approach is based on De Loecker and Warzynski (2012) and Dobbelaere and Mairesse (2013), but I extend their methodology to account for imperfect competition in all variable input markets.

Estimating the physical output elasticities of the different inputs in a context where input

markets are less than competitive is an important contribution of this paper. The key empirical challenge is that data on physical units of output or inputs are not observed, such that industry-wide price deflators are needed to eliminate price variation from nominal variables. This practice, standard in empirical work, leads to well-known output and input price biases if the unobserved prices differ across firms in a way that is correlated with the choice of inputs. Imperfect competition in either output or input markets is a source of such correlation (cf. Katayama et al., 2009; Foster et al., 2008; De Loecker and Goldberg, 2014).

I propose a novel approach to addressing both input and output price biases in estimation, which involves two main steps. First, I construct firm-level price deflators for output and the imported input, which I use to obtain measures of physical output and physical foreign intermediates. This step alleviates concerns about the output price bias, and the price bias associated with foreign inputs. To do so, I leverage data on unit values of exports and imports to construct a measure of the mean (normalized) price of output and the imported input, which I then use to induce across-firms variation in the industry price indices, thereby obtaining firm-level deflators.

The second step is building a control function for the unobserved prices of domestic intermediates. My approach builds on De Loecker et al. (2016), who used similar techniques to deal with unobserved price variation of competitive inputs. I show that, under certain conditions, the buyer share of a firm in a given input market is a sufficient statistic for the effect of buyer power on input prices. It follows that when input markets are less than competitive, such that firm-specific price variation can arise both through variation in input quality, and through differences in buyer power, one can use a flexible polynomial in observed output prices and seller and buyer shares of the firm to control for the price bias of domestic intermediates in estimation.

The bias correction approach dispenses with parametric assumptions on demand and/or market structure in all markets, consistent with the application of the paper. This is important, as it shows that the treatment of imperfect competition is feasible in empirical work, even when data on input or output prices are not directly available.

I apply my methodology using French longitudinal firm-level data on trade and production over the period 1996-2007. My results show that the relative input wedges are large, even with substantial heterogeneity, indicating the existence of distortions in the market of intermediate inputs. In particular, firm and industry behavior in foreign input markets seems to be distorted in the direction that models of monopsonistic or oligopsonistic competition would predict. In contrast, firm and industry behavior in domestic input markets seems close to efficient. The latter result has important implications for the growing empirical literature on the estimation of product and labor market imperfections, as it gives support to the (standard) assumption of competitive intermediate input markets, insofar as the imported share of intermediates is not too high.[1]

I show that the input wedges are higher in sectors that are highly concentrated, where import competition is low and where entry costs into import markets are relatively unimportant. Across

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[1]See, e.g. De Loecker and Warzynski, 2012; De Loecker et al., 2016; De Loecker and Eeckhout, 2017; Dobbelaere and Mairesse, 2013; Dobbelaere and Kiyota, 2018

firms, I find that large and productive firms are relatively more distorted than smaller, unproductive firms. Sector and firm-level analyses corroborate the interpretation of the wedges as buyer power.

The role of unobserved fixed costs of sourcing could raise important concerns about the structural interpretation of the input wedges. As these costs determine import sourcing patterns of firms (Antràs et al., 2017), if large firms disproportionately source from low-cost countries, where market entry costs are high, then they will spend less on shipments of the same size, ceteris paribus. The econometric framework might thus attribute differences in sourcing costs to differences in pricing power across firms. I rule out similar concerns by means of regression analysis. I follow Blaum et al. (2019) and construct sourcing strategy fixed effects, which I then use to purge the input wedges from the variation that is potentially unrelated to market power. The main results are virtually unaffected once I condition on the global sourcing strategy of individual firms.

I complement the findings from the analysis of the input wedges with reduced form evidence on the behavior of import prices at the firm-product-country level. I define an import market as a HS8 product-country-time combination and I show that, as predicted by models of imperfect competition in import markets, firm-level input prices are negatively and significantly correlated with the buyer share in a given import market. This result is robust to controlling for a large set of fixed effects, capturing differences in quality and/or sourcing strategy across firms.

The reduced form evidence contributes to the empirical literature studying the determinants of input price dispersion. Existing studies have emphasized the role of quality (Kugler and Verhoogen, 2012), and demand non-homotheticity (Blaum et al., 2019). Here, I suggest that the buyer power of importers further contributes to generating price dispersion. This has important implications, among other things, for empirical studies interested in understanding the pass-through of shocks into import prices (Feenstra, 1989; Fajgelbaum et al., 2019).

Motivated by the empirical analysis, in the second part of the paper I investigate the effect of buyer power of importers on aggregate variables. To do so, I incorporate buyer power in an otherwise standard general equilibrium model of a production economy with heterogeneous firms, in the spirit of Hsieh and Klenow (2009). In the model, input market power arises due to the existence of rents in horizontally segmented foreign markets, where the importer has a positive buyer share.

The benefits of focusing on a simple model of production are twofold. First, I can investigate the specific channels through which buyer power affects the production decisions of firms. Second, the model yields an analytical characterization of the static aggregate equilibrium distortions.

At the individual firm level, heterogeneous buyer power raises the marginal revenue product of the foreign input, leading to an inefficient substitution of the inputs in production, and to an inefficient firm size. Such allocative inefficiencies result in lower TFP, and lower aggregate output, compared to a counterfactual economy where all firms are price takers in the input markets.

A particularly interesting feature of the model is that, given parameters, the first and second moments of the distribution of the foreign input wedges are *sufficient statistics* for quantifying the losses in aggregate output and TFP due to buyer power. When I plug the estimated wedges in the relevant model equations, I find that by hypothetically eliminating the buyer power of French

importers, and its dispersion thereof, aggregate efficiency would increase by 6%, while aggregate output would increase by about 1%.

In spite of productivity and output distortions, the effect of buyer power on the country's welfare is ambiguous. Buyer power induces a terms-of-trade improvement for the country, such that the increase in profits stemming from rent transfers from foreign suppliers offset losses in aggregate output. The parallelism with the optimal tariff argument suggests that a planner maximizing national welfare could find it optimal to be lenient towards large, distorted, importers. As a result, a lenient national anti-trust policy could substitute for beggar-thy-neighbor trade policies.

The findings of the theoretical analysis contribute in important ways to several related literature in international trade and macroeconomics. Most directly, the results speak to the debate on the role of input trade in generating productivity gains for a country. To date, empirical work based on competitive frameworks has found large positive effects of input trade on productivity.[2] My results suggest that opening up to trade could increase a country's exposure to market distortions, leading to allocative inefficiencies in production. Therefore, the productivity gains of input trade could potentially be lower - by at least 6% - than what traditional studies assert.

My results also speak to the trade literature studying the effect of international trade on markups and competition.[3] Only a few studies have looked at the role of market power of importers for the gains from trade, either in the context of firm-to-firm trade (Bernard and Dhingra, 2019), or in the retail sector (Raff and Schmitt, 2009). The findings in this paper agree with these studies in concluding that the standard effects of a trade liberalization could be reversed due to the buyer power of importers.

This paper also relates to the macroeconomic literature on market power and misallocation.[4] To date, market power in input markets has received some implicit attention in the misallocation literature, but little explicit modeling. This paper is the first to study the effect of heterogenous buyer power on the equilibrium allocation of resources, while pointing out a new type of productivity loss through within-firm allocative inefficiencies, not yet addressed by the literature.

Finally, the findings of this paper speak to the current debate on the importance of market power of firms in the modern economy.[5] While I focus on the specific setting of foreign input markets, both my econometric framework and the theoretical model can be easily extended to think about buyer power in a variety of settings.

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 data and main empirical results, together with the reduced form evidence on buyer power. In section 4 I introduce the theoretical model, the main theoretical results, and the counterfactual exercise. Section 5 concludes.

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[2]See Amiti and Konings, 2007; Gopinath and Neiman, 2014; Topalova and Khandelwal, 2011; Halpern et al., 2015 and Muendler, 2004, for an exception.

[3]See Harrison, 1994; Chen et al., 2009; De Loecker and Warzynski, 2012; De Loecker et al., 2016; Arkolakis et al., 2018; Dhingra and Morrow, 2019

[4]See Epifani and Gancia, 2011; Holmes et al., 2014; Edmond et al., 2015; Peters, 2016; Asker et al., 2018

[5]See De Loecker and Eeckhout, 2017, 2018; Gutiérrez and Philippon, 2017; Syverson, 2019; Eggertsson et al., 2018

2 Empirical Model: A Framework to Estimate Input Market Power

This section sets up an econometric framework to estimate a measure of imperfect competition in input trade. I first describe a general theoretical framework of production that encompasses several models of imperfect competition and input trade. I focus on the optimal firm choice of foreign and domestic intermediate inputs. I show that the ratio of the first order conditions of the two intermediate inputs gives an expression that relates the relative market distortions in the foreign market as a function of observed expenditure shares of the two inputs, and their output elasticities.

I do this in Section 2.1. In section 2.2, I describe a procedure for production function estimation that yields consistent estimates of the output elasticities given the available data.

My approach is based on Hall (1986); De Loecker and Warzynski (2012) and Dobbelaere and Mairesse (2013), but I extend their methodology by dispensing with restrictions on competition in any variable input market. This generalization affects in important ways both the interpretation of the wedges, and the production function estimation procedure.

Notably, the generalization allows for the possibility that large importers can distort prices more in domestic than in foreign intermediate input markets, where their market power is potentially countervailed by large foreign competitors or large sellers (exporters). This is important for two reasons: first, because the effect of buyer power of importers on aggregate variables depends on whether international markets are more or less competitive than domestic ones (Helpman and Krugman, 1989). In other words, it is the market structure of both foreign and domestic input markets, or their difference thereof, the ultimate object of interest for studies of the gains from trade. Second, because the theoretical framework can be reconciled with the recent evidence that market power in firm-to-firm trade is important both within and across borders (Kikkawa et al., 2019), as well as with the granularity of both exporters and importers (Freund and Pierola, 2015; Bernard et al., 2018; Gaubert and Itskhoki, 2019).

2.1 Conceptual Framework

The economy is populated by a mass of firms, indexed by i, which purchase multiple inputs to produce. Inputs can either be sourced domestically or can be imported. Any firm i produces output in each period according to the following technology:

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

where $\mathbf{V}_{it}$ is the vector of variable inputs in production, which the firm can flexibly adjust in each period, and $\mathbf{K}_{it}$ is the vector of "dynamic" inputs, such as capital or labor, which are subject to adjustment costs or time-to-build. I restrict to well-behaved production technologies, and assume that $Q(\cdot)$ is twice continuously differentiable with respect to its arguments.

The vector Θ_{it} includes all the state variables relevant to the firm at the time of production. Importantly, it is assumed that the vector Θ_{it} includes the firm's import sourcing strategy, i.e. a

measure of its extensive margin of imports in the spirit of Antràs et al. (2017) and Blaum et al. (2019). This assumption implies separability between the intensive and extensive margin of firms' import, such that firms' import choices at the intensive margin are the solution to a static cost minimization problem. In other words, the firm imported input is a variable input in production.

Given the application of this paper, I assume that each firm chooses exactly two variable inputs in production, namely a *domestic* intermediate input, which I denote by M_{it}; and a *foreign* intermediate input, which I denote by X_{it}.[6] 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 in the market of input $V = M, X$, I consider the following mapping between input price and input demand of firm i:

$$W_{it}^v = W\left(V_{it}; \mathbf{A}_{it}\right) \tag{2}$$

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

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

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

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

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

$$\psi_{it}^v \equiv 1 + \frac{\partial W_{it}^v}{\partial V_{it}}\frac{V_{it}}{W_{it}^v}, \text{ for } v = m, x. \tag{5}$$

I consider ψ_{it}^v as a measure of firm i's input market power in the market of $v = \{m, x\}$.

Let us denote firm-level markups as price over marginal costs, i.e. $\mu_{it} = P_{it}/\lambda_{it}$. It is easy to

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

show using simple algebra that equation (4) can be rewritten as:

$$\Xi_{it}^v \equiv \psi_{it}^v \cdot \mu_{it} = \frac{\theta_{it}^v}{\alpha_{it}^v}, \text{ for } v = m, x. \tag{6}$$

In other words, a measure of the overall (output and input) market distortions affecting firm be-havior, which I denote as Ξ_{it}^v, can be written as a function of the output elasticity of the input, i.e. $\theta_{it}^v \equiv \frac{\partial Q_{it} V_{it}}{\partial V_{it} Q_{it}}$, and the share of expenditure on the input over total firm's revenues $\alpha_{it}^v \equiv \frac{W_{it}^v V_{it}}{P_{it} Q_{it}}$, for $v = m, x$. If firms are price takers in both output and input markets, then $\Xi_{it}^v = 1$ such that the firm spends on input v a share of revenues equal to the input's output elasticity.

Equation (6) holds for any static input $V_{it} \in \mathbf{V}_{it}$. Given data on *two* static inputs, such as in this case domestic and foreign intermediates, we can get rid of the common (and unobservable) markup term by solving for the *relative* input market power as:

$$\frac{\psi_{it}^x}{\psi_{it}^m} = \frac{\theta_{it}^x}{\theta_{it}^m} \cdot \frac{\alpha_{it}^m}{\alpha_{it}^x}, \tag{7}$$

which is a function of observable shares, and output elasticities only. This expression will constitute the main estimating equation of this paper: the input expenditure shares are directly observed in the data, while the output elasticities can be estimated jointly with production function estimation.

Note that when the domestic input market is assumed competitive (such that $\psi_{it}^m = 1$), the right hand side of equation (7) identifies the *level* of input market power in the market of X as

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

Intuitively, when firms are price takers in the market for input M_{it}, its first order condition (i.e. equation (6)) identifies the firm-level markup as a function of observables. By substituting the markup in the FOC for the foreign input, equation (8) directly follows.

The identification of firm-level markups from wedges in the first order condition of a static competitive input is the main insight of a growing literature of markup estimation (Hall, 1988; De Loecker and Warzynski, 2012; De Loecker et al., 2016), as well as estimation of labor market imperfection (Dobbelaere and Mairesse, 2013; Dobbelaere and Kiyota, 2018; Nesta et al., 2018). The discussion above makes clear that when input market power is mistakenly overlooked (i.e. when $\psi_{it}^m \neq 1$), standard approaches would over- or under- estimate the true level of markups, and in turn under- or over-estimate the level of input market imperfections, depending on whether $\psi_{it}^m \gtrless 1$.

2.1.1 Interpreting the Input Efficiency Wedges

The supply function in (2) can be reconciled with a number of models of imperfect competition in the input markets, and the interpretation of the wedges ψ_{it}^x and ψ_{it}^m, and of their ratio thereof, can vary accordingly. Let ψ_{it} define the input wedge in a generic input market. In models of monopsonistic competition, the function in (2) corresponds to the inverse of the input supply function, which is

TABLE I. VALUE OF ψ_{it} AND INPUT MARKET STRUCTURE

VALUE OF ψ_{it}	$\psi_{it} > 1$	$\psi_{it} = 1$	$\psi_{it} < 1$
TYPE OF COMPETITION	Monopsony/ Oligopsony	Perfect Competition	Quantity Discount/ Efficient Bargaining

typically characterized by a positive supply elasticity. This class of models implies that $\psi_{it} \geq 1$.[7]

Values of $\psi_{it} < 1$ are also admissible. Dobbelaere and Mairesse (2013) show that in models of efficient bargaining, equation (6) identifies ψ_{it} as a function of the relative bargaining power of firms. This class of models are consistent with values of $\psi_{it} < 1$. In Appendix B.1, I show that a model with second degree price discrimination (quantity discounts), and a model with two-part tariffs, also yield an equilibrium expression for input prices similar to (2), and command values of ψ_{it} below unity. More generally, this is the case whenever the input price decreases with the quantity purchased by the firm, i.e. whenever $\frac{\partial W_{it}^v}{\partial V_{it}} \frac{V_{it}}{W_{it}^v} < 0$. Table 1 summarizes the relationship between the values of the wedge ψ_{it} and models of input competition.

This discussion implies that the structural interpretation of the ratio $\psi_{it}^x / \psi_{it}^m$ depends in important ways on whether the nature of competition is similar in the two markets, namely, on whether $sign(\psi_{it}^x - 1) = sign(\psi_{it}^m - 1)$. Knowing the ratio $\psi_{it}^x / \psi_{it}^m$ is not sufficient in itself to establish the type of competition prevailing in the two markets. In Section 3, I show that one can make progress by leveraging (external) information on the markup distribution of firms. If the latter information was available, one could get an estimate of the input wedges ψ_{it}^x and ψ_{it}^m, by purging the overall market distortion wedges Ξ_{it}^x and Ξ_{it}^m by the variation that is due to the markup μ_{it}.

2.1.2 Discussion

Equation (7) identifies the relative input market imperfections in the foreign versus domestic market under two important conditions. The first is that both the domestic and the foreign intermediate inputs are static inputs in production. This assumption can raise concerns, especially when it comes to foreign markets, in light of the evidence of substantial costs associated with international trade, which include market entry costs (Roberts and Tybout, 1997; Das et al., 2007; Antràs et al., 2017), as well as inventory costs and delivery lags (Alessandria et al., 2010, 2013). On the one hand, the use of yearly data partially prevents delivery lags and inventory management from substantially affecting the results. On the other hand, the assumption of separability between intensive and extensive margin import decisions addresses the concern that fixed entry costs can confound the effect of market imperfections on the estimated wedges. In the empirical analysis, I operationalize the assumption by conditioning the analysis, wherever possible, on the sourcing strategy of the firms (e.g. Blaum et al., 2019).

A second, important, identification condition is that measures of *physical* output elasticities of

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

the two intermediate inputs can be obtained, given the available data. It is well-known that when firm-level prices of output and inputs are not observed, as in this paper, standard practices in the empirical literature estimating production functions lead to both input and output price biases in estimation if markets are less than competitive.

This paper contributes a methodology to address price biases in estimation in a context where markets are less than competitive, and firm level prices are not directly observed. I will describe the details of my approach in Section 2.2 and 3. To that end, an important preliminary step is to describe what the theoretical framework implies in terms of behavior of input prices in presence of imperfect competition.

2.1.3   Buyer Power and Input Prices

Let us consider the first order condition in (4) and write the price of input V in equilibrium as:

$$W_{it}^v = MFC_{it}^v \cdot (\psi_{it}^v)^{-1}, \tag{9}$$

where $MFC_{it}^v \equiv \lambda_{it} \frac{\partial Q_{it}(\cdot)}{\partial V_{it}}$ is the marginal factor cost, and ψ_{it}^v is the buyer power wedge.

When the input market is competitive, $\psi_{it}^v = 1$, and the price only depends on the marginal cost. In competitive frameworks, firm-specific input price variation can then arise through exogenous variation in input prices across local input markets, and/or variation in input quality (De Loecker et al., 2016). Let us denote input quality as ι^v, and let the parameter G_i summarize exogenous price relevant variables, such as firm location. It follows that we can write $W_{it}^v = MFC_{it}^v = W_i^v(\iota_{it}^\nu, G_i)$.

To account for the role of imperfect competition, let $V_{It} = V_{it} + V_{-it}$ the total demand of input V, where V_{-it} is total demand of $i's$ competitors. Using its definition, it is easy to show that buyer power ψ_{it}^v can be written as:

$$\psi_{it}^v \equiv 1 + \frac{\partial W_{it}^v}{\partial V_{it}} \frac{V_{it}}{W_{it}^v} \simeq 1 + \eta_t^v \cdot s_{it}^v, \tag{10}$$

where $\eta_t^v \equiv \frac{\partial W_{it}^v}{\partial V_{It}} \frac{V_{It}}{W_{it}^v}$ is the elasticity of the input price with respect to aggregate demand, which is a feature of the supply technology, and $s_{it}^v \equiv \frac{V_{it}}{V_{It}}$ is the share of $i's$ demand over total input demand.

Putting pieces together, the unit price paid by firm i for input V can be written as:

$$W_{it}^v = W_i^v(\iota_{it}^\nu, G_i) \cdot (1 + \eta_t^v \cdot s_{it}^v) = W_i^v(\iota_{v,t}, s_{it}^v, G_i; \eta^v). \tag{11}$$

When input markets are less than competitive, firms buying the same product from the same location pay different prices if their buyer share differs: the higher the share, the lower the price.

Importantly, when the input supply elasticity is approximately constant among customers (firms), in the class of models considered here the input market share of the firm is a *sufficient statistic* for the effect of buyer power on input prices. I will take advantage of this property of input prices both to address input price bias in estimation and to interpret the reduced form evidence in Section 3.5.

2.2 Estimating the Output Elasticities

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

$$Q_{it} = \exp(\omega_{it} + \epsilon_{it}) F_t(K_{it}, L_{it}, M_{it}, X_{it}; \beta), \tag{12}$$

where Q_{it} is physical output, obtained using capital (K_{it}), labor (L_{it}), domestic intermediates (M_{it}), and foreign intermediates (X_{it}). The function $F(\cdot)$ satisfies standard regularity conditions. The term ω_{it} reflects a Hicks-neutral firm-specific productivity shock, while ϵ_{it} captures measurement error and idiosyncratic shocks to production. Neither ω_{it} nor ϵ_{it} are observed by the researcher.

I specify the state variable vector as $\varsigma_{it} = \{\omega_{it}, K_{it}, L_{it}, G_i, \Sigma_{it}\}$, where G_i denotes firms' observable characteristics that might affect material prices (such as firm location), and Σ_{it} is the firm's import sourcing strategy. This means that I consider both the capital and the labor input as dynamic inputs, which the firm chooses one period in advance.

Estimation of (12) requires dealing with several sources of biases. Along with a well-known simultaneity problem caused by the unobserved productivity term ω_{it} (e.g. Olley and Pakes, 1996), the lack of direct data on the quantity produced - as well as input used - by the firm typically implies the existence of both output and input price biases in estimation.[8]

I deal with the simultaneity bias using standard techniques in the industrial organization literature. In particular, I follow the methodology in Ackerberg et al. (2015). The treatment of the output and input price bias is instead original, and it involves two main steps: I first exploit trade data to construct firm-level deflators of output and the imported input. This step deals with the output price bias, as well as the bias in the foreign input market. To deal with the price bias in the domestic markets, I build on the approach developed by De Loecker et al. (2016), while extending their approach to non competitive input markets.

I introduce my estimation procedure, together with my bias-correction approach, in section 2.2.1. I then discuss extensions of the baseline model in section 2.2.2. I describe all the details of the estimation biases and my estimation strategy in section B.3 of the Appendix.

2.2.1 Estimation Procedure

I write the production function in (12) in log terms as follows:

$$q_{it} = f(l_{it}, k_{it}, m_{it}, x_{it}; \beta) + \omega_{it} + \epsilon_{it}, \tag{13}$$

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

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[8]See De Loecker and Goldberg (2014); Syverson (2004); Katayama et al. (2009); De Loecker et al. (2016); De Loecker (2011) for theoretical and empirical treatments of the input and (especially) output price biases.

For the baseline specification, I consider a Cobb-Douglas production function (hereafter, CD) that implies that $f(\cdot)$ is approximated by a first-order polynomial in all its inputs. I will discuss advantages and disadvantages of the CD assumption at the end of this section. To ease exposition, in what follows I will explicitly write equation (13) in its CD form. All the results can be easily extended to more flexible approximations of $f(\cdot)$.

Output Price Bias When information on the quantity produced by the firm is not available, the standard approach in the empirical literature has been to construct a measure of output as $\tilde{Q}_{it} = R_{it}/P_{It}$, where R_{it} is firm-level sales and P_{It} is an industry-wide producer price deflator. Using this definition, one can rewrite equation (13), in logs, as

$$\tilde{q}_{it} = \beta_l l_{it} + \beta_k k_{it} + \beta_m m_{it} + \beta_x x_{it} + (p_{it} - p_{It}) + \omega_{it} + \epsilon_{it} \tag{14}$$

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

My approach to control for output price bias involves the construction of a control for the unobserved term $\hat{p}_{it} = (p_{it} - p_{It})$. I do so by leveraging information on export prices at the firm-product-destination country level, available from international trade data. In the data, I observe how much the firm price deviates from the industry average in each export market, i.e. $\hat{p}_{ipt} = (p_{ipt} - p_{Ipt})$, for each market p. Intuitively, the term $\hat{p}_{it}$ can be easily constructed by aggregate market observations at the level of the firm. I then use $\hat{p}_{it}$ to obtain a *firm-level* price deflator of output as

$$P_{it} = P_{It} \cdot \hat{p}_{it}, \tag{15}$$

thus generating firm-level variation in the industry level output prices. Using P_{it} as a deflators for revenues alleviates the concerns of output price bias in estimation.[9]

Input Price Bias When input quantities are not observed, measures of physical inputs are typically constructed as expenditures deflated by an industry price index of the input, i.e. $\tilde{V}_{it} = E_{it}^V/W_{It}^V$, for each input V. An input price bias arises as firm-level prices for the input systematically deviates from the industry deflator, namely if $\exists \; W_{it}^V \neq W_{It}^V$ for some i. In my setting, the input price bias this is potentially a concern for domestic material and capital inputs, M_{it} and K_{it}, and for the foreign intermediate input X_{it}. Labor, on the other hand, is measured in physical units, and thus does not generate similar problems.

Let us formally introduce the problem by focusing on domestic materials M_{it}, and capital K_{it}.

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

By substituting the observed deflated expenditures in equation (13), we get:

$$q_{it} = \beta_l l_{it} + \beta_k \tilde{k}_{it} + \beta_m \tilde{m}_{it} + \beta_x x_{it} + B(\mathbf{\bar{w}_{It}} - \mathbf{w_{it}}; \boldsymbol{\beta}) + \omega_{it} + \epsilon_{it}. \tag{16}$$

The term $B(\mathbf{\bar{w}_{It}} - \mathbf{w_{it}}; \boldsymbol{\beta}) = \beta_k(w_{It}^k - w_{it}^k) + \beta_m(w_{It}^m - w_{it}^m)$ is unobserved, and captures the input price bias for the two inputs. I propose an approach to control for unobserved input prices using information on observables, building on De Loecker et al. (2016). I provide a formal argument that rationalizes my approach in Appendix B.2, while I summarize the intuition in what follows.

As discussed in section 2.1.3, when markets are less than competitive firm-specific input price variation can arise through exogenous factors, such as firm location (G_i), or input quality (ι_{it}), and\or differences in buyer power. De Loecker et al. (2016) show that the first two sources of price variation can be captured by a flexible polynomial in output prices (p_{it}), and seller shares (ms_{it}).

In section 2.1.3 I argued that, when the supply elasticity of the input is approximately constant across firms, the buyer share in a given market is a sufficient statistic for the effect of buyer power on prices, such that when markets are less than competitive, one can control for unobserved input prices by adding a control for the buyer share $s_{it}^v = \frac{W_{It}^v V_{it}}{W_{It}^v(V_{it}+V_{-it})}$, for a given input v.

In my application, I allow for imperfect competition in the market of input M_{it}. Because data on buyer shares are less reliable for the market of capital, and because input price bias is less of a concern for the capital input, in the baseline estimation I am going to assume that capital is competitive instead. It follows that I construct measures of the unobserved price variations in the two markets as:

$$(w_{It}^m - w_{it}^m) = B^m(p_{it}, ms_{it}, G_i, s_{it}^m, ; \boldsymbol{\rho^m}), \tag{17}$$

$$(w_{It}^k - w_{it}^k) = B^k(p_{it}, ms_{it}, G_i; \boldsymbol{\rho^k}). \tag{18}$$

Together, equations (17) and (18) imply that I can write the unobserved price term as:

$$B(\mathbf{\bar{w}_{It}} - \mathbf{w_{it}}; \boldsymbol{\beta}) = B(p_{it}, ms_{it}, G_i, s_{it}^m; \boldsymbol{\rho}). \tag{19}$$

Since I am not interested in the identification of the coefficients on the price function (ρ^m, ρ^k), controlling for input price bias in this setting is tantamount to controlling for a flexible polynomial in output prices (p_{it}), exogenous variables(G_i), and buyer (s_{it}^m) and seller (ms_{it}) shares. Note that this input control function can also alleviate concerns of quality bias that arise when using deflated expenditures in place of physical inputs.

Foreign Intermediate Inputs   In principle, one could extend the input control function in (17) to control for price differences in foreign input markets. However, this is not necessary in our context, given that information on input prices are directly observed in customs data. To that end, I obtain a physical measure of the imported intermediate X_{it} using a procedure similar to the one used for the output variable. I let $\hat{w_{it}^X}$ denote a measure of average firm deviation from the industry-level

price of different imported inputs, which can be constructed from customs import price data. I then define a firm-level import price deflator as

$$W_{it}^X = W_{It}^X \cdot \hat{w_{it}^X}, \tag{20}$$

where W_{It}^x is an import price index at the industry level, which is observed. Finally, I construct a measure of X_{it} by deflating total expenditure on foreign intermediate inputs E_{it}^X by this firm level import price deflator W_{it}^x. In doing so, I take into account average differences in prices for the intermediate input among firms, such that concerns about input price bias for input X_{it} are avoided.

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). As I show in the Appendix B.3.1, the unobserved term ω_{it} can be written as a nonparametric function of observables as:

$$\omega_{it} = h_t(\tilde{k}_{it}, l_{it}, \tilde{m}_{it}, x_{it}, w_{it}^x, p_{it}, ms_{it}, s_{it}^m, \Sigma_{it}, G_i). \tag{21}$$

This expression can be used in equation (13) to control for firm's productivity. Importantly, note that the proxy function for unobserved productivity includes a control for the extensive margin of import Σ_{it}. This is important, as research has shown that productivity measures can be biased due to offshoring (Houseman et al. (2010)). By comparing firms that are similar in terms of sourcing patterns can help alleviating this concern.

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

$$\begin{aligned} q_{it} =& \beta_l l_{it} + \beta_k \tilde{k}_{it} + \beta_m \tilde{m}_{it} + \beta_x x_{it} + B(p_{it}, ms_{it}, G_i, s_{it}^m; \boldsymbol{\beta}) \\ &+ h_t(\tilde{k}_{it}, l_{it}, \tilde{m}_{it}, \tilde{x}_{it}, w_{it}^x, p_{it}, ms_{it}, s_{it}^m, \Sigma_{it}, G_i) + \epsilon_{it}. \end{aligned} \tag{22}$$

To estimate (22), I follow the 2-steps GMM procedure in Ackerberg et al. (2015).[10] For my baseline estimation, I run the GMM procedure on a sample of firms that simultaneously import and export for two consecutive years. I focus on this subsample of firms because these are the firms for which information on both input and output prices are available.

2.2.2   Discussion and Extensions

The choice of a CD specification of the production function $f(\cdot)$ has several advantages, including the fact that it involves the estimation of a low number of parameters. Choosing the more flexible translog (TL) specification, which involves a second or higher order polynomial approximation of

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[10]See Appendix B.3.2 for more details on the estimation procedure.

$f(\cdot)$, is not feasible in this case, due to the fact that the high number of inputs implies a very large number of coefficients to be estimated, i.e. 20, which can lead to serious collinearity concerns. In the empirical section, I will show results of production function estimation both for the CD case and for the TL case, while pointing out the main problems associated with the TL.

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

The second concern is that the CD exhibits a unit elasticity of substitution among all inputs. This feature of the CD could potentially bias the results in case of important substitutability among foreign and domestic intermediates, which is typically assumed in studies of input trade (Gopinath and Neiman, 2014; Halpern et al., 2015; Blaum et al., 2018).

In principle, the econometric framework could be accommodated to any well-behaved production function. However, existing methods for CES production function estimation crucially rely on the assumption of perfect competition in input markets, and cannot be easily adapted to the current framework (e.g. Halpern et al., 2015; Grieco et al., 2016). The similarity between the qualitative results obtained using a CD and TL specification of technology shows that the choice of a CD specification is inconsequential for the main qualitative results of the paper.

3   Data and Empirical Results

In this section, I rely on the empirical framework in Section 2 to gain insights about the nature of competition prevailing in input trade, for firms operating in a large open economy. Almost the entirety of the literature on input trade relies on the assumption of perfectly competitive input markets.[11] The evidence provided in this paper complements the existing empirical findings, and it also provides new insights for theoretical work.

Once I present the main empirical results, in Section 3.5 I provide additional reduced form empirical evidence that validates the main model assumptions as well as the structural interpretation of the wedges. It follows a discussion on the potential sources of market power in foreign input markets.

3.1   Data

I employ two longitudinal datasets covering the activity of the universe of French manufacturing firms during the period 1996 - 2007. The first dataset contains the full company accounts, including nominal measures of output and different inputs in production, such as capital, labor, and intermediate inputs, at the firm level. The second dataset comes from official files of the French custom

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

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.[12] I describe the construction of the main variables in the Data Appendix.

I select only the firms that both import and export in a given year. These are the firms for which I can observe input and output prices. I will refer to them as "international firms".

Table 2 provides summary statistics for the selected firms. International firms are about 46% of the population of manufacturing firms in France, and they account for about 80% of total manufacturing value added. Consistent with the findings of a large empirical literature on firms and trade (e.g. Bernard and Jensen, 1999; Bernard et al., 2007, 2009), the French data confirm a sizable size and productivity premium of manufacturing importers. These firms heavily rely on foreign intermediates in production: imported inputs account for about a quarter of total material expenditure. The final sample includes around 14 thousands firms per year, spread across 18 two-digit manufacturing sectors.

<div align="center">

TABLE II. SUMMARY STATISTICS (2005)

</div>

Sample	International Firms
Number of Firms	14,206
(% of total)	46%
(% in total value added)	80%
(log) sales premium [a]	0.62
(log) wage premium	0.04
(log) TFP premium[b]	0.10
Belongs to a MNE[c]	50%
Imported Share of Intermediates	26%

Source: Author's calculations. Notes: The number of manufacturing firms in a given year is, after basic cleaning, 30,840.[a] The (log) premium of variable x is computed as the percentage difference in the average x between international firms and the average manufacturer. [b] TFP is computed as real value-added per worker. [c] Benchmark (All firms): 35% A firm is classified as MNE if it belongs to either a French private, or a Foreign private business group.

Table 3 summarizes the means, standard deviations and quartile values of the revenue share of all inputs, as well as of measures of extensive and intensive margin of imports. As expected for firm-level data, the dispersion of all these variables across firms is large. Firm heterogeneity is particularly dramatic when it comes to import behavior, as it can be seen from the 10/90 gap of almost all the import variables. This implies that there is large heterogeneity in the use of foreign inputs in production, which is a feature I will take into account later on when I discuss the robustness of my main results.

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[12]See Blaum et al. (2018) for a detailed description of these data sources.

TABLE III. DISTRIBUTION QUANTILES (1996-2007)

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

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

Domestic Intermediate Inputs   The econometric framework introduced in Section 2 makes clear that the input market power in the market of foreign intermediate inputs can only be identified in relation to a second variable input. I focus on the domestic intermediate input as my second input of interest.

One might be worried that as imperfect competition is potentially large in domestic material input markets, the lack of good data on domestic buyer shares could undermine the ability of the price function in (19) to control for input price bias in estimation, leading to biased results.

In principle, the gross output production function setting allows for multiple variable inputs in production, such that foreign input market power can be computed in relation to any other variable input. A particularly interesting candidate is labor. Since labor is measured in physical units, choosing labor as the variable input of interest would alleviate concerns of input price bias in estimation. However, a well-known feature of labor markets in France is the high degree of regulation to which they are subject, which implies high adjustment costs, especially for large firms.[13] For these reasons, labor is better thought as a dynamic input in this context, and is not a good candidate for the analysis.

Firm-level Prices of Output and Imported Input   I now explain how I construct firm-level deflators for output and the imported input, while leveraging the richness of trade data. In equations (15) and (20), I define firm-level price deflators of output and imported input as $P_{it} = P_{It} \cdot \hat{p}_{it}$, and

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

$W^X_{it} = W^X_{It} \cdot \hat{w}^X_{it}$, respectively, where P_{It} and W^X_{It} are the 2-digit industry output and import deflators, available from public sources.

The (unobserved) terms $\hat{p}_{it}$ and $\hat{w}^x_{it}$ denote firm-level deviations from the industry average prices. I construct the output $(\hat{p}_{it})$ and imported input $\left(\hat{w}^x_{it}\right)$ terms by running the following regression:[14]

$$\log \left(uv^j{}_{iknt}\right) = \theta^j_{it} + c^j_{knt} + \epsilon_{iknt}, \tag{23}$$

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 $(j = IM)$. The variable in the left hand side is the log of the unit value uv^j_{iknt} that firm i charges (pays) for product k sold in (sourced from) country n in year t. I calculate the unit value as value over quantity, for each i, k, n, t quadruple.

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}). 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 the average firm-level deviation from these average prices. In other words, θ^j_{it} represents firm-level average (relative) prices purged of effects due to the composition of products.

I define firm-level average relative input prices of output and imported inputs as these OLS estimates, namely $\hat{p}_{it} = \hat{\theta}^{EX}_{it}$, and $\hat{w}^x_{it} = \hat{\theta}^{IM}_{it}$.[15]

Table A1 in the Appendix summarizes the means, standard deviations and quartile values of $\hat{p}_{it}$ and $\hat{w}^x_{it}$. There is substantial variation in these relative prices across firms. Panel B of Table A1 shows that firm-level relative prices are significantly correlated with both material inputs, and output. This evidence suggests that both input and output price bias are potentially important concerns for production function estimation.

Finally, note that the term $\hat{p}_{it}$ also coincides with the measure of output price that I am going to use in the input control function for unobserved domestic input prices, as well as in the proxy control function for unobserved productivity.[16]

3.2 Output Elasticities

I first analyze the results of production function estimation. Table 4 reports the estimated output elasticities when production function is Cobb-Douglas (CD hereafter) together with standard errors, which I obtain by block bootstrapping over the entire procedure. The CD elasticities are largely in line with standard estimates in the literature.

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[14]Bastos et al. (2018) use a similar procedure to construct firm-level intermediate input prices using Portuguese data.

[15]Note that output prices are inferred from export price data. The underlying assumption is that firm price behavior relative to other French firms does not systematically change in export and domestic output markets. In other words, I am assuming that if a French firm charges a higher price than a second French firm for a given product in a given export destination, the same will be true if these two firms were to sell the same product in the domestic market.

[16]The average (relative) firm output market share $\hat{ms}_{it}$ is constructed in a similar way, starting from information on the firm's market share in each individual export market.

<center>Table IV. Output Elasticities, Cobb-Douglas, By Sector</center>

	Industry	β_K	β_L	β_M	β_X	Return to Scale
15	Food Products and Beverages	0.07 (0.01)	0.20 (0.004)	0.54 (0.003)	0.14 (0.002)	0.96
17	Textiles	0.02 (0.02)	0.25 (0.01)	0.37 (0.005)	0.22 (0.004)	0.87
18	Wearing Apparel, Dressing	0.13 (0.02)	0.25 (0.01)	0.35 (0.006)	0.25 (0.005)	0.99
19	Leather, and Products	0.03 (0.03)	0.28 (0.01)	0.36 (0.009)	0.25 (0.006)	0.93
20	Wood, and Products	0.05 (0.01)	0.28 (0.01)	0.49 (0.005)	0.16 (0.003)	0.98
21	Pulp, Paper, & Products	0.06 (0.02)	0.30 (0.01)	0.40 (0.005)	0.16 (0.004)	0.92
22	Printing and Publishing	0.09 (0.02)	0.43 (0.01)	0.34 (0.006)	0.15 (0.005)	1.01
24	Chemicals, and Products	0.06 (0.01)	0.29 (0.01)	0.42 (0.004)	0.17 (0.003)	0.95
25	Rubber, Plastics, & Products	0.12 (0.01)	0.33 (0.005)	0.41 (0.004)	0.16 (0.003)	1.01
26	Non-metallic mineral Products	0.14 (0.02)	0.34 (0.01)	0.39 (0.005)	0.13 (0.004)	1.01
27	Basic Metals	0.07 (0.02)	0.24 (0.01)	0.38 (0.006)	0.21 (0.005)	0.90
28	Fabricated Metal Products	0.11 (0.01)	0.36 (0.004)	0.37 (0.003)	0.14 (0.002)	0.97
29	Machinery and Equipment	0.07 (0.01)	0.38 (0.01)	0.37 (0.004)	0.16 (0.002)	0.98
31	Electrical machinery & App.	0.07 (0.02)	0.34 (0.01)	0.38 (0.006)	0.17 (0.004)	0.97
32	Radio and Communication	0.15 (0.02)	0.35 (0.01)	0.35 (0.008)	0.16 (0.006)	1.00
33	Medical, Precision, Optical Instr.	0.07 (0.02)	0.40 (0.01)	0.32 (0.005)	0.17 (0.004)	0.96
34	Motor Vehicles, Trailers	0.09 (0.02)	0.29 (0.01)	0.39 (0.007)	0.18 (0.005)	0.95
35	Other Transport Equipment	0.05 (0.13)	0.37 (0.16)	0.32 (0.04)	0.19 (0.05)	0.93

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

in Section TL of the Appendix, I discuss the results of the estimation when I consider the more conventional Translog (TL) specification of the production function. The problem of using a TL production function in this context is that the large positive skewness of the import distribution generates extreme estimates of the output elasticities. This explains the focus on the CD specification for my baseline procedure.

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

In order to get a sense of the importance of these biases, I split the baseline sample into three groups - of small, medium and large importers - and run the estimation procedure separately on each group. The idea is that by comparing firms with similar import behavior we can capture unobserved differences in import and/or production technology. Table A2 in the Appendix shows the estimated elasticities for each of the three subsamples. On average, the foreign input elasticity is bigger, and the labor elasticity is smaller for the larger importers. This is consistent with the disintegration of the production process of large global firms (global value chain), and with a parallel increase in the use of intermediates in production (cf. Feenstra, 1998; Hummels et al., 2001; Yi, 2003). Nonetheless, the differences between these elasticities and those obtained in the entire sample of importers are rather small, suggesting a limited role for technological biases for the main results.

3.3 Market Power in Input Markets

I now use the estimated output elasticities to compute the wedges of interest. Equation (6) implies that we can get an estimate of the impact of both output and input market power on firm-level input choices by just looking at the ratio between output elasticity and expenditure share of the input of interest, namely:

$$\hat{\Xi}_{it}^{v} \equiv \mu_{it} \cdot \psi_{it}^{v} = \frac{\hat{\theta}_{it}^{v}}{\tilde{\alpha}_{it}^{v}}, \text{ for } v = m, x, \tag{24}$$

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

Panel (a) of Figure 1 plots, for each industry, the median estimated level of $\hat{\Xi}_{I}^{v}$, which I obtain by setting $\hat{\theta}_{I}^{v} = \hat{\beta}_{I}^{v}$, where $\hat{\beta}_{I}^{v}$ is the industry Cobb-Douglas elasticity for $v = x, m$. With a few exceptions, the (joint) wedge on the foreign intermediate input is substantially larger than the wedge on the domestic intermediate input. Considering that the effect of markups (μ_{it}) on both wedges is identical, it follows that the foreign input wedge must be larger than the domestic one, namely $\hat{\psi}_{I}^{x} \geq \hat{\psi}_{I}^{m}$ in (almost) all industries.[17]

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[17]The only two exceptions are the Textile and Pulp and Paper sectors. In the former, the joint wedges are not

Figure I. Industry Wedges (Median)

(a) Joint Wedges   (b) Input Market Wedges*
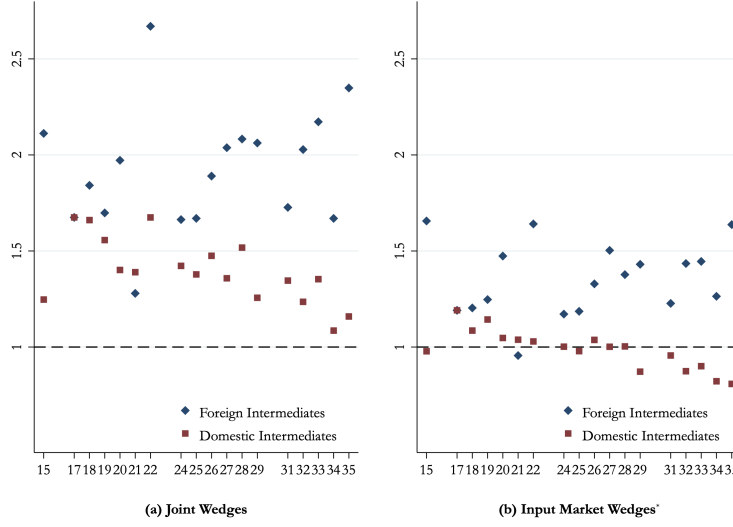
Notes: The figure on the left shows the overall wedges Ξ_I^v, in the foreign ($v = x$) and domestic ($v = m$) material input markets, for each 2-digit industry. The figure on the right shows the input wedge for the foreign and domestic input, obtained by dividing the overall wedge Ξ_I^v, for $v = x, m$, shown in the left panel, by the median industry markup. Markups (at the firm level) are obtained by dividing total sales by total costs as: $E_{it}^l + E_{it}^{int} + RK_{it}$, where E_{it}^l and E_{it}^{int} are total expenditures on labor and intermediates, respectively, and we assume a rental rate of 20% (e.g. Blaum et al., 2018). A similar picture would emerge if I computed markups as in De Loecker and Warzynski (2012). Values in the x-axis represent the 2-digit ISIC industry, which I classify according to the ISIC Rev. 3 classification. Confidence intervals are tiny, as the Cobb-Douglas point estimates are precisely estimated, and are thus omitted.

Even though looking at the joint wedges Ξ_I^v is helpful to establish a ranking between the input wedges ψ_I^x and ψ_I^m, it is not sufficient to infer what type of competition prevails in each individual market, nor to understand which of the two markets is relatively further from the competitive benchmark. In principle, the fact that $\hat{\psi}_I^x \geq \hat{\psi}_I^m$ is both consistent with $\hat{\psi}_I^x \geq \hat{\psi}_I^m \geq 1$, and with $1 > \hat{\psi}_I^x \geq \hat{\psi}_I^m$. These two scenarios have very different implications in terms of market distortions. In the first case, the evidence is consistent with models of monopsony or oligopsony in both markets, with the foreign market substantially more distorted than the domestic one. In the second case, the evidence is closer to models of efficient bargaining, with the domestic market relatively more distorted than the foreign one.

In panel (b) of Figure 1, I try to get a sense of which of these scenarios look more plausible. To do so, I consider standard measures of industry markups, and use them in equation (24) to infer the level of both ψ_I^x and ψ_I^m. As discussed in Section 2, estimating consistent measures of firm-level markups is challenging here, given that methods in the industrial organization literature rely either on the existence of a competitive static input, or on very detailed market-level data, neither of which are available.[18]

To make progress, I consider two potentially imperfect, yet widely used benchmark measures of

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substantially different across markets. In the Pulp and Paper sector, the joint market distortion wedge is instead larger in the domestic than in the foreign market.

[18]See Introduction for a literature review of papers of the first kind, and Goldberg (1995) or Berry et al. (1995) for papers of the second type.

markups. I first construct markups as the ratio of firm revenues to total costs. I refer to this measure as "accounting" markups. The second measure is obtained using the methodology in De Loecker and Warzynski (2012).[19] Table A3 in the Appendix summarizes the markups estimates. Note that when input markets are less than competitive, both methodologies yield upward-biased measures of markups, and in turn, downward-biased estimates of the input wedges. For this reason, this exercise is meaningful to the extent that the implied input wedges are thought of as a lower bound of the true level of market inefficiencies in both input markets.

I find that while the domestic input wedges are rather small and close to the competitive level, the foreign input wedges are quite large across the different manufacturing sectors. The average industry wedge for the domestic input equals 0.99 when I use accounting markups, with a standard deviation of 0.10. On the contrary, the average industry wedge for the foreign input equals 1.35 (standard deviation 0.19).[20] Interpreted through the lens of the theoretical framework, this evidence says that while firms behave almost as price takers in the domestic markets, firms seem to exercise substantial buyer power in the foreign market.

Input Market Power Across Industries In the remainder of this paragraph, I am going to focus on the relative wedge ψ^x/ψ^m as the main variable of interest. The relative wedges are computed from equation (7), that is,

$$\left(\frac{\hat{\psi}_{it}^x}{\psi_{it}^m}\right) = \frac{\hat{\theta}_{it}^x/\tilde{\alpha}_{it}^x}{\hat{\theta}_{it}^m/\tilde{\alpha}_{it}^m}, \tag{25}$$

where the expenditure shares are normalized as explained above.

Table 5 presents the median estimated relative wedge $\left(\frac{\hat{\psi}_I^x}{\psi_I^m}\right)$ for each manufacturing industry I, together with the value of the foreign input wedge obtained when using external measures of markups, which I denote as $\tilde{\psi}_I^x$, and the implied competition regime in the foreign market. I classify an industry as belonging to the monopsony regime, (MO), if the lower bound of the 95% CI of the median sectoral foreign input wedge is above one. Similarly, I classify industries as belonging to the efficient bargaining/quantity discount regime (EB/QD), if the upper bound of the 95% CI of the median input wedge is below one. I classify an industry as perfectly competitive (PC), if it cannot be classified neither as MO, nor as EB/QD. For the classification, I consider the lowest value among ψ_I^x/ψ_I^m and $\tilde{\psi}_I^x$.

My results show that in a large number of sectors, the foreign input wedges are significantly larger than unity. These wedges emerge as importers spend on foreign inputs a fraction of revenues that is "too low" as compared to what they spend on domestic inputs, in light of the differences in their output elasticities.

Seen through the lens of the theoretical framework, the evidence says that on average, the gap

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[19]As discussed above, the latter use similar techniques as the ones in this paper to compute markups, while imposing a unity wedge on the intermediate input market. While incosistent with the assumptions of this paper, markups obtained using the DLW methodology are widely used in the empirical literature, and so are a good benchmark for our purposes.

[20]Using the De Loecker and Warzynski, 2012 methodology to compute markups, the average domestic wedge is 1.04 (standard deviation 0.05), while the average foreign wedge becomes 1.46 (standard deviation 0.25)

Table V. (Relative) Input Market Power, by Sector

Sector	$\psi^x{}_I/\psi^m_I$	$\tilde{\psi^x}_I$	Regime
15 Food and Beverages	1.72	1.66	MO
17 Textiles	1.03	1.19	MO
18 Wearing Apparel	1.15	1.2	MO
19 Leather Products	1.13	1.25	MO
20 Products of Wood	1.46	1.47	MO
21 Pulp and Paper Products	0.95	.956	EB/QD
22 Printing and Publishing	1.49	1.64	MO
24 Chemical Products	1.18	1.17	MO
25 Rubber Products	1.25	1.19	MO
26 Non-metallic minerals	1.27	1.33	MO
27 Basic Metals	1.62	1.5	MO
28 Fabricated Metal Products	1.38	1.38	MO
29 Machinery and Equipment	1.68	1.43	MO
31 Electrical Machinery	1.40	1.23	MO
32 Radio and Communication	1.65	1.43	MO
33 Medical Instruments	1.66	1.45	MO
34 Motor Vehicles, Trailers	1.66	1.26	MO
35 Other Equipment	2.13	1.64	MO
Average	1.43	1.35	MO

Notes: Standard errors are obtained with the Delta Method, and are approximately equal to 0.001 for all industries. The average standard deviation in each industry is about 3. I trim observations with ψ that are above and below the 3rd and 97th percentiles within each sector. I classify an industry as MO, if the lower bound of the 95% CI of the median sectoral input market power is above one.

between an input price and its marginal revenue product is 43% larger when the firm buys this input from foreign markets than when the firm buys it from the domestic markets. In other words, French manufacturing importers exercise more buyer power abroad than domestically.

The similarity of the values in the first and second column of Table 5 makes clear once more that firm behavior in domestic input markets is close to competitive, i.e. $\psi^m_I \simeq 1$. This result has important implications, as it entails that the assumption of competitive firm behavior in intermediate input markets, standard in empirical work on markups estimation (e.g. De Loecker and Warzynski, 2012; De Loecker et al., 2016; Dobbelaere and Kiyota, 2018), is accurate, as long as the imported share of intermediates is not too high.

In spite of the similarities in terms of competition regimes, foreign input wedges vary substantially across sectors: the median relative wedge in Table 5 range from .95-2.13, implying very large differences in sectoral buyer power. This heterogeneity allows for a cross validation of the structural interpretation of the wedges by means of simple correlations.

In Figure 2, I tie the sectoral median relative wedge to industry observables that are plausibly correlated with input market power in foreign markets. Starting from the top-left panel and moving

FIGURE II: RELATIVE WEDGE, ACROSS FIRMS
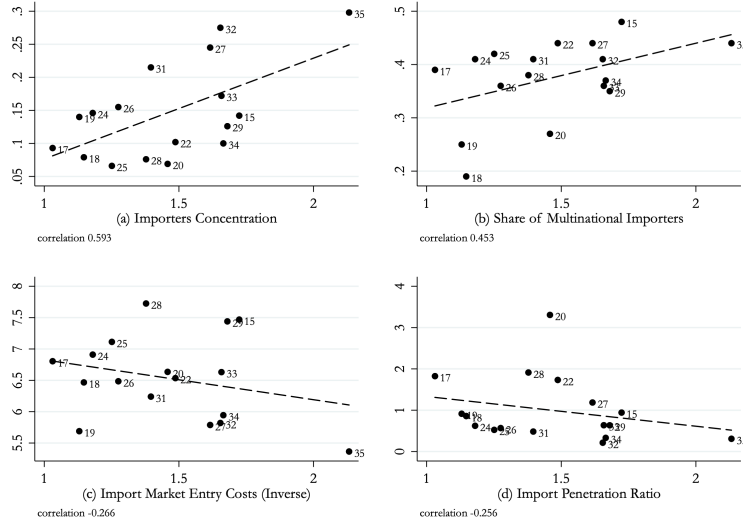
Notes: All statistics are computed on the sample of international firms. (a) Importers concentration is measured as the sectoral Herfindahl Index; (b) I define a firm as an MNE if it belongs to a multinational group, both French of foreign; (3) I use an an inverse measure of import market entry costs the (log) number of importers in a given sector; (4) Import penetration ratio is computed as Total imports over Total Sales. I exclude sector 21 because firms in that sector seem to behave according a different competition regime. Results are robust to including that sector.

clockwise, the figure plots the sectoral wedges against: (1) the degree of concentration of importers (importers Herfindahl index), (2) the share of importers that are part of multinational enterprises (MNEs), (3) the total number of importers in the sector and (4) the import penetration ratio.

The first two measures are plausibly positively correlated with the degree of buyer power of importers. The latter two variables measure, respectively, an inverse of import market entry costs, and import competition, and for this reason they are expected to correlate negatively with buyer power. The evidence in Figure 2 gives strong support to my priors, and thereby to the fact that foreign wedges are related to buyer power.

Input Market Power Across Firms   I now investigate how the relative wedges relate to firm characteristics. I consider the following regression:

$$\log\left(\frac{\hat{\psi}_{it}^x}{\psi_{it}^m}\right) = \gamma_0 + \gamma_1 \log size_{it} + \gamma_2 \log \hat{\omega}_{it} + X_{it}'\mu + \delta_{Ist} + \alpha_{\Sigma_{it}} + \varepsilon_{it}. \tag{26}$$

I define firm size ($size_{it}$) as total sales of firm i in time t. The term $\hat{\omega}_{it}$ is firm-level TFP, obtained from the estimation of the production function. The vector X_{it} contains firm-characteristics such as MNE status and capital-labor ratio, while the term δ_{Ist} denotes industry×activity×time fixed effects, where activity refers to the main reported activity of the firm. Finally, $\alpha_{\Sigma_{it}}$ denotes sourcing-strategy fixed effects, which can either refer to the set of countries or the set of markets (countries×HS6 digit product) where firms source from.[21]

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[21]I construct the sourcing strategy fixed effects using the methodology in Blaum et al. (2019). See the paper for details.

By adding the control variables and fixed effects, I aim to control for variation in the relative wedges due to unobserved differences in technology, an important concern given the use of Cobb-Douglas elasticities. The coefficient of interest are $\hat{\gamma}_i$, with $i = 1, 2$.

As a preliminary step, I consider the following version of equation (26):

$$\log\left(\frac{\hat{\psi}_{it}^x}{\psi_{it}^m}\right) = X'_{it}\mu + \delta_{Ist} + \alpha_{\Sigma_{it}} + \varepsilon_{it}. \tag{27}$$

I estimate (27) via OLS, and define a measure of the relative wedges as the residuals from this regression, i.e. $\left(\frac{\hat{\hat{\psi}}_{it}^x}{\psi_{it}^m}\right) = \exp\left(\log\left(\frac{\hat{\psi}_{it}^x}{\psi_{it}^m}\right) - X'_{it}\mu + \widehat{\delta_{Ist}} + \alpha_{\Sigma_{it}}\right)$. By doing so, I purge the original wedges from the variation potentially unrelated to buyer power. Figure 3 shows the distribution of these implied wedges $\left(\frac{\hat{\hat{\psi}}_{it}^x}{\psi_{it}^m}\right)$, for different quantiles of value added. The figure shows that, even with substantial heterogeneity, larger firms have higher wedges, and so have larger buyer power.

FIGURE III: DISPERSION IN RELATIVE WEDGE, ACROSS FIRMS
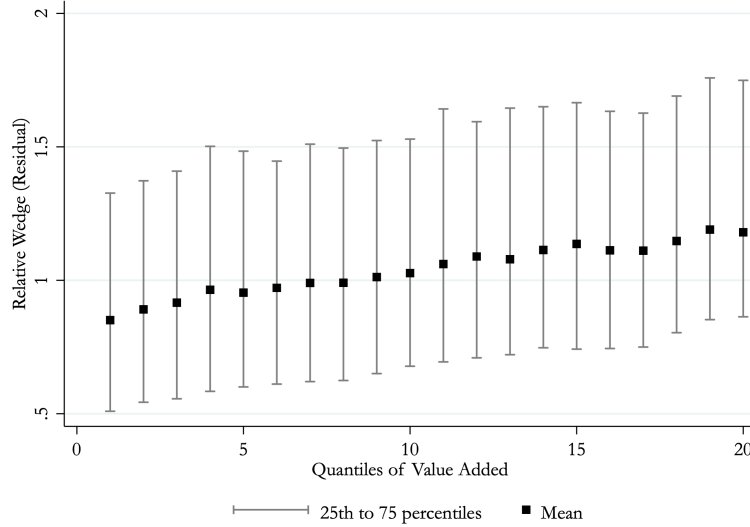
Notes: The figure plots, for each quantile $q = 1, ...20$, the average implied wedge of the quantile: $\left(\frac{\hat{\hat{\psi}}^x}{\psi^m}\right)_q = 1/N_f^q \sum_{i=1}^{N_f^q}\left(\frac{\hat{\hat{\psi}}_{it}^x}{\psi_{it}^m}\right)$ together with the 25th and 75th percentiles of the quantile distribution of implied wedges.

I then confirm this result by means of regression analysis. Table 6 presents the results from estimating equation (26) via OLS fixed effects regressions. Each pair of columns show the coefficients on size ($\hat{\gamma}_1$) and productivity ($\hat{\gamma}_2$), for an increasingly stringent set of fixed effects. Table A4 in the Appendix shows the same table, when the dependent variable is the foreign input wedge $\tilde{\psi}_{it}$ instead.

Columns (5)-(7) are the most preferred estimates, as they take into account the market-level sourcing strategy of the firm. Comparing firms with the same sourcing strategy is important in this context, where the bulk of the variation in the relative wedges comes from variation in the expenditure shares on foreign and domestic inputs. If large firms disproportionately source from low-cost countries, where market entry costs are high, then, ceteris paribus, larger firms are going to spend less on shipments of the same size. The econometric framework might thus attribute

Table VI. Market Power And Firm Characteristics

Dependent variable	$\ln\left(\frac{\hat{\psi_{it}^x}}{\psi_{it}^m}\right)$						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$\log size_{it}$	0.191***		0.25***		0.25***		0.23***
	(0.003)		(0.01)		(0.02)		(0.02)
$\log \hat{\omega}_{it}$		0.16***		0.26***		0.28***	0.19***
		(0.01)		(0.01)		(0.04)	(0.04)
Fixed Effects	δ_{Ist}		δ_{Ist}; α_Σ (Country)		δ_{Ist}; α_Σ (Country×HS6 Product)		
No. Observations	172,814	172,814	110,629	110,629	14,258	14,258	14,258
Adj. R^2	0.25	0.15	0.31	0.30	0.72	0.71	0.72
Impact of Δ_{sd} (size)	0.350		0.460		0.451		
Impact of Δ_{sd} (tfp)		0.091		0.149		0.158	0.110

Notes: The regressions exclude outliers in the top and bottom 3rd percentile of the distribution of input market power. Columns (1) and (2) include 3-digits industry × time fixed effects; Columns (3) and (4) include 3-digits industry × time fixed effects, plus sourcing-strategy fixed effects, where the latter is defined at the level of countries; Columns (5),(6) and (7) include 3-digits industry × time fixed effects, plus sourcing-strategy fixed effects, defined at the HSˆ digit product×country level. All regressions include controls for the MNE status of the firm, and the capital-to-labor ratio. *** denotes significance at the 10% level, ** 5% and *** 1%.

differences in sourcing costs to differences in pricing power across firms.

I find that, across specifications, input market power is positively and significantly correlated with size and measured productivity of firms. Quantitatively, a one standard deviation increase in sales is associated with an increase in the relative wedge of about 45%. A one standard deviation increase in firm TFP is associated with an increase of about 16%. Results in Table A4 are similar, which suggests that the estimated coefficients are mostly driven by larger firms distorting downward their demand of foreign inputs, as in models of monopsony or oligopsony, rather than distorting upward their demand of domestic inputs.

3.4 Discussion

Overall, my analysis highlights three main facts about foreign input markets: first, competition in foreign intermediate markets is substantially more distorted than competition in domestic intermediate markets. Second, firm behavior in domestic markets is well approximated by competitive models, such that relative distortions are almost entirely driven by imperfect competition in foreign markets, which is instead well approximated by models of monopsony or oligopsony. Third, large and productive firms are more distorted than small, unproductive firms.

The econometric framework infers the existence of market distortions from wedges in the behavior of industries and firms in foreign and domestic intermediate markets. An important thing to notice is that foreign and domestic intermediates are defined as firm aggregates throughout the

empirical analysis. On the one hand, given that information on output and inputs are mainly available at the level of the firm, measuring intermediate inputs at this level of aggregation allows me to leverage production function estimation techniques, and obtain consistent estimates of the output elasticities and of the wedges. On the other hand, this type of analysis might raise concerns that confounding factors play an important role in generating the observed wedges. The two factors that create most concerns in this case are: entry costs into import markets, and differences in the sourcing strategies of firms.

For one, if entry costs into foreign markets are particularly large, they could constrain the intensive margin choice of foreign inputs over and above the extensive margin one, in contrast to the assumption of short run flexibility.[22] The finding that larger, more productive firms have higher wedges rules out interpretations of the wedges solely based on trade costs, or capacity constraints.

Even when entry costs do not directly distort the intensive margin choice of firms, they still determine import sourcing patterns of firms (Antràs et al., 2017), which could mechanically drive differences in optimal expenditure shares across firms as explained above, and in the wedges thereof. The regression analysis in Table 5 showed that buyer power seems to play an important role, even when all these factors are taken into account.

The evidence presented so far is nonetheless closely tied to the theoretical framework in Section 2, which builds on some important assumptions. To corroborate my findings, in the remainder of this section I provide reduced form evidence of the existence of buyer power in foreign markets. I do so by leveraging the richness of customs data, while looking at the behavior of import prices across firms and markets.

3.5 Reduced Form Evidence on Buyer Power

The starting point is the discussion in Section 2.1.3. The main message there was that, conditional on quality, when input markets are less than competitive input prices are going to depend on firm level characteristics. In particular, when the input supply elasticity is constant across firms, the buyer share of a firm in a given market is a *sufficient statistic* for the effect of buyer power on input prices: the higher the buyer share, the lower the price.

This discussion implies that one could test for the existence of imperfect competition in foreign input markets by showing that, conditional on quality, firm-level prices depend on the firm buyer share in a given market, as well as other firm characteristics. In the import data, both prices and import shares are observed at the product-country level, which makes this kind of analysis feasible.

The main variable of interest is the (log) price that firm i pays for product k in country n at time t. Products are defined at the 8 digit level. As standard, prices are computed as unit values, namely value over quantity of each individual shipment. I define a market as a product-country-year triple, which is the most disaggregate level I could look at.

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[22]Several papers in the empirical literature find evidence of large trade costs: Roberts and Tybout, 1997; Das et al., 2007; Antràs et al., 2017 provide evidence of substantial fixed entry costs into export and import markets, whereas Alessandria et al., 2010, 2013 discuss the empirical relevance of inventory costs and delivery lags.

A growing empirical literature has studied input price behavior at this level of aggregation. Kugler and Verhoogen (2012) use Colombian data to document that larger plants pay more for their inputs, which they interpret as evidence that quality differences play an important role in generating within market price variation. More recently, Blaum et al. (2019) have looked at the plant size-price correlation using the same French manufacturing import data as those used in this paper, to show evidence of non-homothetic import demand for importers. The evidence presented below confirms and complements these findings.

I document three empirical facts which I interpret as evidence of buyer power in foreign input markets, which I summarize here:

Fact 1: *Within an import market, the average price of an input decreases, as market concentration increases.*

Fact 2: *Across firms and within an import market, firms with higher buyer share pay a lower unit price for the same input.*

Fact 3: *Within a market and within a firm, the price that a French importer pays for an imported input decreases as its buyer share increases, and as the tenure in that market increases.*

I start by showing evidence of Fact 1. I run the following regression:

$$\ln \bar{p}_{knt} = \gamma \times \ln HHI_{knt} + X'_{knt}\mu + c_{kn} + \delta_{nt} + \varepsilon_{knt}. \tag{28}$$

The dependent variable is the average price of an 8-digit product k sold by country n at time t: $\bar{p}_{knt} = \sum_{i=1}^{N_{knt}} p_{iknt}$. The term $\ln HHI_{knt}$ is the (log) Herfindahl index in market $k \times n \times t$, which is a measure of market concentration.[23] The vector X_{knt} include market level controls, such as average shipment size, the total number of French importers, and the total world imports (excluding France) of product k from country n at time t. The latter information is obtained from the UN Comtrade database. Including these controls makes sure that the correlation between price and market concentration is not mechanically driven by market size. Finally, I include fixed effects for product-country (c_{kn}), to control for the characteristics of the product, such as its average marginal cost, as well as country-time fixed effects, to control for country-specific time trends.

Table A5 in the Appendix shows the results of estimating (28) via OLS. The coefficient on market concentration is large, negative, and significant. Column (4) of Table A5 shows that the effect of market concentration is stronger in those markets where France account for a large fraction of world total imports.

The second fact exploits across firms variation in prices, and for this reason is the fact that most closely relates to existing studies on the determinants of import prices. I consider an augmented version of the standard relationship between prices and size, that is:

$$\ln p_{iknt} = \gamma_1 \times \ln size_{it} + \gamma_2 \times s_{iknt} + X'_{knt}\mu + c_{Ikn} + \delta_t + \varepsilon_{iknt}. \tag{29}$$

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[23]Results are robust to using a different measure of market concentration, such as the Mean Log Deviation of import shares.

The dependent variable is now the firm price in each market. Firm size ($size_{it}$) is defined as above. The term s_{iknt} denotes the buyer share of firm i in market $k \times n \times t$, that is, value of imports of firm i over total French imports from that market. The vector X_{knt} include market and firm-level controls, as in equation (28).

In order to control for the average price of a good in a given market, I now include industry-product-country (c_{Ikn}) fixed effects. The coefficients of interest thus indicate the effect of both size and import shares on the firm-level deviation from the average industry price.

Table A6 in the Appendix shows the results of estimating (29) via OLS. While my results confirm the existence of the price-plant size correlation in input prices, as in Kugler and Verhoogen (2012) and Blaum et al. (2019), I also find an important role for the buyer share in determining the price of the imported input. I interpret these results as evidence that conditional on quality, which is captured by firm size, the buyer share of the firm has a large negative effect on prices, consistent with models of imperfect competition such as the one in Section 2.1.

One concern at this point is that, as buyer share is correlated with the shipment size, the coefficient $\hat{\gamma}_2$ might be driven by things like bulk discounts, potentially unrelated to the pricing power of individual firms. Due to collinearity concerns, I cannot include controls for shipment size and buyer share in the same regression. However, by comparing the coefficients on quantity and buyer share from column (2) and (3) respectively, I can conclude that buyer share seems to have a role on prices that goes beyond its correlation with shipment size: if buyer share was important for prices only inasmuch as it correlates with shipment size, we would expect the coefficient on size to be similar in both columns, in contrast to what I find.

Finally, in Table A7 in the Appendix I show evidence for Fact 3, which looks at the within market, within firm variation. The main equation of interest is:

$$\ln p_{iknt} = \gamma_1 \times \ln s_{iknt} + \gamma_2 \times \ln tenure_{iknt} + \gamma_e First_{iknt} + X'_{knt}\mu + c_{Ikn} + \delta_{it} + \varepsilon_{iknt}. \qquad (30)$$

Unlike equation (29), I now add firm-time fixed effects, in order to capture all firm-level characteristics that affect prices, including quality. I then add controls for the tenure of firm i in market $k \times n \times t$, as well as a dummy equal to 1 if t is the first year a firm is importing from that market. In doing so, I aim to verify whether correlates of how much firm i is "important" as a buyer in a given market, are important determinants of the dispersion in prices.

The coefficient of interests are γ_1-γ_3, whose interpretation is now a "within" one: what happens to the price of the firm, as its buyer share (or tenure) increases in a given market.

Even after controlling for firm-time fixed effects, the coefficient on the buyer share is large and negative. I also find a negative and significant coefficient on tenure, albeit smaller. A one standard deviation increase in buyer share is associated with a decrease in the foreign input price of about 20%. Similarly, a one standard deviation increase in firm tenure in a given market is associated with a price decrease of about 3%. The coefficient on the dummy "First" is positive instead: firms pay on average higher prices in markets whey they have just started participating.

Note that both in Table A6 and A7, the coefficient on the buyer share is larger in absolute

value in those markets where France account for a large fraction of world total imports. In other words, the pricing power of firm i is stronger whenever the firm accounts for a larger fraction of total demand, just as in models of monopsonistic or oligopsonistic competition.

Sources of Buyer Power   By and large, the reduced form evidence summarized by Facts 1-3 is consistent with models of oligopsonistic or monopsonistic competition, where firms with higher buyer share are able to push prices more below competitive levels.

The importance of this evidence is twofold: on the one hand, it provides empirical support for the theoretical framework in Section 2, as well as for the structural interpretation of the input wedges. On the other hand, it yields insights into the potential sources of buyer power of importers.

Facts 1-3 unanimously suggest that the pricing power of an importer is large whenever it accounts for a big share of the total demand of a given input. In this sense, the "importance" of a buyer to a market seems to be a major determinant of buyer power.

Note that due to data limitations, I measure the buyer share of firms in terms of the total *world* demand of a given HS6 product from a given country. In reality, markets are much more segmented, both in terms of product characteristics or in terms of geographic barriers. This means that the effective buyer share of firms can be even higher than what I can measure in the data.

In a similar vein, buyer concentration does not necessarily imply that there are large entry barriers into the import markets, or that foreign sellers cannot reach a large enough pool of buyers due to search or information frictions. As a matter of fact, exporters are granular, and they most likely have have enough resources to reach a large number of customers in each country (Bernard et al., 2018; Gaubert and Itskhoki, 2019).

Even in such contexts, buyer concentration can arise if exporters have limited scope of substitution among customers. If relationship-specific investments, such as customization of products, are an important feature of the importer-exporter relationship then the market for a given product might be limited to a small number of importers, who make up for a large fraction of the "effective" demand. That the buyer-seller relationship is important for the dynamics of prices has also been shown in recent empirical work using data on firm-to-firm trade for the U.S. (Heise et al., 2016). In light of this empirical evidence, investment irreversibility and horizontal market segmentation seem to be the most compelling sources of buyer power of importers.

4   Buyer Power and the Aggregate Economy

This section aims to understand the effect of the distortions in input trade documented in section 3 on aggregate variables.

I build an heterogeneous firms model of production as in Hsieh and Klenow (2009), extended to incorporate buyer power in the market of an intermediate input, which the firms source from a foreign country. Consistent with the findings that firm behavior is close to efficient in the domestic market, I assume perfect competition in the market of the domestic input, so that aggregate distortions can

only be driven by firm behavior in import markets.

For simplicity, I abstract from the extensive margin import decisions of firms, which I assume are made one period in advance. This assumption implies that I can focus on constant returns to scale production functions, while considering import decisions as the solution to a static profit maximization problem of firms (Blaum et al., 2019). Notably, this assumption also implies that, up to differences in technology, the framework considered below can be reconciled with standard models of input trade, which correspond to the limit as buyer power goes to zero.

4.1 Environment

I consider a one-sector economy consisting of a Home country (France), and a Foreign country (Rest of the World).[24] I focus on the equilibrium in the Home country. A representative consumer inelastically supplies L units of labor, earning wage W^l for each unit of labor supplied, 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, which is taken as the numeraire, is a CES composite of a continuum of differentiated products:

$$Q = \left(\int_{i \in M} q_i{}^\rho di \right)^{\frac{1}{\rho}}, \quad 0 < \rho < 1, \tag{31}$$

where $\frac{1}{1-\rho}$ is the elasticity of substitution among different goods. The assumption on the numeraire implies that $P = \left(\int_{i \in M} p_i{}^{-\frac{\rho}{1-\rho}} di \right)^{-\frac{1-\rho}{\rho}} = 1$.

I focus on an equilibrium where entry is restricted, such that the measure M of firms active in the economy is fixed, and exogenous. Consumer optimization yields to the standard CES demand for variety i in sector s:

$$q_i = p_i{}^{-\frac{1}{1-\rho}} Q. \tag{32}$$

Total income Y of the representative consumer is given by the sum of the labor income ($W^L L$) plus profits (Π). Because the final good is the numeraire, nominal and real income coincide in this economy, such that we can measure domestic welfare as:

$$W = \frac{Y}{P} = W^L L + \Pi. \tag{33}$$

4.1.1 Technology

Firms differ in their efficiency level $\phi \in (0, \infty)$. Production of the differentiated variety requires both local and foreign inputs according to the following constant returns Cobb-Douglas structure:

$$q_i = \phi_i x_i{}^\beta l_i{}^{1-\beta}, \tag{34}$$

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[24]It is straightforward to extend this model to a multi-sector economy with a competitive final good sector. The choice of a single sector allows for a closed form representation of the aggregate economy, while leaving the qualitative results unchanged.

where x denotes foreign inputs and l denotes domestic labor.[25]

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. This assumption is consistent with the large degree of heterogeneity in the products imported by different manufacturing firms.

4.1.2 The Market of the Foreign Intermediate Input

It is assumed that each firm i buys its differentiated variety of input x_i from a different seller (or market) in the Foreign country, where markets are 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. We can thus exclude general equilibrium effects of the price paid by i on the demand of other domestic firms.

Let us denote total demand by foreign competitors as $X_{-i} \in [0, \infty)$. I assume that X_{-i} varies across firms, and is exogenous. Total input demand in market i is thus given by $X_i = x_i + X_{-i}$, with $\partial X_i / \partial x_i = 1$. The assumption that X_{-i} is exogenous rules out strategic interactions across a Home firm i and its Foreign competitors. A firm is going to exercise buyer power when its demand relative to the competitors is large, namely when the buyer share, defined as $s_i^x = \frac{x_i}{X_i}$, is positive.

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

$$W_i^x = \left(\frac{x_i + X_{-i}}{a_i + X_{-i}} \right)^{\eta}. \tag{35}$$

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 reflects market conditions in the Foreign market for input i, which are taken as given by the firm.

To be consistent with the first part of the paper, I define buyer power of Home firm i in the Foreign market as the gap between the marginal factor cost and the unit price of the input. In this model, this is given by:

$$\psi_i = 1 + \eta s_i^x \geq 1. \tag{36}$$

Equation (5) shows that two conditions are necessary for buyer power to emerge: (i) the firm must

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[25]Note that l can be thought of as constant return to scale aggregator of l_i for $i = 1, .., N$ primary factors, including labor, capital, and domestic intermediates.

[26]Let $C(X)$ denote total costs of producing X. Decreasing returns imply that $C'(X)$ are increasing in X, i.e. $C'' > 0$. This implies that in equilibrium, the unit price 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*.

be large compared to its competitors, namely $s_i^x > 0$, and (ii) the foreign export supply is elastic, i.e. $\eta > 0$.

The model nests the special cases of pure monopsony and perfect competition in a tractable way. When the Home firm is small compared to its competitors in Foreign (i.e. $X_{-i} \to \infty$ and $s_i^x \to 0$), as in the case of perfect competition, then $\psi_i = 1$ and $W_i^x = W^x = 1$. On the contrary, when the Home firm is the only buyer in the market for the differentiated input variety X_i, as in the case of monopsony, then $X_{-i} \to 0$ and $s_i^x \to 1$, such that $\psi_i = 1 + \eta > 1$ and $W_i^x = \left(\frac{x_i}{a_i}\right)^\eta$. The term a_i is chosen such that the input price of each firm W_i^x is constant and equal to 1 whenever the firm chooses the competitive quantity. In other words, we exclude price differences across firms owing to quality or product differentiation.[27]

4.2   Firm-Level Equilibrium

Each firm is thus characterized by two objects: its productivity ϕ_i and the size of foreign competition X_{-i}. Both of these variables are state variables of the firm, and are drawn one period in advance by each firm from independent and known distributions $G_\phi(\cdot)$ and $G_{X_-}(\cdot)$, respectively. I assume that the two distributions are mutually independent.

Given (ϕ_i, X_{-i}), the problem of firm i is to choose inputs so as to maximize variable profits, subject to demand (32), technology (34) and input supply (35), and taking aggregate variables (W^l, Q) 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 specified in (35). Note that this model is a special case of the conceptual framework introduced in section 2, and as such, I can follow similar derivations to obtain the equilibrium variables.

I derive the full equilibrium in Section of the Appendix. Here I summarize the main equations:

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

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

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

For given aggregate variables, the equilibrium can be written in terms of firm TFP (i.e. ϕ_i), and firm buyer power (ψ_i). Notably, buyer power ψ_i is a *sufficient statistic* for the effect of (the exogenous) foreign competition X_{-i} on firm-level variables.

Buyer power in foreign markets generate three sources of inefficiency as compared to an equilibrium where $\psi_i = 1 \ \forall i$. First, demand of the foreign input is too low (equation (37)). Second, firms

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[27]This assumption is without loss of generality.

with higher ψ substitute inefficiently the foreign input with the domestic one, such that l_i/x_i is too high (equation (38)). Third, final production is also too low, such that output prices are higher than competitive (equation (39)). This last point is worth stressing. Even if the firm with buyer power pays lower prices for its inputs, these cost-savings are not passed on to consumers in the form of lower prices, which are in fact higher than their competitive levels. This has to do with the fact that firms distort downward their production in order to obtain lower input prices.

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

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

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

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

Proposition 1: *Buyer power in foreign markets raises the marginal revenue product of foreign inputs of the firm, making it smaller than optimal. As a result, the firm with buyer power charges a price that is higher than competitive in the final good market, despite the reduction in marginal costs.*

4.3 Buyer Power and the Aggregate Economy

Given the structure above, the model allows for a transparent characterization of the aggregate equilibrium. I show in the Appendix that market clearing in the labor market, together with the assumption on the numeraire, implies that we can write aggregate output as:

$$Q = \Gamma_Q \cdot \Phi \cdot \Psi \cdot L \tag{42}$$

where $\Gamma_Q \equiv \left(\frac{1}{\rho}\right)^{-\frac{\beta}{1-\beta}} \left(\frac{1}{\beta}\right)^{-\frac{\beta}{1-\beta}}$ is a constant, $\Phi \equiv \mathbb{E}\left(\phi_i^{\frac{\rho}{1-\rho}}\right)^{\frac{1-\rho}{\rho(1-\beta)}}$ is a productivity index, and $\Psi \equiv \mathbb{E}\left(\psi_i^{-\frac{\rho\beta}{1-\rho+\eta(1-\rho(1-\beta))}}\right)^{\frac{1-\rho}{\rho(1-\beta)}}$ is an index of aggregate distortions.

The index Ψ summarizes the effect of buyer power on aggregate output. We notice that in contrast to a standard result in the misallocation literature, aggregate distortions in this economy depend on the *level* of buyer power: multiplying all the ψ_i by a constant factor does *not* leave output unchanged. This has to do with the fact that buyer power is related to an elastic supply of the foreign input. By changing the level of buyer power, the total supply of the foreign input changes, and so does aggregate output.

I expand on this idea by considering what happens in a counterfactual economy where I assign to all firms the average degree of buyer power, i.e. $\psi_i = E\psi$ for all i. Notice that a standard result in the literature of markups and misallocation is that, when markups are constant across firms, aggregate output and TFP are at their efficient level.[28] I show in the Appendix that the aggregate output in the economy with No Dispersion (ND) is given by:

$$Q^{ND} = \Gamma_Q \cdot \Phi \cdot \Psi' \cdot L, \tag{43}$$

where $\Psi' \equiv \mathbb{E}\psi^{-\frac{\rho\beta}{1-\rho+\eta(1-\rho(1-\beta))} \cdot \frac{1-\rho}{\rho(1-\beta)}}$. For one, equation (43) shows that even in absence of dispersion across firms, buyer power still has a negative effect on aggregate output. Furthermore, by Jensen's inequality, $\Psi' < \Psi$, which means that in fact the equilibrium with misallocation features higher output than the equilibrium without misallocation, fixing the average buyer power.

For an intuition, consider the ratio of labor allocation between two firms, i and j :

$$\frac{l_i}{l_j} = \left(\frac{\phi_i}{\phi_j}\right)^{\frac{\rho}{1-\rho}} \left(\frac{\psi_i}{\psi_j}\right)^{-\frac{\rho\beta}{1-\rho+\eta(1-\rho(1-\beta))}}. \tag{44}$$

When $\psi_i = \psi_j = \psi$, 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. Dispersion in buyer power induces a reallocation of labor towards the less distorted firms: $l_i > l_j \iff \psi_i < \psi_j$.

Because highly distorted firms produce too little in an economy where input supply is elastic, inducing misallocation across firms can alleviate the consequences of an inefficient firm size. Not surprisingly, the "cost" of misallocation is lower, the higher the elasticity of export supply. I summarize the theoretical results of this section in the following propositions:

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.*

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 firms with low buyer power to overproduce, albeit inefficiently.*

4.3.1 Aggregate TFP

I now aim to isolate the effect of buyer power on aggregate TFP. I define TFP as: $\text{TFP} = \frac{Q}{L^{1-\beta}X^{\beta}}$. I show in the Appendix that it is possible to write:

$$\text{TFP} = \left(\mathbb{E}\phi^{\frac{\rho}{1-\rho}}\mathbb{E}\left(\frac{\overline{\text{MRPX}}}{\text{MRPX}}\right)^{\beta\frac{\rho}{1-\rho}}\right)^{\frac{1-\rho}{\rho}} \tag{45}$$

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[28]See, e.g. Epifani and Gancia (2011); Edmond et al. (2015); Peters (2016)

where $\overline{\mathrm{MRPX}}$ is the harmonic mean of the marginal revenue product of intermediates, with weights equal to the market share of the firm, and MRPX_i is defined in (41).[29].

Note that equation (45) implies that the average buyer markups does not matter for aggregate productivity: multiplying all ψ_i by any positive constant leaves aggregate TFP unaffected.

4.4 Aggregate Cost of Buyer Power in Foreign Markets

We are now ready to quantify the cost of buyer power for the aggregate economy. For any given variable X, I denote as $\hat{X} \equiv \log X - \log X^{EFF}$ the log-difference between the value in the distorted economy and the counterfactually efficient value, which is obtained in an equilibrium where all firms behave as price takers in foreign input markets. When ϕ ($\equiv$ TFPQ) and ψ are jointly log-normally distributed, there is a simple closed-form expression for changes in aggregate TFP and in aggregate output:

$$\hat{\mathrm{TFP}} = -\kappa_\Phi \mathrm{var} \log \psi_s^x, \tag{46}$$

where $\kappa_\Phi \equiv \left(\frac{\beta^2}{2(1-\rho)} + \frac{\beta(1-\beta)}{2} \right) \left(\frac{1-\rho}{1-\rho+\eta(1-\rho(1-\beta))} \right)^2$. Similarly, the output cost of buyer power $\hat{Q}$ can be written as:

$$\hat{Q} = -\kappa_{\mathrm{Q},1} \cdot \mathbb{E} \log \psi + \kappa_{\mathrm{Q},2} \cdot \mathrm{var} \log \psi, \tag{47}$$

where $\kappa_{\mathrm{Q},1} \equiv \frac{\beta(1-\rho)}{(1-\beta)(1-\rho+\eta(1-\rho(1-\beta)))}$, and $\kappa_{\mathrm{Q},2} \equiv \frac{\beta(1-\rho)}{(1-\beta)(1-\rho+\eta(1-\rho(1-\beta)))} \left(\frac{\rho\beta}{2(1-\rho+\eta(1-\rho(1-\beta)))} \right)$.

Inspection of equations (46) and (47) reveals a striking result: for a given set of parameters, the only thing we need to know in order to quantify the efficiency and output cost of buyer power is $\mathbb{E} \log \psi_s$ and $\mathrm{var} \log \psi_s$. In other words, first and second moment of the sectoral distribution of $\log \psi$ are sufficient statistics for the effect of imperfect competition in the aggregate economy.

In the next paragraph I show how all the elements necessary to quantify equations (46) and (47) can be derived from the estimates in section 3.

4.4.1 Calibration and Results

In order to compute the right-hand side of equations (46) and (47), one needs estimates of the parameters ρ, β and η, as well as values of both $\mathbb{E} \log \psi$ and $\mathrm{var} \log \psi$ for the manufacturing sectors. We can compute ρ^{-1} from measures of the average sectoral markups. Similarly, the output elasticity β can be directly read from Table 4, as an average across sectors.

The choice of the foreign supply elasticity η is less straightforward, as it cannot easily be mapped to any of the production function parameters. For my baseline results, I compute the median inverse export supply elasticity from the estimates provided by Soderbery (2018). These estimates are from ComTrade data over the period 1991-2007 for every country and good trade worldwide.

Values of both $\mathbb{E} \log \psi$ and $\mathrm{var} \log \psi$ can be derived for each sector from the estimated $\mathbb{E} \psi$ and $\mathrm{var} \psi$, by using the properties of the lognormal distribution.[30] Note that the mapping of the

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[29]$\overline{\mathrm{MRPX}} = \int_{i \in M} \mathrm{MRPX}_i^{-1} \frac{p_i q_i}{Q} = \mathbb{E} \psi^{-\frac{1-\rho}{1-\rho+\eta(1-\rho(1-\beta))}}$

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

estimated (relative) wedges to their theoretical counterparts holds under three conditions. First, based on the observation that $\psi_I^m \simeq 1 \; \forall I$, I am going to assume that the relative wedges are approximately equal to the foreign input wedges in each industry, i.e. $\psi_I^x / \psi_I^m \simeq \psi_I^x$. Second, to avoid variation unrelated to buyer power, I set $\psi_I^x \; \forall I$ equal to the residual wedge, which I obtain in equation (27) by purging the raw wedges from variation in technology and sourcing strategy of the firms. Finally, I impose that the observed first and second moments of the wedge distribution can approximate well the true population moments.[31]

TABLE IX. CHANGES IN AGGREGATE VARIABLES

| | VALUE OF η_s | | | |
	(1)	(2)	(3)	(4)
$\Delta\%$TFP	-0.56	-0.66	-1.11	-0.2
$\Delta\%Q$	-1	-1.07	-1.31	-0.64

Notes: The table reports the main estimates of $\hat{\text{TFP}}$ and $\hat{Q}$ from equations (46)-(47). Different columns correspond to different choices for η. See Appendix Table A8 for more details.

Table 9 summarizes the results. I break down the results by sector in Table A8 in the Appendix. Given that parameters are observed for each manufacturing sector, I consider a weighted average for computing the main results, with weights given by the sectoral share of manufacturing value added. Different columns correspond to different choices for the elasticity η. In columns (1)-(3), I compute the elasticity as both the median, the simple mean, and the weighted average across the elasticities of HS4 manufacturing products for France, taken from Soderbery (2018). In column (4), I use the definition of buyer power: $\psi_I = 1 + \eta_I s_I$, and choose the value of elasticity that is necessary to reconcile the observed ψ_I, with the observed share of France in the world imports of a given HS4 product, obtained from UN Comtrade data.

4.5 Productivity Gains from Input Trade

The results so far suggest that opening up to trade could increase a firm's scope of buyer power, while increasing a country's exposure to input market distortions, and inefficiencies. What do these result imply for the literature on the effects of input trade and productivity?

Consider the following exercise. Under autarky, the representative firm produces according to: $q = \phi^A f(k, l, m)$, where ϕ^A is aggregate efficiency and inputs are defined as before. After a trade

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equations:

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

[31]It is well known that a fat-tailed distribution, as the one of the foreign wedges, features slow convergence of the sample mean to the true population mean (Gaubert and Itskhoki, 2019). I ignore this possibility for the empirical exercise.

liberalization, the firm starts using foreign intermediates in production, such that technology can now be described as $q = \phi^{FT} g(k, l, m, x)$, where ϕ^{FT} is aggregate efficiency under free trade.

Let us decompose ϕ^{FT} as $\phi^{FT} = \phi^{FT,C} + \hat{\phi}$, where $\phi^{FT,C}$ is aggregate TFP in a *counterfactual* competitive economy under free trade, and $\hat{\phi}$ is the change in aggregate TFP due to market inefficiencies. The term $\hat{\phi}$ corresponds to the quantity measured in equation (46). The productivity gains from input trade can be written as: $GT^I = \phi^{FT} - \phi^A = \left(\phi^{FT,C} - \phi^A \right) + \hat{\phi}$. The term in parentheses represents the gains from trade, conditional on input markets being competitive before and after the trade liberalization. This is what traditional studies aim to quantify. The term $\hat{\phi}$ indicates the effect of a noncompetitive environment on aggregate efficiency.

My results say that the gains of trade are about 1% lower than they would be, absent market inefficiencies. If existing estimates of the gains from trade were unbiased, such that they measure $\left(\phi^{FT,C} - \phi^A \right)$ correctly, then my results imply that the gains of trade are 1% lower than what traditional studies assert. However, neglecting the role of input market power in foreign input markets could plausibly generate an upward bias in estimates based on competitive models. In this sense, we can consider the 1% as a lower bound of the reduction in gains from input trade, with respect to standard estimates.

4.6 Welfare and Policy Implications of Buyer Power

Having established the role of buyer power for shaping aggregate output and TFP, I finally turn to discussing its consequences for welfare, and trade policy. Given equation (33), changes in welfare are computed as the sum of changes in domestic labor income, and changes in aggregate profits. It is easy to show that by depressing aggregate output, the income of the inelastically supplied labor must decrease in the distorted economy, due to the adverse effect on wage of a lower labor demand. In contrast, aggregate profits must increase, due to rents transferred from foreign suppliers to domestic firms. We saw earlier that the behavior of firms in foreign market is such that domestic prices increase relative to import prices. Therefore, buyer power induces a terms-of-trade effect for the country, and its effect on welfare is, in principle, ambiguous.

The parallelism with the optimal tariff argument suggests that for a planner maximizing national welfare, it could be welfare maximizing to be lenient towards large, distorted, importers. In contrast, buyer power is unambiguously detrimental from the point of view of global welfare, due to the simultaneous deterioration of the foreign terms of trade.

A lenient antitrust policy could thus substitute for a beggar-thy-neighbor trade policy. Interestingly, this is the same conclusion reached by a recent study Gaubert and Itskhoki (2019), in the context of efficient, granular open economies. My studies further suggests that international cooperation of anti-trust authorities could foster global efficiency and welfare, while reducing the scope of market power of granular international firms.

5 Conclusions

The effect of input trade on a country's economic performance largely depends on the economic environment where importers operate. The goal of this paper is to document the nature of competition in input trade, and understand its aggregate effects. The paper makes two contributions. On the methodological side, I show that the market power in input markets can be consistently estimated from standard firm-level production and trade data. On the theoretical side, I develop a tractable theoretical framework that allows for an analytical characterization of the aggregate implications of buyer power, and thus for an understanding of the main channels at play.

A recent literature in macroeconomics aims to understand the sources of the market power of firm (Blonigen and Pierce, 2016; De Loecker and Eeckhout, 2017; Syverson, 2019). The findings in this paper suggest that in order to to learn about the market power of firms, one should look at the supply side of the economy, over and above the demand side. The theoretical analysis further suggests that there are important differences in the equilibrium effect of market power, depending on its sources.

This study raises a number of questions, which could be further investigated in future research. From a methodological point of view, my empirical analysis takes a firm-level perspective. While this choice allowed me to rely on production function estimation techniques to consistently estimate foreign input wedges, a fruitful direction for future research is to investigate the micro-level determinants of these wedges, by taking advantage of disaggregated import data.

More broadly, my analysis suggests that trade and antitrust policy should collaborate while taking an international perspective, as policies addressed to maximize national welfare could generate important distortions in the global market. I leave it to future work to understand whether this statement hold in more general frameworks.

A   Additional Tables and Figures

TABLE AI. FIRM RELATIVE EXPORT AND IMPORT PRICES

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

Panel B. Correlation with Main PF Variables

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

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

TABLE AII. OUTPUT ELASTICITIES, COBB-DOUGLAS, BY IMPORTER CLASS

Sample of Importers	β_k	β_l	β_m	β_x
Small	0.06	0.40	0.37	0.13
	(0.05)	(0.03)	(0.02)	(0.01)
Medium	0.07	0.32	0.40	0.15
	(0.03)	(0.02)	(0.01)	(0.01)
Large	0.08	0.28	0.39	0.20
	(0.03)	(0.01)	(0.01)	(0.01)
All internationals	0.08	0.32	0.39	0.18
	(0.02)	(0.01)	(0.01)	(0.004)

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

TABLE AIII. MARKUPS, BY SECTOR

| | μ_I | |
SECTOR	ACCOUNTING	DLW (2012)
15 Food and Beverages	1.28	1.23
17 Textiles	1.41	1.51
18 Wearing Apparel	1.53	1.56
19 Leather Products	1.36	1.45
20 Products of Wood	1.34	1.33
21 Pulp and Paper Products	1.34	1.30
22 Printing and Publishing	1.63	1.63
24 Chemical Products	1.42	1.36
25 Rubber Products	1.41	1.36
26 Non-metallic minerals	1.42	1.38
27 Basic Metals	1.36	1.30
28 Fabricated Metal Products	1.51	1.39
29 Machinery and Equipment	1.44	1.23
31 Electrical Machinery	1.41	1.35
32 Radio and Communication	1.41	1.30
33 Medical Instruments	1.50	1.40
34 Motor Vehicles, Trailers	1.32	1.16
35 Other Equipment	1.43	1.21
Average	1.42	1.36

Notes: The table reports the median markup, for each 2-digit manufacturing sector. The average standard deviation in each industry is about 0.34 and 0.46 for the two measures. Accounting markups are defined as total sales over total firm costs. We include capital in our measure of total costs, which I define as $Cost_i = E_i^L + E_i^m + RK_i$, where I assume a value for $R = 20\%$, following Blaum et al. (2019).

TABLE AIV. MARKET POWER AND FIRM CHARACTERISTICS

Dependent variable	$\ln \tilde{\psi}_{it}^x$						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$\log size_{it}$	0.11***		0.13***		0.10***		0.07***
	(0.01)		(0.01)		(0.02)		(0.02)
$\log \hat{\omega}_{it}$		0.19***		0.28***		0.32***	0.3***
		(0.01)		(0.01)		(0.03)	(0.03)
No. Observations	172,814	172,814	110,629	110,629	14,258	14,258	14,258
Adj. R^2	0.27	0.14	0.31	0.31	0.73	0.73	0.73
Impact of Δ_{sd} (size)	0.194		0.240		0.191		
Impact of Δ_{sd} (tfp)		0.111		0.159		0.185	0.169

Notes: The regressions exclude outliers in the top and bottom 3rd percentile of the distribution of input market power. Columns (1) and (2) include 3-digits industry × time fixed effects; Columns (3) and (4) include 3-digits industry × time fixed effects, plus sourcing-strategy fixed effects, where the latter is defined at the level of countries; Columns (5),(6) and (7) include 3-digits industry × time fixed effects, plus sourcing-strategy fixed effects, defined at the HSˆ digit product×country level. All regressions include controls for the MNE status of the firm, and the capital-to-labor ratio. *** denotes significance at the 10% level, ** 5% and *** 1%.

TABLE AV. AVERAGE IMPORT PRICE AND COMPETITION

DEPENDENT VARIABLE:			$\ln p_{pct}$	
	(1)	(2)	(3)	(4)
$\ln \text{HHI}_{pct}$	-0.031***	-0.147***	-0.148***	-0.186***
	(0.002)	(0.001)	(0.002)	(0.010)
ln Average Shipment Quantity		-0.206***	-0.206***	-0.206***
		(0.001)	(0.001)	(0.001)
ln Foreign competitors			0.039***	0.034***
			(0.002)	(0.002)
$\ln \text{HHI}_{pct} \times$ ln Foreign competitors				0.009***
				(0.002)
FIXED EFFECTS:		Country $\times$Product; Country $\times$Time		
IMPACT OF A 1SD INCREASE IN HHI (FROM MEAN)				
	-.015	-.07	-.07	-.09
OBSERVATIONS	4,275,601	4,275,601	3,637,687	3,637,687
FE		Country$\times$Product; Country$\times$Year		
IDENTIFIED FE	141900	141900	114183	114183
OF WHICH SINGLETONS	2	2	2	2

Notes: Regressions at the product $\times$ country level, products (i.e. product-country) imported by at least 2 firms. Robust standard errors in parentheses with ***,** and * respectively denoting significance at the 1%, 5% and 10% levels. All regressions include a control for the number of French importers of the given product-country variety. The sets of fixed effects that are inserted in each specification are indicated in each column. The R^2 is about 0.96 for all specifications

DEPENDENT VARIABLE:	$\ln p_{ipct}$			
	(1)	(2)	(3)	(4)
ln Sales$_{it}$	0.023***	0.064***	0.025***	0.025***
	(0.001)	(0.001)	(0.001)	(0.001)
ln Shipment Size		-0.174***		
		(0.000)		
ln Import Share$_{it}$			-0.139***	-0.113***
			(0.005)	(0.007)
ln France World Share				
				(0.027)
ln Import Share × ln France World Share				-0.295***
				(0.056)
FIXED EFFECTS:	Industry×Product×Country; Time			
IMPACT OF A 1SD INCREASE IN SALES (FROM MEAN)				
	.05	.14	.06	.06
IMPACT OF A 1SD INCREASE IN IMPORT SHARE (FROM MEAN)				
		-.14	-.12	
OBSERVATIONS	3,292,839	3,292,839	3,292,839	3,292,839
IDENTIFIED FE	1251552	1251552	1251552	614815
OF WHICH SINGLETONS	975437	975437	975437	338700

Notes: Regressions at the product × country level, products (i.e. product-country) imported by at least 2 firms. Robust standard errors in parentheses with ***,** and * respectively denoting significance at the 1%, 5% and 10% levels. All regressions include a control for the number of French importers of the given product-country variety. The sets of fixed effects that are inserted in each specification are indicated in each column. The R^2 ranges from 0.76 to 0.89 in all specifications

TABLE AVII: IMPORT PRICES AND COMPETITION: WITHIN VARIATION

DEPENDENT VARIABLE:			$\ln p_{ipct}$	
	(1)	(2)	(3)	(4)
ln Tenure$_{ipct}$	-0.036***		-0.025***	
	(0.001)		(0.001)	
First year (dummy)$_{ipct}$	0.029***	0.051***	0.026***	0.051***
	(0.002)	(0.002)	(0.002)	(0.002)
ln Import Share$_{ipct}$		-0.189***	-0.182***	-0.149***
		(0.003)	(0.003)	(0.005)
ln Import Share$_{ipct}$ ×ln France				-0.446***
World Share				(0.038)
FIXED EFFECTS:		Product×Country×Time; Firm×Time		
IMPACT OF A 1SD INCREASE IN TENURE (FROM MEAN)				
	-0.03		-0.02	
IMPACT OF A 1SD INCREASE IN IMPORT SHARE (FROM MEAN)				
		-.19		-0.15
OBSERVATIONS	3,394,913	3,394,913	3,394,913	3,394,913
IDENTIFIED FE	1574556	1574556	1574556	936642
OF WHICH SINGLETONS	880690	880690	880690	242776

Notes: Regressions at the product × country level, products (i.e. product-country) imported by at least 2 firms. Robust standard errors in parentheses with ***,** and * respectively denoting significance at the 1%, 5% and 10% levels. All regressions include a control for the number of French importers of the given product-country variety. The sets of fixed effects that are inserted in each specification are indicated in each column. The R^2 ranges from 0.76 to 0.89 in all specifications

TABLE AVIII. AGGREGATE COST OF BUYER POWER, DETAILS

| SECTOR | PARAMETERS | | | MOMENTS | | η_s SODERBERY (2018) | | | η_s IMPLIED |
	θ_s	β_s	ρ_s	$\mathbb{E}\log\psi_s^x$	var $\log\psi_s^x$	(1)	(2)	(3)	(4)
15 Food and Beverages	0.15	0.14	0.75	0.16	0.54	0.46	0.81	0.79	2.19
17 Textiles	0.03	0.22	0.68	0.25	0.46	0.74	1.05	1.14	3.78
18 Wearing Apparel	0.01	0.25	0.62	0.33	0.44	1.14	1.19	1.17	3.16
19 Leather Products	0.01	0.25	0.71	0.20	0.44	1.06	1.32	1.69	2.97
20 Products of Wood	0.02	0.16	0.73	0.22	0.60	0.72	1.37	1.29	4.32
21 Pulp and Paper Products	0.05	0.16	0.72	0.19	0.47	0.70	1.17	0.86	2.77
22 Printing and Publishing	0.05	0.15	0.54	0.26	0.43	0.83	1.17	1.48	3.96
24 Chemical Products	0.14	0.17	0.66	0.13	0.42	1.03	1.86	2.62	1.66
25 Rubber Products	0.08	0.16	0.68	0.20	0.51	0.84	0.93	1.13	4.03
26 Non-metallic minerals	0.04	0.13	0.69	0.18	0.47	0.73	1.25	1.15	2.85
27 Basic Metals	0.05	0.21	0.71	0.12	0.43	0.59	0.88	1.02	1.49
28 Fabricated Metal Products	0.10	0.14	0.62	0.22	0.53	0.85	1.20	1.20	3.52
29 Machinery and Equipment	0.10	0.16	0.65	0.21	0.51	1.30	2.52	3.16	3.96
31 Electrical Machinery	0.05	0.17	0.69	0.14	0.48	1.15	1.22	1.30	4.19
32 Radio and Communication	0.02	0.16	0.67	0.22	0.41	1.83	2.81	3.14	4.03
33 Medical Instruments	0.03	0.17	0.63	0.27	0.45	0.84	0.92	1.06	5.54
34 Motor Vehicles, Trailers	0.05	0.18	0.73	0.16	0.43	0.95	1.00	1.01	3.80
35 Other Equipment	0.02	0.19	0.65	0.12	0.49	1.05	1.91	1.15	1.86
Weighted average		0.16	0.68	0.18	0.48	0.88	1.36	1.55	3.1

CHANGES IN AGGREGATE VARIABLES				
$\Delta\%$TFP	-0.56	-0.66	-1.11	-0.2
$\Delta\%Q$	-1	-1.07	-1.31	-0.64

Notes: The table reports estimates of main moments and parameters necessary to compute $\widehat{\text{TFP}}$ and $\hat{Q}$ from equations (52)-(53), together with the main results. The sector shares ζ_s are directly observed in the balance sheet data. The β_s are the Cobb-Douglas βs and ρ are estimated as in Section 3. The ρ_s are calculated as $\rho_s = (\mu_s)^{-1}$, where μ_s is the average markup in sector $s = 1, .., S$, computed as sales over total costs. The η_s are taken from Soderbery (2018), and computed as a median over manufacturing products (1), as the simple mean (2), or as the weighted average, with weights given by the share of the product in total world import of a given HS4 product (3). The values of eta in (4) are instead inferred from the observed buyer power and the observed shares of France in total world import of a given HS4 product, using the formula $\bar{\tilde\psi} = 1 + \eta\bar{s}$. Finally, the $\mathbb{E}\log\psi$ and var $\log\psi$ are computed from the estimated $\mathbb{E}\tilde\psi$ and var $\tilde\psi$ using the properties of the log normal distribution.

B Appendix

B.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.

B.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 $\psi_{it}^j \equiv 1 + \epsilon_{it}^j < 1$.

B.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 $\psi_{it}^j = 1$.

B.2 A Formal Model of Input Price Variation

This appendix provides a description of an economic model that rationalizes the use of a flexible polynomial in output prices, market shares in final good markets, and market shares in domestic material markets to control for input prices. The model combines insights from the literature on input prices and quality variation (e.g. Verhoogen, 2008; De Loecker et al., 2016), and from models of imperfect competition in input markets, as the one in section 2.

B.2.1 Production Function for Output Quality

I start from a benchmark case of perfect competition in input markets. This is the case considered in De Loecker et al. (2016), which I summarize in this paragraph. Let ν denote the quality of the firm output, and ι_v denote the individual quality levels of each input V. It is assumed that the production function for output quality belongs to the class of "O-Ring" production functions discussed in Kremer (1993) and Verhoogen (2008), and can be summarized as:

$$\nu = g\left(\iota_1, .., \iota_V; \omega\right),$$

with $\frac{\partial \nu}{\partial \iota_i \partial \iota_j} > 0$ for any $i \neq j$, $i, j = 1, .., V$ namely, such that it features complementarity in the quality of inputs. This feature of the production function implies that higher output quality requires high quality of all inputs. The production function for quality can vary across industries, but it is assumed that all firms producing in the same industry face the same quality production function. In addition to the production function for quality, it is assumed that higher quality inputs are associated with higher input prices. Let W_I^v denote the sectoral average of the price of input V (e.g., sectoral wage) and $W^v(\iota_v)$ the price of a specific quality ι of input V. Then,

$$W^v(\iota_v) - W_I^v = z_v \iota_v, \text{ with } z_v > 0.$$

Therefore, in a framework that postulates perfectly competitive input markets and input complementarity in the production of quality, input markets are characterized by vertical differentiation only, such that all firms pay the same input prices conditional on input quality.

De Loecker et al. (2016) show that, consistent with demand models commonly used in the literature, and in particular with Berry (1994), one can express output quality as a function of

output prices and market shares in final output markets, as well as exogenous variables:

$$\nu = g_v(p, ms, G).$$

Using a standard firm maximization problem, they also show that in this class of models, input quality is an increasing function of output quality for every input, such that *input* quality can be expressed as:

$$\iota_v = W_v(p, ms, G). \tag{48}$$

Equation (48) implies that when input markets are competitive, one can use a polynomial in output prices, market shares in final good markets, and exogenous observable variables to control for differences in prices among firms, and thus to control for input price bias. The function in (48) will be, in general, input-specific, as the indexation by v indicates.

B.2.2 Quality, and Imperfect Competition

I now consider an extension of the previous model that account for imperfect competition in input markets. For expositional purposes, in what follows I am going to focus on the material input market.

Let us suppose that when buying inputs of a given quality, firms compete under imperfect competition. I showed in section 2 that in a large class of models, a measure of input market power can be written as a function of the firm input market share and the input supply elasticity, which I denote as η_m and assume common across firms. It follows that the unit price of the input M with quality level ι_m is given by i.e.

$$W_i^m(\iota_m, s_i^m) = f(W^m(\iota_m), s_i^m),$$

where $W^m(\iota_m)$ is the price that the firm would pay under perfect competition, which depends on the input quality, and s_i^m is the market share of firm i in market M. When the supply elasticity is constant across firms within an industry, the input market share s_i^m summarizes the (differences in) firms input market power.

It is important to notice that the function f is such that $\frac{\partial f}{\partial s_i^m} < 0$, i.e. firms with higher market share have more buyer power and pay a lower unit price. This means that if $W^m(\iota_m)$ denotes the average price of an input of quality ι_m, we should have

$$W_i^m(\iota_m, s_i^m) - W_i^m(\iota_m) = \tilde{a_m} s_i^m, \text{ with } \tilde{a_m} < 0. \tag{49}$$

Note that by simple manipulations of equation (49), one can write:

$$
\begin{aligned}
W_i^m(\iota_m, s_i^m) - W_I &= (W_i^m(\iota_m, s_i^m) - W_i^m(\iota_m)) + (W_i^m(\iota_m) - W_I) \\
&= z_m W_m(p_{it}, ms_{it}, G_i) + \tilde{a_m} s_i^m \tag{50} \\
&= B(p_{it}, ms_{it}, G_i, s_i^m). \tag{51}
\end{aligned}
$$

This means that in a model with imperfect competition and quality differences, the unobserved price deviation from the industry average can be written as a function of *both* the buyer share of the firm, and the input quality, which we showed in the previous paragraph being a function of observable output prices and the firm market share as a seller.

One important challenge at this point is that the buyer share of firms in the domestic market is not directly observed, as we do not know who are the firm's direct competitors. To make progress, I define a market as an industry (narrowly defined)-region-year triple, and then measure the share s_{it}^m as the firm's share of total material expenditure in such narrowly defined market (denoted as mat_sh_{it}). It follows that we can now write the domestic input prices as:

$$
W^m(\iota_{it}, s_{it}^m) - W_{It} = B(p_{it}, ms_{it}, G_i, \text{mat\_sh}_{it}).
$$

B.3   Production Function Estimation

B.3.1   Simultaneity bias

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

$$
\begin{aligned}
x_i &= f(\omega_i, \psi_i, w_i^x, w_i^m | \varsigma_i) \tag{52} \\
m_i &= g(\omega_i, \psi_i, w_i^x, w_i^m | \varsigma_i), \tag{53}
\end{aligned}
$$

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

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

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:

$$x_i = x(\omega_i, \tilde{m}_i, w_i^x, p_i, G_i | \varsigma_i), \tag{55}$$

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 (55) to get

$$\omega_i = h\left(x_i, \tilde{m}_i, w_i^x, p_i, G_i | \varsigma_i\right). \tag{56}$$

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

$$\omega_{it} = h_t(\tilde{k}_{it}, l_{it}, \tilde{m}_{it}, x_{it}, \hat{w_{it}^x}, \hat{p_{it}}, \hat{ms}_{it}, G_i, \Phi_{it}). \tag{57}$$

I substitute equation (57) in (13) to control for firm's productivity.

B.3.2 Estimation

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

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

which corresponds to equation (22) in the text. 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 $(l_{it}, \tilde{k}_{it}, \tilde{m}_{it}, x_{it}, p_{it}, w_{it}^X, G_i)$:

$$q_{it} = \phi_t(l_{it}, \tilde{k}_{it}, \tilde{m}_{it}, \tilde{x}_{it}, \hat{w_{it}^x}, \hat{p_{it}}, \hat{ms}_{it}, G_i, \Phi_{it}) + \epsilon_{it}. \tag{59}$$

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

$$\omega_{it}(\beta) = \hat{\phi}_{it} - \left(\beta_l l_{it} + \beta_k \tilde{k}_{it} + \beta_m \tilde{m}_{it} + \beta_x x_{it} - \tilde{B}(\hat{p}_{it}, \hat{ms}_{it}, \mathbf{G}_i; \rho) \right). \tag{61}$$

We can now substitute (61) in (60) to derive an expression for the innovation in the productivity shock $\xi_{it}(\beta)$ as a function of only observables and unknown parameters β. Given $\xi_{it}(\beta)$, we can write the moments identifying conditions as:

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

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 $(\xi_{it} + \epsilon_{it})$.

B.4 Data Appendix

B.4.1 Variable Construction

To estimate the production function, we need firm-level output, labor, capital, and materials. Output is measured as total firm sales in a given year, deflated by the firm-level price deflator I define in section 2.2.1. The industry-level output price deflator is taken from the STAN industry dataset. Labor is measured as the total number of "full-time equivalent" employees in a given year. The FICUS Dataset also includes a measure of firm-level cost of salaries, which I use to derive firm-level wages by dividing total cost of labor by total firm employment. I define total intermediate inputs as the total expenditure in raw materials by an enterprise in the process of manufacturing or transformation into product reported on the fiscal files. I construct the *foreign* intermediate input using information on all firm imports of intermediate inputs. First, I drop observations on the import of HS8 digit products which are both imported and exported by the firm in a given year (about 20% of the observations). Then, I drop those import products classified as "final goods" by the Broad Economic Classification (BEC). I finally construct total expenditures on intermediates as the sum of the imports at the firm year level of all residual products. Results are robust to using different definitions of the foreign intermediate input, including restricting the attention to those goods that the BEC classification classifies as intermediates.[32] To measure the expenditure on domestic inputs,

---

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

I subtract the total value of imports of intermediates from the total expenditure on intermediate inputs. Capital is measured by gross fixed assets, which includes movable and immovable assets. As this value is reported at at the historical value, I infer a date of purchase from the installment quota given a proxy lifetime duration of Equipment (20 years) to obtain the current value of capital stock.[33] Results are robust to using an alternative measure of capital, which I construct using a perpetual inventory method, i.e. $K_t = (1 - \delta_s)K_{t-1} + I_t$. I consider the book value of capital on the first year of activity of the firm as the initial level, and take the values for the depreciation rate δ_s, where s indicates that i might vary by sector, from Olley and Pakes (1996).

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

B.4.2 Classification of Industries

I consider 18 manufacturing industries, based on the NACE Rev.1 industry classification, which is similar to the ISIC Rev. 3 industry classification in the US. I classify a firm as "manufacturing" if its main reported activity belongs to the NACE 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). Among those, I drop sectors 16 ("Tobacco Products"), 23 ("Coke, Refined Petroleum Products") and 30 ("Office, Accounting and Computing Machinery") for insufficient number of observations in the selected sample. Table A1 presents the industry classification and the number of firms and observations for each industry $s \in \{1, .., 17\}$.

---

[33]I thank Claire Lelarge for this suggestion

	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.

B.5 Market Power in Input Markets when Production Function is Translog

Table A2 and Figure A1 in the Appendix.[34] Figure A1 plots, for each of the four inputs, the estimated Cobb-Douglas (CD) coefficients against the median estimated Translog (TL) coefficients at the 2-digit industry level. While the coefficients of capital, labor and domestic materials are overall similar across specifications, the one on the foreign intermediate input is, to a great extent, bigger in the Translog case as compared to the Cobb-Douglas case. This is due to the large positive skewness of the import distribution, which is likely to affect the estimates of the TL elasticities.[35] On the contrary, the CD elasticities are less affected by the existence of important outliers, which means that they are more reliable in the current context. This explains the focus on the CD specification for my baseline procedure.

---

[34]Note that in order to obtain the translog elasticities, I duly adjust the procedure to account for interactions of inputs and prices in the relevant control functions.

[35]I write the Translog production function as a second order polynomial in the four inputs, i.e. $q_{it} = \beta_k k_{it} + \beta_l l_{it} + \beta_m m_{it} + \beta_x x_{it} + \beta_{kk} k_{it}^2 + \beta_{ll} l_{it}^2 + \beta_{mm} m_{it}^2 + \beta_{xx} x_{it}^2 + \beta_{kl} k_{it} l_{it} + \beta_{km} k_{it} m_{it} + \beta_{kx} k_{it} x_{it} + \beta_{lm} m_{it} l_{it} + \beta_{lx} l_{it} x_{it} + \beta_{mx} m_{it} x_{it} + \beta_{klm} k_{it} l_{it} m_{it} + \beta_{klx} k_{it} l_{it} x_{it} + \beta_{kmx} k_{it} l_{it} x_{it} + \beta_{lmx} l_{it} m_{it} x_{it} + \beta_{klmx} k_{it} l_{it} m_{it} x_{it}$. In the case of the foreign input, the output elasticity is thus defined as:

$$\theta_{it}^x = \beta_x + 2\beta_{xx} x_{it} + \beta_{kx} k_{it} + \beta_{lx} l_{it} + \beta_{mx} m_{it} +$$
$$= \beta_{klx} k_{it} l_{it} + \beta_{kmx} k_{it} m_{it} + \beta_{lmx} l_{it} m_{it} + \beta_{klmx} k_{it} l_{it} m_{it}$$

TABLE A2. MEDIAN OUTPUT ELASTICITIES, TRANSLOG, BY SECTOR

	INDUSTRY	β_K	β_L	β_M	β_X	RETURN TO SCALE
15	Food Products and Beverages	0.12	0.18	0.52	0.50	0.98
		(0.07)	(0.08)	(0.16)	(0.13)	
17	Textiles	0.06	0.23	0.35	0.82	0.86
		(0.08)	(0.15)	(0.16)	(0.24)	
18	Wearing Apparel, Dressing	0.13	0.25	0.36	0.13	1.00
		(0.07)	(0.13)	(0.19)	(0.18)	
19	Leather, and Products	0.05	0.24	0.35	0.45	0.85
		(0.04)	(0.13)	(0.12)	(0.18)	
20	Wood, and Products	0.09	0.22	0.45	0.27	0.98
		(0.04)	(0.12)	(0.15)	(0.10)	
21	Pulp, Paper, & Products	0.11	0.22	0.39	0.64	0.92
		(0.08)	(0.09)	(0.13)	(0.18)	
22	Printing and Publishing	0.08	0.38	0.26	0.07	1.11
		(0.05)	(0.24)	(0.19)	(0.16)	
24	Chemicals, and Products	0.10	0.32	0.41	0.82	1.14
		(0.10)	(0.15)	(0.18)	(0.17)	
25	Rubber, Plastics, & Products	0.15	0.31	0.41	0.41	1.16
		(0.07)	(0.09)	(0.15)	(0.12)	
26	Non-metallic mineral Products	0.22	0.22	0.38	0.21	1.03
		(0.11)	(0.15)	(0.17)	(0.10)	
27	Basic Metals	0.11	0.34	0.38	0.44	1.13
		(0.07)	(0.15)	(0.17)	(0.13)	
28	Fabricated Metal Products	0.12	0.31	0.34	0.33	1.07
		(0.06)	(0.16)	(0.14)	(0.10)	
29	Machinery and Equipment	0.07	0.27	0.34	0.33	0.93
		(0.04)	(0.19)	(0.17)	(0.11)	
31	Electrical machinery & App.	0.08	0.31	0.40	0.45	1.07
		(0.03)	(0.12)	(0.14)	(0.21)	
32	Radio and Communication	0.13	0.22	0.37	0.26	0.93
		(0.05)	(0.12)	(0.21)	(0.16)	
33	Medical, Precision, Optical Instr.	0.09	0.21	0.32	0.52	0.83
		(0.04)	(0.15)	(0.15)	(0.19)	
34	Motor Vehicles, Trailers	0.09	0.25	0.42	0.51	1.00
		(0.06)	(0.18)	(0.17)	(0.17)	
35	Other Transport Equipment	0.06	0.35	0.31	0.54	1.06
		(0.05)	(0.25)	(0.17)	(0.21)	

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

FIGURE A1. OUTPUT ELASTICITIES, COBB-DOUGLAS VS TRANSLOG
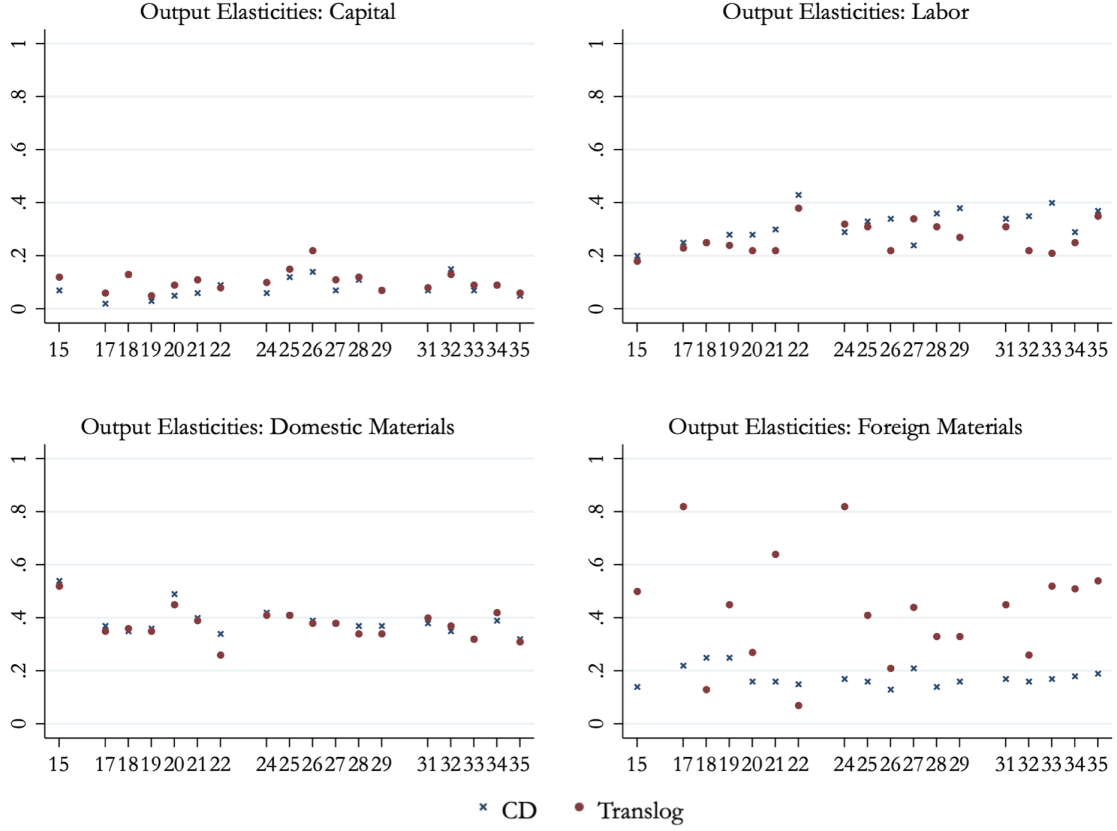
Notes: The figure plots the estimated Cobb-Douglas industry elasticities against the median industry Translog elasticity for each of the four inputs in production. Confidence intervals are quite narrow around the point and median estimates, and they are thus omitted. Values in the x-axis represent the 2-digit ISIC industry, according to the Rev. 3 classification. See Data Appendix for further details on the classification.

TABLE A3. OUTPUT ELASTICITIES, COBB-DOUGLAS, BY IMPORTER CLASS

Sample of Importers	β_k	β_l	β_m	β_x
Small	0.06	0.40	0.37	0.13
	(0.05)	(0.03)	(0.02)	(0.01)
Medium	0.07	0.32	0.40	0.15
	(0.03)	(0.02)	(0.01)	(0.01)
Large	0.08	0.28	0.39	0.20
	(0.03)	(0.01)	(0.01)	(0.01)
All internationals	0.08	0.32	0.39	0.18
	(0.02)	(0.01)	(0.01)	(0.004)

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

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