Market Power in Input Markets:

Theory and Evidence from French Manufacturing

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Abstract

This paper presents micro-level evidence on buyer power in input trade and evaluates its effects on the aggregate economy. I develop a framework to estimate market power in input markets when downstream firms' prices are determined through bilateral negotiations. Using trade and production data from France, I show that buyer power has a much larger impact on foreign than domestic input markets. Descriptive evidence on imported input prices reveals patterns consistent with a sizable buyer power of importers. I build an equilibrium model to explore the output and welfare implications of my estimates. Like an optimal tariff on imports, importers' buyer power can raise national income due to terms-of-trade effects, which more than compensate for losses in consumer surplus and trade volumes. In baseline calibrations, buyer power results in a net increase in welfare of about 2%.

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1 Introduction

Large buyers figure prominently as a salient feature in many sectors of modern economies, and their ability to force sellers to lower prices below competitive levels is a growing concern among economists and policymakers.[1] Buyer power can affect the overall welfare of the economy. In addition to altering the division of surplus between buyers and suppliers, consumers can also be affected through output and price effects.

Concerns about dominant buyers become even more relevant in the context of international trade, where high entry costs create barriers to competition (Antràs et al., 2017), and where activities are concentrated in a small number of high-performing players (Bernard et al., 2007). Given the central role that input trade plays for welfare and growth, buyers' behavior in international input markets may have far-reaching consequences for the economy.[2] However, we only have a limited understanding of the size and implications of importers' buyer power, as canonical studies of input trade typically postulate price-taking behavior on the buyer's side.

In this paper, I develop a methodology for estimating market power in input markets, and I apply it to trade and production data from France. As a large open economy and one of the world's largest importers, France represents an ideal case study of my approach. I then develop a macroeconomic framework that allows me to explore the implications of my estimates for the domestic economy's production and welfare.

My starting point is a dataset that contains detailed information on imported goods for virtually all French manufacturing firms over the period 1996 to 2007. I document three facts about the price of imported intermediate inputs. First, concentration among importers is negatively related to the average price in a given input market.[3] Second, conditional on firm size and proxies for quality choices, firms that account for a larger share of the product's total demand pay a lower price. Lastly, within-firm regressions reveal that as the buyer share of a firm increases, the input price decreases. This evidence shows that dispersion in imported input prices is systematically related to market concentration and the demand of individual importers, and suggests that, contrary to standard models' predictions, transactions within supply chains happen within markets where buyers are concentrated and have market power.

Motivated by these facts, I develop a methodology to estimate market power in input markets, in contexts where input prices are determined through bargaining between upstream sellers and downstream buyers. Estimating market power is notoriously challenging in the absence of detailed product-level data on prices, quantities, product,

[1] See, e.g. *American Antitrust Institute (AAI)'s Transition Report on Competition Policy* (2008, Chapter 3).

[2] For studies documenting productivity and welfare gains associated with input trade, see, e.g. Amiti and Konings (2007); Kasahara and Rodrigue (2008); Goldberg et al. (2010); Topalova and Khandelwal (2011); Halpern et al. (2015); Blaum et al. (2018).

[3] Throughout the paper, an input *variety* is defined by the HS8 product and the country of sourcing.

and consumer characteristics. While methodologies have been recently proposed to overcome data limitations, existing work has mostly focused on product or labor market power, abstracting from market power in markets for intermediate inputs (De Loecker and Warzynski, 2012; De Loecker et al., 2016; Dobbelaere and Mairesse, 2013). Also, existing frameworks are typically based around Walrasian input markets and are thus not readily applicable to the setting under consideration.

Building on this literature, I extend the model of firm behavior in Hall (1988) and De Loecker and Warzynski (2012) to allow for two-sided bargaining between buyers and suppliers of individual input varieties. In my framework, I distinguish between inputs that firms source domestically from inputs that they source from foreign countries. While I allow buyer power to have a role in all input markets, the distinction between firm behavior at home and abroad is critical for identifying buyer power while dispensing with strong assumptions on competition.

Despite the rich micro-foundation, I show that the buyer's problem in each input market can be fully and tractably captured by a supply function mapping the input demand to a negotiated price. Given this function, the buyer optimally chooses the price-quantity combination that minimizes total costs. There is buyer power whenever the negotiated price is below the level that would have prevailed had the firm behaved as a price taker. The size of the price wedge, and buyer power thereof, depends on the firm's share of total input supply: the higher the share, the more elastic the input supply function, the lower the price that the buyer can negotiate.

While I define the wedges at the firm-variety level, production data that can measure them are only available at the firm level. I show that the equilibrium admits a convenient aggregate representation, in the form of an expression relating the weighted average of firm-level buyer power in foreign (domestic) input markets to output elasticity and revenue share of the foreign (domestic) inputs firm-level markups. I get rid of the unobserved markup term by taking the ratio between average buyer power in foreign and domestic input markets, which yields an expression for the relative buyer power that I can quantify given data on input shares, and estimates of the output elasticities.

Estimating output elasticities when markets are less than competitive is another empirical challenge of this paper. When input and output variables are measured in nominal terms, standard production function estimation techniques may lead to biased estimates of the output elasticities (De Loecker and Goldberg, 2014).

I propose an approach to address the output and imported input price bias, which uses price information on imported input and (a subset of) output products observed in customs data. The critical observation is that differences in product-level prices across import and export markets may provide meaningful information about how much a given firm deviates on average from its competitors' price.[4] I use this information to construct a firm-level correction factor for industry-level deflators, whose goal is to induce across-firms variation in observed average output and imported input prices. I can then use these prices to construct consistent physical measures of output and foreign intermediate inputs.

This correction notwithstanding, an input price bias may still arise due to a lack of price data on domestic inputs. If large, such bias may affect the estimates of both domestic and foreign inputs' output elasticity. I argue that the effect of the bias on estimates of buyer power is, in principle, undetermined. I then contend that the size of this bias is plausibly small if firms that have high buyer power over domestic input suppliers are those that buy higher-quality inputs: while quality pushes marginal costs upwards, buyer power implies that firms can negotiate prices lower than marginal costs, such that on average, price dispersion across firms is reduced. To validate this claim, I verify that results remain largely unchanged when I include proxies for domestic input prices. I conclude that input price bias has an overall limited role in generating my results.

I apply my methodology using a firm-level panel, which I obtain by merging trade and production data for French manufacturing firms. My results show that the relative wedges are sizable, indicating that buyer power has a much larger impact on foreign than domestic input purchases.

Both sector- and firm-level evidence corroborate my interpretation of the relative wedges as buyer power. I show that the wedges are large in sectors where importers are highly concentrated, multinational firms' share is large, and import competition is low. Across firms, large and productive firms are relatively more distorted than small, unproductive ones. Notably, the latter is true even conditional on controls for technological differences across firms, and conditional on firms importing the same products from the same countries.

I then impose additional structure on the data to shed light on the sources of the relative wedges. I introduce parametric restrictions on demand and market structure in final good markets to calibrate firm-level markups, which allows me to quantify the *level* of buyer power in both foreign and domestic markets. Markup calibration requires estimates of substitution elasticity across varieties of imported goods, which I estimate from the French customs data following the methodology in Broda and Weinstein (2006) and Soderbery (2015). While the gap between input prices and marginal revenue product ranges from 20 to 50% for imported inputs, the corresponding gap for domestic inputs is close to zero. This evidence implies that the relative wedges are primarily driven by firm behavior abroad, as the buyer behavior in domestic markets is close to efficient.

[4]In the case of output, the theory behind this approach requires that firms sell an overlapping set of products at home and in foreign countries, and that there is positive correlation between firm-product-level markups and marginal costs across destination markets. This condition is satisfied in virtually all models of exporting.

I use a variety of strategies to rule out concerns that the observed patterns arise from omitted factors. I show that my results do not depend on extensive margin differences in firms' sourcing patterns. Holding the firms' sourcing strategy constant, they are inconsistent with the predictions of competitive input sourcing models. Similarly, I show that technology-based explanations of the input wedges cannot rationalize my results.

I embed the model of firm behavior into a macroeconomic framework to quantitatively evaluate the implications of importers' buyer power for production and welfare in the economy. At the individual firm level, buyer power leads to an inefficient substitution of the inputs in production and an inefficiently small firm size. At the aggregate level, micro-level input distortions lead to lower imports and overall lower output than in a world where all firms behave as price takers in all input markets.

The macro model's central theoretical insight is that importers' buyer power acts as a tariff on imports at the aggregate level: it induces distortions on domestic production and trade volume, but it does so while improving the terms-of-trade. On the one hand, lower output and higher prices reduce consumer surplus. On the other hand, profits increase due to foreign rent shifting, and so does producer surplus. The overall effect of buyer power on domestic welfare depends on which of these two effects is more extensive, and so it is ultimately an empirical question.

The micro-level estimates from the first part of the paper are sufficient statistics to provide a quantitative assessment of these effects. Under baseline calibration of the model's parameters, I find that welfare is always higher in the distorted economy than in the counterfactually efficient benchmark. Domestic income may increase by as much as 2.4% due to importer behavior in foreign markets.

A classical result in the theoretical trade literature is that countries with market power in imports exploit it in setting their trade policy (Broda et al., 2008). My results show that even in the absence of import tariffs, when importers are large and have buyer power in input trade they could generate similar terms-of-trade gains. Moreover, these effects are sizable, despite originating from the behavior of individual firms.

These findings have important policy implications. Because importers' buyer power could increase national welfare, nationalistic governments may face weak incentives to restrain the largest firms' market power. A lenient national anti-trust policy could substitute for beggar-thy-neighbor trade policies while being less exposed to the risk of retaliation. I leave for future work a detailed examination of similar policy interdependencies.

In addition to the papers discussed earlier, my work is related to several international trade and macroeconomics literature. While the phenomenon of buyer power in international trade has been drawing increased attention from economists in recent years, there have been only few attempts to quantify its importance, and even fewer attempts to model its aggregate consequences in general equilibrium. Raff and Schmitt (2009) study the implications of retailers/wholesalers' buyer power on the effects of trade liberalization, while Bernard and Dhingra (2019) analyze the impact of changes in the microstructure of import markets on the division of gains from trade. My contribution to this literature is threefold: first, I provide the micro-foundation for a new empirical framework for estimating buyer power in input trade from standard trade and production data. Second, I show novel evidence that importers' buyer power is sizable, using both reduced-form and structural methods. Finally, I study the aggregate implications of buyer power in general equilibrium and uncover a novel rationale for national governments' lenient behavior towards the excessive market power of import-oriented firms.[5]

This paper's findings also contribute to the literature on the effects of input trade for aggregate productivity and growth (e.g. Goldberg et al., 2010; Halpern et al., 2015; Blaum et al., 2018). By providing evidence that foreign input markets are relatively more distorted than domestic ones, this paper shows that input trade can generate allocative inefficiencies. Thus, the productivity gains from input trade may be lower than expected.[6]

Finally, this paper's results naturally relate to the ongoing academic debate about the causes and consequences of rising market power in modern economies by bringing international trade and offshoring into the picture.[7]

The rest of the paper is organized as follows. Section 2 introduces the data and presents descriptive evidence on import prices. In Section 3, I introduce my approach to estimating market power in input markets. In Section 4 I present the main empirical results, and I explore alternative explanations besides buyer power. Section 5 introduces the general equilibrium model and the main qualitative and quantitative results. Section 6 concludes.

2 Data and Empirical Context

2.1 Data

This paper's empirical analysis uses both trade and balance sheet data for French manufacturing importers over the period 1996 - 2007. Firms' balance sheets come from the INSEE-Ficus database of the French Institute of National Statistics. This database includes information on production for the universe of French manufacturing firms, including data on expenditures on different inputs, total sales, and employment.[8]

[5] See Gaubert and Itskhoki (2019) for a similar discussion in the context of a model with granular exporters.

[6] Yet another literature focuses on the role of input trade for domestic firms' market power, but typically look at the effects on firm-level markups. Studies in this literature include Levinsohn, 1993; Harrison, 1994; Chen et al., 2009; De Loecker et al., 2016; Brandt et al., 2017.

[7] See, e.g., De Loecker et al., 2019; Eggertsson et al., 2018; Gutiérrez and Philippon, 2017; Syverson, 2019.

[8] I classify a firm to be in the manufacturing sector if it reports manufacturing as a primary activity for at least one-half of its lifetime in the data.

Data on annual imports and exports, disaggregated by firm, origin/destination countries, and eight-digit (HS) product, come from French Customs Statistics. A key feature of customs data is that they contain information on the value and quantity of imports and exports, which allows constructing import and export prices as unit values.

While data on imports and exports are available at the firm-product level and include both price and quantity information, all the remaining production variables are observed in nominal terms and only available at the firm level. I work around this discrepancy by relying on a structural model that allows me to map micro-level variables to firm-level aggregates. At the same time, I exploit the micro-level dimension of import data to provide motivating evidence for the structural model's main assumptions.

A second, important limitation of the data is that the identity of the foreign exporter of each individual input variety is unknown. Similarly, I do not know whether a given import transaction is arm's length, or rather involves related parties. For France, the share of total manufacturing imports that happens intra-firm is estimated at around 40% (Corcos et al., 2013), in line with the evidence from other countries. Given the sizable volume of trade taking place within multinationals, one may be concerned that dispersion in import unit values across importers may, in part, reflect transfer pricing (Bernard et al., 2006). I will take this possibility into account when interpreting the reduced-form evidence at the end of this section.

Sample Definition My empirical analysis proceeds in two steps: I first provide motivating evidence on imported input prices. I then rely on a structural framework to quantify the size of the buyer power of individual firms. I use disaggregate import data for the first exercise; for the second exercise, I merge trade and production data, thus aggregating information at the firm-level.

Appendix Table A1 reports summary statistics on disaggregated import data. Given the focus on intermediate inputs, I restrict the analysis to imports of products classified as intermediate goods, industrial supplies, or capital good parts in the Broad Economic Categories (BEC) classification.

As expected from import data, there is a large variation across importers in the number of varieties imported and sourcing countries: importers at the 90th percentile import an average of 280 varieties from 22 countries; on the contrary, importers at the 10th percentile import only 3 varieties, from a single country.

Appendix Table A2 shows large dispersion in unit prices of imported varieties across firms. Dispersion in unit values across firms is large both for homogeneous and differentiated products. In the remainder of this section, I exploit this variation to provide some motivating evidence for the structural analysis that follows.

2.2 Reduced Form Evidence on Buyer Power

This section sets up some notation and documents some facts about imported intermediate inputs' prices. Let ν denote a variety of the imported input, where a variety is defined as a HS8 digit product-sourcing country combination, which is the smallest level of aggregation possible. I denote as $M_i(\nu)$ the quantity of variety ν imported by firm i, while $W_i^M(\nu)$ is the price of ν paid by firm i.

Standard models of input trade typically assume that importers behave as price takers in anonymous foreign input markets, where input prices are independent of market concentration and firm-level demand $M_i(\nu)$. However, it is well-recognized that prices in many intermediate input markets are generally set through a process of bargaining between buyers and sellers (Bernard et al., 2018b; Bernard and Dhingra, 2019). In these settings, dispersion in equilibrium prices may systematically relate to the market and firms' size.[9]

A simple way to discriminate between competitive and bargaining theories of price setting in input trade consists of verifying whether market concentration and firm-level quantities have any bearing on input unit prices. I document the following facts consistent with bargaining theories of input price setting:

Fact 1 : *The average price of an input variety is lower in more concentrated input markets.*

Fact 2 : *Within an input market, larger buyers pay a lower price for the same input variety.*

Fact 3 : *A firm's price for an input variety decreases, as its buyer share or tenure in the market increases.*

Market-level Evidence I start by showing evidence of Fact 1, which looks at price variation across input markets. I run the following variety-level regression:

$$\ln \bar{W}_{\nu t}^M = \alpha + \gamma_1 \times \ln N_{\nu t}^M + \gamma_2 \times \ln \bar{M}_{\nu t} + X_{\nu t}' \mu + c_\nu + \delta_{st} + \varepsilon_{knt}. \tag{1}$$

The dependent variable is the average price of variety ν at time t : $\bar{W}_{\nu t}^M = \left(N_{\nu t}^M\right)^{-1} \sum_{i=1}^{N_{\nu t}^M} W_i^M(\nu)$. The term $N_{\nu t}^M$ is the number of French importers importing variety ν at time t, which measures (inversely) the degree of concentration in the market.[10] The term $\bar{M}_{\nu t}$ denotes the average quantity of the good, measured in kilograms, imported by French firms $\bar{M}_{\nu t} = \left(N_{\nu t}^M\right)^{-1} \sum_{i=1}^{N_{\nu t}^M} M_{it}(\nu)$. The vector $X_{\nu t}$ includes controls for total world imports of variety ν. The fixed effect for varieties c_ν controls for things such as average cost of the product or unobserved unit of measurement, while the term δ_{st} is an industry-specific time

[9] A standard result in the theoretical literature is that, when the supplier's marginal costs are increasing, the larger buyers can negotiate lower input prices (Chipty and Snyder, 1999; Inderst and Wey, 2003).

[10] Results are robust to using alternative import market concentration measures, including the Herfindahl Index $HHI_{\nu t}$, and the Mean Log Deviation of import shares.

Table 1: Import Prices and Competition: Market-level Evidence

	(1)	(2)	(3)	(4)	(5)	(6)
		OLS			IV	
Dependent Variable			$\ln \bar{W}^M_{\nu t}$			
$\ln N^M_{\nu t}$	0.015***	0.046***	0.032***	0.170*	0.610***	0.608***
	(0.004)	(0.004)	(0.005)	(0.090)	(0.096)	(0.124)
$\ln \bar{M}_{\nu t}$			0.008***			-0.003
			(0.002)			(0.004)
France Share of ν Imports		-0.162***	-0.144***		-0.172***	-0.149***
		(0.001)	(0.002)		(0.002)	(0.002)
Observations	351,031	351,031	220,379	333,323	333,323	219,253
FE	CP IY	CP IY	CP IY	CP IY	CP IY	CP IY
F-Stat	-	-	-	346.80	320.54	157.32

Notes: *** p<0.01, ** p<0.05, * p<0.1. Standard errors in parentheses are clustered at the variety level. The sample includes all French imports of varieties imported by at least 2 firms between 1996-2007. A variety is defined as a 8-digit product×source country. All regressions include fixed effect at the variety level, and a industry-specific trend, where an industry is defined as a HS4 digit product. Columns (1)-(3) reports the OLS coefficients. Columns (4)-(6) the IV coefficients, obtained by instrumenting the number of French importers with the total imports of variety ν by extra-EU countries in year t. The R^2 is about 0.84 for all specifications.

trend. The coefficient γ is identified off time-series variation in the number of firms over the sample period.

Columns (1)-(3) of Table 1 show the results of estimating equation (1) via OLS. The estimate $\hat{\gamma}_1$ is positive and statistically significant, indicating that on average input prices are higher in less concentrated markets. In columns (4)-(6), I consider an instrumental variable strategy for estimating γ_1, to address the concern of a downward bias in the OLS coefficient due to spurious correlation between the number of importers and the average unit price. I instrument the number of firms with the total imports of variety ν from extra-EU countries, obtained from UN Comtrade data. This variable picks up variation in input market concentration due to supply side factors, such as the cost of sourcing from market ν. The IV estimate of γ_1 is large, positive and significant, which confirms both the main result and the fact that the OLS estimates are biased downwards.

Between-firms Evidence To show evidence of Fact 2, I exploit variation in prices across-firms within a market. I consider the following augmented price-size regression (e.g.

Table 2: Import Prices and Competition: Firm-level Evidence

	(1)	(2)	(3)	(4)	(5)
Dependent Variable			$\ln W_{it}^{M}(\nu)$		
$\ln size_{it}$	0.023***		0.025***	0.028***	0.025***
	(0.001)		(0.001)	(0.001)	(0.001)
$\ln s_{it}^{M}(\nu)$		-0.170***	-0.139***		-0.167***
		(0.001)	(0.001)		(0.001)
$\ln M_{it}(\nu)$				-0.238***	
				(0.001)	
Average Quality Choice $_{it}$					0.250***
					(0.003)
Observations	3,292,839	3,292,839	3,292,839	3,292,839	2,051,575
FE	P C Y	P C Y	P C Y	P C Y	P C Y

Notes: *** p<0.01, ** p<0.05, * p<0.1. OLS regression coefficients. Standard errors in parentheses are clustered at the firm level. The sample includes all French imports of varieties imported by at least 2 firms between 1996-2007. A variety is defined as a 8-digit product×source country. The R^2 ranges from 0.76 to 0.89 in all specifications.

Kugler and Verhoogen, 2012):

$$\ln W_{it}^{M}(\nu) = \gamma_1 \times \ln size_{it} + \gamma_2 \times s_{it}^{M}(\nu) + X'_{\nu t}\mu + c_{s\nu} + \delta_t + \varepsilon_{i\nu t}. \tag{2}$$

The dependent variable is now the firm-level price of variety ν at time t. Size is total firm sales. The term $s_{it}^{M}(\nu) = \frac{M_{it}(\nu)}{\sum_{j=1}^{N_{\nu t}^{M}} M_{it}(\nu)}$ denotes the buyer i's share of total French imports of variety ν. The vector $X_{\nu t}$ includes market- and firm-level controls, including total world imports of variety ν, and a measure of average quality choice of firm i, which I construct starting from export prices of firm i.[11] All regressions include fixed effects at the variety and time level.[12] The coefficient of interest is γ_2, which indicates the effect of firm-level import share on the firm-level input price.

Table 2 shows the results. While the positive coefficient on firm size confirms the existence of the price-plant size correlation in input prices (e.g. Kugler and Verhoogen,

[11] Average export price is a reasonable control for input quality under the assumptions that: (1) output quality choices and input quality choices are correlated, and (2) differences in output prices across firms reflect (in part) higher quality. These assumptions are standard in empirical work (Kugler and Verhoogen, 2012; De Loecker et al., 2016). By construction, this control is available only for the subset of importers who also exports in a given year. These importers account for 50% of importer number and about 90% of import value. For this reason, I do not include this control in all specifications.

[12] This is the specification of fixed effects usually considered in price-size regressions (Blaum et al., 2019), and I adapt this convention to make the results comparable to existing studies of a price-size correlation. Similar results are obtained when considering variety level and variety-time level fixed effects instead.

Table 3: Import Prices and Competition: Within-Firm Evidence

	(1)	(2)	(3)	(4)
Dependent Variable		$\ln W_{it}^{M}(\nu)$		
$\ln s_{it}^{M}(\nu)$	-0.191***			-0.182***
	(0.00)			(0.003)
Tenure$_{it}$ (log)		-0.071***		-0.025***
		(0.001)		(0.001)
First Year Dummy			0.049***	0.026***
			(0.001)	(0.002)
Observations	3,394,913	3,394,913	3,394,913	3,394,913
FE	PC FY	PC FY	PC FY	PC FY

Notes: *** p<0.01, ** p<0.05, * p<0.1. OLS regression coefficients. Standard errors in parentheses are clustered at the firm level. The sample includes all French imports of varieties imported by at least 2 firms between 1996-2007. A variety is defined as a 8-digit product×source country. The R^2 is about 0.88 in all specifications.

2012), prices are strongly negatively correlated to the buyer's share of imports (column (2), (3) and (5)) or to the buyer's demand (column (4)). Conditional on size, firms that account for a higher share of the supplier's output pay a lower unit price.

Within-firms Evidence I conclude this section by showing evidence of Fact 3, which looks at within-firm variation in prices. The main estimating equation is:

$$\ln W_{it}^{M}(\nu) = \gamma_1 \times s_{it}^{M}(\nu) + \gamma_2 \times \ln tenure_{ivt} + \gamma_e First_{ivt} + X_{vt}'\mu + c_{sv} + \delta_{it} + \varepsilon_{ivt}. \quad (3)$$

Unlike equation (2), firm-time fixed effects δ_{it} now capture all firm-level characteristics affecting prices, including average quality, multinational status and exporter heterogeneity.

I include controls for the tenure of firm i in market $\nu \times t$, as well as a dummy equal to 1 if t is the first year firm i imports variety ν. These variables are arguably related to a buyer's bargaining power. The coefficient of interests are γ_1-γ_3, whose interpretation is now a "within" one: what happens to the firm's price, as its buyer share (or tenure) increases in a given market.

Table 3 shows that unit input price is significantly and negatively correlated with the buyer share of imports. The coefficient on tenure is also negative and significant, albeit smaller. A one standard deviation increase in buyer share is associated with a decrease in the foreign input price of about 20%, while a one standard deviation increase in firm tenure in a given market is associated with a price decrease of about 3%.

Discussion Taken together, Facts 1-3 provide empirical support to bargaining models of price setting in markets for imported inputs. A few comments are in order. First, because the identity of foreign exporters is unknown, the analysis above (implicitly) assumes that all importers of a given variety ν buy from the same market/exporter. In reality, a significant fraction of the variation in input prices may be due to unobserved heterogeneity in the exporters' marginal costs. In particular, if the largest buyers are matched with the most efficient suppliers, their lower input prices could be due to lower marginal costs upstream. Similarly, price effects could partly reflect transfer pricing between related parties.

While both these possibilities certainly cannot be ruled out, they are more likely to affect the between-firm evidence of Table 2, rather than then cross-markets and within-firm evidence of Table 1 and 3, respectively. The main conclusion that the variation in input prices is partly attributable to buyers' pricing power is robust to these two unobserved heterogeneity sources.

Finally, because prices are measured as unit values, the correlation between prices and buyer shares may be spurious in the presence of measurement error in physical quantities. For one, measurement error is generally low in French customs data, which alleviates this concern. Furthermore, Table 3 provides independent support to the main results by showing that input prices are negatively related to non-quantity correlates of buyers' bargaining power.

3 A Framework for Estimating Input Market Power

Motivated by the reduced-form results, this section develops an empirical strategy to quantify importers' buyer power using firm-level production and trade data.

Section 3.1 presents the theoretical framework, which extends traditional work in the literature estimating market imperfections (e.g. De Loecker and Warzynski, 2012) to account for bilateral bargaining in intermediate inputs markets. I distinguish between inputs that are sourced domestically from inputs that are sourced from abroad, and identify a relative measure of the firm's buyer power over foreign and domestic input suppliers.

Despite the complexity of the underlying model of firm behavior, I show that estimates of the relative buyer power can be obtained as is customary, given data on firm-level input revenue shares, and estimates of the output elasticities of foreign and domestic inputs. Section 3.2 describes the estimation of the output elasticities. Section 3.3 comments on the assumptions required to implement the methodology.

3.1 Theoretical Framework

I consider an economy populated by a mass of firms, indexed by i, which combine several inputs to produce output Q_i, according to the following technology:[13]

$$Q_i = Q(\mathbf{K}_i, \mathbf{V}_i; \Theta_i). \tag{4}$$

The vector $\mathbf{K}_i = \{L_i, K_i\}$ is the dynamic input vector, which includes the capital and labor input, which I allow to be subject to adjustment costs or time-to-build.[14] The vector $\mathbf{V}_i = \{Z_i, M_i\}$ is the variable input vector, which include a bundle Z_i of diverse intermediate input varieties produced domestically, and a bundle M_i of imported intermediate input varieties. The vector Θ_i contains all the state variables relevant to the firm at the time of production, including firm productivity e^{ω_i}, which is assumed Hicks-neutral.

I assume that foreign input varieties are aggregated according to a constant return to scale, potentially firm specific, production function $h_i^M(\cdot)$, that is:

$$M_i = h_i^M\left([M_i(\nu)]_{\nu \in \Sigma_i}\right), \tag{5}$$

where Σ_i is the sourcing strategy of firm i, that is the set of imported varieties the firm uses in production.[15] Similarly, the bundle of domestically sourced intermediates Z_i is:

$$Z_i = h_i^Z\left([Z_i(\nu)]_{\nu \in (0,1)}\right). \tag{6}$$

Because variety-level information on domestic inputs are not available, I abstract from firm-level differences in the extensive margin choice of domestic inputs and approximate the set of available varieties by a unit continuum.

I assume that the quantity of all intermediate inputs varieties is chosen flexibly in each period, given a sourcing strategy for the imported inputs Σ_i, which the firm decides one period in advance. This assumption is standard in theories of input trade. It makes it makes possible to focus on the optimal choice of input quantities from a given set of suppliers without taking a stand on how such a set is selected (Gopinath and Neiman, 2014; Blaum et al., 2019). Such timing restrictions are reasonable for French imports, given the substantial persistence in firm-level extensive margin choices observed in the data.[16]

[13] I restrict to well-behaved production technologies and assume that $Q(\cdot)$ is twice continuously differentiable with respect to its arguments.

[14] While labor is typically assumed to be a static input in production in related papers (e.g. De Loecker and Warzynski, 2012; Dobbelaere and Mairesse, 2013), there is evidence that labor markets are particularly rigid in France, especially for large firms (50+ employees), which are the object of my analysis (Garicano et al., 2016).

[15] Throughout the text, a 'variety' of imported intermediate input refers to a HS8 digit product - source country combination.

[16] For instance, the probability that a firm sources from a given country in year t, conditional on having imported from that country in year $t-1$, is about 70%, with a standard deviation of 0.26. Similar patterns are observed at the 4-digit product level: the probability that a firm imports a given HS4 product in year t,

3.1.1 A Bargaining Model of Input Price Setting

In light of the evidence in Section 2, I depart from competitive models of input trade and allow importers and exporters of a given input variety to bargain over the terms of trade. To do so, in Appendix C, I lay out a formal partial equilibrium model of bargaining in buyer-supplier relationships with two-sided market power based on Alviarez et al. (2020).

In the model, buyers and sellers bargain over the price and quantity of the exchanged input. I assume many-to-one networks where each buyer buys the input from only one seller, who can sell its product to multiple buyers. Consistent with the reduced form evidence, I focus on settings where the exporters face an increasing marginal cost schedule, such that in equilibrium, larger downstream buyers pay lower unit prices.

I show that from the buyer's point of view, the outcome of the bargaining game can be fully summarized by an input price (or inverse supply) schedule that maps the buyer's demand to a negotiated price. Therefore, despite the complexity of the underlying bargaining problem, it is possible to capture its consequences for the buyer's costs and profits in a tractable way.

In particular, the inverse supply schedule of variety ν of input M can be written as a monotone function of buyer i's demand $M_i(\nu)$:

$$W_i^M(\nu) = W^M\left(M_i(\nu); \mathbf{A}_i^M\right), \tag{7}$$

where $\mathbf{A}_i^M$ is a vector summarizing demand and technology conditions relative to each specific buyer-seller match, which the buyer takes as given. The mapping in (7) is characterized by the following inverse supply elasticity:

$$\Psi_i^M(\nu) \equiv \frac{d\ln W_i^M(\nu)}{d\ln M_i(\nu)} = \Psi_i(s_i^M(\nu); \mathbf{a}_i^M), \tag{8}$$

such that $\Psi_i(0) = 0$, $\Psi_i > 0$ and $\Psi_i' > 0$. The term $s_i^M(\nu)$ is the buyer share of total supply of variety ν of intermediate input M, i.e. $s_i^M(\nu) = \frac{M_i(\nu)}{\sum_j M_j(\nu)}$. The functional relation between the buyer's share and supply elasticity in (8) is firm-specific, as it depends on match-specific conditions, such as the relative bargaining power of exporters and importers and the degree of returns to scale in the supplier's technology, which are summarized by the vector $\mathbf{a}_i^M$.

The mapping in (7) tractably nests the standard case of perfect competition: when $s_i^M(\nu) \to 0$, the inverse supply elasticity also goes to zero such as the buyer effectively behaves as a price taker. Vice versa, when $s_i^M(\nu) > 0$, the input price *increases* in buyer's demand, due to the effect of the buyer's demand on the average cost of production.

conditional on having imported that product in year $t-1$, is about 58% for all years, with a standard deviation of 0.25.

Domestic Intermediate Inputs The analysis below requires assumptions on the market structure of domestic input markets. For the sake of generality, I assume that prices of domestic intermediate inputs are also the outcome of bilateral negotiations between French firms and their domestic suppliers.[17] While I do not have the data to test it directly, this assumption is consistent with recent firm-to-firm trade models in domestic production networks (Kikkawa et al., 2019; Bernard et al., 2019b). As for foreign intermediates, each domestic bargaining problem can be captured in reduced form by an inverse supply function akin to (7).

3.1.2 Market Power in Input Markets

The problem of each firm i is to choose input quantities to minimize short-run costs taking as given the input supply functions, output quantity and state variables.

I focus on the optimal demand of an imported input variety ν. Let $\mathcal{L} = \int_{\Sigma_i} W_i^M(\nu)M_i(\nu)d\nu + \int_{\Omega_i} W_i^Z(\nu)Z_i(\nu)d\nu + \lambda_i\left(Q_i - Q_i(\cdot)\right)$ denote the Lagrangian associated with the firm cost minimization problem. In choosing the optimal $M_i(\nu)$, the buyer takes into account the input price schedule in (7). The first-order condition of the problem yields:

$$\frac{MFC_i^M(\nu)}{W_i^M(\nu)} = 1 + \Psi_i^M(\nu), \tag{9}$$

where I defined $MFC_i^M(\nu) \equiv \lambda_i \frac{\partial Q_i}{\partial M_i(\nu)}$ as the marginal (factor) cost of an input variety ν, and where $\Psi_i^M(\nu)$ is the demand elasticity of input price defined in equation (8). When input markets are competitive, i.e. when $\Psi_i^M(\nu) = 0$, the input price is equal to its shadow cost $MFC_i^M(\nu)$, and is thus at its competitive level. Vice versa, when $\Psi_i^M(\nu) > 0$, input prices are below the competitive level, consistent with the existence of buyer power. I consider the quantity

$$\psi_i^M(\nu) \equiv 1 + \Psi_i^M(\nu), \tag{10}$$

as a measure of firm i's buyer power in the market for variety ν of input M. Because the inverse supply elasticity Ψ_i^M increases in a buyer's share of exporter's output, so does the buyer power, i.e. $\psi_i^M(\nu) = \psi^M\left(s_i^M(\nu)\right)$, with $\psi' > 0$. In other words, larger buyers enjoy higher buyer power, and in equilibrium pay an input price below competitive levels.

While the buyer power wedges are defined at the firm-variety level, information on output that is needed to quantify the marginal product of inputs, and the size of the wedges thereof, is only available at the firm level. To work around this data problem, I consider an aggregation of variety-level wedges into firm-level averages.

[17] It is important to emphasize that I *allow for* buyer power in (both foreign and) domestic markets, rather than assume it. The standard case of perfect competition is tractably nested in the reduced form price equation (7), and whether or not buyer power is large will be an empirical question.

Let us define output markups as price over marginal costs, i.e. $\mu_i = P_i/\lambda_i$. I denote by $\theta_i^M \equiv \frac{\partial Q_i}{\partial M_i}\frac{M_i}{Q_i}$ the elasticity of output with respect to the foreign input bundle M_i, and by $\alpha_i^M \equiv \frac{\int_{\Sigma_i} W_i^M(\nu)M_i(\nu)d\nu}{P_iQ_i}$ the share of foreign input expenditure over total revenues. Lemma 3.1 summarizes the relationship between the average buyer power of firm i, and firm-level variables $(\theta_i^M, \alpha_i^M, \mu_i)$.

Lemma 3.1 *A weighted average of firm i's buyer power across foreign markets of individual input varieties can be written as a function of firm-level markups, output elasticity, and revenue share of imported inputs:*

$$\bar{\psi}_i^M = \left(\frac{\theta_i^M}{\alpha_i^M}\right)\mu_i^{-1}. \tag{11}$$

Proof See Appendix B.1.

The term $\bar{\psi}_i^M \equiv \int_{\Sigma_i}\omega^M(\nu)\psi_i^M(\nu)d\nu$, $\omega^M(\nu) \equiv \frac{W_i^M(\nu)M_i(\nu)}{E_i^M}$ is the weighted average of the variety-level buyer power, with weights given by the share of variety ν in total firm expenditure on imported inputs. The key implication of Lemma 3.1. is that firm-level data are sufficient to gain insights about average buyer behavior in foreign markets.

Because firm-level markups are not observed and are hard to estimate given the available data, equation (11) is not sufficient to estimate the buyer power of importer i. I get rid of the unobserved markup component by considering the first order condition of domestic inputs. Given the symmetric assumptions on domestic and foreign intermediate inputs, an equation similar to (11) can be derived for the average buyer power in domestic input markets, $\bar{\psi}_i^Z$, such that one can write:

$$\frac{\bar{\psi}_i^M}{\bar{\psi}_i^Z} = \frac{\theta_i^M}{\theta_i^Z}\cdot\left(\frac{\alpha_i^M}{\alpha_i^Z}\right)^{-1}. \tag{12}$$

Notably, the relationship in equation (12) holds in a general setting where I impose minimal assumptions about demand, technology, and market structure, and it holds independently of the general equilibrium environment. This expression will constitute the central 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.

Empirical Strategy It is now possible to summarize my proposed strategy to quantify buyer power in input trade. First, I will estimate the output elasticities of different productive inputs and recover an estimate of the relative market imperfections in foreign and domestic markets from (12). Note that because I allowed buyer power in both input markets, it is impossible to infer measures of the level of distortions in each market unless I impose additional assumptions on demand. Estimates of *relative* measures of buyer power are nonetheless useful to gain insights on the competitive structure of import markets - the goal of the first part of this paper. If $\bar{\psi}_i^M/\bar{\psi}_i^Z > 0$, one can conclude that buyer power is more prevalent in foreign than in domestic markets. Vice versa if $\bar{\psi}_i^M/\bar{\psi}_i^Z < 0$.

Estimates of the buyer power wedges $\{\bar{\psi}_i^M\}_i$ are yet necessary to quantify the effect of importers buyer power on the French economy - the goal of the second part of this paper. I will later introduce additional assumptions on the demand function and market structure in the output market, which will allow me to calibrate firm-level markups $\{\mu\}_i$ given the available data, and obtain estimates of $\{\bar{\psi}_i^M\}_i$ from equation (11).

3.2 Estimating the Output Elasticities

There is a long tradition of estimating production functions in the industrial organization literature. While my methodology closely follows this tradition, the focus on non-competitive input markets introduces novel challenges that I must confront. In this section, I briefly describe my approach to production function estimation, with a particular focus on those challenges. I provide full details on my production function estimation procedure in section E of the Appendix.

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

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

where lower-case letters denote log variables. 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. The vector of parameters β is assumed common at the two-digit manufacturing sector level. Moreover, it is assumed that the production function coefficients remain constant over the sample period. I consider flexible approximations to technology $f(\cdot)$, which include the Cobb-Douglas (CD) specification and the Translog (TL) specification.

I assume that both capital and labor are dynamic inputs, subject to adjustment costs or time-to-build. The state variable vector of firm i at time t is thus given by $\varsigma_{it} = \{\omega_{it}, k_{it}, l_{it}, \Sigma_{it}\}$, where Σ_{it} is the firm's import sourcing strategy. My assumptions on firms' production function imply that the offshoring activities of different importers affect the production of firms only through their effect on productivity.[18]

Estimation of equation (13) requires data on both physical units of inputs and output and productivity, which are not directly observed. In what follows, I briefly describe the nature of the ensuing biases and my bias correction approach.

[18]Notably, this means that when the production function is Cobb-Douglas the output elasticity of foreign inputs is uncorrelated to a firm's offshoring activities. I provide evidence in support of this assumption in section 4.5.

Input and Output Price Biases When input and output variables are observed in nominal terms, estimation of equation (13) using standard techniques may lead to biased estimates of the production function coefficients (De Loecker and Goldberg, 2014). Intuitively, a firm may have a higher nominal output (inputs) either because it sells (buys) higher quantities or because it charges higher (pays lower) prices. The common practice of using industry-wide deflators to obtain physical measures from nominal variables is often inconsequential, even more so if price differences across firms are sizable.

I propose an approach to correcting for the output price bias that builds on the observation that, for the subset of importers who also export in a given year, a sample of product-level output prices is included in customs data. If product-level markups and marginal costs of a given firm are correlated across destinations, then differences in export prices across firms can provide meaningful information about average firm deviations from industry-level price of a given product. This information can be then used to induce firm-level variation in industry-wide deflators.

The theory behind this approach is outlined in section E, and hinges on the assumption that firms sell an overlapping set of products at home and in foreign countries, and that firm-product-level markup and marginal costs are correlated across destination markets.[19]

While the information on price and quantity of imported inputs is available at the firm-variety level, the empirical strategy requires firm-level measures of imported input prices and quantities. I construct a firm-level physical measure of imported inputs by dividing total expenditures on imported inputs by firm-level import deflators, which, in turn, I build from a procedure similar to the one used for output prices.[20] This allows me to obtain a physical measure of imported inputs in an internally consistent way.[21] The reader should refer to section E of the Appendix for more details on these procedures.

Domestic Inputs and Input Price Bias Even though trade prices can go a long way towards correcting price biases, an input price bias may still arise due to a lack of price data on domestic inputs. Approaches based on control functions, as in De Loecker et al. (2016), have limited applicability in this context due to data limitations.

I provide a formal discussion of this source of price bias in section E.1.2 of the Appendix. I show that if unobserved differences in domestic input prices across firms exist and are large, an input price bias may affect the estimate of the domestic input elasticity β_z

[19]These conditions are satisfied in virtually all models of exports. Notably, they are consistent with the possibility that firms price-to-market, a common practice for many exporting firms (e.g. Burstein and Gopinath, 2014).

[20]Unlike output, import data contain the full set of prices of imported inputs at the firm-variety level, such that this procedure is even less restrictive in the case of imported inputs than it is for output.

[21]Alternatively, one could consider using product-level quantity information to construct a firm-level quantity measure of imported inputs. I believe the proposed procedure is better in two dimensions: 1) it avoids dealing with the measurement error in physical quantities, and 2) it makes imported inputs comparable to the inputs that are obtained by balance-sheet data.

and the estimate of the foreign input elasticity β_m. In particular, I argue that both coefficient estimates will be biased downwards, such that the overall effect of the bias on buyer power, which is proportional to the ratio $\tilde{\beta}_m/\tilde{\beta}_z$, is undetermined.

These considerations notwithstanding, the size of this bias is arguably small, for several reasons. First, firm-level expenditure data implies that part of the product level price deviations may be washed out in aggregation. Second, the effect of unobserved differences in quality and buyer power across firms can cancel out: while quality pushes marginal costs upwards, buyer power implies that firms can negotiate prices lower than marginal costs. This can reduce price dispersion across firms if the quality choices and buyer power of firms are positively correlated.

Simultaneity Bias and Estimation The last source of bias in equation (13) is the unobserved productivity term ω_{it}. Because firm-level input choices are correlated with unobserved productivity, estimation of equation (69) using OLS will lead to biased estimates of the output elasticities due to a simultaneity problem.

I rely on proxy methods suggested by Olley and Pakes (1996); Levinsohn and Petrin (2003); Ackerberg et al. (2015) to control for unobserved productivity and obtain consistent estimates of the vector β. In particular, I follow the approach in Ackerberg et al. (2015) and build a control function for productivity based on inverting the demand function of domestic and foreign intermediate inputs. The idea behind this approach is that productivity ω_{it} can be isolated as the only unobservable affecting the invertible demand of a static input.[22] By inverting the demand function, one can express the unobserved term ω_{it} as a nonparametric function of observables.

Once I correct for price and simultaneity biases, I can express the production function of interest as a function of observables. I estimate the resulting equation using the 2-steps GMM procedure detailed in Ackerberg et al. (2015). The important assumption behind this procedure is a law of motion for productivity $\omega_{it} : \omega_{it} = g(\omega_{it-1}) + \varepsilon_{it}$, coupled with the assumption that the innovation term ε_{it} is uncorrelated with current levels of the dynamic inputs, and lagged level of the static inputs. The reader can refer to Appendix E for further details on the estimation procedure.

[22] I use both the demand for foreign and domestic inputs to deal with the fact that the domestic and foreign input demand function includes two unobservables: productivity and domestic input price index. See Appendix E for more details.

3.3 Discussion

Before turning to results, I summarize and discuss the assumptions required to implement the methodology with French firm-level data.

Domestic vs Imported Inputs in Production The assumptions on technology require that firms use both domestic and foreign inputs in production. I then theorize that the substitution elasticity between individual varieties of domestic and foreign inputs is more extensive than between domestic and foreign intermediate bundles. These modeling choices resonate with standard theoretical frameworks featuring trade in intermediate inputs, such as Gopinath and Neiman (2014) and Blaum et al. (2018).

However, in baseline analysis, I slightly depart from traditional frameworks by assuming that foreign and domestic intermediate bundles enter the production function in a Cobb-Douglas, rather than a CES fashion.[23] This restriction allows me to log-linearize the production function and rely on standard techniques of production function estimation.[24] Nevertheless, my results do not critically depend on this choice. They are robust to considering a Translog specification of the production function, which allows for any pattern of substitutability across inputs.

The second restriction of my empirical framework is that all firms within an industry operate the same technology. This assumption is even more consequential for the case of foreign inputs, given the considerable heterogeneity in the extensive margin of import behavior across firms. For tractability and data requirements, I allow the extensive margin of imports to affect firm production only through its effect on its physical productivity. However, one may think that the entire production structure may depend on the extent of firm offshoring. I discuss and rule out similar concerns at the end of the next section.

Domestic Input Prices Because prices of domestic inputs are not observed and cannot be adequately controlled for, for my results to be robust to an input price bias, unobserved variation in firm-level domestic inputs prices must be small. As discussed above, this does not necessarily mean that domestic input markets must be competitive, or that domestic input market power must be negligible. Instead, what is required is that underlying forces generating variation in domestic prices (if any) offset each other in the aggregate.

This condition is met when price differences are mostly driven by quality and input market power, and if quality choices and buyer power are positively correlated. While

[23] Estimates of the elasticity of substitution between domestic and foreign input bundles are typically higher than unity. In particular, estimates for French firms are around 2 (Blaum et al., 2018).

[24] While studies have dealt with estimation of a CES production function, existing techniques typically rely on the assumption of price-taking behavior in intermediate inputs markets. They are not easy to generalize to my setting are not easy to generalize to my setting (e.g. Grieco et al., 2016).

quality pushes marginal costs upwards, buyer power implies that firms negotiate prices lower than marginal costs.

To test whether the input price bias substantially affects my results, I proxy the unobserved price term with the firm-level average input price in foreign input markets in robustness exercises. Suppose input prices are correlated across input markets, due to buyer effects, for instance. In that case, this correction should lead to higher values of the output elasticities of material inputs if the input price bias is large. Because results are largely unaffected by this correction, I conclude that the input price bias has an overall limited role in generating my results, and ignore it in what follows.

4 Results

In this section, I apply the methodology laid out in Section 3 to quantify the importance of buyer power in input markets. I first discuss the estimates of the output elasticities and the relative buyer power wedges and investigate how these wedges vary across sectors and firms. I do that in Section 4.2 and 4.3. In section 4.4 I introduce a demand system into the production framework, which allows me to calibrate firm-level markups, and infer the size of buyer power in both foreign and domestic markets. In section 4.5 I explore alternative explanations of the wedges besides buyer power.

4.1 Sample Construction

I construct my firm-level dataset by aggregating production and trade information for the sample of French manufacturing firms that simultaneously import and export in a given year.[25] For these firms, information about (a subset of) output prices is observed. The availability of output price data is critical for my production function estimation approach, as explained above. While not all importers export in a given year, the subset of exporting importers accounts for about 90% of total imports. I thus focus on these importers and exclude all other firms.[26]

The main variables of interest are total firm expenditure on foreign and domestic intermediates. I observe imported intermediate expenditure from customs data, and I infer expenditure on domestic intermediates as total expenditure on intermediates, as reported in balance-sheet data, minus expenditure on imported inputs.

I exclude all those firms whose imported intermediates are larger than total intermediates. The fact that firms import more inputs than they use in production is

[25]The merge between balance-sheet data and customs data is possible using unique firm identifiers.

[26]In robustness checks, I verified the validity of this sample selection criterion by implementing a sample selection correction to address the potential selection bias stemming from large importers' use in estimation. Because results were virtually unaffected, I avoid the sample selection correction in my main analysis for the sake of transparency.

consistent with firms engaging in carry-along trade or re-exports. This practice occurs when firms import goods before re-exporting them, with or without the transfers of ownership (Bernard et al., 2019a). Because customs data do not report information on the type of import transactions, excluding those firms deals with measurement error in foreign intermediate inputs in a conservative way. Results are not significantly affected by including the marginal firms, which suggests that carry-along trade does not seem to drive my results. However, a consequence of the selection rule is that the revenue share of material inputs (domestic + foreign) is possibly understated.

Appendix Table A3 provides summary statistics for this firm-level dataset. International firms account for about 28% of the manufacturing firms in France, and for 80% of total manufacturing value added. These firms are larger and more productive than the average manufacturing firm. International firms rely heavily on foreign intermediates, which account for about a quarter of total material expenditures.

Firm-level Prices of Output and Imported Input I construct firm-level price deflators to go from nominal to physical measures. Deflators are defined as $\tilde{p_{it}} = p_{st} + \hat{p_{it}}$, and $\tilde{w_{it}^{m}} = w_{st}^{m} + \hat{w_{it}^{m}}$ for output and imported inputs respectively, where p_{st} and w_{st}^{m} are the 2-digit industry deflators. The (unobserved) terms $\hat{p_{it}}$ and $\hat{w_{it}^{m}}$ denote firm-level deviations from the industry average prices. The output $(\hat{p_{it}})$ and imported input $(\hat{w_{it}^{m}})$ terms are obtained from:

$$\log\left(uv^{j}{}_{iknt}\right) = \delta_{it}^{j} + c_{knt}^{j} + \epsilon_{iknt}, \tag{14}$$

where k indexes NC8 digit products, n indexes country, and 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_{iknt}^{j} that firm i charges (pays) for product k sold in (sourced from) country n in year t.

I regress the log of the unit values on firm-time fixed effects (δ_{it}^{j}), and product-country-time fixed effects (c_{kct}^{j}). The latter captures the average price of a particular product in a particular market across firms in a given year. Therefore, the firm-year effects δ_{it}^{j} measure the average firm-level deviation from these average prices. I set the terms $\hat{p_{it}}$ and $\hat{w_{it}^{x}}$ equal to these OLS estimates, namely $\hat{p_{it}} = \hat{\delta}_{it}^{EX}$, and $\hat{w_{it}^{m}} = \hat{\delta}_{it}^{IM}$. Appendix Table A4 reports summary statistics on the firm-level price correction factors.

Table 4: Distribution Quantiles (1996-2007)

Variable	Mean	Std Dev	p10	p50	p90
Revenue Shares of Inputs					
Labor α^L_{it}	.19	.08	.09	.18	.30
Capital$^{(a)}$ α^K_{it}	.07	.06	.02	.06	.15
Domestic Materials α^Z_{it}	.38	.15	.20	.36	.48
Imported Materials α^M_{it}	.1	.09	.01	.06	.23
Extensive Margin of Imports					
No. of sourcing countries	5.8	4.5	1	5	11
No. of sourcing markets$^{(b)}$	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 sample of international firms. The total number of observations is 129,787. $^{(a)}$ Capital is measured as 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. Results are robust to using an alternative measure of capital constructed using the perpetual inventory method. $^{(b)}$ A sourcing *market* is defined as a country-NC8 product combination.

4.2 Output Elasticities and Revenue Shares

Table 4 provides summary statistics on the revenue share of all inputs, i.e. $\alpha^V_{it} = \frac{W^V_{it} V_{it}}{P_{it} Q_{it}}$, for $V = L, K, Z, M$, and measures of extensive and intensive margin of imports. As expected for firm-level data, the dispersion of all these variables is large, particularly for measures of firms' import behavior.

Table 5 reports the estimated output elasticities when the production function is Cobb-Douglas (CD) and standard errors, which I obtain by block bootstrapping over the entire procedure. In Appendix section E.3 I replicate the analysis when production function is Translog (TL) instead. Results are largely robust to this different specification of the production function, with one crucial difference. Because output elasticities based on TL production function are a log-linear function of input quantities, their distributions inherit the properties of the raw input data. The skewness in import data shown in Table 4 is reflected in the excessively large estimates of the mean and median output elasticity of foreign inputs when the production function is TL, as shown in Figure A4 in the Appendix. Settling on the Cobb-Douglas production function for the baseline analysis seems a conservative choice in light of these issues.[27]

[27] An important caveat about the Cobb-Douglas production function is that the output elasticities are forced to be constant across firms within an industry. This feature may raise concerns about confounding factors affecting wedges, since if differences in technology exist, at least part of the dispersion in technology across

Table 5: Output Elasticities, Cobb-Douglas, by 2-digit Sector

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

Notes: The table reports the output elasticities when the production function is Cobb-Douglas. Cols 2–4 report the average estimated output elasticity 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.

Table 6: Market Power in Input Markets, by Sector

		Ξ^M	Ξ^Z	ψ^M/ψ^Z
15	Food Products and Beverages	2.11	1.25	1.72
17	Textiles	1.67	1.68	1.03
18	Wearing Apparel, Dressing	1.84	1.66	1.15
19	Leather, and Products	1.69	1.56	1.13
20	Wood, and Products	1.97	1.406	1.46
21	Pulp, Paper, & Products	1.28	1.39	0.95
22	Printing and Publishing	2.65	1.67	1.49
24	Chemicals, and Products	1.66	1.42	1.18
25	Rubber, Plastics, & Products	1.67	1.38	1.25
26	Non-metallic mineral Products	1.89	1.47	1.27
27	Basic Metals	2.04	1.36	1.62
28	Fabricated Metal Products	2.08	1.52	1.38
29	Machinery and Equipment	2.06	1.26	1.68
31	Electrical Machinery	1.73	1.35	1.40
32	Radio and Communication	2.03	1.24	1.65
33	Medical Instruments	2.17	1.35	1.66
34	Motor Vehicles, Trailers	1.67	1.09	1.66
35	Other Equipment	2.35	1.16	2.13
Average		1.92	1.4	1.43

Notes: The table reports estimates of the overall impact of input and output market power on the choice of input $V = M, Z$ in column (1) and (2), respectively. Column (3) reports the value of the relative buyer power, by sector. I report the median value of the estimates for each two-digit sector. The mean relative wedge in the average sector is equal to 2.06, while the mean foreign input wedge is equal to 1.98. 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 3^{rd} and 97^{th} percentiles within each sector.

4.3 Market Power in Input Markets

I now use the output elasticities to compute the wedges of interest. I rearrange equation (11) to obtain the following expression:

$$\Xi_i^V \equiv \mu_i \cdot \bar{\psi}_i^V = \frac{\hat{\beta_V}}{\alpha_i^V}, \text{ for } V = M, Z \tag{15}$$

where $\hat{\beta_V}$ is the Cobb-Douglas elasticity, and α_i^V is the revenue share of input V for firm i.[28] The measures Ξ_i^V reflect the overall impact of input and output market power on the choice of input $V = M, Z$.

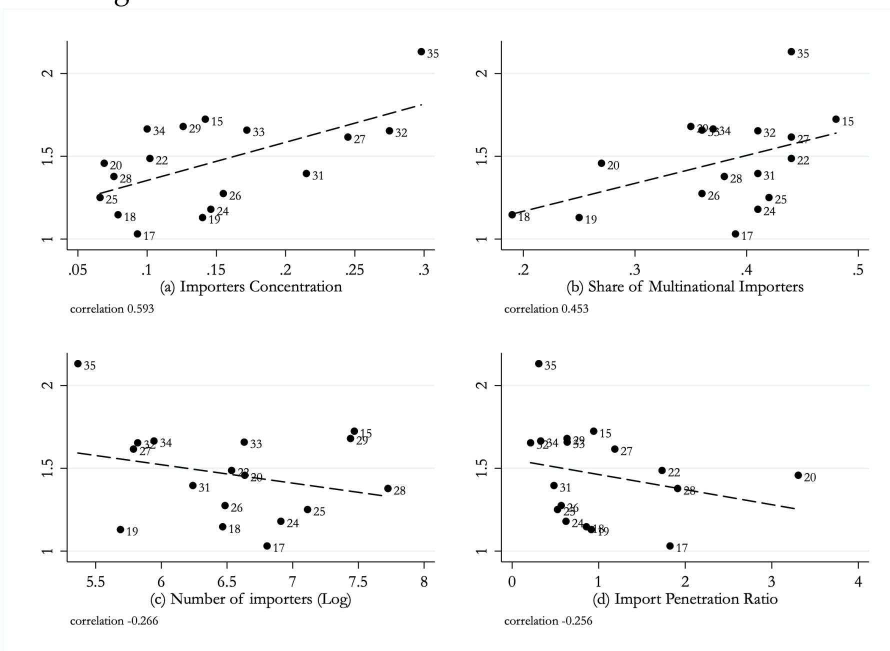
Table 6 reports the median estimates of the joint and relative wedges, for all industries.

firms may be attributed to variation in market power, biasing the results (Raval, 2019). I confront these issues in section 4.5.

[28]In line with the prevailing literature, I apply a correction procedure to the observed revenue share of static inputs. In particular, revenue shares are constructed as $\tilde{\alpha_{it}^v} = \frac{W_{it}^v V_{it}}{P_{it}Q_{it}/\hat{\epsilon_{it}}}$, where $\hat{\epsilon_{it}}$ is the residual of the first stage regression in the production function estimation procedure. This correction aims to purge the shares from variation potentially unrelated to technology or market power (De Loecker and Warzynski, 2012).

Confidence intervals are small, as the Cobb-Douglas elasticities are precisely estimated, and are omitted. With a few exceptions, the results show that market power's overall effect on foreign inputs' choice is substantially larger than on foreign inputs' choice. Because the impact of *output* market power is symmetric on the two markets, this evidence is consistent with *buyer* power having a disproportionate effect on foreign input markets. The median relative wedge $\frac{\bar{\psi}_s^M}{\psi_s^Z}$, is largely above one in almost all sectors, with values ranging from .95-2.13.

Figure 1: RELATIVE WEDGES AND SECTOR CORRELATES



Notes: The figure shows simple correlations between the relative median sectoral wedge, and different sector-level variables. 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; (c) import penetration ratio is computed as Total imports over Total Sales.

The large variability across sectors allows for external validation of the wedges' structural interpretation through simple correlations. In Figure 1, I tie the sectoral relative wedges to industry variables that likely correlate with buyer power in foreign markets. Starting from the top-left panel and moving 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.

I expect the first two measures to correlate positively, while the latter two measures negatively, with importers' buyer power. The evidence in Figure 1 gives strong support to these priors.

Firm-level Evidence It is particularly important to account for confounding factors when comparing wedges across firms. Two obvious candidates are: *(i)* unobserved differences in technology across firms, which are ruled out by construction; and *(ii)* differences in the sourcing strategy across firms. Holding the sourcing strategy fixed is critical. By definition, the extensive margin of imports affects the average firm-level wedge through a composition channel, making unconditional cross-firm comparisons uninformative.

To purge the raw wedges from variation possibly unrelated to market power, I consider the following regression:

$$\log \widehat{\left(\frac{\psi_{it}^{M}}{\psi_{it}^{Z}}\right)} = X_{it}'\pi + \delta_{sIt} + \alpha_{\Sigma_{it}} + \varepsilon_{it}. \tag{16}$$

The vector X_{it} contains firm-characteristics such as MNE status and (log) capital-labor ratio, while the term δ_{sIt} is a fixed effect controlling for the two-digit industry s, time t and principal reported activity of the firm I. Both X_{it} and δ_{sIt} aim to proxy for unobserved differences in the output elasticities across firms.

The term $\alpha_{\Sigma_{it}}$ denotes a full set of sourcing strategy fixed effects as in Blaum et al. (2019), which controls for the set of sourcing countries×product sourced by firms. Including sourcing strategy fixed effects aims instead to control for variation in the wedges due to the different composition of the set of sourcing countries and products across firms. The residuals of regression (16) capture the variation in the relative wedges directly related to buyer power. Table 7 shows summary statistics on these residuals.

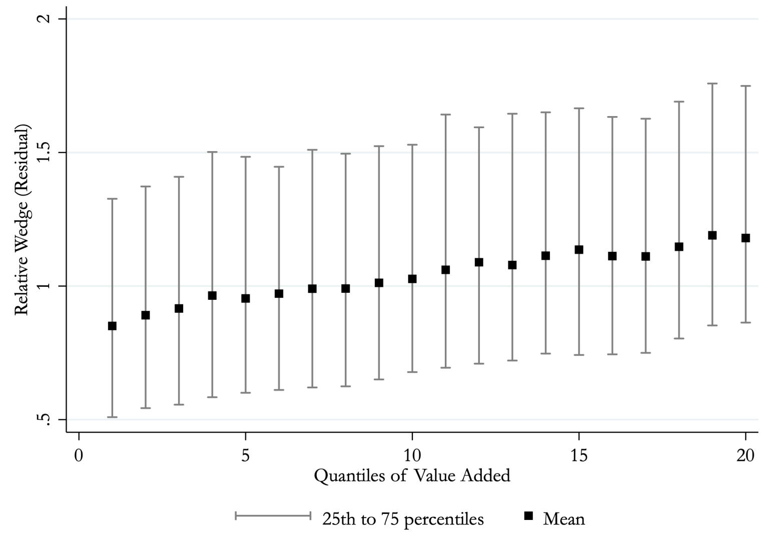
Table 7: Residual Wedges

	ψ^M/ψ^M	
Fixed Effects[a]	MEAN	MEDIAN
α_Σ (country)	1.53	.99
α_Σ (country×HS4 products)	1.20	1
Baseline Estimates		
	2.06	1.43

Notes: The table shows the weighted average across industries of the residual input wedges, obtained as residuals from the OLS regression in equation (24). [a] Regressions include controls for MNE status, capital-labor ratio, and industry×activity×time fixed effects. The only difference between the values in the two rows is the definition of the term $\alpha_{\Sigma_{it}}$, i.e. the sourcing-strategy fixed effects. The industry estimates are given in Table A4 in the Appendix. I show both the value of the residual *relative* wedge $\psi^{x}{}_{s}/\psi^{m}_{s}$, and the value of the residual foreign input wedge $\psi^{\tilde{x}}{}_{s} \equiv \Xi^{x}_{s}/\mu_s$.

Sourcing strategy fixed effects are defined at the country level in the first row, and at the country-HS4 product level in the second row. Despite substantial reductions in both the median wedges across sectors, the average relative wedges remain substantially above one even after the purging procedure, indicating a critical residual role for buyer power distortions.

Figure 2: Residual Relative Wedge, Across Firm Size Distribution



Notes: The figure plots, for each quantile of firm size, the mean relative wedge together with first and third quartiles, obtained as the residuals of the following OLS regression: $\log\widehat{\left(\frac{\psi_{it}^M}{\psi_{it}^Z}\right)} = X_{it}'\mu + \delta_{sIt} + \alpha_{\Sigma_{it}} + \varepsilon_{it}$. Firm size is defined in terms of value added. Results are robust to alternative measures of firm size, including sales and employment.

Figure 2 plots the distribution of the residual wedges across different quantiles of firms' value added. Even with substantial heterogeneity, larger firms have larger estimated wedges, ceteris paribus. These results are confirmed through regression analysis. Table 8 shows the results from running OLS on an equation similar to (16), augmented with firm size and productivity controls. Firm size ($size_{it}$) is total value added of firm i in time t. Firm productivity is the TFP residual from production function estimation. Standard errors are obtained by a bootstrapping procedure. Each pair of columns show the coefficients on size and productivity, for an increasingly stringent set of fixed effects. Across specifications, input market power is positively and significantly correlated with size and measured productivity of firms. Quantitatively, a one standard deviation increase in size 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%. The results in Figure 2 and Table 8 show that the most distorted firms are the largest and more productive ones, consistent with the interpretation of the wedges as buyer power.

4.4 Markup Calibration

The analysis of the relative wedges is not sufficient to gauge the size of buyer power in input trade, nor of buyer power in domestic input markets. Identification of importers' buyer power *level* in foreign and domestic input markets is yet necessary to make any statement about the aggregate effects of buyer power.

Table 8: Relative Buyer Power across Firms

Dependent variable	$\widehat{\ln\left(\frac{\psi_{it}^{Z}}{\psi_{it}^{M}}\right)}$						
	(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×HS4 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 table shows results from OLS estimation of the following regression equation: $\log\left(\widehat{\psi_{it}^{m}/\psi_{it}^{z}}\right) = \gamma_0 + \gamma_1 \log size_{it} + \gamma_2 \log \hat{\omega}_{it} + X_{it}'\mu + \delta_{sIt} + \alpha_{\Sigma_{it}} + \varepsilon_{it}$.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 HS4× 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%. Standard errors are obtained through a bootstrapping procedure.

To single out the magnitude of buyer power in foreign and domestic input markets, I introduce a demand system into the production framework, combined with assumptions on competition in final good markets, which allow me to calibrate firm-level markups from observed trade and production data. I provide a complete description of the calibration exercise in Appendix D. Here, I briefly summarize its main ingredients and results.

I consider a standard CES demand system, akin to Broda and Weinstein (2006). The demand of each firm's goods comes from either the Home country (France) or from foreign countries. I assume that firms (exporters) compete in monopolistic competition in domestic and foreign markets. Product-level markups are constant across firms and destinations and depend on the elasticity of substitution across different goods.

Within this framework, it is easy to show that firm-level markups can be written as a harmonic average of domestic and export markups, with weights given by the (observed) domestic and exported share of revenues. In turn, export markups can be expressed as a harmonic average of good-level markups, with weights given by the (observed) export share of each good in total firm exports.

Because I observe the relevant shares, calibration of firm-level markups only requires estimates of good-level elasticity of substitution across importing countries and the (domestic) elasticity of substitution across firm-level bundles. I obtain estimates of the first

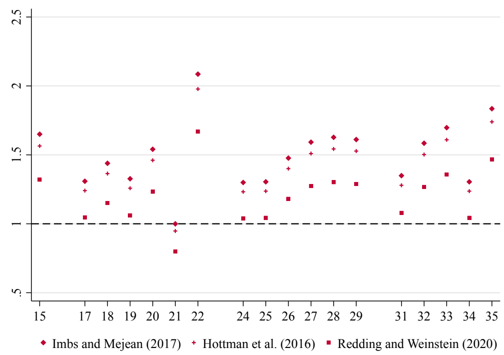


Figure 3: Foreign Input Wedges

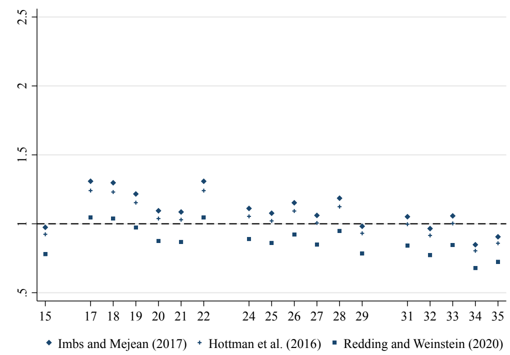


Figure 4: Domestic Input Wedges

Notes: The two figures plot, for each two-digit industry, the median estimate of the input wedge in foreign and domestic input markets, respectively. These wedges are obtained from $\psi^V = \Xi^V/\mu$, for $V = M, Z$. Estimates of Ξ^V are reported in Table 6. Markups estimates are reported in Table D1 in the Appendix instead. Because the markup estimates very much depend on the value of the domestic elasticity of substitution, which I do not directly estimate, I report results for this parameter's different choices. The legend indicates the study from which I take the specific value.

set of elasticities from French customs data, using the methodology developed by Broda and Weinstein (2006) and (Soderbery, 2015). Given the lack of data on domestic sales, I cannot directly estimate the values of the elasticity of substitution across "domestic" varieties. I thus consider existing estimates of similar elasticities, based on studies that evaluate a similar demand system.[29]

The results of the calibration exercise are in Table D1 in the Appendix. The average estimated firm-level markup ranges from 1.28 to 1.60, depending on the elasticity of substitution across firms. These values are broadly consistent with existing estimates of firm-level markups for European countries.[30]

Buyer Power in Foreign and Domestic Markets I can now infer the implied value of buyer power in foreign and domestic input markets from equation (11). Figure 3 and 4 plot the implied sectoral estimates of ψ^M and ψ^Z, respectively, obtained using the different calibrated values of firm-level markups.

Figure 3 shows that estimates of wedges in foreign input markets are above one in almost all sectors. The average estimate of buyer power in foreign market ranges from 1.2 to 1.51. Interpreted through the lens of the theoretical framework, these values imply that, on average, French importers pay input prices between 20 and 50% below marginal costs due to their buyer power. The firm-level evidence in the previous section suggests that the average effect is driven by the largest importers, consistent with the prior that the larger

[29]Specifically, I take the value of the elasticity of substitution across domestic varieties from both Redding and Weinstein (2020), Hottman et al. (2016), and Imbs and Mejean (2017) who find values of this elasticity equal to 2.66, 3.9 and 4.62, respectively.

[30]See, e.g. Andrews et al. (2016); De Loecker and Eeckhout (2018); Calligaris et al. (2018)

buyers pay lower unit prices.

What's more striking, the wedges on the domestic input markets are close to their competitive level, instead. As can be seen from figure 4, estimates of ψ^Z are close to one, ranging from 0.87 to 1.08. My results imply that while bargaining models of competition well-approximate foreign input markets, competitive models are a better approximation of domestic input markets. This evidence motivates the assumptions of the aggregative model in section 5.

4.5 Alternative Explanations

I conclude this section by discussing alternative explanations for the observed wedges and wedge variability across firms, besides buyer power and measurement error. Specifically, I examine varying sourcing strategies with plant size and varying output elasticities within industries. All of these factors undoubtedly contribute to generating dispersion in the input wedges. Still, the question is whether they can ultimately overturn our main result that buyer power in input trade is quantitatively significant.

4.5.1 Heterogeneous Sourcing Strategies

Equation (12) implies that a firm is estimated to have buyer power in input trade when the observed expenditure on imported inputs is too low compared to the one on domestic inputs, in light of the estimated output elasticities. The concern arises as to whether holding output elasticities constant, similar behavior of input expenditures may occur in competitive frameworks due to firms' different sourcing behavior.

To shed light on this issue, let us consider two firms, i and i' operating a Cobb-Douglas technology in the same industry. I let Σ_i and $\Sigma_{i'}$ denote the set of sourcing countries (excluding the Home country) of firm i and i' , respectively. I let h denote the home country and j denote a foreign country, and I denote with χ_{ik} the share of intermediate input purchases sourced by firm i from any country k. The analysis above would conclude that firm i has higher buyer power in foreign markets than i' if

$$\frac{\chi_{ih}}{\sum_{j\in\Sigma_i}\chi_{ij}} > \frac{\chi_{i'h}}{\sum_{j'\in\Sigma_{i'}}\chi_{ij'}}, \tag{17}$$

that is, if firm i spends relatively more on domestic inputs than firm i' does.

Antràs et al. (2017) show that, in a competitive framework of input sourcing, the share of intermediate input purchases sourced by firm i from any country k can be written as $\chi_{ik} = \frac{T_k(\tau_k w_k)^{-\theta}}{\Theta_i}$. The numerator is the so-called sourcing potential of country k, and only depends on origin-specific variables, such as aggregate productivity T_k, trade costs τ_k and production costs w_k. The denominator depends instead on firm-level characteristics, such as productivity. It follows that:

$$\frac{\chi_{ih}}{\sum_{j\in\Sigma_i}\chi_{ij}} = \frac{T_h(w_h)^{-\theta}}{\sum_{j\in\Sigma_i}T_j(\tau_j w_j)^{-\theta}}\ \forall i, \tag{18}$$

which says that in a competitive framework, a firm allocates expenditures across countries based on their relative sourcing potential. Differences in this expenditure share across two firms only depend on firm behavior in foreign markets, and arise if and only if $\Sigma_i \neq \Sigma_{i'}$. Specifically, firm i would spend relatively less on foreign inputs than firm i', if $\sum_{j\in\Sigma_i}T_j(\tau_j w_j)^{-\theta} < \sum_{j'\in\Sigma_{i'}}T_{j'}(\tau_{j'} w_{j'})^{-\theta}$, that is, if the set of countries firm i sources from has a lower sourcing potential.

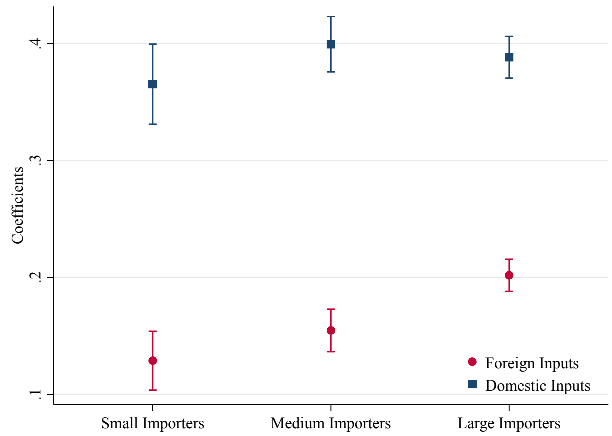
Two considerations follow from this discussion. The first is that the extensive margin of imports is a crucial determinant of input expenditures. It is thus essential to hold the sourcing strategy fixed when comparing the estimated wedges across firms. The second consideration is that the sign of the correlation between firm size and input wedges can help discriminate among models of input competition in the presence of import heterogeneity. Holding the sourcing strategy constant, in a competitive setting, such as the one considered here, there should be no correlation between the input expenditure allocation and firm performance measures. In bargaining frameworks, on the other hand, larger and more productive firms have more buyer power, such that conditional on Σ, I should expect a positive correlation between the input wedges and measures of firm size or productivity. The evidence in section 4.3 lines up with this second class of models.

4.5.2 Heterogeneous Production Function

Our procedure for estimating the input wedges relies on firm-level data and assumes that all firms have the same production function within industries. When the production function is Cobb-Douglas, this assumption further implies that all firms within an industry have the same output elasticity for each input. However, one may think that the output elasticities of domestic and imported inputs vary systematically with firms' different offshoring strategies (Fort, 2017; Bernard et al., 2018a). Such unobserved heterogeneity may lead to the wrong conclusion that buyer power is considerable if, ceteris paribus, firms that spend relatively less on foreign inputs are those for whom the imported inputs have the lowest marginal product.

Figure 5 plots the estimated Cobb-Douglas output elasticities of foreign and domestic inputs across classes of importer size, which are drawn based on terciles of the distribution of the number of sourcing countries. On average, the foreign input elasticity is bigger for the larger importers, indicating that foreign inputs are relatively more productive for large global firms (cf. Yi, 2003). Estimates of the elasticity of the domestic input do not vary across the different samples, instead. If anything, the results in Figure 5 imply that

Figure 5: Output Elasticities, by Class of Importer Size



Notes: The figure plots the estimates of the Cobb-Douglas output elasticity of foreign and domestic inputs, obtained using the production function estimation procedures on three different samples of importers, which are drawn based on terciles of the distribution of the number of sourcing countries. The number of observations in the average industry used in estimation are: 1126, 2800, and 4215 for the sample of Small, Medium and Large importers, respectively.

the wedge for the largest importers should be even larger, which means that the real differences across firms would be even more considerable once production heterogeneity is accounted for. However, the differences between the elasticities across different samples are relatively small, suggesting an overall limited scope for technological biases in my analysis.

5 Buyer Power and the Aggregate Economy

Having established a sizable role for buyer power in input trade, I now aim to quantify its implications for aggregate variables. To do so, I build the most parsimonious model that allows me to address this question in the context of French manufacturing.

I consider a standard heterogeneous firms trade model (Melitz, 2003), and I extend it to allow for bargaining between domestic importers and foreign exporters of intermediate inputs. On account of the empirical findings, I assume perfectly competitive domestic input markets and focus on the role of market distortions in input trade.

5.1 Environment

The economy consists of two symmetric countries: the Home country (France) and a Foreign country (Rest of the World).[31] I focus on the equilibrium in France. A representative consumer in each country inelastically supplies L units of labor, earns a unitary wage W^L, and consumes final goods, either produced domestically or imported.

[31] It is straightforward to extend this model to a multi-sector economy with a competitive final good sector.

In addition to labor income, the consumer owns claims to the profits of domestic firms. Hereafter, I will use capital letters to denote aggregate variables and lower-case letters to denote firm-level variables.

Demand The representative consumer in each country has preferences over a composite of domestic and imported *final* goods, which I assume is the numeraire, defined as:

$$C = \left(X_h^{\kappa} + \left(\varrho X_f \right)^{\kappa} \right)^{1/\kappa}, \tag{19}$$

where X_h denotes the composite domestic good, X_f the composite foreign good, $\kappa \in (0, 1)$ is a parameter governing the elasticity of substitution between domestic and foreign goods, and $\varrho > 1$ captures home-bias in consumption. In turn, the bundles X_h and X_f are defined as:

$$X_k = \left(\int_{i \in N_k} x_{k,i}^{\rho} di \right)^{1/\rho}, \; k = h, f \tag{20}$$

where $x_{k,i}$ is the total demand of variety i sourced from country $k = h, f$, and N_k with $k = h, f$ is the set of domestic ($k = d$) and foreign ($k = f$) varieties, or firms. The same parameter $\rho \in (0, 1)$ governs substitution among domestic and foreign varieties.

Consumer maximization gives rise to demand functions for a given good i

$$x_{h,i} = \left(\frac{p_i}{P_h} \right)^{\frac{1}{\rho - 1}} \left(\frac{P_h}{P} \right)^{\frac{1}{\kappa - 1}} C, \qquad \text{and} \qquad x_{f,i} = \left(\frac{p_{f,i}}{P_f} \right)^{\frac{1}{\rho - 1}} \left(\frac{P_f}{\varrho^{\kappa} P} \right)^{\frac{1}{\kappa - 1}} \tag{21}$$

at home and foreign, respectively, where $P_k = \left(\int_k p_{k,i}^{-\frac{\rho}{1-\rho}} di \right)^{-\frac{1-\rho}{\rho}}$, $k = h, f$ is the price of the domestic and foreign bundles, and $P = \left(P_h^{\frac{\kappa}{\kappa - 1}} + \varrho^{-\frac{\kappa}{\kappa - 1}} \left(P_f \right)^{\frac{\kappa}{\kappa - 1}} \right)^{\frac{\kappa - 1}{\kappa}}$ is the consumption price index, such that $P = 1$ due to the assumptions on the numeraire.

Firms Each firm combines domestic and foreign inputs in order to produce a differentiated variety of the final product:

$$q_i = \phi_i {m_i}^{\beta} {l_i}^{1-\beta}, \tag{22}$$

where $\phi \in \mathbb{R}^+$ denote firm-level productivity, m denotes foreign inputs and l represents domestic labor.[32]

Firms sell both to domestic and foreign customers. As in Krugman (1980), I assume that shipping the good to the foreign country does not entail extra costs, i.e., I rule out both

[32] The variable 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.

fixed and variable trade costs.[33] This assumption, together with symmetric preferences, implies that the firm charges the same price p_i for its final good, such that I can simplify the total demand for firm i's variety as:

$$x_i = \chi \left(p_i\right)^{\frac{1}{\rho-1}} C, \tag{23}$$

where $\chi \equiv \left(1 + \varrho^{-\frac{\kappa}{\kappa-1}}\right)^{\frac{\rho(\kappa-1)}{\kappa(\rho-1)}}$ is a constant affecting sales.

Market Structure *Final Good Market.* I assume that firms compete in monopolistic competition in final good markets. Firms sell final goods directly to final consumers, who act as price takers. This implies that each firm sets a price equal to a constant markup over marginal costs.

Domestic Input Market. Firms act as price takers in the domestic input market. They can hire any amount of labor at a given wage W^L, which they take as given. This assumption is motivated by the empirical evidence in Section 3.

The Market of the Foreign Intermediate Input. Consistent with the analysis in the first part of the paper, I assume that importers bargain over price and quantity of their differentiated input variety. As discussed in section 3, from the buyer's perspective, I can simplify the problem using a tractable input supply function that maps the individual firm demand to the negotiated price. I consider the following functional form for the input supply function:

$$W_i^M = \left(\frac{m_i + M_{-i}}{a_i + M_{-i}}\right)^{\eta}, \tag{24}$$

where $M_{-i} \in [0, \infty)$ denotes total demand by foreign competitors of firm i, a_i is a normalizing factor for firm-level prices, and η is a parameter that governs the returns to scale in upstream production: $\eta > 0$ means that marginal costs of suppliers are increasing in demand. The size of competitors' demand M_{-i} may vary across firms, is exogenous, and is a second source of heterogeneity among French firms.

5.2 Firm-Level Equilibrium

Firms differ on two exogenous dimensions: productivity ϕ_i and foreign market conditions M_{-i}. Given (ϕ_i, M_{-i}), the problem of firm i is to choose inputs so as to maximize profits, subject to final demand, upstream supply, and technology. Formally:

$$\max_{l,m} \; p_i q_i - W^M(m_i, M_{-i}) m_i - W^L l_i, \tag{25}$$

[33] This assumption makes it easy to characterize the world equilibrium (Krugman, 1980). Because I focus on an equilibrium with fixed entry and are interested in the aggregate effect of input market distortions, this assumption on final output markets is without loss of generality.

where $W^M(m_i, M_{-i})$ is specified in (24), p_i varies with output q_i in accordance with the demand function in (23) and q_i is given by (22). Solving the problem in (25) yields:

$$W_i^M = \frac{MRPM_i}{\psi_i}, \tag{26}$$

that expresses the unit price of input m_i as a markdown below its marginal revenue product. The mark-down can be derived as:

$$\psi_i = 1 + \eta s_i^M \geq 1, \tag{27}$$

where $s_i^M = \frac{m_i}{m_i + M_{-i}} \in (0, 1)$ is the buyer share in the market for foreign inputs. The firm-level equilibrium can be summarized by the following system of equations:

$$m_i \propto \phi_i^{\frac{\rho}{1-\rho}} \psi_i^{-\frac{1-\rho(1-\beta)}{1-\rho+\eta(1-\rho(1-\beta))}} \tag{28}$$

$$\frac{l_i}{m_i} \propto \psi_i^{\frac{1-\rho}{1-\rho+\eta(1-\rho(1-\beta))}} \tag{29}$$

$$q_i \propto \phi_i^{\frac{1}{1-\rho}} \psi_i^{-\frac{\beta}{1-\rho+\eta(1-\rho(1-\beta))}}. \tag{30}$$

Buyer power in foreign markets generates three sources of micro-level inefficiencies: first, it reduces the demand of the foreign input (equation (28)). Second, it makes firms substitute inefficiently between foreign and domestic inputs (equation (29)). Third, it lowers firm-level output, increasing final good prices (equation (30)). Notably, the wedge ψ_i fully summarizes all firm-level distortions. This wedge is thus a *sufficient statistic* for the effect of buyer power on firm-level variables. This discussion can be summarized in the following proposition:

Proposition 1: *Buyer power in foreign markets raises the marginal revenue product of the foreign input, inducing an inefficient substitution among inputs in production, and making firms smaller than optimal.*

5.3 Aggregation

The simple model admits an analytical characterization of the aggregate equilibrium. Given a joint distribution $\mu(\phi, \psi) = \mu_\phi(\phi)\mu_\psi(\psi)$ of productivity and buyer power levels over a subset of $(0, \infty) \times (1, \infty)$, the aggregate demand C can be written as:[34]

$$C = \Theta \cdot \tilde{\phi}^{\frac{1}{1-\beta}} \tilde{\psi}^{-\frac{\beta(1-\rho)}{(1-\beta)\Phi}} \cdot L, \tag{31}$$

[34] All derivations are shown in Appendix B.3.

where $\Theta \equiv \chi^{\frac{(1-\rho)(1-\beta\kappa)}{(\rho-\kappa)(1-\beta)}} \left(\frac{1}{\rho}\right)^{-\frac{\beta}{1-\beta}} \left(\frac{1}{\beta}\right)^{-\frac{\beta}{1-\beta}}$ is a constant, and $\tilde{\phi} \equiv \left[\int_0^\infty \phi^{\frac{\rho}{1-\rho}} \mu_\phi(\phi) d\phi\right]^{\frac{1-\rho}{\rho}}$ and $\tilde{\psi} = \left[\int_1^\infty \psi^{-\frac{\beta\rho}{\Phi}} \mu_\psi(\psi) d\psi\right]^{-\frac{\Phi}{\beta\rho}} > 1$ are weighted averages of firm productivity and buyer power levels respectively. Equation (31) clearly demonstrates the effect of buyer power on aggregate output. The higher the average buyer power $\tilde{\psi}$, the lower aggregate output.

The term $\tilde{\psi}^{-\frac{\beta(1-\rho)}{(1-\beta)\Phi}}$ fully summarizes aggregate output and consumption distortions in this simple model, where productivity and buyer power are jointly independent.[35] It is easy to show that aggregate demand C can also be rewritten as:

$$C = C^{EFF} \cdot \tilde{\psi}^{-\frac{\beta(1-\rho)}{(1-\beta)\Phi}}, \tag{32}$$

where $C^{EFF} \equiv \Theta \cdot \tilde{\phi}^{\frac{1}{1-\beta}} \cdot L$ is the value of aggregate consumption in a counterfactually "input efficient" economy where all firms behave as price takers in input markets.

Similar expressions can be derived for all aggregate variables, namely aggregate imports of intermediate inputs E^M, aggregate labor income $W^L L$, aggregate profits Π and welfare, which in this model can be measured as domestic value added: $W = W^L L + \Pi$.[36] In the Appendix, I derive the following expressions:

$$\frac{E^M}{E^{M,EFF}} = \tilde{\psi}^{-\frac{\beta(1-\rho)}{(1-\beta)\Phi}} \widehat{\widehat{\psi}}^{-1} \qquad \frac{W^L L}{(W^L L)^{EFF}} = \tilde{\psi}^{-\frac{\beta(1-\rho)}{(1-\beta)\Phi}}$$
$$\frac{\Pi}{\Pi^{EFF}} = \left[1 + \frac{\beta\rho}{1-\rho}\left(1 - \widehat{\widehat{\psi}}^{-1}\right)\right] \tilde{\psi}^{-\frac{\beta(1-\rho)}{(1-\beta)\Phi}} \qquad \frac{W}{W^{EFF}} = \frac{1-\beta\rho\widehat{\widehat{\psi}}^{-1}}{1-\beta\rho} \tilde{\psi}^{-\frac{\beta(1-\rho)}{(1-\beta)\Phi}}. \tag{33}$$

Together with $\tilde{\psi}$, the term $\widehat{\widehat{\psi}} \equiv \frac{\int_1^\infty \psi^{-\frac{\beta\rho}{\Phi}} \mu_\psi(\psi) d\psi}{\int_1^\infty \psi^{-\frac{\beta\rho+\Phi}{\Phi}} \mu_\psi(\psi) d\psi} > 1$ is the second index of buyer power affecting aggregate variables. While $\tilde{\psi}$ capture the effect of buyer power on output, $\widehat{\widehat{\psi}}$ captures its impact on foreign input markets.

The output distortions lead to lower labor income and lower consumer surplus, as shown by the top right equation in (33). On the contrary, the effect on profits (bottom left equation), and producer surplus thereof, depends both on output and import distortions: the larger the import distortions, i.e. the larger $\widehat{\widehat{\psi}}$, the larger the profits due to sizable rent transfers from foreign countries; the higher the output distortions, i.e. the larger $\tilde{\psi}$, the lower the profits due to lower demand. The former effect always dominates for profit maximizing firms, such that producer surplus always increases in buyer power.

[35] Results would change, while remaining similarly tractable, if instead of assuming independent distributions between productivity and buyer power I allowed for the two distributions to be correlated. The assumption of independent distributions allows for a transparent characterization of the aggregate distortions.

[36] Aggregate imports of intermediate inputs is defined as $E^M = \int_0^\infty \int_1^\infty W^M(\phi,\psi) m(\phi,\psi) N \mu_\phi(\phi) \mu_\psi(\psi) d\phi d\psi$.

The contrasting role of buyer power in consumer and producer surplus results in ambiguous welfare consequences. As the bottom right equation shows, welfare increases in $\widehat{\tilde{\psi}}$, but decreases in $\tilde{\psi}$. Which of these effects prevails is ultimately an empirical question. The following proposition summarizes this result:

Proposition 2: *Buyer power has ambiguous effects on total national income: while consumer surplus decline due to higher output distortions, producer surplus increase due to rent transfers from foreign countries. The net effect on welfare depends on which of these effects prevails, and so it is ultimately an empirical question.*

5.4 Calibration

To quantify the aggregate effect of buyer power on the domestic economy, I need estimates of the parameter η, β and ρ, and a distribution for ψ.

Inverse Supply Elasticity. The parameter η is the inverse supply elasticity of the foreign inputs (equation (24)).[37] Values of $\eta > 0$ mean that marginal costs of suppliers are increasing in downstream demand.

I pin down the value of η from equation (27), and so from the relationship between firm i's buyer power ψ_i and its share as a buyer in foreign input markets, denoted by $s_i^M = \frac{m_i}{M_i}$.

For my baseline result, I choose the value of η that matches the observed ratio between the average median wedge $\bar{\psi^M}$ across sectors and the average buyer share s_i^M, which I observe in French import data.[38] This exercise implies a value of $\eta = 2.61$. This value is in line with the estimates of import supply elasticities in Soderbery (2018), who uses UN Comtrade data over the period 1991-2007 to estimate values of the export supply elasticity by HS4 manufacturing product and import country. His estimates for η range from 0.15 to 5+. I explore the sensitivity of the results to lower (and higher) values of η below.

Demand Elasticity. The parameter ρ governs both the demand elasticity and firm-level markups, which are constant in the model given the assumptions on demand. Because the demand system considered here is a special case of the one introduced in Section 4.4, values of ρ can be inferred from the markup estimates in Table D1 in the Appendix.

My best estimate for the average firm-level markup is $\mu = 1.368$, which implies a value of $\rho = 0.73$. This value of the average markup is taken from my calibration exercise in section 4, and corresponds to the case where the elasticity of substitution across domestic varieties is set as in Hottman et al. (2016). I explore sensitivity to this parameter below.

Output Elasticities and Buyer Power. I read the value of β off Table 5 by setting it equal to the foreign input's output elasticity, i.e. $\beta = \beta_M$. Similarly, I set the values of $\{\psi_i\}_i$ equal

[37] See Appendix C for more details on the micro-foundation of this parameter.

[38] On average, the quantity share of French buyer i in foreign export market ν is observed 0.15, with a median value of .002 and standard deviation equal to .28

Table 9: Aggregate effects of buyer power in input trade

Panel a. Parameter Estimates (Baseline)			
PARAMETER	β	ρ	η
VALUE	0.16	0.73	2.61
SOURCE	ESTIMATED (TABLE 5)	CALIBRATED (TABLE C1)	CALIBRATED

Panel b. Changes in Aggregate Variables		
	Lower Bound	Upper Bound
Output ($\Delta\%$)	-2.97	-4.86
Imports ($\Delta\%$)	-35.97	-59.53
Labor Income($\Delta\%$)	-2.97	-4.86
Profits ($\Delta\%$)	11.37	18.91
Welfare ($\Delta\%$)	1.40	2.38

Notes: Panel a) reports the baseline estimates of the main parameters. See the respective source tables and the main text for more details. Panel b) shows the changes in the main variables of interest when moving from a counterfactual economy where all buyers are price takers to the economy where firms have buyer power. A negative value should be interpreted as the value being lower in the distorted economy, and vice versa for positive values. Lower bound estimates (first column in panel b) are those obtained when I set equal to one the wedge of firms whose raw value is estimated below one in Section 4. Upper bound estimates (second column in panel b) are obtained when I exclude from the sample all the firms whose estimated ψ_i is below one.

to the estimated distribution of firm-level foreign input wedges, i.e. $\psi_i = \psi_i^M \; \forall \; i$.[39]

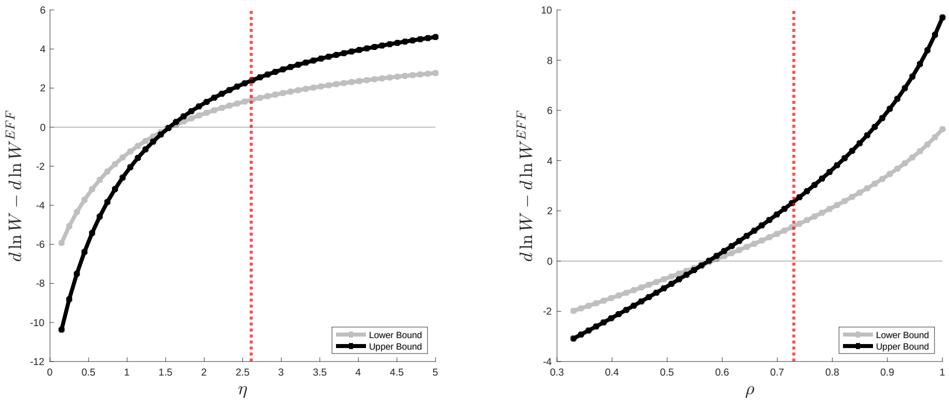
One issue with the raw wedges ψ_i^M obtained from section 4 is that the value of ψ^M is below one for about a fifth of the observations. However, in the model, the buyer power is bounded below at one. To get sensible estimates of the welfare cost of buyer power I need to deal with this discrepancy between the model and the data. I consider two extremes: I first consider only the firms whose estimated ψ is above one, and exclude all others. This case yields an "upper bound" for the effects of buyer power, because it only selects firms with a high level of ψ. I then consider a second scenario where rather than excluding firms whose $\psi < 1$, I set their ψ equal to one. This exercise yields a "lower bound" of the effects of buyer power, by treating the firms with low levels of ψ as competitive. I report results under both assumptions.

5.5 Results

Table 9 summarizes the calibrated parameters and the main results. Losses in aggregate output and labor income range from about 3% to 5%. Buyer power has the most considerable effects on total imports, which I estimate between 36 and 60% below competitive levels. Profits are higher in the distorted than in the efficient economy. The lower bound estimates yield profits 11% higher in the distorted economy than in the competitive one, while the upper bound estimate is 19%. Finally, welfare always increases

[39] The values of ψ_i^M depend on the estimated value of markup, as explained in section 4.4. Therefore, the specific distribution of $\{\psi_i\}$ considered will depend on which value of markup is being considered.

Figure 6: Welfare Gains from Buyer Power in Input Trade - Sensitivity



Notes: The figure shows the impact of elasticity parameters on the welfare gains from buyer power. In the left panel, I show how welfare gains vary when the input supply elasticity η varies. The range of parameter values is chosen so as to match the estimates of the import supply elasticities in Soderbery (2018). In the right panel, I show how welfare gains vary when the demand elasticity ρ varies. The range of parameter values is chosen so that the implied average markups vary from one ($\rho = 1$) to about 3 ($\rho \simeq 0.3$). The black line shows upper bound value estimates, while the grey line show lower bound estimates. The red dotted lines indicate my baseline parameter estimate.

in the distorted economy, by about 1.4 to 2.4%. The welfare gains stem from a terms-of-trade effect induced by the buyer power of the largest importers. Despite lower output and lower volumes of trade, the increase in import prices relative to export prices is such that the economy is better off in the distorted economy.

Figure 6 shows how much the welfare gains' estimates would change when I let parameters η and ρ vary. The red line corresponds to the baseline parameter estimate. The welfare gains' estimates differ widely depending on the parameter values, ranging from -8% to +8%, when parameters are within reasonable ranges. When both elasticities are low, consumer surplus losses are larger than the gains in producer surplus, such that welfare decreases in the distorted economy. This result resonates with the conclusions above: when ρ is high, markups are low, and so are distortions in the final good market. Therefore, the distorting effect of buyer power on demand and consumer surplus is also low. Similarly, when η is high, the foreign input price is very elastic to firms' demand. Thus, firms can extract high rents from foreign firms, which results in higher profits and high domestic welfare.

The considerable sensitivity of the welfare estimates to the value of critical parameters should suggest caution in interpreting the specific welfare numbers, as the proposed model is admittedly stylized. A more rigorous quantification exercise would require extending the model to include trade costs, asymmetries between the Home and the Foreign country, and possibly more realistic assumptions on the joint distribution of productivity and buyer power. These are straightforward extensions of the current model, which I omit for the sake of transparency.

5.6 Buyer Power, Import Tariffs and Trade Policy

The theoretical model provides some valuable insights into the role of importers in modern economies. Similar to an optimal tariff on imports, importers' buyer power could benefit the country due to terms-of-trade effects, which can more than compensate for smaller volumes of trade and losses in consumer surplus (Kaldor, 1940).

A classical result in the theoretical trade literature is that countries with market power in imports exploit it in setting their trade policy (e.g. Broda et al. (2008)). The results in this section show that even in the absence of similar trade policy instruments, large and powerful importers could generate aggregate terms-of-trade gains. The results in Table 9 further show that these effects are sizable, despite originating from individual firms' behavior.

My analysis suggests mixed incentives for governments and antitrust authorities in open economies to restrain the market power of the largest firms. Buyer power in input trade generates gains in national welfare at the expense of foreign countries. It follows that a rationale for lenient antitrust conduct could be found in beggar-thy-neighbor trade policies, while at the same time being less exposed to the risk of retaliation. In similar settings, antitrust policies would require a globally coordinated policy response to credibly prevent large multi-national buyers from accumulating excessive market power.

6 Conclusions

This paper provides micro-level estimates of market power in input trade and examines its macroeconomic implications. I first provide novel empirical evidence that the behavior of imported intermediate inputs' prices is inconsistent with competitive models of input trade. I thus develop an empirical strategy that allows me to estimate measures of market power in input markets from standard firm-level data, building on recent advances in the literature on markups estimation (e.g. De Loecker et al., 2016). I depart from existing frameworks by allowing prices within supply chains to be the outcome of two-sided negotiations between buyers and sellers and dispensing with strong assumptions on competition in any input market.

I estimate the model using data on French manufacturing importers over the period 1996-2007. Consistent estimation of the output elasticities needed to compute buyer power relies on information on both output and foreign intermediate input prices observed in customs data. Results show that buyer power disproportionately affects the foreign market for intermediate inputs. In particular, I find that French importers pay input prices that are 20-50% below marginal cost in foreign input markets. On the contrary, buyer power over domestic suppliers is relatively small and close to its competitive level.

I develop a macro model with heterogeneous firms to link the micro-level wedges to aggregate variables. I show that the role of buyer power in input trade is similar to that of an import tariff: it induces aggregate distortions while generating a terms-of-trade improvement. My paper is the first to show that even in the absence of any trade policy instrument, sizable terms-of-trade gains for the economy may derive from individual importers' behavior in foreign markets.

This paper enhances our understanding of the role of buyers in modern economies. In particular, it uncovers a novel rationale for government policies to be lenient towards the excessive build-up of the market power of import-oriented firms. A fruitful direction for future research would be to explicitly investigate the costs and benefits of industrial policies promoting the growth of these "superstar firms".

Furthermore, this paper's results shed light on the relationship between globalization and market power by showing that as participation in international trade increases, the scope of large firms' market power may also increase. This observation speaks to the debate about the causes behind the observed increase in market concentration, by bringing international trade and offshoring into the picture (See, e.g., De Loecker et al., 2019; Syverson, 2019; Eggertsson et al., 2018; Akcigit and Ates, 2019). I leave for future work the fascinating question of how globalization and input trade may have contributed to the observed increase in concentration and market power in modern economies.

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A Additional Tables and Figures

Table A1: Imported Inputs - Summary Statistics

	Mean	St. Dev.	p10	p50	p90
No. of Varieties per firm	126	318	3	30	282
No. of Countries per firm	9.5	13.9	1	5	22
No. of Firms per variety	198	489	3	45	487
No. of Countries per product	41	25.6	12	37	77
No. of Firms		38,240			
No. of HS8 products		8,139			
No. of Countries		222			
No. of Varieties (HS8×Countries)		100,331			

Source: Author's calculations. Notes: The table shows summary statistics for import data in a typical year. A product is defined at the HS8 level, while a variety is a product×source country combination.

Table A2: Dispersion in Import Prices Across Firms (1996-2007)

Sample	No.Observations	Std Dev
All Products	3,292,839	1.02
Homogeneous Goods*	757,283	.91
Differentiated Goods	2,485,105	1.06

Notes: The table shows the standard deviation of the log normalized unit prices of imports across firms. Log normalized prices are defined as $\log \tilde{W}^M_{ivt} = \log W^M_{ivt} - N^{-1}_{ivt} \sum_{i \in N_{ivt}} \log W^M_{ivt}$, where N_{ivt} is the number of firms importing variety v at time t. Product classification according to Rauch (1999).

Table A3: Characteristics of Importers and Domestic Firms (1996-2007)

	All Firms	Only Domestic	International
# Observations (firm-year)	1,259,558	902,069	354,104
# Firms	105,051	75,226	29,610
Share of Multinationals[(a)]	15.3%	5.1%	41.2%
Sales (log)	13.22	12.55	14.92
Employment (log)	1.88	1.37	3.18
Value Added Per Worker (log)	3.8	3.75	4.3
Imported Share of Intermediates	0.057	0	0.26

Source: Author's calculations. *Notes*: The table reports summary statistics for the firm-level dataset obtained by merging trade and production data. The last column reports statistics on the sample of international firms, the main sample for the empirical analysis. The first two columns report statistics for the full dataset, and the subsample of domestic firms, for comparison. [(a)] A firm is a multinational if at least one affiliate or the headquarter is located outside of France.

Table A4: Firm-level Relative Export and Import Prices (1996-2007)

Panel A. Summary Statistics - Normalized Average Prices

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

Panel B. Correlation with Main PF Variables[(a)]

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

Notes: Panel a. summarizes the normalized prices of output and the imported input, obtained from OLS regression (14). Estimates are pooled across time and sectors, and refer to the full baseline sample of international firms. Number of observations: 129,787. Panel b. reports the main correlation of prices with firm-level variables. [(a)] Correlation is computed across firms, within an industry and time.

B Theoretical Appendix

B.1 Proof of Lemma 3.1

Let $\mathcal{L} = \int_{\Sigma_i} W_i^M(\nu)M_i(\nu)d\nu \; + \int_{\Omega_i} W_i^Z(\nu)Z_i(\nu)d\nu + \lambda_i\left(Q_i - Q_i(\cdot)\right)$ denote the Lagrangian associated with the variable cost minimization problem of firm i. The FOC reads:

$$W_i^M(\nu)\psi_i^M(\nu) = \lambda_i \frac{dQ_i}{dM_i(\nu)}$$

where $\psi_i^M(\nu) \equiv 1 + \frac{dW_i^M(\nu)}{dM_i(\nu)}\frac{M_i(\nu)}{W_i^M(\nu)}$ is the buyer power wedge at the firm-variety level. Using the markup definition $\mu_i = P_i/\lambda_i$, I can rewrite the previous equation as:

$$W_i^M(\nu)M_i(\nu)\psi_i^M(\nu) = \frac{P_iQ_i}{\mu_i}\frac{dQ_i}{dM_i}\frac{M_i}{Q_i}\frac{dM_i}{dM_i(\nu)}\frac{M_i(\nu)}{M_i}.$$

Take integrals in both sides, and divide both sides by $E_i^M \equiv \int_{\Sigma_i} W_i^M(\nu)M_i(\nu)\psi_i^M(\nu)$ to write:

$$\int_{\nu\in\Sigma_i}\frac{W_i^M(\nu)M_i(\nu)}{E_i^M}\psi_i^M(\nu)d\nu = \mu_i^{-1}\frac{P_iQ_i}{E_i^M}\frac{dQ_i}{dM_i}\frac{M_i}{Q_i}\int_{\nu\in\Sigma_i}\frac{dM_i}{dM_i(\nu)}\frac{M_i(\nu)}{M_i}d\nu.$$

Given $M_i = h_i^M\left([M_i(\nu)]_{\nu\in\Sigma_i}\right)$, and the assumption that $h_i^M(\cdot)$ is constant returns, it follows that: $\int_{\Sigma_i}\frac{dM_i}{dM_i(\nu)}\frac{M_i(\nu)}{M_i} = 1$ such that I can finally derive the main equation of Lemma 3.1 that is:

$$\bar{\psi}_i^M = \mu_i^{-1}\frac{\theta^{M_i}}{\alpha_i^M}$$

where $\bar{\psi}_i^M \equiv \int_{\Sigma_i}\frac{W_i^M(\nu)M_i(\nu)}{E_i^M}\psi_i^M(\nu)d\nu$.

B.2 Derivation of Proposition 1

The FOC for labor and foreign intermediates are given by:

$$p_iq_i(1-\beta) = \frac{1}{\rho}W^Ll_i \tag{34}$$

$$p_iq_i\beta = \frac{1}{\rho}\psi_iW_i^Mm_i, \tag{35}$$

which can be combined to get:

$$l_i = \left(\frac{W^L}{1-\beta}\right)^{-1} \left(\frac{W_i^M \psi_i}{\beta}\right) m_i. \tag{36}$$

Output can be then written as:

$$q_i = \phi_i \left(\frac{W^L}{1-\beta}\right)^{-(1-\beta)} \left(\frac{W_i^M \psi_i}{\beta}\right)^{(1-\beta)} m_i. \tag{37}$$

Combining (37) with the demand function, I obtain:

$$m_i = a_i \left(W_i^M \psi_i\right)^{-\frac{1-\rho(1-\beta)}{1-\rho}}, \tag{38}$$

where I defined $a_i \equiv \chi C \phi_i^{\frac{\rho}{1-\rho}} \left(\frac{1}{\rho}\right)^{-\frac{1}{1-\rho}} \left(\frac{W^L}{1-\beta}\right)^{-\frac{\rho}{1-\rho}(1-\beta)} \left(\frac{1}{\beta}\right)^{-\frac{1-\rho(1-\beta)}{1-\rho}}$. Combining (38) with the input price equation, I can solve for optimal demand of intermediates as:[40]

$$m_i \simeq a_i \psi^{-\frac{1-\rho(1-\beta)}{1-\rho+\eta(1-\rho(1-\beta))}} \tag{39}$$

which relates m_i to aggregate variables, and firm-level characteristics ϕ_i and ψ_i . The following expressions follow immediately:

$$W_i^M \psi_i = \psi_i^{\frac{1-\rho}{1-\rho+\eta(1-\rho(1-\beta))}}, \tag{40}$$

$$l_i = \chi C \left(\frac{1}{\rho}\right)^{-\frac{1}{1-\rho}} \left(\frac{W^L}{1-\beta}\right)^{-\frac{1-\rho\beta}{1-\rho}} \left(\frac{1}{\beta}\right)^{-\frac{\rho\beta}{1-\rho}} \phi_i^{\frac{\rho}{1-\rho}} \psi_i^{-\frac{\rho\beta}{1-\rho+\eta(1-\rho(1-\beta))}} \tag{41}$$

$$q_i = \chi C \left(\frac{1}{\rho}\right)^{-\frac{1}{1-\rho}} \left(\frac{W^L}{1-\beta}\right)^{-\frac{1-\beta}{1-\rho}} \left(\frac{1}{\beta}\right)^{-\frac{\beta}{1-\rho}} \phi_i^{\frac{1}{1-\rho}} \psi_i^{-\frac{\beta}{\Phi}}, \tag{42}$$

which are the equations underlying Proposition 1 in the main text.

[40]The solution holds up to the following approximation: the full solution yields:

$$\left(\frac{m_i}{a_i}\right) = \left(\frac{\bar{s}_i}{s_i^M}\right)^{-\frac{\eta(1-\rho(1-\beta))}{1-\rho+\eta(1-\rho(1-\beta))}} \psi_i^{-\frac{1-\rho(1-\beta)}{1-\rho+\eta(1-\rho(1-\beta))}},$$

where $\bar{s}_i \equiv \frac{a_i}{a_i+M_{-i}}$ and $s_i^M = \frac{m_i}{m_i+M_{-i}}$. The term $\frac{\bar{s}_i}{s_i^m}$ is approximately equal to one, both for $s_i^m \to 0$ and for $s_i^m \to 1$, i.e. for firms with high market share. For tractability, and because concentration among importers is arguably large in the data (i.e. $s_i^m \to 1$), I impose $\frac{\bar{s}_i}{s_i^m} \simeq 1$ in what follows.

B.3 Derivation of Proposition 2

Let $\Phi \equiv 1-\rho+\eta(1-\rho(1-\beta))$. Setting price equal to marginal costs yields:

$$p_i = \frac{1}{\rho}\left[\phi_i^{-1}\left(\frac{W^L}{1-\beta}\right)^{(1-\beta)}\left(\frac{1}{\beta}\right)^{\beta}\psi_i^{\beta\frac{1-\rho}{\Phi}}\right], \tag{43}$$

and together with $P=\left(\int_{i\in N} p_i^{-\frac{\rho}{1-\rho}}di\right)^{-\frac{1-\rho}{\rho}}$, it yields

$$P = \frac{1}{\rho}\left(\frac{W^L}{1-\beta}\right)^{(1-\beta)}\left(\frac{1}{\beta}\right)^{\beta}\tilde{\phi}^{-1}\tilde{\psi}^{\beta\frac{1-\rho}{\Phi}} \tag{44}$$

where $\tilde{\phi} \equiv \left[\int_0^\infty \phi^{\frac{\rho}{1-\rho}}\mu_\phi(\phi)d\phi\right]^{\frac{1-\rho}{\rho}}$ and $\tilde{\psi} = \left[\int_1^\infty \psi^{-\frac{\beta\rho}{\Phi}}\mu_\psi(\psi)d\psi\right]^{-\frac{\Phi}{\beta\rho}}$. Because the assumptions on the numeraire imply that $P=\left(1+\varrho^{-\frac{\kappa}{\kappa-1}}\right)^{-\frac{\kappa-1}{\kappa}}=\chi^{\frac{1-\rho}{\rho}}$, I can write

$$\left(\frac{W^L}{1-\beta}\right) = \chi^{\frac{1-\rho}{\rho(1-\beta)}}\left(\frac{1}{\rho}\right)^{-\frac{1}{1-\beta}}\left(\frac{1}{\beta}\right)^{-\frac{\beta}{1-\beta}}\tilde{\phi}^{\frac{1}{1-\beta}}\tilde{\psi}^{-\frac{\beta}{1-\beta}\frac{1-\rho}{\Phi}}. \tag{45}$$

Combining with labor market clearing $\left(L=\int_{i\in N} l_i di\right)$ I derive an expression for aggregate output as:

$$C = \chi^{\frac{1-\rho}{\rho(1-\beta)}}\left(\frac{1}{\rho}\right)^{-\frac{\beta}{1-\beta}}\left(\frac{1}{\beta}\right)^{-\frac{\beta}{1-\beta}}\tilde{\phi}^{\frac{1}{1-\beta}}\tilde{\psi}^{-\frac{\beta(1-\rho)}{(1-\beta)\Phi}}L$$

It is easy to show, using similar derivations, that in a counterfactual equilibrium where $\psi_i=1$ for all i and $W_i^M=1$ for all i, I would get:

$$C^{EFF} = \chi^{\frac{1-\rho}{\rho(1-\beta)}}\left(\frac{1}{\rho}\right)^{-\frac{\beta}{1-\beta}}\left(\frac{1}{\beta}\right)^{-\frac{\beta}{1-\beta}}\tilde{\phi}^{\frac{1}{1-\beta}}L.$$

It follows that I can write total demand in terms of departure from the counterfactually efficient equilibrium as:

$$\frac{C}{C^{EFF}} = \tilde{\psi}^{-\frac{\beta(1-\rho)}{(1-\beta)\Phi}}.$$

Labor income Given the expression for the labor wage in (45), I can write labor income as:

$$\left(\frac{W^L L}{1-\beta}\right) = \chi^{\frac{1-\rho}{\rho(1-\beta)}}\left(\frac{1}{\rho}\right)^{-\frac{1}{1-\beta}}\left(\frac{1}{\beta}\right)^{-\frac{\beta}{1-\beta}}\tilde{\phi}^{\frac{1}{1-\beta}}\tilde{\psi}^{-\frac{\beta}{1-\beta}\frac{1-\rho}{\Phi}}L$$

Note that labor income is a constant fraction of aggregate output $\frac{W^L L}{(1-\beta)C} = \rho(1-\beta)$. It follows that:

$$\frac{W^l L}{(W^l L)^{EFF}} = \frac{C}{C^{EFF}} = \tilde{\psi}^{-\frac{\beta(1-\rho)}{(1-\beta)\Phi}}$$

Total imports

From FOC for intermediates:

$$W_i^M m_i = p_i q_i \beta \left(\frac{1}{\rho}\right)^{-1} \psi_i^{-1}$$

I can derive:

$$W_i^M m_i = \chi C \left(\frac{1}{\rho}\right)^{-\frac{1}{1-\rho}} \left(\frac{W^L}{1-\beta}\right)^{-\frac{\rho(1-\beta)}{1-\rho}} \left(\frac{1}{\beta}\right)^{-\frac{1-\rho(1-\beta)}{1-\rho}} \phi_i^{\frac{\rho}{1-\rho}} \psi_i^{-\frac{\beta\rho+\Phi}{\Phi}}$$

Taking integrals in both sides, and substituting with the wage equation above, I obtain

$$E_M \equiv \int_i W_i^M m_i di = C\rho\beta\hat{\hat{\psi}}^{-1},$$

where $\hat{\hat{\psi}} \equiv \frac{\int_1^\infty \psi^{-\frac{\beta\rho}{\Phi}} \mu_\psi(\psi) d\psi}{\int_1^\infty \psi^{-\frac{\beta\rho+\Phi}{\Phi}} \mu_\psi(\psi) d\psi} > 1$ is an index of buyer power wedges. When firms are price takers in foreign input markets $E^{M,EFF} = \rho\beta C^{EFF}$, so that:

$$\frac{E^M}{E^{M,EFF}} = \frac{C}{C^{EFF}} \hat{\hat{\psi}}^{-1}.$$

Profits

By definition, profits are given by:

$$\Pi = C - W^L L - E^M = C\left(1 - \rho + \rho\beta(1 - \hat{\hat{\psi}})\right)$$

and given $\Pi^{EFF} = C^{EFF}(1-\rho)$, it follows that

$$\frac{\Pi}{\Pi^{EFF}} = \left[1 + \frac{\beta\rho}{1-\rho}(1 - \hat{\hat{\psi}})\right] \tilde{\psi}^{-\frac{\beta(1-\rho)}{(1-\beta)\Phi}}$$

Welfare

Welfare in the model coincides with value added. By definition:

$$VA \equiv C - E^M = C\left(1 - \rho\beta\widehat{\hat{\psi}}\right).$$

Using the same derivations as above, it follows immediately that:

$$\frac{VA}{VA^{EFF}} = \frac{1 - \rho\beta\widehat{\hat{\psi}}}{1 - \beta\rho}\tilde{\psi}^{-\frac{\beta(1-\rho)}{(1-\beta)\Phi}}.$$

C Price Bargaining in Buyer-Supplier Relationships

This appendix provides a formal economic model that rationalizes the use of a reduced-form input price function in section 3 and 5 to capture bargaining in markets of intermediate inputs. The model builds on the two-sided bargaining framework developed by Alviarez et al. (2020).

I consider a partial equilibrium model of bargaining in buyer-supplier relationships. In the model, buyers and sellers are treated equally, and bargain over the price of a given intermediate input. In order to accommodate the fact that information on only the buyer side of the relationship is available, I assume a many-to-one network where each buyer buys the intermediate input from only one seller, who can sell its product to possibly multiple buyers. I show that when production upstream features increasing marginal costs and the buyer share is large, the bilateral input price can be written as a monotone function of the buyer demand.

C.1 Theoretical Model

The final demand for firm i's product is summarized by the following function

$$q_i = D\left(p_i, D_i\right), \tag{46}$$

where q_i is the quantity sold by firm i, p_i is the unit price and the term D_i captures aggregate demand conditions downstream. The demand function in (46) is characterized by a price elasticity $\epsilon_i = -\frac{d \ln q_i}{d \ln p_i} > 1$, which is allowed to vary by firms. Let c_i be the marginal cost of producing each unit of the final good. I define the firm-level markup as $\mu_i = p_i / c_i$, with an associated cost elasticity equal to $\Gamma_j \equiv -\frac{d \ln \mu}{d \ln c_j}$. Any firm i produces output according to a Hicks-neutral technology:

$$q_i = e^{\omega_i} f(l_i, z_i, m_i), \tag{47}$$

combining domestic labor, l_i, domestic intermediates, z_i, and foreign intermediates, m_i with a Hicks-neutral productivity ω_i. Both domestic and foreign intermediate inputs can be thought as bundles of individual products, which are aggregated according to a constant return to scale, potentially firm specific, production function $h_i^k(\cdot)$, that is:

$$z_i = h_i^Z\left(\left[z_i(\nu)\right]_{\nu \in (0,1)}\right) \qquad \text{and} \qquad m_i = h_i^M\left(\left[m_i(\nu)\right]_{\nu \in \Sigma_i}\right), \tag{48}$$

where ν denotes a variety (individual good) of domestic or foreign intermediates, and Σ_i is the sourcing strategy of firm i, that is the set of imported varieties the firm decides to use in production.

I let $\theta_i^k = \frac{d \ln q_i}{d \ln k_i}$ denote the elasticity of output to input k, with $k = l, z, m$. The elasticity of output to an individual variety of, say, foreign inputs will then be equal to: $\theta_i^m(\nu) = \frac{d \ln q_i}{d \ln m_i} x_i^m(\nu)$, where $x_i^m(\nu) \equiv \frac{m_i(\nu)}{m_i}$ is the share of variety ν on foreign input purchases.

I denote with $w_i^k(\nu)$ the unit cost of variety ν of input k. All input prices are allowed to vary across firms, either for exogenous (quality) or endogenous (market power) reasons. The problem of the firm is characterized by a unit cost function, which can be derived from standard cost minimization as:

$$c_i = c\left(w_i^l, \mathbf{w_i^z}, \mathbf{w_i^m}; \omega_i\right). \tag{49}$$

An important object characterizing the bargaining problem of firm i is the sensitivity of marginal cost to the different input price. I denote this elasticity as $\zeta_i^k(\nu) = \frac{d \ln c_i}{d \ln w_i^k(\nu)}$.

I assume that firm i purchases individual varieties of intermediate inputs in the context of business-to-business transactions with upstream suppliers, which I denote by j. I assume that each supplier j produces its output $q_j(\nu)$, with $k = m, z$ using a unique (composite) input $I_j^k(\nu)$, such that $\frac{d \ln q_j^k(\nu)}{d \ln I_j^k(\nu)} = \rho^k(\nu)$. The parameter $\rho^k \in \mathbb{R}_+$ governs the returns to scale of production of variety ν of intermediate input k with $k = z, m$. When $0 < \rho < 1$ the production function exhibits decreasing returns, while $\rho > 1$ implies increasing returns. When $\rho = 1$, production exhibits constant return to scale. I assume that each supplier j can buy input $I_j^k(\nu)$ at a unit price of $p_j^k(\nu)$, which the firm takes as given. I define as $c_j^k(\nu) = \frac{p_j^k(\nu) I_j^k(\nu)}{q_j^k(\nu)}$ the average cost to firm j of producing variety ν of intermediate input k with $k = z, m$.

Bargaining game I assume price bargaining in buyer-supplier relationships. In each bargaining game, the outside options of firm i and firm j are assumed to be the profits when the $i - j$ link is terminated. Firm i will face higher production costs, while firm j will experience less sales, which leads to less profits to both firms. I let $\lambda_i^k \equiv \frac{\tilde{c}_i}{c_i}$ denote the change in marginal cost of firm i, if negotiations with supplier j failed. I assume that firm i engages in contemporaneous negotiations for the prices of both domestic and intermediate inputs. During each negotiation, the firm representative takes as fixed the firm-to-firm network, the demand shifters P_i and Q_i, the price that each supplier j charges to other buyers, as well as prices charged by other suppliers of firm i. In this sense, I assume that all other buyer-supplier pairs reach an agreement (Nash equilibrium). The solution concept is thus the "Nash-in-Nash" solution originally proposed by Horn and Wolinsky (1988).

Equilibrium Given the symmetry in the assumptions for the foreign and domestic market for intermediates, in what follows I am going to focus on one variety of a foreign intermediate input $m_i(\nu)$, and derive the solution of the bargaining problem between buyer (importer) i and a supplier (exporter) j. It is understood that the solution of the bargaining game between buyer i and any domestic supplier can be derived in a similar way. For exposition, in what follows I'm going to use the more compact notation m_{ijv}, where i is the buyer, j is the seller, and v is the input variety.

The generalized Nash bargaining solution over the price w^m_{ijv} between importer i and exporter j is defined as the maximand of the so-called generalized Nash product

$$\max_{w^m_{ijv}} \left(\pi_i(w^m_{ijv}) - \tilde{\pi}_{i(-j)}\right)^{\phi_{ij}} \left(\pi_j(w^m_{ijv}) - \tilde{\pi}_{j(-i)}\right)^{1-\phi_{ij}}, \tag{50}$$

where $\pi_i(w^m_{ijv})$ and $\pi_j(w^m_{ijv})$ are the profits to the buyer i and the supplier j if the negotiations succeeded, and $\tilde{\pi}_{i(-j)}$ and $\tilde{\pi}_{j(-i)}$ are the so-called disagreement payoffs that are obtained by the parties if the negotiations fail. The bargaining power parameter, $0 < \phi_{ij} < 1$, captures other exogenous determinants of the relative bargaining ability of firms that might influence the outcome of the negotiation process. In my notation, a higher ϕ_{ij} denotes higher relative bargaining power to the buyer i.

With the ingredients derived above, I can now solve for the FOC of problem (50) and rearrange it to write the bilateral price as:

$$w^m_{ijv} = \left(\frac{\varepsilon_{iv} + \frac{1-\phi_{ij}}{\phi_{ij}}\varepsilon^b_{iv}\mu^{int}_{ijv}}{\varepsilon_{iv} + \frac{1-\phi_{ij}}{\phi_{ij}}\varepsilon^b_{iv} - 1}\right)\frac{c^m_{jv}}{\rho}, \tag{51}$$

where the different terms are defined as follows. The term c^m_{jv} denotes the average cost of supplier j, and $\rho > 0$ is the returns to scale parameter of production upstream, which may vary across suppliers and varieties. The term $\varepsilon_{ij} \equiv -\frac{d\ln m_{ijv}}{d\ln w^m_{ijv}}$ is the price elasticity of the intermediate input demand. Given the assumptions on technology, this elasticity can be written as:

$$\varepsilon_{iv} = \frac{\zeta^m_{iv}}{\theta^m_{iv}}\epsilon_i(1-\Gamma_i), \tag{52}$$

which is a function of the demand and markups elasticity downstream, ϵ_i and Γ_i, as well as of the elasticity of firm i's marginal cost to the intermediate input price ζ^m_{iv}, and the output elasticity of v, θ^m_{iv}. Similarly, the term ε^b_i can be solved as a function of the demand and markups elasticity downstream, ν_i and Γ_i, the elasticity of marginal cost to the intermediate input ζ^m_{iv}, and the outside option of firm i, as captured by the term λ^m_{iv}. :

$$\varepsilon^b_{iv} = \zeta^m_{iv}\frac{\epsilon_i - 1}{1 - A_i}, \tag{53}$$

where $A_i \equiv \left(\epsilon_i((\lambda^m_{iv})^{-\Gamma}-1)-1\right)(\lambda^m_{iv})^{1-\epsilon_i(1-\Gamma)}$. The term μ^{int}_{ij} is defined as:

$$\mu^{int}_{ijv} \equiv s^m_{ijv}\left(1-\left(1-s^m_{ijv}\right)^{\frac{1}{\rho}}\right), \tag{54}$$

which is a function of the buyer share $s^m_{ijv}=\frac{m_{ijv}}{q^m_{jv}}$, and the return to scale upstream ρ. Finally, the term $\frac{1-\phi_{ij}}{\phi_{ij}} \in (0,\infty)$ is the relative bargaining power of the supplier j. As explained above, this term is exogenous in this problem.

C.2 Reduced form input price function

I now proceed to characterize the relationship between the bilateral price w^m_{ijv} and the quantity purchased by buyer i. Given equations (51)-(54), it is easy to show that:

$$\Psi^m_{ijv} \equiv \frac{d\ln w^m_{ijv}}{d\ln m_{ijv}} \simeq \left(\frac{1-\rho}{\rho}\right) s^m_{ijv}\left[1-\frac{\kappa^m_{ijv}}{2}\left(1-s^m_{ijv}\right)\right] \tag{55}$$

where $\kappa^m_{ijv} \equiv \left(\frac{\frac{1-\phi_{ij}}{\phi_{ij}}\varepsilon^b_{iv}\mu^{int}_{ijv}}{\varepsilon_{iv}-1+\frac{1-\phi_{ij}}{\phi_{ij}}\varepsilon^b_{iv}}\right) \in (0,1)$ is a constant affecting the level, which depends on market conditions upstream and downstream which the buyer takes as given.

Equation (55) shows that in a bargaining game between buyer i and supplier j, the bilateral price, outcome of negotiations, is a function of the buyer share of firm i. When either $\rho=1$ or $s^m_{ijv}\to 0$, the price is independent from the quantity purchased by the buyer, which effectively acts as a price taker upstream. When $\rho\neq 1$ and $s^m_{ijv}>0$, the input price increases in buyer's demand when $\rho\in(0,1)$, that is when marginal costs upstream are increasing in quantity, and vice versa the input price decreases in buyer's demand when $\rho>1$, that is when production upstream features increasing returns (or decreasing marginal costs). The first scenario is consistent with textbook models of buyer (monopsony) power. When the input supply elasticity is positive, the buyer is going to demand less than the competitive amount of input and will end up paying a price below competitive levels.

Given this discussion, it immediately follows that when production upstream features decreasing returns scale (increasing marginal costs), input prices are a (buyer-specific) function of the buyer's demand:

$$w^m_{iv} = w^m_i\left(m_{iv};\mathbf{A}_{\mathbf{i}v}\right), \tag{56}$$

where $\mathbf{A}_{\mathbf{i}v} = (\epsilon_i,\Gamma_i,\zeta^m_{iv},\theta^m_{iv},\lambda^m_{iv})$ is a vector summarizing demand and technology conditions, which the buyer takes as given. The relationship between input price and quantity in (1) is governed by the elasticity Ψ^m_{iv}, defined in (55). Note that I omitted the supplier's subscript in (56) because I do not observe exporter-level information in the data. Heterogeneity in the side of exporters is captured by making the input supply function $w_i^m(\cdot)$ firm-specific.

D A Model of Demand in Final Good Markets

This section introduces a demand system for a firm's i variety in both domestic and foreign markets into the production framework. The functional form assumptions on demand and market structure are motivated by the available data. The goal is to use as much information as possible on sales and trade in order to calibrate firm-level markups.

Note that the production framework in section 3 allows any static model of demand, conditional on flexible price setting. The model that follows satisfies these criteria.

D.1 Theory

Demand of final goods of each firm i comes from either the Home country (France) or from foreign countries. Countries are symmetric, and there is a representative consumer in each country. I assume that firms (exporters) compete in monopolistic competition in both the domestic and the foreign markets. Among other things, this assumption implies that firms takes aggregate variables as given when setting prices.

Preferences The representative consumer in each country has preferences over a composite of domestic and imported goods:

$$C_t = \left(D_t^{(\kappa-1)/\kappa} + M_t^{(\kappa-1)/\kappa}\right)^{\kappa/(\kappa-1)}, \tag{57}$$

where M_t denotes the composite imported good, D_t the composite domestic good, and $\kappa > 1$ is the elasticity of substitution between domestic and foreign goods. I define the composite domestic good as:

$$D_t = \left(\sum_{i \in N} d_{it}^{1/\gamma} D_{it}^{(\gamma-1)/\gamma}\right)^{\gamma/(\gamma-1)}, \tag{58}$$

where D_{it} is the total demand of domestic variety $i \in N$, $\gamma > 1$ is the elasticity of substitution among domestic varieties, and d_{it} is a taste or quality parameter for variety i. I identify domestic varieties with the set of firms, such that i denotes both a variety and a firm. The composite imported good is defined as:

$$M_t = \left(\sum_{g \in G} M_{gt}^{(\gamma-1)/\gamma}\right)^{\gamma/(\gamma-1)}, \tag{59}$$

where M_{gt} denotes the consumption of imported good g in time t, and G is the set of imported goods, which may differ across countries. Note that I impose that the individual has similar substitution patterns over domestic and foreign varieties, namely, I assume that the same elasticity γ governs both (58) and (59). Finally, I represent M_{gt} as:

$$M_{gt} = \left(\sum_{c \in C} d_{gct}^{1/\sigma_g} (m_{gct})^{(\sigma_g - 1)/\sigma_g} \right)^{\sigma_g/(\sigma_g - 1)} \quad ; \; \sigma_g > 1,$$

where σ_g is the elasticity of substitution among varieties of good g, C is the set of all sourcing countries, d_{gct} denotes a taste or quality parameter for good g sourced from country c.

Firms

Each firm i produces a set of goods $g \in G_i \subset G$, which it either sells domestically, or exports, or both. It is assumed that the firm sells all of its goods to the domestic market, while it can export only a subset of products to each of its foreign destinations, with N_{ig}^X denoting the set of export destinations firm i sells product g to. Therefore, I assume the domestic good i as a bundle of all goods $g \in G_i$ produced by the firm. This assumption is motivated by the data I have available, where I observe product-country level information for exported goods, and only firm-level information for domestic sales.

The nested CES demand system above coupled with monopolistic competition implies that when selling to domestic consumers, the firm sets a price equal to

$$p_{it} = \frac{\gamma}{\gamma - 1} c_{it}^D, \tag{60}$$

where c_{it}^D is the marginal cost of supplying goods domestically. Similarly, the price charged for good g sold in country c is given by:

$$p_{gct} = \frac{\sigma_g}{\sigma_g - 1} c_{gct}^X, \tag{61}$$

where c_{gct}^X is the marginal cost of exporting good g to country c. The assumption that countries are symmetric implies that $\mu^D = \frac{\gamma}{\gamma - 1}$ is the markup charged by all firms in the domestic market, while $\mu_g = \frac{\sigma_g}{\sigma_g - 1}$ is the markup charged on exports of good g in every destination served.

D.2 Firm-level Markups

Consider an exporter i. Revenues of firm i in export market c when selling good g can be written as $R_{igct} = p_{igct} q_{igct} = \mu_g \cdot \lambda_{igct} q_{igct}$, where λ_{igct} is the marginal cost of good g sold in country c. I let $R_{igt} = \sum_{c=1}^{N_{igt}^x} R_{igct}$ denote total exports of good g at time t, and $\lambda_{igt} q_{igt} = \sum_{c=1}^{N_{igt}^x} \lambda_{igct} q_{igct}$ denote the total cost of exporting good g. Total exports of good g by firm i at time t can be written as $R_{igt} = \mu_g \lambda_{igt} q_{igt}$. By the same token, total export revenues are given by $R^X_{it} = \sum_{g=1}^{G_i} R_{igt} = \sum_{g=1}^{G_i} \mu_g \lambda_{igt} q_{igt}$. Using the compact expression $R^X_{it} = \mu^X_{it} \lambda^X_{it} q^X_{it}$, I can express average export markups as:

$$\mu^X_{it} = \sum_{g=1}^{G_i} \mu_g \cdot \vartheta^X_{igt}, \tag{62}$$

namely as a weighted average of good-level markups, with weights given by the cost share of good g over total cost of exports, which I denote as $\vartheta^X_{igt} \equiv \frac{\lambda_{igt} q_{igt}}{\lambda^X_{it} q^X_{it}}$. Let $\omega^X_{igt} \equiv R_{igt}/R^X_{it}$ denote the *observed* revenue share of each exported good g. Using the expression for total exports of good g I can write:

$$\omega^X_{igt} = \frac{\mu_g}{\mu^X_{it}} \vartheta^X_{igt} \; \forall g \in G_i, \tag{63}$$

that relates unobserved good cost shares ϑ^X_{igt} to observed revenue shares ω_{igt}. Equation (63) gives, for each firm, a system of G equations in $G + 1$ unknowns (G cost shares and one firm-level export markup). Solving the system of equations (63) and (62) yields the following expression for firm-level export markups:

$$\mu^X_{it} = \left(\sum_{g=1}^{G_i - 1} \frac{\omega_{igt}}{\mu_g} \right)^{-1}. \tag{64}$$

The average export markup can be written as a harmonic mean of the good level markups, with weights given by the observed share of good g over total export revenues of firm i. Therefore, although good level markups are constant across firms, variation across firms in the average firm-level export markups is induced by the relative importance of the different goods in the export baskets of firms.

I can use similar derivation to obtain an estimate of the average markup of each firm i. Domestic and export revenues are defined as:

$$R^D_{it} = \mu^D_{it} \lambda^D_{it} Q^D_{it} \tag{65}$$

$$R^X_{it} = \mu^X_{it} \lambda^X_{it} Q^X_{it}. \tag{66}$$

Total revenues can be written as $R_{it} = \mu^D \lambda^D_{it} Q^D_{it} + \mu^X_{it} \lambda^X_{it} Q^X_{it}$, which implies the following expression for firm-level markups:

$$\mu_{it} = \mu^D \vartheta^D_{it} + \mu^X_{it} \vartheta^X_{it}. \tag{67}$$

The average firm-level markups is a weighted average of the domestic and foreign markups, with weights given by the cost share of domestic and export sales, $\vartheta^D_{it} \equiv \frac{\lambda^D_{it} Q^D_{it}}{\lambda_{it} Q_{it}}$ and $\vartheta^X_{it} \equiv \frac{\lambda^X_{it} Q^X_{it}}{\lambda_{it} Q_{it}}$. As before, a measure of export cost share can be derived as: $\vartheta^X_{it} = \omega^X_{it} \frac{\mu_{it}}{\mu^X_{it}}$, where $\omega_{it}^{X} \equiv \frac{R_{it}^{X}}{R_{it}}$ is the observed export share of revenues. Firm-level markups can be obtained by solving the following system of equations:

$$\begin{cases} \mu_{it} = \mu^{D}(1-\vartheta_{it}^{X}) + \mu_{it}^{X}\vartheta_{it}^{X} \\ \vartheta_{it}^{X} = \omega_{it}^{X}\frac{\mu_{it}}{\mu_{it}^{X}} \end{cases}, \tag{68}$$

which yields the following solution:

$$\mu_{it} = \left[\left(1-\omega_{it}^{X}\right)\left(\mu^{D}\right)^{-1} + \omega_{it}^{X}\left(\mu_{it}^{X}\right)^{-1}\right]^{-1}.$$

Firm-level markups is derived as a harmonic average of foreign and domestic markups, with weights given by the revenue share of exports (ω_{it}^{X}), and domestic sales ($1-\omega_{it}$) respectively.

Because revenue shares are observed, the only thing I need to know in order to get an estimate of μ_{it} is an estimate of domestic markup μ^{D}, and estimates of good-level markups μ_{g}, which are needed to compute μ_{it}^{X}.

D.3 Calibration

Equations (60) and (61) imply that domestic and good-level markups are simple transformations of the demand elasticities γ and σ_g, respectively. I estimate the good-level elasticities σ_g using the Broda and Weinstein (2006) and applying the Soderbery (2015)'s correction.[41]

Figure D1: Estimates of σ_g - Distribution

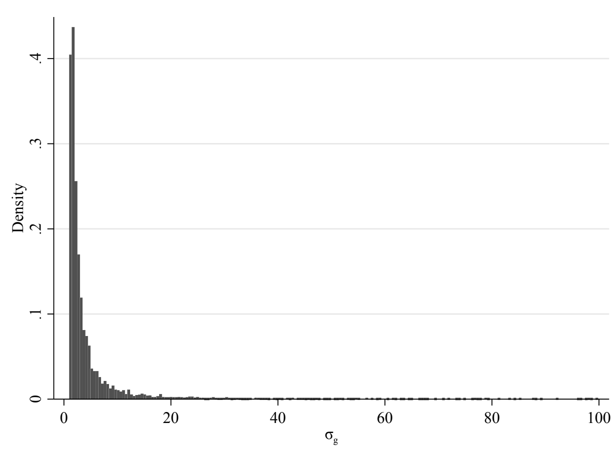


Figure D1 plots the estimated elasticities of the good-level elasticity of substitution σ_g,

[41] I use the STATA codes provided by Soderbery (2015) to implement the methodology on the French export data.

Table D1: Firm-level Markups - Calibration Results

Normal Elasticity-matching process								
Source:	Value of γ	Min	p25	Median	Mean	p75	Max	NA's
Redding and Weinstein (2008)	2.66	1.038	1.602	1.603	1.618	1.611	6.69	5814
Hottman, Redding and Weinstein (2016)	3.9	1.026	1.345	1.347	1.368	1.358	6.42	5814
Imbs and Mejean (2016)	4.624	1.023	1.276	1.278	1.301	1.29	6.334	5814

Elasticity-matching process with HS4-median								
Source:	Value of γ	Min	p25	Median	Mean	p75	Max	NA's
Redding and Weinstein (2008)	2.66	1.024	1.601	1.603	1.618	1.612	6.69	1154
Hottman, Redding and Weinstein (2016)	3.9	1.018	1.345	1.347	1.37	1.36	6.42	1154
Imbs and Mejean (2016)	4.624	1.017	1.276	1.279	1.303	1.292	6.334	1154

Notes: The table reports the estimated distribution of firm-level markups obtained from: $\mu_{it} = \left[\left(1-\omega^X_{it}\right)\left(\mu^D\right)^{-1} + \omega^X_{it}\left(\mu^X_{it}\right)^{-1}\right]^{-1}$, where ω^X_{it} is the observed export share of revenues, $\mu^X_i t$ is the firm-level export markup, obtained from the estimates of σ_g and data on export revenue shares at the good level. Domestic markups are calculated given estimates of γ. The latter are taken from the studies indicated in the first column .

which are used to compute export markups at the firm level using equation (62). Values of γ cannot be estimated using similar procedures given the lack of data on domestic sales. I consider different values for these elasticities, based on existing studies that consider a demand system similar to the one above, namely Redding and Weinstein (2020), Hottman et al. (2016), and Imbs and Mejean (2017) who estimate a value of γ equal to 2.66, 3.9 and 4.62, respectively.

Table D1 summarizes the calibrated distribution of firm-level markups for different values of γ. The last column reports the number of exported goods g for which an estimate of the elasticity of substitution σ_g is not available. In the bottom panel, I replace missing values of the elasticities σ_g with the median estimate for goods in the same HS4 classification. Results are not affected by the missing values. The average firm-level markup ranges from 1.28 to 1.60. Mean and median values are by all means similar. The interquartile range of markup estimates is rather small, indicating precise estimates.

E Production Function Estimation

In this Section I describe the details of my approach to estimating the output elasticities necessary to the construction of the buyer power wedges. To ease the exposition, iI will consider a Cobb-Douglas specification of the production function. All the results can be easily generalized to more flexible approximations of $f(\cdot)$.

I are interested in estimating the following equation:

$$q_{it} = \beta_l l_{it} + \beta_k k_{it} + \beta_z z_{it} + \beta_m m_{it} + \omega_{it} + \epsilon_{it}, \tag{69}$$

where lower-case letters denote log variables and all variables have been defined in the main text. Estimation of equation (69) requires data on physical units of inputs and output, which are not directly observed. Lack of this kind of data may lead to input and output price biases in estimation, which may be particularly severe when price variation across firms is expected to be large (De Loecker and Goldberg, 2014).

Similarly, firm-level productivity ω_{it} is not directly observed. Because firm-level input choices are correlated with unobserved productivity, estimation of equation (69) using OLS will lead to biased estimates of the output elasticities. In what follows, I discuss both the price and simultaneity biases, and my estimation approach.

E.1 Estimation Biases

E.1.1 Output Price Bias

When information on physical output q_{it} is not available, the standard approach in the empirical literature is to construct a measure of output as deflated revenues, i.e. $\tilde{q}_{it} = r_{it} - p_{st}$, where r_{it} is log sales of firm i and p_{st} is the log producer price deflator for the two-digit sector s. The quantity q_{it} is related to deflated revenues $\tilde{q}_{it}$ as: $q_{it} = \tilde{q_{it}} - (p_{it} - p_{st})$, such that one can rewrite equation (13) as:

$$\tilde{q}_{it} = \beta_l l_{it} + \beta_k k_{it} + \beta_z z_{it} + \beta_m m_{it} + (p_{it} - p_{st}) + \omega_{it} + \epsilon_{it} \tag{70}$$

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

My approach to correcting for the output price bias is based on the observation that, for the subset of importers who also export in a given year, a sample of product-level output prices is included in the customs data. Specifically, I can observe how much the price of a French firm deviates from the average price charged by other French exporters selling the same product to the same destination.[42] This variety-level information can be aggregated into a firm-level measure $\hat{p}_{it}$ of the average firm deviation from the industry-level price. Armed with this measure, I can finally construct a firm-level output price deflator as

$$\tilde{p_{it}} = p_{st} + \hat{p_{it}}, \tag{75}$$

which I use instead of p_{st} to deflate firm-level revenues. Intuitively, my price-correction approach aims to induce firm-level variation in the industry output deflator, based on the observed deviations at the individual variety level.

E.1.2 Input Price Bias

When the quantity of a generic input V is not observed, a physical measure of the input can be constructed by deflating expenditures e^v_{it} with an industry-wide deflator w^v_{st}, i.e. $\tilde{v}_{it} = e^v_{it} - w^v_{st}$. An input price bias arises as firm-level prices for the input systematically deviate from this deflator, namely if $(w^v_{it} - w^v_{st}) \neq 0$ for some firm i. In my setting, an input price bias may affect the elasticity estimate of both the domestic intermediate input Z_{it}, and the foreign input M_{it}.[43] I discuss the two biases separately.

Foreign Intermediates To construct a firm-level measure of the quantity of imported input M_{it}, I use a procedure similar to the one used for output. I first use a fixed effect strategy on variety-level import prices to construct a measure $\hat{w^m_{it}}$ of average firm deviation

[42] Let p_{ipct} the price that firm i charges for product p in destination market c. I allow firms to price-to-market, and I let firm-product markup vary across different destinations. I thus write (log) markup in destination c as:

$$\mu_{ipct} = \mu_{ipt} + \hat{\mu}_{ipct}, \tag{71}$$

where $\hat{\mu}_{ipct}$ is the deviation in country c from average firm-product markup μ_{ipt}. The (log) price p_{ipct} in destination c can be written as

$$p_{ipct} = mc_{ipt} + \mu_{ipt} + \hat{\mu}_{ipct} + \tau_{ict}, \tag{72}$$

where τ_{ict} denotes (log) iceberg trade costs. The corresponding domestic price of product p will be given by:

$$p^H_{ipt} = mc_{ipt} + \mu_{ipt} + \hat{\mu}^H_{ipt}, \tag{73}$$

where $\hat{\mu}^H_{ipt}$ is the deviation of the domestic output price from average firm-product markup μ_{ipt}. Equations (72) and (73) suggest that a fixed effects OLS regression of firm-product-country prices on firm-product-time fixed effects

$$p_{ipct} = \gamma_{pit} + \varepsilon_{fint}, \tag{74}$$

can yield an estimate of the average firm-product price as $\hat{p}_{ipt} = \hat{\gamma}_{ipt} = \widehat{mc_{ipt} + \mu_{ipt}}$, where the γ_{ipt} are firm-product-time fixed effects. Intuitively, to the extent that markups and marginal costs are positively correlated across destinations, these fixed effects will capture the effect of common factors affecting prices in all markets, including firm-productivity, quality choices, and market power.

[43] Labor is measured in physical units, and thus does not generate similar problems. I am going to abstract from the problem of unobserved input price variation for capital, given that firm-level prices are never observed.

from the industry-level price of different imported inputs. I then construct a firm-level import price deflator as

$$\tilde{w_{it}^m} = w_{st}^m + \hat{w_{it}^w}, \tag{76}$$

where w_{st}^m is the observed industry deflator for imported intermediates. Finally, I construct a physical measure of the imported input by deflating total expenditures on the imported inputs by the firm-level deflator in (76). In doing so, differences in imported input prices among firms are accounted for, thus alleviating concerns about the foreign input price bias.

Domestic Intermediates and Input Price Bias The concern of an input price bias is particularly relevant for the domestic intermediate inputs, due to the lack of price data. Approaches based on control functions, as recently proposed by De Loecker et al. (2016), similarly have a limited applicability in this context where data availability is scarce.

To understand the effect of the input price bias for the coefficient estimates, let us write:

$$q_{it} = \beta_l l_{it} + \beta_k k_{it} + \beta_z \tilde{z}_{it} + \beta_m m_{it} + \beta_z (w_{st}^z - w_{it}^z) + \omega_{it} + \epsilon_{it}, \tag{77}$$

where $\tilde{z}_{it}$ is deflated expenditure, and the term $\beta_z(w_{st}^z - w_{it}^z)$ is the firm-level price deviation from the average industry price w_{st}^z. This term is unobserved, and captures the input price bias associated with the domestic intermediate input.

Because the price term is not observed, the estimated coefficients for the foreign and domestic input elasticities would be given by:

$$\tilde{\beta}_m = \beta_m - \beta_z \delta_{mz}$$
$$\tilde{\beta}_z = \beta_z - \beta_z \delta_{zz},$$

where the coefficients δ_{mz} and δ_{zz} capture the correlation between foreign input demand (m_i) and deflated domestic input expenditure $(\tilde{z}_i)$, respectively, with unobserved prices of domestic inputs. I expect both coefficients to be positive, due to substitutability across inputs in production in the first case, and by construction in the second case. In turn, both coefficient estimates $\tilde{\beta}_m$ and $\tilde{\beta}_z$ will be biased downwards, such that the overall effect of input price bias on the estimate of buyer power, which is proportional to the ratio $\tilde{\beta}_m / \tilde{\beta}_z$, is unclear.

These considerations notwithstanding, the size of this bias is arguably small, in light of two considerations. First, the use of firm-level expenditure data implies that part of the product level price deviations may be washed out in aggregation. Second, if firms that have high buyer power over domestic input suppliers are those that buy higher quality inputs, the dispersion in input prices would be attenuated by these opposite forces. In such case, the size of the coefficient estimates δ_{mz} and δ_{zz} would go towards zero, and the overall effect of the input price bias would be small.

Lastly, notice that if buyer power is correlated across input markets, because of buyers effects, than I could in part control for the input price bias by correcting the deflator for domestic prices by the firm price correction factor computed from foreign input price data. Because results are largely unaffected by this correction, it is likely that the input price bias has an overall limited role in generating my results.

E.1.3 Simultaneity bias

The last source of bias in equation (13) is the unobserved productivity term ω_{it}. I deal with the well-known associated simultaneity problem by relying on a control function for productivity, building on Ackerberg et al. (2015).

Let us consider the FOC in (11) and write the demand for the foreign and domestic intermediate input bundle as:

$$M_{it} = h\left(\mathbf{W}_{it}, \mathbf{V}_{it}/\{M_{it}\}, \mathbf{K}_{it}, P_{it}, e^{\omega_{it}}\right) \tag{78}$$

$$Z_{it} = g\left(\mathbf{W}_{it}, \mathbf{V}_{it}/\{Z_{it}\}, \mathbf{K}_{it}, P_{it}, e^{\omega_{it}}\right). \tag{79}$$

The demand functions can be written as a function of input prices, summarized by the vector $\mathbf{W}_{it}$, input quantities, summarized by vectors $\mathbf{V}_{it}$ and $\mathbf{K}_{it}$, output price P_{it} and productivity $e^{\omega_{it}}$. Equations (78) and (79) include two unobservables: firm productivity, $e^{\omega_{it}}$ and domestic input prices W^{z}_{it}. Because demand is monotonic in both prices and productivity, I can invert the second equation to write:

$$W^{z}_{it} = g^{-1}\left(\mathbf{W}_{it}/\{W^{Z}_{it}\}, \mathbf{V}_{it}, \mathbf{K}_{it}, P_{it}, e^{\omega_{it}}\right), \tag{80}$$

which is a function of only one observable, $e^{\omega_{it}}$. I can then plug equation (80) into (78) to write:

$$M_{it} = \tilde{h}\left(\mathbf{W}_{it}/\{W^{Z}_{it}\}, \mathbf{V}_{it}/\{M_{it}\}, \mathbf{K}_{it}, P_{it}, e^{\omega_{it}}\right),$$

which I can invert to obtain:

$$e^{\omega_{it}} = \tilde{h}^{-1}(\mathbf{V}_{it}, \mathbf{K}_{it}, \mathbf{W}_{it}/\{W^{Z}_{it}\}, P_{it}). \tag{81}$$

Even though output prices P_{it} are not directly observed, I can proxy for the term P_{it} using the firm level output deflators derived above. Equation (81) shows that a control function for productivity can be written in terms of observable variables. By substituting this expression into the main estimating equation, I obtain:

E.2 Estimation

Putting pieces together, the estimating equation reads:

$$q_{it} = \beta_l l_{it} + \beta_k k_{it} + \beta_z \tilde{z}_{it} + \beta_m m_{it} + \tilde{\tilde{h}}^{-1}(k_{it}, l_{it}, \tilde{z}_{it}, m_{it}, w^m_{it}, w^l_{it}, p_{it}) + u_{it}, \tag{82}$$

where $u_{it} = \epsilon_{it} + \beta_z(w^z_{st} - w^z_{it})$ and $\tilde{\tilde{h}}^{-1} = \ln \tilde{h}^{-1}$. To estimate (82), 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 on:

$$q_{it} = \phi_t(l_{it}, k_{it}, m_{it}, z_{it}, w^m_{it}, w^l_{it}, p_{it}) + \epsilon_{it}, \tag{83}$$

where the function ϕ_t is approximated by a third order polynomial. 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 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:

$$\omega_{it} = g(\omega_{it-1}) + \xi_{it}, \tag{84}$$

where I approximate $g(\cdot)$ as a second order polynomial in all its arguments. Using (82) and (83) I can express ω_{it} as

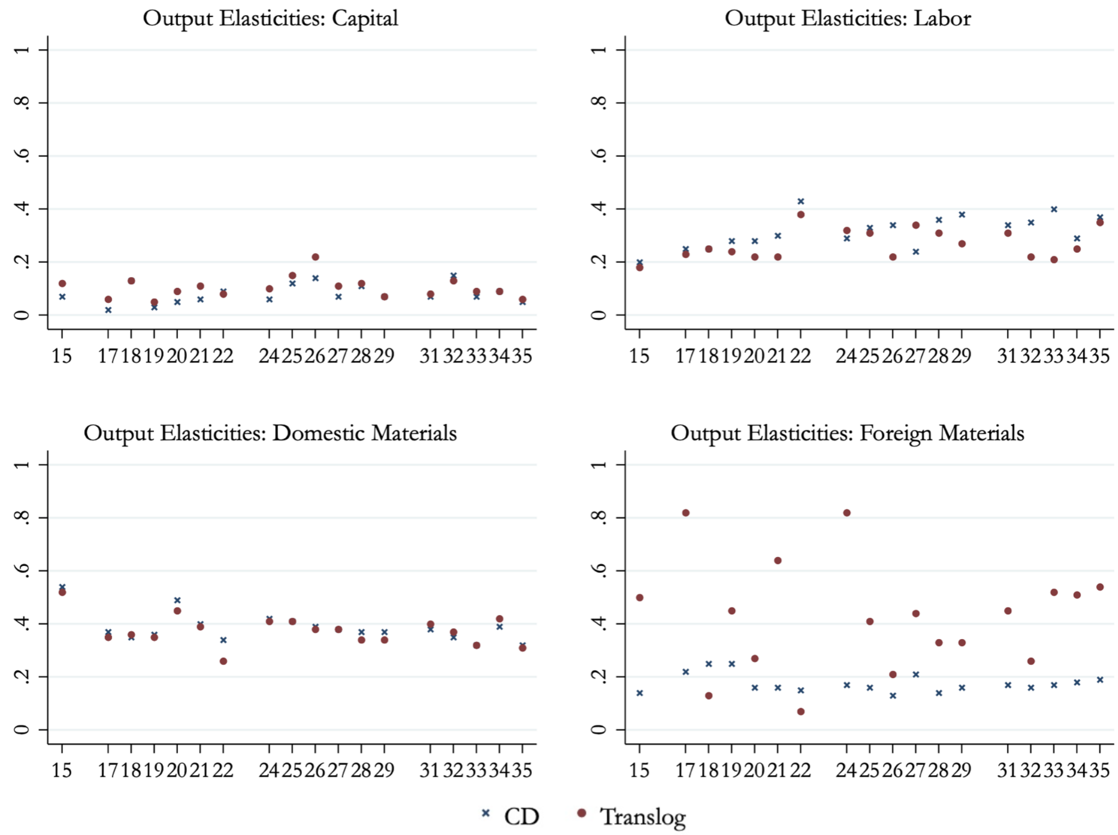
$$\omega_{it}(\beta) = \hat{\phi}_{it} - (\beta_l l_{it} + \beta_k k_{it} + \beta_z \tilde{z}_{it} + \beta_m m_{it}) \, . \tag{85}$$

I can now substitute (85) in (84) 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 $\xi_{it}(\beta)$, I can write the moments identifying conditions as:

$$\mathbb{E}\left(\ \xi_{it}(\beta) \ \ \mathbf{Y}_{it} \right) = 0, \tag{86}$$

where $\mathbf{Y}_{it}$ contain lagged domestic and foreign materials, and current capital and labor. 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. These moment conditions are fully standard in the production function estimation literature (e.g. Levinsohn and Petrin, 2003; Ackerberg et al., 2015).

Figure E1: 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.

E.3 Market Power in Input Markets when Production Function is Translog

Table E1 shows the results of production function estimation using a TL production function. Figure E1 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.[44] 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.

[44] I write the TL 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

Table E1: 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 to each factor of production. Col. 5 reports the median returns to scale.

F Data Appendix

F.1 Variable Construction

I now describe the variables used. Unless otherwise specified, all variables are measured at the plant level and are taken from the accounting data (FICUS dataset). *Nominal output* is total firm sales in a given year. *Total intermediate expenditures* are computed as total expenditures in raw materials. *Total domestic intermediates* is total expenditure on intermediates minus total imports of intermediates. *Total imports of intermediates* is computed from the Customs data as the sum of imports of products that are not classified as either "final good consumption" or "capital goods" by the Broad Economic Classification (BEC). 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.[45] *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. *Capital* is measured as 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. 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 $i\delta$ might vary by sector, from Olley and Pakes (1996). The depreciation rates are taken from public sources.

All these variables are deflated by two-digit price deflators. The industry-level price deflators for output, intermediates (domestic), and capital are taken from the STAN industry dataset. The industry-level deflators for imports are taken from the INSEE website (https://www.insee.fr/). As I describe in Section 2.2., I correct a subset of these deflators by a firm-level deviation term that I construct from customs data, to induce firm level variation in the price index.

I construct the sourcing strategy term Σ_{it} included in the control function for unobserved productivity as the number of countries from which firm i is sourcing in year

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output elasticity is thus defined as:

$$\begin{aligned}\theta^x_{it} =& \beta_x + 2\beta_{xx}x_{it} + \beta_{kx}k_{it} + \beta_{lx}l_{it} + \beta_{mx}m_{it} + \\ =& \beta_{klx}k_{it}l_{it} + \beta_{kmx}k_{it}m_{it} + \beta_{lmx}l_{it}m_{it} + \beta_{klmx}k_{it}l_{it}m_{it}\end{aligned}$$

[45] 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.

Table F1: MANUFACTURING SECTORS, AND SAMPLE SIZE

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

t. This information is included in the customs data. Other definitions of Σ_{it} based on, for instance, which set of countries firm i is importing from are not feasible in production function estimation, as they limit too much the number of observations available.

I proxy the buyer share in the domestic market of intermediates s_{it}^{m} with total expenditures of firm i on domestic intermediates at time t, over total expenditures on domestic intermediates by firms that belong to the same industry as firm i, report the same principal activity, and are located in the same geographical region. Results are robust to different definitions of the relevant market.

F.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 $s \in \{1, .., 17\}$.