Firm Market Power in Intermediate Input and Labor Markets*

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Abstract

In order to understand the nature of firm market power in intermediate input and labor markets, we study the determinants of the prices that firms pay for their inputs. To do this, we use uncommonly rich and highly disaggregated administrative data for textile firms in the Brazilian state of São Paulo. The fine granularity of the data allows us to depart from previous work, and impose less stringent assumptions to find the following main results. First, we find evidence of the existence and intricate nature of market power of firms in the access to inputs. Second, our results challenge mainstream findings and methods in the classical monopsony power literature that uses instrumental variable identification strategies. These results highlight the importance of market power of firms in the access to inputs, and how its complexity requires a more thorough approach to fully understand its determinants and implications than previously considered.

Keywords: Market power, monopsony, oligopsony, input markets
JEL Classification: D22, J42, L13

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1 INTRODUCTION

The last decades have witnessed an unprecedented increase in industry concentration, markups, and corporate profit rates (e.g., Grullon et al. [2019] and De Loecker et al. [2020]). This has raised concerns among scholars and policy makers, bringing into the spotlight issues such as common ownership, killer acquisitions, reduced trade barriers, or problems in the enforcement of competition policy rules and regulations as candidates to explain the increasing levels of firm market power. However, little attention has been paid to the fact that monopsony power in input markets can also play a role in understanding the low levels of competition in output markets. If some firms can pay lower prices for their inputs, this will reduce their marginal costs, increasing their competitive edge and unleveling the playing field for competition. Numerous case studies and anecdotal evidence point that firms like Wal-Mart or Amazon are able to obtain lower input prices from suppliers than competitor firms.[1] However, to the best of our knowledge, there is no systematic empirical analysis of this phenomenon.

In this paper we try to fill this void and present clear-cut stylized facts about the determinants of the prices that firms pay for their inputs, providing evidence of the existence of market power and its nature. To this aim, we use uncommonly rich and highly disaggregated data for intermediate input and labor markets. The data covers 3,535 plants, which we will refer to as firms hereafter, in the textile sector in the Brazilian state of São Paulo for the period 2011 to 2017. First, we have data on firm-to-firm transactions of intermediate inputs that contains information on prices (unit-values) at the transaction level. This makes our dataset unique and ideal for our purpose. For each transaction, we have information on the identities of the seller and the buyer, and very detailed information on the product being transacted. This allows us to exploit variation across buyers of a given product sold by a firm whilst controlling for product unobserved characteristics, circumventing usual problems caused by heterogeneity in product quality. Second, for the labor market, we have information on firm employment levels and wage bills for different occupation-education categories. This disaggregation allows us to control for the composition and quality of the workforce and estimate the wage elasticity when firms hire more workers.

We find evidence of market power of firms in input markets of a completely different nature from the one documented so far by the classical monopsony literature. For intermediate input markets, we find substantial variation in prices across buyers of a product sold by a

[1] See for example Bonanno and Goetz [2012] and Weise [2019].

given firm. This implies the law of one price does not hold, and suppliers sell the same product at different prices to different buyers. Trying to uncover the origin of these differences, first, we find evidence consistent with the existence of quantity discounts of up to 26% in our baseline specification (this means a 100% increase in quantity is associated with a 26% unit price decrease). This result is of great importance and contrasts with previous work that, relying on instrumental variable identification strategies, finds input prices are increasing in the quantity demanded by firms. This upward sloping supply curve has been interpreted as evidence of firm market power which leads buying firms to reduce demanded quantities, lowering input prices, and increase profits (e.g., Rubens [2023] and Morlacco [2020]). By contrast, we find intermediate input prices decrease in the quantity demanded. Second, we also find that market power is reflected through the higher bargaining power of buyer firms that have more suppliers. Intuitively, firms with more suppliers induce competition among them, and are able to negotiate lower input prices. And third, we document how buyers partially share profits with their suppliers by paying a higher price for the same input products after receiving a positive demand or productivity shock. For labor markets, we find no evidence of firms needing to pay higher wages to hire more workers. This finding suggests the absence of classical monoposony power for firms in our data, and, moreover, contrasts with standard labor search models predicting an increasing labor supply curve. Additionally, we find evidence of rent-sharing between firms and workers. Firms receiving positive shocks partially share their higher profits with workers by paying them higher wages.[2]

We argue that the finding of the existence of rent-sharing, that would occur as a result of bargaining both between firms and suppliers, and firms and workers, has deep implications for the validity of the classical methodology used to study monopsony power. Traditional papers use variation in input quantities induced by a firm demand shock to identify the residual supply curve faced by a firm in the acquisition of labor and intermediate inputs. The key assumption for the validity of these instruments is that the firm demand shock will only affect input prices through the increase in demanded quantities. However, rent-sharing proves this is not the only channel. If firms receiving a positive demand shock not only demand higher quantities of intermediate inputs and hire more workers but, in some extent, also share part of their good luck with suppliers and workers by paying higher prices and wages, the exclusion restriction of usual instrumental variables would be seriously compromised rendering positively biased elasticity estimates.[3]

[2]A comprehensive review of previous works also documenting evidence of rent-sharing between firms and workers can be found in Card et al. [2018].

[3]To formalize this finding, we present a simple model in which buyer firms and suppliers (or workers) negotiate input prices (or wages) using Nash-barganing. This very stylized framework delivers that down-

The contribution of our work comes from exploiting highly disaggregated data to study the nature of firm market power in input markets. Our rich data allows us to depart from previous work, and rely on a methodology that imposes less stringent identification assumptions. Our findings, first, highlight the existence of market power of firms in the access to inputs and uncovers its complex nature. Second, our findings challenge mainstream results in the classical monopsony power literature that uses instrumental variable identification strategies. More generally, our results imply that firm market power in input markets can have important implications for competition in output markets and consumer welfare.[4] Therefore, the connection between market power in input and output markets should be considered in a rigorous competition policy design.

The closest papers to ours belong to the literature studying market power of firms in labor markets. This is a long literature going back to Robinson [1933], well summarized in Manning [2021], that is gaining renewed attention in the last years with important contributions such as Naidu et al. [2016], Azar et al. [2019], and Goolsbee and Syverson [2023], among others. The methodological approach of this literature considers that identifying an upward-sloping labor supply curve facing an individual employer proves the existence of monopsony power. We refer to this type of employer market power as "classical monopsony". Under classical monopsony, an employer's power to pay wages below the marginal product of labor arises from the ability to restrict employment below its competitive equilibrium level. Because usual datasets do not include information on the skill and composition of firm's labor force and the quality and characteristics of firm intermediate inputs, simple OLS estimates will suffer from endogeneity. To circumvent this issue they resort to potentially problematic instrumental variable identification strategies that, as we argue in this paper, can render positively biased supply elasticities bringing into question the results.

This approach has been taken in a variety of industries and markets, including nurses (Sullivan [1989]; Staiger et al. [1999]), grocery store workers (Ransom and Oaxaca [2010]), educators (Ransom and Sims [2010], Goolsbee and Syverson [2023]), migrant workers [Naidu et al., 2016], and occupations represented in job vacancy data [Azar et al., 2019]. Following the same empirical strategy, Rubens [2023] and Morlacco [2020] analyze the existence of monopsony power in intermediate input markets. The closest paper to ours in this literature is Prager and Schmitt [2021], who find evidence of reduced wage growth of hospital workers as a result of the increasing labor market power of employers following hospital mergers.

stream demand shocks and productivity shocks received by the buyer will have a direct impact on input prices (or wages), rendering those shocks invalid instruments.

[4] This is also supported by Huang [2022], who empirically documents how a dynamic monopsonistic cartel strategy in upstream markets affects downstream markets and reduces consumer welfare.

However, Prager and Schmitt find no evidence of employment suppression, and conclude that, at least in their setting, labor market power is more consistent with models of wage setting involving bargaining or search frictions.

This article also relates to the literature studying price discrimination in firm transactions. The closest papers to ours in this literature are Brugués [2023] and Ignatenko [2023]. To the best of our knowledge, these are the only two papers using data on firm-to-firm transaction prices that include information on the seller identity and the product being transacted, allowing to exploit variation across buyers of a given product. On the one hand, Brugués [2023], using information for 107 firms in Ecuador, documents the importance of long-term relations between buyers and sellers in shaping transaction prices. On the other hand, Ignatenko [2023] documents price discrimination in imports of Paraguayan firms. Following Katz (1987), she shows how larger importers have a more credible threat of vertically integrating and, as a result, obtain lower prices for the same input product. Other empirical papers that, without such rich information, study the patterns and implications of price discrimination in firm-to-firm trade include Cajal-Grossi et al. [2023], Dhyne et al. [2022], and Heise [2019]. Price discrimination in firm-to-consumers relations has been analyzed in Simonovska [2015], Gerardi and Shapiro [2009], and Attanasio and Pastorino [2020]. There is also an important literature implementing an structural empirical analysis of contracting in vertical markets, well summarized in Lee et al. [2021], and including papers such as Collard-Wexler et al. [2019], Ho and Lee [2019], and Grennan [2013]. These papers depart from considering theoretical models of contracting and bargaining that they take to the data to estimate structural models and obtain predictions of counterfactual policy choices. Finally, Stole [2007] and Armstrong [2006] provide excellent reviews of the theory of price discrimination in oligopoly.

The results in this paper have important implications for a number of fields. First, they are relevant to the literature studying the dynamics and determinants of firm market power in output markets (e.g., Berry et al. [1995], Gutiérrez and Philippon [2017], De Loecker et al. [2020] and Autor et al. [2020]).[5] Second, understanding the determinants of intermediate input prices and labor wages carries implications for a number of topics in Macroeconomics including the literature on buyer-supplier production networks (see Bernard and Moxnes [2018]), the propagation of shocks across firms (e.g., Carvalho et al. [2020], Acemoglu et al. [2012], Di Giovanni et al. [2014], Baqaee and Farhi [2018] and Baqaee and Farhi [2019]), the decreasing labor share in GDP (see Elsby et al. [2013] and Dorn et al. [2017]), and

[5] Furthermore, the existence of firm market power in input markets has implications for the correct estimation of firm markups (see Morlacco [2020]).

the transmission of monetary policy shocks Abbritti et al. [2021]. Last but not least, since differences in input prices can affect the allocation of production across firms, our paper is relevant for understanding resource misallocation (e.g., Baqaee and Farhi [2020] and Hsieh and Klenow [2009]).

The rest of the paper is structured as follows. Section 2 introduces the data. Section 3 lays out the empirical strategy, discussing challenges in identification, explaining shortcomings in previous work and detailing our solution. Section 4 presents the results, and Section 5 concludes.

2 DATA

This article uses novel administrative datasets from the Department of Finance of São Paulo (SEFAZ/SP) with anonymized information for firms in the textile sector.[6] The state of São Paulo is the most important of the 26 states in Brazil, producing about one third (34%) of the country's GDP and being home to over a fifth (22%) of its population.[7] Nationwide, the textile industry represented 2.5% of the GDP in 2015 and was responsible for almost 17% of total employment in the industrial sector, making Brazil the fifth largest textile producer worldwide with a market share of 2.7% (see Lucato et al. [2017] and De Oliveira Mendes Junior [2017]). Moreover, São Paulo stands out as the main driver of the economic relevance of the textile industry in Brazil, producing 37.4% of its gross value (see De Oliveira Mendes Junior [2017]).[8]

On the one hand, we use firm-to-firm transaction level data for every input acquired by firms in the textile sector from January 2011 to December 2017.[9] For each transaction we

[6]Other papers using data from SEFAZ/SP include Gerard et al. [2018], Gerard and Naritomi [2021] and Naritomi [2019] among others. However, none of these papers have information on transaction-specific prices as we do.

[7]Actually, the economy of São Paulo is the biggest in South America, and second to Mexico in Latin America.

[8]The textile industry primarily uses as inputs natural fibers (cotton, silk, wool, etc.), artificial filaments (viscose, acetate, etc.) derived from natural materials, and synthetic filaments (polyester, nylon, lycra, etc.) derived from petrochemicals. Its main tasks are spinning to make threads, weaving and knitting to produce fabrics and processing such as dyeing, stamping and laundry. Afterwards, it sells its output to the apparel industry (for a more detailed description of the textile industry see De Oliveira Mendes Junior [2017]). The whole process is depicted in Figure B.1. in Appendix B.

[9]Data on firm purchases and sales is collected electronically from invoices. One of the key advantages of the Brazilian electronic invoice data over other newly available datasets is that all firms must use electronic invoicing irrespectively of the tax regime they choose, reducing the usual concerns of misreporting. In addition, mechanisms to reduce tax evasion such as the "Nota Fiscal Paulista", introduced in 2008, increased

have information on the identities of the seller firm, buyer firm, product being transacted at the 8-digit code, and product characteristics.[10] Moreover, for each transaction, we have information on the measurement units of the product being transacted (kilos, meters, gallons, units, etc.) and the corresponding number of units (or quantities). We define a product as the triple of 8-digit product - measurement unit - product characteristics. With this information at hand, we are able to calculate unit values (that we will refer to as prices) for each transaction as the ratio between total transaction costs over number of units.[11] On the other hand, regarding labor, we use data coming from RAIS that contains monthly information on the number of employees and the wage bill at the firm level.[12] The data is disaggregated by occupation at the 2-digit code (99 occupations) and by level of education, which comprises 11 categories (ranging from high-school dropout to PhD). Importantly, this level of disaggregation will allow us to control for differences in quality and composition of the labor force.

Table 1 shows descriptive statistics on data aggregated at the quarterly frequency for the 3,535 firms in our sample. Since firms enter and exit our data, for each quarter we have on average information on 2,158 firms, each of them employing almost 44 workers on average, with a very skewed distribution. Firms buy on average 75 different input products per quarter from about 25 different suppliers. Again, the distribution of these variables is very skewed with some large firms buying a large number of products from a large number of providers. On average a firm buys inputs from six different 2-digit sectors, which implies a firm has more than one supplier per sector.

the quality of the data (see Naritomi [2019]). Moreover, the data is linked to administrative records containing the total number of employees and payroll.

[10] For each transaction we have two pieces of information. First, on the origin of the products. This refers to the degree of imported content in the products being transacted, ranging from 1 "fully domestic" to 7 "foreign". Second, on the characteristics of the transactions. This takes the values of "production", when the good was manufactured by the firm selling it, "commercialization", when the good is merely resold, and "others".

[11] Because qualities of the input products being sold by different sellers, even within our narrow definition of product, can differ (e.g., some firms sell high quality cotton and others sell low quality) we will conduct our analysis exploiting variation across buyers of a given seller-product-time.

[12] Relacao Anual de Informacoes Socials (RAIS) is administrative data from the Ministry of Labor and Employment (MTE) that covers about 97% of the Brazilian formal market.

Table 1: Descriptive statistics

	(1) Mean	(2) SD	(3) Median
Number of firm	2158	71.7	2190
Number of employees	43.5	121	11
Number of products bought	74.9	130.4	27
Number of providers	24.7	41.2	10
Number of 2-digit sectors	6.36	5.29	5

Note: Quarterly data for 3,535 firms in the textile sector in the State of São Paulo covering years 2011 to 2017.

3 EMPIRICAL STRATEGY

3.1 CHALLENGES IN IDENTIFICATION

Previous work has tried to infer the existence of market power of firms in input markets by identifying the residual supply curve that a firm faces when buying intermediate inputs (the same applies when hiring labor). Basically, this requires the estimation of a firm supply curve in which input prices are a function of demanded quantities and an error term. This is shown in Equation 1, where the subscripts b and t refer to buyer firm and time period, respectively. Identifying a positive supply curve, i.e. input prices are increasing in demanded quantities, is taken as evidence of the existence of market power for the buyer firm. That is, a firm facing an upward sloping supply curve has an incentive to reduce demanded quantities to lower input prices and increase profits. Intuitively, this resembles the case of a monopolist in output markets that reduces production to increase output prices and hence profits.

$$p_{bt} = \alpha \; + \beta q_{bt} + \epsilon_{bt} \tag{1}$$

However, directly identifying β in Equation 1 is problematic. The reason is that the error term contains unobserved variation across buyer firms in the determinants of the prices that they pay for their inputs. One fundamental driver of these differences in input prices is likely to be unobserved differences in the quality of inputs. Because quantities in equilibrium are a function of these unobserved input qualities, OLS estimates will suffer from endogeneity.

3.2 PREVIOUS WORK AND IDENTIFICATION THREATS

The literature has tried to solve this problem by using firm demand shocks in output markets to instrument input quantities. The validity of these instruments relies on the assumption that firm demand shocks in the market for outputs will only affect input prices through the increase they induce in input quantities. For example Goolsbee and Syverson [2023] instrument size of tenure and non-tenure track faculty in US universities with the number of student applications. They argue that the number of student applications should affect the decision of universities about how much faculty to hire but should not affect wages of faculty through any other channel. Kroft et al. [2023] instrument number of workers in construction firms with quasi-random variation in the assignment of procurement contracts. Again, a firm getting a procurement contract will need to hire more workers but this should not affect wages directly. Finally, Rubens [2023] instruments firm demand of intermediate inputs using firm productivity shocks. With the same logic as before, a positive productivity shock should only affect input prices through the increase it induces in input demand.

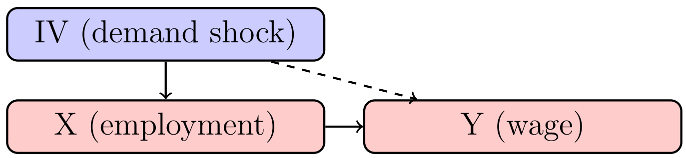
The main concern for the validity of demand sock instruments comes from the existence of bargaining, both between firms and workers, and firms and suppliers.[13] An abundant literature documents that firm shocks pass through to wages in labor markets. This implies that firms receiving positive shocks will share part of their good luck with workers.[14] Moreover, in the results section we will show how firm shocks also pass through to input prices in intermediate input markets. To understand how bargaining poses a threat to the exclusion restriction of standard instruments let's consider the already mentioned paper of Kroft et al. [2023]. In their framework, they use variation induced by the quasi-random assignment of procurement contracts to construction firms. When firms receive a procurement contract, they need to hire more workers in order to complete the works. For the instrument to be valid we need the demand shock (the assignment of a procurement contract) to affect wages only through the increase it induces in firm employment (see solid line in Figure 1), and not through any other channel. However, if construction firms share part of their good luck with workers, wining a procurement contract will also induce direct increases in workers'

[13] Appendix A presents another threat to the validity of demand shock instruments that can apply in many settings and has not been considered previously in the literature. We consider rent sharing to be a concern that applies more generally in all situations in which there is no posted prices and price bargaining exists in some extent. For this reason we present this as the main concern for the validity of demand shocks instruments for the identification of market power of firms in upstream markets.

[14] In words of Lamadon et al. [2022] "...idiosyncratic value added shocks to a firm transmit significantly to the earnings of its employees". For a literature review on how firm shocks pass through to wages see Card et al. [2018].

wages (see dashed line in Figure 1). This is actually happening in the context of Kroft et al. [2023], where they show how the assignment of a procurement contract induces an increase in the wages of incumbent workers.[15] This implies that the assignment of a procurement contract affects average firm wages directly, and not only through the increase in number of workers, which invalidates the exclusion restriction and generates positively biased elasticity estimates.

Figure 1: Identification strategy



To formalize the rent-sharing between both firms and workers, and firms and suppliers, we present a simple bargaining model that shows how input prices directly depend on buyer demand or productivity shocks, precluding the possibility of using these shocks as instruments of input quantities. In equation 2 we consider a Nash-bargaining problem between a seller firm, denoted by s, and a buyer firm, denoted by b, that negotiate the price (p_{sb}) at which they will trade. The first term in square brackets represents the profit of the seller from this match, which depends on the quantity transacted (M_{sb}), and the margin between the price and the marginal cost of production ($c_s(M_{sb})$). The second term represents the buyer profits from this match, given by the difference between the marginal revenue and the marginal cost of the relation. The marginal revenue (π_b) generically depends on all determinants of firm demand in output markets and all determinants of firm production costs. These include firm demand shocks in output markets (D_b), quality of the output (η_b), firm productivity (A_b), labor (L_b) and capital (K_b), amount of other intermediate inputs (M_b) and the quantity transacted in this relation (M_{sb}). The relative bargaining power of the seller in the relation is given by $\phi_{sb} \in (0, 1)$.

$$\max_{p_{sb}} \left[M_{sb}[p_{sb} - c_s(M_{sb})] \right]^{\phi_{sb}} \left[\pi_b(D_b, \eta_b, A_b, L_b, K_b, M_b, M_{sb}) - M_{sb}p_{sb} \right]^{1-\phi_{sb}} \tag{2}$$

The Nash-Bargaining solution of this problem shown in equation 3 implies that the negotiated price depends not only on the marginal cost of the seller, but also on the marginal

[15]See Table 1 in their paper.

profit of the buyer. In other words, all determinants of firm demand in output markets and firm production costs will directly affect prices. As a result, a positive demand shock to the buyer firm in output market or a positive productivity shock will pass through into higher input prices, generating rent-sharing between the seller and the buyer. Consequently, the validity of using firm demand or productivity shocks as instruments in estimating a supply function would be compromised. The same exact reasoning follows if we consider the negotiation of wages between firm and workers. Notice, moreover, that for this argument to pose a threat to the exclusion restriction of demand shock instruments we do not need input prices to be fully determined by a bargaining process between firms and suppliers, or firms and workers, but the existence of some rent-sharing between firms and sellers and firms and workers would invalidate its use.

$$p^*_{sb} = \phi_{sb}\frac{\pi_b(D_b, \eta_b, A_b, L_b, K_b, M_b, M_{sb})}{M_{sb}} + (1-\phi_{sb})c_s(M_{sb}) \tag{3}$$

3.3 PROPOSED SOLUTION

The arguments presented above preclude the strategy of using traditional demand instruments to estimate Equation 1. All shocks in output markets that affect input quantity demand by a firm (firm productivity shocks, firm demand shocks, shocks to competitors, market liberalizations, etc.) will in turn affect firm marginal profits from a relation with a supplier, and hence pass-through into input prices as explained in the previous section. The same applies when we think of a firm hiring labor. This prevents the option of estimating a residual supply curve with traditional instruments and requires an alternative approach.

In this paper we leverage the high quality of our data to circumvent endogeneity concerns in the estimation of a supply equation to identify the determinants of the prices that a firm pays for its inputs. We start by presenting our strategy for intermediate input markets. In this case, the high granularity of our data allows us to exploit variation across buyers whilst controlling for all factors affecting quality and costs of a product. Firstly, we exploit variation across different buyers of an specific product. Consider Equation 4 where the price of input product k, sold by seller s, to buyer b, in time period t, is a function of quantities. By introducing product-seller-time fixed effects (λ_{kst}), we exploit differences in the quantities demanded by different buyers of an specific product. This way, we are able to estimate the impact of demanded quantities on prices, whilst controlling for all product unobserved characteristics. Usual datasets do not have information on transaction prices and identifiers of the specific product being transacted, precluding this estimation strategy.

$$p_{ksbt} = \alpha + \beta q_{ksbt} + \lambda_{kst} + \epsilon_{ksbt} \tag{4}$$

However, this demanding specification may still not account for some identification concerns, as it is possible that serving some customers is costlier than serving others. For example it seems reasonable to believe that serving customers located far away is more expensive than serving customers located very close to the seller firm, and this should affect prices. To address this concern, we exploit variation for a given buyer of a seller-product over time by introducing product-seller-buyer fixed effects (γ_{ksb}) to Equation 4, which delivers Equation 5

$$p_{ksbt} = \alpha + \beta q_{ksbt} + \lambda_{kst} + \gamma_{ksb} + \epsilon_{ksbt} \tag{5}$$

In addition, Equation 5 may still suffer problems of endogeneity since buyers can receive time-specific shocks. For instance, if a firm is located in a region where a natural disaster just occured, we can expect the costs of selling to this firm to increase and pass-through to prices. To address this concern we add buyer-time fixed effects (δ_{bt}) to Equation 5, resulting in Equation 6, which is going to be our baseline specification.

$$p_{ksbt} = \alpha + \beta q_{ksbt} + \lambda_{kst} + \gamma_{ksb} + \delta_{bt} + \epsilon_{ksbt} \tag{6}$$

This very refined specification controls for all plausible systematic factors that could affect the cost that a firm bears when serving a client.[16] Additionally, we conduct a number of robustness tests that support the use of this specification as our baseline. We will also use this model to study how buyer input reliance and buyer demand shocks affect input prices by including extra variables in the baseline specification.

Our strategy for estimating the residual labor supply that a firm faces when hiring workers follows a similar approach. Exploiting our high quality data we try to control for all unobserved factors affecting wages such us the composition of the labor force. Thus, we use Equation 7 as our baseline specification where w_{kft} is the wage paid by firm f to workers in an occupation-education category k in time period t. First, wage depends on the number

[16]The existence of some types of non-systematic factors affecting prices could pose a problem to our identification strategy. For instance, if supplier firms decide to randomly alternate high and low prices for the same product across different buyers over time our estimates would be compromised. We consider the existence of this type of threats unlikely.

of workers in this firm by occupation-education category by time (n_{kft}). Because workers of different occupation-education categories can be expected to receive different wages we can control for occupation-education category by time fixed-effects (λ_{kt}), and study variation across firms for a given occupation-education category and period.

Moreover, there can be differences in wages across firms, for instance, due to differences in the availability of workers of different skills or characteristics across municipalities. To control for this we include occupation-education category by firm fixed effects (γ_{kf}).

Finally, we control for firm by time fixed effects (δ_{ft}). This way, we exploit variation across different education-occupation categories within a firm, whilst controlling for aggregate changes at the firm level. For example, this would account for the case that firms pay a wage premium as they grow. Hence, our baseline specification takes the following form:

$$w_{kft} = \alpha + \beta n_{kft} + \lambda_{kt} + \gamma_{kf} + \delta_{ft} + \epsilon_{kft} \tag{7}$$

4 RESULTS

4.1 INTERMEDIATE INPUT MARKETS

In order to circumvent endogeneity concerns in the analysis of the determinants of the prices that firms pay for their inputs we exploit variation across buyers of a given seller-product. Therefore, the first step is to check whether there exists variation across buyers of a given seller-product-quarter. In Table 2 we show that the coefficient of variation across buyers of a given seller-product-quarter is on average 0.334, which provides evidence that different buyers pay substantially different prices for the same product from the same supplier.

Table 2: Variation in prices

	(1) **Mean**	**(2)** **SD**	**(3)** **Median**
Coefficient of variation across buyers of a firm product in a quarter	0.334	0.413	0.166

Note: Information on 1,104,483 product-quarter observations corresponding to all purchases of intermediate inputs by firms in the textile sector from 2011 to 2017.

After documenting the existence of price variation across buyers, we proceed to study its determinants. To do so, following Equation 6, we regress the log of transaction price on the log of quantity. In the first column (Basic I) of Table 3 we control for seller-product-quarter fixed effects and find that an increase in quantities of 100% is associated to decreases in prices of almost 17%. Further controlling for seller-product-buyer fixed effects (Basic II) estimates go up to 26%. Finally, after adding buyer-quarter fixed effects (Baseline) the estimated reduction on prices remains unchanged at 26%.

To test the robustness of this result, in subsequent columns we show estimated effects under variations of the baseline specification. Firstly, in Column 4, instead of controlling for buyer-quarter fixed effects we control for buyer-product(2-digit)-quarter fixed effects. Doing this we exploit variation across the different providers of a buyer firm of products at the 2-digit code. Secondly, Column 5 replicates the baseline specification in Column 3 but using controls at the monthly level instead of quarterly level. A potential concern is that the seller-product-buyer fixed-effect remains constant over the sample period, generating problems if, for instance, the conditions of a contract between a buyer and a seller change over time. To address this issue, thirdly, in Column 6 we limit our sample period to year 2015, as in this reduced time span contract characteristics are less likely to change. Once again, results are robust to this alternative specification. Additionally, factors such as taxes involved in a transaction can also affect prices. To address this concern, fourthly, in Column 7 we control non-parametrically for VAT taxes paid in each transaction, and find how this does not affect the results.[17] Moreover, in previous work, Brugués [2023] finds how the duration of a business relation between a buyer and a supplier affects transaction prices. Therefore, fifthly, controlling again non-parametrically for this results remain unchanged.[18]

These results imply the existence of quantity discounts such that firms face a decreasing supply curve when buying intermediate inputs. However, it is possible that the estimated negative effect of quantities on prices is explained by the presence of fixed costs at the transaction level. In this case, an increase in quantities would lead to a decrease in the fixed-cost per unit, making prices decreasing in quantities. Moreover, the presence of transaction-specific fixed-costs would imply that the estimated quantity discounts should be decreasing in quantities. To reject this hypothesis, lastly, in Column 9, we introduce as a regressor log-quantity squared and actually find the opposite, i.e. quantity discounts are increasing in

[17] We control for VAT tax rate (ICMS rate) that applies to each transaction linearly and quadratically.

[18] For each triple buyer-seller-product we obtain the quarterly date at which the first transaction took place, creating the variable first-date. We control for the impact of first-date considering its effects are heterogeneous for each quarter in our sample. This implies that for the transactions taking place in every quarter we are flexibly controlling for the impact of the business duration.

quantities. This is at odds with the potential existence of fixed costs being the main driver of our results.

Table 3: Effect of quantities on prices

Dependent variable: Log of transaction price

	(1) Basic I	(2) Basic II	(3) Baseline	(4) Extra Controls	(5) Monthly Controls	(6) Year 2015	(7) Control for Taxes	(8) Control for Duration	(9) Quantity Squared
Log quantity	-0.168***	-0.264***	-0.262***	-0.305***	-0.278***	-0.272***	-0.269***	-0.269***	-0.244***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Log quantity squared									-0.00280***
									(0.0000)
Observations	6,835,226	6,835,226	6,835,226	6,835,226	6,835,226	944,509	6,835,226	6,835,226	6,835,226
Seller-product-date FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Seller-Product-Buyer FE		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Buyer-date FE			Yes		Yes	Yes	Yes	Yes	Yes
Buyer-product2d-date FE				Yes					
Controls for taxes							Yes		
Controls for relation duration								Yes	

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

We are also interested in analyzing other factors that can potentially affect intermediate input prices. First, we consider the effect that differences in buyers' bargaining power have on transaction prices. Intuitively, firms with more suppliers have more bargaining power as a result of relying less intensively on each seller and inducing more competition among them. To study how relying less intensively on the input product provided by a supplier allows the buyer firms to negotiate lower prices, we introduce in our baseline specification the share that a given product that the buyer is purchasing from a seller represents in its total amount of inputs. This is characterized by the following equation:

$$p_{ksbt} = \alpha + \beta q_{ksbt} + \pi Input\ reliance_{ksbt} + \lambda_{kst} + \gamma_{ksb} + \delta_{bt} + \epsilon_{ksbt} \tag{8}$$

The regression in the first column of Table 4 includes as a regressor the log of the share that the transacted product represents in total quarterly inputs. To calculate this, we sum the value of every transaction in which buyer and seller exchange the same product during a quarter, and divide this by total value of inputs acquired by the buyer in that quarter.

We find this has a positive impact on transaction prices, which suggests that the lower the reliance on a given seller-product, the lower the negotiated price. In Columns 2 to 4 we use alternative measures of input reliance. In Column 2 we introduce as a regressor the share that the transacted product represents in the total amount of inputs that the firm is purchasing from the (2-digit) sector of the seller firm in a quarter. In Column 3 we use the share that the transacted product represents in the total inputs that the firm is purchasing of the corresponding 2-digit product in a quarter. Finally, in Column 4 we define instead product groups at the 8-digit level, which is the highest level of disaggregation in our data. The results confirm the positive impact of input reliance on negotiated prices.[19][20]

To conclude our analysis for intermediate input markets we want to check whether a firm pays higher prices to its suppliers after receiving a positive demand or productivity shock. This would be consistent with the existence of rent-sharing in buyer-seller relations, similar to what previous literature has documented for firm-worker relations. Moreover, finding evidence of rent-sharing in intermediate input markets would invalidate the use of demand and productivity shocks as instrumental variables in supply function estimation. To test the pass-through of buyer shocks to intermediate input prices we consider a specification which includes buyer-quarter demand shocks in output markets or productivity shocks received by the seller and controls for transaction quantities, input reliance, seller-product-quarter fixed-effects and seller-product-buyer fixed-effects.[21]

$$p_{ksbt} = \alpha + \mu \ Shock_{bt} + f(q_{ksbt}, Input\ reliance_{ksbt}) + \lambda_{kst} + \gamma_{ksb} + \epsilon_{ksbt} \tag{9}$$

We construct residual demand shocks in two ways. First, we calculate, for each firm, the value of total sales at the 4-digit product-quarterly level and then retrieve the residual from regressing the log of this variable on product and quarter fixed-effects. Column 1 shows a positive correlation between this demand shock and transaction prices, which is

[19] The decrease in the estimates as we use a more narrow product group in the denominator could be explained by the varying importance that different input products have in the production process. It seems reasonable to believe that an increase in input reliance in non fundamental input suppliers (e.g. office supplies for a textile firm) will not have a big repercussion in the bargaining position of the firm and on negotiated prices. By contrast, an increase in input reliance of fundamental suppliers (e.g. those representing a large share of total inputs such as thread for a textile firm) will have a much larger impact on negotiated prices. This could explain the observed decrease in the estimates.

[20] We find that large firms benefit more from quantity discounts (they buy larger quantities per transaction) and also rely less intensively on their suppliers as a result of having a larger number of them. Results available upon request.

[21] Notice that since our measure of shocks is at the buyer-quarter level we cannot include buyer-quarter fixed effects as in the baseline specification.

Table 4: Effect of input reliance on prices

Dependent variable: Log of transaction price

	(1) Total	(2) Sector	(3) 2-digit Product	(4) 8-digit Product
Log quantity	-0.367***	-0.333***	-0.315***	-0.282***
	(0.00)	(0.00)	(0.00)	(0.00)
Log share in total inputs	0.361***			
	(0.00)			
Log share in sector inputs		0.259***		
		(0.00)		
Log share in 2-digit product			0.205***	
			(0.00)	
Log share in product				0.155***
				(0.00)
Observations	6,835,226	6,835,226	6,835,226	6,835,226
Seller-product-date FE	Yes	Yes	Yes	Yes
Seller-product-buyer FE	Yes	Yes	Yes	Yes
Buyer-date FE	Yes	Yes	Yes	Yes

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

consistent with rent-sharing between a firm and its suppliers. Second, we alternatively construct firm demand shocks using the Arellano-Bond estimator controlling for quarter fixed-effects.[22] Once again results are consistent (see column 2). We also construct supply shocks in two different ways by estimating firm production functions and obtaining estimates of firm productivity. First, we obtain firm employment productivity at the quarterly level by dividing firm quarterly revenues on total number of workers in each quarter. Column 3 shows a positive correlation between this supply shock and transaction prices, indicating the presence of rent-sharing. Second, we alternatively construct firm productivity using Ackerberg-Caves-Frazer estimation strategy.[23] Once again results are consistent (see column 4).

These results confirm the existence of rent-sharing in buyer-seller relations. Consequently, demand and productivity shocks are not valid instruments in supply estimation

[22] See Arellano and Bond [1991].
[23] See Ackerberg et al. [2015].

since they have a direct impact on prices violating the exclusion restriction.

Table 5: Effect of buyer shocks on prices

Dependent variable: Log of transaction price

	(1)	(2)	(3)	(4)
Demand shock I	0.0336***			
	(0.001)			
Demand shock II		0.0105***		
		(0.001)		
Employment productivity			0.0382***	
			(0.001)	
TFP productivity				0.0410***
				(0.001)
Observations	6,835,226	6,835,226	6,835,226	4,328,184
Seller-product-date FE	Yes	Yes	Yes	Yes
Seller-product-buyer FE	Yes	Yes	Yes	Yes
Buyer-date FE				

Note: All regressions control for log of quantity, log share in total inputs, log share in sector inputs, log share in 2-digit product, and log share in product. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

4.2 LABOR MARKETS

In labor markets we also find substantial variation across firms in the wages they pay to workers of a given occupation-education category. That is, firms wage-discriminate workers that perform the same job in the firm and have the same level of education. Table 6 shows that the coefficient of variation across firms of a given occupation-education category in a quarter is 0.51.

We analyze how the impact on wages in an occupation-education category for a given firm and quarter depends on the number of workers on that occupation-education category in that firm and quarter. However, in our baseline regression we include several fixed effects. For example, because workers of different occupation-education categories should receive different wages we can control for occupation-education category and quarter fixed effects and study variation across firms. Moreover, it can be that a firm has to pay higher wages

Table 6: Variation in wages

	(1) Mean	(2) SD	(3) Median
Coefficient of variation across firms in the wages paid to workers of a given occupation and education category	0.512	0.235	0.487

Note: Information on 7,416 2-digit category-quarter observations.

because, for instance, it operates in a more competitive market or its located in a very secluded region. To control for this we include occupation-education category and firm fixed effects. And finally we can control for firm and quarter fixed effects. Hence, our baseline specification takes the following form:

$$w_{kft} = \alpha + \beta n_{kft} + \lambda_{kt} + \gamma_{kf} + \delta_{ft} + \epsilon_{kft} \tag{10}$$

Our estimates for the impact of the log of employment on the log of wages are displayed in Table 7. In the first column, just studying variation across firms, only including position-education-quarter fixed effects, we find a positive impact of employment on wages, statistically significant but quantitatively small. Previous literature has typically found elasticities around 4%, which is about 100 times larger than our result. In the second column we further control for firm-position-education-quarter fixed effects and study variation over time and our already-low estimates are further reduced by 75%. In our baseline specification, when we include firm-quarter fixed effects the estimate actually turns negative, but again very small in magnitude. This is not like the downward-slope supply curve that we found for intermediate input markets but clearly contrasts the results documented so far in the literature. Our results are maintained if instead of quarterly controls we include monthly controls.

Once again, we are interested in analyzing how shocks to the firms impact the wages they pay to their workers to see if there is evidence of rent-sharing. This is not only interesting in its own right but also because it would cast doubt on the identification strategies followed in the literature that finds monopsony power of firms in labor markets. To study this, we regress log wages at the worker-category and firm level on a firm shock whilst controlling for number of workers, category-quarter foxed-effects, category-firm fixed-effects and firm-date

Table 7: **Effect of Employment Levels on Wages**

Dependent variable: Log of wages

	(1) Basic I	(2) Basic II	(3) Baseline	(4) Monthly controls
Log employment	0.0488***	0.0126***	-0.0180***	-0.0210***
	(0.000491)	(0.000842)	(0.000841)	(0.000864)
Observations	1,988,354	1,988,354	1,988,354	1,988,354
Position-education-date FE	Yes	Yes	Yes	Yes
Firm-position-education FE		Yes	Yes	Yes
Firm-date FE			Yes	Yes

Note: *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$.

fixed-effects. This is characterized by the following equation:

$$w_{kft} = \alpha + \mu \ Shock_{ft} + \beta^s n_{kft} + \lambda_{kt} + \gamma_{kf} + \delta_{ft} + \epsilon^s_{kft} \quad (11)$$

Analogously to the case of the intermediate product market, we use the same demand and supply shocks. Results are displayed in Table 8, showing a positive impact of firm demand and productivity shocks on wages.

5 CONCLUSIONS

In this paper we contribute to understanding the nature of firm market power in input markets by studying the determinants of the prices that firms pay for intermediate inputs and labor. To do so, we use administrative data for firms in the textile sector in São Paulo, Brazil, which includes information on transaction-specific prices for every purchase of intermediate inputs as well as firm employment levels and wages for different occupation-education categories. The fine granularity of the data allows us to circunvent usual problems in this type of frameworks and provide clear-cut stylized facts about the determinants of the prices that firms pay for their inputs.

For intermediate inputs, we exploit variation across different buyers of a given product and over time. This sheds light on some of the factors explaining why some firms pay lower

Table 8: Effect of Buyer Shocks on Wages

Dependent variable: Log of wages

	(1)	(2)	(3)	(4)
Log employment	0.00811***	0.00802***	0.00493***	0.00872***
	(0.000839)	(0.000838)	(0.000839)	(0.00110)
Demand shock I	0.00880***			
	(0.00124)			
Demand shock II		0.0105***		
		(0.000449)		
Employment productivity			0.00945***	
			(0.000517)	
TFP productivity				0.0194***
				(0.000692)
Observations	1,988,354	1,988,354	1,988,354	1,268,643
Position-education-date FE	Yes	Yes	Yes	Yes
Firm-position-education FE	Yes	Yes	Yes	Yes
Firm-date FE				

Note: $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

prices than others for the same input product. First, we find firms buying higher quantities enjoy lower prices as a result of quantity discounts. Second, buyers relying less intensively on a given supplier pay lower prices. And third, buyers pay higher prices for the same input after receiving a positive demand or productivity shock. For labor, we do not find evidence of firms needing to pay higher wages to hire more workers. Moreover, we show that firms increase wages after receiving a positive shock. We further provide a detailed explanation about why finding evidence of pass-through of shocks from buying firms to input prices, and from hiring firms to wages, compromises the usual empirical strategy of using demand shocks as instruments in supply function estimation. If firms receiving a demand shock not only demand higher quantities of inputs and hire more labor but also share part of their good luck with suppliers and workers by increasing prices and wages, the exclusion restriction of usual instrumental variables would be seriously compromised and so would be the conclusions of research conducted using this type of identification strategy.

These results show how the nature of firm market power in input markets requires a more thorough analysis to understand its determinants and implications. Fortunately, the increasing availability of datasets as the one employed in this paper facilitates this endeavor. This should allow researchers to look at old questions such as monopsony power with new eyes, constructing theories based on solid empirical evidence. This research agenda would include de following steps. First, finding clear-cut empirical evidence about the determinants of input prices. Second, building solid theories and well-identified models accounting for the discovered stylized facts. And third, studying the implications of firm market power in input markets for downstream competition, unifying upstream and downstream market power in a single framework.

Appendix A

Another reason why traditional instrumental variable identificacion strategies may present indentificacion problems is based on the stylized fact that firms producing high quality outputs employ high quality inputs (see Atkin et al. [2017], De Loecker et al. [2016], and Kugler and Verhoogen [2012]). Consider the case of a firm that at some point gets access to higher quality inputs for its production process, coming these at a higher price. This will increase the quality of outputs and consumer demand. However, the econometrician will just observe the increase in output demand, together with an increase in input demand and input prices, while input and output quality remain unobserved. This can lead him to wrongly conclude that the increase in product demand generated an increase in input demand that in turn increased input prices, providing evidence of an upward sloping supply curve.

To be more specific about this first concern, consider Equation 12 representing the downstream demand function for the products that firm b produces (q_{bt}^{d}), which depends on the product price (p_{bt}^{d}) as well as on unobserved demand shocks (ϵ_{bt}^{d}). These demand shocks depend on the unobserved quality (η_{bt}^{d}) of the products of firm b. At the same time, the price that firm b pays for its inputs is captured by the upstream supply function in Equation 13, and depends on the quantity of inputs (q_{bt}^{u}) and an unobserved supply shock (ϵ_{bt}^{u}). Again, this supply shock depends on the unobserved quality of inputs (η_{bt}^{u}). If, as previously argued, input quality and output quality are correlated, the strategy to instrument input quantities with demand shocks is compromised because the exclusion restriction of the instrument is invalidated.[24] Many works could be subject to this criticism. For instance, in the aforementioned paper of Goolsbee and Syverson [2023], size of tenure and non-tenure track faculty in US universities is instrumented with the number of student applications. The following argument could pose a threat to their identification strategy. If a university exogenously increases the quality of its faculty (e.g. by hiring a Nobel Laureate), this will, on the one hand, increase the average faculty wage (because higher quality faculty earns higher wages), and, on the other hand, increase student applications (because student demand will react to the increase in quality of the University). Estimating a supply equation using as an instrument for faculty size the number of student applications would deliver positively biased elasticity estimates, wrongly leading to conclude the existence of market power in the form of an increasing supply curve. The unobserved quality of inputs (faculty in this case) generates an increase in input prices and an increase in output demand. But, obviously, the

[24] See Bastos et al. [2018] for a paper providing evidence of the correlation betwen input and output product quality.

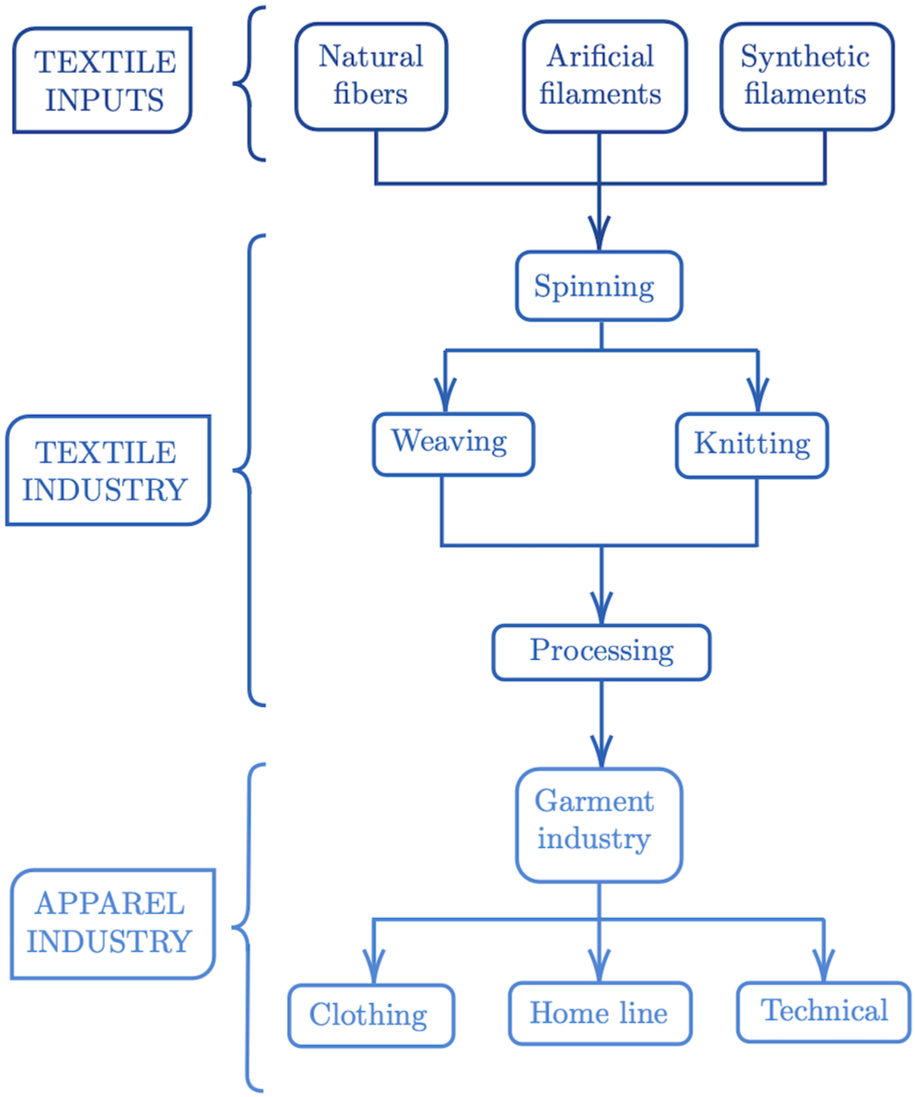
increase in demand is not a good instrument for the effect of faculty size on wages in this case.

$$q^d_{bt} = \alpha^d + \beta^d p^d_{bt} + \underbrace{f(\eta^d_{bt}) + u^d_{bt}}_{=\epsilon^d_{bt}} \tag{12}$$

$$p^u_{bt} = \alpha^u + \beta^u q^u_{bt} + \underbrace{h(\eta^u_{bt}) + u^u_{bt}}_{=\epsilon^u_{bt}} \tag{13}$$

Appendix B

Figure 2: Textile industry chain production flow



Source: Adapted from De Oliveira Mendes Junior [2017].

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