The Effects of Minimum Wage Increases on Labor Demand Growth.

A Case Study of the Colombian Manufacturing

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Abstract

This work discusses the effects of the minimum wage on Colombian Manufacturing labor using the estimation of conditional and unconditional labor demand models, as well as the panel structure of the Colombian Annual Manufacturing Survey (AMS). Findings show significant long term minimum wage elasticities in labor demand: 0.638, -0.774, and -0.6 for skilled, unskilled, and total workers, respectively; meaning that minimum wage pressures the substitution of unskilled for skilled workers. The substitution effect, however, is not enough to prevent a negative reaction on aggregate labor demand due to the predominantly unskilled composition of the manufacturing workforce. The minimum wage negative effect on labor demand is especially sizable for unskilled temporary workers. The largest employment generating sectors are more sensitive to minimum wage and own price variations revealing the presence of heterogeneity within the manufacturing. Additionally, a positive TFP elasticity of labor demand is found in the unconditional labor demand model but it is not statistically significant implying the link between TFP and labor demand could potentially be affected by the increased prevalence of temporary contracts among workers.

Key words: labor demand, skilled workers, unskilled workers, regional disparities, sector disparities.
JEL classification: *J*23, *23*.

1. Introduction

In 2008 in Colombia a former Minister of Finance at the moment stated: "the minimum wage in Colombia is a joke, ridiculously high, and must be reduced". Ten years later the nominal minimum wage has increased nearly 60% and inflation has not kept up with it, resulting in a 20% increase in the real minimum wage, in fact since 2000 it has grown 52%. In an orthodox setting the nominal variations should be engulfed by inflation but in Colombia the rampant informality prevents the minimum wage to hold a stronger grip on inflation. Instead the formal labor demand has been facing the unwanted effects of the increases of the minimum wage. I use data of the Colombian *Annual Manufacturing Survey* (AMS) to portrait the effects that that sustained increase of the real minimum wage can have on labor demand behavior.

The AMS data I use is an establishment panel that allows the measurement the total number of workers enrolled and their corresponding average wages for each skill and contract modality. This panel data structure allows to control for firms' unobservable heterogeneity that could simultaneously affect the labor demand, wages and output (Roberts and Skoufias, 1997). The work of Blundell and Bond (1998) provides a generalized method of moments estimator for the empirical model, using as instruments for the demand equation the lagged levels and lagged difference of endogenous variables. This empirical model captures the dynamics of labor adjustment cots allowing to estimate short and long run elasticities. The empirical model is further complemented with the Windmeijer (2005) correction that addresses possible downward bias of the determinant parameters. Therefore, the AMS data allows to estimate unbiased determinants of labor demand that consider the endogenous relation the later has with wages and output.

I estimate conditional and unconditional labor demand models first grouping workers all together and then separate them by skills and type of contracts allowing a thorough examination of the effects labor demand determinants have on the composition of labor demand. Specifically, output has a greater effect on skilled than unskilled workers and is the main engine of labor demand growth, while the TFP growth only exerts a positive influence on unskilled workers in the long run. On the other hand, minimum wage variations manage to affect the composition of labor demand in both skills and contract modalities playing a key role on the evolution of the composition of manufacturing workforce.

In the case of Colombian Manufacturing the minimum wage increases over the last decade substantially slowed down the growth of employment. The real minimum wage long run elasticity estimated was -0.6 for the whole workforce in a conditional demand model. The skilled and unskilled elasticities estimated are 0.648 and -0.774 respectively suggesting a substitution effect toward skilled labor. The substitution effect is also present for contract modalities were unskilled temporary labor is affected negatively by minimum wage while unskilled permanent workers long run elasticity is positive. I argue that permanent contracts can facilitate the increase of workload for workers more than temporary contracts, and help compensating or the artificial increase of wage. Another possibility is that having permanent contracts favor positive TFP dynamics overtime and establishments use this to make up for the increase in labor costs.

These elasticities fit adequately with the behavior of manufacturing labor composition in regard of skills and contract modality. In the manufacturing workforce, the prevalence of permanent contracts in the manufacturing fell 20 pp in the period of 2000 to 2006. However, this tendency reverted when the real minimum wage reached the average wage of unskilled workers. From that moment the participation of permanent contracts among unskilled workers recovered, increasing 10 pp. A substitution effect as that implied by the long run minimum wage elasticities can explain why and when the falling prevalence of permanent contracts among unskilled workers reverted.

In addition to the former results, I discuss sectoral heterogeneity of labor demand determinants by introducing the interaction of determinants with a dummy equal to one for establishments in the largest sectors regarding employment. This makes possible to estimate parameters of heterogeneity directly instead of comparing the parameters of separated labor demand models. I find that the six largest sectors in the Colombian manufacturing are more sensitive to price variations, i.e. own price and minimum wage variations, while is less responsive to output variations. This means the largest employment generators receive a greater impact from minimum wage amplifying the effect of the former.

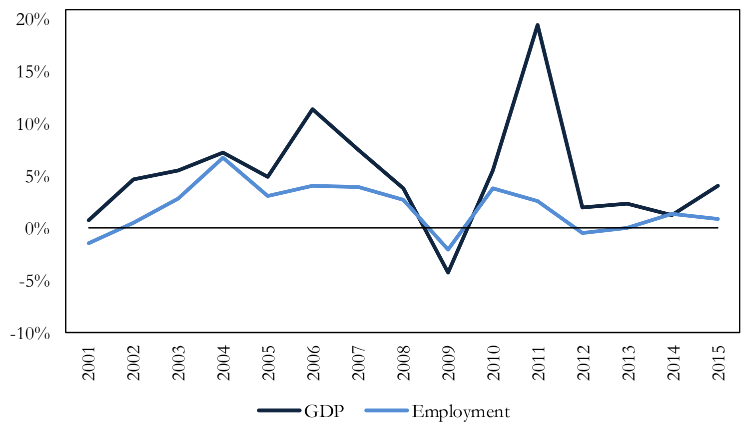
The rest of the document is developed in 6 sections after this introduction. Section 2 is a brief description of the role of minimum wage in the manufacturing and its relationship with wages across skills and contract modalities. The section after presents the existing literature on labor demand, specifically in Colombia and the empirical methods available for the estimation of the demand models. Section 4 summarizes the theoretical and empirical model and discusses the identification of the parameters. Section 5 discusses the results of the estimated models and their most likely implications. The heterogeneity of labor demand determinants across manufacturing sectors is presented in section 6. And finally, section 7 presents the conclusions of this work and possible paths to follow in labor research, specifically in regard of the relationship of productivity and labor.

2. Minimum wage in the Colombian Manufacturing

Since 2001 until 2018 the Colombian manufacturing sector participation in the economy's total employment has ranged from 11 to 14.5%, making it throughout the whole period the forth sector in employment. In 2018 it contributed with 12.3% of the jobs, placed behind trade (26.7%), services (20%) and agriculture (16%)[1]. According to the *Great Integrated Household Survey* (GIHS) in 2015 this share corresponded to 2.7 million jobs, of which 697,011 were formal jobs registered by 8,945 establishments in the AMS. The Figure 1 shows the behavior of GDP and employment growth rates during the period and suggests that GDP has been the main engine of employment growth. To reinforce the argument, the estimated long run output elasticities in Arango, Castellani and Obando, (2016) are 1.12 and 1.05 for skilled and unskilled workers respectively, both larger than own price elasticities of -0.59 and -0.42.

Figure 1. Employment and GDP annual growth rates

[1] See, Great Integrated Household Survey, June Annex (2018).



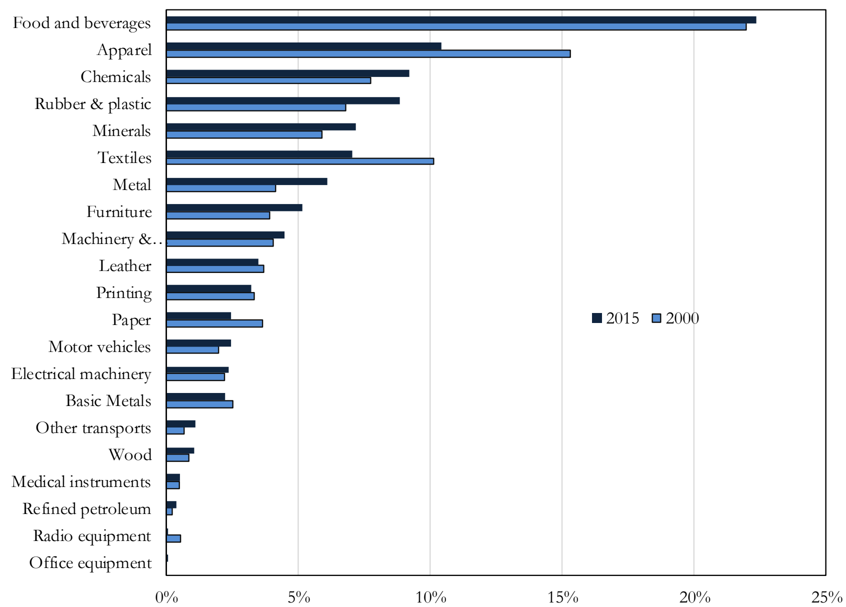
Source: DANE-EAM. Author calculations

From 2000 to 2015 the EAM reports the average annual growth rate of manufacturing employment was 1.9%, less than half of the GDP growth. During that time added value and GDP's average annual growth rates were 5.1% and 3.9% respectively. A possible reason for this to happen would be the sustained growth of production in a sector that is not intense in the use of labor, however this does not seem to be the case. Figure 2 shows the percentual contributions of each subsector to employment and added value generation to test whether sector not intense in labor is at fault for the discrepancy between added value and employment growth rates. In 2000 food and beverages, apparel, chemicals, rubber and plastic, minerals and textiles were the six largest sectors in employment concentrating 68% of the jobs and have remained the top employment generators since then. Out of them, five are also among the top 6 added value producers where refined petroleum takes away one of the spots, displacing apparel in 2000 and textiles in 2015.

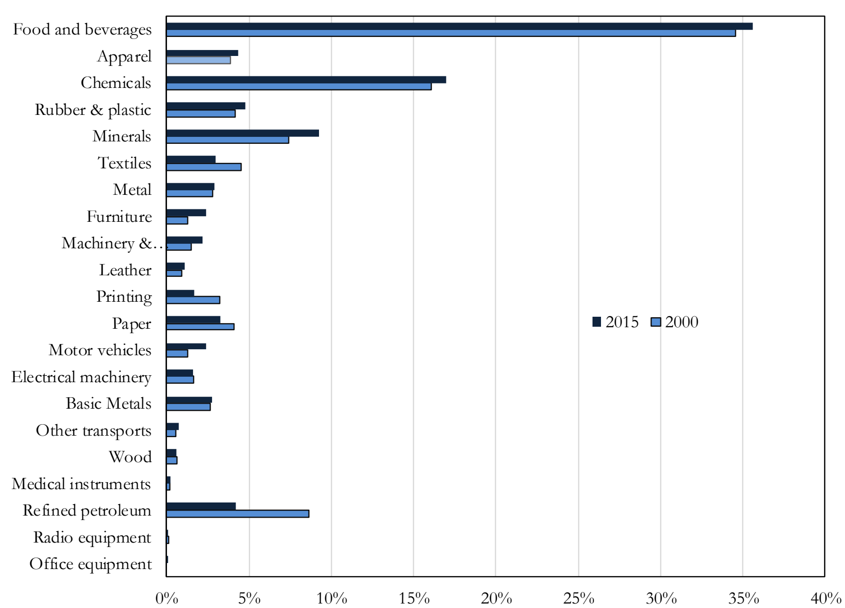
The participations shown in figure 2 rule out the possibility that sectors not intensive in labor were responsible for manufacturing employment growing below the potential implied in previous works. With the exception of textiles, the largest sectors in employment increased their participations on the manufacturing's added value, while refined petroleum went from a participation of 8.6 in 2000 to 4.2% in 2015. The remaining suspect for the slow manufacturing employment growth is wage, specially the minimum wage because it remains rigid despite its effects on employment levels.

Figure 2. Employment and added value generation by sector 2000-2015

2.1 Employment



2.2 Added Value

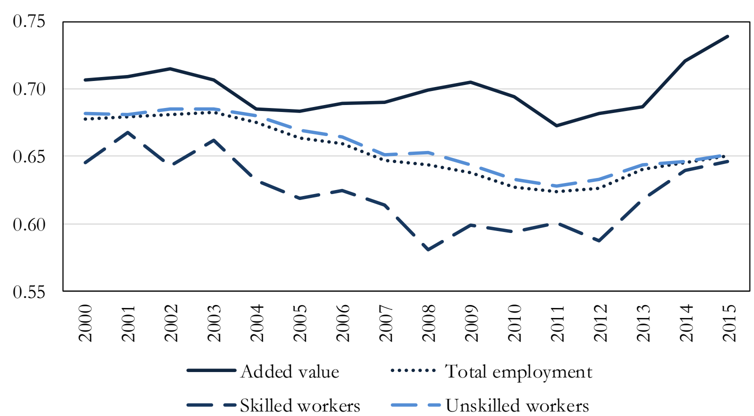


Source: DANE-EAM. Author calculations.

An examination within the industry revealed that the link between aggregated output and labor demand appears to be more relevant for skilled than for unskilled labor segments. The figure 3 shows the behavior of the six largest sectors participation in added value and in employment, both skilled and unskilled during that period of time. The participation of the largest six in skilled labor seems to be related to fluctuations in added value participation. After 2011 the participation of the largest six in added value grew 6 percentual points (pp) and along with it the participation in skilled labor grew 5 pp, instead participation in unskilled labor went up only 2 pp. However, this behavior is counterintuitive since unskilled labor is supposed to be more closely related to production, in fact, unskilled labor has a larger output elasticity than the skilled segment of labor (Arango et al. 2016).

Output is not the sole determinant of labor demand, wages determinate labor demand as well and a sustained shock can counter the effect of output expansion. A shock boosting wages, especially in unskilled segment of labor demand could explain why the skilled workers segment appears to be more closely related to output then the unskilled. The effects of minimum wage shocks are more likely to be concentrated on the unskilled segment, but the former could only affect labor demand if it were binding for a big enough portion of the unskilled workers. The data in the EAM does not provide a straightforward answer in this sense, since wages are obtained through dividing the annual payroll in real terms by the number of workers reported for each establishment. Yet, both the payrolls and number of workers reported by the establishments are discriminated by skill and type of contract and thus, it is actually possible to know and see the effect of minimum wage on the average wages of skilled and unskilled workers.

Figure 3. Added value and employment fluctuations within the industry.



Source: DANE-EAM. Author calculations.

From 2000 to 2015 averages wages for each skill were affected by the decreasing prevalence of permanent contracts, for skilled workers it went from 84 to 71%. Figure 4 displays the participation of both skilled workers and permanent contracts in Colombian industry by subsectors. It also presents the evolution of permanent contracts participation by skilled for the six largest subsectors and the rest of them. In the first two graphs the vertical axis are presentes the participations in 2000 and the horizontal axis the participations in 2015, where the pale line in both figures is a 45-degree line on which participations are the same in 2000 and 2015, below it the participation increased and vice versa. Figure 4 reveals that the share of skilled labor in the workforce has increased in almost all of the subsectors, where refined petroleum, medical instruments and chemicals had the largest changes. At the same time the prevalence of permanent contracts has decreased especially in textiles, leather, medical instruments and other type. The result is a manufacturing workforce with a larger participation of skilled workers and larger prevalence of temporary contracts.

Figure 4. Skill and contract modality distribution by subsector

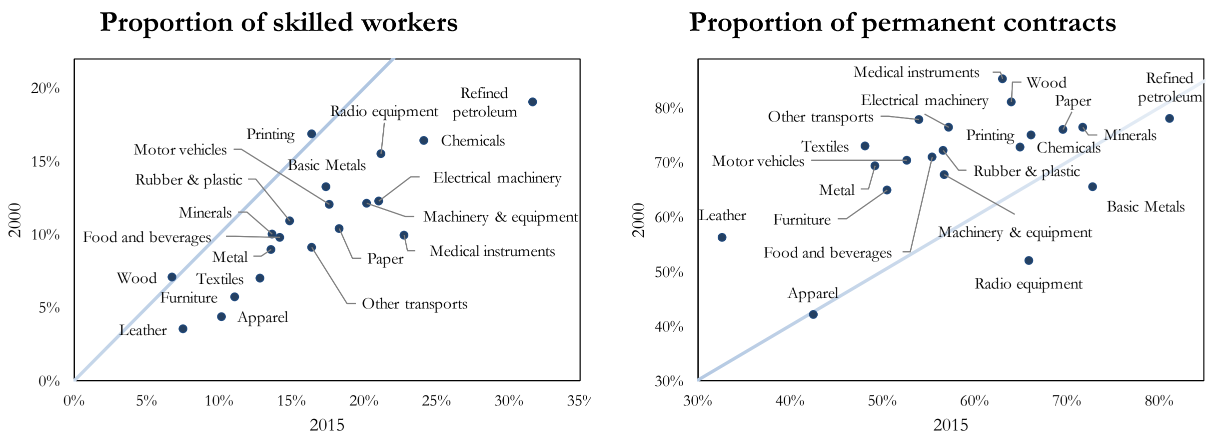
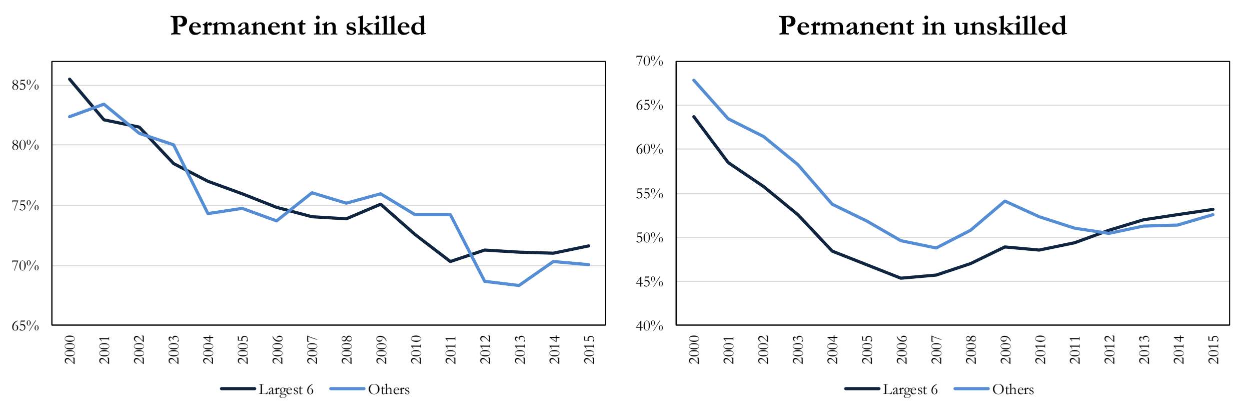


Figure 4b. Proportion of permanent contracts by skill

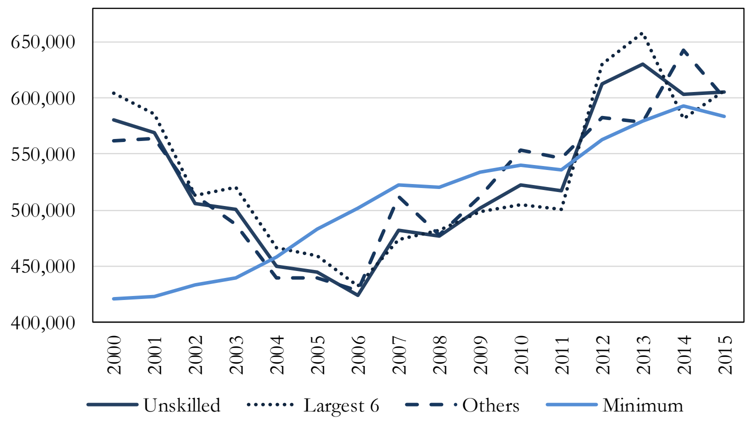


Source: DANE-EAM. Author calculations.

The rise in temporary contracts among the skilled exerted a negative effect on wages and resulted in a decrease of 3.2% of the average real wages in the segment, contrasting with the parallel increase of 46% of the real minimum wage. In 2000 the ratio of skilled real wage to real minimum wage was 4.3 and fell steadily until it reached 2.8 in 2015. In spite the lurking substantial growth of minimum wage there is still a considerable gap between average real wages of skilled workers and the minimum wage. Taking this two facts into account it is fair to say that the real minimum wage is not binding for the manufacturing's skilled segment and does not influence its prices, at least directly, otherwise its 46% increase would have resulted in a sizeable increase of the average real wage of skilled workers.

Other is the case for the unskilled segment of the workforce which saw a 4.3% increase of its real minimum wage. The figure 5 presents the series of the average real wage of unskilled workers, for the total, the largest six sectors, the other subsectors and the real minimum wage. Much like in the skilled segment the unskilled wages were rapidly falling due to the decrease of permanent contracts within the segment. However, that tendency was immediately reverted once the gap between the average real wage of the unskilled and the minimum wage closed. This abrupt change in the behavior also happens to coincide with the tendency change in the prevalence of permanent contracts among unskilled workers. It appears the behavior of the unskilled average real wage is heavily determined by the minimum wage since 2005, the moment in which the gap between the unskilled average wages and the minimum wage is closed. Thus, confirming the minimum wage is binding for a large portion of the manufacturing labor force concentrated in the unskilled segment.

Figure 5. Unskilled workers average wage and minimum wage.



Source: DANE-EAM**.** Author calculations.

The average real wage of the unskilled grew 42% from the moment the gap between the unskilled wage and the minimum wage was closed. This increase in a span of only 10 years seems dramatically large when compared to the 0.2% increase of the skilled wage in the same period of time. I argue that this dramatic increase in the average real unskilled wage is most likely a result of the real minimum wage growth. Thus, the later has put an enormous pressure on the unskilled workers demand, and therefore prevented the manufacturing labor demand from reaching a level coherent with the sector's GDP expansion. The conditional and unconditional labor demand models confirm that the demand for unskilled workers is reduced as a result of the minimum wage increases, and that the effect concentrates principally on temporary workers. Also, the increases in the minimum wage have induced a substitution effect towards skilled workers that is totally insufficient to compensate for the aggregate effect in the bulk of labor demand.

3 Literature review

The labor demand in Colombia has been studied using mainly the Colombian Annual Manufacturing Survey (AMS) data for different period times. For example, Roberts and Skoufias (1997) used this panel data between 1981 and 1987, finding that long-run wage elasticities are greater for unskilled workers than for skilled, making the former more sensitive to labor costs shocks. Since then, several more aspects of labor demand in the Colombian industry have been studied.

One of these aspects is how the sensitivity of labor demand has changed. In this venue Vivas, Farné and Urbano (1998) study the effects of institutional reforms seeking trade liberalization on the labor demand determinants. Using AMS data for the period 1980-1996 they intended to verify the existence of structural changes using different specifications of the labor demand function. These specifications include both the dynamic model derived from rational expectations as presented in Hamermesh (1993) and an error correction model (ECM) using four series integrated of order 1.[2] Using the AMS data the ECM showed product and labor costs elasticities of labor demand decreased because of the trade liberalization, which was not to be expected for labor costs elasticity.

The results of Vivas, Farné and Urbano (1998) however also point toward a higher sensitivity of labor demand. The ECM with the Colombian Household Survey information and more importantly their dynamic model with AMS data shows that the magnitude of the labor costs elasticities grew as a direct result of liberalization.[3] On the same subject Arango and Rojas (2004), also present evidence regarding the relation between the degree of liberalization and the sensitivity of labor demand to exogenous shocks. According to them the greater the liberalization the faster the adjustment velocity is, just as the theory predicts in this kind of settings. The trade liberalization in Colombia brought about a much more flexible labor structure for the industry.

A flexible labor demand structure, where workers are easily hired and fired, means greater magnitude of labor demand elasticities and therefore, as Arango and Rojas (2004) highlight, more unstable conditions for the workers. By the late 90s and the beginning of the 21th century Colombian economy was in the middle of a crisis and unemployment suffered historical climb. It was then that the greater flexibility presented an opportunity for policymakers to exert a positive effect on the labor market. Bernal and Cardenas (2003) argued that contrary to the common belief at that moment, the efficiency gains of a labor reform were substantial, and that, reducing labor costs would help a great deal to reduce unemployment.

The rich data in the AMS allows Eslava, Haltiwanger, Kugler, and Kugler (2010) to separately measure productivity and costs shocks. The longitudinal data of the AMS has information on establishments' prices and quantities of both outputs and inputs. The use of this data results in two methodological innovations: the analysis of interrelated factor demands with nonlinear adjustment costs, and the adequate estimation of productivity and demand shocks used to obtain desired factor demands. In the end these procedures help to prevent confounding productivity differences with demand shifts or market power variation within subsectors in the industry.

In other words, the desired factor demands are frictionless labor and capital levels and to measure them Eslava et al. (2010) use a semiparametric model. Their model defines expected and actual factor adjustment costs functions. Put together they result in adjustment hazards obtained through the use of a parametric adjustment function, allowing the adjustment of one factor to depend on the gap of the other factor and to respond differently to shortages and surpluses. In fact, the adjustment hazards can be projected over the shortage distribution making it easier to analyze them.

An important discovery about the adjustment hazards in the Colombian Industry is that they are highly nonlinear, and they are also asymmetrical between shortages and surpluses. Further pre and post 90's liberalization reform helped them to show an increase in flexibility of labor demand as a

[2] For the second methodology they also used the information of the Integrated Household Survey (EIH)

[3] This independently of whether they are measured as remuneration or salary. See Vivas et al. (1998).

direct result of deregulation, as other works had also concluded (Vivas et al. 1998 and Arango and Rojas, 2004). The reform reduced significantly adjustment costs which in turn increased productivity substantially, due to relocation of labor towards high productivity plants. However, this gains in factor adjustment costs and productivity came at a price, job destruction hazard almost doubled while the creation side did not shift upwards.

Despite the evidence so far on the increased flexibility of labor demand and the gains in efficiency reported by Eslava et al. (2010), there's still substantial room for improvement. Medina, Posso, Tamayo and Monsalve (2013) conclude that industrial employment is highly persistent which means recovery after shocks might take long. The reported halfways in Arango, Castellani and Obando (2016) vary from 1.5 years for unskilled permanent workers to 0.7 years for skilled temporary workers for a conditional demand specification. This means the effects of shocks in the demand take some time to vanish specially for unskilled workers.

Aside from these aspects, Arango et al. (2016) use the AMS to show that regional, sectoral and size heterogeneity is to be considered for the design of labor market policies. Also, on the line of regional and sectoral heterogeneity is the work of Balat and Casas (2018) that focuses instead on the productivity disparities across these dimensions. Instead of using the AMS the later use the "Business' Risk and Information System" (BRIS) dataset provided by the Colombian Superintence of Corporations[4]. This dataset pinpoints the exact locations of firms which allow them to examine the determinants of firms' productivity related to city and sector characteristics.

The potential determinants of productivity explored in Balat and Casas (2018) are both related to spatial characteristics but may be divided into two broad categories: agglomeration forces and urban congestion costs that hinder productivity. They define agglomeration forces as any mechanism capable of increasing firms' output resulting from local economy growth. The measures related to this concept are the scale of local economic activity[5], the degree of sector specialization and a measure of industrial variety. They do not find scale economies to affect firms' productivity, instead they find evidence supporting that specialization and cross-industry spillovers matter, especially the former. Also, for city characteristics, or "amenities", they find sizeable and significant effects on productivity.

Heterogeneity must be accounted for when analyzing labor demand determinants not only because there is evidence supporting sectoral heterogeneity (Arango et al. 2016) but there is also feedback effect on firms' productivity through sector specialization and city amenities (Balat and Casas, 2018). The latter analysis is constructed using Olley and Pakes (1996) while the former follows the TFP estimation procedure of Levinsohn and Petrin (2003) and so this work also uses structural framework to estimate the TFP. The works of Arango et al. (2016) and Balat and Casas (2018) help define a

[4] The AMS does not include firms' locations but indicators for the major metropolitan areas which constitutes an obstacle for Balat and Casas (2010) paper. The BRIS includes the exact location, as well as, balance sheets with revenues from each product, use of raw materials, investments, capital stock, and employees and payroll divided by type of worker i.e., executive, administrative or production worker, and tenure.

[5] These include calculations for variables such as manufacturing employment, capital stock, production and number of establishments.

criterion to test whether establishments in the sectors that demand more labor and are more productive respond differentially to labor demand determinants.

In summary, labor market policies can affect labor demand outcomes, but the effect attained is differentiated across skills, contract modalities, regions, sectors, and establishments sizes (Balat and Casas 2018, Arango, Castellani and Obando 2016); it may even be asymmetrical in terms of creation and destruction of jobs (Eslava et al. 2010). This paper examines the effect of minimum wage and other determinants of labor demand both in the short run and long run using conditional and unconditional specifications of labor demand. All these while taking into account and paying special attention to sectoral heterogeneity and seeking to determine whether the largest job generators have differentiated responses to labor determinants' shocks.

4 Theoretical and empirical models

The labor theory presents the framework to estimate conditional an unconditional labor demand functions in competitive model settings (Cahuc and Zilberberg, 2004). With a multifactorial production function in a static setup, the conditional labor demand can be obtained by minimizing the cost function conditional on a production level and depends on product demand, productivity and relative factor prices: $l(r/w\,, y, A; \alpha)$, where w, r, y, A and α correspond, respectively to real wage, capital price, output[6], technology and the parameters of the production function. The labor demand can also be obtained by maximizing the profit function and the resulting unconditional labor demand depends on the same variables except for the product demand $l(r, w, A; \alpha)$.

Though useful, the static framework neglects the presence of adjustment costs in a dynamic context where there is uncertainty about factor prices, final good prices, taxes, new profit opportunities and productivity (Hamermesh, 1993). However, adjustment cost can be addressed including quadratic and symmetric adjustment costs in a setup where firms maximize their expected profits, resulting in the following intertemporal expression:

$$\Pi_t = E_t\{\textstyle\sum_{j=0}^{\infty}(1+r_t)^{-j}\left[F\left(l_{t+j}, A_{t+j}\right) - w_{t+j}l_{t+j} - .5b(l_{t+j} - l_{t+j-1})^2\right]\} \qquad (1)$$

where E_t represents the expectations operator, r_t the interest rate, l_t the number of employees, and A_t are shocks to the production function that affect the products supply. The corresponding first order condition for each period j yields the following Euler equation:

$$F_l(A_t, l_t) = w_t + b(\Delta l_t) - \frac{b}{1+r}E_t(\Delta l_{t+1}) \qquad \forall t \geq 1 \qquad (2)$$

This second-order difference equation describes the dynamics of employment where the current employment depends both on past employment and on expected employment for the next period. This means the formation of expectations plays a key role in the determination of current demand of labor. The assumption made to obtain a close form of labor demand is that the producer has rational

[6] In the case of this paper the production corresponds to added value. In the AMS it is obtained from the difference between gross production and intermediate consumption.

expectations.[7] This means particularly that the producer knows that the value of l_{t+1} is determined by equation 2 applied to the next period $t+1$, the value l_{t+2} comes from applying the same equation to period ($t+2$), and so on. By replacing forward this expression the demand of employment l_t depends on past employment l_{t-1} and expectations of all future shocks to the production function. If the production function can be approximated by a linear quadratic function of the form, $\mathrm{F}(A_t, l_t) = A_t l_t - (.5B)l_t^2$ then the labor demand function has the following explicit solution[8]:

$$a_0 E_t l_{t+1} - l_t + a_1 l_{t-1} + a_t = 0 \qquad (3)$$

where $a_0 = \frac{b}{(B+b)(1+r)+b}$, $a_1 = (1+r)a_0$, and $a_t = \frac{(A_t - w_t)a_1}{b}$.

This notation allows us to rewrite l_t as a linear form of its past value l_{t-1}, the realization of the random variable a_t and all its expected future values a_{t+i}, resulting:

$$l_t = \lambda l_{t-1} + \sum_{j=0}^{\infty} \mu_i E_t a_{t+j} \qquad (4)$$

Equation 4 depends on the expectations of all future shocks to wages and productivity which can be expressed as the sum of a constant plus a mean zero random shock, i.e. $\bar{\alpha} + \alpha_{t+j}$,.

Assuming expectations of periods after t are formed using all available information to the employer and specifying the process that generates those expectations, it is possible to empirically estimate equation 4. Rational expectations literature points out that the specification needs to be based on the stochastic process that generate the shocks mentioned before, which in are assumed to be first-order autoregressions. Thus, although the demand for labor in t depends on expectations it is possible to explicitly estimate the empirical model using lags and contemporary observations of the labor determinants[9]. In notation of Hamermesh (1993, chapter 7)

$$l_{i,t} = \lambda l_{i,t-1} + \sum_{m=1}^{K} \sum_{j=0}^{Jm} \mu_{m,j} X_{i,m,t-j} + \omega_{i,t} \qquad (5)$$

Suffix i corresponds to the establishment, and t to the period[10], so that $l_{i,t}$ is the logarithm of the number of workers demanded at establishment i in the period t. The model includes just one autoregressive term as in Arango et al. (2016), which allows to recover information of the adjustment costs. The m in $X_{i,m,t-j}$ corresponds to the K different labor demand determinants which in the empirical model include the minimum wage, a total factor productivity TFP[11] indicator, the added value of the firm and the average real wage paid by the firm. Additional controls such as energy price,

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[7] See Cahuc and Zilberberg (2004), chapter 8, section 3.

[8] Although being very restrictive assumptions, they allow to obtain a solution that realistically rely formation of expectations to the dynamic labor demand (Hamermesh, 1993).

[9] Hamermesh (1993, chapter 6) presents a full description of how the equation 4 can be turn into an observable equation that depends on the lags of determinants instead their forwards.

[10] In this case the AMS panel is constructed in year basis and so our periods correspond to years.

[11] Computed using the Levinsohn & Petrin (2003) algorithm.

a proxy of capital price and depreciation, are included in the regression. The vector of parameters to be estimated is $\mu_{m,j}$, while $\omega_{i,t}$ is a residual term.

According to Roberts and Skoufias (1997) an adequate estimation of demand parameters depends on the source of errors on the residual term $\omega_{i,t}$ of which they present three potential sources: $\omega_{i,t} = \eta_i + \upsilon_{i,t} + \varepsilon_{i,t}$. The first element η_i corresponds to establishments heterogeneity that is to be related to characteristics such as properties of the output, managerial efficiency and technical knowledge. If plant owners are aware of these establishment specific components it will most likely lead to observable differences in output and factor levels and price. Neglecting this would result in biased coefficients via simultaneity.[12]

On the other hand, idiosyncratic time varying shocks to establishments, like equipment breakdowns, unforeseen fluctuations in demand, factor supplies, and reporting errors, correspond to the second source of error $\upsilon_{i,t}$. The demand model is based on expectations and thus the appropriate determinants are those planned or foreseen, nonetheless these do not necessarily correspond to observed levels. This measurement error results in biased elasticities toward zero[13]. Finally, the third source of error $\varepsilon_{t,i}$ is a well-behaved mean zero shock varying across time and establishments.

Addressing the sources of bias aforementioned, as well as potential reverse causality of both real wage and added value with labor demand, requires the use of instrumental variables and moment conditions. This paper follows the estimation procedure of Blundell and Bond (1998) generalized method of moments (GMM) estimator that combines both lagged levels and lagged first differences as instruments to improve efficiency of the estimator. Additionally, Windmeijer (2005) correction is implemented to address the downward bias of the two step GMM estimator shown in Arellano and Bond (1991) in Monte Carlo simulations of the estimator.

The initial assumptions in Arellano and Bond (1991) are that errors $\upsilon_{i,t}$.have expected value zero: $E(\upsilon_{i,t}) = 0$, and are uncorrelated across periods and establishments: $E(\upsilon_{i,t}, \upsilon_{i,s}) = 0$ for $i = 1, \dots, N$ and $t \neq s$. Additionally, an assumption concerning the initial conditions $y_{i,1}$ that must not be correlated to $\upsilon_{i,t}$ errors after the initial period: $E(y_{i,1}, \upsilon_{i,t}) = 0$ for $i = 1, \dots, N$ and $t = 2, .., T$. These assumptions imply linear moment conditions sufficient to estimate λ for $T \geq 3$. A total of $m = 0.5(\mathrm{T} - 1)(\mathrm{T} - 2)$ orthogonality conditions can be expressed as $E(y_{i,t-s}, \Delta\upsilon_{i,s}) = 0$ for $t = 3, \dots, T$ and $s \geq 2$.To solve this problem the GMM two stage instrumental variable estimator is available.

Additional moment conditions are available depending on the whether the relation of $x_{i,t}$ with $\upsilon_{i,t}$and η_i is considered to be exogenous or not. If the determinants $x_{i,t}$ are correlated to establishment fixed effects η_i, the first difference transformation is required to eliminate the individual fixed effects but that was already required. Further, if $x_{i,t}$ is assumed to be endogenous, i.e. it is correlated to $\upsilon_{i,t}$

[12] See Tybout and Westbrook (1995) on the effect of unobserved heterogeneity on scale estimates.
[13] Roberts and Skoufias (1995) discuss this bias is especially important for output and own price elasticities.

then $x_{i,t}$ is treated in the same way as the dependent variable $y_{i,t}$. This implies lagged values $x_{i,t-2}$, $x_{i,t-3}$ and longer lags are valid instrumental variables in the first-differenced equations because the moment conditions now include $x_{i,t}$. The vector $(y_{i,1}, \ldots, y_{T-2})$ becomes $(y_{i,1}, .., y_{T-2}, x_{i,1}, .., x_{i,T-2})$ inside the instrument matrix $Z_{i,t}$.

In this model of labor demand the variables considered endogenous are wage $w_{i,t}$ and output $q_{i,t}$ because both can also be affected by unexpected time varying shocks in the same way as labor demand. Unforeseen fluctuations in demand of the firm's products can alter both output and labor demand at the same time. In another scenario the technical characteristics required for the completion of a task or product can vary due to equipment breakdown thus affecting the type of labor hired as well as its corresponding payroll. Financial idiosyncratic shocks can alter both the average wage paid to employees and the total of employees hired. These are some examples of how both variables are related to the time varying idiosyncratic shocks. On the other hand, the minimum wage does not operate as an idiosyncratic shock since it affects all manufacturing firms at the same time, though the magnitude of its effect depends on the skill and contract modality composition of each one.

Fortunately, output and wage endogeneity can be addressed by using lagged values of the endogenous variables in levels, taking advantage of the instrument matrix $Z_{i,t}$ structure. Additional to the level instruments Blundell and Bond (1998) show that the implementation of lagged variables in difference as additional instruments is possible. This additional instruments help improve efficiency when the lagged levels are weak instruments. This happens when λ is close to one and or when the variance of the fixed effects is relatively higher than the variance of the time varying idiosyncratic shocks, i.e. σ_η^2/σ_v^2 is high. Thus, I use lagged levels and lagged differences of output and wages[14] as instruments in the conditional specification and lagged levels and differences of wages in the unconditional specification.

Following Arango, Castellani and Obando (2016) I use the Annual Manufacturing Survey panel at establishment level between 2000 and 2015, adding 2 years to the sample. The unbalanced panel has in average 8143 firms each year of which 20.62% are small, 47.95% are medium and 29.01% are large and 2.43% are very large firms [15]. For the empirical estimation, only firms with more than 10 employees and that survive the whole period are included.

The estimated models correspond to both conditional and unconditional specifications for labor demand, where the dependent variable is the log of the number of employees at the establishment. The determinants include an own lag of the labor, as well as contemporary and lagged values of the real minimum wage, real mean wage at the establishment, added value, total factor productivity, energy

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[14] This includes the own prices of labor demand as well as the minimum wage since both are included in the model as determinants of labor demand.

[15] Following Arango et al. (2016), small sized establishments are those that employ 10 people or less, medium sized between 11 and 50, large between 51 and 500 and very large more than 500.

prices and the real interest rate[16]. The contemporary depreciation rate value is also included.[17] Since the dynamic allows the inclusion of long term elasticities the paper presents both short and long-term elasticities. The long-term elasticities are calculated as $(\mu_{m,0} + \mu_{m,-1})/(1 - \lambda)$[18] and their standard errors are obtained by using the delta method.

Finally, the TFP was computed using the Levinsohn and Petrin (2003) algorithm as in Arango et al. (2016). Estimation of the TFP particularly can be severely biased by firms' selection through time (i.e. survival), the endogeneity between inputs and production, and unobservable heterogeneity of firms, and for most cases this problem cannot be solved using fixed effects alone. Olley and Pakes (1996) developed a consistent semi parametric approach that solves the simultaneity problem by using the firm's capital investment decision as a source of identification of unobserved productivity shocks. The key in their model is to note that TPF is a function of capital and investment and hence it is possible to control for it.

However, the former approach forces observations with zero investment to be dropped out of the sample. To solve this problem Levihnson and Petrin (2003) came up with a solution. The Levinsohn and Petrin (2003) algorithm does not need to dropout the zero investment observations because it uses a different source of identification, the use of an intermediate input as a proxy for identification. In this work that intermediate input is the energy price paid by the establishments. This change helps to achieve a sizeable increase in the number of observations available for the estimation.

The identification of the TFP in Levinsohn and Petrin (2003) is achieved because they replace Olley and Pakes (1996) investment equation with the intermediate input demand equation (energy price). Assuming the demand of the intermediate input is strictly increasing in the unobserved TFP shocks allows to invert the intermediate demand function. Thus, the TFP shock can be expressed as a function of the intermediate input and capital that is approximated in the production function by a polynomial of both the intermediate input and the capital. The production function and the corresponding productivity shocks are estimated using OLS, regressing output on labor and the discussed polynomial terms.

5 Results[19]

The models were estimated for the whole sample and then by types of workers to examine in detail the behave of the labor demand. Table 1 shows minimum wage, own price output and TFP short term elasticities of conditional labor demand for all workers, and then separately for skilled and unskilled workers.[20] The contemporary elasticity of the minimum wage for all workers is not statistically

[16] The interest rate included in the estimation is obtained from the Financial Superintendence of Colombia and the assumption made is that large and very large firms (approximately 30%) obtain a preferential interest rate, while the rest only can access ordinary interest rates. This variable is included as a proxy of the cost of capital for the firms in the sample.

[17] This depreciation rate is calculated following the AMS documentation.

[18] See Hamermesh, (1993), chapter 7

[19] For the estimation we balance the panel to focus only on the elasticities of the most resilient firms.

[20] As discussed before the models estimated also included the interest rate, the depreciation and the price of energy as controls, although they are not discussed.

different from zero while its lag is (-0.626), the contemporary output is (0.512), the contemporary TFP is (-0.483), the own price lag is (-0.193) and the autoregressive coefficient is (0.468). These elasticities show that labor demand is more responsive to output shocks than to its own price, however, another source of variation for the price of labor, the minimum wage, is also an important determinant. The first column of Table 1 shades complementary or substitution effects between types of labor and contract modalities and so the columns 2 and 3 present the determinants separately for skilled and unskilled workers.

Table 1. Short term elasticities of conditional labor demand (2000-2015)

Specification	All workers (1)	Skilled (2)	Unskilled (3)
Autoregressive coefficient	**0.468*** **	**0.495*** **	**0.429*** **
	(0.078)	**(0.113)**	**(0.080)**
Minimum wage	0.296	**0.854***	0.321
	(0.207)	**(0.470)**	(0.223)
Minimum wage lag	**-0.626*** **	-0.637	**-0.763*** **
	(0.203)	(0.491)	**(0.224)**
Own-price	-0.042	**-0.575*** **	0.082
	(0.109)	**(0.023)**	(0.118)
Own-price lag	**-0.193***	**0.284*** **	**-0.311*** **
	(0.106)	**(0.069)**	**(0.117)**
Output	**0.512*** **	**0.783*** **	**0.592*** **
	(0.090)	**(0.213)**	**(0.089)**
TFP	**-0.483*** **	**-0.846*** **	**-0.473*** **
	(0.100)	**(0.258)**	**(0.098)**
TFP lag	-0.005	0.188	-0.052
	(0.013)	(0.134)	(0.042)
No. observations (plants)	1,898	1,668	1,893
Sargan test (p-value)	0.086	0.000	0.052
Hansen test (p-value)	0.000	0.161	0.002
Ar2 (p-value)	0.601	0.208	0.611

Source: DANE-AMS, author's calculations. **Note:** Output lag elasticities were taken out from the table because all the estimated coefficients were zero. Elasticities are significant at 10% (*), 5% (**) and 1% (***) confidence level.

The own price elasticities of labor demand provide evidence of differentials in firing costs, factors' substitutability, or both, for skilled and unskilled types of workers. The autoregressive coefficient of the skilled workers (0.495) is slightly higher than that of the unskilled (0.429) which suggest adjustment cost are higher for the skilled segment. The contemporary own price elasticity for the skilled workers is (-0.575) while the unskilled is positive but no significant, instead, the lagged elasticities are (0.284) for skilled and (-0.311) for unskilled workers. The firms respond extemporaneously when faced with shocks to own price in the unskilled segment, as if it were easier to fire skilled than unskilled workers in the immediate term[21]. Table 2 displays the long-term elasticities derived from the models presented in table 1., showing that overall the skilled workers are more sensitive to its own price reinforcing the argument the unskilled segment of demand might face larger firing costs.

[21] Robert and Skoufias (1997) for Colombia and Litcher et, al. (2014) with a meta-regression analysis with y 151 studies of micro-data estimates find larger sensitivity of unskilled employment to the own price. However, Arango et al. (2016) also find skilled labor to be more sensitive.

The minimum wage long run elasticity for the whole workforce is (-0.6), yet, when it is splitted out by type of workers, it is (0.638) for the skilled workers meaning it boosts that labor demand segment, though significant only a 0.1 significance level. On the other hand, the unskilled workers' long-term elasticity is (-0.774) meaning this segment of workers is more sensitive to variations of the minimum wage. This combined with the fact that unskilled workers largely outnumbered skilled workers with a participation in the workforce that ranges from 80% to 89 in the sampled period explains why the overall effect is negative on the labor demand. The sensitivity of the unskilled segment is to be expected if as I have shown the minimum wage is binding enough as to generate variations in the average unskilled wage.

There exists the possibility that the elasticities estimated were inflated as a result of including both the own price and the minimum wage in the model at the same time. Nonetheless, this possibility is ruled away. The annex tables one to four present additional models where the own price is taken out the model and the minimum wage remains. In all these cases the minimum wage remains statistically significant and the magnitude of elasticities is higher. This discards the possibility that the estimated magnitudes of the minimum wage elasticities result from including colinear variables in the main model.

Table 2. Long term elasticities of conditional labor demand (2000-2015)

Specification	All workers	Skilled	Unskilled
Minimum wage	**-0.600***** **(0.193)**	**0.638*** **(0.356)**	**-0.774***** **(0.205)**
Own-price	**-0.482***** **(0.031)**	**-0.595***** **(0.047)**	**-0.477***** **(0.041)**
Output	**1.064***** **(0.048)**	**1.481***** **(0.170)**	**1.023***** **(0.047)**
TFP	**-0.909***** **(0.073)**	**-1.498***** **(0.235)**	**-0.918***** **(0.066)**
No. observations (plants)	1,898	1,668	1,893
Sargan test (p-value)	0.0861	0.000	0.052
Hansen test (p-value)	0.000	0.161	0.002
Ar2 (p-value)	0.601	0.208	0.611

Source: DANE-AMS, author calculations. **Note:** Elasticities are significant at 10% (*), 5% (**) and 1% (***) confidence level.

The effect on the skilled workers can arise due to a substitution effect since the minimum wage is most likely binding for the unskilled segment and less so for the skilled. Unfortunately, the data structure in the AMS does not allow to observe the prevalence of minimum wage contracts, since the data reported for each establishment is the payroll. Nonetheless, Arango, Herrera and Posada (2007) show that by 2006 in the whole formal sector around 35% of the workforce earned up to one minimum wage and 73% earned up to two. This evidence plus the results in the estimated demand models suggest the minimum wage is indeed binding in the Colombian industry and has a sizeable effect on the demand for labor, seemingly reducing the demand for unskilled while also inducing an apparent substitution for skilled workers.[22]

Estimations that consider contract modalities are presented in table 3 with short term elasticities of the conditional labor demand model, and the correspondent long term elasticities in table 4. Immediately it becomes apparent that tenure increases considerably adjustment costs for the firms both for skilled and unskilled alike. The skilled temporary workers have the smallest autoregressive coefficient (0.295), meaning the effect of shocks wears off much faster for the skilled temporary workers than for any other segment of the workforce. Though in the aggregate the skilled have slightly higher adjustment costs, the unskilled permanent workers have the highest (0.789). The skilled temporary halfway is 0.57 meaning shocks dissolve in about half a year, considerably less than the other segments where halfways are 0.94, 1.31 and 2.9 for the unskilled temporary, skilled permanent and unskilled permanent workers respectively.

Table 3. Short term elasticities of conditional labor demand (2000-2015)

Specification	Permanent	Temporary	Permanent	Temporary
	Skilled		Unskilled	
Autoregressive coefficient	**0.590*****	**0.295*****	**0.789*****	**0.479*****
	(0.107)	**(0.107)**	**(0.074)**	**(0.082)**
Minimum wage	0.299	1.699	**0.538***	0.405
	(0.469)	(1.086)	**(0.308)**	(0.652)
Minimum wage lag	0.066	-1.744	-0.134	**-2.420*****
	(0.518)	(1.230)	(0.390)	**(0.732)**
Own-price	**-0.603*****	**-0.238****	**-0.272***	**-0.288*****
	(0.024)	**(0.116)**	**(0.145)**	**(0.110)**
Own-price lag	**0.318*****	0.030	0.024	**0.088**
	(0.072)	(0.107)	(0.145)	**(0.118)**
Output	**0.596*****	**0.392*****	**0.165****	**0.452*****
	(0.192)	**(0.130)**	**(0.074)**	**(0.104)**
TFP	**-0.541****	**-0.548****	-0.031	**-0.447****
	(0.225)	**(0.277)**	(0.089)	**(0.223)**
TFP lag	-0.015	0.173	-0.030	-0.027
	(0.038)	(0.185)	(0.023)	(0.141)
No. observations (plants)	1,570	967	1,783	1,573
Sargan test (p-value)	0.001	0.000	0.001	0.000
Hansen test (p-value)	0.122	0.441	0.615	0.009
Ar2 (p-value)	0.773	0.284	0.674	0.890

Source: DANE-AMS, author's calculations. **Note:** Output lag elasticities were taken out from the table because all the estimated coefficients were zero. Elasticities are significant at 10% (*), 5% (**) and 1% (***) confidence level.

The long run elasticities can be significant even when short term elasticities are not; this is the case of the minimum wage elasticity for the skilled permanent workers. This happens when the adjustment costs implied by the model are high as is the case for the skilled permanent workers. The long run minimum wage elasticities are positive for permanent workers, 0.804 and 1.963 for skilled and

[22]An important concern for this analysis is the possibility that the employees reported by the firms might not be formally attached to them, and so the minimum wage is not really binding. However, workers without direct contracts with the firms are most likely hired trough outsourcing or in the worst-case scenario reported as such in the AMS.

unskilled respectively, while for the unskilled temporary is negative but of twice the magnitude: -4.028. This is probably due to the lower adjustment cost of the unskilled temporary, but also the minimum wage is more binding for the unskilled temporary workers than for any other labor segment. As a result, the unskilled temporary labor demand responds negatively to minimum wage variations and in a magnitude much greater than the positive response of permanent labor. In the aggregate the negative effect on unskilled temporary labor dominates the others and the overall effect of minimum wage on labor demand is negative.

The positive elasticities for the permanent segment of labor can be explained as consequence of factors' substitutability.[23] The more alike production factors are, the easier it is to substitute one for the other when relative prices change and the segment of workforce that is most likely to resemble unskilled temporary workers are unskilled permanent workers. Thus, this segment should response respond more than any other when the relative price of the first rises, and the elasticities seem to fit adequately this notion since the unskilled permanent do respond more intensively than skilled permanent workers.

The positive minimum wage elasticity for permanent workers indicates substitution of unskilled temporary workers for permanent ones especially unskilled. This sort of substitution can happen if a permanent contract can diminish learning and training costs for the workers. Also, increasing the prevalence of permanent contracts can exert a positive effect on TFP dynamics as is shown in Addressi (2014) for the case of the Italian manufacturing. The prospect of a more stable labor relationship with firms can induce workers to boost their productivity and this could potentially compensate for the artificial increase in the price of their work.

It is also possible that contract modality affects the quality and quantity of task assigned to workers. In this case the permanent and temporary workers play different roles and integrate differentially to the production process. For establishments the permanent contracts can have relative advantage over temporary contracts, when assigning task and responsibilities to workers. A permanent contract can favor the increase of workload to compensate for minimum wage increases.

The direction and magnitude of the long run elasticities presented in table 4 imply a behavior that is coherent with the observed behavior of permanent contract share among both skilled and unskilled workers (figure 4). Once minimum wage growth started growing disproportionally, firms in the industry were forced to substitute by types of contract and reverse the trend of increasing share of temporary labor among unskilled workers. On the other hand, permanent contracts among skilled workers continued to decrease in proportion, although it is worth noting that by the end of the study period the share of permanent contracts seems to have stabilized around 71% for the skilled. The Minimum wage has had the heavier toll on the most unstable and precarious type of labor, the unskilled temporary and prevent it from growing accordingly with output.

Table 4. Long term elasticities of conditional labor demand (2000-2015)

[23] See, Cahuc, P., & Zylberberg, A. (2004).

Specification	Permanent	Temporary	Permanent	Temporary
	Skilled		Unskilled	
Minimum wage	**0.804***	-0.208	**1.963***	**-4.028***
	(0.436)	(0.791)	**(1.002)**	**(0.702)**
Own-price	**-0.660***	**-0.302***	**-1.280***	**-0.386***
	(0.048)	**(0.056)**	**(0.154)**	**(0.090)**
Output	**1.268***	**0.555***	**0.803***	**0.904***
	(0.184)	**(0.165)**	**(0.209)**	**(0.179)**
TFP	**-1.182***	**-0.532***	-0.289	**-0.947***
	(0.259)	**(0.225)**	(0.321)	**(0.244)**
No. observations (plants)	1,570	967	1,783	1,573
Sargan test (p-value)	0.001	0.000	0.001	0.000
Hansen test (p-value)	0.122	0.441	0.615	0.009
Ar2 (p-value)	0.773	0.284	0.674	0.890

Source: DANE-AMS, author calculations. **Note:** Elasticities are significant at 10% (*), 5% (**) and 1% (***) confidence level.

The long run elasticities respect to the own price, the output and total factor productivity are all significant and influence in the same direction each of the four segments of labor demand, except for the TFP elasticity for the unskilled permanent workers which is negative but not significative. The own price elasticity has bigger elasticities for permanent than for temporary workers, for both skilled and unskilled, where skilled temporary workers have the smallest (-0.302) and unskilled permanent (1.280) the highest. Output has the greatest effect on labor demand for all segments but unskilled temporary workers for which the highest elasticity is that of the minimum wage. Unlike the minimum wage, the output does not seem to induce substitution between types of work but rather boosts the bulk of labor, favoring skilled permanent (1.268) and unskilled temporary workers (0.904) the most.[24]

Table 5 presents short term elasticities of unconditional labor demand, which basically does not include the output in the determinants, relating the empirical estimation to a profit maximization rather than a costs minimization type of problem. This specification is used to analyze what happens in longer periods of time when capital mobility is possible. The analysis of the elasticities in this model is close to the previous but allows to examine the effect of productivity shocks when labor demand is not restricted by a specific output level. In the setting of the unconditional labor demand, the TFP is expected to exert a positive effect and it does for the aggregate workforce (0.129), and the skilled (0.326) and unskilled workers (0.176), in the short run. Table 6 shows associated long term elasticities to hold positive for the unskilled workers and the aggregate workforce though it is not significative for the latter.

With the output out of the equation the minimum wage and the own price elasticities remain sizeable and significant in the short term, though with some alterations in the temporality of the effects. In the case of the minimum wage the relevant elasticity is now the contemporary and for the aggregate is of greater magnitude than before. In the long term the elasticity for the aggregate workforce is substantially higher than before because the unconditional demand model has a larger autoregressive coefficient of 0.869 which inflates the already sizeable sum of the short-term elasticities. The short-term elasticities show the skilled segment to respond more intensely to the minimum wage

[24] It is worth noting that since the share of unskilled workers in the workforce is lager (permanent 44% and temporary 42%), in aggregate the bulk of the demand's variation corresponds to them.

than the unskilled, however, the larger autoregressive coefficient of the latter induce this relation to inverse in the long run.

Table 5. Short term elasticities of unconditional labor demand (2000-2015)

Specification	All workers	Skilled	Unskilled
Autoregressive coefficient	**0.869*** **	**0.583*** **	**0.777*** **
	(0.040)	**(0.122)**	**(0.057)**
Minimum wage	**-0.760*** **	**1.119* **	**-0.559* **
	(0.194)	**(0.629)**	**(0.292)**
Minimum wage lag	0.320	-0.599	0.127
	(0.206)	(0.661)	(0.294)
Own-price	**-0.264*** **	**-0.241** **	**-0.203*** **
	(0.061)	**(0.111)**	**(0.073)**
Own-price lag	**0.226*** **	0.149	**0.137** **
	(0.046)	(0.111)	**(0.068)**
TFP	**0.129* **	-0.332	**0.176* **
	(0.077)	(0.239)	**(0.104)**
TFP lag	-0.061	**0.326* **	-0.066
	(0.074)	**(0.175)**	(0.101)
No. observations (plants)	1,898	1,668	1,893
Sargan test (p-value)	0.939	0.0431	0.038
Hansen test (p-value)	0.001	0.704	0.006
Ar2 (p-value)	0.478	0.293	0.346

Source: DANE-AMS, author's calculations. **Note:** Output lag elasticities were taken out from the table because all the estimated coefficients are zero. Elasticities are significant at 10% (*), 5% (**) and 1% (***) confidence level.

On the other hand, the own price has more drastic change where contemporary and lagged elasticities seem to balance each other out and the result are non-significant long-term elasticities. It is possible to argue this as the result of labor prices impossibility to stay out of the equilibrium for too long. The substitution of productive factors, labor demand shifts, and productivity reconfiguration can make it hard for prices to affect labor demand in a time horizon longer than a year, especially if production is not fixed in a specific level. The associated halfways for skilled and unskilled workers in this specification are 1.25 and 2.7 years respectively, which means the effects of own price shocks to labor demand dissipates around those times, probably due to demand reconfigurations that restore the equilibrium.

Table 6. Long term elasticities of unconditional labor demand (2000-2015)

Specification	All workers	Skilled	Unskilled
Minimum wage	**-3.365** **	**1.291** **	**-1.848* **
	(1.345)	**(0.631)**	**(1.001)**
Own-price	-0.291	-0.221	-0.283
	(0.328)	(0.137)	(0.222)
TFP	0.520	-0.015	**0.604** **
	(0.319)	(0.440)	**(0.308)**
No. observations (plants)	1,898	1,668	1,893
Sargan test (p-value)	0.939	0.0431	0.038
Hansen test (p-value)	0.001	0.704	0.006
Ar2 (p-value)	0.478	0.293	0.346

Source: DANE-AMS, author's calculations. **Note:** Elasticities are significant at 10% (*), 5% (**) and 1% (***) confidence level.

Further division of labor demand into contract modalities presented for short term elasticities in tables 7 and for long term elasticities in table 8, show a scenario in which own price elasticities are significant determinants in the long term. Even so, this does not contradict the former analysis but provides a possible explanation of why it works. If firms face a shock in the price of unskilled workers, the easiest way to sort it out might be to recompose contract modalities (i.e. temporary or permanent) in this segment, instead of recomposing by skills. The contemporary own price elasticities of unconditional demand of skilled permanent workers (-0.227), skilled temporary workers (0.303), and unskilled permanent workers (-0.441) are all significant and result in significant long-term elasticities despite the backlash of lagged elasticities.

Table 7 Short term elasticities of unconditional labor demand (2000-2015)

Specification	Permanent	Temporary	Permanent	Temporary
	Skilled		Unskilled	
Autoregressive coefficient	**0.557*** **	**0.365** **	**0.769*** **	**0.188** **
	(0.107)	**(0.176)**	**(0.145)**	**(0.084)**
Minimum wage	0.501	1.547	**1.083** **	**1.554** **
	(0.621)	(1.248)	**(0.503)**	**(0.665)**
Minimum wage lag	0.445	-2.009	-0.463	**-3.615*** **
	(0.608)	(1.370)	(0.507)	**(0.696)**
Own-price	**-0.277*** **	**-0.303*** **	**-0.441*** **	-0.036
	(0.100)	**(0.082)**	**(0.072)**	(0.200)
Own-price lag	0.128	0.160	**0.283** **	-0.014
	(0.106)	(0.099)	**(0.131)**	(0.201)
TFP	-0.239	-0.303	0.301	-0.223
	(0.342)	(0.329)	(0.205)	(0.186)
TFP lag	0.294	0.488	-0.318	0.221
	(0.304)	(0.400)	(0.201)	(0.206)
No. observations (plants)	1.570	967	1.783	1.573
Sargan test (p-value)	0.006	0.004	0.000	0.000
Hansen test (p-value)	0.611	0.649	0.162	0.130
Ar2 (p-value)	0.349	0.318	0.286	0.458

Source: DANE-AMS, author's calculations. **Note:** Elasticities are significant at 10% (*), 5% (**) and 1% (***) confidence level.

As in the case of conditional the results for the unconditional demand suggest that firms face lager costs of adjustment for permanent type of workers than for temporary ones, in both skilled and unskilled segments. The minimum wage again appears to provoke an increase in the demand of skilled permanent, and unskilled permanent workers at the expense of unskilled temporary workers as the correspondent long-term elasticities 2.133, 2.683 and -2.598 show. Even though this is the case when taking into account contract modalities it is important to remember that in the aggregate the dominant effect is that of the unskilled temporary workers, which reduces the demand for workers as a whole. Finally, back to the TFP all its long-term elasticities are positive es expected from a theoretical model, except for unskilled permanent workers, yet none of them are statistically significant.

The effect of TFP on the aggregated unskilled segment is significant yet it is no longer when split up by contract modality. This raises the question of how exactly productivity is interacting with labor demand in the long-run in a setting unrestricted at least in terms of output level. Is it a matter of the nature of the productivity growth not being assimilated easily enough for the workforce, or rather a lack of sufficient growth of productivity to stimulate the labor demand?

Table 8. Long term elasticities of unconditional labor demand (2000-2015)

Specification	Permanent	Temporary	Permanent	Temporary
	Skilled		Unskilled	
Minimum wage	**2,133*** **	-0.619	**2.683*** **	**-2.598*** **
	(0,470)	(1.092)	**(0.972)**	**(0.453)**
Own-price	**-0.335*** **	**-0.225*** **	**-0.683*** **	-0.062
	(0.110)	**(0.066)**	**(0.188)**	(0.097)
TFP	0.124	0.291	-0.082	0.054
	(0.399)	(0.344)	(0.619)	(0.272)
No. observations (plants)	1.570	967	1.783	1.573
Sargan test (p-value)	0.006	0.004	0.000	0.000
Hansen test (p-value)	0.611	0.649	0.162	0.130
Ar2 (p-value)	0.349	0.318	0.286	0.458

Source: DANE-AMS, author calculations. **Note:** Elasticities are significant at 10% (*), 5% (**) and 1% (***) confidence level.

In Addessi (2014) it is argued that workers help determine productivity and not only how they interact with it, in his work the incidence of permanent contracts has a positive effect on TFP dynamic. Labor conditions are key on the workers willingness to participate in the improvement of the productivity process and the prospect of a short-term relationship can reduced said willingness. This insight suggest that the observed increasing prevalence of temporary contracts could be damping the growth of productivity and in turn diminish its effects on the labor demand. Additionally, the pressure imposed by the minimum wage that forces firms to pay workers a price irrespective of their productivity could also diminish the TFP elasticity of labor demand.

6 Heterogeneous effects by sectors participation in employment.

As it has been discussed before there is evidence of heterogenous effects in the labor demand of Colombian manufacturing sector in a series of dimensions such as contract modalities, skills, plant sizes, region or sector documented in Arango et al. (2016). Even the probability of adjusting the labor demand depends on whether there is a shortage or a surplus of labor (Eslava et al. 2010). The present work tries to identify whether the sectors that have the larger participation in the labor force do have a differentiated respond to determinants. Specially because the employment level is the result of aggregation of different sectors' employment and their response to different determinants and therefore an adequate employment policy design must identify these differences.

Traditionally the papers that have been discussed here estimate different production functions (Balat and Casas 2018) and labor demand functions (Arango et al. 2016) for each of the subsectors in the manufacturing. In Judzik (2014) the heterogeneity is analyzed in the context of international trade an examines the specifically the determinants in four types of merchandise to provide information on which type of trade is more beneficial for the countries in his study. In these works, the estimated elasticities are indeed heterogeneous making a case for sectoral heterogeneity, but the comparisons between them must be made outside the model.

In contrast, this work procures to test heterogeneity inside the model by introducing sector interactions with the determinants into the model and using the variance covariance matrix and the delta method to produce standard errors for these tests. Is important to stress out that the coefficients associated with this interactions are to be interpreted as additional effects to the previous estimated elasticities presented in the tables of section 5. Testing heterogeneity inside the model helps to have a better understanding of the magnitude and statistical significance of said heterogeneity.

Out of 21 sectors in manufacturing the largest six sectors in terms of employment -food and beverages, apparel, chemicals, textiles, rubber and plastic, and minerals- concentrate around two thirds of the whole manufacturing workforce. In Balat and Casas (2018) these sectors are shown to be the ones with larger unskilled and skilled labor elasticities of production, meaning in this sectors labor contributes the most to the production function. These two characteristics make them especially suitable candidates to test sectoral heterogeneity.

Table 9 presents heterogeneous effects that result from the interaction of labor demand determinants with a dummy equal to one if the establishments belong to any of these six sectors.[25] In other words, the coefficients shown are additional effects of the determinants on the labor demand that result from belonging to the six largest sectors in terms of employment, estimating both the conditional and unconditional demand specifications. These inside the model tests are presented for the aggregate workforce, and for each skill and contract modalities segments in the different rows, while the determinants go in the columns.

The coefficients in table 9 are not to be mistaken with the output elasticities. For example, in the conditional labor demand model the output elasticities for all workers (0.512), skilled (0.783) and skilled permanent (0.596) are shown in tables 1 and 3 and serve as a point of reference for the coefficients in table 9. For the same specification the interaction coefficients that correspond to the short-term output elasticities are significant for the whole workforce (-0.010), the skilled (-0.037), and the skilled permanent segments (-0.036), meaning in the six largest sectors these labor demand segments are slightly less sensitive to variations of the firms' demand shocks. This way to analyze coefficients in table 9 holds for the remaining determinants.

The TFP displays heterogeneous effects for the unskilled (-0.110), and skilled permanent (-0.308) workers in the conditional specification (Table 9). In a setting restricted to a specific output level the shocks to productivity that already exert negative influence in labor demand, have an even larger impact in the largest sectors. On the other hand, in the unconditional model for the unskilled temporary segment the TFP contemporary interaction for the unskilled temporary workers is -1.134 while the lagged TFP coefficient is 1.150, leaving in aggregate a slight positive effect of 0.016. The unconditional TFP elasticities for this segment in table 7 are not statistically significant but the former elasticities suggest that the largest sectors in terms of employment are closer to have positive TFP elasticities as the theory predicts.

[25] Each pair of contemporary and lagged interactions were estimated together for each determinant.

Table 9. shows own price and minimum wage heterogeneous effects to be statistically significant for unskilled, unskilled permanent workers, and the aggregate labor force. Nonetheless, the contemporary and lagged coefficients seem to counterbalance each other. In all these cases the contemporary negative effect is faced in the next period with an almost identical effect in the opposite direction as if the labor demand in the six largest sectors tended to overreact to price shocks in the unskilled segment.[26] Thus, most long run heterogeneous effect elasticities are not statistically significant for the minimum wage and the own price. The long run heterogenous effects for each determinant and all demand segments are presented in table 10 for both the conditional and unconditional labor demand models.

Table 9. Heterogeneous effects in the short term for the six largest sectors in employment.

[26] There is the extreme case of the minimum wage heterogeneous effects for the unskilled permanent workers. This is most likely because the participation of the largest six in unskilled permanent labor is the highest among the four labor segments and this might cause redundancy of the interaction.

	Minimum wage	Minimum wage lag	Own-price	Own-price lag	TFP	TFP lag	Output
				Conditional demand			
All workers	-0.105 (1.346)	0.093 (1.348)	**-0.617*** **(0.170)**	**0.609***** **(0.171)**	-0.043 (0.061)	0.026 (0.062)	**-0.010**** **(0.004)**
Skilled workers	-6.111 (3.863)	6.088 (3.866)	0.203 (0.210)	-0.224 (0.208)	0.161 (0.174)	-0.195 (0.165)	**-0.037*** **(0.020)**
Unskilled workers	-0.601 (1.966)	0.597 (1.967)	**-0.732***** **(0.174)**	**0.728***** **(0.174)**	**-0.110*** **(0.060)**	0.101 (0.062)	-0.007 (0.006)
Skilled permanent	-5.312 (4.151)	5.294 (4.156)	-0.076 (0.196)	0.058 (0.195)	0.280 (0.177)	**-0.308*** **(0.174)**	**-0.036**** **(0.018)**
Skilled Temporary	4.400 (7.929)	-4.373 (7.937)	-0.087 (0.170)	0.115 (0.173)	0.240 (0.227)	-0.197 (0.227)	0.026 (0.020)
Unskilled permanent	-3.910 (3.415)	3.919 (3.419)	**-0.569**** **(0.225)**	**0.572**** **(0.225)**	-0.142 (0.096)	0.144 (0.097)	0.002 (0.008)
Unskilled temporary	-4.859 (6.333)	4.857 (6.341)	-0.033 (0.173)	0.027 (0.181)	-0.162 (0.186)	0.144 (0.186)	-0.004 (0.018)
				Unconditional demand			
All workers	**3.090*** **(1.870)**	**-3.092*** **(1.872)**	**-0.666***** **(0.190)**	**0.666***** **(0.189)**	-0.053 (0.086)	0.055 (0.086)	
Skilled workers	-3.082 (16.415)	3.051 (16.428)	0.452 (0.312)	-0.478 (0.315)	0.169 (0.397)	-0.212 (0.388)	
Unskilled workers	9.396 (6.054)	-9.399 (6.059)	**-1.310***** **(0.320)**	**1.317***** **(0.319)**	-0.440 (0.289)	0.445 (0.282)	
Skilled Permanent	-0.586 (19.564)	0.559 (19.597)	-0.096 (0.287)	0.074 (0.286)	-0.301 (0.372)	0.263 (0.377)	
Skilled Temporary	8.243 (21.277)	-8.159 (21.301)	-0.215 (0.206)	0.298 (0.231)	0.430 (0.367)	-0.289 (0.370)	
Unskilled permanent	**-46.966***** **(13.369)**	**47.048***** **(13.390)**	-0.758 (0.515)	0.770 (0.516)	-0.088 (0.460)	0.103 (0.458)	
Unskilled temporary	27.839 (18.245)	-27.850 (18.260)	0.027 (0.292)	-0.013 (0.297)	**-1.134**** **(0.461)**	**1.150**** **(0.459)**	

Source: Author's calculations. **Note:** The column for output lag is omitted because the additional elasticity is always less than 0.0005. even though sometimes it is statistically significant. Elasticities are significant at 10% (*), 5% (**) and 1% (***) confidence level.

The unconditional model does not suggest the existence of heterogeneity in the long run for any of the determinants in any of the labor demand segments (Table 10). This suggest the labor demand the largest sectors and the rest tends to behave similarly in the long run as long as the firms' output is not bounded to a certain level. However, this is not the case when output is held as a determinant i.e. the labor demand is obtained through the minimization of the cost function conditional on a production level.

Table 10. Heterogeneous effects in the long term for the six largest sectors in employment

	Minimum wage	Own-price	TFP	Output
	Conditional labor demand			
All workers	**-0.022*** (0.008)**	**-0.016*** (0.006)**	**-0.032*** (0.011)**	**-0.019*** (0.007)**
Skilled workers	-0.046 (0.037)	-0.043 (0.028)	-0.073 (0.052)	**-0.070** (0.029)**
Unskilled workers	-0.008 (0.012)	-0.007 (0.009)	-0.016 (0.016)	-0.011 (0.010)
Skilled Permanent	-0.044 (0.042)	-0.044 (0.028)	-0.071 (0.056)	**-0.078*** (0.030)**
Skilled Temporary	0.038 (0.035)	0.040 (0.025)	0.062 (0.045)	0.036 (0.027)
Unskilled permanent	0.039 (0.046)	0.015 (0.037)	0.011 (0.066)	0.009 (0.039)
Unskilled temporary	-0.004 (0.043)	-0.012 (0.036)	-0.036 (0.056)	-0.008 (0.033)
	Unconditional labor demand			
All workers	-0.016 (0.034)	-0.001 (0.023)	0.009 (0.040)	
Skilled workers	-0.073 (0.091)	-0.065 (0.072)	-0.104 (0.122)	
Unskilled workers	-0.016 (0.042)	0.035 (0.031)	0.021 (0.053)	
Skilled Permanent	-0.062 (0.107)	-0.047 (0.054)	-0.087 (0.104)	
Skilled Temporary	0.131 (0.130)	0.141 (0.107)	0.222 (0.186)	
Unskilled permanent	0.501 (0.411)	0.060 (0.063)	0.063 (0.100)	
Unskilled temporary	0.063 (0.100)	0.016 (0.040)	0.022 (0.068)	

Source: Author's calculations. **Note:** Elasticities are significant at 10% (*), 5% (**) and 1% (***) confidence level.

The long run output elasticity is smaller in the six largest sectors, by -0.019 for the whole workforce, -0.07 for the skilled, and -0.078 for the skilled permanent workers, corresponding to 1.7%, 4.7% and 6.7% of the original elasticities respectively. Although being relatively modest differences they definitely add up since these sectors add up to more than a 65% of the total workforce. The heterogenous effects suggest that the largest sectors are less sensitive than the rest to output variations, specially in the skilled workers segment. Labor demand being less sensitive to output benefits the workers as fewer jobs are destroyed as a result of a negative output shock, however, this also means that aggregate demand shocks do not work less to boost labor demand.

On the other hand, price shocks heterogenous effects reinforce the effect of the initial elasticity. In the six largest sectors both the minimum wage (-0.022) and the own price (-0.016) have larger effects on the aggregate labor demand compare to the rest of the industry that correspond to 3.6% and 3.3% of the elasticities for the whole industry. For the TFP holds the same reinforcing effect with a coefficient of -0.032 that corresponds to 3.5% of the reference elasticity. It seems in the long run heterogenous effects of the determinants do not influence particular segments of the labor demand but rather all of it, with the exception of skilled permanent workers that face a smaller output elasticity in the six largest sectors than in the rest.

The six sectors that concentrate more than half of the industry's labor demand do respond differently to shocks of the determinants. This heterogeneous response is present in both short term and long run, but more so in the short term where both the conditional and unconditional specifications have significant coefficients. In the short term the heterogenous effects in own price, minimum wage and TFP, seem to be more associated with the unskilled segment, while output heterogenous effects are significant only for skilled workers. In the long run the heterogeneity does not concentrate in a particular segment, instead in the conditional specifications it is significant for the aggregated workforce and all determinants[27]. The overall absolute magnitude of the heterogenous coefficients expressed as percentage of the reference elasticity varies from 1.7 to 6.7%. These are rather modest differences but if a shock is persistent enough it can derive in divergent paths for the sectors composition and sheer participation in the industry's labor force.

7 Conclusions

This paper uses the Colombian Annual Manufacturing Survey (AMS) between 2000 and 2015 to present evidence of the negative effect that sustained increases in the real minimum wage have exerted on labor demand growth in the Colombian manufacturing sector. The estimated elasticities are aggregate, skill specific and type of contract specific allowed a through examination of the effects of minimum wage, output, wage and TFP elasticities. Output and the own price of labor also appear as key determinants of labor demand.

[27] The only exception being the output heterogeneity coefficient that is significant for skilled and skilled permanent workers.

The models estimated show a negative effect of the real minimum wage that is concentrated on unskilled labor and has induced a substitution effect toward skilled labor. Most likely the negative effects of the minimum wage on unskilled labor demand triggered when its level reached the average payroll of unskilled workers. The negative minimum wage elasticity of the unskilled labor is larger than the positive elasticity for the skilled in both the conditional (Skillled: 0.638, Unskilled: -0.774) and unconditional (Skilled: 1.291, Unskilled: -1.848) labor demand specifications. Additionally, the participation of unskilled labor in the manufacturing workforce is significantly larger, consisting of around 85% of the total labor. As a result, the aggregate manufacturing labor demand suffered sizeable backlash from the constant increases of the real minimum wage during the 2000 to 2015 period since the minimum wage elasticity of the aggregate labor demand was -0.6 in the conditional specification and -3.365 in the unconditional.

According to the conditional labor demand estimates if the minimum wage had grown at half its observed rate the result would have been an additional increase of 0.6% in manufacturing labor demand each year. This percentage translates into an average of roughly 2800 more formal jobs each year in Colombian manufacturing sector, and a total of 42000 jobs for the whole period of the study (2000-2015). The 42000 jobs in this counterfactual exercise are a fair representation of the costs associated to increasing the minimum wage without regarding the increase in labor productivity. During the study period the real minimum wage grew at an average annual rate of 2%. Hence, a more moderate increase of 1% could have actually boost formal labor.

The models that consider contract modality suggest that the unskilled temporary workers are the most affected by the increases in minimum wage. So, the minimum wage harms most those workers that already have the most precarious type of relation with their employers, and therefore are more vulnerable. Additionally, the negative minimum wage elasticity of unskilled temporary workers is twice the size of the positive elasticity for the unskilled permanent labor and the incidence of temporary contracts is about half among unskilled workers. Therefore, the implied substitution effect of the minimum wage on permanent unskilled and skilled labor does not come close to compensate the negative effect on unskilled temporary labor.

I argue this sort of substitution can happen when firms try to compensate the increase of the minimum wage trough increasing workloads or seeking to augment TFP. Permanent contract could potentially diminish learning and training costs for the workers. Also, the prospect of a more stable labor relationship with firms can induce workers to boost their productivity and favor positive TFP dynamics. Another possibility is that contract modality affects the quality and quantity of task assigned to workers. For establishments the permanent contracts can have relative advantage over temporary contracts, when assigning task and responsibilities to workers. A permanent contract can favor the increase of workload and help to compensate for minimum wage increases.

On the other hand, the employment in Colombian manufacturing is strongly driven by the behavior of six subsectors, food and beverages, chemicals, apparel, rubber and plastic, and textiles. This sectors behave significantly different from the rest sectors in manufacturing, specifically their labor demand is more sensitive to price variations, i.e. own price and minimum wage variations, while is less responsive to output variations. The employment generation in the largest sectors is more vulnerable than in the rest of the manufacturing to increases in the minimum wage. This evidence of heterogeneity among subsectors in the Colombian manufacturing has the advantage of being tested inside the model as opposed to previous works.

Finally, the link between TFP growth and employment growth in the long run appears to be severed in the Colombian manufacturing. The TFP elasticity of labor demand in the unconditional demand model is positive as expected from the firm theory, nonetheless it is not statistically significant. Temporary contracts offer fewer incentives to stablish employment relations that favor the transmission of employee's knowledge towards the firms (Addessi 2014) and therefore the increased prevalence of temporary contracts, especially among unskilled workers, could negatively affect the dynamic of TFP growth, and consequently its feedback on labor demand.

This work explicitly shows how labor demand is affected by minimum wage and whose jobs receive a more negative impact. However, there is still much to do. The discussion of the effects of minimum wage could be greatly improved by having information on the characteristics of the firm's employees. The model used in this paper is limited to the type of skill and contract modality used in the establishments and cannot talk about the effects of minimum wage on income distribution, or composition of the workforce in important dimensions of analysis such as age or education of the labor force. Also, the analysis so far cannot fully explain the severed link between labor demand and TFP in an unconditional setting. In regard of this problem, it is equally likely that productivity growth and technical change is not being well assimilated by the workers due to a mismatch of their characteristics with the actual characteristics required by the technical change that is occurring in the manufacturing.

8 References

Addessi, W. 2014. The productivity effect of permanent and temporary labor contracts in the Italian manufacturing sector. *Economic Modelling*, 36, 666-672.

Arango-Thomas. L. E., Castellani. F. & Obando. N., 2016. It is mainly about where you work! Labor demand in the Colombian manufacturing sector. *Borradores de Economía.* No 933. Banco de la República de Colombia.

Arango, L. E., Herrera, P., & Posada, C. E., 2007. El salario mínimo: aspectos generales sobre los casos de Colombia y otros países. *Borradores de economía*, No 436, Banco de la República de Colombia.

Arango. C.A. and Rojas. A.M., 2003. Demanda laboral en el Sector Manufacturero Colombiano: 1977-1999. *Borradores de Economía.* No. 247. Banco de la República de Colombia.

Arellano. M. and Bond. S.R., 1991. Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. Review of Economic Studies 58. 277–298.

Balat. J. & Casas. C., 2018. Firm Productivity and Cities: The Case of Colombia. *Borradores de Economía.* No. 1032. Banco de la República de Colombia.

Blundell. R. and Bond. S., 1998. Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics*. Vol. 87. pp. 115-143.

Cahuc, P., and Zylberberg, A., 2004. *Labor economics*. Cambridge. MIT Press c2004.

Eslava. M., Haltiwanger. J., Kugler. A. and Kugler. M., 2010. Factor adjustments after deregulation: panel evidence from Colombian plants. *The Review of Economics and Statistics*. 92(2). pp.378-391.

Hamermesh. D., 1993. *Labor Demand*. New Jersey. Princeton Academic Press. pp. 444.

Judzik, D. (2014). Heterogeneous labor demand: sectoral elasticity and trade effects in the US, Germany and Sweden. Munich Personal RePEc Archive

Lichter, A., Peichl, A., and Siegloch, S., 2014, The Own-Wage Elasticity of Labor Demand: A Meta-Regression Analysis, *IZA Discussion Paper Series*, No. 7958.

Levinsohn. J. and Petrin. A., 2003. Estimating Production Functions Using Inputs to Control for Unobservables. *The Review of Economic Studies*. No. 70. pp. 317-341.

Medina. C., Posso. C., Tamayo. J. and Monsalve. E., 2013. Dinámica de la demanda laboral en la industria manufacturera colombiana 1993-2009: una estimación panel VAR. Chapter 7. in *Mercado de trabajo en Colombia: hechos. tendencias e instituciones*. Arango L.E and F. Hamann (eds.). Banco de la República. coeditor. 2013.

Olley. G. S. and A. Pakes 1996: The Dynamics of Productivity in the Telecommunications Equipment Industry. Econometrica. 64. 1263–1297.

Roberts. M. and Skoufias. E. 1997. The long-run demand for skilled and less skilled labor in the Colombian manufacturing plants. *The Review of Economics and Statistics*. Vol. 79. No. 2. pp. 330-334.

Tybout. J. R. & Westbrook. M. D., 1995. Trade liberalization and the dimensions of efficiency change in Mexican manufacturing industries. *Journal of International Economics*. 39(1-2). 53-78.

Vivas. A., Farne. S. and Urbano. D., 1998. Estimaciones de funciones de demanda de trabajo dinámicas para la economía colombiana. 1980-1996. *Archivos de Macroeconomía*. No. 092. Departamento Nacional de Planeación.

Annex tables: Omitting the own price from the determinants set

Annex table 1. Short term elasticities of conditional labor demand without own price (2000-2015)

Specification	Permanent	Temporary	Permanent	Temporary
	Skilled		Unskilled	
Autoregressive coefficient	0.256	**0.324****	**0.676*****	**0.397*****
	(0.266)	**(0.143)**	**(0.153)**	**(0.091)**
Minimum wage	-0.015	1.691	-0.632	-0.775
	(0.630)	(1.322)	(0.432)	(0.774)
Minimum wage lag	0.775	-2.172	0.770*	**-2.149****
	(0.653)	(1.534)	(0.456)	**(0.965)**
Output	**0.971****	0.273	**0.346***	**0.679*****
	(0.390)	(0.236)	**(0.193)**	**(0.243)**
Output lag	-0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
TFP	**-0.959****	-0.549	-0.254	**-0.766*****
	(0.448)	(0.453)	(0.197)	**(0.293)**
TFP lag	0.037	0.204	0.014	0.083
	(0.069)	(0.286)	(0.033)	(0.069)
Variables interacted with the six bigger sectors in employment				
Minimum wage	12.727	-13.916	-10.755	4.810
	(13.640)	(16.145)	(11.710)	(16.312)
Minimum wage lag	-12.814	13.951	10.724	-4.844
	(13.661)	(16.160)	(11.718)	(16.327)
Output	**-0.065****	0.014	-0.029	-0.017
	(0.032)	(0.023)	(0.018)	(0.027)
Output lag	0.000	0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)
TFP	**0.475****	0.244	0.013	-0.288
	(0.242)	(0.336)	(0.109)	(0.217)
TFP lag	**-0.557****	-0.218	-0.076	0.258
	(0.243)	(0.339)	(0.116)	(0.227)
No. observations (plants)	1.570	969	1.783	1.574
Sargan test (p-value)	0.000	0.000	0.017	0.039
Hansen test (p-value)	0.132	0.140	0.206	0.0261
Ar2 (p-value)	0.915	0.172	0.693	0.624

Source: Author's calculations. **Note:** Elasticities are significant at 10% (*), 5% (**) and 1% (***) confidence level.

Annex table 2. Long term elasticities of conditional labor demand without own price (2000-2015)

Specification	Permanent	Temporary	Permanent	Temporary
	Skilled		Unskilled	
Minimum wage	**1.023*****	-0.593	0.426	**-4.849*****
	(0.359)	(1.005)	(0.678)	**(0.801)**
Output	**1.306*****	0.337	**1.068*****	**1.125*****
	(0.250)	(0.356)	**(0.321)**	**(0.380)**
TFP	**-1.239*****	-0.422	**-0.741****	**-1.133*****
	(0.290)	(0.377)	**(0.338)**	**(0.363)**

Elasticities for the six bigger sectors in employment				
Minimum wage	**-0.123*** **	0.051	-0.090	-0.059
	(0.041)	(0.047)	(0.059)	(0.053)
Output	**-0.087*** **	0.021	**-0.090** **	-0.028
	(0.030)	(0.035)	**(0.046)**	(0.044)
TFP	**-0.139** **	0.039	**-0.192** **	-0.056
	(0.056)	(0.059)	**(0.080)**	(0.061)
No. observations (plants)	1.570	969	1.783	1.574
Sargan test (p-value)	0.000	0.000	0.017	0.039
Hansen test (p-value)	0.132	0.140	0.206	0.0261
Ar2 (p-value)	0.915	0.172	0.693	0.624

Source: Author's calculations. **Note:** Elasticities are significant at 10% (*), 5% (**) and 1% (***) confidence level.

Annex table 3. Short term elasticities of unconditional labor demand without own price (2000-2015)

Specification	Permanent	Temporary	Permanent	Temporary
	Skilled		Unskilled	
Autoregressive coefficient	**0.635*** **	**0.628*** **	**0.982*** **	**0.173***
	(0.124)	**(0.147)**	**(0.057)**	**(0.103)**
Minimum wage	-0.771	-0.378	0.370	-0.927
	(0.609)	(1.221)	(0.403)	(0.735)
Minimum wage lag	**1.367** **	0.345	-0.092	-1.062
	(0.659)	(1.271)	(0.379)	(0.792)
TFP	0.381	-0.003	0.220	0.230
	(0.303)	(0.451)	(0.198)	(0.159)
TFP lag	0.118	0.239	-0.241	**0.359*** **
	(0.272)	(0.442)	(0.213)	**(0.138)**
Variables interacted with the six bigger sectors in employment				
Minimum wage	-16.379	-9.393	10.875	17.861
	(10.824)	(17.734)	(6.730)	(12.055)
Minimum wage lag	16.380	9.447	-10.904	-17.873
	(10.837)	(17.752)	(6.741)	(12.066)
TFP	-0.441	0.155	-0.288	-0.414
	(0.432)	(0.674)	(0.282)	(0.376)
TFP lag	0.411	-0.093	0.267	0.423
	(0.430)	(0.681)	(0.280)	(0.372)
No. observations (plants)	1.570	969	1.783	1.574
Sargan test (p-value)	0.585	0.000	0.005	0.000
Hansen test (p-value)	0.879	0.060	0.174	0.046
Ar2 (p-value)	0.516	0.078	0.116	0.005

Source: Author's calculations. **Note:** Elasticities are significant at 10% (*), 5% (**) and 1% (***) confidence level.

Annex table 4. Long term elasticities of unconditional labor demand without own price (2000-2015)

Specification	Permanent	Temporary	Permanent	Temporary
	Skilled		Unskilled	
Minimum wage	**1.633*** **	-0.088	15.422	**-2.435*** **
	(0.598)	(1.471)	(51.598)	**(0.442)**
TFP	**1.368*** **	0.634	-1.158	**0.713*** **
	(0.224)	(0.570)	(6.962)	**(0.152)**

Elasticities for the six bigger sectors in employment				
Minimum wage	0.005	**0.144***	-0.987	-0.014
	(0.074)	**(0.078)**	(1.650)	(0.048)
TFP	-0.083	**0.167***	-1.180	0.011
	(0.063)	**(0.098)**	(3.236)	(0.068)
No. observations (plants)	1.570	969	1.783	1.574
Sargan test (p-value)	0.585	0.000	0.005	0.000
Hansen test (p-value)	0.879	0.060	0.174	0.046
Ar2 (p-value)	0.516	0.078	0.116	0.005

Source: Author's calculations. **Note:** Elasticities are significant at 10% (*), 5% (**) and 1% (***) confidence level.