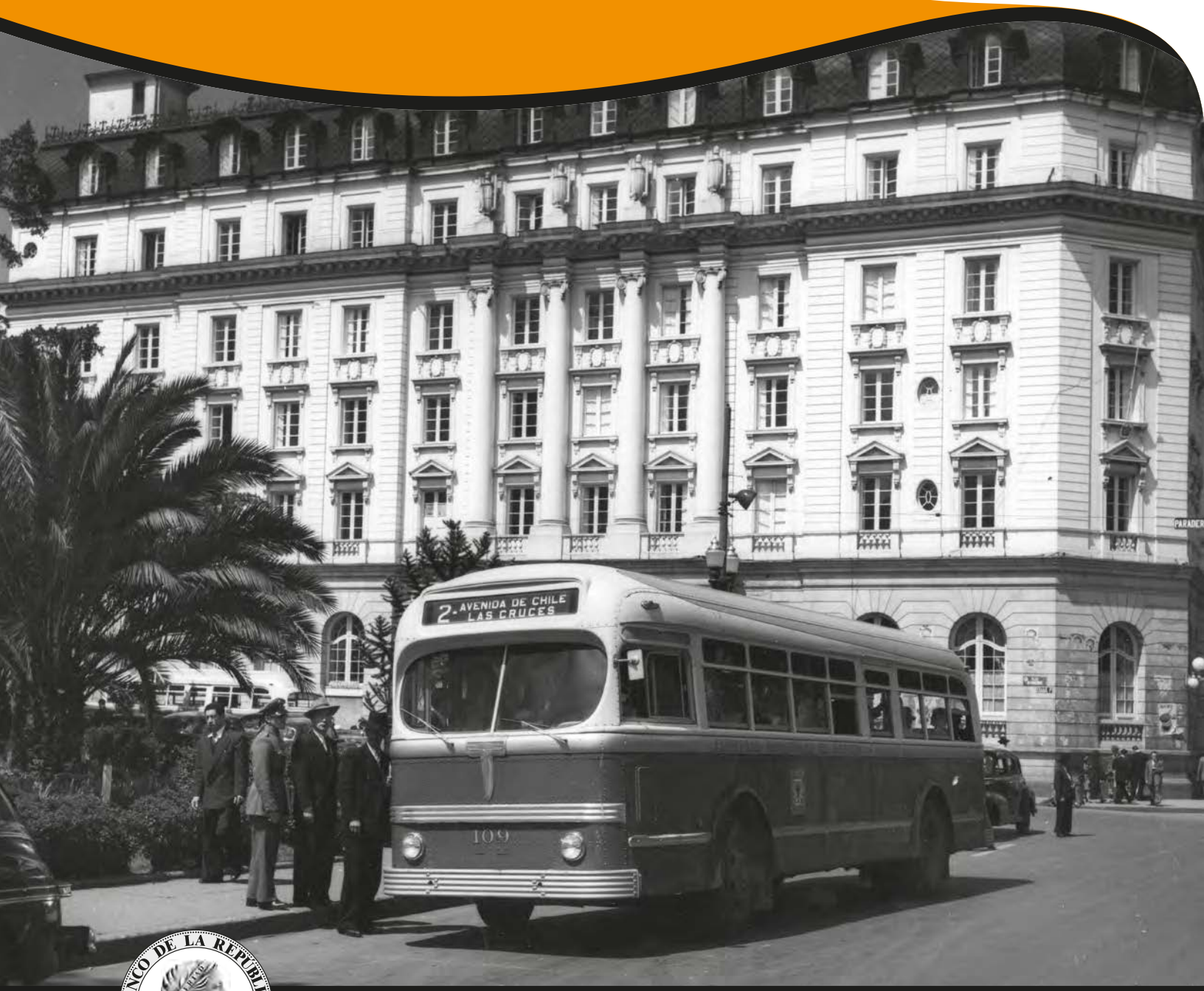
Borradores de ECONOMÍA

‘Disemployment’ effects of the minimum wage in the Colombian manufacturing sector

By: Luis E. Arango
Sergio A. Rivera

No. 1107
2020



Bogotá - Colombia - Bogotá - Colombia - Bogotá - Colombia - Bogotá - Colombia - Bogotá - Colombia - Bogotá - Colombia - Bogotá - Colombia

‘Disemployment’ effects of the minimum wage in the Colombian manufacturing sector

By

Luis E. Arango
Banco de la República
larangth@banrep.gov.co

Sergio A. Rivera[*]
Universidad del Rosario
riverad.sergio@gmail.com

Abstract

In a labour demand approach, we present evidence of the effect that variations of the real minimum wage has on the formal employment of the industrial sector. The sample includes all industrial establishments of the Annual Manufacturing Survey between 2000 and 2015 that were always active during the whole period. We differentiate the workforce between skilled and unskilled by types of contracts (permanent and temporary). The real wage paid to workers by plants is divided into two components: one linked to the minimum wage and other that mirrors the plants’ own-policy remuneration. The labour demand functions, conditional and unconditional, that we estimate are consistent with the theory and the previous literature. The evidence suggests that increases of the real minimum wage destroy employment fundamentally of unskilled labour, both permanent and temporary mainly in plants with less than 100 workers dedicated to production. The long-term elasticities of labour demand to the real minimum wage that we estimate in multiple specifications are between -0.615 and -0.715. Thus, an increase of 1 percent of the minimum wage reduces, ceteris paribus, labour demand about 0.7 percent within a period between one and two years. The real wage elasticity is between -0.358 and -0.718 while the sizeable output elasticity, about 1.6, suggests a high cyclicality of labour demand.

Keywords: minimum wage, employment, permanent workers, temporary workers, skilled and unskilled workers.
JEL classification: *J*23

[*] The series Borradores de Economía is published by the Research Unit of Banco de la República (the Central Bank of Colombia). The documents published are provisional, and their authors are fully responsible for the opinions expressed in them, as well as for possible mistakes. The contents of the works published do not compromise Banco de la República or its Board of Directors. We acknowledge the superb research assistance of Ingri Katherine Quevedo Romero. The authors are, respectively, senior researcher of the Research Unit and M.Sc. in Economics at Universidad del Rosario. Corresponding author: Luis E. Arango, phone + 57 1 3430676; Carrera 7 No. 14-78, Banco de la República, Bogotá - Colombia.

Efectos del salario mínimo en el empleo del sector manufacturero de Colombia

Luis E. Arango
Banco de la República
larangth@banrep.gov.co

Sergio A. Rivera[*]
Universidad del Rosario
riverad.sergio@gmail.com

Resumen

En un enfoque de demanda laboral, presentamos evidencia del efecto que tienen la variaciones del salario mínimo real en el empleo formal del sector industrial. La muestra incluye los establecimientos industriales de la Encuesta Anual de Manufactura entre 2000 y 2015 que estuvieron activos durante todo el período. Diferenciamos los trabajadores entre calificados y no calificados con contratos permanentes y temporales. El salario real que pagan las plantas a sus trabajadores se divide en dos componentes: uno vinculado al salario mínimo y otro que refleja la política de remuneración propia de la firma. Las funciones de demanda laboral estimadas, condicional e incondicional, son consistentes con la teoría y la literatura previa. La evidencia sugiere que los aumentos en el salario mínimo real destruyen el empleo fundamentalmente de mano de obra no calificada, tanto permanente como temporal, principalmente en planteas con menos de 100 trabajadores dedicados a la producción. Las elasticidades a largo plazo de la demanda laboral al salario mínimo real estimadas en múltiples especificaciones están entre -0,615 y -0,715. Esto es, con todo lo demás constante, un aumento del SM real de 1% produce una pérdida de puestos de trabajo de 0,7% en un horizonte de uno a dos años. La elasticidad al salario real está entre -0,358 y -0,718 mientras que la elasticidad al producto se sitúa alrededor de 1,6, lo cual sugiere una alta dependencia de la demanda laboral al ciclo económico.

Palabras clave: salario mínimo, empleo, empleados permanentes, empleados temporales, trabajadores calificados y no calificados.

JEL classification: *J*23

---

[*] La serie Borradores de Economía es publicada por la Unidad de Investigaciones Económicas del Banco de la República. Los trabajos publicados son provisionales y sus autores son enteramente responsables de las opiniones expresadas en ellos, así como de posibles errores. El contenido de los trabajos publicados no compromete al Banco de la República ni a su Junta Directiva. Se agradece la excelente labor como asistente de investigación de Ingri Katherine Quevedo Romero. Los autores son, respectivamente, investigador principal de la Unidad de Investigaciones del Banco de la República y Máster en Economía de la Universidad del Rosario. Autor para correspondencia: Luis E. Arango, teléfono + 57 1 3430676; Carrera 7 No. 14-78, Banco de la República, Bogotá - Colombia.

1. Introduction

In Colombia, like in many other developing countries, the minimum wage is a crucial policy variable aimed to protect the workers located in the lower end of the skills distribution. Furthermore, the support of the *International Labour Organization (ILO) Minimum Wage Fixing* allows the countries to use this instrument of policy to reduce financial and social injustice (ILO, 2013, p.51). Regardless that this labour market institution is present –practically– all over the world,[1] there is no agreement on whether such an institution reaches the objectives or not.

The controversy about the effects of the minimum wage on different aspects of the labour market such as employment, unemployment, informality, etc. and other dimensions of the economy like fiscal balances, pensions and protection to elderly, poverty and income distribution, economic growth, and so on, has been one of the hottest in economics. For example, by focussing in employment effects of the minimum wage, on the one hand, Neumark and Wascher (2008) show that it reduces employment opportunities for the less skilled workers, especially for those whose wage is close to the minimum, since employers tend to replace them with more qualified ones when the minimum wage increases. Neumark (2018, p.4) asserts that the minimum wage has adverse effects on employment, a conclusion based on studies about economies as diverse as Canada, Colombia, Costa Rica, Mexico, Portugal, the UK, and the US. For developing countries, Andalon and Pages (2008) found adverse effects of minimum wage legislation in Kenya on formal employment as well as an increase in labour informality. Broecke et al. (2017) compile the evidence found for some developing countries showing that while on average the effects found on employment generally are not large, they provide evidence of important negative effects for some vulnerable groups such as young people and people with low skills (see also, Wang et al., 2019; Okudaira et al. ,2019).

On the other hand, Card (1992a, 1992b) and Card and Krueger (1994, 1995), presented evidence that casts doubt on the adverse effects on employment of minimum wage increases. Furthermore, they showed positive effects of the increases. Meta-analyses conducted by Doucouliagos and Stanley (2009) found a negligible effect of the minimum wage on teenage employment in the US. In this strand of literature, De Linde Leonard, Stanley and Doucouliagos (2014) report no significant effect of the minimum wage on employment for the UK. In the same sense, conclude Belman and Wolfson (2014, chapter 4). More recently, Millea et al. (2017) examine some of the effects of the legislation on the sectoral minimum wage introduced in 2002 in South Africa. Their results do not suggest effects on the formal employment of any demographic group covered by the law, although they do for other workers in informal covered sectors.

As a synthesis of the mixed evidence and the lack of consensus of the effects of the minimum wage, Dube et al. (2010) uses two different methodologies, cross-state neighbour counties and nation-wide, the former with no employment effects while the latter with a labour demand elasticity close to -1.

[1] At 2012, "… less than a tenth of countries (6%) have monthly minimum wages of less than USD 50 per month, while a slightly higher percentage (8%) has no minimum wage. The largest group of countries comprises those that have monthly minimum wages of USD 50 to USD 149 (28%). The rest of the countries vary between USD 1000 or more (15%) and USD 300 to USD 999 (22%). The majority of countries with monthly minimum wages set above USD 1000 are industrialised countries." ILO (2013, p.53).

As for Colombia, Arango and Flórez (2018) provide evidence in the sense that the minimum wage has been a determinant of structural unemployment since 1984; nevertheless, its relevance has declined.[2] However, the contribution of the minimum wage to the structural or the observed unemployment persistence is not its only negative effect in the case of Colombia. Given the low productivity of the labour force (for a comparison with a bunch of countries, see Arango and Flórez, 2017, Figure 8[3]), the minimum wage seems to be a key determinant of the high labour informality. In fact, according to Arango and Flórez (2017) the high value of the minimum wage with respect to the median wage (about 85 percent), or with reference to the 70th percentile wage (about 65 percent), might be the source of the high labour informality rate and other symptoms of the faulty functioning of the labour market. Thus, Colombia seems to be an interesting case to observe the effects of the minimum wage policy in the employment dimension.

The purpose of this paper is to verify, within a labour demand framework, whether the minimum wage has adverse effects on manufacture employment between 2000 and 2015. To this aim, we use the panel structure of the Annual Manufacturing Survey (AMS hereafter). By differentiating across skills and contract modalities, we estimate the demand for labour and focus on long-term elasticities to the minimum wage, own-factor price, output, and total factor productivity (TFP). Thus, our approach is closer to a nation-wide study-case where the primary source of variation is the exogenous change of the minimum wage set annually all over the country. Then, we control for some time-varying slope coefficients and other labour demand variables. This work employs a parcial equilibrium approach; moreover, we disregard many other dimensions of the minimum wage such as its effects on welfare, labour informality, inequality, poverty, human capital accumulation, long-run growth, and so on.

A number of works have previously studied the factors behind labour demand in the manufacturing sector of Colombia (see, among many others, Roberts and Skoufias, 1997; Vivas, Farné and Urbano, 1998; Bernal and Cardenas, 2003; Arango and Rojas, 2005; Eslava, Haltiwanger, Kugler, and Kugler, 2010; Medina, Posso, Tamayo and Monsalve, 2013; Balat and Casas, 2018;[4] and, more recently, Arango, Castellani and Obando, 2019). Nevertheless, only Linda Bell (1997) analysed explicitly the effects of the minimum wage. She showed some of the negative effects of the minimum wage on employment using both time series and the AMS panel. In the first case, according to the author, the elasticity of employment to the minimum wage was -0.33 percent: the increase of 15 percent in the real minimum wage that occurred between 1977 and 1987, reduced manufacturing employment by 5 percent. With the panel, estimated that the elasticity of employment with respect to the minimum wage is between -0.15 percent and -0.33 percent in the case of unskilled workers and between -0.03 percent and -0.24 percent in the case of the qualified ones. In particular, Linda Bell points out that the 10 percent increase in the real minimum wage between 1981 and 1987 reduced low-skilled employment between 2 percent and 12

[2] The structural unemployment in Colombia is around 10 percent, one of the highest in Latin America (Ball, De Roux, & Hofstetter, 2013).

[3] While the output per worker (GDP constant 2005 US$ - ILO modelled estimates, Nov. 2016), for Colombia was US$10,066 the average for the rest of the OECD countries was US$59.200.

[4] Instead of using the AMS they used the "Business' Risk and Information System" (BRIS) dataset provided by the Colombian Superintendence of Corporations. This dataset pinpoints the exact locations of firms, which allow them to examine the determinants of firms' productivity related to city and sector characteristics.

percent in the same period. Ours adds Bell's (1997) work, contract modalities and a more fully-fledged demand for labour functions both conditional and unconditional for small and large establishments.

Apart from distinguishing between permanent-temporary and skilled-unskilled workers, our approach decomposes the own-factor price between the contribution of the minimum wage and a residual component. This way of treating the real wage allows us to separate the effect of the policy variations of the real minimum wage from the establishments' wage setting. Based not only on our preferred specification but also in most of the results, we found that, *ceteris paribus*, the increases of the real minimum wage destroys the employment mainly of unskilled workers both permanent and temporary in plants with 99 workers at most, that we call "small" in our work. Thus, the policy of sustained large increases of the real minimum wage carried out during this century (see Figure 4 below) might not have helped to formal employment in Colombia as we show in this paper. We also find a large cyclicality of industrial employment; in fact, the evidence suggests that labour demand is highly dependent on the demand for the product of the establishments.

The rest of the document develops in four sections after this introduction. Section 2 briefly describes the manufacturing across skills and contract modalities. Section 3 presents the theoretical guidelines and the empirical approach. Section 4 discusses the results of the estimated models and their most likely implications. Finally, Section 5 draws some conclusions.

2. Recent related facts of the Colombian manufacturing sector

The short description carried out in this section aims to highlight three aspects of the manufacturing employment. First, the subsectors that generate jobs the most; second, the composition of skilled and unskilled workers by contract modalities, and third, the behaviour of the minimum wage during the sample period.

Between 2001 and 2018, the participation of the manufacturing sector in the total employment, ranged between 11 and 14.5 percent being the fourth sector of the economy. In 2018, it contributed with 12.3 percent of the jobs, behind trade (26.7 percent), services (20 percent) and agriculture (16 percent).[5] According to the *Great Integrated Household Survey*, GIHS, of the Administrative Department of Statistics in Colombia (Departamento Administrativo Nacional de Estadístico, Dane) in 2015, the industrial sector generated 2.7 million jobs while according to the information of the Annual Manufacturing Survey (AMS) of the Dane 9,015 establishments, generated 711,827 jobs.

The average annual growth rate of the output of the manufacturing sector and GDP were 2.88 percent[6] and 4.26 percent, respectively, between 2000 and 2015, while the average annual growth rate of manufacturing employment was 1.9 percent. The manufacturing output and employment growth rates during the period are highly correlated, suggesting that the former has been the main engine of manufacturing employment growth. In fact, Arango, Castellani, and Obando, (2019; Table 1) estimated

[5] See the Great Integrated Household Survey of June Annex (2018).

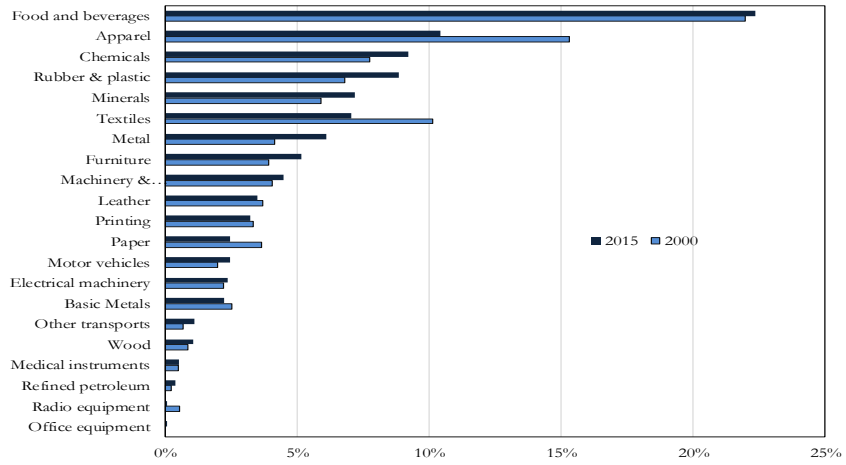
[6] The information of the manufacturing sector output is available on the Administrative Department of Statistics (DANE) website from 1992 to 2016; it includes a summary of the manufacturing sector principal variables. Using the historic annual information, we generate a time series data by year of the total added value in real terms from 2000 to 2015 and calculate the average annual growth rate.

long-term output elasticities as high as 1.12 and 1.05 for skilled and unskilled workers respectively, both larger than the own-factor price elasticities of -0.59 and -0.42.

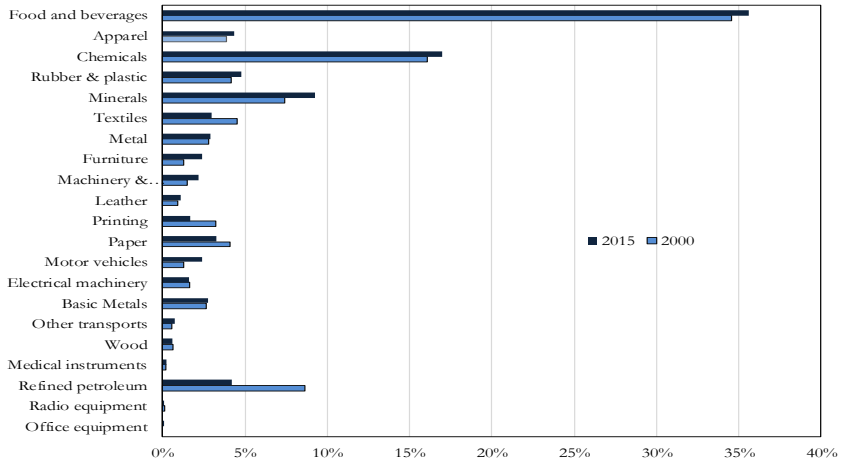
Figure 1 shows the contributions, in percentage terms, of each subsector to employment (panel A) and value added generation (panel B) in the years 2000 and 2015. In the former, food and beverages, apparel, chemicals, rubber and plastic, minerals and textiles were the six largest subsectors in employment, concentrating 68 percent of the jobs; these subsectors remained at the top as employment generators in the sixteen years of the sample. Indeed, they contribute with about 65 percent of jobs in 2015. Out of them, five subsectors are also among the top six with the highest output, where refined petroleum displaced apparel in 2000 and textiles in 2015. With the exception of the latter, the largest employment generator subsectors increased their participation in the manufacturing's output.[7]

Figure 1. Employment and output by industrial subsector 2000-2015

A. Employment



B. Value added



Source: DANE-EAM. Author's calculations.

[7] Refined petroleum reduced its share from 8.6 percent in 2000 to 4.2 percent in 2015.

Figure A1 in the Appendix shows that the output shares of food and beverages, and chemicals, surpass the employment shares in about 13.2 and 7.8 percentage points in 2015. This fact might well suggest that these subsectors have highly productive workers while there are subsectors with a high share of employment and lower share in the output value such as textiles, apparel, and rubber and plastic. In these subsectors, the per capita output is rather low.

Employment in manufacturing can be analysed by sorting workers in different groups. Three of them are qualification (skilled and unskilled), contract modalities (open-ended and temporary) and the size of plants (large and small)[8]. The composition of labour force along these dimensions, within the manufacturing sector, mirrors the demand for the output of plants, labour costs, regulations, and characteristics of labour supply.

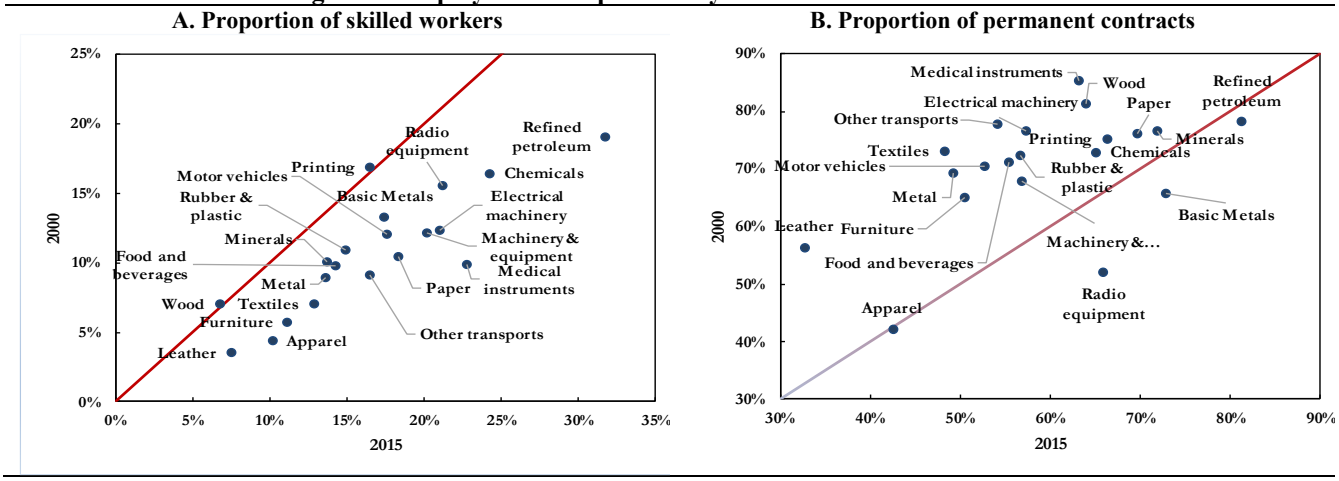
The AMS provides information about the skills of workers. This type of workers include professionals, technicians, and specialists such as mechanical, chemical, industrial, electrical, mining, and petroleum engineers, etc., while unskilled workers are those involved in activities such as manufacturing, processing, assembly, installation, maintenance, inspection, storage, packing, loading, and unloading.

Figure 2A displays the participation of both skilled workers and permanent-contract workers in the Colombian industry by subsectors. The vertical axis presents the participation in 2000 and the horizontal axis the participations in 2015. The 45-degree line corresponds to equal shares in those two years; thus, a dot below and to the right of the line represents an increase in the participation in 2015 with respect to 2000. Accordingly, the share of skilled labour in the workforce has increased in almost all subsectors, where refined petroleum, medical instruments, and chemicals had the largest changes.

Based on the evidence of Castellani et al. (2017) and Arango et al. (2019) we split the workers between permanent and temporary depending on the contract modality in which they are engaged with the establishments. In fact, according to these authors, there is a two-tier employment regime that drives the labour market to a partial segmentation between permanent and temporary workers. These authors suggest a strategic composition of the labour force in the industrial sector as a response to the differential costs generated by open-ended contracts and fixed-term contracts.[9] Figure 2B shows that the prevalence of permanent contracts has decreased especially in textiles, leather, medical instruments, and other types of transport equipment. The result is a manufacturing workforce with a larger participation of skilled workers in 2015 with respect to 2000 and a larger prevalence of temporary contracts in the extreme years of the sample period; these changes in the composition of the labour force might be the result of changes in the relative prices of different types of labour force and other facts related, for example, to the exposition to competence, the demand for the output, quality of products, and so on.

[8] Sex, geographical, and sectoral compositions are also available.
[9] See footnote 11 of Arango, Castellani and Obando (2019) for cost differences between permanent and temporary workers. Such differences are not included here to save space.

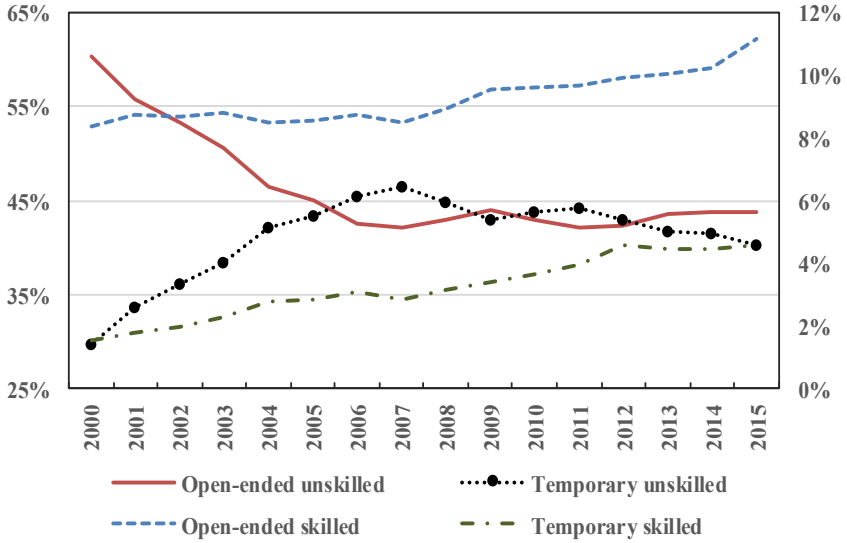
Figure 2. Employment composition by skill and contract modalities



Source: DANE-EAM. Author's calculations.

Figure 3 shows the composition of the labour force attached to the production process in the manufacturing sector by skill-level and contract modalities. The behaviour of permanent unskilled workers is remarkable; their share decreased until 2007 and then had a slight recovery. The reduction of workers with permanent contracts was about 16 percentage points during the sample period; first, there was a reduction of 18 percentage points and then a recovery of about 2 percentage points between 2007 and 2015. Conversely, temporary unskilled workers increased up until 2007 when it reached a proportion of 46 percent of total manufacturing workers then it decreased by about 6 percentage points. At the end of the sample period, the unskilled workers both permanent and temporary represented 84 percent of total workers in the industrial sector. In 2015, the skilled workers, on the other hand, represented the 16 percent of the total workers where the open-ended contracted were about 11 percent while those contracted temporarily represented 5 percent.

Figure 3. Composition of the labour force attached to the production process in the manufacturing sector by skill and contract modalities.

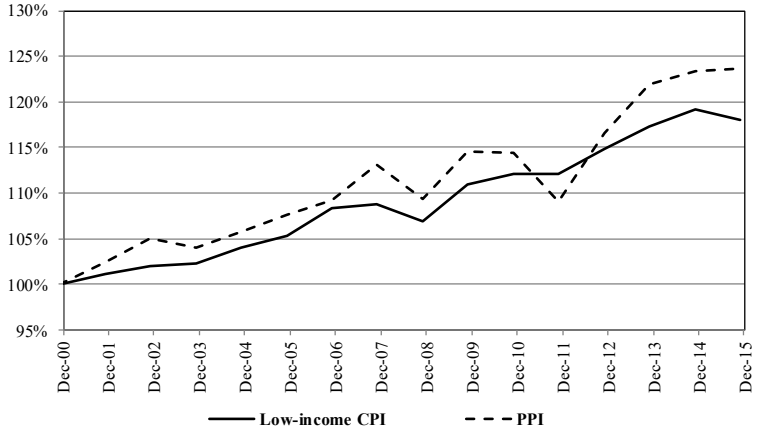


Note: Open-ended and temporary unskilled are measured on the left-hand-side axis while open-ended and temporary skilled are measured on the right-hand-side axis.
Source: DANE-EAM. Author's calculations.

The change of permanent workers' participation –in total employment- over the sample period was about 14 percentage points; in fact, it started in 2000 with a proportion of 69 percent and ended in 2015 with a proportion of 55 percent. This structural change in employment composition is the optimal response of employers, who are in the search for lower labour costs and more flexible contract modalities, to shocks to the relative prices of different types of labour as we show below and other types of shocks. However, it poses a challenge as a larger number of temporary workers might affect firm productivity in the long run (see Castellani et al., 2017; Lisi and Malo, 2017). Temporary contracts have been associated with fewer incentives to establish solid labour relations, training, etc. (Alaimo et al. 2015; Pierre and Scarpetta 2013; Addison and Teixeira 2003).

In this work, we check the hypothesis that the demand for labour is affected by the minimum wage. Figure 4 shows the behaviour of the minimum wage index during the sample period in real terms. Such variable that –in nominal terms- should be set in accordance with the evolution of economic activity and some other considerations[10] had a positive slope trend deflated with both the consumer price index for the low-income people and producer price index. In the first case, the increase was 18 percentage points during the sample period while in the second case the increase was 23.7 percentage points. This, would mean that labour productivity of less skilled workers grew annually between 1.2 percent and 1.58 percent, an interpretation that is not easy to endorse given the effects of minimum wage on the labour informality already documented (see, for example, Arango and Flórez, 2017).

Figure 4. Real minimum wage index



Source: Ministry of Labour and DANE. Author's calculations.

[10] In Colombia, the minimum wage is determined annually at the end of the year. Article 53 of Chapter 2 of the Political Constitution entitle "On social, economic and cultural rights", states that "[…] the labour legislation must take into account the minimum remuneration, proportional to the quantity and quality of work as one of its basic elements." In accordance with Law 278 of 1996, the Permanent Commission for Salaries and Labour Policies Coordination must "[...] establish in a concerted manner the general minimum wage, taking into account that a decent quality of life must be guaranteed for the worker and his family." The rule says that "[...] when definitively no consensus at the thirty (30) of December of each year, the Government will determine it taking as parameters the inflation target of the following year set by the Board of Directors of the Central Bank and the productivity stipulated by the tripartite productivity committee coordinated by the Ministry of Labour. It also must be taken into account, the contribution of wages to national income, the increase in the gross domestic product (GDP) and the consumer price index (CPI)." In 1999, the Constitutional Court (Judgment C-815/99) stipulated that past inflation had to be included to the criteria for setting the minimum wage.

In summary, six subsectors, out of twenty-one, generate most (65 percent) of the manufacturing employment; in the sample period, temporary workers went from representing 31 percent to represent 45 percent of the total workforce linked to the production process. Conversely, the permanent workers were 69 percent in 2000 while in 2015 it represented 55 percent of workers. Finally, the increase in the real minimum wage suggests an increase in the productivity of less skilled workers that exceed 1% per year, a pace of growth difficult to endorse.

3. Empirical approach and data

The labour theory presents the framework to estimate conditional an unconditional labour demand functions in the settings of the competitive model (Cahuc and Zylberberg, 2004). With a multifactorial production function in a static setup, the conditional labour demand is obtained by minimizing the cost function conditional on a production level and depends on product demand, productivity and relative factor prices: $l(1/w\,, r, y/A\,; \alpha)$, where w, r, y, A and α correspond, respectively to real wage, capital price, output, technology and the parameters of the production function. The labour demand can also be obtained by maximizing the profit function and the resulting unconditional labour demand depends on the same variables except for the demand of the firm's product; that is, $l(1/w\,, 1/r\,, A; \alpha)$.

The static framework is useful to guide the inclusion of variables in empirical labour demand specifications. However, it neglects the presence of adjustment costs in a dynamic context where there is also uncertainty about factor prices, final good prices, taxes, new profit opportunities and productivity (Hamermesh, 1993). By assuming that the firm has rational expectations and that all available information at period *t* is used to form the expectations about future labour demand, we have the empirical model (see Hamermesh, chapter 7, 1993) given by

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

where $l_{i,k,t}$ is the logarithm of the number of workers type k (total, skilled, unskilled, permanent, and temporary workers) at establishment i in period (year) t. The model includes just one autoregressive term as in Arango et al. (2019), which allows us to recover information about the adjustment costs. The index m in $X_{i,m,k,t-j}$ corresponds to the K different factors behind labour demand which in the empirical model include the real minimum wage, the own-factor price (the average real wage paid by the firm), the total factor productivity (TFP) indicator, the real interest rate, the value added of the firm in real terms, the real price of energy, etc.[11] Thus, the vector of parameters to be estimated is $\mu_{m,k,j}$, while $\omega_{i,k,t}$ is a residual term. Additional controls such as energy price, depreciation rate, and a lagged value of the labour participation rate in the city of the plant are also included in the regression. The latter variable has the purpose of controlling for some aspects of labour supply that interplay with the demand for labour within cities.

Given the difficulty to analyse the short-run elasticities within a dynamic framework, we compute long-term coefficients. Based on expression (1), this corresponds to $\partial l_{k,m}/\partial X_{k,m} = (\mu_{k,m,0} + \mu_{k,m,1})/(1 - \lambda_k)$ (see Hamermesh, 1993, chapter 7) while the standard errors of the long-run

[11] Variables are all in real terms unless otherwise stated.

elasticities are computed by using the delta method. As we just stated, m indexes variables such as the real minimum wage, real wage (i.e., own-factor price), interest rate, output, TFP, etc.

The labour demand corresponds to the number of type$-k$ workers reported by each establishment. This variable can be splitted depending on the group in which the researcher is interested. Thus, we focus on skills and contract modalities. In addition, output corresponds to the total value added in each plant computed as the difference between gross production and intermediate consumption, while the energy prices are the payments for this concept made by the establishment. The depreciation rate is the annual value established as a replacement for the use or obsolescence of fixed assets adjusted for inflation during their useful life as a proportion of total assets. The real interest rate corresponds to the ordinary and preferential interest rates[12] since the real rental price of each plant is not available.

Two variables deserve special attention; these are real wages (minimum and own-factor price) and TFP. With respect to the formers, as the AMS does not provide information about individual real wages, these are computed by dividing the respective payroll, in real terms (deflated by 2 digit SIC PPI), among the number of total, skilled, unskilled, permanent, and temporary workers. However, the own-factor price and the minimum wage might exhibit some simultaneity (i.e., share some information) in the sense that the internal wage policy of the plants might overlap, to some extent, with the national wage policy represented by the annual variation of the minimum wage. In other words, the annual variation of the minimum wage may affect the annual variation of the wage paid by the establishment.[13] Moreover, the level of the minimum wage might also influence the level of the former. Thus, instead of incorporating the two wages (own-factor price and minimum) in the empirical specifications of labour demand used below, we split the real wage into two components: the information it contains about the minimum wage and the residual, which would represent the internal wage policy of the plants. Thus, we estimate seven different panels; one for the wage of total workers and six for each type of them combined by skill and contract modalities. That is, wages for total workers, skilled, unskilled, open-ended skilled, temporary skilled, open-ended unskilled, and temporary unskilled. The specification of the panel is

$$ln\left(wp_{i,k,t}\right) = \delta_k^{const} + \delta_k ln(mw_t) + \epsilon_{i,k,t} \quad j = skilled, unskilled, etc. \qquad (2)$$

where $wp_{i,k,t}$ represents the wage paid by plant i to workers type k in time t; mw_t is the minimum wage, and $\epsilon_{i,k,t}$ stands for the residual term associated with the wage policy of the plants. The results of these estimations appear in Table 1.

All models suggest that the minimum wage is mirrored in the own-factor price paid by the establishment to the workers, where the highest loading factors correspond, as is expected, to unskilled workers as we can observe in columns (3), (6) and (7) of Table 1. By contrast, the coefficients associated with the wages of skilled workers are lower. To generate the minimum wage used in the regressions of labour demand presented below, we use the second element of the right-hand-side of (2); that is: $\delta_k \ln(mw_t)$, while the

[12] We use these two rates depending on the size of the plant. Preferential rate is the interest rate on loans granted to large and very large establishments (about 32 percent of the plants) while the ordinary corresponds to the interest rate of credits requested by medium size establishments. The interest rate included in the estimation is obtained from the Financial Superintendence of Colombia and the assumption we make is that large and very large firms obtain a preferential interest rate, while the rest only can access ordinary interest rates. This variable is used as proxy of the cost of capital for the firms in the sample.

[13] We refer to this as the signalling introduced by the minimum wage increases.

own-factor price corresponds to $\delta_k^{const} + \epsilon_{i,k,t}$. Since these two elements reflect the own-factor price policy of each plant in the AMS, we do not expect it is free of some autocorrelation or any other structure of the innovation processess. Thus, do not carry out any further tests in this sense.

Table 1. Effect of minimum wage on own-factor price (real wage) in the balanced panel. Fixed-effects. 2000-2015

Variables	Total workers	Skilled	Unskilled	Open-ended skilled	Temporary skilled	Open-ended unskilled	Temporary unskilled
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Minimum wage	0.830***	0.383***	0.844***	0.552***	0.628***	1.022***	0.883***
	(0.007)	(0.026)	(0.010)	(0.027)	(0.087)	(0.015)	(0.026)
Constant	5.729***	12.288***	5.436***	10.230***	8.382***	3.350***	4.623***
	(0.089)	(0.334)	(0.136)	(0.357)	(1.137)	(0.196)	(0.340)
Observations	32,418	20,735	32,068	18,367	7,709	26,537	19,387
Plants	2,043	1,709	2,042	1,616	1,145	1,945	1,736
R^2	0.327	0.012	0.181	0.024	0.008	0.160	0.061

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

The construction of the TFP also calls for some attention since this unobserved variable could be biased by firms' selection through time, the endogeneity between inputs and production, and unobservable heterogeneity of firms. Then TFP is computed by means of the Levinsohn and Petrin's (2003) algorithm, which uses the energy price paid by the establishments as the intermediate input.[14] Following the prescription of Levinsohn and Petrin (2003), to compute TFP we also include the total cost of all materials used by the establishments in the production. Thus, the TFP shock can be expressed as a function of intermediate inputs and capital that are approximated in the production function by polynomials.

Finally, it is important to mention that, except for the real interest rate, the depreciation rate, and labour participation; all variables are expressed in logarithms.

4. Determinants of labour demand

Having defined the variables and the empirical model, we first estimate a fixed-effects panel by using all plants of the balanced panel and the conditional version of demand for labour. The estimates of labour demand in Table 2 correspond not only to total workers but also to different groups of the manpower. In fact, we split the labour demand between skilled, unskilled, and further by contract modalities. The dissection of workers in this way relies upon the segmentation hypothesis of the labour force in the industrial sector set forth by Castellani et al. (2017) [see also Arango et al., (2019)]. According to them, the optimal responses of employers to shocks depend on the type of workers they have or could have in the plants.

[14] This is different from Olley and Pakes' (1996) approach that uses the firm's capital investment decision as an identification strategy.

Table 2. Long term elasticities of conditional labour demand. Fixed-effects panel. (2000-2015)

Variables	Total workers	Skilled	Unskilled	Open-ended skilled	Temporary skilled	Open-ended unskilled	Temporary unskilled
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Minimum wage	-0.181***	-0.307	-0.261**	0.523*	0.474	-0.204*	0.000
	(0.067)	(0.416)	(0.085)	(0.288)	(0.726)	(0.118)	(0.233)
Own-factor price	-0.271***	-0.243***	-0.114***	-0.409***	-0.133***	-0.448***	-0.061***
	(0.008)	(0.007)	(0.006)	(0.009)	(0.013)	(0.009)	(0.009)
TFP	-1.316***	-1.828***	-1.199***	-1.374***	-1.871***	-0.627***	-1.233***
	(0.013)	(0.039)	(0.018)	(0.040)	(0.104)	(0.030)	(0.048)
Value added	1.422***	1.819***	1.313***	1.374***	1.843***	0.733***	1.475***
	(0.013)	(0.027)	(0.008)	(0.039)	(0.104)	(0.030)	(0.048)
Interest rate	0.001	-0.008**	0.001	0.001	-0.008	0.005**	-0.003
	(0.001)	(0.004)	(0.002)	(0.004)	(0.009)	(0.003)	(0.004)
Observations	28,658	15,240	25,363	18,033	4,388	19,997	13,978

Notes: *, ** and * denote significance at the 1%, 5% and 10% levels, respectively. The estimates correspond to the balanced panel. Source: DANE-AMS, authors' calculations.**

We use the AMS panel at establishment level between 2000 and 2015. This balanced panel accounts for 2,025 plants.[15] As we can observe in Table 2, all estimates of own-factor price, TFP, and value added long-run elasticities are statistically significant and have the expected sign. Noteworthy, the real minimum wage is significant and with the expected sign in the demand functions for total, unskilled, and open-ended unskilled workers. It is also significant in the case of skilled workers but with a positive sign, a fact that could be explained in the light of labour substitution, but this is a discussion we postpone for later. Table 2 also shows another important result such as the high elasticity of labour demand with respect to output; that is the high cyclicality of the employment in the industrial sector.

Regardless that estimates in Table 2 may well represent labour demand functions, the coefficients might be biased due to some potential endogeneity. An accurate estimation of the parameters of interest should consider the source of variation grouped in the residual term, $\omega_{i,k,t}$, which includes four elements: $\omega_{i,k,t} = \eta_{i,k} + \gamma_{k,t} + \upsilon_{i,k,t} + \varepsilon_{i,k,t}$. The first element, $\eta_{i,k}$, comprises the establishments' unobserved heterogeneity related to characteristics such as properties of the output, managerial efficiency, and technical knowledge as set forth by Roberts and Skoufias (1997). If managers are aware of these establishments' specific components, these will most likely lead to observable differences in dimensions as output, factor demands, prices, etc. Disregarding such components would result in biased coefficients.[16] Time varying shocks such as changes in labour or competition regulations announced within the year might affect relative prices of different types of labour used by all plants of the industry; this kind of shocks, denoted by $\gamma_{k,t}$, might also affect decisions related to the level or composition of output. On the other hand, idiosyncratic time varying shocks to establishments, like equipment breakdowns, unforeseen fluctuations in demand, factor supplies, changing financial environment, and reporting errors, are linked to the third error source, $\upsilon_{i,k,t}$.[17] Finally, the fourth source of error, $\varepsilon_{i,k,t}$, is a

[15] Composed by plants that survive the whole sample period, have a value added greater than zero each period, and have sensible total (production and non-production) labour shares, although we admit it were 1.5 at most for just one period. Since this measurement error is not common in AMS, we retain those observations.

[16] See Tybout and Westbrook (1995) on the effect of unobserved heterogeneity on scale estimates.

[17] Unforeseen fluctuations in demand of the firm's products can alter both output and labour demand simultaneously. 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 labour hired as well as its corresponding payroll. Financial idiosyncratic shocks can modify both the average wage paid to employees and the total of employees hired.

well-behaved zero-mean shock varying across time and establishments. Thus, our identification strategy also should consider that real wages [$\delta_k^{const} + \epsilon_{i,k,t}$ in the notation of expression (2)] and output are also potentially endogenous. We assume that minimum wage, Levinsohn-Pretin-type TFP, and interest rates are exogenous.

Addressing the aforementioned sources of bias, as well as any potential reverse causality of both real wage and value added with labour demand, we use an instrumental variables approach along with some moment conditions. Thus, we follow the generalized method of moments (GMM) estimation procedure of Blundell and Bond (1998) that combines, within a panel framework, both lagged levels and lagged first differences as instruments to improve the efficiency of the estimator. Additionally, we also implement the Windmeijer (2005) correction to address the downward bias of the two-step GMM standard deviation estimator shown in Arellano and Bond (1991).

Output and real wage endogeneity can be addressed by using lagged values of these variables, as well as labour demand and the nominal minimum wage taking advantage of the instrument matrix structure. In addition, lagged first differences are also used which can, in turn, help to improve efficiency when the lagged levels are weak instruments. This happens when λ_k is close to one or when the variance of the fixed effects (σ_η^2, σ_γ^2) are higher than the variance of the time varying idiosyncratic shocks (σ_v^2). Thus, lagged levels and lagged differences of labour demand, output, wages, and the nominal minimum wage[18] are used as instruments in the conditional specification and lagged levels and differences of labour demand, real wages and minimum wage are used in the unconditional specifications of labour demand.

Table 3 shows the initial estimates of the total labour demand based in the balanced panel. Apart from the autoregressive component, it also includes the minimum wage, own-factor price (real wage), TFP, and value-added long-term elasticities. The results in this table and subsequent correspond to models with contemporary and lagged values of most variables, including, as we stated before, lagged energy prices, depreciation rate and other intermediate inputs as well as lagged realizations of labour participation rate in the city of the establishments as a way to control for some labour supply movements. All models of Table 3 include time fixed effects.

Columns (1) to (5) content conditional labour demand coefficients while columns (6) to (9) show those of the unconditional specifications. Column (1) shows the results of the basic model while columns (2) to (5) present the same model but including interactions of subsectors -other than the six ones that generate jobs the most- with minimum wage, own-factor price, TFP, and value added. The coefficients of the basic model in column (1) for total workers are statistically significant and have the expected sign. In addition, the size of coefficients correspond to those found, in general, in the literature (see Hamermesh, 1993). In particular, the parameter of interest is negative suggesting that *–ceteris paribus-* one percent increase of the minimum wage reduces employment in 0.741 percent.

[18] This includes the own prices of labour demand as well as the minimum wage since both are included in the model as determinants of labour demand. Average real wage, minimum wage, added value starting at lag three as well as year dummies are used as instruments.

Table 3. Long term elasticities of labour demand. Balanced panel GMM estimates (2000-2015)

Variables	Conditional labour demand					Unconditional labour demand			
	Basic	Interactions with all but six subsectors that generate employment the most				Basic	Interactions with all but six subsectors that generate employment the most		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Autoregressive	0.644***	0.729***	0.729***	0.731***	0.734***	0.329**	0.407**	0.305*	0.351**
	(0.068)	(0.037)	(0.037)	(0.037)	(0.037)	(0.140)	(0.191)	(0.149)	(0.156)
Minimum wage	-0.741***	-0.734***	-0.693***	-0.701***	-0.686***	-0.081	2.883*	-0.120	-0.105
	(0.139)	(0.139)	(0.131)	(0.134)	(0.136)	(0.279)	(1.623)	(0.305)	(0.314)
Own-factor price	-0.387**	-0.554***	-0.558***	-0.543***	-0.535***	-0.413*	-0.325	-0.065	-0.570***
	(0.155)	(0.154)	(0.144)	(0.150)	(0.155)	(0.215)	(0.285)	(0.623)	(0.215)
TFP	-1.582***	-1.649***	-1.637***	-1.646***	-1.606***	0.618	0.370	0.628	0.254
	(0.313)	(0.241)	(0.240)	(0.242)	(0.246)	(0.521)	(0.588)	(0.495)	(0.499)
Value added (AV)	1.700***	1.834***	1.834***	1.825***	1.783***				
	(0.294)	(0.205)	(0.202)	(0.206)	(0.210)				
MW × (1-six main subsectors)		0.029					-7.280*		
		(0.022)					(4.043)		
Own-factor price × (1-six main sectors)			0.059					-0.774	
			(0.041)					0.605	
TFP × (1-six main subsectors)				0.030					0.906
				(0.021)					0.247
AV × (1-six main subsectors)					0.021				
					(0.016)				
Number of observations	25,032	25,032	25,032	25,032	25,032	25,032	25,032	25,032	25,032
Number of id	2,025	2,025	2,025	2,025	2,025	2,025	2,025	2,025	2,025
***p*-Hansen**	0.0117	0.0167	0.0111	0.0106	0.00649	6.83e-05	0.000445	8.97e-05	0.0697
***p*-Ar(2)**	0.349	0.469	0.475	0.478	0.518	0.434	0.598	0.344	0.917

Notes: coefficients are significant at 10% (*), 5% (**) and 1% (***) confidence level. All models include time fixed-effects. Source: DANE-AMS, authors' calculations.

As we mentioned above, six subsectors account for 65 percent of jobs in the industrial sector.[19] Thus, we check whether the elasticities are different from the rest of the manufacturing sectors and, mainly, whether the parameter of interest changes when including interactions of the least job-generator subsectors with the main variables of the labour demand functions (minimum wage, own-factor price, value added, and TFP). However, as we can observe, there are not important changes in the coefficients. In these specifications, the elasticities corresponding to TFP and value added are higher than 1, in absolute value, suggesting that plants operate production functions under diminishing returns to scale. In other words, according to these estimates, the industrial labour demand presents important cyclical effects with important adjustments in the quantities demanded of the labour force.

Coefficients of the unconditional labour demand [columns (6) to (9)] are not always statistically significant. In particular, in the case of the minimum wage the results suggest that given an increase of the minimum wage, destruction of employment only occurs in plants of subsectors that do not generate the highest proportion of jobs in the manufacturing sector [see column (7)]. In plants of the six subsectors with the higher proportion of workers increases of the minimum wage conduct to an increase of the number of workers.

Apart from the generation of jobs in the industrial sector, another interesting partition of the panel is by the size of the plants to observe any difference in the responses to changes in the minimum wage. Thus, in first place, we divide the establishments between large (those with 100 workers or more) and small (with up to 99 workers). All models, from now on, also include SIC fixed effects with the aim,

[19] These subsectors are food and beverages, apparel, chemicals, rubber and plastic, minerals and textiles.

among other things, of controlling for mark-up movements in unconditional specifications of labour demands.

Table 4 shows the estimates of conditional [columns (1) and (2)] and unconditional [columns (3) and (4)] labour demand functions by dividing the panel by size of plants.[20] According to the autoregressive coefficients, the conditional demand functions exhibit more memory of the previous levels of workers than the unconditional ones; this might be signaling some slower adjustment processes in the case of the constant product. This result is consistent with those of Table 3 but not with the two types of demand functions that we are estimating since the adjustment should be slower when the scale effects are considered as in the case of unconditional demand functions, but the outcome is the other way around. In addition, the estimates suggest that the adjustments are faster in large plants than in the small ones in the case of conditional demand but slower than the small plants in the case of unconditional. The minimum wage elasticities are significant for large and small plants under the conditional specification but not under the unconditional ones. As we can observe, the conditional demand elasticities with respect to output are rather high [see columns (1) and (2)].

Table 4. Long-term elasticities of labour demand by plants' size. Balanced panel GMM estimates (2000-2015)

Variables	Conditional		Unconditional	
	Large	Small	Large	Small
	(1)	(2)	(3)	(4)
Autoregressive	0.446***	0.695***	0.399*	0.316**
	(0.106)	(0.068)	(0.225)	(0.127)
Minimum wage	-0.430**	-0.693***	-0.145	0.135
	(0.209)	(0.175)	(1.007)	(0.267)
Own-factor price	-0.555***	-0.268*	-0.802	-0.479***
	(0.214)	(0.161)	0.356	(0.147)
TFP	-1.370***	-2.150***	0.356	-0.040
	(0.418)	(0.511)	(0.489)	(0.268)
Value added (AV)	1.638***	2.289***		
	(0.399)	(0.484)		
Observations	6,970	18,062	6,970	18,062
Number of id	535	1,490	535	1,490
***p*-Hansen**	0.431	0.0339	0.000545	0.00334
***p*-Ar(2)**	0.490	0.158	0.739	0.601

Notes: large plants are those with 100 workers or more while with less than 100 workers. All models include time and SIC fixed-effects. Coefficients are significant at 10% (*), 5% (**) and 1% (***) confidence level. Source: DANE-AMS, authors' calculations.

The estimates for total labour in Tables 3 and 4 might not be fully informative about the true factors behind the labour demand given the segmentation of the labour force in the industrial sector (see Castellani et al., 2017; and, Arango et al., 2019). Thus, in Table 5 and subsequent, we consider as in Table 2 different kinds of workers. In columns (2) and (4), the estimates suggest that increases of the minimum wage reduce the employment of unskilled workers. According to the elasticities with respect to the minimum wage, the demand for unskilled permanent workers is more responsive (-0.983) than the temporary one for which the estimate is not significant (-0.278). Interestingly, in the former case, the

[20] Average employment in small size plants is about 9.2% of the total employment during the sample period in the balanced panel we use for empirical purposes.

own-factor price elasticity (-0.955) remains significant and with the expected sign. The elasticity with respect to the minimum wage of total unskilled workers is -0.860.

The magnitude of minimum wage elasticities suggests a rather small increase of earnings of the less skilled stayer workers. That is, considering that the (absolute) value of the elasticities is less than 1, the aggregate earnings of (the stayers) unskilled workers will increase when the minimum wage also increases, but this labour market outcome might not be fully satisfactory given the firing process that –accordingly- takes place in response to the minimum wage's increases. In this specification, the demand for skilled workers is completely inelastic to the minimum wage but not to the own-factor price as we can observe in columns (1), (3) and (5).

The evidence of the adverse effects of the real minimum wage increases in the demand for unskilled workers is clearer in the case of conditional demand than in the unconditional where, regardless of having the expected sign, no coefficient is statistically significant [see columns (7) to (12)]. In this sense, the null hypothesis that the demand for labour is inelastic with respect to the minimum wage cannot be rejected. Except for the unskilled temporary workers under both conditional and unconditional specifications and skilled open-ended in the latter, we can assert that the demand for labour is responsive to changes of the real wage.

One possible element of the labour demand functions that we should consider is the potential substitution among different kinds of labour. This is because some types of work can be substituted out by others depending on the technical conditions of the production process and relative prices of the different types of labour we are considering. In first place, to account for potential substitutability among workers, we use the levels (stocks) of other workers used in the production process. The argument to include substitution this way is that not only the wage of the potential substitutes –also used below– is relevant; the real interest rate, the compatibility with TFP movements, etc., could also be important. Thus, these variables are better accounted for via the stocks of potential labour force substitutes.

Accordingly, the results of the specifications in Table 6 include the levels of other workers used in the production process. As we just mentioned, under particular technical conditions, any type of labour force might replace other. That is, in some cases, permanent skilled workers can be used instead of other temporary skilled in the production process or the other way around. These levels of potential substitutes are endogenous variables; thus, the specifications in Table 6 instrument them as well as the other endogenous variables adding their past realizations to the set of instruments. As before, columns (1) to (6) correspond to conditional demand while columns (7) to (12) correspond to unconditional.

First, in columns (1) to (6), we observe that the adverse effects of changes in the minimum wage are statistically significant only for unskilled workers, corresponding the highest elasticity to temporary unskilled workers (-0.715) and the lowest to total unskilled workers (-0.618). The own-factor price elasticities are also significant and negative, except for temporary workers, both skilled and unskilled, although the size of the coefficients –when these are significant- accord with those found in similar studies (see Hamermesh, 1994), thus, on these grounds, this is our preferred specification where the importance of the inclusion substitutes is manifest.

Table 5. Long-term labour demand elasticities without substitutes. Balanced panel GMM estimates (2000-2015)

Variables	Conditional demand for labour						Unconditional demand for labour					
	Skilled	Unskilled	Open-ended		Temporary		Skilled	Unskilled	Open-ended		Temporary	
			Skilled	Unskilled	Skilled	Unskilled			Skilled	Unskilled	Skilled	Unskilled
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Autoregressive	0.470***	0.582***	0.471***	0.751***	0.344***	0.521***	0.305***	0.378***	0.449**	0.506***	0.227***	0.361***
	(0.055)	(0.064)	(0.053)	(0.059)	(0.055)	(0.047)	(0.093)	(0.093)	(0.205)	(0.160)	(0.083)	(0.062)
Minimum wage	0.220	-0.860***	-0.099	-0.983*	0.469	-0.278	0.174	-0.191	0.510	-0.510	0.164	-0.761
	(0.701)	(0.207)	(0.414)	(0.558)	(0.820)	(0.396)	(0.810)	(0.242)	(0.613)	(0.423)	(1.281)	(0.674)
Own-factor price	-0.331**	-0.378*	-0.254*	-0.955***	-0.288**	-0.049	-0.528*	-0.397*	-0.367	-1.021***	-0.367*	0.207
	(0.132)	(0.213)	(0.144)	(0.308)	(0.133)	(0.212)	(0.302)	(0.217)	(0.371)	(0.185)	(0.210)	(0.277)
TFP	-1.899***	-1.250**	-1.682***	-1.639	-0.723	-0.077	0.701	0.579*	0.899	1.131*	-0.710	1.378***
	(0.517)	(0.579)	(0.516)	(1.073)	(0.648)	(0.649)	(0.434)	(0.336)	(0.650)	(0.590)	(0.539)	(0.485)
Value added (AV)	1.858***	1.475***	1.686***	2.656**	0.471	0.555						
	(0.554)	(0.537)	(0.555)	(1.035)	(0.601)	(0.621)						
Observations	15,712	24,715	13,755	19,985	5,112	14,425	15,712	24,715	13,755	19,985	5,112	14,425
Number of id	1,577	2,016	1,471	1,858	881	1,570	1,577	2,016	1,471	1,858	881	1,570
P-Hansen	0.111	0.00838	0.0257	0.161	0.353	0.0527	0.00407	0.000489	0.00528	0.687	0.424	8.87e-06
P-Ar(2)	0.486	0.404	0.387	0.740	0.849	0.440	0.863	0.782	0.948	0.654	0.941	0.145

Notes: coefficients are significant at 10% (*), 5% (**) and 1% (***) confidence level. All models include time and SIC fixed-effects. Source: DANE-AMS, authors' calculations.

Table 6. Long-term labour demand elasticities with levels of potential substitutes. Balanced panel GMM estimates (2000-2015)

Variables	Conditional demand for labour						Unconditional demand for labour					
	Skilled	Unskilled	Open-ended		Temporary		Skilled	Unskilled	Open-ended		Temporary	
			Skilled	Unskilled	Skilled	Unskilled			Skilled	Unskilled	Skilled	Unskilled
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Autoregressive	0.552***	0.714***	0.583***	0.747***	0.524***	0.635***	0.435***	0.638***	0.533***	0.755***	0.428***	0.575***
	(0.036)	(0.040)	(0.040)	(0.039)	(0.041)	(0.037)	(0.039)	(0.046)	(0.041)	(0.045)	(0.046)	(0.045)
Minimum wage	0.050	-0.618***	-0.202	-0.678***	0.249	-0.715***	-0.115	-1.101***	-0.468	-0.874***	0.501	-1.045***
	(0.369)	(0.122)	(0.280)	(0.165)	(0.515)	(0.222)	(0.411)	(0.191)	(0.313)	(0.223)	(0.498)	(0.263)
Own-factor price	-0.379***	-0.358**	-0.427***	-0.718***	-0.061	-0.082	-0.413***	-0.647***	-0.477***	-0.685***	-0.092	0.056
	(0.094)	(0.155)	(0.096)	(0.214)	(0.074)	(0.127)	(0.122)	(0.200)	(0.103)	(0.233)	(0.079)	(0.152)
TFP	-1.922***	-1.520***	-1.842***	-0.735	-1.132**	-1.856***	0.565**	0.539***	0.635***	0.607**	0.107	0.532**
	(0.259)	(0.289)	(0.316)	(0.463)	(0.534)	(0.450)	(0.238)	(0.199)	(0.175)	(0.279)	(0.182)	(0.235)
Value added (AV)	1.831***	1.793***	1.848***	1.272***	1.118**	1.898***						
	(0.231)	(0.254)	(0.286)	(0.415)	(0.490)	(0.418)						
Observations	15,712	24,715	13,755	19,985	5,112	14,425	15,712	24,715	13,755	19,985	5,112	14,425
Number of id	1,577	2,016	1,471	1,858	881	1,570	1,577	2,016	1,471	1,858	881	1,570
P-Hansen	0.593	0.00617	0.233	0.204	0.261	0.00980	0.346	0.000228	0.171	0.687	0.366	5.57e-05
P-Ar(2)	0.696	0.585	0.225	0.224	0.0586	0.479	0.0654	0.105	0.471	0.844	0.0274	0.445

Notes: coefficients are significant at 10% (*), 5% (**) and 1% (***) confidence level. All models include time and SIC fixed-effects. Source: DANE-AMS, authors' calculations.

Again, the high elasticities with respect to output (between 1.118 and 1.898) are evidence of the cyclicality of industrial employment. This finding – different from Roberts and Skoufias' (1997) and Bell's (1997) but similar to Medina's et al. (2013) –suggest important employment fluctuations explained by demand (output or value added) shocks.

The results of the unconditional demand for labour also show important effects of the minimum wage in the demand for unskilled workers. Moreover, the respective elasticities are higher with respect to the conditional specifications. These are between -0.874 and -1.101. Except for the permanent unskilled workers (-0.685), the coefficients linked to the own-factor price are higher than those of columns (1) to (4) as predicted by the theory although the demand for temporary workers remains inelastic with respect to the real wage. Importantly, the TFP elasticities, are positive and mostly significant. Thus, this indicator appears as a complement of labour force in the production process.

Another way of introducing information about potential substitutes is by considering the real wage paid to other types of work in the production process. However, not all establishments demand all types of labour and, therefore, the missing wages of potential substitutes would reduce the number of observations available for the estimations. To address this issue, we replace the missing wages by the average wages in the industry of each worker's classification and estimate the corresponding specification of substitute's wages which gives place to the second estimate with potential substitutes of the labour force, in this case, by including the average wage of workers paid by the industry. That is, when a plant is not demanding one type of workers –has zero of them-, the substitution is considered by including the average wage paid by the subsector (2 digits SIC) under the assumption that the plant is prevented from having such workers because of the wage or technological reasons or both.

Consistently, the results in Table 7 suggest that the minimum wage affects negatively only unskilled workers under both conditional and unconditional specifications of the demand for labour. Thus, plants that have less qualified workers are face job losses when –*ceteris paribus*- there are increases of the minimum wage. These elasticities are also higher in the case of unconditional functions since these incorporate scale effects. When the potential substitutes are taken into account as we did, increases of the minimum wage produce increases of the labour demand for skilled workers under the conditional specification.

However, this way of introducing the potential substitution of the different types of manpower, shows something interesting under the conditional specification; that is, the positive sign of the coefficients linked to the skilled workers [columns (1), (3) and (5)]. This could mean that, given the increases of the minimum wage, the labour demand for skilled workers will increase because of the reduction of the relative price of the this type of labour force. Recall Table 1, where the pass-through of the minimum wage to the own-price is less in the case of skilled workers than in the unskilled. Thus, it is possible that the increases of the latter are less than the increases of the minimum wage. Nevetheless, these results should be taken with some caution given the low *p*-value of the exogeneity of instruments.

In summary, while preserving the most relevant properties of labour demand functions, the results so far show that minimum wage increases impulse job destruction in the industrial sector, corresponding the most important effects to the unskilled workers.

Table 7. Long-term labour demand elasticities with average wages of potential substitutes. Balanced panel GMM estimates (2000-2015)

Variables	Conditional demand for labour						Unconditional demand for labour					
	Skilled	Unskilled	Open-ended		Temporary		Skilled	Unskilled	Open-ended		Temporary	
			Skilled	Unskilled	Skilled	Unskilled			Skilled	Unskilled	Skilled	Unskilled
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Autoregressive	0,589***	0,627***	0,487***	0,567***	0,325***	0,512***	0,422***	0,726***	0,395***	0,648***	0,253***	0,440***
	(0,039)	(0,044)	(0,055)	(0,061)	(0,067)	(0,053)	(0,054)	(0,070)	(0,065)	(0,071)	(0,069)	(0,068)
Minimum wage	1,429**	-0,515***	0,957**	-1,194***	0,259	-1,155***	-0,824	-0,609*	-0,526	-1,378***	-0,198	-1,684***
	(0,717)	(0,158)	(0,454)	(0,262)	(0,703)	(0,316)	(0,856)	(0,330)	(0,545)	(0,379)	(0,725)	(0,355)
Own-factor price	-0,182*	-0,189	-0,468***	-0,997***	-0,400***	-0,335*	-0,339*	-0,121	-0,527***	-0,834***	-0,444***	-0,178
	(0,099)	(0,135)	(0,117)	(0,162)	(0,127)	(0,201)	(0,185)	(0,286)	(0,119)	(0,231)	(0,138)	(0,200)
TFP	-2,873***	-1,292***	-2,276***	-0,780**	-2,517***	-2,148***	0,162	0,415	0,216	1,366***	-0,320	0,324
	(0,474)	(0,233)	(0,357)	(0,385)	(0,455)	(0,531)	(0,342)	(0,290)	(0,246)	(0,351)	(0,303)	(0,325)
Value added (VA)	2,569***	1,505***	2,255***	1,556***	2,008***	2,045***						
	(0,407)	(0,182)	(0,301)	(0,335)	(0,385)	(0,450)						
Observations	16418	24763	14531	20525	6168	15280	16418	24763	14531	20525	6168	15280
Number of id	1,653	2,019	1,553	1,897	1,082	1,676	1,653	2,019	1,553	1,897	1,082	1,676
P-Hansen	0,00153	0,421	0,00174	0,0114	0,00522	6,04e-08	0,000137	1,20e-08	2,05e-06	0,00853	6,39e-06	0
P-Ar(2)	0,362	0,411	0,767	0,766	0,793	0,524	0,671	0,153	0,751	0,805	0,729	0,801

Notes: coefficients are significant at 10% (*), 5% (**) and 1% (***) confidence level. All models include time and SIC fixed-effects. Source: DANE-AMS, authors' calculations.

We next show the results of considering potential substitution among different types of labour distinguishing the plants by size since the optimal responses might be different. As before small plants correspond to those with 99 workers at most while large plants are those with 100 workers or more devoted to production duties. Thus, specifications in Table 8 include information on potential substitutes as measured by levels and prices (wages) of each type of potential substitutes. Here we focus on the elasticities with respect to the minimum wage and own-factor price.

According to these results, with the two types of substitutes, the effects of the minimum wage are focussed just on unskilled workers hired by small plants. These workers, that are supposed to have a lower labour productivity, hired by firms of lower productivity are the most affected by increases of the minimum wage. At the same time, the labour force of small establishments have –in general- negative responses to increases of the own-factor prices.

The evidence we provide show the adverse effects of increases of the minimum wage in the labour demand which affects the most to unskilled workers hired by small plants. However, these results might be incomplete in the sense that we do not have information about the establishments that are deterred from hiring new workers, mainly unskilled, given the increases of the minimum wage.

5. Conclusions

This paper uses the Colombian Annual Manufacturing Survey (AMS) between 2000 and 2015 to present estimates of labour demand. It focuses on the long-term elasticities which comprise contemporary and lagged responses of the aggregate, skill specific and type of contract labour demand to variations of the minimum wage, output, own-factor price wage, and TFP shocks controlling for the autoregressive coefficients. Regardless that our interest is in the effects of the minimum wage, we show in most of regressions all the coefficients to make sure that the effects correspond to coherent labour demand functions.

This is a parcial equilibrium approach where, moreover, many other dimensions of the minimum wage such as its effects on welfare, labour informality, inequality, poverty, human capital accumulation, long-run growth, and so on, are disregarded. To model the wage that industrial establishments pay to workers, we split this variable between the national minimum policy and the own-wage policy of plants. That is, the wage firms pay to workers is divided between the portion associated with the minimum wage and the residual which mirrors the remuneration policy of the plants.

The labour demand functions show coefficients close to those found in the literature for these types of estimations based in particular sectors of the economy. Moreover, in most cases value added, TFP and own-factor price elasticities have the sign predicted by the theory both under conditional and unconditional specifications. To arrive to these results, it was important to consider different types of the labour force and the potential substitutability among them.

Table 8. Long-term labour demand elasticities with potential substitutes. Balanced panel (2000-2015)

Variables	Conditional demand for labour						Unconditional demand for labour					
	Skilled	Unskilled	Open-ended		Temporary		Skilled	Unskilled	Open-ended		Temporary	
			Skilled	Unskilled	Skilled	Unskilled			Skilled	Unskilled	Skilled	Unskilled
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Levels of potential labour substitutes												
Large establishments												
Minimum wage	1.112	-0.274	-0.232	-0.277	0.400	-0.168	1.938	-0.516	0.068	-0.453	0.741	-0.036
	(0.759)	(0.286)	(0.504)	(0.515)	(0.682)	(0.462)	(1.212)	(0.474)	(0.707)	(0.639)	(0.813)	(0.589)
Own-factor price	-0.245	0.144	-0.774***	-0.567*	0.006	0.334	-0.551**	-0.056	-1.022***	-0.342	-0.046	0.331
	(0.156)	(0.205)	(0.100)	(0.312)	(0.087)	(0.218)	(0.244)	(0.330)	(0.135)	(0.424)	(0.094)	(0.274)
p- value Hansen	0.199	0.130	0.455	0.261	0.571	0.207	0.503	0.0189	0.183	0.412	0.412	0.108
Number of plants	514	534	492	499	389	497	514	534	492	499	499	497
Small establishments												
Minimum wage	-0.458	-0.909***	-0.291	-1.024***	0.392	-0.611***	-0.222	-1.127***	-0.278	-1.059***	-0.141	-0.791***
	(0.409)	(0.193)	(0.295)	(0.196)	(0.590)	(0.215)	(0.507)	(0.221)	(0.352)	(0.263)	(0.634)	(0.273)
Own-factor price	-0.267***	-0.755***	-0.273***	-1.280***	-0.121	-0.340**	-0.402***	-1.053***	-0.327***	-1.145***	-0.177*	-0.221
	(0.087)	(0.230)	(0.077)	(0.201)	(0.078)	(0.173)	(0.102)	(0.225)	(0.096)	(0.227)	(0.090)	(0.172)
p- value Hansen	0.385	0.0904	0.640	0.669	0.384	0.491	0.204	0.00106	0.561	0.304	0.416	0.149
Number of plants	1,063	1,482	979	1,359	492	1,073	1,063	1,482	979	1,359	492	1,073
Average wages of potential labour substitutes												
Large establishments												
Minimum wage	1.666	-0.418	1.075	-1.025	0.476	-0.553	2.574	0.548	3.374	-0.025	0.857	0.024
	(1.259)	(0.343)	(1.230)	(0.921)	(1.134)	(0.876)	(1.951)	(2.322)	(2.638)	(1.700)	(1.190)	(0.878)
Own-factor price	-0.137	-0.066	-0.519***	-0.599**	-0.026	0.247	-0.065	3.763	-0.393	-0.479	-0.078	0.319
	(0.151)	(0.182)	(0.158)	(0.268)	(0.099)	(0.451)	(0.300)	(4.940)	(0.411)	(0.545)	(0.134)	(0.370)
p- value Hansen	0.419	0.674	0.322	0.615	0.235	0.428	0.636	0.0235	0.153	0.505	0.102	0.242
Number of plants	518	533	501	505	437	510	0 518	533	501	505	437	510
Small establishments												
Minimum wage	-0.177	-0.612***	0.305	-1.236***	-0.563	-1.523***	-0.273	-0.552**	-0.200	-1.190***	-0.035	-1.698***
	(0.795)	(0.148)	(0.547)	(0.255)	(0.686)	(0.339)	(0.818)	(0.249)	(0.578)	(0.304)	(0.723)	(0.399)
Own-factor price	-0.192**	-0.365**	-0.332**	-1.268***	-0.350**	-0.460**	-0.334*	-0.410*	-0.417***	-1.176***	-0.468**	-0.402*
	(0.091)	(0.185)	(0.136)	(0.191)	(0.174)	(0.219)	(0.196)	(0.245)	(0.148)	(0.230)	(0.207)	(0.226)
p- value Hansen	0.0322	0.213	0.0212	0.0490	0.178	7.96e-05	0.000104	0.000241	6.43e-05	0.0161	0.139	2.71e-05
Number of plants	1,135	1,486	1,052	1,392	645	1,166	1,135	1,486	1,052	1,392	645	1,166

Notes: coefficients are significant at 10% (*), 5% (**) and 1% (***) confidence level. All models include time and SIC fixed-effects. Source: DANE-AMS, authors' calculations.

The increases of the real minimum wage destroy formal employment mainly of unskilled workers both permanent and temporary hired by small plants. This is one of the two main messages from the evidence we provide here. According to the elasticities of our preferred specifications (see Table 6), increases of one percent of the real minimum wage, *ceteris paribus*, reduces employment between 0.618 percent and 0.715 percent. Thus, an increase of 1 percent of the minimum wage reduces, *ceteris paribus*, labour demand about 0.7 percent within a period between one and two years. Thus, the policy of sustained large increases of the real minimum wage carried out during this century in Colombia might not have helped the generation of formal employment.

The effects concentrate in small plants; in effect, the elasticities fluctuate between -0.552 and -1.698, depending on the conditional or unconditional specification used to estimate the effects (see Table 8). These numbers –obtained by using the balanced panel of establishments along the sample period- are not negligible. These results might be incomplete in the sense that we are enable to account for those plants deterred of hiring new skilled and unskilled workers because of the minimum wage's increases when, *ceteris paribus*, such increases are well above of increases the labour productivity of unskilled workers.

The second result we want to underline is the size of the labour demand elasticity with respect to output. In our preferred specifications it is around 1.6. That is, the level of employment heavily depends on the behaviour of the demand for the output of the plant and probably when the economy is in a slowdown, the adjustment rests in job losses.

References

Addison John T., and Teixeira P. 2003. The economics of employment protection. Journal of Labor Research. 24, pp. 85-129. DOI: 10.1007/s12122-003-1031-0

Alaimo V., Bosch M., Kaplan D. S., Pagés C., and Ripani L. 2015. Jobs for Growth. Inter-American Development Bank. ISBN 1597822426, 9781597822428

Andalon, M., and Pages S. C. 2008. Minimum Wages in Kenya. IZA Discussion Paper No. 3390. Available at SSRN: https://ssrn.com/abstract=1294536 or http://dx.doi.org/10.1111/j.0042-7092.2007.00700.x

Arango. L. E., Castellani. F., and Obando. N. 2019. Heterogeneous labour demand in the Colombian manufacturing sector. Journal Labour Market Research (2019) 53: 1. https://doi.org/10.1186/s12651-018-0252-x

Arango, L. E., and Flórez, L. A. 2018. Determinants of structural unemployment in Colombia: A search approach. Empirical Economics. https://doi.org/10.1007/s00181-018-1572-y

Arango, L. E., and Flórez, L. A. 2017. Informalidad laboral y elementos para un salario mínimo diferencial por regiones en Colombia. Borradores de Economía, Working Paper No. 1023.

Arango, L. E., Herrera, P., and Posada, C. E. 2008. El salario mínimo: Aspectos generales sobre los casos de Colombia y otros países. Ensayos Sobre Política Económica, 26(56), pp. 15–71.

Arango, C.A., and Rojas, A.M. 2004. Demanda laboral en el Sector Manufacturero Colombiano: 1977–1999. Ensayos Sobre Política Económica. 44, pp. 96–154.

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, pp. 277–298.

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

Ball, L., De Roux, N., and Hofstetter, M. 2013. Unemployment in Latin America and the Caribbean. Open Economies Review, 24(3), pp. 397–424.

Bell, L. A. 1997. The impact of minimum wages in Mexico and Colombia. Journal of labour Economics, 15(3), pp. 102-135.

Belman, D., and Wolfson, P. J. 2014. What does the minimum wage do? W.E. Upjohn Institute for Employment Research. DOI: 10.17848/9780880994583

Bernal, R., and Cárdenas, M. 2003. Determinants of Labor Demand in Colombia: 1976-1996. NBER Working Papers Series 10077.

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

Broecke S., Forti A., and Vandeweyer M. 2017. The effect of minimum wages on employment in emerging economies: a survey and meta-analysis. Oxford Development Studies. 45:3, pp. 366-391, DOI: 10.1080/13600818.2017.1279134

Cahuc, P., and Zylberberg, A., 2004. Labour economics. Cambridge. MIT Press.

Castellani, F., Lotti, G., and Obando, N. 2017. Fixed or open-ended? labor contracts and productivity in the Colombian manufacturing sector. IDB Working Paper Series N° IDB-WP-832.

Card, D. 1992a. Do minimum wages reduce employment? A case study of California, 1987–89. Industrial Labour Relations Review. 46(1), pp. 38–54.

Card, D. 1992b. Using regional variation in wages to measure the effects of the federal minimum wage. Industrial Labour Relations Review. 46(1), pp. 22–37.

Card, D., and Krueger, B. 1994. Minimum wages and employment: A case study of the fast-food industry in New Jersey and Pennsylvania. American Economic Review. 84(4), pp. 772–793.

Card, D., and Krueger, A. 1995. Myth and Measurement: The New Economics of the Minimum Wage. Princeton, NJ: Princeton University Press.

Card, D., and Krueger, A. 2000. Minimum wages and employment: A case study of the fast-food industry in New Jersey and Pennsylvania: Reply. American Economic Review. 90(5), pp. 1397–1420.

Constitución política de Colombia [Const.] (1991) Título 2 - De los derechos, las garantías y los deberes, Capítulo 2: De los derechos sociales, económicos y culturales, Artículo 53. 2da Ed. Legis.

Congreso de Colombia. (30 de Abril de 1996). Ley 278 de 1996 “"Comisión permanente de concertación de políticas salariales y laborales creada por el artículo 56 de la Constitución Política". Diario Oficial No. 42.783.

Corte Constitucional de Colombia. (20 de Octubre de 1999). Sentencia C-815/99. [MP: Jose Hernandez Galindo].

De Linde Leonard, M., Doucouliagos, H., and Stanley, T. D. 2014. Does the UK minimum wage reduce employment? A meta-regression analysis. British Journal of Industrial Relations. 52(3), pp. 499–520, DOI: 10.1111/bjir.12031.

Doucouliagos, H., and Stanley, T. D. (2009). Publication selection bias in minimum-wage research? A meta-regression analysis. British Journal of Industrial Relations. 47(2), pp. 406–428, DOI: 10.1111/j.1467-8543.2009.00723.x

Dube, A., Lester, W., and Reich, M. 2010. Minimun Wage Effects across State Borders: Estimates Using Contiguous Counties. The Review of Economics and Statistics. 92(4) pp. 945-964.

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. Labour Demand. Princeton, NJ: Princeton University Press. ISBN 0-691-04254-3, pp. 444.

ILO, Ghosheh, N. 2013. Working conditions laws report 2012: A global review. International Labour Office (ILO) - Geneva.

Lisi D., and Malo M. 2017. The impact of temporary employment on productivity. Journal for Labour Market Research. 50(1), pp. 91-112. https://doi.org/10.1007/s12651-017-0222-8

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.

Neumark, D. 2018. Employment effects of minimum wages. IZA World of Labor. Vol. 2. No 6, doi: 10.15185/izawol.6.v2

Neumark, D., and Wascher, W. 2008. Minimum Wages. MIT Press. Retrieved from http://www.jstor.org/stable/j.ctt5hhh46

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.

Millea, M. J., Rezek, J. P., Shoup, B., and Pitts, J. 2017. Minimum wages in a segmented labour market: Evidence from South Africa. Journal of Labour Research, 38(3), pp. 335–359.

Okudaira H., Takizawa M., and Yamanouchi K. 2019. Minimum wage effects across heterogeneous markets. Labour Economics. 59, pp. 110-122 https://doi.org/10.1016/j.labeco.2019.03.004

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

Pierre G., and Scarpetta, S. 2013. Do firms make greater use of training and temporary employment when labor adjustment costs are high? IZA Journal of Labor Policy. 2, pp. 1-17, DOI: 10.1186/2193-9004-2-15

Roberts. M. and Skoufias. E. 1997. The long-run demand for skilled and less skilled labour 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) pp.53-78.

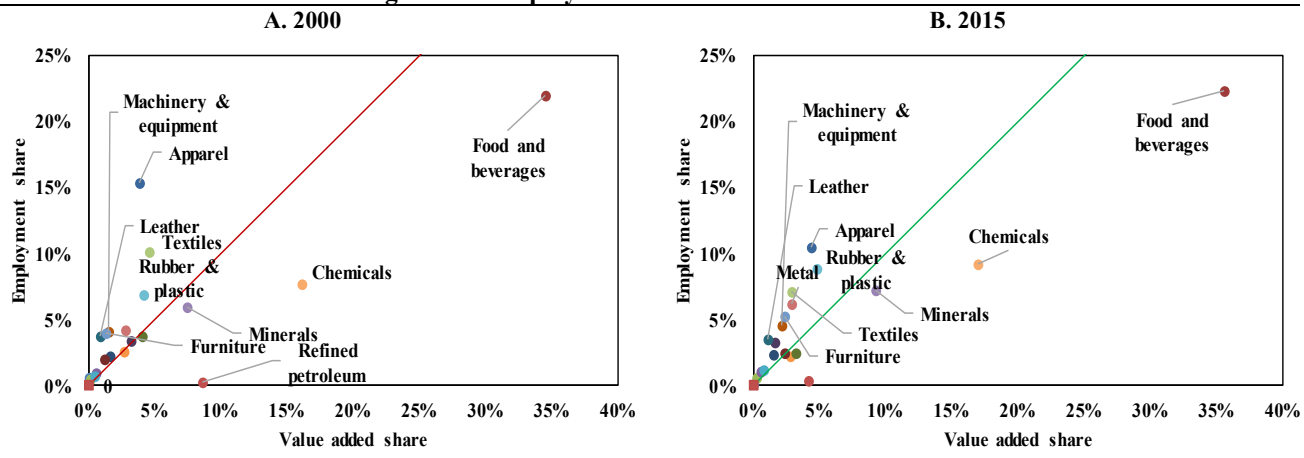
Vivas, A., Farne. S. and Urbano. D., 1998. Estimaciones de funciones de demanda de trabajo dinámicas para la economía colombiana. 1980-1996. Archivos de Macroeconomía. No. 092. Departamento Nacional de Planeación.

Wang W., Phillips P., and Su Liangjun. 2019. The heterogeneous effects of the minimum wage on employment across states. Economics Letters. 174, pp. 179-185. https://doi.org/10.1016/j.econlet.2018.11.002.

Windmeijer F. 2005. A finite sample correction for the variance of linear efficient two-step GMM estimators. Journal of Econometrics. 126(1) pp. 25-51. https://doi.org/10.1016/j.jeconom.2004.02.005

Appendix

Figure A1. Employment and value added shares



Source: DANE-EAM. Author's calculations.


BANCO DE LA REPÚBLICA
COLOMBIA