DOI: https://doi.org/10.14393/REE-v40n1a2025-67597
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Wages in Brazil's Traditional Industry: The Impact of the Minimum Wage

O Salário da Indústria Tradicional Brasileira: Impacto do Salário Mínimo

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Abstract: This study investigates the determinants of wages in Brazil's traditional industry from 1996 to 2015, with particular emphasis on the effect of the minimum wage. Characterized by low technological intensity and a high capacity to absorb low-skilled labor, this industry plays a key role in employment. Both static and dynamic panel data models were estimated. The tests indicated that the dynamic panel model was the most appropriate. The results suggest that the minimum wage has a significant effect on wages in the traditional industry. We conclude that the minimum wage exerts a meaningful influence on earnings in the traditional industrial sector and, by extension, on the income and welfare of its workforce. Nonetheless, in the medium and long run, policies aimed at increasing labor productivity—alongside improvements in the education system—should be expanded and strengthened.

Keywords: Minimum Wage; Wages in Traditional Industry; Wage Impacts.
JEL Classification: J30; J31; J38

Resumo: O objetivo principal é analisar os determinantes dos salários da indústria tradicional do Brasil de 1996 a 2015, particularmente o efeito do salário mínimo. Essa indústria possui baixa intensidade tecnológica e alta capacidade em absorver mão de obra menos qualificada. Foram estimados dados de painel estático e dinâmico. Os testes mostram que o painel dinâmico era o mais adequado. Concluímos que o salário mínimo tem efeito importante sob o salário da indústria tradicional, repercutindo, na renda e no bem-estar da força de trabalho, a despeito deste efeito, no médio e longo prazos, devem ser ampliados e aprimorados os programas de promoção de produtividade do trabalho, bem como o sistema educacional.

Palavras-chave: Salário Mínimo; Salário na Indústria tradicional; Impactos do salário.
Classificação JEL: J30; J31; J38

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1. Introduction

In recent years, low- and lower-middle-technology industries have been losing ground in international markets, facing serious challenges even in maintaining their share of the domestic market (MOREIRA, 1999; BONELLI, 2002; ALVES, 2012). These industries belong to a segment of the economy characterized by low levels of investment in research and technological development, with returns comparable to the purchase of equipment (BRITO, 2009), which hinders their integration and competitiveness in the market (CONCEIÇÃO and ALMEIDA, 2005). Despite these limitations, low- and lower-middle-technology industries remain highly relevant to the national economy and, in particular, to many regions of Brazil, due to their capacity to absorb low-skilled labor.

Starting in the 1990s, this sector experienced both expansion and a simultaneous process of relocation or productive decentralization—developments that had a significant impact on cities in the interior. However, industrial growth lost momentum in the following decade, as evidenced by a decline in the sector's share of total employment and its contribution to gross domestic product. This phenomenon has sparked a debate around the hypothesis of deindustrialization (BRESSER-PEREIRA, 2008; OREIRO and FEIJO, 2010). Some authors argue that this process is being driven by the Dutch disease (BRESSER-PEREIRA, 2008; OREIRO, FEIJO, 2010; SOUZA, VERÍSSIMO, 2019). Others see it as a case of relative deindustrialization, given that productive capacity remains in various segments (FEIJÓ, CARVALHO, ALMEIDA, 2005).

According to Goncalves *et al*. (2019), some groups within the low-technology industrial sector generate spillovers to several other industrial groups, regardless of their level of technological intensity. Low- and middle-technology industries are notable for their potential to accumulate gains from scale and agglomeration; on the other hand, they tend to offer low wages (LALL, 2000; NASSIF, 2008). In general, wages are determined by the cost of reproducing the labor force, and more qualified workers—whose training costs are higher—tend to receive higher wages. Furthermore, due to the relative scarcity of skilled labor, these workers also enjoy more favorable conditions in the labor market (OCIO, 1978).

Approaches grounded in neoclassical theory argue that wages should reflect the contribution of labor to production—that is, they should match the marginal productivity of labor in competitive market structures. However, several authors have shown that labor productivity in Brazilian industry has not been growing, including Barbosa Filho, Pessôa, and Veloso (2010), Galeano and Wanderley (2013), and Cavalcante and De Negri (2014). More recently, Veloso, Matos, and Peruchetti (s/d) present similar findings on labor productivity in the national industry. According to Squeff (2012), the decline in labor productivity across all technological levels of industry has played a major role in Brazil's deindustrialization.

The role of the minimum wage in shaping wages for low-skilled urban labor was widely debated during the 1970s and 1980s. In low-wage sectors of the economy, wage formation is closely linked to institutional wages, which tend to ensure compensation sufficient for social reproduction. The influence of the minimum wage on wage structures is known as the lighthouse effect, whose impact diminishes for higher wage brackets (FOGUEL, 1998; CAMARGO, NERI, and GONZAGA, 2001; MALONEY and NUNEZ, 2000; STADUTO, BACHA, and BACHI, 2002; BOERI, GARIBALDI, RIBEIRO, 2010).

The minimum wage policy was designed to promote social and economic equity by legally ensuring minimally adequate levels of income and consumption for workers and their families—serving as an instrument to combat poverty and improve income distribution (REIS and RAMOS, 1993). The minimum wage has long been one of the most controversial topics in both academic and political contexts, and as such, it has been widely debated in Brazil and abroad. Despite its positive effects, the topic remains far from a consensus in the literature (GINDLING, 2018), particularly regarding its impact on formal employment rates, informal sector wages, and poverty reduction (FOGUEL, 1998).

In this regard, it is reasonable to expect that sectors with a high proportion of workers earning wages near the minimum wage are more sensitive to changes in its value. Moreover, given the abundant empirical evidence of weak labor productivity growth, the following question arises: what are the variables that influence wage formation in Brazil's traditional industry? The working hypothesis is that the minimum wage is a dominant factor in determining wages in low- and middle-technology industries—i.e., in the traditional industrial sector.

Given this context, the objective of this study is to analyze wage formation in Brazil’s traditional industry, with particular focus on the influence of the minimum wage between 1996 and 2015—a period marked by relative monetary stability and a cycle of economic growth, with no clear evidence of structural breaks. This article contributes to the literature on wage formation in the industrial sector, particularly in low-technology segments. Its main innovation lies in the estimation of a wage equation that incorporates performance variables for both the industrial subsector and its workers, as well as in the application of a dynamic panel data approach.

2. The Minimum Wage

2.1 The Effects of the Minimum Wage

In Brazil, Bacha, Mata, and Modenesi (1972) engaged in one of the most influential debates on the importance of the minimum wage in determining industrial wages. In the early 1970s, specifically, they analyzed the evolution of the share of workers earning wages around the minimum wage between 1940 and 1969. They concluded that, except for the period from 1946 to 1951, the minimum wage played a relevant role in shaping industrial wages. However, there was a clear downward trend in this influence over time, though it never disappeared entirely (CORSEUIL and SERVO, 2002).

Macedo and Garcia (1978) questioned the role of the minimum wage, as they did not recognize it as an effective wage floor and argued that it was not capable of influencing the wages of low-skilled workers. Cacciamali, Portela, and Freitas (1994) summarize Macedo and Garcia's view as follows: a) the scope of the minimum wage is limited, excluding wage levels below it; b) if the minimum wage exceeds the equilibrium wage, workers will be laid off and shift to the informal sector; and c) wages in the formal sector will be determined by the subsistence wage.

According to Sabóia (1985), the minimum wage was perceived as a reference point in wage bargaining between employers and employees, with workers seeking to raise their wages above the minimum wage level. Thus, he attributed even greater importance to the minimum wage in determining overall wage rates in the economy. He also concluded that the existence of wage floors above the minimum wage reflects stronger labor union organization.

Souza (1978) found that, between 1950 and 1970, the minimum wage served as the basis for wage determination in Brazilian industry, particularly among low-skilled workers in less developed industries—a conclusion supported by the observed convergence between industrial wages and the minimum wage. According to Medeiros (2015), increases in the minimum wage have been a key factor in setting wage floors for major occupational groups in the formal sector of the economy. Although the official minimum wage regained much of its purchasing power during the sharp upward trend of the early 2000s, it remains far below the social minimum wage—that is, the necessary minimum wage for workers and their families as defined by the 1988 Federal Constitution. According to Medeiros (2015), this scenario reflects a situation in which the State primarily considered the interests of capital when setting the minimum wage.

For Lemos (2004) and Fajnzylber (2001), variations in the minimum wage are responsible for significant changes in wage distribution in Brazil, especially for wages below two minimum wages. Lemos (2004) argues that increases in the minimum wage, in turn, raise both wages and prices, while having a small adverse impact on employment levels. De Mendonça (2017) warns that, in the short term, minimum wage increases that exceed labor productivity growth may contribute to layoffs and job losses in sectors covered by the legislation. On the other hand, Pereira, Melo, and Xavier (2017) emphasize that increases in the minimum wage do not have long-term effects on employment, average labor qualification, unemployment rates, or profits.

2.2 International Perspective: A Brief Overview

The United States Fair Labor Standards Act of 1938 established various labor market regulations, including the creation of a federal minimum wage. Initially, research found no positive evidence of the minimum wage's impact on the labor market. The seminal study by Stigler (1946) examined three negative effects of the minimum wage on the U.S. economy: resource allocation, aggregate employment, and household income[1]. He also

[1] In summary, the negative impacts are as follows: a) resource allocation—firms that pay workers according to productivity lose competitiveness when wages exceed productivity; b) aggregate employment—higher minimum wages would lead to more formal workers being laid off; and c)

found no positive effects of the minimum wage on income inequality reduction. Articles by Peterson (1957, 1959) corroborated the findings by Stigler (1946). However, Lester (1960) revisited Peterson's work and found opposing results, concluding that the minimum wage did not affect employment levels.

Research advanced in the following decades, largely corroborating Stigler's (1946) findings. According to Mincer and Leighton (1980), minimum wages negatively affected workers' professional development and wages, especially among those with lower educational levels. In addition to these arguments, Meyer and Wise (1982) found that minimum wage increases for younger workers are associated with higher unemployment, and that there is no correlation between minimum wage hikes and positive impacts on the distribution of other wages. Brown *et al.* (1982), after 40 years since the enactment of the law establishing the minimum wage, still reported evidence consistent with Stigler's (1946) initial findings—specifically, the negative influence of the minimum wage on employment rates.

However, the research of Katz and Krueger (1992) and Card and Krueger (1994), through case studies in the U.S. fast food industry, challenged the prevailing paradigm about some of the detrimental effects of the minimum wage on the U.S. labor market. They presented evidence indicating employment growth following minimum wage increases, and found no evidence that product prices rose as a result of these wage hikes. However, according to Katz and Krueger (1992) and Card and Krueger (1994), high minimum wage levels may lead to higher unemployment rates.

Freeman (1996) supports the idea that minimum wages can have redistributive effects; however, such effects depend on the interaction between wage policy and the broader system of labor relations. Gosling (1996), in contrast to Freeman (1996), concluded that the minimum wage is not an effective tool for income redistribution. Machin and Manning (1997) studied France, the Netherlands, Spain, and the United Kingdom using the approach of Katz and Krueger (1992) and Card and Krueger (1994). Their findings supported the paradigm shift, showing little evidence that the minimum wage negatively affects employment. Moreover, the authors argued that some evidence suggests the minimum wage plays an equalizing role in the distribution of household income. Levin-Waldman (2002) believes that the minimum wage system—when combined with labor organization—helps reduce inequalities in income distribution.

Neumark and Wascher (2007) compiled and discussed the main debates in the field. They noted that the vast majority of studies found that the minimum wage tends to have negative effects on employment levels. On the other hand, although studies showing positive effects of the minimum wage on employment are in the minority, they have

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household income—the connection between hourly wages of all family members and the standard of living is unlikely. Therefore, to increase household income, the minimum wage would have to vary with employment quantity, number of wage earners, non-wage income, family size, and many other factors. Considering all these factors, the minimum wage would be an ineffective policy instrument.

presented convincing data indicating that the minimum wage has an insignificant impact at the macroeconomic level. More recent research has examined the relationship between the minimum wage and productivity, with some studies reporting positive effects (KIM and JANG, 2019; MAYNERIS, PONCET, and ZHANG, 2014).

3. Methodology

3.1 Structural Model

The minimum wage plays a key role in determining wage levels for low-skilled labor, particularly at the lower end of the income distribution—where there is significant mobility between formal and informal sectors of the economy (MALONEY, NUNEZ, 2000)—creating a lighthouse effect on other occupational groups[2]. The structural model is inspired by a Mincerian framework and includes variables such as the minimum wage, productivity, firm size, and the economic performance of low-skilled industries. Prior research by Bacha and Taylor (1978), Arbache and De Negri (2004), Bell (1999), Fajnzylber (2001), and more recently, Antoniazzi (2013), contributed to the formulation of equation (1). Specifically, in order to measure the impact of the minimum wage on wages, it is essential to apply appropriate econometric methods capable of isolating the effects of the minimum wage from those of other variables.

$$\mathrm{WR}_{it} = \alpha + \beta_1 \,\mathrm{ESC}_{it} + \beta_2 \,\mathrm{IDA}_{it} + \beta_3 \,\mathrm{SEXO}_{it} + \beta_4 \,\mathrm{TAM}_{\mathrm{it}} + \beta_5 \,\mathrm{SMN}_{it} + + \beta_6 \mathrm{RLR}_{it} + \beta_7 \,\mathrm{PRL}_{it} + \varepsilon_{it} \quad (1)$$

Where:

Log WR_{it} = Logarithm of the average monthly wage (in R$) of workers employed as of December 31 in state i and year t—annual monthly average;

β_1 ESC_{it} = Share of workers by education level: the ratio between the number of workers at each education level and the total number of employed individuals as of December 31 of each year. Six education levels are considered: illiterate; completed 5th grade of elementary school; incomplete 6th to 9th grade; completed elementary school; completed high school; and completed higher education;

β_2 IDA_{it} = Share of workers by age group: the ratio between the number of workers in each age group and the total employed as of December 31 of each year. Seven age groups are considered: 10–14, 15–17, 18–24, 25–39, 40–49, 50–64, and 65 or older;

β_3 SEX_{it} = Share of male employees: the ratio between the number of employed men and the total employed as of December 31 of each year;

β_4 SMN_{it} = Real national minimum wage (R$), calculated based on the IPCA—annual monthly average.

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[2] This debate among the authors gave rise to two additional articles: one by Macedo and Garcia (1980) offering a commentary, and another by Souza and Baltar (1980) in reply.

β_5 TAM_{it} = Industry size: a categorical dummy variable representing firm size: 1–99 employees; 100–499 employees; 500+ employees;

β_6 RLR_{it} = Logarithm of real et revenue: ratio between real net industrial sales revenue (R$) and the number of local industrial units—annual monthly average (WINTER *et al.*, 2019);

β_7 PRL_{it} = Logarithm of labor productivity: ratio (R$) between industrial value added and the number of employees as of December 31—annual monthly average (COELHO; DE NEGRI, 2010);

α = Regression intercept;

β = Vector of coefficients;

ε_{it} = Error term or random disturbance.

The model was estimated for the Brazilian states and the Federal District in the period from 1996 to 2015, a timeframe of relative economic stability, thus minimizing the impact of idiosyncratic shocks. Equation (1) was estimated using a balanced panel model, where the 26 states and the Federal District (N) represent the observational units over the period from 1996 to 2015 (T), totaling 540 observations (N * T = 27 * 20 = 540 observations).

3.1 Database

The national minimum wage was obtained from the Ministry of Labor and Employment (MTE – *Ministério do Trabalho e Emprego*). Changes in the minimum wage occurred one or more times per year and in different months; therefore, the annual value was calculated using a weighted average based on the number of months each minimum wage level was in effect. The data on industries come from the Annual Industrial Survey (PIA – *Pesquisa Industrial Anual*), which has the following requirements: an active status in Central Register of Companies (CEMPRE – *Cadastro Central de Empresas*); have their primary activity classified under Sections C and D (Mining and Manufacturing Industries); headquarters located within the national territory; and a minimum of five employees on December 31 of the reference year. Available PIA data are only at the state level, thus representing state averages. Finally, the Annual Social Information Report (RAIS – *Relação Anual de Informações Sociais*) served as the source for employee characteristic data. According to Decree No. 76,900, dated December 23, 1975, every establishment is required to provide the MTE with information on each employee, aimed at compiling labor statistics and making labor market information available to government agencies. The averaging of variables by state reduces variability, which is an important limitation of the data. Table 1 presents four technology-intensity classifications for industry, based on OECD criteria.

Table 1 – Classification of Industrial Sectors by Technology Intensity.

Classification	Description
Low	Food, beverages, and tobacco; textiles, apparel, and footwear; wood, paper, pulp; publishing and printing; non-metallic minerals, basic metallurgy, metal products, furniture, and miscellaneous (CNAE 1995: Divisions 15 to 22, and Divisions 26 and 27; CNAE 2007: Divisions 10 to 18, and Divisions 23 and 24).
Medium-Low	Refining and others; chemicals; rubber and plastics; pharmaceuticals;
Medium-High	Computing equipment; machinery and equipment; motor vehicles and instruments;
High	Electrical materials and machinery; electronics; other transportation equipment.

Source: Furtado and Carvalho (2005), based on the OECD.

3.2 Static and Dynamic Panel Models

Panel data combine time-series and cross-sectional observations, offering greater information content and variability, reduced multicollinearity among regressors, more degrees of freedom, and higher efficiency. Their main drawbacks are potential heteroskedasticity, autocorrelation, and cross-sectional dependence at a given point in time (DUARTE; LAMOUNIER, and TAKAMATSU, 2007). The general panel-data model is represented by equation (2), where intercepts and slope parameters may differ across states and over time:

$$Y_{it} = \beta_{0it} + \beta_{1it}X_{1it} + \beta_{nit}X_{kit} + \varepsilon_{it} \quad (2)$$

Where:
i indexes the Brazilian states;
t indexes the time period under analysis;
β_{0it} is the intercept term (constant);
β_k is the slope coefficient for the k-th explanatory variable;
ε_{it} is the error term.

Several panel-data estimation techniques are available: (i) pooled OLS model (pooled data); (ii) fixed-effects model; and (iii) random-effects model. The process known as pooling corresponds to a panel model that ignores the cross-sectional and time-series dimensions of the data (WOOLDRIDGE, 2009), thus assuming that parameters α and β are the common ones for all individuals, as shown in equation (3):

$$Y_{it} = \alpha + \beta X_{it} + u_{it} \quad (3)$$

In this framework, the explanatory variables are assumed to be stochastic and strictly exogenous—i.e., they do not depend on current, past, or future values of the error term, with each state's individual effect incorporated into the error term. Pooled models can be estimated via Ordinary Least Squares (OLS) method, assuming the constant part for all states and that the error terms u_{it} follow white noise and are uncorrelated with the regressors, Cov (X_{it}, u_{it}) = 0 (BALTAGI, 2008).

The fixed-effects model accounts for heterogeneity across states by allowing each to have its own intercept, as shown in equation (4):

$$Y_{it} = \alpha_i + \beta X_{it} + u_{it} \quad (4)$$

Here, the subscript i indicates that intercepts may differ across units due to state-specific characteristics. The slope coefficient β is assumed common to all states and constant over time. The term "fixed effects" refers to the fact that, although intercepts vary across states, they remain fixed (unchanged) over time.

The random-effects—or error-components—model makes the same assumptions as the fixed-effects model regarding intercept variation across units, but treats those intercepts as random variables (WOOLDRIDGE, 2009). A general specification for the random-effects model is given in equation (5):

$$Y_{it} = \beta_{1i} + \beta X_{it} + u_{it} \quad (5)$$

In this case, β_{1i} is not treated as fixed but is assumed to be a random variable with mean β_1. The intercept for each unit is therefore expressed by equation (6):

$$\beta_{1i} = \bar{\beta}_1 + \varepsilon_i \quad (6)$$

Where ε_i is an error term with zero mean and variance σ_ε^2. Equation (6) implies that the sample units are drawn from a much larger population, sharing a common mean intercept ($\bar{\beta}_1$) with individual deviations captured by ε_i.

Substituting equation (5) into equation (6) yields:

$$Y_{it} = \bar{\beta}_1 + \beta X_{it} + \varepsilon_i + u_{it}$$
$$Y_{it} = \bar{\beta}_1 + \beta X_{it} + w_{it} \quad (7)$$

Therefore:

$$w_{it} = \varepsilon_i + u_{it} \quad (8)$$

In equation (8), ε_i is the cross-sectional (individual-specific) component, while u_{it} is the combined time-series and cross-sectional error—also called the idiosyncratic term, since it varies both across individuals and over time.

Dynamic panel models, despite certain theoretical and practical constraints, allow for the consideration of time variation and potential endogeneity issues (LABRA and TORRECILLAS, 2018). “In economic terms, endogeneity can be interpreted as the effect of the past on the present—both in the model (the dependent variable) and in the independent variables—or as the causal relationship between regressors and the explained variable over time” (LABRA and TORRECILLAS, 2018, p. 37). The dynamic panel approach addresses individual heterogeneity and also permits the use of instrumental variables to correct possible endogeneity problems in the model.

However, dynamic panels can yield unstable estimators, and reported values may depend on sample characteristics; moreover, including lagged variables does not necessarily resolve serial-correlation issues. A key limitation of the dynamic framework is when the time dimension (t) is large relative to the number of cross-sectional units (n), which can lead to model overidentification and the possibility of multiple solutions for the structural parameters (LABRA and TORRECILLAS, 2018).

The studies by Arellano and Bond (1991), Arellano and Bover (1995), Blundell and Bond (1998), and Roodman (2009) offer key contributions to dynamic panel modeling (LABRA and TORRECILLAS, 2018; SILVEIRA *et al*., 2019). The choice of a dynamic panel framework is warranted by the interdependence of many economic series with both each other and their own past values. Models that treat the lagged dependent variable as an explanatory regressor—such as those estimated via the Generalized Method of Moments (GMM)—can, unlike static panel estimators, deliver greater efficiency (SILVEIRA *et al*., 2019). In this study, employing GMM to estimate wages in Brazil’s traditional industry makes it possible to account for the persistence of the dependent variable over time. equation (9) specifies the dynamic panel model structure:

$$Y_{it} = \propto Y_{it-n} + \beta_i X_{it} + w_{it} \tag{9}$$

Where:
Y_{it} is the dependent variable for unit i at time t
Y_{it-n} is the one-period lagged dependent variable
$\propto$ is the constant term
β_i is the individual-specific coefficient
X_{it} is the vector of independent variables for unit i at time t
w_{it} is the composite error term $\varepsilon_i + u_{it}$

The main issues in panel data estimation using GMM are instrument proliferation and serial correlation of errors. The Sargan test is used to verify the existence of overidentification, while the Arellano-Bond test assesses the presence of serial correlation in the error terms (LABRA and TORRECILLAS, 2018).

The Sargan test evaluates the validity of the instruments used in the estimation. This test is appropriate when the weighting matrix is homoskedastic[3], as in the one-step estimation. In contrast, when the weighting matrix is heteroskedastic—as in two-step estimations—the Hansen test is recommended (LABRA and TORRECILLAS, 2018).

The Arellano-Bond test, applied to detect autocorrelation in the error term in dynamic panel data models[4], reports results for both first- and second-order serial correlation (AR(1) and AR(2)) (LABRA and TORRECILLAS, 2018). The AR(2) test statistic should ideally not be significant at the 5% level (Prob > z > 0.05), indicating the absence of second-order serial correlation in the residuals. In contrast, the AR(1) statistic is typically expected to be significant (Prob > z < 0.05), reflecting the first-order differencing of the endogenous variable. The AR(2) test is used to accept or reject the null hypothesis. Rejection of the null at the 5% significance level (AR(2) Prob > z < 0.05) suggests the presence of serial correlation. Conversely, if the null is not rejected, it can be concluded that there is no issue of serial correlation (LABRA and TORRECILLAS, 2018).

4. Results and Discussions

Figure 1 shows the real average wage in the traditional industry sector by state across Brazilian regions from 1994 to 2015. There is considerable heterogeneity among the states within each region—except in the South. In the South region, the average wage increased over the period, reaching approximately R$1,900.00 in 2015. The wage curves showed similar patterns across the states, indicating a comparable industrial structure. In the Southeast, wage dispersion among states was greater. São Paulo recorded the highest average, approximately R$2,700.00 in 2015, reflecting the greater economic dynamism of the country’s wealthiest state. The states of Rio de Janeiro, Espírito Santo, and Minas Gerais reported average wages of about R$2,300.00, R$2,100.00, and R$1,950.00, respectively, in 2015.

In the Central-West region, the Federal District had the highest real average wage in 2015. However, this variable fluctuated significantly over the period—rising in the late 1990s, falling in the early 2000s, increasing again after 2009, and finally dropping in 2015 to around R$1,950.00. In 2015, the average real wage in the state of Mato Grosso was approximately R$1,840.00; in Goiás, R$1,740.00; and in Mato Grosso do Sul, R$1,650.00.

Also, according to Figure 1, in the North Region, the state with the highest average real wage was Amazonas, despite considerable fluctuations over the period analyzed. From 1996 to 2015, wages increased, reaching around R$2,080.00 in 2015, reflecting the industrial output of the Manaus Free Trade Zone. The state of Pará had the second highest average wage in the region, approximately R$1,690.00 in 2015. Roraima recorded the lowest average wage in the North, around R$1,150.00 in 2015. The other states in the region showed average wages ranging between R$1,240.00 and R$1,590.00. In the Northeast

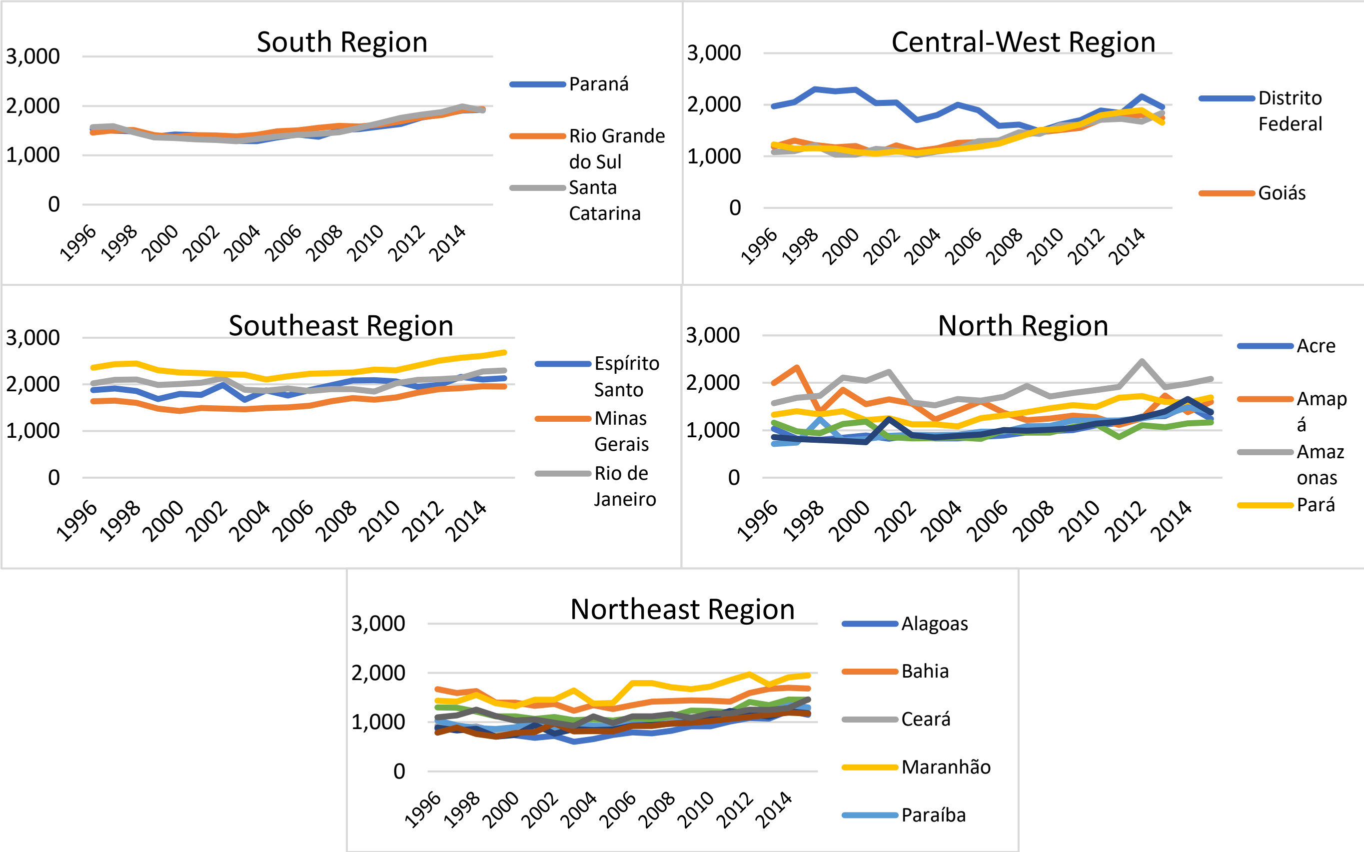
[3] The Stata command used to run the test is “estat sargan”.

[4] The Stata command used to perform the Arellano-Bond test is “estat abond”. By default, the output reports results for first- and second-order autocorrelation (AR(1) and AR(2)).

Region, all states reported average real wages below R$2,000.00 in 2015. Maranhão had the highest wage, around R$1,950.00, followed by Bahia with R$1,980.00. The remaining states reported values ranging from R$1,170.00 to R$1,450.00.

Despite the industrial decentralization that began in the 1970s and resumed in the 1990s, the state of São Paulo remains the country's largest industrial hub—which is reflected in its wage levels. Moreover, as pointed out by some authors in Brazil, agglomeration economies are associated with productive diversification—concentrated in the country's largest urban centers—which, in turn, has a positive effect on wages (GALINARI et al., 2007; DALBERTO and STADUTO, 2013). According to Hanson (1997) and Galinari *et al.* (2007), regional wage differentials may arise from local characteristics such as transportation costs and the abundance of specific natural resources. Thus, industries that intensively use these natural resources may cluster in those regions—particularly agribusiness chains, which are usually associated with traditional, labor-intensive industries. In addition, certain government policies may affect the relative attractiveness of specific regions as productive hubs, potentially creating regional wage gradients.

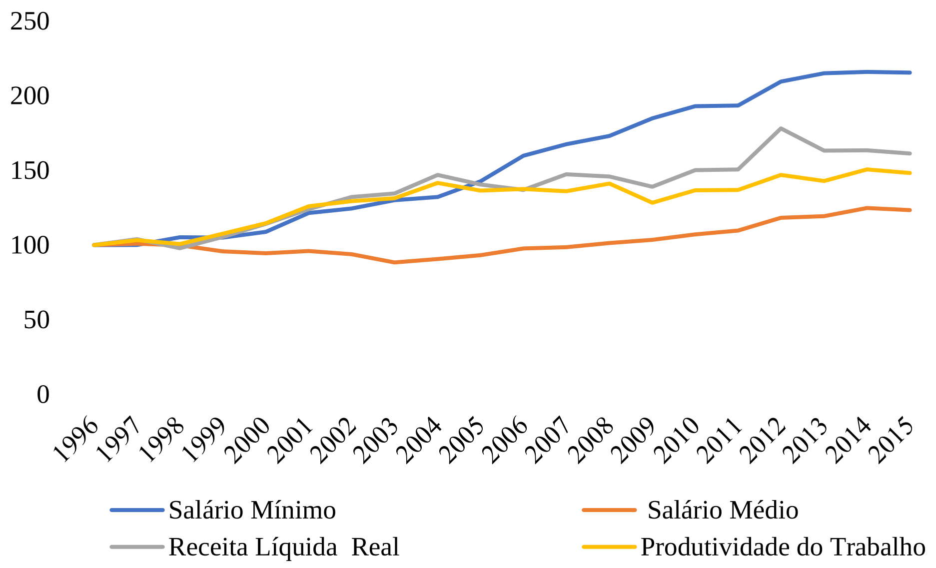
Figure 1 - Real average wage in the traditional industry by state in the Brazilian regions from 1996 to 2015 (in R$)



Source: elaborated by authors based on the PIA.
Note: values were deflated by the IPCA, using 2015 as the base year.

Figure 2 depicts the evolution of the Brazilian minimum wage, average wage, average net revenue, and labor productivity in the traditional manufacturing sector from 1996 to 2015. Throughout this period, the minimum wage exhibited a more sustained growth trajectory and displayed lower volatility relative to the other variables. While all variables increased over time, average wages declined between 1999 and 2003, with a subsequent recovery that lagged behind the other indicators. Net revenue and real labor productivity demonstrated the highest fluctuations over the analyzed timeframe. The minimum wage appears to act as a leading factor influencing the dynamics of the other sector variables.

Figure 2 – Minimum Wage, Average Wage, Average Net Revenue, and Labor Productivity in Brazil's from 1996 to 2015 (1996=100)



Source: elaborated by authors based on the PIA.
Note: values were deflated by the IPCA, using 2015 as the base year.

Table 2 presents the means, standard deviations, minimum, and maximum values of all variables used in this study. The largest share of employed employees in Brazil's traditional industry falls within the 30 to 39 years age group (30.64%). In terms of educational level, employees with completed secondary education accounted for the largest proportion (40.98%). However, 96.29% of workers held, at most, a high school diploma, highlighting the overall low skill level in the sector. This is consistent with certain labor-intensive segments of traditional industry—such as meat processing—where high worker turnover is economically viable due to low wages and low schooling levels (WESTEREN, et al., 2018). It is also noteworthy that most employees are men (72.63%). Additionally, the majority of employees are concentrated in large-scale industries with over 500 employees (73.52%). Importantly, the average wage in the traditional industry was above the institutional wage, as expected, since the database only captures formal wages, which must comply with current labor legislation.

Table 2 – Mean and Standard Deviation of Variables employed in the Study

Variable	Mean	Standard Deviation	Min	Max
Illiterate	0.132	0.121	0.012	0.672
Completed 5th grade	0.098	0.056	0.015	0.308
Incomplete 6th to 9th grade	0.166	0.059	0.040	0.351
Completed Elementary School	0.157	0.044	0.046	0.304
Completed High School	0.409	0.161	0.076	0.749
Completed Higher Education	0.034	0.019	0.000	0.180
Aged 14–24	0.252	0.044	0.154	0.396
Aged 25–29	0.207	0.023	0.145	0.279
Aged 30–39	0.306	0.020	0.217	0.359
Aged 40–49	0.162	0.028	0.078	0.231
Aged 50 and over	0.070	0.022	0.028	0.172
Male	0.726	0.096	0.538	0.946
1–99 employees	0.061	0.239	0.000	1.000
100–499 employees	0.203	0.403	0.000	1.000
500+ employees	0.735	0.441	0.000	1.000
Log of real minimum wage	6.315	0.276	5.911	6.686
Log of real net revenue	13.226	0.649	10.935	14.931
Log of real labor productivity	4.423	0.533	2.949	6.181
Log of real average wage	7.193	0.306	6.398	7.895

Source:elaborated by authors based on research data.

Table 3 presents the results of the static panel data model tests. The Chow test rejects H_0, indicating that the fixed effects model is preferable to the pooled OLS model. The Breusch-Pagan Lagrange Multiplier (LM) test also rejects H_0, suggesting that the random effects model is preferable to the pooled OLS model. Finally, the Hausman test rejects H_0, meaning that the random effects model is preferable to the fixed effects model. Table 2 also reports the results of diagnostic tests for autocorrelation and heteroskedasticity in static panel data models. Woodridge's test rejects H_0, indicating the presence of first-order autocorrelation. This result may stem from series inertia, omitted explanatory variables, model misspecification, or imperfect adjustments in statistical series (HILL *et al.*, 2006). The Wald test also rejects H_0, suggesting that the model suffers from heteroskedasticity. Possible causes include omitted variables, misspecification, presence of outliers, or skewed distributions in one or more regressors (WOOLDRIDGE, 2009).

Table 3 – Econometric Test Results for Static Panel Data Models

Test	Chow F Test	Hausman Test	Breusch-Pagan LM Test	Wooldridge Test	Wald Test
Description	H_0 : *Pooled*	H_0: *Pooled*	H_0: Fixed Effects	H_0: No autocorrelation	H_0: No heteroscedasticity
	H_1: Fixed Effects	H_1: Random Effects	H_1: Random Effects	H_1: Autocorrelation present	H_1: Heteroscedasticity present
p-value	Prob>F 0.000	Prob>chi2 0.000	Prob>chibar2 0.000	Prob>F 0.000	Prob>chi2 0,000
	Fixed Effects	Random Effects	Random Effects	Autocorrelation detected	Heteroscedasticity detected

Source: Wooldridge (2009).Elaborated by authors.

Several procedures[5] can be used to address the issues of autocorrelation and heteroskedasticity. The feasible generalized least squares (FGLS) method and the weighted least squares (WLS) method are the most common (WOOLDRIDGE, 2009). However, the estimated model (Table 2) exhibited both autocorrelation and heteroskedasticity issues simultaneously. Therefore, the dynamic panel model was chosen for estimation (LABRA and TORRECILLAS, 2018).

Table 4 presents the econometric tests for the dynamic panel data model. The Arellano-Bond test was applied to verify the absence of zero autocorrelation in the first-differenced errors. According to the results, the null hypothesis (H_0) cannot be rejected;

[5] Iterative Cochrane-Orcutt procedure; two-step Cochrane-Orcutt method; two-step Durbin method; first-difference method; and Hildreth-Lu sweep search procedure.

therefore, the dynamic panel data model does not exhibit autocorrelation. Table 3 also presents the result of the Sargan test, in which it rejects H_0, there is no problem of overidentification of the model. Therefore, dynamic panel models can provide more efficient estimators (SILVEIRA *et al.*, 2019).

Table 4 – Econometric Test Results for Arellano and Bond Test and Sargan Test

Test	**Arellano and Bond test AR (2)**	**Sargan test**
Description	H_0: No autocorrelation	H_0: Overidentification restrictions are valid
	H_1: Autocorrelation present	H_1: Overidentification restrictions are not valid
p-value	Prob>F 0.1170	Prob>chi2 0.0000
	No autocorrelation	Overidentification restrictions are not valid

Source: elaborated by authors based on research data.

Table 4 reports the estimation results for both static and dynamic panel models applied to the traditional Brazilian manufacturing sector. The findings from the static and dynamic specifications are largely consistent, albeit with some differences. Regarding similarities, all models exhibit positive coefficients for **Minimum Wage**, **Net Revenue** and **Labor Productivity** confirming their robustness as key explanatory variables. The **Minimum Wage** variable, in particular, shows strong statistical significance, highlighting its critical role in wage determination within the traditional industry. The analysis focuses on the dynamic panel model results, where the Wald chi-square test confirms the joint statistical significance of the coefficients at the 1% level, indicating they are collectively different from zero.

The inclusion of the lagged dependent variable captures the persistence of wages over time, as discussed by Pindyck and Rubinfeld (2004). The estimated coefficients on the lagged dependent variable (Table 5) suggest that past wage levels exert a positive and significant impact on current average wages in the traditional sector. Incorporating lagged regressors also helps control for unobserved factors, such as government policy effects or legislative pressures influencing minimum wage setting. In model 1, the variation of 1% of salary in the previous year increases the current average salary by 0.58%, because as we introduce other variables, models 2 and 3, the influence of this variable reduces to 0.44%. For much of the period analyzed there were no explicit rules for the minimum wage; its value was close to the variation in the economy's prices, that is, it was adjusted for inflation and, therefore, wage adjustments were largely influenced by previous periods.

In model 3, of the five levels of education, only **Completed Elementary School** showed significance and a negative sign, indicating that individuals with this level of education received a greater variation in the average wage in traditional industry in relation to illiterate workers (omitted category), as these less qualified employees should receive much closer to the minimum wage than the others, therefore having a greater impact given a wage variation. In part, the lack of variability in the data may have contributed to the lack of significance of the other categories of this variable. This limitation was discussed in the section on data sources.

In model 3, the age group **40–49** was not significant. The remaining age categories were statistically significant and showed positive coefficients, indicating that higher age is associated with higher average wages in the traditional industry. This suggests that experience is highly valued in this low-innovation sector. Gender was not statistically significant, indicating no wage advantage associated with being male. Given that men account for 72.63% of the workforce, the low variability in this variable may have contributed to the lack of statistical significance.

The **Minimum Wage** was statistically significant and exhibited a positive coefficient in model 3. Specifically, a 1% increase in the minimum wage is associated with a 0.70% increase in the average wage in this industry. As discussed in the overview section, this finding aligns with national empirical studies showing that the minimum wage plays a relevant role in shaping overall wage levels in the labor market. This reflects its “lighthouse effect,” whereby changes in the minimum wage exert a stronger influence on lower-wage segments and taper off along the wage distribution (FOGUEL, 1998; CAMARGO, NERI and GONZAGA, 2001; STADUTO, BACHA and BACHI, 2002). In this regard, Bhorat *et al.* (2013) found evidence of real wage increases in South Africa following the implementation of minimum wage legislation in four out of the five sectors examined. Another example is the significant impact of the minimum wage on agricultural wages in Brazil, where wage levels during the period under analysis (1970 to 1996) were extremely low (STADUTO, BACHA, and BACCHI, 2002).

Minimum wage adjustments followed various approaches over time, often lacking clear rules. For instance, in the years 1996, 1997, 1998, 1999, and 2000, adjustments depended on the balance of power between the executive and legislative branches. Only in 2006 were formal rules for minimum wage adjustments established (DE MENDONÇA, 2017). According to Oreiro (2017), past inflation was consistently used as a component in minimum wage adjustments, reflecting, to some extent, the inflationary dynamics of the previous year. Thus, the minimum wage contributed to updating wages in response to losses caused by inflation.

Industry Size variables were stratified into: 1–99 employees (omitted category); 100–499 employees; 500+ employees. The last two categories were statistically significant, indicating that larger firms offer higher wages compared to smaller ones. In general, large firms operate in market structures with greater market power, which increases their ability to withstand negative shocks through various adjustment mechanisms. In contrast, small and medium-sized firms tend to have less capacity to adjust (DALBERTO and STADUTO, 2013). The number of workers is an important variable in wage determination. This implies that the scale of production is a key factor in shaping wage structures in the labor market (SILVA and ALVES, 2010; MEDEIROS, 2015; SILVA JÚNIOR and GONÇALVES, 2016). Production scale thus proves to be an important determinant of average wages in traditional industries.

Real Net Revenue showed a positive and statistically significant coefficient, indicating that a 1% increase in this variable leads to a 0.10% increase in wages within the traditional industry. This suggests that, in Brazil's traditional industry, workers may experience wage increases as firm revenues grow. Araújo (2006), in his study on export-oriented firms, found that a substantial share of the observed gains in labor productivity was driven by increases in net sales revenue, which outpaced employment growth. According to Araújo (2006, p. 16), "The significant productivity gains are essentially due to the increase in net sales revenue resulting from exports (ranging between 5.3% and 53.1%, depending on the estimate), which was much greater than the increase in employment, which grew by at most 21.3%." The **Labor Productivity** variable also exhibited a positive and statistically significant relationship with wages, further confirming that productivity gains are directly associated with wage growth in the traditional industry sector. In particular, a 1% increase in productivity leads to a 0.10% increase in average wages. Thus, productivity improvements in traditional industries partially translate into higher wages.

Table 5 – Estimates of Static and Dynamic Panel Data Models for the Traditional Brazilian Industry

	Static Panel			Dynamic Panel		
Variable	**Pooled**	**Fixed effects**	**Random effects**	**Model 1**	**Model 2**	**Model 3**
Lagged wage				0.616***	0.432***	0.426***
Completed 5th grade	1.104**	0.871***	1.090***	0.019	–0.096	0.106
Incomplete 6th to 9th Grade	0.541	0.400	0.622***	–0.240	0.189	0.242
Completed Elementary School	0.518	–0.401**	–0.226	–0.426*	–0.333	–0.610**
Completed High School	0.945***	0.518***	0.804***	0.027	–0.003	–0.063
Completed Higher Education	5.547***	1.739***	2.491***	0.679	0.925*	0.766
Aged 25–29	–1.238	0.440	0.286		1.386*	1.588**
Aged 30–39	–0.245	1.686***	1.344***		3.224***	2.868***
Aged 40–49	1.500***	1.215***	1.299**		2.199***	0.806

Aged 50 and over	2.895**	4.016***	4.209***		2.949**	4.555***
Male	0.270	–0.656***	–0.380**		–0.142***	–0.196
Minimum Wage	0.707***	0.576***	0.584***		0.672***	0.704***
100–499 employees	–0.115	–0.083***	–0.100***			0.116***
500+ employees	–0.078	0.011	–0.028			0.229***
Net Revenue	0.028	0.106***	0.074***			0.100***
Labor Productivity	0.189***	0.064**	0.116***			0.103**
Trend	–0.048***	–0.037***	–0.041***	0.0039***	–0.0363***	–0.042***
Constant	0.940	1.297*	1.187*			
Wald chi2				37430.81***	17530.29***	21820.94***

Source: elaborated by authors based on research data.
Note: *** Denotes significance at the 1% level; ** Denotes significance at the 5% level, * Denotes significance at the 10% level.

A trend in a time series refers to a change in the series' average level over time. It may reflect a decline, an increase, or stability (no trend) in the long-term behavior of the average value (LAMOUNIER, 2007). The **Trend** variable was found to be statistically significant and negatively signed, suggesting a downward trajectory in the average wage of the traditional industry over the analyzed period.

5. Conclusion

This study aimed to analyze wage formation in Brazil's traditional industry, with a particular focus on the role of the minimum wage from 1996 to 2015, corresponding to the period following the implementation of the Real Plan. This sector is characterized by low to medium-low technological intensity and a high capacity to absorb less-skilled labor. Wage equations were estimated using both static and dynamic panel data models.

One of the variables with the greatest impact on wage determination in this sector was the lagged dependent variable, which captures unobserved factors. The findings indicate that the minimum wage played a key role in influencing wage levels in the traditional industry. Changes in the minimum wage can have a significant impact on the labor market, especially on the remuneration of low-skilled workers. Thus, the minimum wage stands out as one of the main determinants of wages in Brazil's traditional industry.

Although institutional factors proved central, firm-level economic performance indicators—such as firm size, net revenue, and labor productivity—also contributed to wage formation, albeit to a much lesser extent. These findings align with a portion of the empirical literature, both domestic and international.

We conclude that the minimum wage exerts a meaningful influence on earnings in the traditional industrial sector and, by extension, on the income and welfare of its workforce. In the medium and long term, however, it is advisable to reinforce mechanisms that promote labor productivity and enhance the competitiveness of this sector. This includes expanding and improving public and private initiatives aimed at raising productivity, as well as advancing the education system to increase workers' average schooling level.

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