The wage curve model with workforce underutilization and spatial and labor heterogeneity: New evidence using the Brazilian Continuous National Household Sample Survey

William Kratochwill
PhD Student, University of Coimbra, Faculty of Economics

Paulino Maria Freitas Teixeira
University of Coimbra, CeBER, Faculty of Economics, and IZA Bonn

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Abstract:
This study examines the wage curve in Brazil, considering the unique characteristics of the country's labor market, marked by significant regional and socioeconomic disparities. Using a robust econometric model with fixed effects and control for endogeneity, the analysis covers both the standard wage curve and an extended version that includes additional labor force underutilization measures, such as time-related underemployment (TRU) and potential labor force (PLF). The results indicate that a 10% increase in the unemployment rate (UR) results in a reduction of approximately 0.4% in wages. The wage elasticity is higher for male and young workers, while workers with a college degree show no wage sensitivity with respect to the unemployment rate. Interestingly, model estimation with regional versus group-specific labor underutilization reveals no cross effects of women's UR on men's wages, for example. However, there are cross-effects when the PLF and TRU variables are included in the model, as the estimated differences between the two models are statistically significant. Within this comparative exercise, cohorts of workers from low-density areas have their wages affected by labor underutilization observed in high-density areas. Our results also show significant differences for workers in either rural or non-metropolitan areas, while the converse is not true, that is, the wage elasticity in urban or metropolitan areas depend exclusively on the labor underutilization rate observed in the corresponding area, without any significant cross effects from the rural or non-metropolitan areas, respectively. Finally, there is no statistically significant difference between the model with group-specific versus the overall (regional) measure in the case of young workers. In other words, there is evidence that the salary of young workers is not affected by variations in the UR, PLF, and TRU of other age groups.

JEL Classification: C23, C26, J21, J31, J64

Keywords: Wage curve, labor underutilization, econometric model, unemployment, time-related underemployment.

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1. Introduction

The dynamics of wages and their intricate interplay with labor market conditions have been a main concern for economists and policymakers alike. Instrumental for understanding how wages are associated with fluctuations in the unemployment rate, in particular, is the wage curve, a theoretical-empirical construct initially proposed by Blanchflower and Oswald (1990). This study examines in particular the case of Brazil, and its unique labor market characteristics characterized by substantial regional and socio-economic disparities.

A full understanding of labor market dynamics requires, the inclusion of time-related underemployment (TRU), on the one hand, and potential labor force (PLF) variables, on the other, two proxies for "dormant" labor and, as such, key determinants of wage developments. These dimensions offer indeed the possibility to depict a sharp picture of how labor underutilization determines wage levels, especially if one takes into consideration that the potential labor force in Brazil represents some 6.6 million workers in 2023Q2. At the same time, in the same quarter, workers in time-related underemployment were 5.1 million, most with a clear desire to expand their working hours.

We deploy a robust econometric model with fixed effects and control for possible endogeneity. Our modeling also comprises group-specific analyses to evaluate the extent to which the wage in a particular group correlates with group-specific labor market unemployment and underutilization measures. An advantage of this approach is that it allows us to study the interaction across groups. Our approach also offers a more complete picture of the wage determination process, namely in relation to unemployment, underemployment, and potential labor force components.

Confirming the existence of a standard wage curve, we found that a 10% increase in the unemployment rate in Brazil results in approximately 0.4% reduction in wages, a result that is highly comparable with Bell and Blanchflower (2021) and Blanchflower et al. (2022), for example. Male workers have a higher wage elasticity than female workers, while younger workers, in comparison with older workers, reveal higher wage responsiveness to changes in unemployment. Workers with a complete college education or more do not show any wage sensitivity with respect to the unemployment rate.

Extending the analysis of the wage curve to comprise the time-related underemployment and the potential labor force arguments, we found that the gender wage elasticity gap increases in the former and becomes insignificant in the latter, while wages of young workers do not respond to changes in potential labor force, and highly educated workers show a significant wage elasticity with respect to both underutilization measures. The role of informality in employment contracts is also addressed, and we found that the wage curve elasticity of workers in the informal sector is highly significant.

In a final exercise, controlling for group-specific labor market underutilization indicators, this study identifies group-specific variations in wage elasticity, demonstrating that certain worker groups are unaffected by the unemployment rate of other groups. Our investigation underscores gender disparities in the wage curve, with male workers displaying a higher wage elasticity than females. In turn, while the unemployment rates of men and women do not influence each other's wages, group-specific PLF and TRU have cross effects. Notably, women are more sensitive to group-specific PLF than men, and wages in low-density areas, namely rural and nonmetropolitan areas, depend on labor underutilization in highly dense areas but not the converse.

Following this Introduction, this study comprises four additional sections. Section 2 provides a comprehensive literature review, including studies regarding the Brazilian wage curve. Section 3 outlines the estimation model and provides a detailed description of the data. Section 4 presents the findings and some detailed discussion. The concluding section summarizes the key results and discusses some implications.

2. The wage curve and the extended wage curve

In their pioneering study, Blanchflower and Oswald (1994) presented the wage curve as an empirical regularity that negatively correlates the real wage (at worker-regional level) and the unemployment rate (at the regional level). Blanchard and Oswald (1994, p. 12) argue that in the *wage* × *unemployment space*, every country seems to have a wage curve. Following their study, results from the United States, the United Kingdom and many other countries confirmed the proposed negative relationship. More recently, the analysis has been extended to comprise the *wage* × *underemployment space*, showing that time-related underemployment is even a better predictor of wage growth in the post-Great Recession. The unemployment rate in this period seems indeed to have little impact, while underemployment is responsible for -2.2% to -3.5% of the change in wages (Bell and Blanchflower, 2021; Blanchflower et al., 2022).

According to Blanchard and Oswald (1994), there are three possible explanations for the relationship between wages and local unemployment: regionally-based implicit contracts, union bargaining, and efficiency wages. The regionally-based implicit contracts explanation assumes an economy divided into spatially isolated regions, where workers, at the beginning of the period, are free to move to the most attractive areas. It is also assumed that return costs are prohibitive before the end of the period, while regions differ in employment conditions, wages, and unemployment, as well as in work *amenities*. In turn, unemployment benefits (a proxy for the reservation wage) are constant across regions. In this context, firms must pay different wages to compensate for differences in work amenities, and, as a result, regions with higher amenity values attract more workers, thus increasing the local unemployment rate. Firms will then offer contracts with lower wages, given that a higher unemployment rate lowers the expected employment likelihood, and the downward slopping wage curve follows. Card (1995) identifies two key issues with the contractual model in relation to Blanchflower and Oswald's findings. First, the model focuses on wages and employment, with unemployment being residual and indirectly linked to wages, contradicting the labor supply explanation. Second, while the model predicts a negative relationship between wages and permanent unemployment rates, U.S. data shows a weak positive correlation with permanent unemployment and a strong negative correlation with contemporaneous unemployment rates. These discrepancies indicate the model's limitations in explaining the empirical data.

Blanchflower and Oswald (1994) also use the union bargaining model to examine pricing in the context of market imperfections and salaries determined through negotiation. In this framework, high unemployment rates decrease the bargaining power of workers and unions, and hence the likelihood of obtaining an alternative job and a higher wage. On the other hand, in a scenario of high unemployment, unions tend to prioritize employment over wages, so that unemployment negatively affects wages. The main shortcoming of the bargaining model is, however, that it cannot be applied in situations where unionization is low or wage negotiations are predominantly conducted at the non-regional level. Card (1995) critiques a union bargaining framework, noting that the model may not be suitable for countries with low unionization (the U.S. case) or national wage negotiations (Sweden). This author also finds it puzzling that the wage curve's slope is lower for union than nonunion workers, especially in Britain. Additionally, he criticizes their use of annual earnings as a wage measure instead of a standardized hourly wage, which may confound the relationship between employee hours and profits with bargaining effects. Despite these issues, Card acknowledges that the wage curve may well encourage further research on the impact of short-term changes in employer profitability on wages.

The third explanation offered by Blanchflower and Oswald is based on efficiency wages and it establishes that worker productivity depends on effort, and effort on wage incentives. Accordingly, a high unemployment level works as a discipline device for those employed because the higher the unemployment rate, the lower the prospects of re-employment if the worker is laid off. From the firm's point of view, high unemployment, therefore, allows the firm to pay lower wages for the same level of effort, as the firm in this situation can easily shed the underperformers and quickly find a substitute from the large pool of unemployed (Shapiro and Stiglitz, 1984). However, Card (1995) highlights the lack of empirical evidence supporting the relationship between group-specific wages and unemployment rates, and the failure to explore differences in the wage curve's slope across worker groups. In general, it can be said that Blanchflower and Oswald's findings are consistent with short-run responses of wages and employment to local labor market shocks studied by Bartik (1991) and Blanchard and Katz (1992).

Card (1995) finds it problematic that the Wage Curve is not a Phillips Curve or a Labor Supply Function, as the former traditionally shows an inverse relationship between unemployment and wage inflation. Thus, Card questions whether the Wage Curve is just an ill-specified version of this relationship, which could mean that it is not a discovery but a reinterpretation of an already known concept.

The job supply function describes how workers respond to changes in wages. If the wage curve is not a function of labor supply, it implies that it does not adequately capture how workers adjust their labor supply in response to changes in unemployment and wages. Thus, in his analysis, Card raises doubts about the interpretation and applicability of the Wage Curve as a new economic law.

Blanchflower and Oswald (1995), using the wage curve in a log-log regression model of real wages on the unemployment rate and controlling for regional fixed effects and individual characteristics, found that the wage elasticity coefficient is significant and around -0.1, or that a 10% unemployment rate increase is associated with a 1% wage reduction. Recent studies by Elsby et al. (2015), Fontaine et al. (2020), and Fiaschi and Tealdi (2021), however, shed light on the complexities of unemployment and the importance of labor market flows, arguing that the most significant contributors to the volatility of the unemployment rate are after all worker transitions from inactivity to job search or employment and from employment to inactivity. Variables such as the potential labor force and time-related underemployment measures are therefore crucial.

Our definition of labor underutilization follows the ILO (2013a):

> *Labor underutilization refers to mismatches between labor supply and demand, which translate into an unmet need for employment among the population. Measures of labor underutilization include, but may not be restricted to:*
>
> *a) Time-related underemployment, when the working time of persons in employment is insufficient concerning alternative employment situations in which they are willing and available to engage;*
>
> *b) Unemployment, reflecting an active job search by persons not in employment who are available for this form of work;*
>
> *c) Potential labor force, which refers to persons not in employment who express an interest in this form of work but for whom existing conditions limit their active job search or availability.* (ILO, 2013a)

In particular, those who work less than standard weekly hours and want to work longer hours are classified in the TRU group. In the case of the United Kingdom, for example, there is evidence that workers want to work more hours even at a constant hourly wage rate (Bell and Blanchflower, 2021). This means that worker flows between TRU and full-time employment will affect monthly earnings even if the hourly wage is unchanged. In this case, the effect of TRU in the wage curve are expected to be less intense.

Borowczyk-Martins and Lalé (2020), for example, found a strong cyclicality in transition probabilities between involuntary part-time employment and full-time and voluntary part-time employment. Accordingly, in an economic downturn, firms may reduce the number of working hours for the existing workforce prior to any dismissal, while in the upturn they may increase the working hours before hiring new workers. As a result, changes in the unemployment rate may well be preceded by changes in the TRU.

From the labor supply side, changes in the unemployed population can be driven by individual decisions (e.g., voluntary quits, inactivity or job search). Those who are not in the labor force may decide at same point to return to the labor market based on their economic perception of the economic cycle. As a "reserve army" (Engels, 1845, and Marx, 1847), an inflated PLF represents a stock of labor available to work, implying a downward pressure on wages. Labor slack therefore enables firms to resist nominal wage increases while workers may be forced to accept reduced wages.

Consideration of time-related underemployment and potential labor force categories offers a valuable opportunity to examine the impact of labor underutilization measures on the wage level. However, despite extensive research, a notable failure of the wage curve literature has been the inability to fully address the effect of TRU and PLF on wages. The introduction of the potential labor force variable seeks therefore to complete the analysis of the effects of labor underutilization on the wage curve.

3. The wage curve in Brazil

Table 1 presents a survey of the wage curve in Brazil. We emphasize the corresponding sample period, methodology and data sources, as well as the estimated wage elasticity.

Table 1 – The Brazilian wage curve

Studies	Sample Period	Methodology	Data source	Wage elasticity
Barros and Mendonça (1997)	Feb.1982-Sep.1994	Cell-means (Log-lin model)	PME	-4 (for the six largest metropolitan areas)
Garcia (2002)	1981-1999	Two-step Least Squares	PNAD	-0.13
Souza and Machado (2004)	1981-1999	Two-step Least Squares	PNAD	-0.23 (for urban areas) -0.06 (for rural areas)
Reis (2006)	1990-1999	Two-step Least Squares	PNAD	-0.013 for skilled, -0.045 for semiskilled, and -0.051 for unskilled workers
Santolin and Antigo (2009)	1997-2005	Dynamic Panel (GMM)	PNAD	-0.2 (for formal workers in the six largest metropolitan areas)
Estevão and Carvalho Filho (2012)	1981-2009	Two-step Least Squares	PNAD	-0.1
Silva, Monsueto, and Porsse (2015)	2002-2009	Dynamic Panel (GMM-AB)	PNAD	-0.04
Baltagi, Rokicki, and Souza (2017)	2002-2009	FE2SLS	PNAD	-0.076
Santolin and Antigo (2020)	2001-2015	Dynamic Panel (GMM)	PNAD	-0.174 (for the six largest metropolitan areas)
Paula and Marques (2022)	2012-2019	FE2SLS	PNADC	-0.031

Barros and Mendonça (1997), in the first row of the table, using data from the Monthly Employment Survey (*Pesquisa Mensal de Emprego-PME, 1982-1994*), studied the wage curve slope in six large metropolitan regions by splitting the male labor market into 54 cell means, three educational groups, and three age groups. Their results confirm the presence of a wage curve, with a slope of -4 and a higher wage elasticity for middle-aged workers. For their part, Souza and Machado (2004) found a wage elasticity of -0.235 for urban areas and a non-significative wage curve in rural areas.

Reis (2006) examined the elasticity of the wage curve from the PNAD database (1990-1999) by classifying workers into skilled, semiskilled, and unskilled. For these three groups, the estimated elasticity was -0.013, -0.045, and -0.051, respectively. Silva, Monsueto, and Porsse (2015), also using data from PNAD (2002-2009), studied wage flexibility in the spirit of Blanchflower and Oswald (1994), that is, taking into account the criticism contained in Card (1995), namely endogeneity problems and selection bias. Their findings reveal a wage curve elasticity with a coefficient of -0.04, which is substantially smaller (in absolute value) than the values reported in the international literature. However, there is the caveat that the economy was relatively prosperous in the sample interval and the unemployment rate low.

Santolin and Antigo (2009, 2020) use different periods of PNAD. The first analysis was from 1997-2005, while the second used updated data from 2001 through 2015. Despite using PNAD, they follow Barros and Mendonça (1997) and analyze a dynamic wage curve across six major Brazilian metropolitan areas, where the autoregressive coefficient of wages captures the dynamics of the model. They focused on formal employment to estimate the wage curve and the importance of wage flexibility in reducing unemployment persistence. The corresponding wage elasticity estimates vary from -0.20 to -0.174.

Estevão and Carvalho Filho (2012, p.12), using PNAD data from 1981 to 2009, found an elasticity of -0.092 applying a two-step approach. In their work, Estevão and Carvalho Filho estimated a wage equation at individual level, including the interaction between regional dummies and time and excluding UR in the first step. In the second step, the adjusted wages variable is regressed on time and the regional effects as well as on the regional unemployment rate lagged in one period. Their results suggest that the elasticity was lower in the late 1980s, possibly due to the 1988 Brazilian new Constitution.

Baltagi, Rokicki, and Souza (2017), also based on PNAD data (2001-2009), found a wage elasticity of -0.076 for Brazil, -0.134 for males, and no statistically significant coefficient for women. By using the gender-specific unemployment rate, women's elasticity is still insignificant, while it is reduced to -0.093 for men. For the group of formal workers, the wage elasticity is insignificant, in sharp contrast with the case of informal workers at an expressive -0.251. It is also shown that among informal workers, the wage elasticity is higher for men (-0.281) than for women (-0.189). Finally, using PNADC annual data (2012-2019), Paula and Marques (2022) found an elasticity of -0.014 for women, -0.052 for men, and -0.037 for the aggregate.

4. Model

In our investigation, we estimate two distinct models: the standard wage curve model, wherein wages are a function of the unemployment rate; and an extended version of the wage curve, in which wages are expressed as a function of labor underutilization measures, namely, time-related underemployment and the potential labor force. Furthermore, we estimate both models by employing two types of regional measures of labor underutilization:

overall and group-specific. Following Blanchflower and Oswald (1995), we proceed with the estimation of the *conventional* wage curve equation by specifying the model:

$$ln\, w_{irt} = \beta_0 + \beta_1 ln\, UR_{rt} + \beta_2 X_{irt} + \gamma_r + \vartheta_t + \varepsilon_{irt}, \quad (1)$$

where $ln\, w_{irt}$ is the log of the real hourly wage rate of individual *i* in region *r* and quarter *t*, and UR_{rt} is the unemployment rate in region *r* and quarter *t*. *X* is the vector of control variables containing gender, race, age, age squared, years of schooling, years of schooling squared, the interaction between race and gender, number of hours usually worked per week, sector of activity, employment formality, rural/urban area, metropolitan area, and sectoral shares in regional employment. γ and ϑ are region and time fixed-effects, while ε_{irt} denotes the random error. To control for possible endogeneity, the selected underutilization measure is instrumented by its lagged value in one quarter (Cameron and Trivedi, 2005; Baltagi, Rokicki, and Souza, 2017). Specifically, we use a time and region Fixed Effects Two-Stage Least Squares (FE-2SLS) regression model as in Baltagi, Rokicki, and Souza (2017) and Paula and Marques (2022). Our approach therefore addresses both the unobserved heterogeneity and endogeneity of labor underutilization via fixed-effects (that capture time-invariant regional differences and quarter-specific macro shocks) and instrumental variables, respectively.

Our second model is an extension of the conventional wage curve, as follows:

$$ln\, w_{irt} = \beta_0 + \beta_1 ln\, Und_{rt} + \beta_2 X_{irt} + \gamma_r + \vartheta_t + \varepsilon_{irt}, \quad (2)$$

where we replace the variable UR_{rt} by Und_{rt}, the latter containing the selected measures of labor underutilization (the unemployment rate, UR, the time-related underemployment, TRU, and the potential labor force, PLF).

As suggested by Card (1995, p.794), we also test whether the individual wage in a given group *j* (say, male workers) has a stronger relationship with the group-specific labor market underutilization measure (say, the unemployment rate of males, UR_{rtj}) than with the corresponding overall measure (the overall unemployment rate of males and females in region *r*, UR_{rt}). For instance, when the wage elasticity estimates for UR_{rtj} (the male unemployment rate in region *r*) is statistically equal to the wage elasticity estimate for UR_{rt} (the unemployment rate of all workers, male and female, in region *r*), it means that women's unemployment rate does not interfere with men's wages.

In this setting, equations (1) and (2) become, respectively:

$$ln\, w_{irtj} = \beta_0 + \beta_1 ln\, UR_{rtj} + \beta_2 X_{irtj} + \gamma_r + \vartheta_t + \varepsilon_{irt}, \quad (3)$$

$$ln\, w_{irtj} = \beta_0 + \beta_1 ln\, Und_{rtj} + \beta_2 X_{irtj} + \gamma_r + \vartheta_t + \varepsilon_{irt}, \quad (4)$$

where j denotes the selected group or labor market.

In the presence of an endogenous variable, OLS estimation implies that changes in the endogenous variable are associated with changes in the regressand and the error term. As a consequence of this correlation between the endogenous variable and the error, the OLS estimator will capture the effects of the endogenous variable via itself and via error term (Cameron and Trivedi, 2005 p. 96). However, whenever the right-hand-side variable is exogenous, the OLS generates estimators that are, in principle, more efficient than in the 2SLS case, as a loss in efficiency in the latter can be very substantial (Cameron and Trivedi, 2005 p. 275).

To test for endogeneity, we apply the Hausman test for endogeneity and the Wald F test for weak instruments in order to select whether to choose 2SLS or OLS by comparing whether their estimates are sufficiently distant to be considered statistically different (Cameron and Trivedi, 2005, section 4.9; Wooldridge, 2010, section 6.3; and Greene, 2018, section 8.6). The Hausman and Wald F tests come as an output of *ivreg2* command with *endog* option for the Und_{rtj} variables in Stata 17. We shall consider the OLS-Fixed effects model whenever the Hausman test does not reject the null hypothesis that the variables are exogenous. All the regressions are weighted quarterly, with correction for non-interview with post-stratification by population projection, provided by the survey documentation, using *pweights* option in Stata 17 with robust standard errors, as suggested in Moulton (1986 and 1990).

Additionally, as shown by Card (1995, p. 794), if the accurate model specification requires a region-specific unemployment rate for a given worker group, then employing the aggregate regional unemployment metric for the estimation of the wage curve for group j can lead to a change in wage elasticity for the group under analysis. Thus, assuming $\log(w_{ijrt}) = a \log U_{jrt} + X_{ijrt}b + \ldots$, where w_{ijrt} is the wage of the ith person in group j in labor market r and period t, and U_{jrt} is the unemployment rate of the group in market r, the wage elasticity is given by a; and if $\log U_{jrt} = d_{jt} + e_j \log U_{rt}$, where U_{rt} is the overall unemployment rate in market r, then the wage curve elasticity for group j using the aggregate unemployment rate is given by ae_j. Thus, by calculating the difference ae_j-a, we can test whether group j's labor underutilization influences the group j's wages only or whether other groups' underutilization impacts group j's wages. If the difference ae_j-a is insignificant, we conclude that the labor underutilization of other groups does not affect the wage of group j.

Clogg et al. (1995) proposes a method for comparing regression coefficients across models. Thus, following their methodology, firstly, we test the difference d between the coefficients of equations (1) and (3) using a *t-test*, where *t* is given by $t = d/s(d)$), and *s*(*d*) is given by $s(d) = \left[se_e^2 \; - \; se_g^2 \left(\hat{\sigma}_e^2/\hat{\sigma}_g^2\right)\right]^{1/2}$, with se_e and se_g denoting the standard error of the corresponding coefficients in model (1) and (3), respectively; and $\hat{\sigma}_e^2$ and $\hat{\sigma}_g^2$ are the corresponding variance of errors in the regressions. A similar procedure was followed for the comparison between models (2) and (4). As Card (1995, p. 797) highlights, a fundamental property of the efficiency wage model is the absence of cross-effects among groups. In other words, a higher unemployment for unskilled workers should not affect the wages of skilled workers, for example. Thus, any evidence that the difference between estimates is significant means that cross-effects exist among groups and that the efficiency wages hypothesis is violated.

Clogg et al. (1995) also presents a method for comparisons across groups within a given model. In this case, the same regression model for different groups (for males and females, for instance) is run, and then, given that the corresponding error variances are not the same, Clogg suggests that in large samples, the significance of the difference between the coefficient $\hat{\beta}_a$ and the coefficient $\hat{\beta}_b$ be assessed using the statistic $z = \left[(\hat{\beta}_a - \hat{\beta}_b)/\left(s^2(\hat{\beta}_a) + s^2(\hat{\beta}_b)\right)\right]^{1/2}$, where $\hat{\beta}_a$ and $\hat{\beta}_b$ are the coefficients of the regressions for the two selected groups, *a* and *b*, respectively, and $s^2(.)$ denotes the standard error of the coefficient.

5. Data

Our dataset contains quarterly cross-sectional observations from the Continuous Household National Sample Survey (PNADC) from the Brazilian Institute of Geography and Statistics (IBGE). Of its numerous surveys, PNADC is particularly noteworthy as it covers all Federative Units (UF), with a broader coverage than any prior survey except in the case of the Census data. PNADC comprises representative information for Brazil and all major regions, including the federative units and metropolitan areas. PNADC releases quarterly and annual information on approximately 211,000 households in each quarter. The sample rotation scheme adopted is 1-2 (5), in which a given household is interviewed quarterly in five consecutive quarters (IBGE, 2021). Our study selected an interval from the second quarter of 2012 to the second quarter of 2023.

Individuals belong to a total of 53 regions.[1] They are also grouped into 32 separate sub-samples. Each sub-sample comprises a group of workers with a particular characteristic (say, gender, race, age, or schooling level). The (log) hourly wage is the sum of earnings in all jobs a worker holds in a given period. Since wages and working hours are available monthly and weekly, respectively, the hourly rate is computed as follows:

$$log\ of\ real\ wageh_{irt} = ln\left(\left(\frac{all\ jobs\ monthly\ wage_{irt} \times 12}{weekly\ working\ hours_{irt} \times 52}\right) \times Deflator_{rt}\right)$$

where *i*, *r*, and *t* represent individual, region, and time in quarters. IBGE provides a deflator for each federative unit based on the Broad Consumer Price Index (IPCA – *Índice de Preços ao Consumidor Amplo*).

The data allow us to calculate variables at a regional level and also for each worker group in region *r* at quarter *t*. The unemployment rate (UR), the potential labor force rate (PLF), and the time-related underemployment rate follow the ILO (2016) and Bennes and Walsh (2018) definitions, and were calculated for each of the 53 Brazilian regions, as follows:

$UR_{rt} = unemployment_{rt} / labor\ force_{rt}$,

$PLF_{rt} = potential\ labor\ force_{rt} / (labor\ force_{rt} + potential\ labor\ force_{rt})$,

$TRU_{rt} = time\text{-}related\ underemployment_{rt} / employment_{rt}$.

We note that the TRU variable slightly differs from PNADC's official measure due to a methodological change in the weekly working hours used to calculate TRU in the third quarter of 2015. The calculation of the TRU in Brazil started to use hours usually worked instead of the hours actually worked per week. To construct a continuous series, we calculated the TRU for all workers aged 16 and over who worked less than 40 hours/week, were willing to work more hours per week, and were available to work more hours on the week of reference. In the process, we lost part of the sample due to differences in the questionnaires before and after the change. We note, however, that this reduction implies a change in the TRU rate of ±0.2 percentage points only.

Individuals in our sample are 16 years old or older, up to 70. Our dataset excludes observations on employers, self-employed workers, and those who report working less than 10 hours per week. Individuals in the first and last percentiles of the hourly wage distribution

[1] We split the federative units into the metropolitan region or capital of the UF and other municipalities. The IBGE does not release data at a level of granularity lower than metropolitan region and non-metropolitan region, to preserve confidentially and representativeness.

are also dropped from our sample. As a result of these procedures, our estimation sample comprises some 6,165,430 observations.

We categorized these individuals into two racial groups 'white' (i.e., individuals of White and Asian ethnicity) and 'nonwhite' (i.e., Black and Brown). They are also stratified into age groups (16-22, 23-34, 35-54, and 55 years or older), as well as according to the schooling level (without formal education or incomplete elementary education, with completed elementary education or incomplete high school, with a high school diploma or some college education, and with at least a college degree).

Workers are classified by sector (public or private), and, within the private sector, a further differentiation was made by employment type of employment contract (formal or informal) and regions (rural and urban, as well as metropolitan and nonmetropolitan). These categories are also extended to encompass 12 discrete industries or sectors of economic activity affiliation, following *Classificação Nacional de Atividades Econômicas* (CNAE) framework established by the Brazilian Institute of Geography and Statistics (IBGE). This classification follows the International Standard Industrial Classification (ISIC) for all economic activities. Finally, the employment share of industries (agriculture, manufacturing, construction, wholesale and retail trade, transportation and utilities, leisure and hospitality, information, government and defense, education and health services, other services, housekeeping, and family workers) within each geographic region. The summary statistics of these variables are provided in Appendix Table A1.

6. Results and discussion

6.1 *The standard wage curve*

Using FE-2SLS and OLS-FE, we estimate four sets of regressions presented in Tables 2 to 5. Tables 2 and 3 report the results from a standard wage curve, while Tables 4 and 5 present the extended version estimates.

Table 2 presents the wage elasticity with respect to the region-level unemployment rate for all workers and by subsample, in separate regressions. As seen in the first column of the first row of the table, wage elasticity for all workers is equal to -0.0384 and highly significant at the 0.01 level.

The wage elasticity is larger (in absolute value) for men (at -0.0442, in the second row) than for women (-0.0326, in the third row). Both estimates are highly significant at the 0.01 level. White workers (-0.0451) face higher wage elasticity than nonwhite workers (-

0.0350). Regarding age, the wage elasticity is relatively high in the case of young workers, lower for the middle age, and increasing for the older group. Specifically, for workers aged 16-22, the wage elasticity is -0.0764, while for workers who are 23-34 years old, the elasticity is -0.0488; for workers aged 35-54 and for 55 or more, the estimates are equal to -0.019 and -0.020, respectively. In the case of these two groups, note that the null hypothesis of the exogeneity of UR is not rejected, as shown in the Appendix Table A3. Running a FE-OLS model, we obtained -0.0159 and -0.0209, respectively. They are not statistically different.

Workers with a college degree or higher have a non-significant wage elasticity than their counterparts with lower educational attainment. In effect, individuals who have completed high school or have attained some college education have an elasticity coefficient of -0.0549, while workers with a lower educational background have an elasticity of -0.0592 (in the case of workers with elementary complete or high school incomplete), and -0.0508 (for those with elementary incomplete).

We found that for the sample of workers in the public sector, the elasticity is -0.0216, lower than the elasticity for workers in the private sector (-0.0388), and both estimates are highly significant at the 1% level. However, the Hausman test does not reject the null, that the unemployment rate is exogenous in the public sector. In the latter, the corresponding FE-OLS estimate is equal to -0.0151, which is substantially smaller than the corresponding estimate for the private sector.

Not surprisingly, informal workers in the private sector have a wage elasticity almost three times larger than workers in the formal sector (at -0.0838 and -0.0298, respectively). A combination of economic, labor market, and regulatory factors explains the substantial difference in wage elasticity between informal and formal workers in the private sector in Brazil. The informal sector often includes low-skilled/low-wage jobs (Fortin et al., 1997; Maloney, 2004; La Porta and Shleifer, 2014), and employees typically lack job security, and benefits (Fortin et al., 1997; Maloney, 2004). Workers in the informal sector are also at a disadvantage compared to those in the formal sector as they have limited access to collective bargaining or labor organization, which makes their wages much more sensitive to changes in the economic environment. Formal sector workers, in turn, benefit from stronger labor protection and higher collectively agreed wages.

Table 2 – Wage curve elasticities for all workers and by separated worker groups

Sample	Wage elasticity							
	FE-2SLS				FE-OLS			
	UR		N	R^2	UR		N	R^2
All Workers	-0.0384***	(0.003)	6,165,430	0.517	-0.0307***	(0.002)	6,165,430	0.517
Men	-0.0442***	(0.004)	3,373,944	0.507	-0.0342***	(0.003)	3,373,944	0.507
Women	-0.0326***	(0.004)	2,791,486	0.533	-0.0268***	(0.003)	2,791,486	0.533
White	-0.0451***	(0.005)	2,610,579	0.507	-0.0370***	(0.003)	2,610,579	0.507
Nonwhite	-0.0350***	(0.003)	3,554,851	0.480	-0.0270***	(0.003)	3,554,851	0.480
16-22	-0.0764***	(0.006)	770,130	0.367	-0.0589***	(0.004)	770,130	0.367
23-34	-0.0488***	(0.005)	2,042,397	0.475	-0.0388***	(0.003)	2,042,397	0.475
35-54	-0.0199***	(0.004)	2,759,313	0.523	-0.0159***	(0.003)	2,759,313	0.523
55 or more	-0.0200**	(0.010)	593,590	0.529	-0.0209***	(0.007)	593,590	0.529
Elementary incomplete	-0.0508***	(0.005)	1,523,106	0.338	-0.0416***	(0.004)	1,523,106	0.338
Elem. complete or high school incomplete	-0.0592***	(0.006)	963,024	0.339	-0.0459***	(0.004)	963,024	0.339
High school complete or some college	-0.0549***	(0.004)	2,514,925	0.346	-0.0411***	(0.003)	2,514,925	0.346
College or more	0.0047	(0.008)	1,164,375	0.272	-0.0049	(0.006)	1,164,375	0.272
Public	-0.0216***	(0.007)	1,260,510	0.463	-0.0151***	(0.005)	1,260,510	0.463
Private	-0.0388***	(0.003)	4,893,164	0.465	-0.0326***	(0.002)	4,893,164	0.465
Formal	-0.0298***	(0.003)	3,372,283	0.447	-0.0248***	(0.002)	3,372,283	0.447
Informal	-0.0838***	(0.006)	1,520,881	0.374	-0.0648***	(0.004)	1,520,881	0.374
Rural	-0.0575***	(0.007)	871,172	0.410	-0.0492***	(0.005)	871,172	0.410
Urban	-0.0375***	(0.003)	4,021,992	0.457	-0.0317***	(0.002)	4,021,992	0.457
Metropolitan region	0.0005	(0.004)	2,129,761	0.462	-0.0073**	(0.003)	2,129,761	0.462
Non-Metropolitan region	-0.0628***	(0.005)	2,763,403	0.461	-0.0475***	(0.003)	2,763,403	0.461
Agriculture	-0.0697***	(0.011)	517,769	0.399	-0.0583***	(0.007)	517,769	0.399
Manufacturing	-0.0266***	(0.008)	850,381	0.484	-0.0181***	(0.006)	850,381	0.484
Construction	-0.0477***	(0.012)	335,801	0.380	-0.0384***	(0.008)	335,801	0.380
Wholesale and retail trade	-0.0477***	(0.006)	1,043,526	0.401	-0.0396***	(0.004)	1,043,526	0.401
Transportation and utilities	-0.0242*	(0.013)	244,625	0.345	-0.0290***	(0.010)	244,625	0.345
Leisure and hospitality	-0.0435***	(0.011)	241,585	0.347	-0.0360***	(0.008)	241,585	0.347
Information	0.0015	(0.009)	663,578	0.478	-0.0005	(0.006)	663,578	0.478
Government and Defense	-0.0037	(0.011)	578,016	0.467	-0.0067	(0.007)	578,016	0.467
Education and health services	-0.0277***	(0.008)	963,230	0.472	-0.0218***	(0.005)	963,230	0.472
Other Services	-0.0289	(0.018)	158,505	0.394	-0.0310**	(0.013)	158,505	0.394
Housekeeping	-0.0834***	(0.008)	567,236	0.361	-0.0576***	(0.006)	567,236	0.361

Notes: We compute the unemployment rate (UR) at the regional level. Each row reports the wage elasticity for the corresponding group of workers. We instrument the logarithm of UR in the region *r* at time t by its lagged value in one quarter. We control for working hours, age, age squared, sex, race (white and non-white), years of schooling and the square of years of formal education, formal or informal sector, public or private sector, 12 industries, rural area, shares of activities in the labor force, and excluded employers and self-employed workers. We ran the ivreg2 command in Stata 17 for all regressions with time and region-fixed effects. Robust standard errors are in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

The estimated wage elasticity in Rural regions is -0.0575 in the FE-2SLS model. Given that the Hausman test in Appendix Table A3 does not reject that the UR is exogenous, the FE-OLS model yields an elasticity of -0.0492. In the Urban areas, the FE-2SLS estimate is -0.0375, while workers in metropolitan areas do not have a significant wage elasticity. However, for those in nonmetropolitan regions, the elasticity is -0.0628, which is significant at the 0.01 level. Thus, as indicated in the literature (e.g., Card, 1995; Longhi et al., 2006; and Baltagi and Rockiki, 2014), workers in low-density regions are likely to have fewer job opportunities, and as a result, large differences in wage elasticities are expected. Paula and Marques (2020), who found an estimate of -0.0414 for the rural area and -0.0136 for the urban area, also confirm that demographic density is an important determinant of the wage curve. Our study proves that this finding holds for metropolitan versus nonmetropolitan regions.

In examining wage dynamics across industries (at the base of the table), we found that the regional overall unemployment rate is not statistically rejected as an exogenous variable in nine out of eleven sectors, as shown in Appendix Table A3. In the FE-OLS case, there are two notable exceptions, that is, the Wholesale and retail trade sector and the Housekeeping sector, at -0.0477 and -0.0834, respectively. They have the highest wage elasticity among all sectors.

The housekeeping sector, in particular, is worthwhile looking at in detail. It represents approximately 8.4% of the total employment and is overwhelming female, averaging 92%. Furthermore, nearly 50% of individuals employed in this sector have less than an elementary degree, as shown in the Appendix Table A4. (This table provides a comprehensive breakdown of workforce distribution across various industries, genders, and schooling levels.)

The Information, Government and defense, and Other services sectors yield insignificant estimates in contrast with all the other industries. In Agriculture, in particular, the wage elasticity coefficient is equal to -0.0583, while in Construction, for example, the estimate is -0.0384. In both sectors, there is a considerable proportion of individuals with a very low schooling level, at 63.1% and 42.6%, respectively. Education and Health Services and Manufacturing display a wage elasticity of -0.0218 and -0.0181, respectively. These estimates are small and statistically equal, but it is worth highlighting that the average schooling level is quite dissimilar: in Education and Health Services, there is a prevalence of employees holding college degrees (in more than 50% of the cases), while in Manufacturing only 13.7% hold a college degree.

Table 3 presents the results derived from equation (3) using both the FE-2SLS and FE-OLS estimators, with the two last columns providing the difference between the elasticity estimates in equations (1) and (3) and the t-test for the difference. For example, in the first row, male wage elasticity is -0.0414; if compared with the elasticity given in the first column of Table 2, there is a change of 0.0028, which is significant at the 0.01 level. As discussed in section 3, a significant difference suggests a cross-effect between demographic groups. For example, if male wage elasticity with respect to male-specific UR is different from the wage elasticity with respect to the overall UR, we conclude that female unemployment impacts the male wage elasticity.

The t-test in the final column of the table further shows that the change in the wage elasticity is significant for men but not for women. It follows then that women's wages are unaffected by men's unemployment rate. However, as shown in Appendix Table A4, observe that women are in a slight majority in the unemployed population (at 52.3%), but most of them hold at least a high-school degree (in more than 62 % of the cases). There seems to be therefore the case that women, who are as well qualified as men, are overlooked when competing for vacancies. Hence, women compete with both men and women, while men compete only with men.

No statistical difference is detected for white workers, while for the nonwhite group of workers, the change is significant. This suggests that wages for white workers operate independently of nonwhite unemployment. For its part, an intriguing observation emerges from examining age groups: for the group of young workers (i.e., 16-22) and for the oldest (i.e., 55 or more), there is no difference across models (1) and (3). This absence of discernible wage effects implies a potential constraint in labor demand. It suggests the existence of job vacancies specifically tailored for starting and ending career workers that other individuals cannot fulfill. In contrast, the difference observed in the 23-34 and 35-54 groups suggests stiff competition among workers aged 23 to 54.

Table 3 – Wage curve elasticities by separate worker groups (the unemployment rate is group-specific)

Group of workers	Wage curve elasticity						The first column in Table 2 versus the first column in this table	
	FE-2SLS			FE-OLS				
	UR	N	R^2	UR	N	R^2	*Difference*	*t-test*[a]
Men	-0.0414*** (0.004)	3,373,944	0.507	-0.0282*** (0.003)	3,373,944	0.507	-0.0028 (0.0009)	-3.2
Women	-0.0342*** (0.004)	2,791,486	0.533	-0.0237*** (0.003)	2,791,486	0.533	0.0016 (0.0013)	1.2
White	-0.0447*** (0.005)	2,610,532	0.507	-0.0325*** (0.003)	2,610,556	0.507	-0.0004 (0.0017)	-0.2
Nonwhite	-0.0328*** (0.003)	3,554,851	0.480	-0.0241*** (0.002)	3,554,851	0.480	-0.0022 (0.0000)	-254.4
16-22	-0.0799*** (0.007)	770,130	0.367	-0.0538*** (0.004)	770,130	0.367	0.0035 (0.0034)	1.0
23-34	-0.0401*** (0.006)	2,042,397	0.475	-0.0259*** (0.003)	2,042,397	0.475	-0.0087 (0.0033)	-2.7
35-54	-0.0172*** (0.004)	2,759,166	0.523	-0.0106*** (0.002)	2,759,313	0.523	-0.0027 (0.0000)	-234.4
55 or more	-0.0156* (0.008)	590,731	0.529	-0.0080*** (0.003)	592,157	0.529	-0.0044 (0.0048)	-0.9
Elementary incomplete	-0.0505*** (0.005)	1,523,050	0.338	-0.0299*** (0.003)	1,523,084	0.338	-0.0003 (0.0017)	-0.2
Elem. comp. or high school incomplete	-0.0509*** (0.006)	963,024	0.339	-0.0276*** (0.003)	963,024	0.339	-0.0083 (0.0011)	-7.8
High school complete or some college	-0.0530*** (0.004)	2,514,925	0.346	-0.0319*** (0.003)	2,514,925	0.346	-0.0019 (0.0013)	-1.5
College or more	0.0152* (0.008)	1,163,458	0.272	0.0034 (0.003)	1,163,940	0.272	-0.0105 (0.0029)	-3.7
Rural	-0.0436*** (0.007)	869,193	0.409	-0.0187*** (0.003)	869,894	0.409	-0.0139 (0.0024)	-5.8
Urban	-0.0362*** (0.003)	4,021,992	0.457	-0.0303*** (0.002)	4,021,992	0.457	-0.0013 (0.0000)	-211.6
Metropolitan region	-0.0003 (0.004)	2,129,761	0.462	-0.0075** (0.003)	2,129,761	0.462	0.0008 (0.0009)	0.9
Non-metropolitan region	-0.0607*** (0.005)	2,763,403	0.461	-0.0457*** (0.003)	2,763,403	0.461	-0.0021 (0.0010)	-2.2

Notes: We compute the unemployment rate (UR) for the corresponding group observed at the regional level. Each row reports the wage elasticity for the corresponding group of workers. The log of UR instrumented in the region *r* at time *t* lagged in one quarter. Control for working hours, age, age squared, sex, race, years of schooling and its square, formality, public sector, 12 industries, rural area, activities shares, and excluded employers and self-employed. We ran the ivreg2 command in Stata 17 with time and region-fixed effects. Robust standard errors are in parentheses. * p<0.10, ** p<0.05, *** p<0.01. [a] t-test rejects the null of equal coefficients if not in [-1.96, 1.96] at a 5% level of significance or not in [-2.58, 2.58] at a 1% level of significance.

In Table 2, the wages of workers with at least a college degree are unaffected by the overall regional UR. In Table 3, however, we see that, as expected, the estimate is significant (at a 10% level). Since in model (3) the Hausman test indicates that we cannot reject the null hypothesis of an exogenous variable, we implemented the FE-OLS estimator, and the coefficient became insignificant. In short, contrary to all other schooling groups, there seems to be no evidence of a wage curve for highly educated workers in Brazil. Interestingly, only the elementary complete or high school incomplete group presents a significant change in the wage elasticity. It indicates that the wages of those groups are affected by the unemployment rate of other groups. According to Green and McIntosh (2007) and Sánchez-Sánchez and Puente (2020), this result indicates a mismatch in employment, where overeducated workers can fill job vacancies available to less educated workers. This scenario leads to a reduced bargaining power and to a decrease in the returns to schooling. More generally, individuals at the top and the bottom of the schooling distribution will tend to occupy more specialized and less interchangeable jobs.

The findings on highly dense versus low-density regions also yield interesting insights. In effect, analysis of workers in metropolitan regions reveals no significant variations between the wage elasticity estimates across equations (1) and (3), while in the case of low-density areas, such as rural and nonmetropolitan regions, and medium-dense areas, such as urban out-of-metropolitan regions, the change in the wage elasticity is significant. The implication is, therefore, that wages within metropolitan labor markets operate independently from other labor markets, while wages in out-of-metropolitan areas depend on the level of labor underutilization observed in highly dense regions.

6.2 *The extended wage curve*

Table 4 uses equation (2) and presents, for different samples, FE-2SLS and FE-OLS estimates of the extended wage curve elasticities with respect to UR, PLF, and TRU. The *t*-test on the equality of UR coefficients in Table 4 and Table 2, as proposed by Clogg et al. (1995) and described in section 3, is also presented in the last column of Table 4.

Table 4 – Wage curve elasticities by separate worker groups, extended model

Sample	Wage curve elasticity								The first column in Table 3 versus the first column in this table	
	FE-2SLS				FE-OLS					
	UR	PLF	TRU	R^2	UR	PLF	TRU	R^2	*Difference*	*t-test*[a]
All Workers	-0.0341*** (0.003)	-0.0196*** (0.003)	0.0074*** (0.002)	0.517	-0.0252*** (0.002)	-0.0121*** (0.002)	-0.0004 (0.001)	0.517	-0.0043 (0.0019)	-2.2
Men	-0.0402*** (0.005)	-0.0183*** (0.004)	0.0069** (0.003)	0.507	-0.0293*** (0.003)	-0.0108*** (0.002)	-0.0005 (0.002)	0.507	-0.0040 (0.0026)	-1.5
Women	-0.0256*** (0.005)	-0.0213*** (0.004)	0.0059* (0.003)	0.533	-0.0194*** (0.003)	-0.0138*** (0.002)	-0.0019 (0.002)	0.533	-0.0070 (0.0028)	-2.5
White	-0.0288*** (0.007)	-0.0089* (0.005)	-0.0079* (0.004)	0.507	-0.0279*** (0.004)	-0.0046* (0.003)	-0.0082*** (0.002)	0.507	-0.0163 (0.0043)	-3.8
Nonwhite	-0.0361*** (0.004)	-0.0263*** (0.003)	0.0156*** (0.003)	0.480	-0.0237*** (0.003)	-0.0170*** (0.002)	0.0045*** (0.002)	0.480	0.0011 (0.0019)	0.6
16-22	-0.0600*** (0.007)	-0.0049 (0.006)	-0.0133*** (0.005)	0.367	-0.0466*** (0.005)	-0.0062* (0.003)	-0.0139*** (0.003)	0.367	-0.0164 (0.0042)	-3.9
23-34	-0.0494*** (0.006)	-0.0098** (0.005)	0.0064* (0.004)	0.475	-0.0349*** (0.004)	-0.0067** (0.003)	-0.0015 (0.002)	0.475	0.0006 (0.0031)	0.2
35-54	-0.0129** (0.005)	-0.0260*** (0.005)	0.0083** (0.004)	0.523	-0.0100*** (0.003)	-0.0158*** (0.003)	0.0011 (0.002)	0.523	-0.0070 (0.0029)	-2.4
55 or more	0.0001 (0.012)	-0.0402*** (0.010)	0.0044 (0.008)	0.529	-0.0070 (0.008)	-0.0214*** (0.006)	-0.0057 (0.005)	0.529	-0.0201 (0.0072)	-2.8
Elementary incomplete	-0.0343*** (0.006)	-0.0152*** (0.005)	-0.0085** (0.004)	0.338	-0.0315*** (0.004)	-0.0107*** (0.003)	-0.0092*** (0.002)	0.338	-0.0165 (0.0031)	-5.3
Elem. comp. or high school incomplete	-0.0400*** (0.007)	-0.0136** (0.006)	-0.0101** (0.005)	0.339	-0.0332*** (0.005)	-0.0111*** (0.003)	-0.0110*** (0.003)	0.339	-0.0192 (0.0041)	-4.7
High school comp. or some college	-0.0437*** (0.005)	-0.0198*** (0.004)	0.0006 (0.003)	0.346	-0.0314*** (0.003)	-0.0134*** (0.002)	-0.0054*** (0.002)	0.346	-0.0112 (0.0026)	-4.3
College or more	-0.0166* (0.010)	-0.0279*** (0.008)	0.0350*** (0.006)	0.272	-0.0127** (0.006)	-0.0120*** (0.005)	0.0170*** (0.004)	0.272	0.0213 (0.0058)	3.7
Public	-0.0235*** (0.008)	-0.0314*** (0.007)	0.0202*** (0.005)	0.463	-0.0127** (0.005)	-0.0233*** (0.004)	0.0104*** (0.003)	0.463	0.0019 (0.0045)	0.4
Private	-0.0333***	-0.0133***	0.0026	0.465	-0.0271***	-0.0075***	-0.0032**	0.465	-0.0055	-2.5

Table 4 – Wage curve elasticities by separate worker groups, extended model

Sample	Wage curve elasticity								The first column in Table 3 versus the first column in this table	
	FE-2SLS				FE-OLS					
	UR	PLF	TRU	R^2	UR	PLF	TRU	R^2	*Difference*	*t-test*[a]
	(0.004)	(0.003)	(0.003)		(0.002)	(0.002)	(0.001)		(0.0022)	
Formal	-0.0275*** (0.004)	-0.0141*** (0.004)	0.0062** (0.003)	0.447	-0.0214*** (0.003)	-0.0072*** (0.002)	-0.0002 (0.002)	0.447	-0.0023 (0.0025)	-0.9
Informal	-0.0571*** (0.007)	-0.0059 (0.007)	-0.0253*** (0.005)	0.375	-0.0468*** (0.005)	-0.0045 (0.004)	-0.0252*** (0.003)	0.375	-0.0267 (0.0039)	-6.9
Rural	-0.0468*** (0.008)	-0.0125 (0.008)	-0.0058 (0.007)	0.410	-0.0411*** (0.005)	-0.0157*** (0.004)	-0.0054 (0.004)	0.410	-0.0107 (0.0037)	-2.9
Urban	-0.0334*** (0.004)	-0.0117*** (0.003)	0.0030 (0.003)	0.457	-0.0269*** (0.003)	-0.0057*** (0.002)	-0.0030** (0.002)	0.457	-0.0041 (0.0022)	-1.8
Metropolitan region	-0.0052 (0.005)	-0.0109*** (0.004)	0.0101*** (0.003)	0.462	-0.0091*** (0.003)	-0.0041* (0.002)	0.0043** (0.002)	0.462	0.0057 (0.0024)	2.4
Non-Metropolitan region	-0.0605*** (0.006)	0.0169*** (0.005)	-0.0160*** (0.005)	0.461	-0.0413*** (0.004)	0.0047* (0.003)	-0.0158*** (0.003)	0.461	-0.0023 (0.0030)	-0.8
Agriculture	-0.0707*** (0.012)	-0.0083 (0.012)	0.0071 (0.010)	0.399	-0.0504*** (0.008)	-0.0143** (0.006)	-0.0090 (0.006)	0.399	0.0010 (0.0054)	0.2
Manufacturing	-0.0145 (0.010)	-0.0085 (0.008)	-0.0054 (0.007)	0.484	-0.0108* (0.006)	0.0001 (0.005)	-0.0099** (0.004)	0.484	-0.0121 (0.0063)	-1.9
Construction	-0.0312** (0.014)	-0.0506*** (0.012)	0.0133 (0.009)	0.380	-0.0269*** (0.009)	-0.0247*** (0.007)	-0.0023 (0.005)	0.380	-0.0165 (0.0071)	-2.3
Wholesale and retail trade	-0.0420*** (0.007)	-0.0145** (0.006)	0.0031 (0.005)	0.401	-0.0337*** (0.004)	-0.0125*** (0.003)	-0.0007 (0.003)	0.401	-0.0057 (0.0039)	-1.5
Transportation and utilities	-0.0140 (0.016)	-0.0455*** (0.013)	0.0167 (0.010)	0.345	-0.0248** (0.010)	-0.0235*** (0.007)	0.0080 (0.006)	0.345	-0.0102 (0.0096)	-1.1
Leisure and hospitality	-0.0275** (0.013)	-0.0078 (0.012)	-0.0111 (0.009)	0.347	-0.0243*** (0.009)	-0.0108* (0.006)	-0.0103** (0.005)	0.347	-0.0160 (0.0075)	-2.1
Information	-0.0142 (0.010)	0.0077 (0.009)	0.0102 (0.007)	0.478	-0.0087 (0.007)	0.0079* (0.005)	0.0064* (0.004)	0.478	0.0157 (0.0058)	2.7
Government and Defense	-0.0126 (0.012)	-0.0168* (0.010)	0.0180** (0.008)	0.467	-0.0072 (0.008)	-0.0113** (0.006)	0.0072 (0.005)	0.467	0.0089 (0.0066)	1.3
Education and health services	-0.0296*** (0.009)	-0.0401*** (0.008)	0.0250*** (0.006)	0.472	-0.0203*** (0.006)	-0.0244*** (0.004)	0.0121*** (0.003)	0.472	0.0019 (0.0050)	0.4

Table 4 – Wage curve elasticities by separate worker groups, extended model

Sample	Wage curve elasticity								The first column in Table 3 versus the first column in this table	
	FE-2SLS				FE-OLS					
	UR	PLF	TRU	R^2	UR	PLF	TRU	R^2	*Difference*	*t-test*[a]
Other Services	-0.0363* (0.021)	0.0150 (0.019)	-0.0014 (0.015)	0.394	-0.0317** (0.014)	0.0077 (0.010)	-0.0034 (0.008)	0.394	0.0074 (0.0118)	0.6
Housekeeping	-0.0531*** (0.010)	-0.0246*** (0.008)	-0.0158*** (0.006)	0.361	-0.0366*** (0.006)	-0.0173*** (0.004)	-0.0197*** (0.004)	0.361	-0.0303 (0.0052)	-5.9

Notes: We compute the unemployment rate (UR), the potential labor force rate (PLF), and the time-related underemployment at the regional level. Each row reports the wage elasticity for the corresponding group of workers. We instrument the logarithm of UR in the region *r* at time *t* by its lagged value in one quarter. We control for working hours, age, age squared, sex, race (white and non-white), years of schooling and the square of years of formal education, formal or informal sector, public or private sector, 12 industries, rural area, shares of activities in the labor force, and excluded employers and self-employed workers. We ran the *ivreg2* command in Stata 17 for all regressions with time and region-fixed effects. * p<0.10, ** p<0.05, *** p<0.01.

[a] t-test rejects the null of equal coefficients if not in [-1.96, 1.96] at a 5% level of significance or not in [-2.58, 2.58] at a 1% level of significance.

In the sample of all workers, there is a slight change in the UR coefficient, which is now equal to -0.0341, smaller (in absolute value) than the corresponding coefficient in Table 2, at -0.384. There is, therefore, a slight reduction in the wage elasticity, which is nevertheless statistically different at the 0.01 level (in the last column of the Table). The elasticity of wages with respect to PLF is -0.0196, while in the case of TRU, it is positive, at 0.0074, both significant at the 0.01 level. Thus, the model indicates a -0.2% change in wages given a 10% increase in PLF and a +0.07% change in wages if TRU increases by 10%. Note that the estimated value is positive for TRU, which differs from Blanchflower et al. (2022, p. 20), who found for the USA an estimate of -0.0182 using 1980-2020 annual data and simply defining the underemployment variable as the share of part-time workers (i.e., workers working less than 35 hours per week for economic reasons).

The wage elasticities with respect to PLF and TRU were significant for men (-0.0183 and 0.0069, respectively) and for women (-0.0213 and 0.0059, respectively), in the second and third rows of Table 4, showing that excess labor underutilization affects wages irrespective of gender. However, we found no statistical difference between men and women regarding the PLF and TRU arguments, as shown in Appendix Table A5. (This table reports the results of the t-test across groups as described in section 3).

Interestingly, underutilization of labor seems to affect more nonwhite workers (PLF: -0.0263; TRU: 0.0156) than white workers (PLF: -0.0089; TRU: 0.0079). For the age-based groups, the wage elasticity with respect to UR is declining up to statistically zero for the group of oldest workers. The elasticity is increasing in the case of PLF, while in the case of TRU the coefficient goes from -0.0133 for workers aged 16-22, to a 0.0083 for workers aged 35-54.

Our extended model indicates that the wage income of workers with incomplete elementary school changes -0.34% if the regional unemployment rate increases by 10%, 0.17 percentage points less (in absolute value) than in the standard wage curve in Table 2. The corresponding wage elasticities with respect to PLF (-0.0152) and TRU (-0.0085) are significant at 1% and 5%, respectively. The results in the extended wage curve for workers with elementary complete or high school incomplete also present similar changes, with the UR, PLF, and TRU elasticities at -0.0400, -0.0136, and -0.0101, respectively. Again, the evidence indicates that labor underutilization substantially affects wage determination. For the sample of college graduates, a 10% change in UR implies a -0.17% change in wages; a

10% increase in PLF and TRU, in turn, implies a wage reduction of -0.28% and a wage increase of 0.35%, respectively.

The UR estimates in Table 4 for rural and urban areas are -0.0468 and -0.0334, respectively. However, the difference between these estimates is not statistically significant, as presented in Appendix Table A5. These results, therefore, show the role of PLF in wage dynamics since we cannot identify a difference in the UR between urban and rural areas. Note also that the PLF coefficient is significant in urban areas but not in rural areas. In other words, the role of the potential labor force variable in highly dense areas seems to be more relevant than in the less dense counterparts. The TRU coefficient, in turn, is never statistically significant.

Metropolitan regions, i.e., groups of neighboring municipalities with greater economic development, are established by complementary state law and attract more workers than other regions. Notwithstanding a lack of wage elasticity concerning UR for metropolitan regions in the standard and extended models (in Table 2 and Table 4, respectively), the former enriches the analysis by adding alternative labor underutilization measures. The latter shows that wages in these areas are reduced by 0.11% if the PLF rate increases by 10%; and increased by 0.10% if the TRU increases by 10%. Both estimates are significant at the 0.01 level. These results strengthen the idea that the *reserve army* does matter in densely populated areas. However, contrary to our expectation, the wage elasticity with respect to PLF is positive in nonmetropolitan areas. A possible positive relation of a long-term association for PLF effects on wages in nonmetropolitan areas is the existence of an amenities' gap, as in the Harris-Todaro framework. Busso et al. (2021) find evidence of Harris and Todaro equilibrium relationships in the Brazilian economy, mainly for workers with lower levels of education, which, in Brazil, is predominant in areas outside the metropolitan regions. Accordingly, once workers perceive a higher chance of finding a job in nonmetropolitan areas, they migrate, increasing the local labor force. Following Hall (1970, 381-384), the excess of labor in nonmetropolitan areas is seen as an advantage by employers as it reduces voluntary quits (as well as shirking), thus reducing hiring and training costs and increasing the possibility of higher wages. The result will, therefore, be higher wages and higher labor underutilization.

Table 5 uses model (4) to give the wage elasticities with respect to group-specific labor underutilization measures, again in separate regressions. In the last main column, this table also presents the difference between the elasticity given in the table and the estimates given in Table 4. For instance, for the nonwhite workers in the fourth row, the wage elasticity with respect to UR is -0.0340. This estimate is -0.0021 lower (in absolute value) than the corresponding wage elasticity of -0.0361 in the fifth row of Table 4. Since the corresponding *t* statistic is -2.4, the implication is that this difference is evidence of the influence of the whites' unemployment rate on nonwhite wages.

For men and women, note that the wage elasticity with respect to the unemployment rate, at -0.0396 and -0.0269, respectively, is significant at a 1% level in both cases; and for both groups of workers, the difference between Table 5 and Table 4 estimates is insignificant. This result indicates that the unemployment rate of males has no impact on women's wages (and conversely) once one takes into account the effect of the PLF and TRU variables. However, we cannot confirm that the same occurs concerning the PLF and TRU, as the difference reported in the last main row is statistically significant. Although the magnitude of the difference is very small, there is, therefore, the suggestion that labor underutilization may be a real threat to wage growth.

The wage elasticity for white workers concerning the UR for white (at -0.0259) is not statistically different from the corresponding coefficient in Table 4, in contrast with the PLF and TRU cases. However, it is worth noting that PLF is not significant when considering white PLF and is small and significant at a 10% level when considering regional PFL (-0.0089, in Table 4). Therefore, there is evidence that white workers' wages are independent of nonwhite workers' labor underutilization, but the wages of nonwhites are correlated with the underutilization of white workers. Nonwhite wage elasticities with respect to (w.r.t.) UR, PLF, and TRU are equal to -0.0340, -0.0331, and -0.0184, respectively. They are significant at the 0.01 level, as well as statistically different from their corresponding estimates in Table 4. Changes in whites' underutilization have, therefore, a significant effect on the wages of nonwhites.

Table 5 – Wage curve elasticities by separate worker groups, extended model (the unemployment rate is group-specific)

Sample	Wage curve elasticity								Table 4 elasticities versus respective elasticities in this table					
	FE-2SLS				FE-OLS				UR		PLF		TRU	
	UR	PLF	TRU	R^2	UR	PLF	TRU	R^2	*Diff.*	*t-test*[a]	*Diff.*	*t-test*[a]	*Diff.*	*t-test*[a]
Men	-0.0396*** (0.005)	-0.0267*** (0.004)	0.0112*** (0.003)	0.51	-0.0238*** (0.003)	-0.0109*** (0.002)	-0.0015 (0.002)	0.51	-0.001 (0.001)	-0.6	0.008 (0.001)	6.6	-0.004 (0.000)	-142.2
Women	-0.0269*** (0.005)	-0.0143*** (0.004)	0.0020 (0.003)	0.53	-0.0169*** (0.003)	-0.0081*** (0.002)	-0.0057*** (0.002)	0.53	0.001 (0.002)	0.7	-0.007 (0.000)	-292.9	0.004 (0.001)	3.4
White	-0.0259*** (0.008)	0.0015 (0.006)	-0.0175*** (0.005)	0.51	-0.0261*** (0.003)	0.0005 (0.002)	-0.0106*** (0.002)	0.51	-0.003 (0.004)	-0.8	-0.010 (0.002)	-4.5	0.010 (0.002)	4.5
Nonwhite	-0.0340*** (0.004)	-0.0331*** (0.004)	0.0184*** (0.003)	0.48	-0.0219*** (0.002)	-0.0186*** (0.002)	0.0053*** (0.001)	0.48	-0.002 (0.001)	-2.4	0.007 (0.001)	4.7	-0.003 (0.001)	-3.9
16-22	-0.0671*** (0.009)	0.0008 (0.007)	-0.0162*** (0.005)	0.37	-0.0460*** (0.004)	-0.0054** (0.003)	-0.0123*** (0.002)	0.37	0.007 (0.004)	1.6	-0.006 (0.004)	-1.5	0.003 (0.001)	2.1
23-34	-0.0382*** (0.007)	-0.0132** (0.006)	0.0022 (0.004)	0.47	-0.0230*** (0.003)	-0.0045** (0.002)	-0.0050*** (0.002)	0.47	-0.011 (0.004)	-3.0	0.003 (0.003)	1.3	0.004 (0.001)	3.5
35-54	-0.0058 (0.006)	-0.0284*** (0.005)	0.0083** (0.004)	0.52	-0.0060** (0.003)	-0.0128*** (0.002)	-0.0008 (0.002)	0.52	-0.007 (0.002)	-4.0	0.002 (0.003)	0.9	0.000 (0.002)	0.0
55 or more	0.0121 (0.013)	-0.0065 (0.009)	-0.0244** (0.010)	0.53	-0.0038 (0.003)	-0.0055* (0.003)	-0.0094*** (0.003)	0.53	-0.012 (0.005)	-2.3	-0.034 (0.005)	-7.1	0.029 (0.006)	4.7
Elementary incomplete	-0.0402*** (0.005)	-0.0158*** (0.005)	-0.0021 (0.004)	0.34	-0.0243*** (0.003)	-0.0082*** (0.002)	-0.0072*** (0.002)	0.34	0.006 (0.002)	2.8	0.001 (0.002)	0.4	-0.006 (0.002)	-4.2
Elementary complete or high school incomplete	-0.0333*** (0.008)	-0.0136 (0.009)	-0.0081 (0.006)	0.34	-0.0180*** (0.003)	-0.0095*** (0.002)	-0.0106*** (0.002)	0.34	-0.007 (0.003)	-2.5	0.000 (0.006)	0.0	-0.002 (0.004)	-0.5
High school comp. or some college	-0.0404*** (0.005)	-0.0185*** (0.004)	-0.0035 (0.003)	0.35	-0.0238*** (0.003)	-0.0106*** (0.002)	-0.0084*** (0.001)	0.35	-0.003 (0.002)	-1.7	-0.001 (0.002)	-0.8	0.004 (0.000)	239.5
College or more	0.0112 (0.012)	-0.0182* (0.011)	0.0214*** (0.007)	0.27	0.0011 (0.003)	-0.0018 (0.002)	0.0101*** (0.002)	0.27	-0.028 (0.007)	-3.7	-0.010 (0.007)	-1.3	0.014 (0.003)	4.1
Rural	-0.0284*** (0.008)	-0.0046 (0.007)	-0.0262*** (0.006)	0.41	-0.0143*** (0.003)	-0.0104*** (0.002)	-0.0149*** (0.002)	0.41	-0.018 (0.003)	-6.6	-0.008 (0.004)	-2.0	0.020 (0.004)	5.1
Urban	-0.0321*** (0.004)	-0.0115*** (0.003)	0.0027 (0.003)	0.46	-0.0255*** (0.002)	-0.0056*** (0.002)	-0.0034** (0.001)	0.46	-0.001 (0.001)	-1.5	0.000 (0.001)	-0.2	0.000 (0.001)	0.4
Metropolitan region	-0.0047	-0.0114***	0.0097***	0.46	-0.0090***	-0.0043**	0.0041**	0.46	-0.001	-0.4	0.001	0.3	0.000	0.4

Table 5 – Wage curve elasticities by separate worker groups, extended model (the unemployment rate is group-specific)

Sample	Wage curve elasticity								Table 4 elasticities versus respective elasticities in this table					
	FE-2SLS				FE-OLS				UR		PLF		TRU	
	UR	PLF	TRU	R^2	UR	PLF	TRU	R^2	*Diff.*	*t-test*[a]	*Diff.*	*t-test*[a]	*Diff.*	*t-test*[a]
	(0.005)	(0.004)	(0.003)		(0.003)	(0.002)	(0.002)		(0.001)		(0.002)		(0.001)	
Nonmetropolitan region	-0.0579*** (0.006)	0.0193*** (0.006)	-0.0183*** (0.005)	0.46	-0.0395*** (0.004)	0.0060** (0.003)	-0.0169*** (0.003)	0.46	-0.003 (0.001)	-2.5	-0.002 (0.001)	-2.3	0.002 (0.001)	2.3

Notes: We compute the unemployment rate (UR), the potential labor force rate (PLF), and the time-related underemployment observed in the corresponding group at the regional level. Each row reports the wage elasticity for the corresponding group of workers. We instrument the logarithm of UR in the region *r* at time *t* by its lagged value in one quarter. We control for working hours, age, age squared, sex, race (white and non-white), years of schooling and the square of years of formal education, formal or informal sector, public or private sector, 12 industries, rural area, shares of activities in the labor force, and excluded employers and self-employed workers. We ran the *ivreg2* command in Stata 17 for all regressions with time and region fixed effects. Robust standard errors are in parentheses. * p<0.10, ** p<0.05, *** p<0.01.
[a] *t-test* rejects the null of equal coefficients if not in [-1.96, 1.96] at 5% level of significance; or not in [-2.58, 2.58] at 1% level of significance.

The analysis based on age groups is also interesting. In this case, only the younger group of 16 to 22, with an estimate of -0.0671 w.r.t. UR in Table 5, does not present a significant change compared with Table 4. For this group, PLF is insignificant, while the TRU coefficient, at -0.0162, is significantly different from Table 4. To clarify, unemployment in other age groups, as well as the number of young workers in PLF, do not seem to affect the wages of young workers' jobs, in contrast to TRU.

In the other age groups, the significant difference in the estimates of equations (2) and (4) highlights the cross-effect of the unemployment rate. These results support the perception of increased job competition among workers in these older age groups.

The wage elasticity of workers with at least a college degree is insignificant in the first column of Table 5; it was marginally significant in Table 4. The wage elasticity w.r.t. PFL is, in turn, statistically equal across Tables 4 and 5. The TRU coefficient of 0.0214 in Table 5 is statistically lower than in Table 4. These results indicate that labor underutilization from low-educated workers inflates the labor underutilization effect on highly educated workers' wages.

Analysis of wage curves in high- and low-density areas is also worthwhile. The estimated wage elasticities for urban areas were -0.0321 w.r.t. UR, -0.0115 w.r.t. PLF, and was not significant for TRU. In metropolitan areas, elasticity w.r.t. UR was not significant, and w.r.t. PLF and TRU were -0.0114 and 0.0097, respectively. These estimates for urban and metropolitan areas are not different from the estimates in Table 4. Hence, these findings are associated with the independence of metropolitan areas from labor underutilization in low-density areas. Additionally, the PLF effect on wages is similar and low in the two geographic areas.

Wage elasticities in rural areas w.r.t. UR, PLF, and TRU are -0.0284, -0.0046 (insignificant), and -0.0262, and in nonmetropolitan areas are -0.0579, 0.0193, and -0.0183, respectively. Given that nonmetropolitan areas encompass nearly all rural regions, we can extrapolate that the effect of the unemployment rate is greater in urban nonmetropolitan regions than in rural regions. Conversely, the impact of TRU on wages is more pronounced in rural areas. Furthermore, the strong significance observed in the difference between the estimates presented in Tables 4 and 5 implies that wages in less densely populated areas depend on labor underutilization observed in high-density regions.

7. Conclusions

In this study, we examined the relationship between wages and labor underutilization using quarterly microdata from the Brazilian Continuous National Household Sample Survey from 2012Q2 to 2023Q2, with labor underutilization variables being given by the unemployment rate (UR), potential labor force rate (PLF), and time-related underemployment rate (TRU). Our detailed wage elasticities estimates are derived from time and region fixed effects model and from a fixed effects two-stage least squares implementation, where in the latter the selected underutilization measures are instrumented by their lagged value.

Unlike previous studies that rely on annual data, we use quarterly data to confirm the presence of a standard wage curve in the Brazilian labor market. Specifically, we found an elasticity of -0.0384, implying that a 10% increase in the unemployment rate is associated with a 0.38% decrease in wages. In other words, if the unemployment rate in the second quarter of 2023, which was at 8.0%, increases by 0.8 percentage points, the real wages of employees in the following quarter will decline by approximately 0.4%, a quite sizeable effect.

The wage elasticity is at the highest level for informal workers, at -0.0838, which is almost three times larger than for workers with a formal employment contract, at -0.0298. The wage elasticity is also very large for workers aged 16-22, at -0.0764. There is no evidence of a wage curve for workers with a college degree and workers in metropolitan regions. We also could not find significant estimates for workers in the information, and government and defense sectors. For workers with high school degrees and elementary complete or high school incomplete, the wage elasticity is significant and equal to -0.0549 and -0.0592, respectively, while in urban and metropolitan areas, workers have a lower (in absolute value) wage elasticity than in the less-dense rural and nonmetropolitan cases.

The standard wage curve model also shows that men have a higher wage elasticity than women, at -0.0442 and -0.0326, respectively. Women are the majority in unemployment (at 52.3%) and the minority in employment (45.5%), with 62.1% of unemployed women having at least a high school degree, 48.8% in the case of men.

Extending the analysis to comprise the effect of PLF and TRU we found that the UR effect holds for almost half of the selected worker groups. That is the case of men, nonwhite, and aged 23-34 workers, workers in the public sector with a formal contract, and in urban and nonmetropolitan areas. For women, white, aged 16-22 and 35 or more, in all schooling levels, in private sector, informal sector, rural areas, metropolitan regions, in construction, leisure and hospitality, information and housekeeping workers, we have that the difference in the estimates concerning unemployment rate between the models is statistically significant, and in most of them slightly lower in the extended model. These results show therefore the importance of controlling for the potential labor force and time-related underemployment to understand the wage dynamics, since it provides an additional source of wage variation.

Specifically, for the sample of all workers, the extended model yields that a 10% increase in UN, PLF, and TRU is associated with a wage change of -0.34%, -0.20%, and +0.07%, respectively. Regarding the UR variable, the elasticity is slightly lower than in the standard model, with the highest level observed for agriculture workers, at -0.0707, which is more than twice as large as the estimate for all workers. The wage elasticity is also large for informal workers, at -0.0571, and aged 16-22, at -0.0600. Similarly to what we found in the standard wage curve, we found no evidence of a wage curve concerning UR for workers in metropolitan regions, however, PLF and TRU were significant. The elasticity with respect to PLF, for its part, is the highest for workers in the construction industry, at -0.0506, and is also high for the older group of workers, 55 or older, at -0.0402. The estimates are significant for men, women, white, and nonwhite workers (at -0.0183, -0.0213, -0.0089, and -0.0263, respectively). In contrast, PLF does not affect the wages of informal and rural workers. Finally, the TRU's elasticity is 0.350 (i.e., positive) for workers with a college degree and -0.0253 (i.e., negative) for informal workers.

Model estimation with regional versus group-specific labor underutilization reveals no cross effects of UR between men and women. However, there are cross-effects when the PLF and TRU variables are included in the model, as their estimated differences between the two models are statistically significant. Within this comparative exercise, cohorts of workers from low-density areas have their wages affected by labor underutilization observed in high-density areas. Our results also show significant differences between the models with regional versus group-specific variables for those workers in either Rural or Non-metropolitan areas. Thus, the effect on wages in low-density areas (i.e., Rural and Non-metropolitan, respectively) is influenced by both their own labor underutilization and the labor underutilization in the corresponding high-density areas (i.e., Urban and Metropolitan, respectively). But the converse is not true: that is, the wage elasticity in Urban and Metropolitan areas depend exclusively on the labor underutilization rate observed in these areas, without any significant cross effects (from Rural and Non-metropolitan areas, respectively). Again, this seems to be a quite relevant result.

There is also a wage curve for young workers, with the interesting finding that there is no statistically significant difference between the model with group-specific versus regional measures. In other words, there is evidence that the labor market for young workers is separated, or that the salary of young workers is not affected by variations in the UR, PLF, and TRU of other age groups.

This study thoroughly examined the complex relationship between wages and labor underutilization in the Brazilian labor market. The standard wage curve, in particular, revealed the presence of a significant elasticity, confirming that substantial wage reductions are expected in the event of an uptick in the unemployment rate. The extended wage curve, in turn, allowed us to additionally estimate the wage elasticity with respect to the potential labor force rate and time-related underemployment rate, thus enlarging our view of the nature of wage determination in selected worker groups. Finally, examination of group-specific measures of labor underemployment highlighted differences in wage responsiveness, underlining key effects across groups.

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Appendix

Table A1 – Variable description and basic statistics

Variable	Obs	Unique	Mean	Min	Max	Description
INDVIDUAL-LEVEL VARIABLES						
qdate	6,165,430	45	229.41	209	253	From quarter 1 (=209) to quarter 45 (=253)
age	6,165,430	55	37.09	16	70	Age
yeduc	6,165,430	17	10.72	0	16	Years of schooling
ioo	6,165,430	12	5.81	1	12	Industry of affiliation: 1 Agriculture; 2 Manufacturing; 3 Construction; 4 Wholesale and retail trade; 5 Transportation and utilities; 6 Leisure and hospitality; 7 Information; 8 Government and Defense; 9 Education and health services; 10 Other Services; 11 Housekeeping; 12 Non-defined activities.
workh	6,165,430	111	40.57	10	120	Weekly working hours
lwageh	6,165,430	746,103	2.38	0.433	4.694	Log of real wage/hour at 2023Q2 values
regions	6,165,430	53	325.94	110	530	Code for the regional division of each UF
non-white	6,165,430	2	0.58	0	1	=1 if non-white
posocup	6,165,430	3	2.07	1	5	Position in occupation: 1 Formal; 2 Informal; 3 Government and defense
setpub	6,165,430	2	0.20	0	1	=1 if public sector
sex	6,165,430	2	0.45	0	1	=1 if women
rural	6,165,430	2	0.17	0	1	=1 if rural areas
RM	6,165,430	2	0.43	0	1	=1 if metropolitan regions
REGIONAL-LEVEL VARIABLES						
lm1a41	6,165,430	2,384	3.11	1.472	4.168	Unemployment rate: workers aged 16-22
lm1a42	6,165,430	2,385	2.26	0.695	3.531	Unemployment rate: workers aged 23-34
lm1a43	6,165,430	2,385	1.69	-0.577	3.174	Unemployment rate: workers aged 35-54
lm1a44	6,145,092	2,350	1.17	-1.640	3.326	Unemployment rate: workers aged 55 or more
lm1e1	6,165,074	2,384	2.07	0.324	3.677	Unemployment rate: Elementary incomplete
lm1e2	6,165,430	2,384	2.50	-0.329	3.703	Unemployment rate: Elementary complete or high school incomplete
lm1e3	6,165,430	2,384	2.29	0.824	3.633	Unemployment rate: High school complete or some college
lm1e4	6,162,721	2,379	1.49	-0.989	3.332	Unemployment rate: College or more
lm1f	6,165,430	2,385	2.38	0.720	3.705	Unemployment rate: female
lm1g	6,165,430	2,385	2.18	0.706	3.281	Unemployment rate
lm1m	6,165,430	2,385	1.99	0.291	3.216	Unemployment rate: male

Table A1 – Variable description and basic statistics

Variable	Obs	Unique	Mean	Min	Max	Description
lm1nrm	3,599,518	1,170	2.05	0.706	3.261	Unemployment rate: Nonmetropolitan
lm1nw	6,165,430	2,385	2.32	0.797	3.321	Unemployment rate: non-white
lm1r	6,097,723	2,324	1.82	-1.785	3.784	Unemployment rate: rural
lm1rm	3,350,483	1,395	2.32	0.395	3.455	Unemployment rate: Metropolitan
lm1u	6,165,430	2,384	2.22	0.707	3.445	Unemployment rate: urban
lm1w	6,165,238	2,383	2.01	-0.009	3.556	Unemployment rate: white
lm2a41	6,165,430	2,385	2.23	-0.407	3.980	Potential LF rate: workers aged 16-22
lm2a42	6,165,430	2,385	1.28	-1.309	3.577	Potential LF rate: workers aged 23-34
lm2a43	6,164,085	2,382	1.10	-1.393	3.338	Potential LF rate: workers aged 35-54
lm2a44	6,143,921	2,359	1.49	-2.268	3.399	Potential LF rate: workers aged 55 or more
lm2e1	6,162,129	2,380	1.69	-0.888	3.693	Potential LF rate: Elementary incomplete
lm2e2	6,164,661	2,383	1.81	-1.358	3.826	Potential LF rate: Elementary complete or high school incomplete
lm2e3	6,165,430	2,385	1.33	-1.314	3.553	Potential LF rate: High school complete or some college
lm2e4	6,131,199	2,336	0.48	-2.324	3.422	Potential LF rate: College or more
lm2f	6,165,430	2,385	1.82	-1.138	3.901	Potential LF rate: female
lm2g	6,165,430	2,384	1.47	-0.652	3.570	Potential LF rate
lm2m	6,165,430	2,385	1.04	-1.721	3.347	Potential LF rate: male
lm2nrm	3,599,518	1,169	1.63	-0.652	3.570	Potential LF rate: non-metropolitan
lm2nw	6,165,430	2,385	1.58	-1.340	3.579	Potential LF rate: non-white
lm2r	6,021,779	2,279	1.64	-2.428	3.856	Potential LF rate: rural
lm2rm	3,350,483	1,395	1.33	-0.634	3.611	Potential LF rate: metropolitan
lm2u	6,165,430	2,385	1.41	-0.676	3.371	Potential LF rate: urban
lm2w	6,163,452	2,377	1.33	-1.502	3.545	Potential LF rate: white
lm3a41	6,149,260	2,357	1.86	-1.338	3.891	Time-related underemployment rate: workers aged 16-22
lm3a42	6,162,320	2,380	1.52	-2.107	3.521	Time-related underemployment rate: workers aged 23-34
lm3a43	6,162,558	2,380	1.47	-2.547	3.357	Time-related underemployment rate: workers aged 35-54
lm3a44	6,135,898	2,342	1.32	-2.470	3.094	Time-related underemployment rate: workers aged 55 or more
lm3e1	6,158,495	2,374	1.77	-2.283	3.536	Time-related underemployment rate: Elementary incomplete
lm3e2	6,157,518	2,369	1.66	-1.385	3.622	Time-related underemployment rate: Elementary complete or high school incomplete
lm3e3	6,162,021	2,378	1.38	-2.124	3.271	Time-related underemployment rate: High school complete or some college
lm3e4	6,143,927	2,338	1.20	-1.878	3.049	Time-related underemployment rate: College or more

Table A1 – Variable description and basic statistics

Variable	Obs	Unique	Mean	Min	Max	Description
lm3f	6,164,886	2,384	1.81	-2.404	3.466	Time-related underemployment rate: female
lm3g	6,165,430	2,385	1.54	-2.192	3.389	Time-related underemployment rate
lm3m	6,162,869	2,381	1.24	-2.150	3.383	Time-related underemployment rate: male
lm3nrm	3,599,518	1,170	1.67	-0.306	3.409	Time-related underemployment rate: non-metropolitan
lm3nw	6,164,886	2,384	1.66	-2.404	3.445	Time-related underemployment rate: non-white
lm3r	5,920,598	2,215	1.63	-1.796	4.220	Time-related underemployment rate: rural
lm3rm	3,350,483	1,395	1.44	-2.192	3.276	Time-related underemployment rate: metropolitan
lm3u	6,165,430	2,385	1.51	-2.529	3.222	Time-related underemployment rate: urban
lm3w	6,153,736	2,364	1.38	-1.738	3.314	Time-related underemployment rate: white
rind1	6,165,430	2,385	10.75	0.106	48.754	Share of agriculture in employment
rind2	6,165,430	2,385	12.92	2.556	29.561	Share of manufacturing in employment
rind3	6,165,430	2,385	8.13	3.015	18.554	Share of construction in employment
rind4	6,165,430	2,385	19.52	7.331	32.404	Share of wholesale and retail trade in employment
rind5	6,165,430	2,385	4.77	1.056	9.497	Share of transportation and utilities in employment
rind6	6,165,430	2,385	5.03	1.563	11.142	Share of leisure and hospitality in employment
rind7	6,165,430	2,385	10.30	0.847	28.656	Share of information in employment
rind8	6,165,430	2,385	6.40	1.971	24.471	Share of government and defense in employment
rind9	6,165,430	2,385	11.17	2.680	26.213	Share of education and health services in employment
rind10	6,165,430	2,385	4.71	0.903	9.798	Share of other services in employment
rind11	6,165,430	2,385	6.28	1.614	11.980	Share of housekeeping in employment
rind12	6,165,430	705	0.03	0.000	2.092	Share of family work in employment

Notes: The sum of rind1 to rind 12 equals 100.

Table A2 - Difference between selected groups and the t-statistic of the difference from the estimates of the regular wage curve (equation 1)

Worker groups compared	Difference	*t-statistic*
	Panel A	
Men x women	2.1	0.0116
White x nonwhite	1.7	0.0101
16-22 x 23-34	3.6	0.0276
16-22 x 35-54	7.7	0.0565
16-22 x 55 or more	4.9	0.0564
23-34 x 35-54	4.5	0.0289
23-34 x 55 or more	2.7	0.0288
35-54 x 55 or more	0.0	-0.0001
Elementary incomplete x Elementary complete or high school incomplete	-1.1	-0.0084
Elementary incomplete x High school complete or some college	-0.7	-0.0041
Elementary incomplete x College or more	6.0	0.0555
Elementary complete or high school incomplete x High school complete or some college	0.6	0.0043
Elementary complete or high school incomplete x College or more	6.6	0.0639
High school complete or some college x College or more	6.8	0.0596
Public x private	-2.3	-0.0172
Formal x informal	-7.6	-0.0540
Rural x urban	2.5	0.0200
Metropolitan x nonmetropolitan	-9.8	-0.0633

Panel B

Industries	Agriculture	Manufacturing	Construction	Wholesale and retail trade	Transportation and utilities	Leisure and hospitality	Information	Government and Defense	Education and health services	Other Services	Housekeeping
Agriculture	**0.0**	0.043	0.022	0.022	0.046	0.026	0.071	0.066	0.042	0.041	-0.014
Manufacturing	3.3	**0.0**	-0.021	-0.021	0.002	-0.017	0.028	0.023	-0.001	-0.002	-0.057
Construction	1.4	-1.5	**0.0**	0.000	0.024	0.004	0.049	0.044	0.020	0.019	-0.036
Wholesale and retail trade	1.8	-2.2	0.0	**0.0**	0.024	0.004	0.049	0.044	0.020	0.019	-0.036
Transportation and utilities	2.7	0.2	1.3	1.6	**0.0**	-0.019	0.026	0.021	-0.004	-0.005	-0.059
Leisure and hospitality	1.7	-1.3	0.3	0.3	-1.1	**0.0**	0.045	0.040	0.016	0.015	-0.040
Information	5.3	2.4	3.4	4.8	1.6	3.2	**0.0**	-0.005	-0.029	-0.030	-0.085
Government and Defense	4.4	1.8	2.8	3.7	1.2	2.6	-0.4	**0.0**	-0.024	-0.025	-0.080
Education and health services	3.3	-0.1	1.5	2.1	-0.2	1.2	-2.6	-1.9	**0.0**	-0.001	-0.056
Other Services	2.0	-0.1	0.9	1.0	-0.2	0.7	-1.5	-1.2	-0.1	**0.0**	-0.055
Housekeeping	-1.0	-5.1	-2.5	-3.6	-3.8	-2.9	-7.2	-6.0	-5.0	-2.8	**0.0**

Note: Panel A present the difference between two selected groups and the t-test statistic, as well as Panel B present the same information in a matrix format for the industries. The t-test tests the null hypothesis of the difference equals to zero. Test t significance critical values: 1% if t > 2.57; 5% if t > 1.96; and 10% if t > 1.645.

Table A3 - Statistics for the endogeneity tests by equation

Groups of workers	Tests for regressions in Table 3 - Eq. (1)			Tests for regressions in Table 4 - Eq. (2)			Tests for regressions in Table 5 - Eq. (3)			Tests for regressions in Table 6 - Eq. (4)		
	Hausman test		Wald F statistic	Hausman test		Wald F statistic	Hausman test		Wald F statistic	Hausman test		Wald F statistic
	Chi-sq	p-value		Chi-sq	p-value		Chi-sq	p-value		Chi-sq	p-value	
All Workers	15.15	0.000	3,017,095				23.15	0.000	269,025			
Men	13.14	0.000	1,644,862	18.75	0.000	899,189	16.20	0.001	141,722	37.17	0.000	93,810
Women	4.07	0.044	1,374,439	10.39	0.001	825,186	8.91	0.031	127,413	8.52	0.036	72,690
White	5.19	0.023	1,201,726	7.66	0.006	500,789	6.37	0.095	116,523	13.60	0.004	51,654
Non-white	11.16	0.001	1,739,966	12.21	0.001	1,295,340	35.67	0.000	161,068	39.52	0.000	94,132
16-22	16.40	0.000	358,866	20.61	0.000	149,818	8.28	0.041	31,036	15.58	0.001	11,463
23-34	8.62	0.003	951,439	8.74	0.003	380,653	12.94	0.005	88,955	10.25	0.017	39,444
35-54	1.77	0.184	1,387,750	3.12	0.077	587,240	8.79	0.032	121,790	13.04	0.005	64,476
55 or more	0.02	0.891	346,862	0.88	0.348	37,488	5.73	0.125	29,387	5.42	0.143	4,849
Elementary incomplete	6.99	0.008	723,513	29.34	0.000	185,284	6.84	0.077	60,242	27.47	0.000	28,514
Elem. complete or high school incomplete	10.24	0.001	467,336	21.59	0.000	132,417	5.30	0.151	43,163	12.74	0.005	8,446
High school comp. or some college	25.57	0.000	1,312,671	42.37	0.000	751,548	19.87	0.000	117,686	33.31	0.000	63,623
College or more	2.85	0.092	531,855	2.33	0.127	68,124	14.96	0.002	49,853	3.99	0.263	6,162
Public	1.68	0.195	561,261				5.41	0.144	49,128			
Private	8.06	0.005	2,455,770				10.50	0.015	220,172			
Formal	4.25	0.039	1,687,088				9.91	0.019	157,759			
Informal	18.16	0.000	747,482				8.80	0.032	62,021			
Rural	2.39	0.122	376,106	15.99	0.000	16,317	1.00	0.801	14,546	14.74	0.002	3,298
Urban	6.45	0.011	2,151,585	6.42	0.011	2,019,942	10.09	0.018	203,958	9.41	0.024	193,029
RM	6.61	0.010	1,012,260	5.72	0.017	964,917	12.09	0.007	137,700	11.86	0.008	127,474
nRM	19.09	0.000	1,244,257	19.29	0.000	1,227,040	25.75	0.000	104,845	26.63	0.000	104,630

Table A3 - Statistics for the endogeneity tests by equation

Groups of workers	Tests for regressions in Table 3 - Eq. (1)			Tests for regressions in Table 4 - Eq. (2)			Tests for regressions in Table 5 - Eq. (3)			Tests for regressions in Table 6 - Eq. (4)		
	Hausman test		Wald F statistic	Hausman test		Wald F statistic	Hausman test		Wald F statistic	Hausman test		Wald F statistic
	Chi-sq	p-value		Chi-sq	p-value		Chi-sq	p-value		Chi-sq	p-value	
Agriculture	2.29	0.131	205,591				16.73	0.001	11,769			
Manufacturing	2.22	0.136	376,729				3.76	0.288	38,480			
Construction	1.25	0.263	171,919				8.37	0.039	13,146			
Wholesale and retail trade	4.03	0.045	517,667				2.78	0.428	46,382			
Transportation and utilities	0.28	0.594	133,198				5.30	0.151	13,292			
Leisure and hospitality	0.89	0.345	127,936				0.18	0.981	11,701			
Information	0.11	0.737	354,725				1.11	0.774	38,549			
Government and Defense	0.16	0.689	281,708				5.32	0.150	21,639			
Education and health services	1.19	0.275	451,295				8.74	0.033	43,774			
Other Services	0.03	0.864	87,157				1.44	0.696	8,865			
Housekeeping	21.25	0.000	297,088				14.44	0.002	26,455			

Notes: Hausman test tests the null of exogeneity of the selected measures of labor underutilization. The reported Wald F-test is the Anderson-Rubin Wald test computed by *ivreg2* command in Stata 17, and the high values indicate no weak identification problem.

Table A4 – Employment distribution through industry and gender by educational attainment and gender aged 16-70.

Industry	N	%	Total	Educational attainment				Total	Gender	
				Elementary incomplete	Elementary complete or high school incomplete	High school complete or some college	College or more		Men	Women
Employed	60,811,322	100.0	100.0	20.6	15.3	43.6	20.5	100.0	54.5	45.5
Agriculture	3,254,177	5.4	100.0	63.1	17.9	16.8	2.1	100.0	88.6	11.4
Manufacturing	9,535,617	15.7	100.0	19.4	17.8	49.1	13.7	100.0	71.7	28.3
Construction	3,275,675	5.4	100.0	42.6	22.1	29.1	6.2	100.0	94.2	5.8
Wholesale and retail trade	10,850,156	17.8	100.0	14.5	18.6	56.7	10.1	100.0	58.3	41.7
Transportation and utilities	2,682,884	4.4	100.0	20.8	19.5	49.2	10.6	100.0	85.5	14.5
Leisure and hospitality	2,578,849	4.2	100.0	22.7	24.8	47.0	5.5	100.0	42.7	57.3
Information	7,749,750	12.7	100.0	10.7	10.7	48.1	30.5	100.0	55.6	44.4
Government and Defense	4,940,343	8.1	100.0	9.7	7.5	43.8	39.0	100.0	59.3	40.7
Education and health services	9,140,788	15.0	100.0	5.0	5.2	38.5	51.2	100.0	23.7	76.3
Other Services	1,677,347	2.8	100.0	13.3	16.3	49.0	21.3	100.0	49.2	50.8
Housekeeping	5,113,376	8.4	100.0	49.6	22.4	26.9	1.1	100.0	7.9	92.1
Non-defined activities	12,360	0.0	100.0	17.9	12.7	45.3	24.1	100.0	61.5	38.5
Employed	60,811,322	100.0								
Men	33,169,986	54.5	100.0	24.4	17.3	42.9	15.4	100.0	100.0	
Women	27,641,336	45.5	100.0	16.1	12.8	44.4	26.7	100.0		100.0
Unemployed	10,570,095	100.0								
Men	5,037,577	47.7	100.0	28.1	23.2	41.6	7.2	100.0	100.0	
Women	5,532,519	52.3	100.0	17.3	20.6	50.5	11.6	100.0		100.0

Note: Excluded employers and self-employed. Average 2012Q2 to 2023Q2.

Table A5 – Extended wage curve coefficients of equation (3) difference between the group of workers and t-tests

Groups of workers in comparison	Difference			*t-statistic*		
	UR	PLF	TRU	UR	PLF	TRU
Men x women	0.015	-0.003	-0.001	2.2	-0.5	-0.2
White x nonwhite	-0.007	-0.017	0.024	-1.0	-2.8	4.6
16-22 x 23-34	0.011	-0.005	0.020	1.1	-0.6	3.2
16-22 x 35-54	0.047	-0.021	0.022	5.3	-2.8	3.6
16-22 x 55 or more	0.060	-0.035	0.018	4.3	-3.0	1.9
23-34 x 35-54	0.037	-0.016	0.002	4.7	-2.4	0.4
23-34 x 55 or more	0.050	-0.030	-0.002	3.7	-2.7	-0.2
35-54 x 55 or more	0.013	-0.014	-0.004	1.0	-1.3	-0.4
Elementary incomplete x Elem. comp. or high school incomplete	-0.006	0.002	-0.002	-0.6	0.2	-0.3
Elementary incomplete x High school comp. or some college	-0.009	-0.005	0.009	-1.3	-0.7	1.9
Elementary incomplete x College or more	0.018	-0.013	0.044	1.6	-1.3	5.8
Elem. comp. or high school incomplete x High school comp. or some college	-0.004	-0.006	0.011	-0.4	-0.8	1.9
Elem. comp. or high school incomplete x College or more	0.023	-0.014	0.045	1.9	-1.4	5.7
High school comp. or some college x College or more	0.027	-0.008	0.034	2.5	-0.9	4.8
Public x Private	-0.010	0.018	-0.018	-1.1	2.4	-3.0
Formal x informal	-0.030	0.008	-0.032	-3.5	1.1	-5.4
Rural x urban	0.013	0.001	0.009	1.5	0.1	1.2
Metropolitan x nonmetropolitan	-0.055	0.028	-0.026	-7.4	4.1	-4.5

Note: Test *t* significance critical values: 1% if $t > 2.57$; 5% if $t > 1.96$; and 10% if $t > 1.645$.

Table A6 - Extended wage curve coefficients difference between the group of workers and t-tests, concerning UR

Group of workers		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Agriculture	(1)	**0.0**	0.0562	0.0395	0.0287	0.0567	0.0432	0.0565	0.0581	0.0411	0.0344	0.0176
Manufacturing	(2)	3.6	**0.0**	-0.0167	-0.0275	0.0005	-0.0130	0.0003	0.0019	-0.0151	-0.0218	-0.0386
Construction	(3)	2.2	-1.0	**0.0**	-0.0108	0.0172	0.0037	0.0170	0.0186	0.0016	-0.0051	-0.0219
Wholesale and retail trade	(4)	2.1	-2.3	-0.7	**0.0**	0.0280	0.0145	0.0278	0.0294	0.0124	0.0057	-0.0111
Transportation and utilities	(5)	2.8	0.0	0.8	1.6	**0.0**	-0.0135	-0.0002	0.0014	-0.0156	-0.0223	-0.0391
Leisure and hospitality	(6)	2.4	-0.8	0.2	1.0	-0.6	**0.0**	0.0133	0.0149	-0.0021	-0.0088	-0.0256
Information	(7)	3.6	0.0	1.0	2.2	0.0	0.8	**0.0**	0.0016	-0.0154	-0.0221	-0.0389
Government and Defense	(8)	3.4	0.1	1.0	2.1	0.1	0.8	0.1	**0.0**	-0.0170	-0.0237	-0.0405
Education and health services	(9)	2.8	-1.1	0.1	1.1	-0.8	-0.1	-1.1	-1.1	**0.0**	-0.0067	-0.0235
Other Services	(10)	1.4	-0.9	-0.2	0.3	-0.8	-0.4	-0.9	-1.0	-0.3	**0.0**	-0.0168
Housekeeping	(11)	1.2	-2.8	-1.3	-0.9	-2.1	-1.6	-2.8	-2.6	-1.8	-0.7	**0.0**

Note: Statistics t are below the diagonal with one decimal. The difference of coefficients is above the diagonal, with four decimals. Test *t* critical values: 1% if *t* >2.57; 5% if *t* > 1.96; and 10% if *t* > 1.645.

Table A7 - Extended wage curve coefficients difference between the group of workers and t-tests, concerning PLF

Group of workers		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Agriculture	(1)	**0.0**	-0.0002	-0.0423	-0.0062	-0.0372	0.0005	0.0160	-0.0085	-0.0318	0.0233	-0.0163
Manufacturing	(2)	0.0	**0.0**	-0.0421	-0.0060	-0.0370	0.0007	0.0162	-0.0083	-0.0316	0.0235	-0.0161
Construction	(3)	-2.6	-2.9	**0.0**	0.0361	0.0051	0.0428	0.0583	0.0338	0.0105	0.0656	0.0260
Wholesale and retail trade	(4)	-0.5	-0.6	2.8	**0.0**	-0.0310	0.0067	0.0222	-0.0023	-0.0256	0.0295	-0.0101
Transportation and utilities	(5)	-2.2	-2.5	0.3	-2.2	**0.0**	0.0377	0.0532	0.0287	0.0054	0.0605	0.0209
Leisure and hospitality	(6)	0.0	0.0	2.6	0.5	2.2	**0.0**	0.0155	-0.0090	-0.0323	0.0228	-0.0168
Information	(7)	1.1	1.3	4.0	2.1	3.5	1.1	**0.0**	-0.0245	-0.0478	0.0073	-0.0323
Government and Defense	(8)	-0.6	-0.6	2.2	-0.2	1.8	-0.6	-1.9	**0.0**	-0.0233	0.0318	-0.0078
Education and health services	(9)	-2.3	-2.8	0.8	-2.7	0.4	-2.4	-4.2	-1.9	**0.0**	0.0551	0.0155
Other Services	(10)	1.1	1.1	3.0	1.5	2.7	1.0	0.4	1.5	2.7	**0.0**	-0.0396
Housekeeping	(11)	-1.2	-1.4	1.9	-1.0	1.4	-1.2	-2.8	-0.6	1.4	-2.0	**0.0**

Note: Statistics t are below the diagonal with one decimal. The difference of coefficients is above the diagonal, with four decimals. Test *t* critical values: 1% if *t* >2.57; 5% if *t* > 1.96; and 10% if *t* > 1.645.

Table A8 - Extended wage curve coefficients difference between group of workers and t-tests, concerning TRU

Group of workers		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Agriculture	(1)	**0.0**	-0.0125	0.0062	-0.0040	0.0096	-0.0182	0.0031	0.0109	0.0179	-0.0085	-0.0229
Manufacturing	(2)	-1.0	**0.0**	0.0187	0.0085	0.0221	-0.0057	0.0156	0.0234	0.0304	0.0040	-0.0104
Construction	(3)	0.5	1.7	**0.0**	-0.0102	0.0034	-0.0244	-0.0031	0.0047	0.0117	-0.0147	-0.0291
Wholesale and retail trade	(4)	-0.4	1.0	-1.0	**0.0**	0.0136	-0.0142	0.0071	0.0149	0.0219	-0.0045	-0.0189
Transportation and utilities	(5)	0.7	1.8	0.3	1.2	**0.0**	-0.0278	-0.0065	0.0013	0.0083	-0.0181	-0.0325
Leisure and hospitality	(6)	-1.4	-0.5	-2.0	-1.5	-2.1	**0.0**	0.0213	0.0291	0.0361	0.0097	-0.0047
Information	(7)	0.3	1.6	-0.3	0.9	-0.5	2.0	**0.0**	0.0078	0.0148	-0.0116	-0.0260
Government and Defense	(8)	0.9	2.2	0.4	1.7	0.1	2.6	0.8	**0.0**	0.0070	-0.0194	-0.0338
Education and health services	(9)	1.5	3.3	1.1	3.0	0.7	3.5	1.7	0.7	**0.0**	-0.0264	-0.0408
Other Services	(10)	-0.5	0.2	-0.9	-0.3	-1.0	0.6	-0.7	-1.2	-1.7	**0.0**	-0.0144
Housekeeping	(11)	-1.9	-1.1	-2.7	-2.5	-2.7	-0.5	-2.9	-3.5	-4.8	-0.9	**0.0**

Note: Statistics *t* are below the diagonal with one decimal. The difference of coefficients is above the diagonal, with four decimals. Test *t* critical values: 1% if $t > 2.57$; 5% if $t > 1.96$; and 10% if $t > 1.645$.