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Labor Market Concentration

Erick Baumgartner[*]   Raphael Corbi[†]   Renata Narita[‡]

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Abstract

How much employment can be generated by decreasing payroll taxes? We examine this question by exploring the staggered rollout of a large payroll tax reform in Brazil. Using administrative matched employer-employee data, we find an increase of 5 percent on employment due to both firm growth and firm entry, no impact on wages and an increase of 59 percent in profits. Moreover, employment effects are driven by less concentrated labor markets, consistent with predictions from an oligopsony model.

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1 Introduction

Payroll taxation is an important policy instrument for governments. It is a large source of public revenue and a major component of labor costs, with tax rates paid by the firms averaging 18.4% across OECD countries (OECD, 2019). Despite its potentially distortionary nature, the effects of payroll taxes on employment are unclear as wages may fully adjust to changes in the tax firms face, as predicted by canonical models of tax incidence.[1]

In this paper, we examine this question by studying the effects of a large reduction in payroll taxes for selected sectors in Brazil. Our empirical findings show a positive sizable effect on total employment due to both firm entry and firm growth in treated sectors, but no impact on wages. Moreover, the effects are driven by labor markets with relatively low levels of concentration which is consistent with predictions of an oligopsony model.

Our setup studies a change in firm taxation that was part of a government program called *Plano Brasil Maior* (PBM). Such tax reform altered the tax base upon which payroll taxes are calculated for selected sectors in Brazil, *de facto* introducing an average reduction of 51% in the total tax burden associated with payroll.[2] We exploit the gradual implementation of the PBM tax reform across 65 sectors (4-digit ISIC) from 2009 to 2014 in an event-study design.

Our baseline results show a sharp increase in sectoral employment in the first quarter after the tax cut that intensifies over the following quarters and stabilizes around 5 percent. We find that sectors with above-median (below-median) labor cost reduction experience an average increase in employment by 7.3% (2.2%). Furthermore, total increase in sectoral employment can be decomposed as 40% coming from firm entry (i.e. jobs created by new firms) and 60% from firm growth (i.e. increase in hiring by existing firms). On the other hand, we find small and insignificant effects on wages and show that PBM implementation was not designed as a response to labor outcomes sectoral trends.

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[1]At least in the case when aggregate labor supply is much less elastic than aggregate labor demand.

[2]Instead of paying a flat 20% on wages, firms were required to contribute to social security with tax rates between 1% and 2% on gross revenue (net of export earnings). See Section 2.1 for a detailed explanation.

We also explore how our main estimates vary according to the degree of local labor market concentration. We follow Berger, Herkenhoff and Mongey (2019) and measure labor market concentration as a wage-bill Herfindahl-Hirschman Index (HHI) for all 558 micro-regions in Brazil. In particular, we find that firms in less concentrated labor markets are responsible for virtually all of the estimated effect on employment. Then we present an oligopsony model that rationalizes our findings. Firms are able to pay less than the worker's marginal productivity due to imperfect labor mobility within and across markets but must trade off lower wages against higher firm size. Unlike in a monopsony model, the existence of many firms makes labor market concentration a relevant measure in this context. In particular, there is less scope for firms in less concentrated labor markets to adjust wages in response to changes in labor costs. As concentration varies greatly across labor markets within a country, the employment and wage effects of a payroll tax reduction are thus likely highly market specific. The oligopsony model then predicts that (i) the impact of a labor subsidy is positive on both employment and wages, (ii) the employment effect dominates the wage effect for most levels of labor market concentration,[3] and (iii) the employment (wage) effect decreases (increases) as markets become more concentrated. Taken together, our empirical estimates are qualitatively consistent with the theoretical prediction based on the oligopsony model.

Next, we take advantage of the micro-structure of our matched employer-employee administrative dataset to study heterogeneity with respect to firm size and workers' education. We find that employment across different firm sizes and education levels reacts to the tax reform in a similar way. We also consider heterogeneity across sectors with respect to labor informality, as this is a significant source of jobs in developing countries. Importantly, another potential reason for the very small impact on wages in Brazil is the very highly elastic labor supply due to movement between the formal and informal sectors. However, we do not find any differential response to the payroll tax cut comparing sectors with high and low

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[3]Based on a model calibration with plausible elasticities of substitution between firms within and across markets.

levels of informality.

Finally, we perform a cost-benefit analysis of the PBM tax reform and estimate firm profit gains. A simple back-of-the-envelop calculation reveals that this policy created a total of 322,054 jobs at a cost of a job of approximately US$17,055 in 2018 prices, around 2.1 times more costly than estimates from a major federal program that transfers funds to municipalities to finance local public spending in Brazil (Corbi, Papaioannou and Surico, 2019). Also, based on a structural approach we find that firms' profits increase by 59%.

The evidence on the labor market effects of changing labor costs is quite mixed. A few studies find that the incidence of such costs is fully on wages with no significant effects on employment for the US (e.g. Gruber, 1994; Gruber and Krueger, 1991) and Latin American countries (e.g. Gruber, 1997; MacIssac and Ramma, 1997; and Mondino and Montoya, 2004).[4] Other papers show that a share of the (but not the total) increase in the payroll tax burden was passed onto wages (e.g. Hamermesh, 1979; Holmlund, 1983; and Kugler and Kugler, 2009).[5] More recent work finds zero wage effect (relatively to the control group) but a sizable impact on employment in Sweden (Saez et al, 2019) and Colombia (Kugler et al, 2017).[6]

To understand their findings, the empirical literature explicitly or implicitly assumes a standard competitive labor market model in which the impact of payroll taxes on employment is nonexistent and wages fully adjust when workers value one-to-one the benefits they get

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[4]Gruber (1997) looks at the Chilean case, where the privatization of Social Security decreased the payroll tax by an average of 25% over 6 years. Using firm-level data from the manufacturing sector, he estimates that the incidence is fully on wages with no effects on employment. MacIssac and Ramma (1997) shows that the effect of mandated benefits in the Ecuadorian labor market is mitigated by a reduction of base earnings. And, similarly, Mondino and Montoya (2004) estimate that wages are 2.8-8% lower for workers with social security in Argentina.

[5]In particular, Hamermesh (1979) estimates that 0-36% of social security tax were shifted to wages, with a large negative effect on adults employment. Kugler and Kugler (2009) find that a 10 percent increase in payroll taxes reduces formal employment by five percent with wages decreasing by 1.4-2.3% in Colombia.

[6]Saez et al (2019) for Sweden also found a zero effect on net-of-tax wages for the directly treated young workers compared to the slightly older ineligible control group, and a 2–3 percentage point increase in youth employment. This replicates some of the findings in Skedinger (2014), Egebark and Kaunitz (2013, 2018) and Bennmarker et al (2014) for the same country. Kugler et al (2017) analyze the effects of a more recent tax reform introduced in Colombia in 2012 that reduced payroll taxes by 13.5% for workers earning below 2 minimum wages and the self-employed with more than 2 employees. They find an increase of 15-32% in the probability of formal employment and 15% in the likelihood of transitioning into registered employment.

from payroll taxation or in the extreme cases of inelastic labor supply or perfectly elastic labor demand (Summers, 1989; Gruber, 1997). Then, evidence of employment effects associated with payroll tax changes is typically attributed to wage rigidities such as legal minimum wages and pay equity within firms (e.g., Kugler and Kugler, 2009; and Saez et al, 2017).[7] Our paper contributes to this literature by offering an alternative rationale to understand why employment effects can be sizable even in absence of wage or contract frictions. By allowing firms to operate in oligopsonistic labor markets, the model predicts and we empirically show that for all observed levels of concentration the tax burden is not borne by workers.

Our paper is also related to the empirical literature that explored the early stage of the payroll tax reduction introduced by the PBM (Dallava, 2014 and Scherer, 2015).[8] Regarding these works, our paper offers three main advantages. First, we complement them by presenting a labor market model to understand the key findings while exploiting similar institutional changes. Second, we explore the timing of all tax changes implemented until the end of 2014 while these papers focused only at the first round of PBM implementation. By the end of 2012, only one quarter of eligible sectors had been affected by the policy (Figure 1). Third, when assigning sectors to treatment, they did not separate or exclude those for which treatment eligibility was defined by the problematic product-based NCM criterion (see Section 2.1).

Finally, there is a recent and growing literature that provides several insights on how to measure labor market concentration and its association with market power and welfare. In particular, Azar, Marinescu and Steinbaum (2017) use a rich vacancies dataset to find that

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[7]For Colombia, downward wage rigidity is consistent with binding minimum wages (Maloney, 2004). In Sweden, one explanation is that employers cannot discriminate net pay by age due to fairness norms within the firm.

[8]Dallava (2014) conducts a difference-in-difference analysis by comparing sectors (within each 1-digit class) that are treated against those which are not over the period 2011-2012. She finds positive effects on employment and wages only for Information and Telecommunications. Scherer (2015) also analyzes the reform in 2011-2012 exploiting the fact that firms that belonged to the *SIMPLES* tax regime, as explained in Section 2.1, were not eligible for the tax reduction and used them as a control group. However, PBM implementation provided an incentive for firms to switch from *SIMPLES* to the standard tax regime, which we empirically show to be the case in subsection 4.2. This also accounts for the unreasonably large effects on employment that he reports, 15% on average.

higher labor market concentration is associated with lower posted wages, which is evidence that concentration increases labor market power. Berger, Herkenhoff and Mongey (2019) map measures of concentration to labor market power through a structural model with oligopsony. They simulate a significant increase in the minimum wage and find that only very small firms exit and there are positive employment and welfare effects, consistent with the imperfect labor market theory they propose. Similar to them, we use the wage-bill Herfindahl as a measure of labor market concentration, and compute it for submarkets defined by each of the 558 microregions in Brazil. We add to this literature by quantifying how the labor market effects of a payroll tax change vary according to labor market concentration, and arguing that an oligopsony framework rationalizes our findings.[9]

In Section 2 we provide background information on the Brazilian payroll tax reform and describe the data. Next, we present the empirical strategy in Section 3. We report our main estimates of the effects of the payroll tax reduction on wages and employment, study how they vary according to labor market concentration and explore further heterogeneity by firm, sector and individual characteristics in Section 4. Then we perform a cost-benefit analysis of the PBM reform, compare its effectiveness in job creation to another federal program, and provide an estimate for the profit gains in Section 5. Finally, we conclude.

2   Background and Data

In this section, we first describe the Brazilian tax system and the introduction of the PBM tax reform. Then we present the main sources of data, discuss summary statistics of our sample and show the staggered roll-out of the reform across sectors.

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[9]Earlier theoretical work develops models of oligopsony or monopsonistic competition (e.g. Bhaskar, Manning and To, 2002; and To, 2009). These studies do not estimate the effects of payroll taxes on employment and wages, or relate it to labor market concentration.

2.1   The Payroll Tax Reform

Under the Brazilian Corporate Tax System, firms choose one of two main tax regimes in the beginning of each calendar year. Under the standard regime, firms pay a contribution to social security (COFINS) and to the employees' savings program (PIS/PASEP) of varying rates, based on gross income, and a flat payroll tax of 20%. They also pay additional corporate taxes (CSLL and IRPJ) on either gross or net income according to revenue size.[10] The *SIMPLES* tax regime was enacted in December 1996 and created a differentiated tax system for micro, small and medium enterprises in Brazil, which reduced red tape, consolidated several taxes and social security contributions into a single payment based on gross income, and lowered the overall tax burden (Assunção and Monteiro, 2012).

The year of 2011 marked the introduction of *Plano Brasil Maior* (PBM) - a set of industrial policies created by President Dilma Roussef's government aimed at increasing formal job creation and fostering the competitiveness of Brazilian companies. Among other measures[11], this program implemented a tax reform that changed the base upon which the social security tax is calculated for some sectors. With the implementation of the PBM on selected sectors, all standard tax regime firms were exempted from paying the 20% payroll tax and were instead required to contribute to social security with tax rates between 1% and 2% on gross revenue (net of exports).[12] Firms in the *SIMPLES* tax regime were not directly affected by PBM.

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[10]This regime is governed by Law 8,212, from July 24, 1991.

[11]Other measures that were part of this program include the Programa de Sustentação do Investimento that expanded credit lines by the Brazilian Development Bank's (BNDES), the creation of REINTEGRA, a tax waiver of federal tax costs for exporting companies of manufactured goods, and the introduction of a minimum Brazilian-made content in investments in the local oil industry. For an overview of the PBM, see Brasil (2011). Virtually all of these other measures were directed at the manufacturing sector, so should not represent an important concern in our empirical analysis that focuses on services.

[12]Initially published as Provisional Measure (PM) 540, and later converted into Law 12,546.

2.2 Data Sources and Sample Description

The labor market outcomes data comes from Relação Anual de Informações Sociais (RAIS), spanning the period from 2009 to 2014. RAIS is a matched employer-employee administrative dataset assembled yearly by the Brazilian Ministry of Labor (MTE), providing a high quality census of the Brazilian formal labor market. The Brazilian government uses RAIS to check the eligibility criteria of mandated benefits programs. Firms are required to report workforce data yearly (which can be reinforced by employees if they fail to receive benefits because of a report error). This creates a structure where workers and firms have an incentive to provide accurate information. Virtually all formal workers are included in RAIS, except interns and domestic workers.

The dataset includes information at the level of workers and firms. Firm-level data include detailed sector information and tax regime.[13] Worker-level data includes age, gender, education, monthly wage in December, admission and dismissal date. Even though RAIS is produced on an yearly basis, we use the admission and dismissal dates to reconstruct a monthly workforce panel aggregated at the 4-digit sector level. This is an important aspect of the analysis, since the allocation of sectors (treatment) in the new tax regime is also made on a monthly basis.

Our Sample. A complicating feature of the PBM is that the criteria used in the legislative acts to include a sector under the gross revenue contribution scheme were not always drafted in a uniform fashion. While many firms eligible for PBM were included according to a list of standard 4-digit ISIC *sectors*, some were included instead according to a list of *product* codes from the Mercosur Common Nomenclature (NCM). The second criterion is problematic for our analysis as firms that were eligible to the new regime according to the second criterion were exempt from payroll taxation only in proportion to the share of their gross income coming from eligible products. As we do not have access to detailed firm-level information

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[13]Firms may belong to the standard tax regime or a simplified system called SIMPLES, according to predetermined gross revenue thresholds and sector.

on gross income by product, we are unable to measure the extent of the tax exemption within a firm.

Table 1 tabulates Level 1 ISIC sectors included in the PBM reform according to ISIC and NCM criteria. NCM-based eligibility affected mainly specific agriculture and manufacturing products, while ISIC-based eligibility was mainly used in services.[14] We focus our analysis on all Level 1 ISIC categories (in bold) that had at least one 4-digit sector included in PBM by the first criterion (ISIC or sector-based) and none by the second criterion (NCM or product-based). This strategy leaves us with a final sample of 219 sectors, among which 65 eventually are included in the PBM. While the other 154 never-treated sectors do not offer direct variation for identifying the treatment effect of interest, they are useful for estimating time fixed effects and seasonality patterns specific to different broadly defined economic sectors (ISIC section level).

This strategy leaves us with a final sample of 15,768 sector-month observations spread across 219 sectors and the 2009-2014 period.[15] Within each sector, all firms in the standard tax regime are included in our main dataset.[16] They correspond to around 20.4 million workers and 1.9 million firms, or 50% of total employment and total active firms in 2014.[17] Table 2 reports summary characteristics of the main variable in our analysis. The average 4-digit sector employs nationally close to 95,000 workers, ranging from small sectors with a little

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[14]In Appendix Section B, we replicate our empirical analysis to sectors included in the PBM tax reform by the NCM criterion, based on products instead of sector ISIC codes. Tables B.1 and B.2 replicate baseline estimates reported in Tables 4 and 5 and show that the estimated effects are small and statistically indistinguishable from zero across all specifications.

[15]We exclude data from 2015 onwards for two reasons. First, in mid-2015 the federal government started a somewhat unsuccessful attempt to roll back the new tax scheme, significantly changing the new taxation structure, creating uncertainty for the new regime throughout the year and eventually making participation in the program optional. The associated political turmoil increased the animosity between the Executive and Legislative powers, culminating in the impeachment process of president Dilma Rousseff in 2016. Moreover, on the economic front Brazil faced the most severe economic downturn in its history in 2015-2016. Results are qualitatively similar and somewhat larger if we include data from 2015.

[16]In order to maintain a minimum empirical relevance, we exclude the only two 4-digit sector (spatial transportation and street vendors) that had less than 100 employees nationwide at any point across our period of analysis.

[17]Firms in the SIMPLES tax regime are excluded from our main analysis as they were not directly affected by the PBM. In Section 4.2 we discuss the possibility that SIMPLES firms self-select into the standard regime as a response to treatment and show that our results are robust to including all firms. See Appendix Section C for the estimates.

Figure 1: Staggered rollout of PBM tax reform

(a) number of eligible sectors

(b) employment in eligible sectors
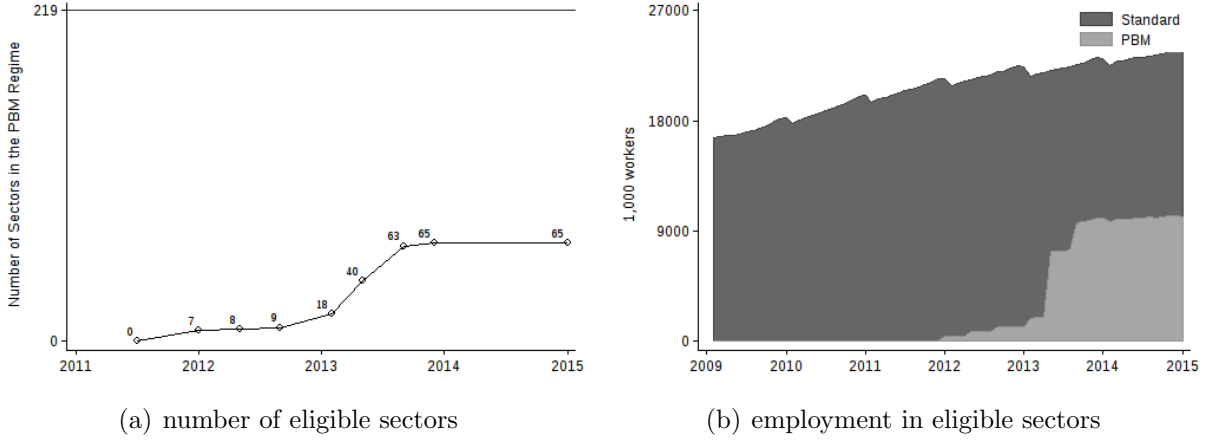
less than 200 to sectors with more than $1,350,000$. The workforce has 32% of individuals with elementary school or lower and a majority of 55% with a high school degree. The reduction in the burden of payroll taxation for treated sectors ranges from -2% to 84%.[18]

Staggered PBM Implementation The tax reform was implemented in a staggered roll-out fashion across sectors from 2011 to 2014. Following the beginning of the program, several legislative acts were enacted, broadening the scope of the new regime. While only a small number of sectors were initially contemplated, the reform reached roughly 30% of all 4-digit ISIC sectors in our sample by the end of 2014.

Figure 1 depicts the number of sectors and their respective employment share affected by the introduction of the PBM tax reform in our sample period. PBM is introduced in December 2011 affecting initially software companies, call centers and hotels, then reaching 65 sectors that accounted for approximately 10 million jobs (43% of total) by the end of 2015. The list of all legislative acts and associated regulating laws with implementation dates are reported in Appendix Table A.2.

Another feature of the PBM tax reform is the heterogeneous magnitude of its tax reduction potential across different sectors. This is because shifting from a payroll tax to

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[18]A negative number implies that some sectors are expected to suffer a small increase in taxes as a result of the PBM reform.

one based on gross income will impact firms differently according to their degree of labor intensiveness. Table A.1 reports estimates for the change in tax bill experienced by different treated sectors. All sectors presented in these tables were allocated to PBM based on their economic activity (ISIC), and according to these calculations, had a considerable decrease in the contributions towards Social Security. Among all these sectors, only one (Retail trade of discs, CDs, DVDs and tapes) has increased their contributions to Social Security relative to the old regime, and even in this case, the observed difference observed is very small (2 percentage points).

3 Empirical Strategy

Now we explain how we explore the staggered timing of implementation of PBM by comparing changes in employment and wages for sectors that introduced it in different months between 2011 and 2015, i.e. earlier vs. later entrants, within an event-study framework. Therefore, we start by investigating the plausibility of our key identification assumption, namely that the timing of PBM implementation is uncorrelated with other determinants of changes in sectoral labor market outcomes. In particular, we study whether sector characteristics predict the timing implementation. Table 3 presents estimates for γ in the following equation:

$$Month_s = \gamma X_{s,t_0} + \psi_s \tag{1}$$

where $Month_s = 1, ..., 60$ denotes the month of PBM implementation in sector s, X_{s,t_0} is a vector of sector-level average firm and labor force characteristics calculated in the 12-month period before the beginning of the program in 2011.

Column (1) of Table 3 reports estimates of the equation 1 for firms in the standard tax regime and shows that the month of implementation is correlated with the level of the workforce education. Column (2) adds ISIC section (broadly-defined sector) fixed effects and finds that the coefficient on the share of workers with college degree loses statistical

significance, but earlier implementation of PBM took place in sectors with a greater share of younger, male workers and firms with slightly less employees. Column (3) and (4) recalculate sectoral averages including firms from all tax regimes and finds virtually the same pattern. To account for these potential threats to internal validity, we add sectoral fixed effects to account for pre-existing differences in levels across sectors and control in some specifications for monthly fixed effects interacted with pre-determined baseline characteristics that significantly correlate with the timing of implementation, as discussed above.

The political process by which sectors are included in the tax reform is likely influenced by both the legislative power and executive structure. While the relative economic and political strength of different sectors does not represent an identification challenge *per se*, the effect of the tax reform would be confounded if the selection and implementation timing were determined as a response to sector-specific trends in employment. As a way to overcome these challenges, we estimate the effect of the PBM tax reform using an event study research design that is capable of testing for such trends and recovering any dynamics of the impact of the new tax regime. We specify a regression model for labor market outcomes that exploits the different implementation timing across sectors. Specifically, we assume that:

$$Y_{st} = \sum_{\tau=-T}^{T} \beta_\tau D_{st}^\tau + \rho_{ct} + \gamma_s + \alpha_t + u_{st} \tag{2}$$

where s and t index 4-digit sector and time in months, respectively. Y_{st} denotes labor market outcomes - sectoral employment and wage rate in logarithmic terms. ρ_{ct} represent ISIC section monthly dummies in order to control for seasonality patterns specific to different broadly defined economic sectors. γ_s accounts for time-invariant sector-specific factors (such as technology, geographical distribution, market structure) and α_t are monthly fixed effects. In some specifications, we also control for a set of pre-determined characteristics that significantly correlate with the timing of implementation (see Table 3) interacted with α_t as discussed above. These controls are sectoral averages calculated using data from the

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12 months prior to the PBM implementation and include average age of employees and its square, share of males and the average number of employees per firm.

Treatment assignment is denoted by D_{st}^{τ} that is set to 1 if the PBM implementation date for sector s is τ periods away from the current month, with $\tau < 0$ referring to periods before implementation and $\tau > 0$ after implementation. Thus, for a sector entering the new regime in month e_s we have:

$$D_{st}^{\tau} = \mathbb{1}_{[t-e_s=\tau]}$$

The β_{τ} coefficients represent the time path of employment and wages relative to the date of implementation of the new tax regime for sectors subject to the new regime conditional on the three unobserved variance components α_t, γ_s and an error term u_{st} which may exhibit arbitrary dependence within sector but is uncorrelated with the other right hand side variables.

An appealing feature of the event-study research design is that it provides an explicit way of testing our main identification assumption of whether sector-specific trends in outcomes determine PBM implementation. This is particularly relevant in out setup as tax changes are effectively implemented 3 months or more after enactment, potentially allowing anticipation effects to build up.[19] In other words, we can directly test whether implementation is not systematically preceded by trends in sectoral employment. More formally, if implementation dates are randomly assigned the following restriction should hold:

$$\beta_{\tau} = 0 \quad \forall \tau < 0$$

Our main results in this paper are obtained by estimating equation 2 by ordinary least squares, including a set of event-time dummies along with time and sector dummies. For ease of exposition, in our main set of estimates we define τ as a period of 3 months, in practice forcing the treatment effect to be the same within a 3-month period. As usual,

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[19]Brazilian law requires a minimum period of 3 months before new taxation rules are implemented.

not all β's can be identified as D_{st}^{τ} are perfect collinear in the presence of sector 4-digit fixed effects. For this reason, we follow common practice and normalize $\beta_{-1} = 0$, so that all post-implementation coefficients can be thought of as treatment effects. We also impose the following endpoint restrictions:

$$
\beta_{\tau} =
\begin{cases}
\overline{\beta} & \text{if } \tau \geq 5 \\
\underline{\beta} & \text{if } \tau \leq -5
\end{cases}
$$

which simply state that any dynamics wear off after five quarters.[20] This restriction helps to reduce some of the collinearity between the year and event-time dummies. By limiting the analysis to a four-quarter window around treatment, we ensure that the event-time coefficients are identified off of a nearly balanced panel of sectors. We report robust standard errors clustered at the sector level.

4 Results

In this section, we first examine the responses of sectoral employment and wages to the changes in payroll taxation. Second, we investigate whether firms self select into the PBM tax scheme and provide evidence regarding firm entry and average firm size. Third, based on a model of imperfect labor markets we explore how our estimated effects vary across markets with different levels of labor market concentration. Finally, we further discuss heterogeneity estimates according to firm and worker characteristics, as well as labor informality.

4.1 Baseline Effects on Employment and Wages

We begin by examining the impact of the PBM tax scheme implementation on sectoral employment of all firms who are part of the standard tax regime.

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[20]For another example of such endpoint restrictions, see Kline (2011). Nearly identical results ensue if we fully saturate the model in event time.

Figure 2: Impact of PBM tax reform on employment
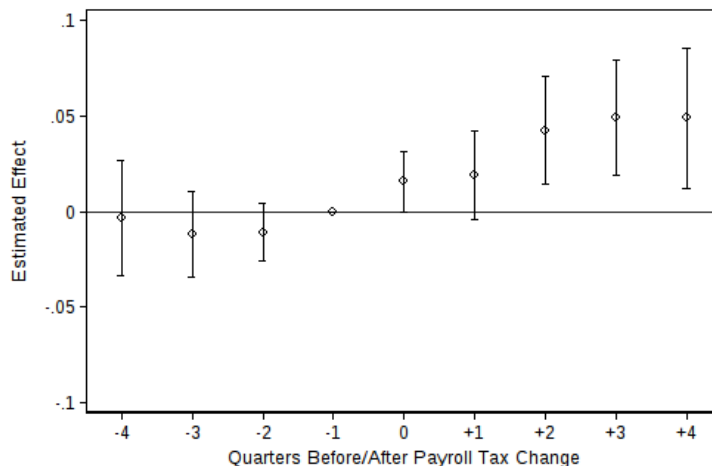
Figure 2 plots the estimated β_τ coefficients from a regression of the form given in Equation 2 where the dependent variable is the log of employment. The bands around the point estimates are 95 percent cluster-robust confidence intervals. Prior to implementation, there is no differential trend in employment across treated and control sectors. This suggests that the PBM inclusion criterion, despite potentially having a political component, was not designed as a response to trends in employment. We find an increase in employment in the first quarter after implementation that intensifies over the following months and stabilizes around 5 percent.

In Table 4, we report specifications that associate employment and PBM implementation. Columns (1) gives estimates corresponding to Figure 2. Columns (2) and (3) add broad sector-specific seasonality dummies, ρ_{ct}, and a set of pre-determined characteristics, X_{s,t_0}, interacted with α_t as discussed in Section 3. The pattern observed in Figure 2 is virtually unchanged across all specifications.

We also explore whether these estimates vary with treatment intensity. More specifically, we use calculations by ANFIP (2015) of the expected change on firm taxation by sector due to the introduction of PBM and replicate our baseline specifications allowing treatment effects to vary according to whether a sector is above/below the median of the expected reduction.

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Figure 3: Impact of PBM tax reform on employment according to treatment intensity

(a) above median

(b) below median
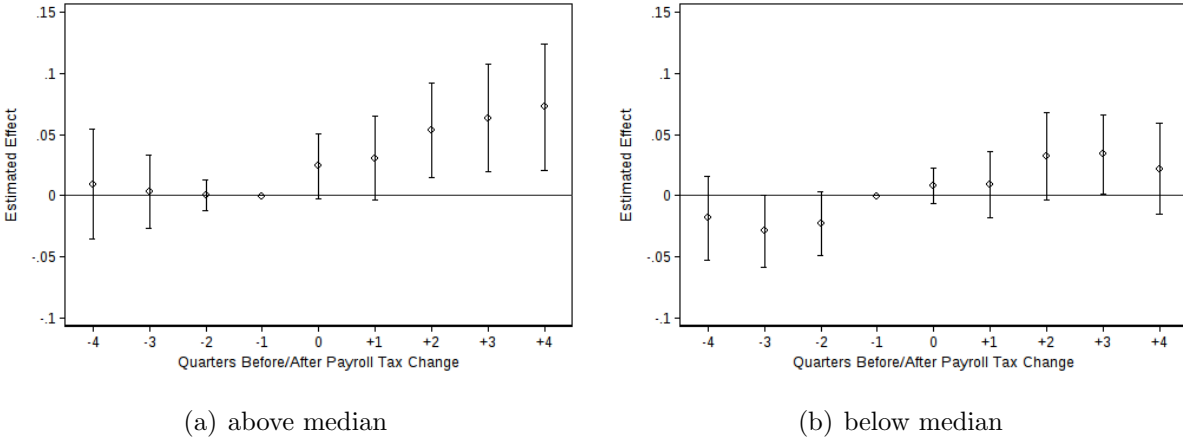
Table 2 reports the range. For sectors above the sample median (higher reduction), taxation change under the new tax scheme ranges from an economy of 52% up to 84% of the tax bill under the standard tax regime. For sectors below the median (lower reduction), it ranges between -2% to 52%.[21] Figure 3 shows that employment in sectors expected to gain more from the reform increases more sharply after implementation. As before, employment increases in the first quarter after the tax reform and intensifies over the following periods. It stabilizes around 7.3 percent with high statistical significance. Employment levels in sectors below the median also seem to respond to the PBM implementation, albeit more slowly and with a smaller magnitude and precision, stabilizing around 2.2 percent. Table 5 reports the corresponding estimates for all specifications. Once again, the estimates with respect to intensity observed in Figure 3 are virtually unchanged across specifications.

The estimated effects on wages are reported in Table 6. Due to the nature of our dataset, we only have access to hourly contractual wages of new hires. Across all three specifications, point estimates are small and insignificant indicating that firms do not hire new workers at higher wages when labor costs go down due to the PBM implementation. Figure 4 illustrates the results. The lack of an effect is true for sectors both above and below the

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[21]A negative number implies that some sectors are expected to suffer a small increase in taxes as a result of the PBM reform. See Section 2.1 for a detailed discussion and the Appendix Table A.1 for the estimated tax changes in each sector.

Figure 4: Impact of PBM tax reform on average wages of new hires
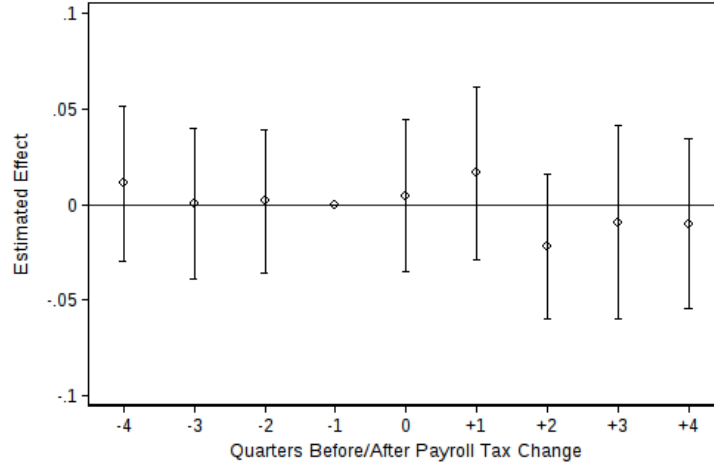
median treatment intensity level as shown in Table 7.

Summing up, our estimates indicate that the effect of a labor subsidy (or tax cut) is (i) positive on employment and (ii) null on wages.

4.2   Firm Selection into the PBM Tax Regime

Our empirical analysis has so far focused on firms in the standard tax regime because they are the only ones directly affected by the PBM reform, as discussed in Section 2.1. In this section, we analyze the possibility that firms in the alternative *SIMPLES* tax regime may self-select into the standard regime as a response to the implementation of PBM in their respective sector. According to Brazilian law, firms are allowed to switch tax regimes once a year in January. In that case, the estimated effects reported in Section 4.1, especially longer term ones, could potentially be explained by firms simply switching tax regimes instead of actual job creation.

We explicitly test whether firms switch from *SIMPLES* into the standard tax regime due to lower labor costs by exploiting yearly variation of PBM implementation across sectors. Table 8 reports the estimates. Columns (1) and (2) compare differences in means of the rate at which firms switch from *SIMPLES* to the standard regime between treated and control

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Figure 5: Impact of PBM tax reform on employment - all tax regimes
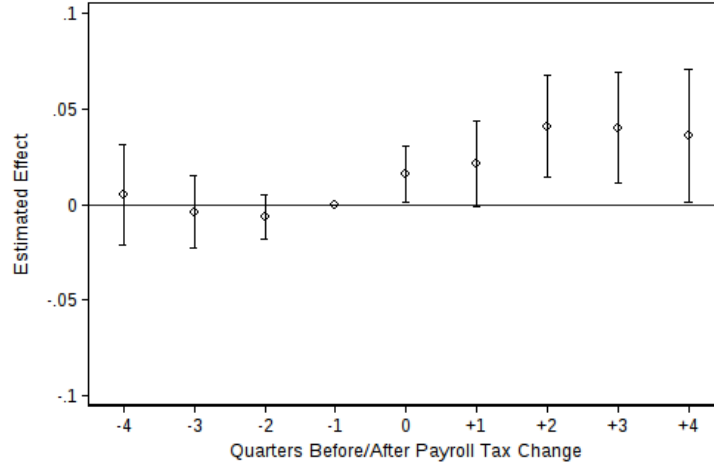
sectors in 2009-2010, before the introduction of PBM. The coefficients are insignificant and change signs once we control for firms and workers' characteristics. In other words, sectors that were eventually included in the PBM (treated) had indistinguishable *SIMPLES* exit rates when compared to sectors that were not included (control) before the program started. Columns (3) and (4) instead associate *SIMPLES* exit rates to the actual timing of PBM implementation for our entire sample period 2009-2014. The estimates are now statistically significant and indicate that PBM is associated with an increase of $0.7 - 0.9$ percentage points in the share of firms changing tax regimes (or equivalently 8-10% of the average exit rate in 2009-2010). Moreover, while the average size of firms in the *SIMPLES* regime is indistinguishable between treated and control sectors before PBM implementation, such difference becomes $5.4 - 5.7$ percent after implementation, as reported in columns (5)-(8). This is consistent with the idea that firms with more employees on average are likely to benefit more from the tax reform.

On the one hand, these results represent additional evidence that firms react to payroll tax incentives and take advantage of a reduction in labor costs. On the other hand, they suggest that our baseline estimates may be overestimating the true effect of the PBM program by capturing firms simply transitioning across tax regimes as opposed to real job creation. We

account for this possibility by replicating our main results based on equation 2 on sectoral employment calculated over all firms, including both standard and *SIMPLES* tax regime. Figure 5 shows an increase in employment in the first quarter after implementation that intensifies over the following months and stabilizes around 3.6 percent. This exercise can be interpreted as an intent-to-treat estimate as *SIMPLES* firms are not eligible to the PBM tax reduction. Consistent with an ITT result, the magnitude is 2/3 of our baseline from Figure 2 and slightly more noisy. The corresponding estimates are reported in Appendix Table C.1. In addition, we also show in Appendix Tables C.2 and C.3 that firms in sectors that experience a greater reduction in payroll tax react more to treatment and tend to hire more educated workers.

4.3 Firm Entry and Firm Growth

In this section, we further explore our baseline estimates by decomposing the observed increase in sectoral employment into firm entry (i.e. jobs created by new firms) or firm growth (i.e. increase in hiring by existing firms). Figure 6(a) illustrates that in response to a reduction in labor costs, net entry across firms in our main sample (firms in standard tax regime) increases by 2 percent. The effect is marginally significant at 5% confidence level. As these estimates may conflate actual net entry and firms switching from *SIMPLES* into the standard regime, Figure 6(b) replicates the analysis including all tax regimes and finds very similar results. Corresponding regression estimates are reported in Table 9 and Appendix Table C.4.

These results contribute to the understanding of firm formalization and development. In a recent review of the literature on informality, Ulyssea (2020) argues that positive effects on formalization come from enforcement efforts, and policies that mainly reduce the ongoing costs of formality instead of entry/registration costs. In particular, Rocha et al. (2018) estimates that a formalization policy in Brazil targeted at microentrepreneurs with at most one employee led to an increase of around 11% in the number of formal firms, driven entirely

Figure 6: Impact of PBM tax reform on net firm entry

(a) standard regime

(b) all tax regimes
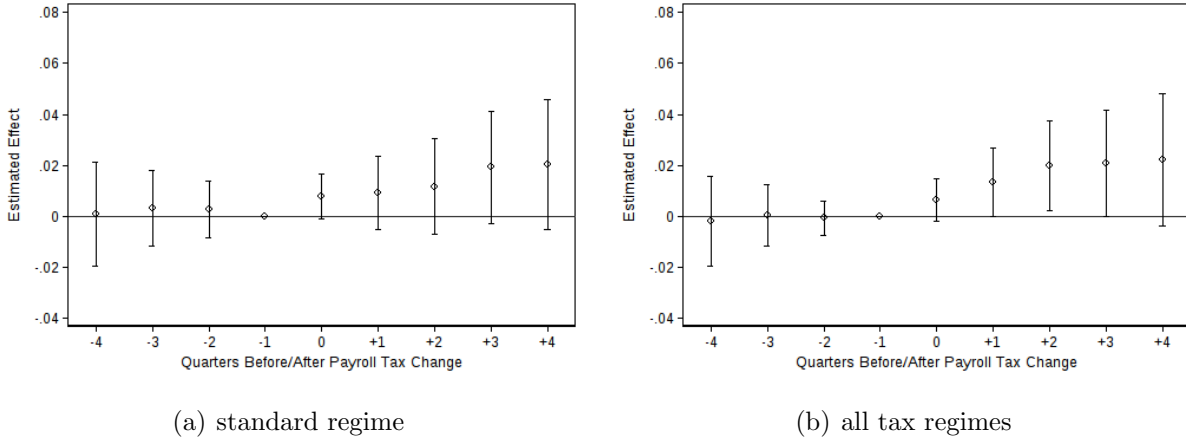
by the formalization of existing informal firms. While we are unable to distinguish whether our firm entry estimates are driven by the formalization of informal firms or the creation of new firms due to data limitations, our sample display average firm size of 26.7 employees, ranging between 2.5 and 426.8 across sectors (see Table 2).

The estimates of the effect of the PBM tax reform on firm growth are depicted in Figure 7. Two quarters after implementation, firms increase their average number of employees by approximately 3 percent in the main sample, and a little less for firms in all tax regimes. Corresponding regression estimates are reported in Table 10 and Appendix Table C.5. Overall, these results indicate that the total increase in sectoral employment discussed in Section 4.1 can be attributed roughly 60% to increased firm size and 40% firm entry into the standard regime.

4.4 Labor Market Concentration and Payroll Tax

In this subsection we first describe a theoretical framework to study the consequences of payroll taxes to employment and wages in imperfect labor markets characterized by (oligo)monopsony power. Then we lean on the model to obtain useful predictions as to inform our empirical exercise regarding how labor market concentration influences the impact of a payroll tax on our main outcomes.

Figure 7: Impact of PBM tax reform on firm growth

(a) standard regime

(b) all tax regimes
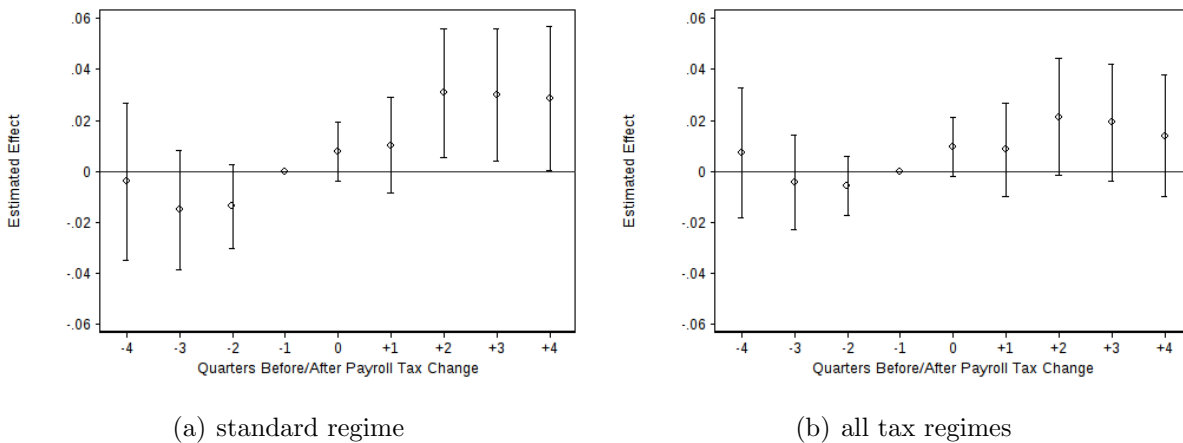
In a simple monopsony model with tax on labor, firms are assumed to face an upward sloped labor supply curve with its inverse denoted $w(\ell)$. The equilibrium values of wage and employment are obtained by profit maximization and can be solved by choosing the quantity of labor, i.e.

$$\max_{\ell}[y - (1+T)w(\ell)]\ell \tag{3}$$

where y is the marginal productivity of labor, and T is a tax (or subsidy) on wages. This leads to the first order condition

$$\frac{y - w}{w} = \frac{1}{\varepsilon} + \left(1 + \frac{1}{\varepsilon}\right)T$$

According to this result, both wage and employment are lower than under perfect competition and a labor subsidy can be used to raise wages and increase employment. In fact, the employer will choose the competitive allocation with $w = y$ if the government chooses $T = -1/(\varepsilon+1)$, i.e. a subsidy on labor that depends on the labor supply elasticity, ε. To put that into perspective, assume two monopsonistic labor markets, A and B, where individuals are equally productive between them but less elastic in market A than in B. In market A, the subsidy rate would have to be greater than that in market B so that both markets achieve the level of employment under perfect competition.

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We now consider an oligopsony model as we are interested in understanding how the impact of a labor tax reduction varies with the degree of labor market concentration. Instead of one firm, we have a finite number of employers (J_m) that are assumed to compete a la Cournot by choosing how many workers to hire in market m.

In models of oligopsony, upward-sloping supply curves for particular firms can arise even when there are many firms competing in the market (Bhaskar, Manning and To, 2002; Manning, 2003). We follow Berger, Herkenhoff and Mongey (2019) and specify an inverse labor supply function for each firm j in market m as

$$w_{jm}(\ell_{jm}) = \zeta \ell_{jm}^{\frac{1}{\eta}} L_m^{\frac{1}{\theta}-\frac{1}{\eta}} \tag{4}$$

where ζ depends on individual preference parameters and aggregate labor supply, all taken as exogenous. L_m is total labor in market m. η denotes the elasticity of substitution across firms within market with a high elasticity representing low within-market mobility costs. θ is the elasticity of substitution across markets. Following these authors, we also maintain the assumption of imperfect substitution across firms and higher mobility costs between markets than within market, together implying $\theta < \eta < \infty$.[22]

Analogous to the problem (3), the firm chooses the quantity of labor taking as given the labor supply function (4), by solving the profit maximization problem

$$\max_{\ell_{jm}}[y_{jm} - (1+T)w_{jm}(\ell_{jm})]\ell_{jm} \tag{5}$$

where y_{jm} is the (exogenous) marginal product of labor for firm j in market m. The first order condition implies:

$$\frac{y_{jm} - w_{jm}}{w_{jm}} = \frac{1}{\varepsilon_{jm}} + \left(1 + \frac{1}{\varepsilon_{jm}}\right)T$$

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[22]Berger, Herkenhoff and Mongey (2019) obtain the labor supply function from a representative household model in which households decide on how much labor to supply to each firm, ℓ_{jm}. This is similarly obtained by Dixit and Stiglitz (1977) for the product market and To (2009) for the labor market.

As in the monopsony case, this condition states that a subsidy on labor $T = -1/(\varepsilon_{jm}+1)$ can be used to correct market failures and bring both wages and employment to their competitive levels. However, as shown by Atkeson and Burstein (2008) for the product market and Berger, Herkenhoff and Mongey (2019) for the labor market, there is a relationship between the firm labor supply elasticity and its labor market share defined in terms of the wage bill, i.e. $s_{jm} = w_{jm}\ell_{jm}/\sum_{k=1}^{J_m} w_{km}\ell_{km}$, since the inverse labor supply of a firm under the oligopsony model is a function of its own employment as well as the market employment. From taking log on both sides of (4) and differentiating $\log(w_{jm})$ with respect to $\log(\ell_{jm})$, the share of a firm j in labor market m is

$$s_{jm} = \frac{\frac{1}{\varepsilon_{jm}} - \frac{1}{\eta}}{\frac{1}{\theta} - \frac{1}{\eta}} \tag{6}$$

with $1/\theta > 1/\varepsilon_{ij} \geq 1/\eta$ since $s_{ij} \in [0, 1)$. It is clear from this equation that in markets with high labor supply elasticity the firm share is lower.

Next, the maximization problem (5) implies

$$y_{jm} - (1+T)w_{jm}(\ell_{jm}) - (1+T)w'_{jm}(\ell_{jm})\ell_{jm} = 0 \tag{7}$$

which is an implicit function of employment, ℓ_{jm}, given y_{jm} and (4). We can use (7) to compute the marginal effect of changing labor costs $(1+T)$ on employment. The effect on employment in percentage terms is

$$\frac{d\log(\ell_{jm})}{d\log(1+T)} = -\frac{1 + \alpha + \beta s_{jm}}{2\alpha + \beta s_{jm}(3 - s_{jm})} < 0 \tag{8}$$

with $\alpha = 1/\eta$ and $\beta = 1/\eta - 1/\theta$.

The model also predicts that a marginal decrease in labor cost increases employment relatively less for firms with a higher share of the market as taking the derivative of (8) with

respect to s_{jm} obtains:

$$\frac{\partial \left| \frac{d\log(\ell_{jm})}{d\log(1+T)} \right|}{\partial s_{jm}} = -\frac{\beta(3 + \alpha + \beta s_{jm}^2)}{[2\alpha + \beta s_{jm}(3 - s_{jm})]^2} < 0 \tag{9}$$

A similar analysis can be done for wages. Since $\frac{dw}{d(1+T)} = \frac{dw}{d\ell}\frac{d\ell}{d(1+T)}$, it follows that

$$\frac{d\log(w_{jm})}{d\log(1+T)} = \frac{1}{\varepsilon_{jm}}\frac{d\log(\ell_{jm})}{d\log(1+T)} < 0 \tag{10}$$

Equation (10) shows that the wage effect of a tax reduction is positive but lower than the employment effect in markets where the labor supply elasticity is higher than one. The wage effect is lowest as the firm's share tends to zero. Furthermore, by taking the derivative of (10) with respect to s_{jm}, we also show that a decrease in labor costs increases wages more for firms with a higher share of the market,

$$\frac{\partial \left| \frac{d\log(w_{jm})}{d\log(1+T)} \right|}{\partial s_{jm}} = \frac{\beta\left[2\alpha + \beta s_{jm}(3 - s_{jm})\right]\left[1 + 2(\alpha + \beta s_{jm})\right]}{[2\alpha + \beta s_{jm}(3 - s_{jm})]^2} > 0 \tag{11}$$

Figure 8 illustrates how the employment and wage effects obtained in (8) and (10) vary with firm share, by calibrating η and θ with values estimated in the literature.[23] For most firm share levels, the effect on wages is smaller than on employment.[24] This indicates that the wage pass-through of a labor subsidy should be generally lower under imperfect labor markets characterized by oligopsony power. In this environment, due to imperfect mobility within and across markets, firms trade off wages against size. If their share of the market is small, there is less scope for them to affect wages and thus it is more profitable to adjust their level of employment.

Now we make the case for the need of an oligopsony model to understand how labor

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[23]We use $\eta = 3.74$ and $\theta = 0.76$ from Berger, Herkenhoff and Mongey (2019).

[24]If we take a 20% payroll tax rate as a starting point, then a decrease in the labor cost of 1% is equivalent to a decline of 6% in the tax rate. This implies that the elasticity for wages is 0.11 and for employment 0.4 when the firm share is close to zero.

Figure 8: Effects of a labor subsidy on employment and wages
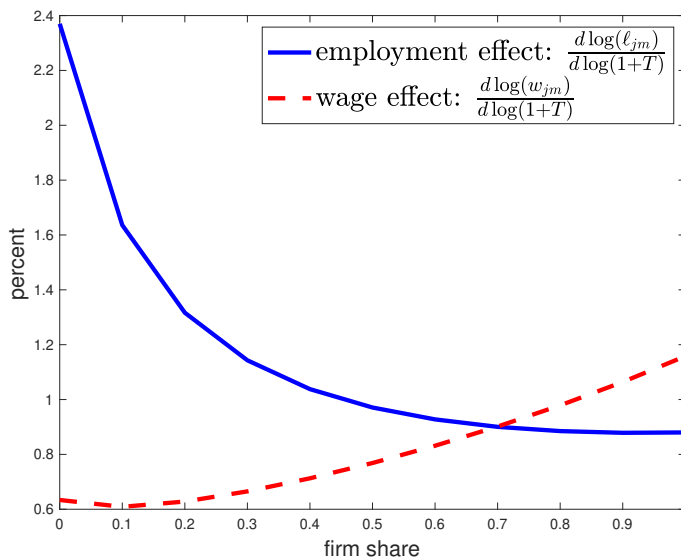
market concentration influences the impact of a labor tax. In a standard version of the competitive labor market approach, it is well known that wage and employment effects of labor subsidies depend on the elasticity of labor supply as well as of labor demand.[25] In the extreme case of inelastic (perfectly elastic) labor supply, both competitive and oligopsony models deliver similar results, that is, a labor cost reduction is transferred to workers in the form of higher wages (more employment). However, for all other cases, the oligopsony model brings novel insights as to who receives what in the context of an introduction of a labor subsidy.

The oligopsony framework gives a market structure reason behind a more or less elastic labor supply, i.e. the within market supply elasticities depend on firm share (equation 6). At the market (instead of firm) level, the recent literature has documented that labor market power is closely related to labor market concentration. In addition, standard measures taken at the market level such as the Herfindahl-Hirschman Index (HHI) have the advantage that they can be used to compare with the thresholds in the antitrust agencies' horizontal merger

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[25]A simple competitive equilibrium is characterized by $L^d[w(1+T)] = L^s(w)$. From differentiating this implicit function, the wage elasticity with respect to labor cost (1+T) is $\frac{d \log(w)}{d \log(1+T)} = \frac{\varepsilon^d}{\varepsilon^s - \varepsilon^d}$ where ε^s (ε^d) denotes labor supply (demand) elasticity.

guidelines (Azar, Marinescu and Steinbaum, 2017; Berger, Herkenhoff and Mongey, 2019).

The correlation between the wage-bill HHI and the average firm share across markets is 0.72 in our data.[26] Since the market concentration index is positively related to average firm share s_m, it is straightforward to interpret the labor market effects of reducing labor costs in equations (8) and (10) with respect to HHI_m at the market level.

In sum, the theory predicts that a reduction of labor costs should be associated with:

i) higher levels of employment and wages (equations 8 and 10);

ii) larger effects on employment relative to wages for most levels of market concentration (Figure 8);

iii) positive effects on employment (wages) that decrease (increase) with labor market concentration, i.e.

$$\frac{\partial \left| \frac{d \log(\ell_{jm})}{d \log(1+T)} \right|}{\partial HHI_m} < 0; \quad \frac{\partial \left| \frac{d \log(w_{jm})}{d \log(1+T)} \right|}{\partial HHI_m} > 0.$$

which are analogous to conditions (9) and (11).

Our baseline results discussed in section 4.1 are broadly consistent with predictions (i) and (ii). Larger effects on employment than on wages are expected in our setup as the observed wage-bill firm share is in the range $[4E - 06, 0.593]$, placing us in the interval where employment effects are dominant (see Figure 8).

We then test prediction (iii) from the oligopsonistic labor market model by repeating the employment and wage analysis for markets with different levels of labor market concentration. We follow Berger, Herkenhoff and Mongey (2019) and measure labor market concentration as a wage-bill Herfindahl-Hirschman Index (HHI).[27]

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[26]In particular, this would be the case as well if we assume all firms have the same share within market m, i.e. $s_{jm} = \frac{1}{J_m}$. In this case, the wage-bill Herfindahl measure of market concentration becomes $HHI_m = \sum_{j=1}^{J_m} s_{jm}^2 = J_m \frac{1}{J_m^2} = s_{jm}$, i.e. exactly the same as firm share.

[27]We chose to employ a wage-bill HHI to measure labor market concentration, and employment Herfindahls may overstate competition (Berger, Herkenhoff and Mongey, 2019). For completeness, we replicate the results from this section in the Appendix D using a more traditional employment-based HHI of labor market concentration. All results are qualitatively identical.

Figure 9: Geographical distribution of labor market concentration
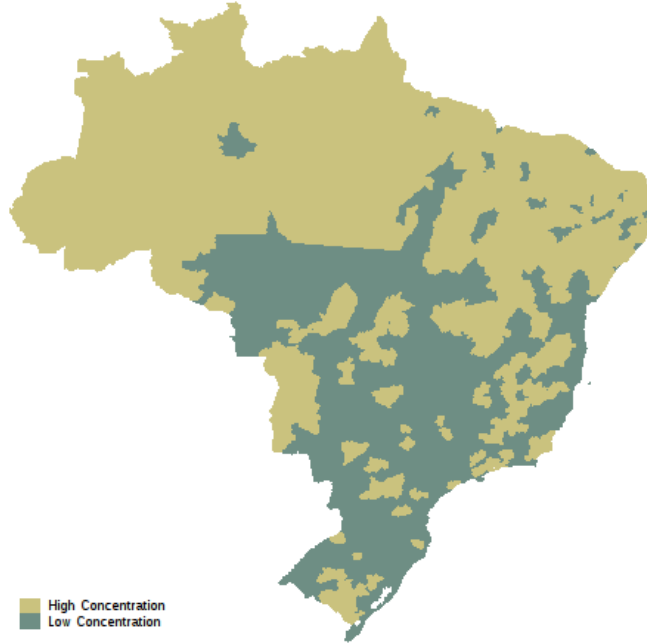
Note: For each of the 558 geographic micro-regions of Brazil, we measure labor market concentration as a wage-bill Herfindahl-Hirschman Index (*HHI*). High (low) concentration is defined by a *HHI* index above (below) our sample median of 0.029.

HHI ranges from $0.003 - 0.433$ across the 558 Brazilian micro-regions with mean (median) of 0.051 (0.029).[28] Figure 9 shows the geographical distribution of labor market concentration (above/below median). Regions with low levels of concentration (darker color) are scattered across most regions including southern, central and northeastern states of the country. Regions with above median HHI (lighter color) can be found across all states and dominate the Northwest/Amazon area.

Based on the HHI, we recalculate our main dependent variables, sectoral employment and wages, separately for firms in low/high HHI micro-regions and replicate our main analysis. Figure 10 displays a sharp difference. Firms in less concentrated labor markets are responsible for virtually all of the estimated average effect. Sectoral employment in more concentrated markets does not seem to respond to the PBM tax reform. Tables 11 and 12 report the corresponding point estimates. Overall, these results are consistent with predic-

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[28]The Brazilian Statistical Agency (IBGE) defines a micro-region as "groups of economically integrated municipalities sharing borders and structure of production".

Figure 10: PBM tax reform and employment according to labor market concentration

(a) high concentration

(b) low concentration
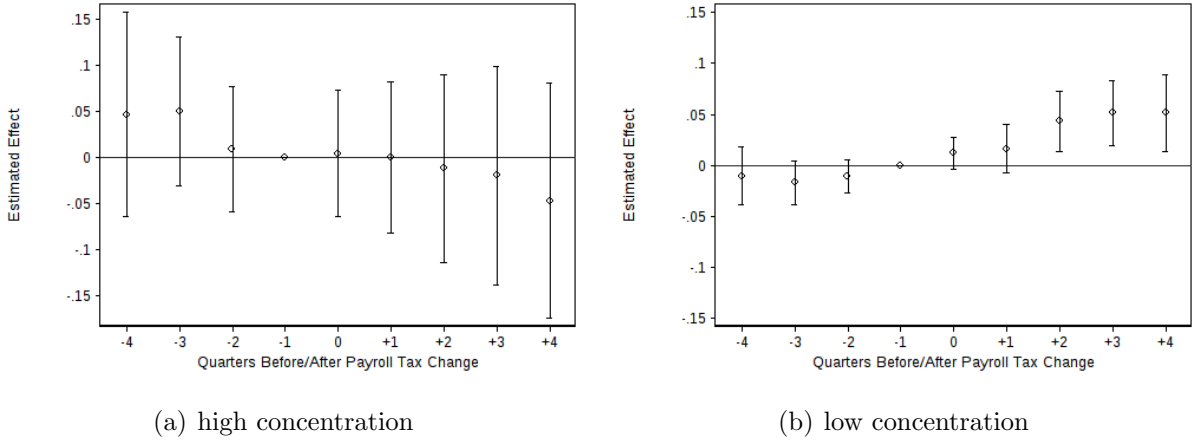
tion (iii) since the effect of a labor subsidy (or tax cut) on employment is decreasing in labor market concentration. In contrast, the effect on average wages is small and insignificant across specifications for both low and high HHI micro-regions, as reported in Tables 13 and 14.

4.5 Further Evidence

In this section, we take advantage of the micro-structure of the administrative dataset to investigate the heterogeneity of the impact of PBM tax scheme on sectoral employment with respect to firm size, workers' education and the level of labor informality.

In Figures 11(a) and 11(b), we plot the estimated effect of the PBM tax reform on employment in small and large firms, respectively. A firm is considered small (large) if it is below (above) the median size in its sector. As before, the timing of PBM implementation is associated with a sharp increase in sectoral employment, stabilizing around 5 percent. Moreover, sectoral employment in both small and large firms seem to react to the tax reform in a similar way. The corresponding point estimates are reported in Tables 15 and 16.

In Table 17, we explore the heterogeneity of our results with respect to workers' level of education. The dependent variables are sectoral employment of workers with less than high school in columns (1)-(3) and with high school or more in columns (4)-(6). As usual,

Figure 11: Heterogeneity according to workers' schooling and firm size
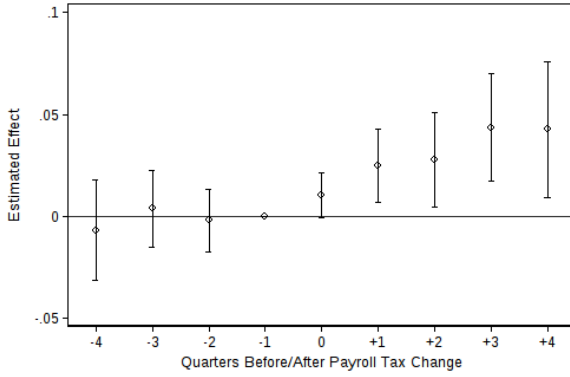
(a) small firms
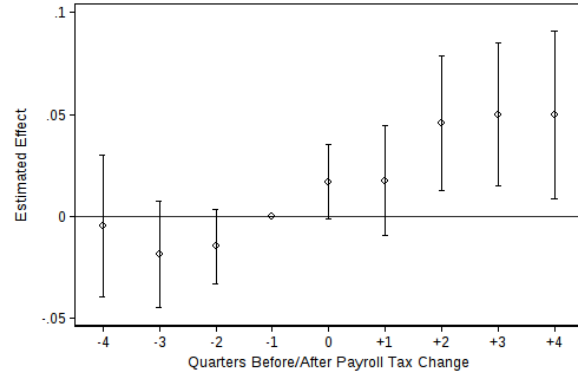
(b) large firms
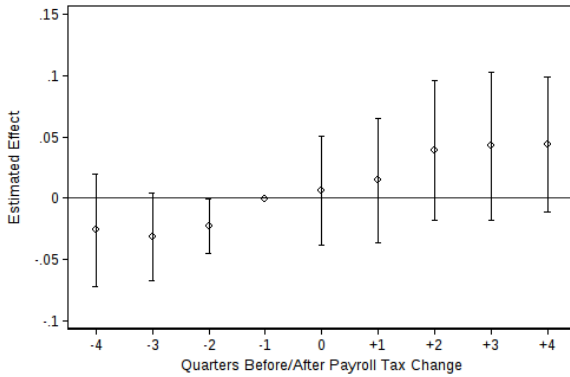
(c) less than high school
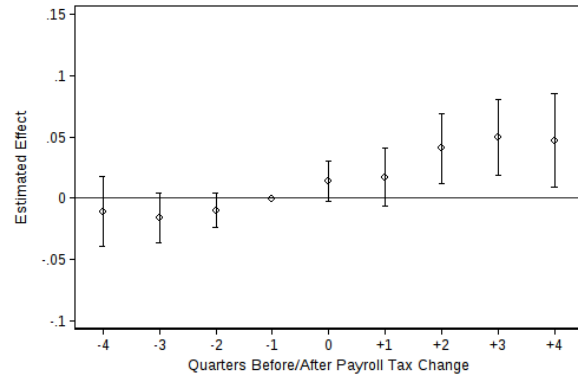
(d) high school or more

Figures 11(c) and 11(d) provide a visual illustration based on columns (1) and (4). The effect seems to be similar in magnitude across different levels of education, although they are more tightly estimated for more educated workers.

We now move on to explore the heterogeneity with respect to labor informality. This analysis is particularly important as developing countries' labor markets are known to have a large informal sector. In fact, over 40 percent of employment is in the informal sector (e.g. Meghir, Narita and Robin, 2015). In this situation, labor supply is likely to be more elastic than in developed countries as workers can find jobs in the unregulated sector, limiting the extent to which costs are shifted to workers (Heckman and Pages, 2004).[29]

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[29]This argument depends on workers having access to similar jobs in both the formal and informal sectors. In fact, Meghir, Narita and Robin (2015) show a significant overlap of the productivity distributions in the

Figure 12: Impact of PBM tax reform on employment level according to the level of formality

| (a) above median | (b) below median |
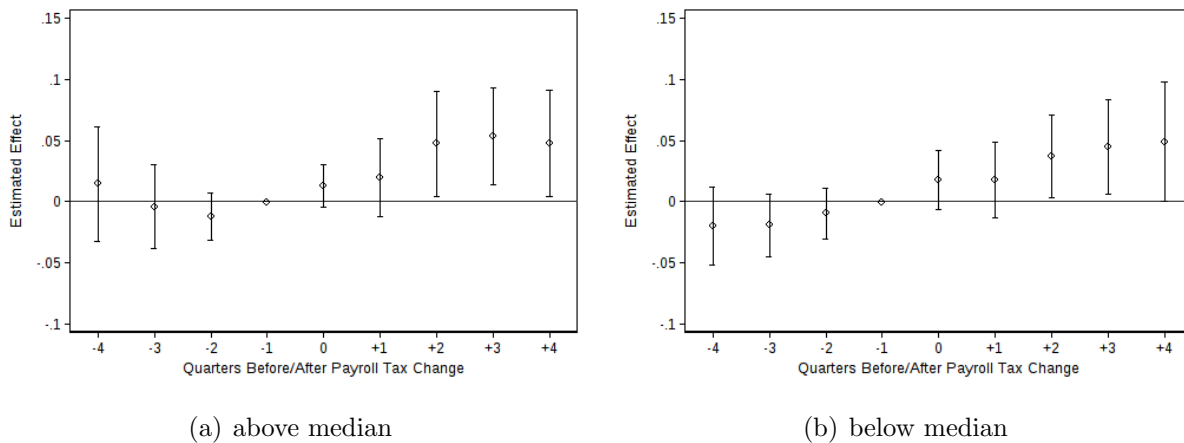
Table 18 tests this conjecture by allowing our baseline estimates to vary according to the degree of labor informality across sectors. This is done by interacting our treatment variables with a dummy indicating whether a sector is below or above the sectoral median level of formality according to the 2010 Census. The results illustrated in Figure 12 show that the effects are very similar across sectors with high and low informality levels. Therefore, we do not find support to the prediction of more labor adjustment in labor markets with higher informality.

5   Cost-benefit Analysis and Effect on Profits

In this section, we perform a cost-benefit analysis of the PBM reform and compare its effectiveness in terms of job creation to another federal program. In addition, based on a structural approach we provide an estimate for the firms' profit gain.

The PBM was officially introduced as a means to incentivize job creation by the productive sector. Despite having achieved a significant impact on employment in treated sectors as discussed in Section 4.1, its costs in terms of forgone tax income were substantial. Across the rollout of the program across the 65 different sectors in our sample, the accumulated

formal and informal sectors.

loss of tax revenue triggered by the PBM amounted to R$15.3 billion in 2014 according to ANFIP (2015).[30]

A simple back-of-the-envelop calculation reveals that the average sector included in the program experiences an increase in 4,954 employees, leading to a total of 322,054 jobs created in 65 treated sectors.[31] Dividing the total tax relief by the estimated number of jobs created, we find an estimated cost of a job of approximately R$47,585 in 2014 prices (or US$17,055 in 2018 prices).

It is useful to compare that with other estimates for programs funded by the federal government. For example, Corbi, Papaioannou and Surico (2019) explore a series of discontinuities in the allocation mechanism of federal transfers to municipal governments in Brazil (Fundo de Participação dos Municípios or FPM). They find that federal transfers increase local public spending and generate an increase in local labor markets at the rate of one new job per extra spending of US$8,000 in 2018 prices (R$22,320 in 2014 prices), mainly in services. This indicates that the cost of a job associated with the PBM estimated in this paper is roughly 2.1 times more costly than the estimates of the FPM federal transfer program.

This kind of simple cost-benefit analysis comes with the important caveat that it does not take into account other consequences of this kind of reform. For instance, workers are likely to face welfare consequences related to lower social security tax revenues. Second, the fiscal position of the government is likely to deteriorate. A more complete and quantitative general equilibrium would be needed to assess such tradeoffs.

Profits. As we do not have data on profits, we use the oligopsony model in section 4.4 to back out an estimate for the effect of the PBM reform on profits. Using a structural approach, explained in detail in Appendix Section E, we estimate that the average profit

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[30]These estimates are available at http://bit.ly/38tOy7B. In this section, we convert BRL 1998 to BRL 2014 at a 2,79 rate using the IBGE IPC-A index. Also, 1 BRL in 1998 prices is roughly equivalent to 1 USD in 2018 prices.

[31]The full calculation is $322,054 \approx 137,630 \times 0.036 \times 65$, where $137,630$ is the employment level of the average treated sector before PBM implementation, 0.036 is the long-run (+4 quarters) treatment estimate for all tax regimes from column (1) in Table C.1 times 65 treated sectors.

gain for firms in the sectors included in the PBM reform is 59%. Therefore, our results on firm profits along with those on employment and a null effect on wages show that firms did not pass on some of the tax windfall to workers in terms of wages. Instead, while firms have expanded due to the PBM reform, they pocket most of the tax cut.

6   Conclusion

This paper provides an empirical analysis of a large payroll tax cut for selected sectors in Brazil. Our findings show a positive sizable effect on total employment due to both firm entry and firm growth, but no impact on wages.

The effect on employment is found mainly in markets with relatively low levels of labor market concentration, consistent with predictions of an oligopsony framework. We additionally explore other sources of heterogeneity at the firm, worker and sector level. We find that treated sectors expand employment regardless of firm size, worker's education and degree of labor informality.

These findings shed light on how payroll taxation can be an important policy instrument in the government tool kit. However, job creation through tax policy is likely least effective in regions where labor markets are more concentrated, as in such environments subsidies are mostly absorbed by firms as profit. Indeed, based on a structural approach we find that the tax cut generates a significant profit windfall.

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Tables

Table 1: Sectors in the PBM tax regime according to ISIC and NCM criteria

Level 1 ISIC sections	Share of sectors in PBM regime	Total number of 4-digit sectors	Included by ISIC criterion (sector)	Included by NCM criterion (product)
A - Agriculture, Hunting, Forestry and Fishing	41.18%	34	0	14
B - Mining and Quarrying	12.50%	16	0	2
C - Manufacturing	74.03%	259	4	187
D - Electricity, and Gas Industries	0.00%	6	0	0
E - Water, Sanitation and Waste	9.09%	11	0	1
F - Construction	**95.24%**	**21**	**20**	**0**
G - Repair and Sale of motor vehicles	**15.96%**	**95**	**15**	**0**
H - Transportation, Storage and Mail Services	**41.18%**	**34**	**14**	**0**
I - Accomodation and Food Industries	**20.00%**	**5**	**1**	**0**
J - Information and Communication Industries	**43.75%**	**32**	**14**	**0**
K - Financial Activities, Insurance and Related	0.00%	37	0	0
L - Real Estate	0.00%	3	0	0
M - Professional, Scientific and Technical	0.00%	19	0	0
N - Administrative Activities and Services	**2.94%**	**34**	**1**	**0**
O - Public Admin, Defense and Social Security	0.00%	10	0	0
P - Education	0.00%	14	0	0
Q - Human Health and Social Services	0.00%	13	0	0
R - Arts, Culture, Sport and Recreation	0.00%	13	0	0
S - Other Service Activities	0.00%	16	0	0
T - Domestic Services	0.00%	1	0	0
U - International Organizations	0.00%	1	0	0

Note: List of ISIC sectors allocated to the PBM tax regime. Firms were included in PBM by either their standard 4-digit ISIC sector codes (criterion 1) or their product codes based on the Mercosur Common Nomenclature (NCM). Highlighted ISIC sections (F, G, H, I, J, and N) have at least one 4-digit sector eligible by the ISIC criterion and none by the NCM criterion and are included in our main empirical analysis. Our main sample includes 219 sectors (out of 221), as two sectors did not have active firms in all years.

Table 2: Summary statistics

	Mean	σ	Min	Max	Median
Total employment	94,465	182,337	187	1,358,143	32,009
Total number of firms	8,976	21,488	11	178,232	2,062
Average employment per firm	26.77	46.37	2.52	426.84	11.55
Elementary school or less	0.32	0.18	0.00	0.79	0.30
High school	0.55	0.13	0.18	0.91	0.56
College degree	0.13	0.13	0.01	0.64	0.07
Average age	34.32	2.70	26.15	47.68	34.15
Male	0.66	0.18	0.13	0.96	0.68
Average real hourly wage	13.44	8.37	4.99	69.49	10.47
Share of employment in SIMPLES	0.31	0.26	0.00	0.90	0.24
% Expected variation in tax burden due to PBM (treated sectors)	0.51	0.17	-0.02	0.84	0.52
Observations	15,768	15,768	15,768	15,768	15,768

Note: Summary statistics of the 219 sectors in the sample used in the analysis in the period 2009-2014. Wages per hour are in Brazilian Reais of December 2014.
Source: RAIS (MTE) and ANFIP (2015).

Table 3: Determinants of timing in the PBM allocation

	Regular regime		All regimes	
	Month of PBM Allocation	Month of PBM Allocation	Month of PBM Allocation	Month of PBM
Total Number of Firms	-0.000	0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Average Employees per Firm	-0.002	0.032***	0.012	0.046***
	(0.010)	(0.007)	(0.016)	(0.009)
High school	-5.900	-0.095	-7.033	2.259
	(7.369)	(7.476)	(7.245)	(8.150)
College degree or more	-27.275***	-16.923	-24.592**	-16.636
	(9.251)	(14.350)	(9.358)	(15.390)
Average Age	0.358	1.027**	0.406	1.057**
	(0.360)	(0.425)	(0.389)	(0.452)
Share of Employees in a SIMPLES Firm	1.406	4.075	4.565	4.547
	(4.752)	(4.505)	(4.432)	(4.390)
Male	-4.180	-16.340*	-2.086	-12.955*
	(7.709)	(8.575)	(7.016)	(7.358)
Average Real Hourly Wage	0.179	0.062	0.159	0.010
	(0.177)	(0.154)	(0.184)	(0.173)
Observations	65	65	65	65
R-squared	0.370	0.569	0.365	0.561
ISIC section fixed-effect	-	✓	-	✓

Note: The table reports regression estimates associating the timing of PBM implementation to sector characteristics at their average level prior to PBM (from December 2010 to November 2011). The dependent variable is the month in which each of the sectors was allocated to PBM. The sample consists of all 65 sectors that entered the PBM tax regime at some point. The first 2 columns report estimates for firms in the standard tax regime, while the last 2 columns show the results for all regimes. For both specifications, we present estimates without and with the ISIC section fixed-effects. Robust standard errors are reported in parentheses below the coefficients. Significantly different from zero at 99% (***), 95% (**) and 90% (*) confidence level.

Table 4: PBM implementation and sectoral employment

	(1) log(sectoral employment)	(2) log(sectoral employment)	(3) log(sectoral employment)
-4 quarters	-0.003	-0.007	-0.009
	(0.015)	(0.016)	(0.017)
-3 quarters	-0.012	-0.011	-0.009
	(0.011)	(0.011)	(0.012)
-2 quarters	-0.011	-0.008	-0.009
	(0.008)	(0.008)	(0.009)
0 (1st quarter of the tax relief)	0.016*	0.008	0.011
	(0.008)	(0.008)	(0.008)
+1 quarter	0.019	0.012	0.017
	(0.012)	(0.012)	(0.013)
+2 quarters	0.042***	0.036**	0.034**
	(0.014)	(0.015)	(0.017)
+3 quarters	0.049***	0.045**	0.042**
	(0.015)	(0.019)	(0.020)
+4 quarters	0.049***	0.057**	0.057**
	(0.019)	(0.024)	(0.025)
Constant	9.755***	9.754***	9.915***
	(0.005)	(0.006)	(1.295)
Observations	15,768	15,768	15,768
R-squared	0.991	0.991	0.991
Sector FE	✓	✓	✓
Monthly FE	✓	-	-
Monthly FE x ISIC level 1 category	-	✓	✓
Monthly FE x Worker/firm char. before PBM	-	-	✓

Note: The table reports regression estimates associating the log of sectoral employment to the timing of PBM implementation as defined by specification (2). Column (1) reports estimates that control for sector and month fixed effects. Column (2) interacts monthly fixed effects with category-specific (level 1 ISIC) dummies. Column (3) adds the interaction of monthly fixed-effects with worker and firm characteristics at their averages in the one year period before the PBM implementation. The controls are the average age of employees in each sector and its square, share of male employees and the average number of employees per firm. These variables were selected based on the regression on table 3. Our main sample consists of a balanced panel of sector-month pairs and includes all firms in the standard tax regime from 219 sectors during the period $2009 - 2014$, as described in section 2.1. Heteroskedasticity-adjusted standard errors clustered at the sector level are reported in parentheses below the coefficients. Significantly different from zero at 99% (***), 95% (**) and 90% (*) confidence level.

Table 5: PBM implementation and sectoral employment according to treatment intensity

	(1) log(sectoral employment)	(2) log(sectoral employment)	(3) log(sectoral employment)
-4 quarters (High int.)	0.010	-0.004	-0.006
	(0.023)	(0.024)	(0.026)
-3 quarters (High int.)	0.003	-0.006	-0.003
	(0.015)	(0.017)	(0.018)
-2 quarters (High int.)	0.000	-0.002	-0.002
	(0.007)	(0.009)	(0.010)
0 (1st quarter of the tax relief (High int.)	0.024*	0.017	0.018
	(0.014)	(0.014)	(0.014)
+1 quarter (High int.)	0.031*	0.024	0.028
	(0.017)	(0.019)	(0.019)
+2 quarters (High int.)	0.053***	0.052**	0.052**
	(0.020)	(0.023)	(0.025)
+3 quarters (High int.)	0.064***	0.067**	0.062**
	(0.022)	(0.027)	(0.029)
+4 quarters (High int.)	0.073***	0.087***	0.086***
	(0.026)	(0.031)	(0.033)
-4 quarters (Low int.)	-0.018	-0.013	-0.015
	(0.017)	(0.020)	(0.021)
-3 quarters (Low int.)	-0.029*	-0.019	-0.021
	(0.015)	(0.016)	(0.017)
-2 quarters (Low int.)	-0.023*	-0.016	-0.019
	(0.013)	(0.013)	(0.014)
0 (1st quarter of the tax relief (Low int.)	0.008	0.000	0.007
	(0.007)	(0.005)	(0.006)
+1 quarter (Low int.)	0.009	-0.001	0.008
	(0.014)	(0.010)	(0.012)
+2 quarters (Low int.)	0.032*	0.018	0.020
	(0.018)	(0.015)	(0.017)
+3 quarters (Low int.)	0.034**	0.021	0.023
	(0.016)	(0.018)	(0.020)
+4 quarters (Low int.)	0.022	0.019	0.026
	(0.019)	(0.021)	(0.023)
Constant	9.755***	9.755***	9.882***
	(0.005)	(0.006)	(1.338)
Observations	15,768	15,768	15,768
R-squared	0.991	0.991	0.992
Sector FE	✓	✓	✓
Monthly FE	✓	-	-
Monthly FE x ISIC level 1 category	-	✓	✓
Monthly FE x Worker/firm char. before PBM	-	-	✓

Note: The table reports regression estimates associating the log of sectoral employment to the timing of PBM implementation as defined by specification (2), allowing effects to differ according to high/low intensity (above/below median) in the reduction of the payroll tax burden due to PBM (see Table A.1 for the average reduction by sector). Column (1) reports estimates that control for sector and month fixed effects. Column (2) interacts monthly fixed effects with category-specific (level 1 ISIC) dummies. Column (3) adds the interaction of monthly fixed-effects with worker and firm characteristics at their averages in the one year period before the PBM implementation. The controls are the average age of employees in each sector and its square, share of male employees and the average number of employees per firm. These variables were selected based on the regression on table 3. Our main sample consists of a balanced panel of sector-month pairs and includes all firms in the standard tax regime from 219 sectors during the period $2009 - 2014$, as described in section 2.1. Heteroskedasticity-adjusted standard errors clustered at the sector level are reported in parentheses below the coefficients. Significantly different from zero at 99% (***), 95% (**) and 90% (*) confidence level.

Table 6: PBM implementation and average wage (new hires)

	(1) log(hourly wage in contract) (among new hires)	(2) log(hourly wage in contract) (among new hires)	(3) log(hourly wage in contract) (among new hires)
-4 quarters	0.011	0.018	0.019
	(0.021)	(0.023)	(0.025)
-3 quarters	0.001	0.010	0.009
	(0.020)	(0.023)	(0.025)
-2 quarters	0.002	0.009	0.007
	(0.019)	(0.020)	(0.021)
0 (1st quarter of the tax relief)	0.005	0.004	-0.001
	(0.020)	(0.023)	(0.023)
+1 quarter	0.017	0.019	0.009
	(0.023)	(0.027)	(0.028)
+2 quarters	-0.022	-0.010	-0.004
	(0.019)	(0.022)	(0.022)
+3 quarters	-0.009	-0.009	-0.009
	(0.026)	(0.027)	(0.028)
+4 quarters	-0.010	-0.017	-0.011
	(0.023)	(0.026)	(0.027)
Constant	1.982***	1.980***	4.847***
	(0.005)	(0.006)	(1.200)
Observations	15,768	15,768	15,768
R-squared	0.845	0.849	0.853
Sector FE	✓	✓	✓
Monthly FE	✓	-	-
Monthly FE x ISIC level 1 category	-	✓	✓
Monthly FE x Worker/firm char. before PBM	-	-	✓

Note: The table reports regression estimates associating the log of the hourly wage of new hires to the timing of PBM implementation as defined by specification (2). Column (1) reports estimates that control for sector and month fixed effects. Column (2) interacts monthly fixed effects with category-specific (level 1 ISIC) dummies. Column (3) adds the interaction of monthly fixed-effects with worker and firm characteristics at their averages in the one year period before the PBM implementation. The controls are the average age of employees in each sector and its square, share of male employees and the average number of employees per firm. These variables were selected based on the regression on table 3. Our main sample consists of a balanced panel of sector-month pairs and includes all firms in the standard tax regime from 219 sectors during the period $2009 - 2014$, as described in section 2.1. Heteroskedasticity-adjusted standard errors clustered at the sector level are reported in parentheses below the coefficients. Significantly different from zero at 99% (***), 95% (**) and 90% (*) confidence level.

Table 7: PBM implementation and average wage according to treatment intensity

	(1) log(hourly wage in contract) (among new hires)	(2) log(hourly wage in contract) (among new hires)	(3) log(hourly wage in contract) (among new hires)
-4 quarters (High int.)	0.004	0.019	0.020
	(0.035)	(0.037)	(0.038)
-3 quarters (High int.)	0.002	0.018	0.013
	(0.036)	(0.040)	(0.042)
-2 quarters (High int.)	-0.001	0.009	0.005
	(0.034)	(0.036)	(0.037)
0 (1st quarter of the tax relief (High int.)	-0.002	-0.006	-0.012
	(0.038)	(0.041)	(0.041)
+1 quarter (High int.)	0.050	0.054	0.040
	(0.043)	(0.048)	(0.050)
+2 quarters (High int.)	-0.002	0.011	0.010
	(0.035)	(0.037)	(0.037)
+3 quarters (High int.)	-0.011	-0.009	-0.010
	(0.048)	(0.048)	(0.047)
+4 quarters (High int.)	-0.014	-0.016	-0.008
	(0.039)	(0.042)	(0.043)
-4 quarters (Low int.)	0.019	0.017	0.017
	(0.021)	(0.022)	(0.025)
-3 quarters (Low int.)	0.000	0.002	0.004
	(0.017)	(0.019)	(0.019)
-2 quarters (Low int.)	0.005	0.009	0.008
	(0.014)	(0.015)	(0.016)
0 (1st quarter of the tax relief (Low int.)	0.010	0.013	0.007
	(0.017)	(0.018)	(0.016)
+1 quarter (Low int.)	-0.017	-0.016	-0.022
	(0.016)	(0.018)	(0.017)
+2 quarters (Low int.)	-0.041**	-0.035*	-0.022
	(0.017)	(0.018)	(0.017)
+3 quarters (Low int.)	-0.007	-0.012	-0.012
	(0.019)	(0.020)	(0.021)
+4 quarters (Low int.)	-0.005	-0.018	-0.015
	(0.022)	(0.024)	(0.023)
Constant	1.982***	1.980***	4.898***
	(0.005)	(0.006)	(1.186)
Observations	15,768	15,768	15,768
R-squared	0.845	0.849	0.853
Sector FE	✓	✓	✓
Monthly FE	✓	-	-
Monthly FE x ISIC level 1 category	-	✓	✓
Monthly FE x Worker/firm char. before PBM	-	-	✓

Note: The table reports regression estimates associating the log of the hourly wage of new hires to the timing of PBM implementation as defined by specification (2), allowing effects to differ according to high/low intensity (above/below median) in the reduction of the payroll tax burden due to PBM (see Table A.1 for the average reduction by sector). Column (1) reports estimates that control for sector and month fixed effects. Column (2) interacts monthly fixed effects with category-specific (level 1 ISIC) dummies. Column (3) adds the interaction of monthly fixed-effects with worker and firm characteristics at their averages in the one year period before the PBM implementation. The controls are the average age of employees in each sector and its square, share of male employees and the average number of employees per firm. These variables were selected based on the regression on table 3. Our main sample consists of a balanced panel of sector-month pairs and includes all firms in the standard tax regime from 219 sectors during the period $2009 - 2014$, as described in section 2.1. Heteroskedasticity-adjusted standard errors clustered at the sector level are reported in parentheses below the coefficients. Significantly different from zero at 99% (***), 95% (**) and 90% (*) confidence level.

Table 8: PBM implementation and firm transition from SIMPLES into the standard tax regime

	(1) Before PBM 2009-2010 SIMPLES Exit Rate	(2) Before PBM 2009-2010 SIMPLES Exit Rate	(3) All years 2009-2014 SIMPLES Exit Rate	(4) All years 2009-2014 SIMPLES Exit Rate	(5) Before PBM 2009-2010 log(avg firm size)	(6) Before PBM 2009-2010 log(avg firm size)	(7) All years 2009-2014 log(avg firm size)	(8) All years 2009-2014 log(avg firm size)
Treated sector = 1	-0.008	-0.011			0.002	-0.006		
	(0.006)	(0.008)			(0.029)	(0.032)		
Payroll Tax Change			0.007*	0.009***			-0.057**	-0.054**
			(0.003)	(0.003)			(0.025)	(0.027)
Constant	0.084***	-0.090	0.073***	0.224	1.727***	1.801*	1.712***	2.715
	(0.001)	(0.211)	(0.000)	(0.337)	(0.004)	(0.958)	(0.003)	(2.187)
Observations	436	436	1,308	1,308	436	436	1,308	1,308
R-squared	0.869	0.874	0.777	0.786	0.961	0.968	0.906	0.920
Sector FE	✓	✓	✓	✓	✓	✓	✓	✓
Yearly FE	✓	✓	✓	✓	✓	✓	✓	✓
Yearly FE x Worker/firm char. before PBM	-	✓	-	✓	-	✓	-	✓

Note: The table reports regression estimates associating the probability of leaving the SIMPLES tax regime (columns 1-4) and the log of the sectoral average number of employees in SIMPLES firms (columns 5-8) to the timing of PBM implementation in a given sector. Treated sector=1 is an indicator that equals 1 if a sector was eventually included in the PBM in any year. PBM implementation is a dummy variable that equals 1 if a sector is included in the PBM tax regime at a given year. Columns (1), (2), (5) and (6) present results of a simple mean difference test between treated and control groups before the implementation of PBM. Columns (3), (4), (7) and (8) explore the timing of PBM implementation (yearly variation) across sectors. Columns (2), (4), (6) and (8) add the interaction of year fixed-effects with worker and firm characteristics at their averages in the one year period before the PBM implementation. The controls are the average age of employees in each sector and its square, share of male employees and the average number of employees per firm. These variables were selected based on the regression on table 3. All columns report estimates that control for sector and year fixed effects. Our sample consists of a balanced panel of sector-month pairs and includes all firms in the standard tax regime from 218 sectors during the period $2009 - 2014$, as described in section 2.1. We lose 1 sector out of 219 of the main sample - "Microwave-based operators of TV channels" - as it did not have active SIMPLES firms in all years. Heteroskedasticity-adjusted standard errors clustered at the sector level are reported in parentheses below the coefficients. Significantly different from zero at 99% (***), 95% (**) and 90% (*) confidence level.

Table 9: PBM implementation and the number of firms

	(1) log(number of firms)	(2) log(number of firms)	(3) log(number of firms)
-4 quarters	0.001	0.007	0.011
	(0.010)	(0.013)	(0.013)
-3 quarters	0.003	0.009	0.011
	(0.007)	(0.009)	(0.009)
-2 quarters	0.003	0.008	0.008
	(0.006)	(0.007)	(0.007)
0 (1st quarter of the tax relief)	0.008*	0.003	0.002
	(0.004)	(0.005)	(0.006)
+1 quarter	0.009	0.007	0.009
	(0.007)	(0.008)	(0.009)
+2 quarters	0.012	0.011	0.013
	(0.010)	(0.011)	(0.012)
+3 quarters	0.019*	0.021	0.018
	(0.011)	(0.014)	(0.015)
+4 quarters	0.020	0.026	0.020
	(0.013)	(0.017)	(0.017)
Constant	6.711***	6.710***	6.429***
	(0.004)	(0.005)	(0.316)
Observations	15,768	15,768	15,768
R-squared	0.995	0.995	0.995
Sector FE	✓	✓	✓
Monthly FE	✓	-	-
Monthly FE x ISIC level 1 category	-	✓	✓
Monthly FE x Worker/firm char. before PBM	-	-	✓

Note: The table reports regression estimates associating the log of the number of active firms in each sector to the timing of PBM implementation as defined by specification (2). Column (1) reports estimates that control for sector and month fixed effects. Column (2) interacts monthly fixed effects with category-specific (level 1 ISIC) dummies. Column (3) adds the interaction of monthly fixed-effects with worker and firm characteristics at their averages in the one year period before the PBM implementation. The controls are the average age of employees in each sector and its square, share of male employees and the average number of employees per firm. These variables were selected based on the regression on table 3. Our main sample consists of a balanced panel of sector-month pairs and includes all firms in the standard tax regime from 219 sectors during the period 2009 − 2014, as described in section 2.1. Heteroskedasticity-adjusted standard errors clustered at the sector level are reported in parentheses below the coefficients. Significantly different from zero at 99% (***), 95% (**) and 90% (*) confidence level.

Table 10: PBM implementation and firm size

	(1) log(avg employees per firm)	(2) log(avg employees per firm)	(3) log(avg employees per firm)
-4 quarters	-0.004	-0.014	-0.017
	(0.016)	(0.015)	(0.016)
-3 quarters	-0.015	-0.020*	-0.019
	(0.012)	(0.011)	(0.012)
-2 quarters	-0.014	-0.016*	-0.016*
	(0.008)	(0.009)	(0.009)
0 (1st quarter of the tax relief)	0.008	0.005	0.008
	(0.006)	(0.006)	(0.007)
+1 quarter	0.010	0.005	0.008
	(0.010)	(0.010)	(0.012)
+2 quarters	0.031**	0.024*	0.024
	(0.013)	(0.014)	(0.016)
+3 quarters	0.030**	0.025	0.026
	(0.013)	(0.016)	(0.019)
+4 quarters	0.029**	0.031*	0.036*
	(0.014)	(0.018)	(0.021)
Constant	3.044***	3.044***	3.658*
	(0.005)	(0.005)	(1.894)
Observations	15,768	15,768	15,768
R-squared	0.984	0.984	0.985
Sector FE	✓	✓	✓
Monthly FE	✓	-	-
Monthly FE x ISIC level 1 category	-	✓	✓
Monthly FE x Worker/firm char. before PBM	-	-	✓

Note: The table reports regression estimates associating the log of the sectoral average number of employees to the timing of PBM implementation as defined by specification (2). Column (1) reports estimates that control for sector and month fixed effects. Column (2) interacts monthly fixed effects with category-specific (level 1 ISIC) dummies. Column (3) adds the interaction of monthly fixed-effects with worker and firm characteristics at their averages in the one year period before the PBM implementation. The controls are the average age of employees in each sector and its square, share of male employees and the average number of employees per firm. These variables were selected based on the regression on table 3. Our main sample consists of a balanced panel of sector-month pairs and includes all firms in the standard tax regime from 219 sectors during the period $2009 - 2014$, as described in section 2.1. Heteroskedasticity-adjusted standard errors clustered at the sector level are reported in parentheses below the coefficients. Significantly different from zero at 99% (***), 95% (**) and 90% (*) confidence level.

Table 11: PBM implementation, employment and low market concentration

	(1) log(sectoral employment)	(2) log(sectoral employment)	(3) log(sectoral employment)
-4 quarters	-0.010	-0.008	-0.009
	(0.014)	(0.016)	(0.017)
-3 quarters	-0.017	-0.010	-0.007
	(0.011)	(0.011)	(0.013)
-2 quarters	-0.011	-0.005	-0.004
	(0.008)	(0.009)	(0.010)
0 (1st quarter of the tax relief)	0.012	0.005	0.008
	(0.008)	(0.008)	(0.008)
+1 quarter	0.016	0.008	0.012
	(0.012)	(0.013)	(0.014)
+2 quarters	0.043***	0.035**	0.032*
	(0.015)	(0.016)	(0.018)
+3 quarters	0.052***	0.046**	0.040*
	(0.016)	(0.020)	(0.022)
+4 quarters	0.052***	0.057**	0.054**
	(0.019)	(0.024)	(0.024)
Constant	9.664***	9.663***	9.216***
	(0.005)	(0.006)	(1.289)
Observations	15,768	15,768	15,768
R-squared	0.990	0.991	0.991
Sector FE	✓	✓	✓
Monthly FE	✓	-	-
Monthly FE x ISIC level 1 category	-	✓	✓
Monthly FE x Worker/firm char. before PBM	-	-	✓

Note: The table reports regression estimates associating the log of sectoral employment to the timing of PBM implementation as defined by specification (2). The dependent variable is sectoral employment in micro-regions associated with low levels (below median) of labor market concentration which is measured by a wage-bill HHI index, as discussed in section 4.4. Column (1) reports estimates that control for sector and month fixed effects. Column (2) interacts monthly fixed effects with category-specific (level 1 ISIC) dummies. Column (3) adds the interaction of monthly fixed-effects with worker and firm characteristics at their averages in the one year period before the PBM implementation. The controls are the average age of employees in each sector and its square, share of male employees and the average number of employees per firm. These variables were selected based on the regression on table 3. Our main sample consists of a balanced panel of sector-month pairs and includes all firms in the standard tax regime and in low-concentration micro-regions from 219 sectors during the period 2009 − 2014, as described in section 2.1. Heteroskedasticity-adjusted standard errors clustered at the sector level are reported in parentheses below the coefficients. Significantly different from zero at 99% (***), 95% (**) and 90% (*) confidence level.

Table 12: PBM implementation, employment and high market concentration

	(1) log(sectoral employment)	(2) log(sectoral employment)	(3) log(sectoral employment)
-4 quarters	0.046	-0.019	-0.018
	(0.056)	(0.056)	(0.049)
-3 quarters	0.050	0.009	0.016
	(0.041)	(0.040)	(0.038)
-2 quarters	0.009	-0.013	-0.016
	(0.034)	(0.040)	(0.044)
0 (1st quarter of the tax relief)	0.004	-0.006	-0.024
	(0.035)	(0.034)	(0.035)
+1 quarter	-0.001	-0.012	-0.019
	(0.042)	(0.044)	(0.043)
+2 quarters	-0.012	-0.020	-0.029
	(0.052)	(0.057)	(0.052)
+3 quarters	-0.020	-0.030	-0.020
	(0.060)	(0.068)	(0.058)
+4 quarters	-0.047	-0.049	-0.010
	(0.064)	(0.079)	(0.072)
Constant	7.007***	7.017***	12.712***
	(0.014)	(0.015)	(3.134)
Observations	15,336	15,336	15,336
R-squared	0.970	0.971	0.973
Sector FE	✓	✓	✓
Monthly FE	✓	-	-
Monthly FE x ISIC level 1 category	-	✓	✓
Monthly FE x Worker/firm char. before PBM	-	-	✓

Note: The table reports regression estimates associating the log of sectoral employment to the timing of PBM implementation as defined by specification (2). The dependent variable is sectoral employment in micro-regions associated with high levels (above median) of labor market concentration which is measured by a wage-bill HHI index, as discussed in section 4.4. Column (1) reports estimates that control for sector and month fixed effects. Column (2) interacts monthly fixed effects with category-specific (level 1 ISIC) dummies. Column (3) adds the interaction of monthly fixed-effects with worker and firm characteristics at their averages in the one year period before the PBM implementation. The controls are the average age of employees in each sector and its square, share of male employees and the average number of employees per firm. These variables were selected based on the regression on table 3. Our main sample consists of a balanced panel of sector-month pairs and includes all firms in the standard tax regime and in high-concentration micro-regions from 219 sectors during the period 2009 − 2014, as described in section 2.1. Heteroskedasticity-adjusted standard errors clustered at the sector level are reported in parentheses below the coefficients. Significantly different from zero at 99% (***), 95% (**) and 90% (*) confidence level.

Table 13: PBM implementation, average wage and low market concentration

	(1) log(hourly wage in contract) (among new hires)	(2) log(hourly wage in contract) (among new hires)	(3) log(hourly wage in contract) (among new hires)
-4 quarters	0.026	0.032	0.030
	(0.018)	(0.021)	(0.022)
-3 quarters	0.017	0.025	0.026
	(0.015)	(0.019)	(0.020)
-2 quarters	0.016	0.024	0.025
	(0.013)	(0.016)	(0.016)
0 (1st quarter of the tax relief)	0.017	0.015	0.007
	(0.018)	(0.021)	(0.021)
+1 quarter	0.032*	0.026	0.017
	(0.019)	(0.025)	(0.026)
+2 quarters	-0.009	-0.003	0.002
	(0.017)	(0.020)	(0.020)
+3 quarters	0.004	0.001	-0.000
	(0.023)	(0.025)	(0.026)
+4 quarters	0.005	-0.004	0.002
	(0.020)	(0.024)	(0.025)
Constant	1.989***	1.987***	4.772***
	(0.004)	(0.005)	(1.125)
Observations	15,767	15,767	15,767
R-squared	0.854	0.858	0.863
Sector FE	✓	✓	✓
Monthly FE	✓	-	-
Monthly FE x ISIC level 1 category	-	✓	✓
Monthly FE x Worker/firm char. before PBM	-	-	✓

Note: The table reports regression estimates associating the log of the hourly wage of new hires to the timing of PBM implementation as defined by specification (2). The dependent variable is sectoral hourly wage in micro-regions associated with low levels (below median) of labor market concentration which is measured by a wage-bill HHI index, as discussed in section 4.4. Column (1) reports estimates that control for sector and month fixed effects. Column (2) interacts monthly fixed effects with category-specific (level 1 ISIC) dummies. Column (3) adds the interaction of monthly fixed-effects with worker and firm characteristics at their averages in the one year period before the PBM implementation. The controls are the average age of employees in each sector and its square, share of male employees and the average number of employees per firm. These variables were selected based on the regression on table 3. Our main sample consists of a balanced panel of sector-month pairs and includes all firms in the standard tax regime and in low-concentration micro-regions from 219 sectors during the period $2009 - 2014$, as described in section 2.1. Heteroskedasticity-adjusted standard errors clustered at the sector level are reported in parentheses below the coefficients. Significantly different from zero at 99% (***), 95% (**) and 90% (*) confidence level.

Table 14: PBM implementation, average wage and high market concentration

	(1) log(hourly wage in contract) (among new hires)	(2) log(hourly wage in contract) (among new hires)	(3) log(hourly wage in contract) (among new hires)
-4 quarters	-0.058*	-0.034	-0.013
	(0.033)	(0.035)	(0.035)
-3 quarters	-0.040	-0.024	-0.004
	(0.032)	(0.034)	(0.037)
-2 quarters	-0.041	-0.019	-0.003
	(0.032)	(0.033)	(0.035)
0 (1st quarter of the tax relief)	-0.007	0.010	0.028
	(0.032)	(0.034)	(0.035)
+1 quarter	-0.024	0.002	0.023
	(0.036)	(0.037)	(0.039)
+2 quarters	-0.072*	-0.048	-0.035
	(0.038)	(0.040)	(0.041)
+3 quarters	-0.009	0.021	0.024
	(0.041)	(0.044)	(0.045)
+4 quarters	-0.029	0.003	0.014
	(0.039)	(0.042)	(0.043)
Constant	1.721***	1.714***	0.892
	(0.010)	(0.010)	(0.861)
Observations	14,867	14,867	14,783
R-squared	0.596	0.605	0.614
Sector FE	✓	✓	✓
Monthly FE	✓	-	-
Monthly FE x ISIC level 1 category	-	✓	✓
Monthly FE x Worker/firm char. before PBM	-	-	✓

Note: The table reports regression estimates associating the log of the hourly wage of new hires to the timing of PBM implementation as defined by specification (2). The dependent variable is sectoral average hourly wage in micro-regions associated with high levels (above median) of labor market concentration which is measured by a wage-bill HHI index, as discussed in section 4.4. Column (1) reports estimates that control for sector and month fixed effects. Column (2) interacts monthly fixed effects with category-specific (level 1 ISIC) dummies. Column (3) adds the interaction of monthly fixed-effects with worker and firm characteristics at their averages in the one year period before the PBM implementation. The controls are the average age of employees in each sector and its square, share of male employees and the average number of employees per firm. These variables were selected based on the regression on table 3. Our main sample consists of a balanced panel of sector-month pairs and includes all firms in the standard tax regime and in high-concentration micro-regions from 219 sectors during the period $2009 - 2014$, as described in section 2.1. Heteroskedasticity-adjusted standard errors clustered at the sector level are reported in parentheses below the coefficients. Significantly different from zero at 99% (***), 95% (**) and 90% (*) confidence level.

Table 15: PBM implementation and sectoral employment in small firms

	(1) log(sectoral employment)	(2) log(sectoral employment)	(3) log(sectoral employment)
-4 quarters	-0.007	0.001	0.020
	(0.012)	(0.015)	(0.014)
-3 quarters	0.004	0.009	0.021*
	(0.010)	(0.012)	(0.011)
-2 quarters	-0.002	0.002	0.008
	(0.008)	(0.009)	(0.009)
0 (1st quarter of the tax relief)	0.010*	0.008	0.001
	(0.006)	(0.007)	(0.007)
+1 quarter	0.025***	0.023**	0.018
	(0.009)	(0.011)	(0.011)
+2 quarters	0.028**	0.025*	0.018
	(0.012)	(0.015)	(0.015)
+3 quarters	0.044***	0.046**	0.034*
	(0.013)	(0.018)	(0.018)
+4 quarters	0.043**	0.053**	0.034
	(0.017)	(0.023)	(0.021)
Constant	8.365***	8.362***	6.774***
	(0.004)	(0.005)	(1.559)
Observations	15,264	15,264	15,264
R-squared	0.994	0.994	0.994
Sector FE	✓	✓	✓
Monthly FE	✓	-	-
Monthly FE x ISIC level 1 category	-	✓	✓
Monthly FE x Worker/firm char. before PBM	-	-	✓

Note: The table reports regression estimates associating the log of sectoral employment in small firms to the timing of PBM implementation as defined by specification (2). A small firm is defined as a firm with less employees than the average in its sector before the beginning of PBM. Column (1) reports estimates that control for sector and month fixed effects. Column (2) interacts monthly fixed effects with category-specific (level 1 ISIC) dummies. Column (3) adds the interaction of monthly fixed-effects with worker and firm characteristics at their averages in the one year period before the PBM implementation. The controls are the average age of employees in each sector and its square, share of male employees and the average number of employees per firm. These variables were selected based on the regression on table 3. Our main sample consists of a balanced panel of sector-month pairs and includes all small firms in the standard tax regime from 219 sectors during the period $2009 - 2014$, as described in section 2.1. Heteroskedasticity-adjusted standard errors clustered at the sector level are reported in parentheses below the coefficients. Significantly different from zero at 99% (***), 95% (**) and 90% (*) confidence level.

Table 16: PBM implementation and sectoral employment in large firms

	(1) log(sectoral employment)	(2) log(sectoral employment)	(3) log(sectoral employment)
-4 quarters	-0.005	-0.014	-0.022
	(0.018)	(0.018)	(0.020)
-3 quarters	-0.019	-0.021	-0.023
	(0.013)	(0.013)	(0.014)
-2 quarters	-0.015	-0.014	-0.017
	(0.009)	(0.010)	(0.011)
0 (1st quarter of the tax relief)	0.017*	0.008	0.015
	(0.009)	(0.009)	(0.010)
+1 quarter	0.017	0.013	0.024*
	(0.014)	(0.013)	(0.014)
+2 quarters	0.046***	0.044***	0.045**
	(0.017)	(0.017)	(0.018)
+3 quarters	0.050***	0.049**	0.049**
	(0.018)	(0.020)	(0.022)
+4 quarters	0.050**	0.061**	0.066**
	(0.021)	(0.025)	(0.026)
Constant	9.526***	9.527***	9.256***
	(0.006)	(0.007)	(1.150)
Observations	15,624	15,624	15,624
R-squared	0.988	0.989	0.989
Sector FE	✓	✓	✓
Monthly FE	✓	-	-
Monthly FE x ISIC level 1 category	-	✓	✓
Monthly FE x Worker/firm char. before PBM	-	-	✓

Note: The table reports regression estimates associating the log of sectoral employment of large firms to the timing of PBM implementation as defined by specification (2). A large firm is defined as a firm with at least as many employees as the average in its sector before the beginning of PBM. Column (1) reports estimates that control for sector and month fixed effects. Column (2) interacts monthly fixed effects with category-specific (level 1 ISIC) dummies. Column (3) adds the interaction of monthly fixed-effects with worker and firm characteristics at their averages in the one year period before the PBM implementation. The controls are the average age of employees in each sector and its square, share of male employees and the average number of employees per firm. These variables were selected based on the regression on table 3. Our main sample consists of a balanced panel of sector-month pairs and includes all large firms in the standard tax regime from 219 sectors during the period $2009 - 2014$, as described in section 2.1. Heteroskedasticity-adjusted standard errors clustered at the sector level are reported in parentheses below the coefficients. Significantly different from zero at 99% (***), 95% (**) and 90% (*) confidence level.

Table 17: PBM implementation and sectoral employment according to education level

	(1) Incomplete HS log(sectoral employment)	(2) Incomplete HS log(sectoral employment)	(3) Incomplete HS log(sectoral employment)	(4) Complete HS log(sectoral employment)	(5) Complete HS log(sectoral employment)	(6) Complete HS log(sectoral employment)
-4 quarters	-0.026	-0.029	-0.022	-0.011	-0.003	-0.009
	(0.023)	(0.025)	(0.025)	(0.015)	(0.016)	(0.018)
-3 quarters	-0.031*	-0.025	-0.021	-0.016	-0.008	-0.009
	(0.018)	(0.018)	(0.019)	(0.010)	(0.011)	(0.013)
-2 quarters	-0.023**	-0.010	-0.013	-0.010	-0.004	-0.007
	(0.011)	(0.011)	(0.013)	(0.007)	(0.008)	(0.009)
0 (1st quarter of the tax relief)	0.006	0.013	-0.005	0.014*	0.007	0.012
	(0.023)	(0.027)	(0.027)	(0.008)	(0.008)	(0.008)
+1 quarter	0.015	0.022	0.000	0.017	0.008	0.018
	(0.026)	(0.031)	(0.031)	(0.012)	(0.012)	(0.013)
+2 quarters	0.039	0.044	0.011	0.041***	0.033**	0.037**
	(0.029)	(0.035)	(0.035)	(0.014)	(0.015)	(0.017)
+3 quarters	0.043	0.047	0.015	0.050***	0.043**	0.050**
	(0.031)	(0.038)	(0.037)	(0.016)	(0.019)	(0.021)
+4 quarters	0.044	0.061	0.043	0.047**	0.052**	0.061**
	(0.028)	(0.040)	(0.035)	(0.019)	(0.024)	(0.026)
Constant	8.349***	8.348***	8.814***	9.348***	9.341***	10.741***
	(0.007)	(0.008)	(0.827)	(0.005)	(0.006)	(1.592)
Observations	15,768	15,768	15,768	15,768	15,768	15,768
R-squared	0.987	0.988	0.989	0.990	0.991	0.991
Sector FE	✓	✓	✓	✓	✓	✓
Monthly FE	✓	-	-	✓	-	-
Monthly FE x ISIC level 1 category	-	✓	✓	-	✓	✓
Monthly FE x Worker/firm char. before PBM	-	-	✓	-	-	✓

Note: The table reports regression estimates associating the log of sectoral employment according to educational level to the timing of PBM implementation as defined by specification (2). Different estimates are presented for employees without a high school diploma (columns (1)-(3)), and employees with at least a high school (columns (4)-(6)). Columns (1) and (4) report estimates that control for sector and month fixed effects. Columns (2) and (5) interact monthly fixed effects with category-specific (level 1 ISIC) dummies. Columns (3) and (6) add the interaction of monthly fixed-effects with worker and firm characteristics at their averages in the one year period before the PBM implementation. The controls are the average age of employees in each sector and its square, share of male employees and the average number of employees per firm. These variables were selected based on the regression on table 3. Our main sample consists of a balanced panel of sector-month pairs and includes all firms in the standard tax regime from 219 sectors during the period 2009 − 2014, as described in section 2.1. Heteroskedasticity-adjusted standard errors clustered at the sector level are reported in parentheses below the coefficients. Significantly different from zero at 99% (***), 95% (**) and 90% (*) confidence level.

Table 18: PBM implementation and sectoral employment according to sector formality levels

	(1) log(sectoral employment)	(2) log(sectoral employment)	(3) log(sectoral employment)
-4 quarters (High Form.)	0.015	0.008	0.011
	(0.024)	(0.023)	(0.026)
-3 quarters (High Form.)	-0.004	0.001	0.006
	(0.018)	(0.017)	(0.019)
-2 quarters (High Form.)	-0.012	-0.005	-0.005
	(0.010)	(0.009)	(0.010)
0 (1st quarter of the tax relief) (High Form.)	0.013	0.011	0.010
	(0.009)	(0.008)	(0.009)
+1 quarter (High Form.)	0.020	0.023	0.027*
	(0.016)	(0.015)	(0.016)
+2 quarters (High Form.)	0.048**	0.054**	0.055**
	(0.022)	(0.022)	(0.023)
+3 quarters (High Form.)	0.054***	0.069***	0.067**
	(0.020)	(0.024)	(0.026)
+4 quarters (High Form.)	0.048**	0.082***	0.079***
	(0.022)	(0.028)	(0.030)
-4 quarters (Low Form.)	-0.019	-0.021	-0.027
	(0.016)	(0.019)	(0.021)
-3 quarters (Low Form.)	-0.019	-0.020	-0.022
	(0.013)	(0.014)	(0.016)
-2 quarters (Low Form.)	-0.010	-0.010	-0.012
	(0.011)	(0.013)	(0.014)
0 (1st quarter of the tax relief) (Low Form.)	0.018	0.005	0.010
	(0.012)	(0.012)	(0.011)
+1 quarter (Low Form.)	0.018	-0.001	0.004
	(0.016)	(0.017)	(0.017)
+2 quarters (Low Form.)	0.037**	0.018	0.013
	(0.017)	(0.020)	(0.022)
+3 quarters (Low Form.)	0.045**	0.024	0.018
	(0.020)	(0.023)	(0.025)
+4 quarters (Low Form.)	0.049*	0.036	0.037
	(0.025)	(0.030)	(0.031)
Constant	9.755***	9.754***	9.840***
	(0.005)	(0.006)	(1.313)
Observations	15,768	15,768	15,768
R-squared	0.991	0.991	0.991
Sector FE	✓	✓	✓
Monthly FE	✓	-	-
Monthly FE x ISIC level 1 category	-	✓	✓
Monthly FE x Worker/firm char. before PBM	-	-	✓

Note: The table reports regression estimates associating the log of sectoral employment to the timing of PBM implementation as defined by specification (2). Different estimates are presented for sectors below and above the median level of formality (defined as the percentage of total employees working in a formal firm in that sector according to the 2010 Census). Column (1) reports estimates that control for sector and month fixed effects. Column (2) interacts monthly fixed effects with category-specific (level 1 ISIC) dummies. Column (3) adds the interaction of monthly fixed-effects with worker and firm characteristics at their averages in the one year period before the PBM implementation. The controls are the average age of employees in each sector and its square, share of male employees and the average number of employees per firm. These variables were selected based on the regression on table 3. Our main sample consists of a balanced panel of sector-month pairs and includes all large firms in the standard tax regime from 219 sectors during the period $2009 - 2014$, as described in section 2.1. Heteroskedasticity-adjusted standard errors clustered at the sector level are reported in parentheses below the coefficients. Significantly different from zero at 99% (***), 95% (**) and 90% (*) confidence level.

Payroll Tax, Employment and Labor Market Concentration

Erick Baumgartner, Raphael Corbi and Renata Narita

ONLINE APPENDIX

A   Supplementary Tables

Table A.1: Tax burden before and after PBM implementation

Description	ISIC	PBM Tax Rate	Tax Burden* Before	After	$\frac{\text{After}}{\text{Before}}$
Construction of buildings	4120	2%	3583,9	1886,3	52,6%
Construction of roads, railways, urban works and special works of art	421	2%	1358,7	2228,1	61,0%
Infrastructure works for electricity, telecommunications, water, sewage and pipeline transportation	422	2%	364,1	874,0	41,7%
Construction of other infrastructure works	429	2%	914,4	1537,8	59,5%
Demolition and site preparation art	431	2%	195,2	350,5	55,7%
Electrical Installations	4321	2%	469,4	176,3	37,5%
Installation of hydraulic, ventilation and cooling systems	4322	2%	170,7	88,2	51,7%
Installation work in constructions not cited previously	4329	2%	284,0	136,0	47,9%
Finish work	4330	2%	215,2	95,6	44,4%
Foundation work in construction	4391	2%	118,8	57,9	48,7%
Specialized services in construction not cited previously	4399	2%	377,5	169,9	45,0%
Retail trade of general merchandise without predominance of food products	4713	1%	504,9	352,3	69,8%
Retail trade of hardware, wood and construction materials	4744	1%	1173,3	815,2	69,5%
Specialized retail trade of computer equipment and supplies	4751	1%	208,9	109,8	52,6%
Specialized retail trade of telephony and communication equipment	4752	1%	83,8	38,7	46,2%
Specialized retail trade of household appliances and audio and video equipment	4753	1%	839,2	602,0	71,7%
Specialized retail trade of furniture, bedding and lighting articles	4754	1%	340,4	182,9	53,7%
Specialized retail trade of textiles and bedding, bath and table	4755	1%	73,5	42,4	57,6%
Retail trade of household articles not previously specified	4759	1%	61,5	43,5	70,6%
Retail sale of books, newspapers, magazines and stationery	4761	1%	130,2	74,4	57,2%
Retail trade of discs, CDs, DVDs and tapes	4762	1%	5,1	5,3	102,0%
Retail trade of recreational and sporting goods	4763	1%	244,3	179,2	73,3%
Retail trade of pharmaceutical products for human and veterinary use	4771	1%	642,3	361,1	56,2%
Retail trade of cosmetics, perfumery and personal hygiene products	4772	1%	140,7	93,9	66,7%
Retail trade of clothes and accessories	4781	1%	719,4	376,6	52,4%
Footwear and travel goods retail trade	4782	1%	250,2	116,5	46,6%
Retail trade of other new products not previously specified	4789	1%	43,9	40,4	92,0%
Freight rail transport	4911	1%	168,6	117,4	69,6%
Railway passenger transport	4912	2%	418,8	96,8	23,1%
Collective transportation of road passengers with a fixed route in municipal and metropolitan regions	4921	2%	1857,7	640,2	34,5%

Note: This table compares the contribution schemes of the treated sectors in our sample before and after the implementation of PBM. "ISIC" denotes the 4-digit sector code according the Brazilian classification system (CNAE). Some sectors are identified with higher granularity than others. This reflects the structure presented by ANFIP (2015) that provided the calculations. "PBM Tax Rate" shows whether the initial tax rate of the sector after its entry in the tax regime was either 1% or 2%. Columns "Before" and "After" show the tax burden that would be paid in the standard regime (before) and in PBM (after). Finally, $\frac{\text{After}}{\text{Before}}$ compares the contribution in PBM to the one that would be paid before. *Millions of BRL.

(Continued) Tax burden before and after PBM implementation

Description	ISIC	PBM Tax Rate	Tax Burden*		
			Before	After	$\frac{After}{Before}$
Collective transportation of road passengers with a fixed route across different municipalities, states and countries	4922	2%	553,9	263,1	47,5%
Road freight transport	4930	1%	2971,0	1390,2	46,8%
Cabotage shipping	5011	1%	149,1	103,1	69,2%
Long sea shipping	5012	1%	43,0	16,0	37,2%
Inland freight transportation	5021	1%	64,1	23,6	36,9%
Inland waterway passenger transportation on scheduled lines	5022	1%	3,5	0,5	16,1%
Support Navigation	5030	1%	580,1	118,1	20,4%
Regular passenger air transportation	5111	1%	703,4	286,5	40,7%
Air cargo transportation	5120	1%	28,8	18,3	63,6%
Loading and unloading	5212	1%	110,8	35,6	32,2%
Port and terminal management	5231	1%	307,7	127,3	41,4%
Book publishing	5811	1%	141,4	54,0	38,2%
Newspaper publishing	5812	1%	84,5	19,6	23,2%
Magazine edition	5813	1%	28,5	12,1	42,7%
Integrated edition and printing of newspapers	5822	1%	224,2	44,6	19,9%
Radio activities	6010	1%	96,6	22,5	23,3%
Open television activities	6021	1%	719,2	215,1	29,9%
Development of custom computer programs	6201	2%	1000,8	377,7	37,7%
Development and licensing of customizable computer programs	6202	2%	244,1	101,1	41,4%
Development and licensing of non-customizable computer programs	6203	2%	382,0	154,6	40,5%
Consulting in information technology	6204	2%	864,0	364,8	42,2%
Technical support, maintenance and other information technology services	6209	2%	511,4	279,8	54,7%
Data processing, application service providers and web hosting services	6311	2%	414,7	174,5	42,1%
Portals, content providers and other internet information services	6319	1%	130,6	61,5	47,1%
Call center activities	8220	2%	1104,5	290,9	26,3%

Note: This table compares the contribution schemes of the treated sectors in our sample before and after the implementation of PBM. "ISIC" denotes the 4-digit sector code according the Brazilian classification system (CNAE). Some sectors are identified with higher granularity than others. This reflects the structure presented by ANFIP (2015) that provided the calculations. "PBM Tax Rate" shows whether the initial tax rate of the sector after its entry in the tax regime was either 1% or 2%. Columns "Before" and "After" show the tax burden that would be paid in the standard regime (before) and in PBM (after). Finally, $\frac{After}{Before}$ compares the contribution in PBM to the one that would be paid before. *Millions of BRL.

Table A.2: Legislative acts and the implementation of the PBM tax reform

Act	Law	Date	Sectors
MP 540	12.546	Dec 2011	**Service sector** (*call centers* and IT companies) **Manufacturing** (clothing and leather artifacts)
MP 563	12.715	Sept 2012	**Service sector** (*design houses* and hotels) **Manufacturing** (furniture, plastic, textiles, electric material, among others)
PLV 18	12.715	Sept 2012	**Manufacturing** (toys, medications and pharmaceutical drugs, ornamental stones, among others) **Transportation** (air, road and sea)
MP 582	12.794	April 2013	**Industry** (glass, metallic construction, railway equipment, paper and cellulose, among others)
MP 610	12.844	July 2013	**Service sector** (technical support in IT) **Construction** (construction industry) **Manufacturing** (rubber, copper, maintenance and repair of vessels, among others) and **Retail** **Transportation** (road cargo, subway, among others)

Note: List of all legislative acts and associated regulating laws with the date of implementation of the PBM tax reform.

B Sectors included by product-based (NCM) criterion

In this section, we replicate our event-study analysis to sectors included in the PBM tax reform by the NCM criterion, based on products instead of sector ISIC codes. This criterion affected mainly firms in Agriculture, Mining and Manufacturing, as reported in Table 1.

Figure B.1 depicts the number of 4-digit sectors (included by the NCM criterion) and their respective employment share affected by the introduction of the PBM tax reform between 2009 and 2015.

Tables B.1 and B.2 replicate estimates reported in Tables 4 and 5 for the NCM criterion. The estimated effects are small and statistically indistinguishable from zero across all specifications.

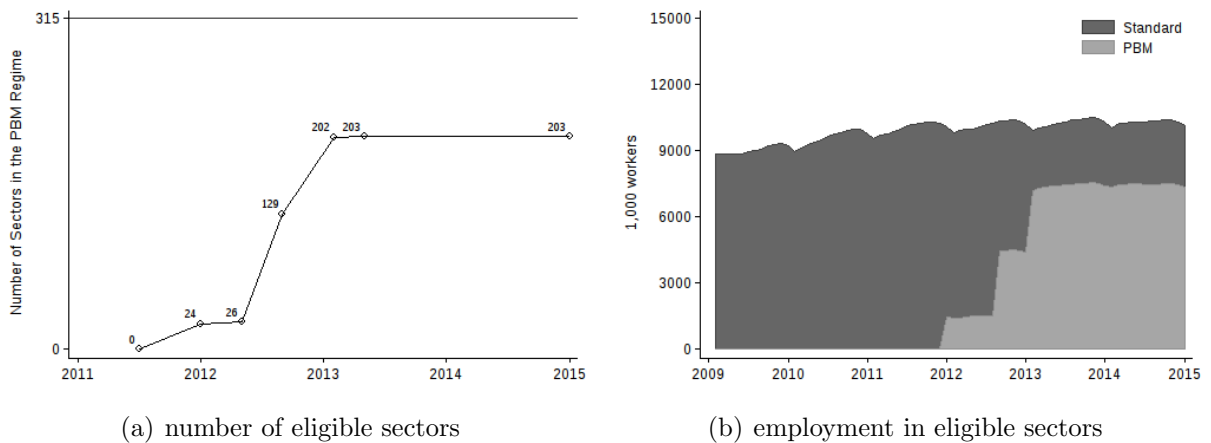Figure B.1: Staggered Rollout of PBM Tax Reform (NCM criterion)

(a) number of eligible sectors

(b) employment in eligible sectors

Table B.1: PBM implementation and employment for product-based (NCM) eligible sectors

	(1) log(sectoral employment)	(2) log(sectoral employment)	(3) log(sectoral employment)
-4 quarters	0.011	0.001	0.003
	(0.010)	(0.010)	(0.010)
-3 quarters	0.012*	0.002	0.001
	(0.007)	(0.007)	(0.008)
-2 quarters	0.008**	0.000	-0.002
	(0.003)	(0.003)	(0.004)
0 (1st quarter of the tax relief)	-0.009	-0.001	-0.001
	(0.006)	(0.006)	(0.006)
+1 quarter	-0.009	0.001	-0.003
	(0.008)	(0.008)	(0.008)
+2 quarters	-0.010	0.006	-0.001
	(0.011)	(0.010)	(0.011)
+3 quarters	-0.009	0.013	0.007
	(0.013)	(0.012)	(0.013)
+4 quarters	-0.011	0.016	0.010
	(0.015)	(0.014)	(0.014)
Constant	9.345***	9.346***	11.890***
	(0.005)	(0.005)	(2.380)
Observations	22,392	22,392	22,392
R-squared	0.989	0.990	0.991
Sector FE	✓	✓	✓
Monthly FE	✓	-	-
Monthly FE x ISIC level 1 category	-	✓	✓
Monthly FE x Worker/firm char. before PBM	-	-	✓

Note: The table reports regression estimates associating the log of sectoral employment to the timing of PBM implementation as defined by specification (2). Column (1) reports estimates that control for sector and month fixed effects. Column (2) interacts monthly fixed effects with category-specific (level 1 ISIC) dummies. Column (3) adds the interaction of monthly fixed-effects with worker and firm characteristics at their averages in the one year period before the PBM implementation. The controls are the average age of employees in each sector and its square, share of male employees and the average number of employees per firm. These variables were selected based on the regression on table 3. Our NCM sample consists of a balanced panel of sector-month pairs and includes all firms in the standard tax regime from 523 sectors during the period $2009 - 2014$, as described in section 2.1. Heteroskedasticity-adjusted standard errors clustered at the sector level are reported in parentheses below the coefficients. Significantly different from zero at 99% (***), 95% (**) and 90% (*) confidence level.

Table B.2: PBM implementation and employment for product-based (NCM) eligible sectors according to treatment intensity

	(1) log(sectoral employment)	(2) log(sectoral employment)	(3) log(sectoral employment)
-4 quarters (High int.)	0.005	-0.002	0.001
	(0.012)	(0.012)	(0.012)
-3 quarters (High int.)	0.008	0.000	-0.002
	(0.008)	(0.008)	(0.010)
-2 quarters (High int.)	0.010***	0.001	-0.004
	(0.004)	(0.004)	(0.005)
0 (1st quarter of the tax relief (High int.)	-0.006	0.002	0.004
	(0.006)	(0.007)	(0.007)
+1 quarter (High int.)	-0.007	0.002	-0.001
	(0.009)	(0.010)	(0.011)
+2 quarters (High int.)	-0.011	0.002	-0.005
	(0.015)	(0.015)	(0.016)
+3 quarters (High int.)	-0.013	0.008	0.003
	(0.017)	(0.016)	(0.017)
+4 quarters (High int.)	-0.017	0.013	0.009
	(0.019)	(0.018)	(0.019)
-4 quarters (Low int.)	0.017	0.004	0.004
	(0.011)	(0.011)	(0.011)
-3 quarters (Low int.)	0.016**	0.005	0.004
	(0.008)	(0.008)	(0.008)
-2 quarters (Low int.)	0.006*	-0.000	-0.000
	(0.003)	(0.004)	(0.004)
0 (1st quarter of the tax relief (Low int.)	-0.013	-0.005	-0.007
	(0.008)	(0.008)	(0.008)
+1 quarter (Low int.)	-0.012	-0.000	-0.006
	(0.010)	(0.009)	(0.010)
+2 quarters (Low int.)	-0.008	0.010	0.002
	(0.012)	(0.011)	(0.012)
+3 quarters (Low int.)	-0.006	0.018	0.009
	(0.014)	(0.013)	(0.013)
+4 quarters (Low int.)	-0.005	0.020	0.009
	(0.016)	(0.015)	(0.015)
Constant	9.345***	9.346***	11.891***
	(0.005)	(0.005)	(2.389)
Observations	22,392	22,392	22,392
R-squared	0.989	0.990	0.991
Sector FE	✓	✓	✓
Monthly FE	✓	-	-
Monthly FE x ISIC level 1 category	-	✓	✓
Monthly FE x Worker/firm char. before PBM	-	-	✓

Note: The table reports regression estimates associating the log of sectoral employment to the timing of PBM implementation as defined by specification (2), allowing effects to differ according to high/low intensity (above/below median) in the reduction of the payroll tax burden due to PBM (see Table A.1 for the average reduction by sector). Column (1) reports estimates that control for sector and month fixed effects. Column (2) interacts monthly fixed effects with category-specific (level 1 ISIC) dummies. Column (3) adds the interaction of monthly fixed-effects with worker and firm characteristics at their averages in the one year period before the PBM implementation. The controls are the average age of employees in each sector and its square, share of male employees and the average number of employees per firm. These variables were selected based on the regression on table 3. Our NCM sample consists of a balanced panel of sector-month pairs and includes all firms in the standard tax regime from 523 sectors during the period $2009 - 2014$, as described in section 2.1. Heteroskedasticity-adjusted standard errors clustered at the sector level are reported in parentheses below the coefficients. Significantly different from zero at 99% (***), 95% (**) and 90% (*) confidence level.

C Evidence for all tax regimes

Table C.1: PBM implementation and sectoral employment - all tax regimes

	(1) log(sectoral employment)	(2) log(sectoral employment)	(3) log(sectoral employment)
-4 quarters	0.005	-0.003	-0.004
	(0.013)	(0.013)	(0.015)
-3 quarters	-0.004	-0.007	-0.006
	(0.010)	(0.009)	(0.010)
-2 quarters	-0.007	-0.007	-0.007
	(0.006)	(0.006)	(0.006)
0 (1st quarter of the tax relief)	0.016**	0.008	0.011
	(0.008)	(0.007)	(0.007)
+1 quarter	0.022*	0.013	0.019*
	(0.011)	(0.010)	(0.011)
+2 quarters	0.041***	0.031**	0.035**
	(0.014)	(0.013)	(0.015)
+3 quarters	0.040***	0.029*	0.031*
	(0.015)	(0.017)	(0.019)
+4 quarters	0.036**	0.034	0.042*
	(0.018)	(0.021)	(0.023)
Constant	10.234***	10.232***	11.089***
	(0.004)	(0.005)	(1.545)
Observations	15,768	15,768	15,768
R-squared	0.993	0.993	0.993
Sector FE	✓	✓	✓
Monthly FE	✓	-	-
Monthly FE x ISIC level 1 category	-	✓	✓
Monthly FE x Worker/firm char. before PBM	-	-	✓

Note: The table reports regression estimates associating the log of sectoral employment to the timing of PBM implementation as defined by specification (2). Column (1) reports estimates that control for sector and month fixed effects. Column (2) interacts monthly fixed effects with category-specific (level 1 ISIC) dummies. Column (3) adds the interaction of monthly fixed-effects with worker and firm characteristics at their averages in the one year period before the PBM implementation. The controls are the average age of employees in each sector and its square, share of male employees and the average number of employees per firm. These variables were selected based on the regression on table 3. Our main sample consists of a balanced panel of sector-month pairs and includes all firms in both standard and SIMPLES tax regime from 219 sectors during the period $2009 - 2014$, as described in section 2.1. Heteroskedasticity-adjusted standard errors clustered at the sector level are reported in parentheses below the coefficients. Significantly different from zero at 99% (***), 95% (**) and 90% (*) confidence level.

Table C.2: PBM implementation and sectoral employment according to treatment intensity
- all tax regimes

	(1) log(sectoral employment)	(2) log(sectoral employment)	(3) log(sectoral employment)
-4 quarters (High int.)	0.018	0.002	0.005
	(0.021)	(0.022)	(0.022)
-3 quarters (High int.)	0.012	0.000	0.004
	(0.014)	(0.016)	(0.016)
-2 quarters (High int.)	0.006	0.000	0.002
	(0.005)	(0.007)	(0.007)
0 (1st quarter of the tax relief (High int.)	0.024*	0.016	0.018
	(0.013)	(0.013)	(0.013)
+1 quarter (High int.)	0.032*	0.025	0.031*
	(0.017)	(0.017)	(0.017)
+2 quarters (High int.)	0.051***	0.048**	0.053**
	(0.020)	(0.021)	(0.023)
+3 quarters (High int.)	0.057**	0.056**	0.059**
	(0.022)	(0.025)	(0.027)
+4 quarters (High int.)	0.058**	0.065**	0.074**
	(0.025)	(0.028)	(0.030)
-4 quarters (Low int.)	-0.010	-0.009	-0.015
	(0.014)	(0.017)	(0.018)
-3 quarters (Low int.)	-0.021*	-0.016	-0.021
	(0.012)	(0.013)	(0.014)
-2 quarters (Low int.)	-0.019*	-0.015*	-0.018*
	(0.010)	(0.009)	(0.009)
0 (1st quarter of the tax relief (Low int.)	0.009	-0.001	0.006
	(0.007)	(0.004)	(0.005)
+1 quarter (Low int.)	0.013	-0.000	0.010
	(0.013)	(0.008)	(0.010)
+2 quarters (Low int.)	0.032*	0.012	0.020
	(0.017)	(0.012)	(0.014)
+3 quarters (Low int.)	0.022	-0.000	0.006
	(0.014)	(0.014)	(0.017)
+4 quarters (Low int.)	0.011	-0.004	0.009
	(0.017)	(0.018)	(0.020)
Constant	10.234***	10.232***	11.094***
	(0.004)	(0.005)	(1.550)
Observations	15,768	15,768	15,768
R-squared	0.993	0.993	0.993
Sector FE	✓	✓	✓
Monthly FE	✓	-	-
Monthly FE x ISIC level 1 category	-	✓	✓
Monthly FE x Worker/firm char. before PBM	-	-	✓

Note: The table reports regression estimates associating the log of sectoral employment to the timing of PBM implementation as defined by specification (2), allowing effects to differ according to high/low intensity (above/below median) in the reduction of the payroll tax burden due to PBM (see Table A.1 for the average reduction by sector). Column (1) reports estimates that control for sector and month fixed effects. Column (2) interacts monthly fixed effects with category-specific (level 1 ISIC) dummies. Column (3) adds the interaction of monthly fixed-effects with worker and firm characteristics at their averages in the one year period before the PBM implementation. The controls are the average age of employees in each sector and its square, share of male employees and the average number of employees per firm. These variables were selected based on the regression on table 3. Our main sample consists of a balanced panel of sector-month pairs and includes all firms in both standard and SIMPLES tax regime from 219 sectors during the period 2009 − 2014, as described in section 2.1. Heteroskedasticity-adjusted standard errors clustered at the sector level are reported in parentheses below the coefficients. Significantly different from zero at 99% (***), 95% (**) and 90% (*) confidence level.

Table C.3: PBM implementation and sectoral employment according to education level - all tax regimes

	(1) Incomplete HS log(sectoral employment)	(2) Incomplete HS log(sectoral employment)	(3) Incomplete HS log(sectoral employment)	(4) Complete HS log(sectoral employment)	(5) Complete HS log(sectoral employment)	(6) Complete HS log(sectoral employment)
-4 quarters	-0.014	-0.017	-0.012	-0.002	-0.001	-0.009
	(0.020)	(0.021)	(0.021)	(0.013)	(0.014)	(0.015)
-3 quarters	-0.018	-0.014	-0.011	-0.009	-0.006	-0.009
	(0.016)	(0.015)	(0.017)	(0.009)	(0.009)	(0.010)
-2 quarters	-0.015*	-0.005	-0.005	-0.006	-0.004	-0.007
	(0.009)	(0.008)	(0.010)	(0.005)	(0.005)	(0.006)
0 (1st quarter of the tax relief)	0.004	0.010	-0.007	0.014*	0.005	0.010
	(0.022)	(0.026)	(0.025)	(0.008)	(0.007)	(0.007)
+1 quarter	0.011	0.016	-0.003	0.020*	0.009	0.019*
	(0.025)	(0.029)	(0.029)	(0.011)	(0.011)	(0.011)
+2 quarters	0.030	0.031	0.006	0.041***	0.029**	0.038**
	(0.027)	(0.033)	(0.033)	(0.014)	(0.013)	(0.015)
+3 quarters	0.030	0.026	0.004	0.041***	0.027	0.037**
	(0.029)	(0.035)	(0.035)	(0.015)	(0.017)	(0.018)
+4 quarters	0.024	0.028	0.023	0.036**	0.031	0.046**
	(0.025)	(0.036)	(0.032)	(0.018)	(0.021)	(0.023)
Constant	8.911***	8.907***	9.569***	9.808***	9.801***	11.454***
	(0.006)	(0.007)	(1.044)	(0.005)	(0.005)	(1.756)
Observations	15,768	15,768	15,768	15,768	15,768	15,768
R-squared	0.990	0.991	0.991	0.991	0.992	0.993
Sector FE	✓	✓	✓	✓	✓	✓
Monthly FE	✓	-	-	✓	-	-
Monthly FE x ISIC level 1 category	-	✓	✓	-	✓	✓
Monthly FE x Worker/firm char. before PBM	-	-	✓	-	-	✓

Note: The table reports regression estimates associating the log of sectoral employment according to educational level to the timing of PBM implementation as defined by specification (2). Different estimates are presented for employees without a high school diploma (columns (1)-(3)), and employees with at least a high school (columns (4)-(6)). Columns (1) and (4) report estimates that control for sector and month fixed effects. Columns (2) and (5) interact monthly fixed effects with category-specific (level 1 ISIC) dummies. Columns (3) and (6) add the interaction of monthly fixed-effects with worker and firm characteristics at their averages in the one year period before the PBM implementation. The controls are the average age of employees in each sector and its square, share of male employees and the average number of employees per firm. These variables were selected based on the regression on table 3. Our main sample consists of a balanced panel of sector-month pairs and includes all firms in both standard and SIMPLES tax regime from 219 sectors during the period 2009 − 2014, as described in section 2.1. Heteroskedasticity-adjusted standard errors clustered at the sector level are reported in parentheses below the coefficients. Significantly different from zero at 99% (***), 95% (**) and 90% (*) confidence level.

Table C.4: PBM implementation and the number of firms - all tax regimes

	(1) log(number of firms)	(2) log(number of firms)	(3) log(number of firms)
-4 quarters	-0.002	0.002	0.003
	(0.009)	(0.011)	(0.011)
-3 quarters	0.000	0.002	0.003
	(0.006)	(0.007)	(0.007)
-2 quarters	-0.001	0.001	0.003
	(0.003)	(0.004)	(0.004)
0 (1st quarter of the tax relief)	0.006	0.001	0.004
	(0.004)	(0.005)	(0.005)
+1 quarter	0.013*	0.006	0.013*
	(0.007)	(0.007)	(0.008)
+2 quarters	0.020**	0.012	0.021**
	(0.009)	(0.009)	(0.010)
+3 quarters	0.021*	0.011	0.020
	(0.011)	(0.012)	(0.013)
+4 quarters	0.022*	0.013	0.020
	(0.013)	(0.015)	(0.016)
Constant	7.606***	7.602***	7.436***
	(0.004)	(0.004)	(0.339)
Observations	15,768	15,768	15,768
R-squared	0.996	0.996	0.527
Sector FE	✓	✓	✓
Monthly FE	✓	-	-
Monthly FE x ISIC level 1 category	-	✓	✓
Monthly FE x Worker/firm char. before PBM	-	-	✓

Note: The table reports regression estimates associating the log of the number of active firms in each sector to the timing of PBM implementation as defined by specification (2). Column (1) reports estimates that control for sector and month fixed effects. Column (2) interacts monthly fixed effects with category-specific (level 1 ISIC) dummies. Column (3) adds the interaction of monthly fixed-effects with worker and firm characteristics at their averages in the one year period before the PBM implementation. The controls are the average age of employees in each sector and its square, share of male employees and the average number of employees per firm. These variables were selected based on the regression on table 3. Our main sample consists of a balanced panel of sector-month pairs and includes all firms in both standard and SIMPLES tax regime from 219 sectors during the period $2009 - 2014$, as described in section 2.1. Heteroskedasticity-adjusted standard errors clustered at the sector level are reported in parentheses below the coefficients. Significantly different from zero at 99% (***), 95% (**) and 90% (*) confidence level.

Table C.5: PBM implementation and firm size - all tax regimes

	(1) log(avg employees per firm)	(2) log(avg employees per firm)	(3) log(avg employees per firm)
-4 quarters	0.007	-0.005	-0.003
	(0.013)	(0.011)	(0.013)
-3 quarters	-0.004	-0.009	-0.008
	(0.009)	(0.008)	(0.009)
-2 quarters	-0.006	-0.008	-0.009
	(0.006)	(0.006)	(0.006)
0 (1st quarter of the tax relief)	0.010*	0.007	0.007
	(0.006)	(0.006)	(0.006)
+1 quarter	0.009	0.007	0.007
	(0.009)	(0.008)	(0.009)
+2 quarters	0.021*	0.019*	0.016
	(0.012)	(0.011)	(0.012)
+3 quarters	0.019*	0.018	0.012
	(0.012)	(0.013)	(0.015)
+4 quarters	0.014	0.021	0.018
	(0.012)	(0.014)	(0.016)
Constant	2.628***	2.630***	2.368**
	(0.004)	(0.004)	(1.059)
Observations	15,768	15,768	15,768
R-squared	0.990	0.990	0.991
Sector FE	✓	✓	✓
Monthly FE	✓	-	-
Monthly FE x ISIC level 1 category	-	✓	✓
Monthly FE x Worker/firm char. before PBM	-	-	✓

Note: The table reports regression estimates associating the log of the sectoral average number of employees per firm to the timing of PBM implementation as defined by specification (2). Column (1) reports estimates that control for sector and month fixed effects. Column (2) interacts monthly fixed effects with category-specific (level 1 ISIC) dummies. Column (3) adds the interaction of monthly fixed-effects with worker and firm characteristics at their averages in the one year period before the PBM implementation. The controls are the average age of employees in each sector and its square, share of male employees and the average number of employees per firm. These variables were selected based on the regression on table 3. Our main sample consists of a balanced panel of sector-month pairs and includes all firms in both standard and SIMPLES tax regime from 219 sectors during the period $2009 - 2014$, as described in section 2.1. Heteroskedasticity-adjusted standard errors clustered at the sector level are reported in parentheses below the coefficients. Significantly different from zero at 99% (***), 95% (**) and 90% (*) confidence level.

D Labor Market Concentration (employment HHI) and the effects of Payroll Taxation

Now we replicate our analysis introduced in Section 4.4 that explored how the effects of a reduction in labor costs vary across markets with different levels of labor market concentration, but using a Herfindahl-Hirschman Index (HHI) based on employment (instead of wage-bill) as a measure of labor market concentration.

Figure D.1 shows the geographical distribution of the 558 micro-regions according to above/below median (employment-based) labor market concentration. Similarly, Figure D.2 replicates Figure 10 and Tables D.1-D.4 replicate results from Tables 11-14.

Figure D.1: Geographical distribution of labor market concentration - employment HHI

Note: For each of the 558 geographic micro-regions of Brazil, we measure labor market concentration as the employment Herfindahl-Hirschman Index (*HHI*). High (low) concentration is defined by a *HHI* index above (below) our sample median of 0.008.

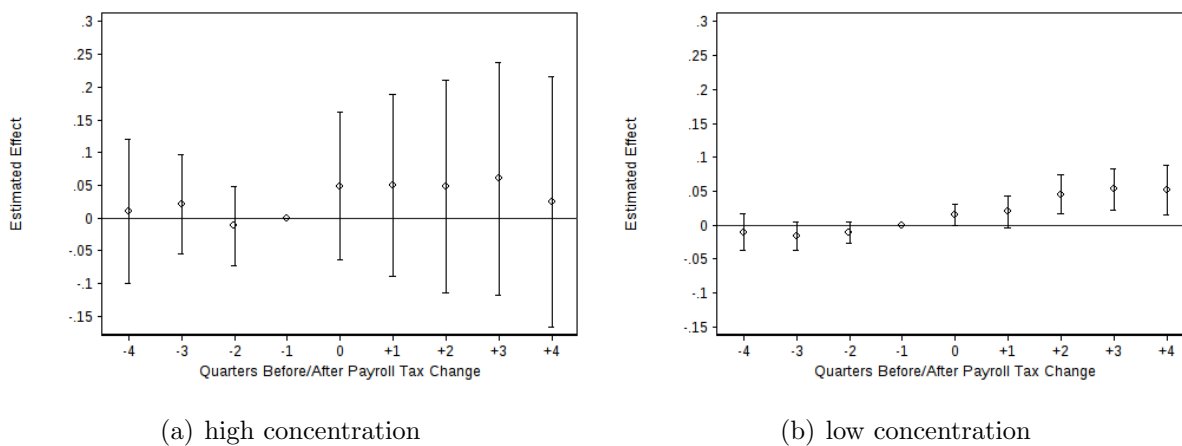Figure D.2: PBM tax reform and employment according to employment HHI

(a) high concentration

(b) low concentration

Table D.1: PBM implementation, employment and low employment HHI

	(1) log(sectoral employment)	(2) log(sectoral employment)	(3) log(sectoral employment)
-4 quarters	-0.010	-0.007	-0.009
	(0.014)	(0.016)	(0.017)
-3 quarters	-0.016	-0.010	-0.009
	(0.011)	(0.011)	(0.012)
-2 quarters	-0.011	-0.005	-0.007
	(0.008)	(0.008)	(0.009)
0 (1st quarter of the tax relief)	0.015*	0.010	0.013
	(0.008)	(0.008)	(0.008)
+1 quarter	0.020	0.013	0.018
	(0.012)	(0.012)	(0.013)
+2 quarters	0.045***	0.038**	0.038**
	(0.015)	(0.015)	(0.017)
+3 quarters	0.053***	0.048**	0.044**
	(0.016)	(0.019)	(0.021)
+4 quarters	0.052***	0.058**	0.057**
	(0.019)	(0.024)	(0.025)
Constant	9.686***	9.684***	9.855***
	(0.005)	(0.006)	(1.277)
Observations	15,768	15,768	15,768
R-squared	0.990	0.991	0.991
Sector FE	✓	✓	✓
Monthly FE	✓	-	-
Monthly FE x ISIC level 1 category	-	✓	✓
Monthly FE x Worker/firm char. before PBM	-	-	✓

Note: The table reports regression estimates associating the log of sectoral employment to the timing of PBM implementation as defined by specification (2). The dependent variable is sectoral employment in micro-regions associated with low levels (below median) of labor market concentration which is measured by an employment-based HHI index, as discussed in section 4.4. Column (1) reports estimates that control for sector and month fixed effects. Column (2) interacts monthly fixed effects with category-specific (level 1 ISIC) dummies. Column (3) adds the interaction of monthly fixed-effects with worker and firm characteristics at their averages in the one year period before the PBM implementation. The controls are the average age of employees in each sector and its square, share of male employees and the average number of employees per firm. These variables were selected based on the regression on table 3. Our main sample consists of a balanced panel of sector-month pairs and includes all firms in the standard tax regime and in low-concentration micro-regions from 219 sectors during the period 2009 − 2014, as described in section 2.1. Heteroskedasticity-adjusted standard errors clustered at the sector level are reported in parentheses below the coefficients. Significantly different from zero at 99% (***), 95% (**) and 90% (*) confidence level.

Table D.2: PBM implementation, employment and high employment HHI

	(1) log(sectoral employment)	(2) log(sectoral employment)	(3) log(sectoral employment)
-4 quarters	0.010	-0.071	-0.021
	(0.055)	(0.062)	(0.049)
-3 quarters	0.021	-0.028	0.015
	(0.038)	(0.045)	(0.041)
-2 quarters	-0.012	-0.033	-0.008
	(0.031)	(0.041)	(0.049)
0 (1st quarter of the tax relief)	0.049	0.049	0.027
	(0.057)	(0.065)	(0.062)
+1 quarter	0.050	0.056	0.039
	(0.071)	(0.085)	(0.082)
+2 quarters	0.048	0.060	0.039
	(0.083)	(0.104)	(0.099)
+3 quarters	0.060	0.069	0.050
	(0.090)	(0.113)	(0.101)
+4 quarters	0.025	0.032	0.027
	(0.097)	(0.127)	(0.112)
Constant	6.613***	6.630***	6.900
	(0.017)	(0.018)	(4.902)
Observations	15,192	15,192	15,192
R-squared	0.963	0.965	0.966
Sector FE	✓	✓	✓
Monthly FE	✓	-	-
Monthly FE x ISIC level 1 category	-	✓	✓
Monthly FE x Worker/firm char. before PBM	-	-	✓

Note: The table reports regression estimates associating the log of sectoral employment to the timing of PBM implementation as defined by specification (2). The dependent variable is sectoral employment in micro-regions associated with high levels (above median) of labor market concentration which is measured by an employment-based HHI index, as discussed in section 4.4. Column (1) reports estimates that control for sector and month fixed effects. Column (2) interacts monthly fixed effects with category-specific (level 1 ISIC) dummies. Column (3) adds the interaction of monthly fixed-effects with worker and firm characteristics at their averages in the one year period before the PBM implementation. The controls are the average age of employees in each sector and its square, share of male employees and the average number of employees per firm. These variables were selected based on the regression on table 3. Our main sample consists of a balanced panel of sector-month pairs and includes all firms in the standard tax regime and in high-concentration micro-regions from 219 sectors during the period 2009 − 2014, as described in section 2.1. Heteroskedasticity-adjusted standard errors clustered at the sector level are reported in parentheses below the coefficients. Significantly different from zero at 99% (***), 95% (**) and 90% (*) confidence level.

Table D.3: PBM implementation, average wage and low employment HHI

	(1) log(hourly wage in contract) (among new hires)	(2) log(hourly wage in contract) (among new hires)	(3) log(hourly wage in contract) (among new hires)
-4 quarters	0.025	0.032	0.031
	(0.018)	(0.021)	(0.022)
-3 quarters	0.016	0.023	0.023
	(0.014)	(0.019)	(0.019)
-2 quarters	0.018	0.027*	0.029*
	(0.012)	(0.015)	(0.017)
0 (1st quarter of the tax relief)	0.018	0.016	0.008
	(0.018)	(0.022)	(0.021)
+1 quarter	0.034*	0.033	0.023
	(0.019)	(0.025)	(0.026)
+2 quarters	-0.005	0.003	0.006
	(0.017)	(0.021)	(0.021)
+3 quarters	0.004	0.001	-0.002
	(0.024)	(0.026)	(0.026)
+4 quarters	0.003	-0.005	-0.003
	(0.020)	(0.025)	(0.025)
Constant	1.985***	1.984***	4.168***
	(0.004)	(0.005)	(1.295)
Observations	15,768	15,768	15,768
R-squared	0.852	0.856	0.861
Sector FE	✓	✓	✓
Monthly FE	✓	-	-
Monthly FE x ISIC level 1 category	-	✓	✓
Monthly FE x Worker/firm char. before PBM	-	-	✓

Note: The table reports regression estimates associating the log of the hourly wage of new hires to the timing of PBM implementation as defined by specification (2). The dependent variable is sectoral hourly wage in micro-regions associated with low levels (below median) of labor market concentration which is measured by an employment-based HHI index, as discussed in section 4.4. Column (1) reports estimates that control for sector and month fixed effects. Column (2) interacts monthly fixed effects with category-specific (level 1 ISIC) dummies. Column (3) adds the interaction of monthly fixed-effects with worker and firm characteristics at their averages in the one year period before the PBM implementation. The controls are the average age of employees in each sector and its square, share of male employees and the average number of employees per firm. These variables were selected based on the regression on table 3. Our main sample consists of a balanced panel of sector-month pairs and includes all firms in the standard tax regime and in low-concentration micro-regions from 219 sectors during the period $2009-2014$, as described in section 2.1. Heteroskedasticity-adjusted standard errors clustered at the sector level are reported in parentheses below the coefficients. Significantly different from zero at 99% (***), 95% (**) and 90% (*) confidence level.

Table D.4: PBM implementation, average wage and high employment HHI

	(1) log(hourly wage in contract) (among new hires)	(2) log(hourly wage in contract) (among new hires)	(3) log(hourly wage in contract) (among new hires)
-4 quarters	-0.046	-0.048	-0.046
	(0.040)	(0.040)	(0.042)
-3 quarters	-0.026	-0.024	-0.021
	(0.038)	(0.038)	(0.041)
-2 quarters	-0.024	-0.000	0.004
	(0.043)	(0.043)	(0.045)
0 (1st quarter of the tax relief)	-0.011	-0.005	-0.019
	(0.040)	(0.038)	(0.041)
+1 quarter	-0.064*	-0.049	-0.061
	(0.036)	(0.037)	(0.041)
+2 quarters	-0.085**	-0.069*	-0.066
	(0.038)	(0.037)	(0.041)
+3 quarters	-0.022	-0.011	-0.019
	(0.041)	(0.041)	(0.045)
+4 quarters	-0.066*	-0.064	-0.073
	(0.040)	(0.044)	(0.047)
Constant	1.711***	1.708***	1.864**
	(0.009)	(0.009)	(0.757)
Observations	14,486	14,486	14,357
R-squared	0.503	0.513	0.525
Sector FE	✓	✓	✓
Monthly FE	✓	-	-
Monthly FE x ISIC level 1 category	-	✓	✓
Monthly FE x Worker/firm char. before PBM	-	-	✓

Note: The table reports regression estimates associating the log of the hourly wage of new hires to the timing of PBM implementation as defined by specification (2). The dependent variable is sectoral hourly wage in micro-regions associated with high levels (above median) of labor market concentration which is measured by an employment-based HHI index, as discussed in section 4.4. Column (1) reports estimates that control for sector and month fixed effects. Column (2) interacts monthly fixed effects with category-specific (level 1 ISIC) dummies. Column (3) adds the interaction of monthly fixed-effects with worker and firm characteristics at their averages in the one year period before the PBM implementation. The controls are the average age of employees in each sector and its square, share of male employees and the average number of employees per firm. These variables were selected based on the regression on table 3. Our main sample consists of a balanced panel of sector-month pairs and includes all firms in the standard tax regime and in high-concentration micro-regions from 219 sectors during the period $2009 - 2014$, as described in section 2.1. Heteroskedasticity-adjusted standard errors clustered at the sector level are reported in parentheses below the coefficients. Significantly different from zero at 99% (***), 95% (**) and 90% (*) confidence level.

E   Computing the Effect of the PBM Reform on Profits

To estimate the effect of the PBM tax reform on firm profits we use a structural approach that takes advantage of the oligopsony model described in Section 4.4. First, recall that this is a large scale reform involving a change of tax base upon which payroll taxes are calculated for selected sectors and firms in the standard taxation regime. The reduction of 20 p.p. in the tax rate paid on wages and the increase of 1-2 p.p. in the tax rate paid on revenue implied an average reduction of 51% in the total firm payroll tax burden.

Let $\Pi_{jm,t}$ denote the solution to the profit maximization problem (5). Below we expand it to explicit the main time-varying wage and revenue tax parameters, T_t and f_t, with $t = 0, 1$ indicating pre- and post-reform respectively, as well as time-invariant parameters, $\bar{T}$ and $\bar{f}$.

$$\Pi_{jm,t} = [(1 - f_t - \bar{f})y_{jm} - (1 + T_t + \bar{T})w^*_{jm,t}]\ell^*_{jm,t} \tag{12}$$

From the first order condition of problem (5) in $t = 0$ we also obtain the mark-down ratio, i.e. (fixed) labor productivity, y_{jm}, in terms of $w^*_{jm,0}$:

$$\frac{y_{jm}}{w^*_{jm,0}} = \left(1 + \frac{1}{\varepsilon_{jm,0}}\right)\frac{\left(1 + T_0 + \bar{T}\right)}{\left(1 - f_0 - \bar{f}\right)}$$

We further use relation (6) between labor supply elasticity and firm share to write the mark-down function in terms of the firm share:

$$\frac{y_{jm}}{w^*_{jm,0}} = \left[1 + \frac{1}{\eta} + s_{jm,0}\left(\frac{1}{\theta} - \frac{1}{\eta}\right)\right]\frac{\left(1 + T_0 + \bar{T}\right)}{\left(1 - f_0 - \bar{f}\right)} \tag{13}$$

where θ and η are calibrated with values from the literature (see Section 4.4 and $s_{jm,0}$ is estimated from our data in 2010 (pre-program) using the wage-bill definition of firm share.

From (12), we can calculate the profit gain in percentage terms by using the formula

$$100\times \left(\frac{\Pi_{jm,1} - \Pi_{jm,0}}{\Pi_{jm,0}}\right) =$$

$$100 \times \frac{\left[(1 - f_1 - \bar{f})\frac{\ell^*_{jm,1}}{\ell^*_{jm,0}} - (1 - f_0 - \bar{f})\right]\frac{y_{jm}}{w^*_{jm,0}} - (1 + T_1 + \bar{T})\frac{w^*_{jm,1}}{w^*_{jm,0}}\frac{\ell^*_{jm,1}}{\ell^*_{jm,0}} + (1 + T_0 + \bar{T})}{(1 - f_0 - \bar{f})\frac{y_{jm}}{w^*_{jm,0}} - (1 + T_0 + \bar{T})} \tag{14}$$

where $y_{jm}/w^*_{jm,0}$ is derived in (13). The tax parameters are calibrated from laws allowing for the changes in the tax rates due to the PBM reform with $f_0 = 0$, $f_1 = 0.015$, $T_0 = 0.20$, $T_1 = 0$, $\bar{f} = 0.0365$, and $\bar{T} = 0.057$.[32] $\ell^*_{jm,1}/\ell^*_{jm,0}$ and $w^*_{jm,1}/w^*_{jm,0}$ are set equal to the

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[32]The time-invariant tax parameters, $\bar{f}$ and $\bar{T}$, represent other social security contributions charged as a percentage of revenue (Cofins (3%) and PIS/PASEP (0.65%) based on the most typical taxation criterion

reduced-form estimates for the employment and wage average treatment effect, respectively, 1.05 and 1. After plugging all these calibrated parameters and estimated average treatment effects into (14), we obtain an effect on profits of 59.4% for firms with the average firm share (0.0015).