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Minimum Wages and Informality*

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Abstract

How do minimum wages affect informality? We study the near-doubling of the real minimum wage from 2000 to 2009 in Brazil, where 46% of the workforce is informal. Using labor force surveys covering the informal sector, we show the minimum wage exhibits near full passthrough to informal employees working in formal firms, about half of all informal employees. The formal-to-informal reallocation elasticity with respect to the formal wage is small: -0.28. Our findings illustrate how minimum wages can positively affect living standards for workers thought beyond the reach of labor law, a sizable share of the workforce in developing economies.

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1 Introduction

Minimum wages are a popular labor market policy throughout the world, including in low- and middle-income countries with high levels of informality. What are the effects of minimum wage increases in these settings? Standard, perfectly competitive models of dual-sector economies predict that wage floors should induce sizable reallocation from formal to informal employment.[1] At the same time, recent evidence suggests that strict segmentation is a poor characterization of formal vs. informal employment and that gradients of informality may be a more accurate description of labor markets (Meghir et al., 2015; Ulyssea, 2018; 2020; Haanwinckel and Soares, 2021; Feinmann et al., 2024). Because hundreds of millions of workers are in some form of informality throughout the world, understanding how the minimum wage affects labor markets in this context matters greatly for the analysis of labor markets globally.

To shed light on this issue, we study large increases in the national minimum wage that occurred in Brazil between 2000 and 2009. These increases moved the country from a regime of low minimum wage bite (a minimum-to-median wage ratio of 0.34) to one of high bite (a minimum-to-median wage ratio of 0.58) in ten years. About 46% of all workers employed in the Brazilian private sector are informal. Within this group of workers, there is substantial heterogeneity in their type of employment: about half of informal workers work in formal firms, while the other half are employed in informal firms. These features of the Brazilian labor market, combined with the availability of rich data capturing formality status, make Brazil an ideal context for analyzing the effects of minimum wages on informality.

We answer three key questions. First, what are the wage effects of minimum wage increases on workers outside of formal salaried employment? Second, how do these effects vary across different gradients of informality? Third, what is the "own-wage" reallocation elasticity, that is, to what extent does the workforce shift out of formal employment in response to an increase in the formal wage caused by a minimum wage hike? To our knowledge, our paper is the first to estimate this own-wage reallocation elasticity, a key parameter in settings with a large informal sector.

To address these questions, we implement a variety of difference-in-differences approaches that leverage heterogeneity in the bite of the minimum wage across states and industries. We examine effects on four groups of workers: formal workers, informal workers in formal firms,

[1] There is a long tradition that views the informal sector as the disadvantaged sector of a dualistic or segmented labor market. See, e.g., Peattie (1987); Fields (1990); Turnham and Erocal (1990); Tokman (1992); Portes and Schauffler (1993); La Porta and Shleifer (2014) for overviews and the Harris and Todaro (1970) model.

informal workers in informal firms, and the self-employed. To do so, we make use of several data sources in Brazil that track workers in the informal sector and show that industry closely approximates informal employees' gradient of informality—that is, whether they work at a formal or informal firm. These data allows us to study heterogeneous effects of the minimum wage on these four groups of workers over a 20-year period.

Our main findings are twofold. First, we find an immediate and substantial passthrough of the minimum wage of 0.88 for informal workers working in formal firms—meaning, for the same increase in the share of affected workers as in the formal sector, wages increase by 88% of the increase in the formal sector. For informal workers employed in informal firms, the passthrough is smaller (59%), and takes several years to materialize. We do not find any evidence of passthrough to the self-employed. Second, because the wages of informal workers rise nearly in line with the increase in the minimum wage, it is perhaps not surprising that we find a modest own-wage reallocation elasticity of -0.28. Altogether, these results indicate that minimum wage increases had positive effects for low-income people working in the informal sector in Brazil, with non-zero but relatively modest shifts out of formal employment. Our findings raise the possibility that the minimum wage may be an effective tool to improve living standards for workers in developing economies typically considered beyond the reach of labor law. They also shed light on the historical record of other countries, for instance the United States, which experienced strong increases in its minimum wage in the 1950s and 1960s while formalizing and whose GDP per capita then was comparable to that of Brazil in the 2000s.

Our analysis unfolds in four main steps. First, we show that the monthly earnings distributions of formal workers *and* informal workers in formal firms strongly track the minimum wage throughout the period of large increases in the 2000s. We observe full compliance with the policy among formal workers and substantial bunching at the minimum: 20% of the workforce is paid within 10% of the minimum wage in 2009. Compliance is also high for informal employees in formal firms, starting at 92.7% in 1999 and only falling to 84.3% in 2009, the peak of the minimum in terms of bite. The mass at the minimum is even higher among this group of workers relative to formal employees—25% in 2009. The spike is similar for informal employees in informal firms; however, non-compliance is much higher, reaching 40% in 2009.

Second, to quantify the magnitude of the wage effect among formal employees, we use a difference-in-differences design exploiting variation in the bite of the reform across states and industries. We measure the bite of the reform for the formal sector as the fraction of

formal employees paid at or below the 2009 minimum wage in 1999, across 279 state and industry cells defined pre-reform. We find that a one standard deviation increase in the share of affected workers is associated with a 13.2 log point increase in average monthly wages.

Using a similar research design, we find large and immediate wage increases among informal employees working in formal firms. Consistent with the descriptive evidence in our first step above, using a bunching difference-in-differences design *à la* Cengiz et al. (2019) reveals that the effects of the 2009 minimum wage are concentrated at the level of the minimum wage for formal and informal employees in formal firms, with no impacts higher in the wage distribution.

We also document wage gains among informal employees working in informal firms, although wage gains take a few years to materialize for this group of informal workers. This result highlights the importance of minimum wage policies even for parts of the economy that are further removed from the formal sector. Interestingly, these wage gains come from a larger mass of workers paid just below the minimum wage. We find no effect of the minimum wage increases on wages of the self-employed.

Third, our wage effects are robust to a series of specification checks and are consistent across data sources. Using a bunching difference-in-differences approach separately by year, we show that effects on the density of wages show up exactly in the bin containing the statutory minimum for that year. Further, we show consistent effects on wages using census data, where we can also use a microregion-by-industry design, and thus exploit finer geographical variation in the bite of the minimum wage.[2] Wage effects in the formal sector are of the same magnitude within state-by-industry cells as within microregion-by-industry cells, suggesting that the wage passthrough occurs within fine local labor markets, consistent with a recent literature on minimum wage spillovers (Machin and Giupponi, 2024; Hazell et al., 2025; Hjort and Sarsons, 2025; Derenoncourt and Weil, 2025).

Lastly, we turn to employment effects, using our research design to study shifts out of formal employment to all other forms of employment. We examine this both with linear probability models as well as a bunching design that transparently documents employment effects along the wage distribution. We find very small effects on formal employment around the part of the distribution close to the minimum wage. Using a conservative approach that takes into account changes in employment across the entire wage distribution, we find small declines in formal employment. Because we find no evidence that the minimum wage

[2]Microregions are groups of geographically contiguous municipalities within a state, as defined by the Brazilian Institute of Geography and Statistics (IBGE).

caused employment losses, we focus on the reallocation effects of the minimum wage towards other sectors of employment. The estimated declines in formal employment, together with our estimated effects on formal sector wages, imply an own-wage reallocation elasticity of -0.28. That is, a 10% increase in average formal wages is associated with a 2.8 percent shift towards other modes of employment. To provide some perspective on the magnitude of this elasticity, we simulate a counterfactual evolution of the formal share of employment absent the 2000-2009 minimum wage increases and find that the formalization process would have been sped up by at most one year for the entire private workforce of salaried workers.

Related literature. An extensive literature studies the economic effects of the minimum wage. Although most of it is focused on the United States and Europe, there is growing attention paid to countries with high informality: see Neumark and Mungía Corella (2021) and Broecke et al. (2017) for two recent reviews. Due to the difficulty in measuring the informal sector with microdata (Perry et al., 2007), the literature focuses mainly on wage and employment effects in the formal sector (Engbom and Moser, 2022; Saltiel and Urzúa, 2022). Our main contribution is to provide clear evidence on how the minimum wage affects the informal sector.

Earlier studies document a spike at the minimum wage in the informal wage distribution in Brazil for select years (Neri et al., 1999; Fajnzylber, 2001; Soares, 2002; Lemos, 2009; Jales, 2018).[3] We expand the documentation of this phenomenon using our new series on informal workers and show that compliance with the minimum varies by margin of informality. We also formally quantify the wage effects of the minimum wage on the informal sector using variation in the bite of the policy across state and industry cells.

We also add to a body of work studying the economy-wide effects of the minimum wage, including the effect on formalization.[4] Most closely related to our paper, Machado Parente et al. (2025) combines empirics with a structural model to study the effect of the 2000s minimum wage increases in Brazil on inequality, finding that the policy increased aggregate

[3]See Maloney and Méndez (2004) for an analysis across Latin American countries. These "lighthouse" effects (Bacha and Taylor, 1978; Macedo and Garcia, 1978; Souza and Baltar, 1979) have been attributed to the fact that the minimum wage may serve as a fairness norm among formal and informal employees alike. See Card and Krueger (1995) and Brown (1999) for the existence of a spike at the minimum wage in the uncovered sector in the United States.

[4]Neumark and Mungía Corella (2021) highlight negative effects on formal employment while Broecke et al. (2017) find mixed evidence on the employment effects of the minimum wage, with the most vulnerable groups prone to reallocation to the informal sector. Additionally, Neumark et al. (2006) report negative employment effects across six Brazilian metropolitan areas between 1996 and 2001 while Hinojosa (2019) find small but significant adverse effects of the minimum wage on formal employment over the period 1995-2015 in Brazil.

inequality due to reallocation from the formal to informal sector.[5] Our study, which uses a granular empirical approach and bunching in the wage distribution, also finds reallocation effects; however, these are modest in size due to de facto compliance with the policy for a large share of informal employees. Given that the minimum wage falls relatively high in the informal wage distribution — i.e. between the 70th and the 80th percentile over our period of study — increases in the minimum plausibly pull the middle of the informal distribution away from the bottom, which could lead to an increase in aggregate inequality as documented by Machado Parente et al. (2025). A key contribution of our paper to this literature is the computation of the own-wage reallocation elasticity. To maximize comparability of studies of the minimum wage in low- and middle-income countries, the estimation of own-wage reallocation elasticities in different settings is a fruitful avenue for future research.

Finally, our findings add to a body of work documenting substantial spillovers of the minimum wage across multiple dimensions. Machin and Giupponi (2024) find large within-firm spillovers of the minimum wage to younger workers. Hjort and Sarsons (2025) document "anchored" wage setting with transmission of minimum wage increases from the headquarters of multinationals to their establishments abroad, and Hazell et al. (2025) find evidence of national wage setting by multi-establishment firms in the U.S. Bassier (2022) studies sectorally bargained wage floors and finds large spillovers to the uncovered competitors of covered firms. We document spillovers of the minimum wage to workers in informal work arrangements, where compliance with labor market regulations is thought to be minimal.

0.1 formal sector

Roadmap. The paper is organized as follows. Section 2 provides the institutional context of the 2000s-era minimum wage increases in Brazil and presents our data. Section 3 analyses compliance with the minimum wage among the different categories of informal workers. Section 4 quantifies wage effects among formal employees and the passthrough of the minimum wage to the various gradients of informality in a difference-in-differences design. Section 5 assesses whether the minimum wage displaced workers from employment to non-employment, and out of formal salaried employment to informal arrangements or to self-employment. We present own-wage reallocation elasticities that combine estimated wage effects with a bunching difference-in-differences design for analyzing employment changes. Section 6 concludes.

[5] Bosch and Manacorda (2010) also study the effect of the minimum wage on inequality in Mexico in the formal and informal sectors, finding that the minimum wage reduced inequality in the formal sector with no clear effect on the informal sector.

2 Context, Data, and Measuring the Margins of Informality

Brazil underwent large minimum wage increases in the 2000s, making the country an ideal context for studying the effects of the minimum wage on informal workers. We provide background on these increases below and detail the data sources we use to measure their effects in both the formal and informal sectors.

2.1 Context on the 2000-2009 minimum wage increases

The minimum wage in Brazil is set in monthly gross terms, at the federal level. It applies to all regions, states, industries, and occupations. While subnational minimums exist in some states and industries, the federal minimum remains the most important wage floor throughout the country.[6]

Legislation and enforcement. Legally, the minimum wage applies to all workers, regardless of whether or not they are employed via a formal contract.[7] Enforcement occurs either through labor inspections or workers' claims. Whether formal or informal, any worker can file a claim against their employer if they are paid below the minimum wage. In 1999, firms found to violate minimum wage laws were subject to penalties of up to 11 times the monthly minimum wage per worker paid below the minimum wage. The amount of the fine doubles in case of recidivism. We provide additional details on the legislation and on the penalties associated with paying below the minimum wage in Appendix A.

Sharp increases from 2000 to 2009. The ratio between the federal minimum wage and the median wage for full-time formal workers rose from 0.34 in 1999 to 0.58 in 2009, leveling off thereafter (see Figure 1a). This was a stark increase: in 1999, the minimum-to-median wage ratio in Brazil was similar to the contemporaneous ratio in the U.S. A decade later, the ratio was close to the contemporaneous ratio in France (OECD, 2025), or, equivalently, the ratio in the U.S. when the minimum wage peaked in 1968 (Derenoncourt and Montialoux, 2021). The

[6]Since 2001, five states have raised the minimum wage above the federal level in particular industries and occupations. However, even across studies that have leveraged the richness of the matched employer-employee data, there is no definitive evidence that these wage floors are binding. In particular, Corseuil et al. (2013) reported non-compliance with the floor in Parana and São Paulo. Finally, we show using our database of state-by-industry minimum wages that the bite of the federal minimum across states and industries is highly correlated with the bite of the highest applicable minimum, taking subnational minimum wages into account. See Section 4.4 for more details.

[7]The 1943 Labor code, Article 76, stipulates that "the minimum wage is the minimum compensation owed and paid directly by the employer to every worker."

magnitude of this increase is comparable to the 2000-2002 minimum wage reform analyzed by Harasztosi and Lindner (2019) in Hungary.

Evolution of the structure of employment. Brazil is characterized by a large informal sector. We follow Ulyssea (2018) and Haanwinckel and Soares (2021) in defining the informal sector as unregistered employees (i.e., those without an official working permit), but we differ from them by including domestic service workers, a key low-wage group likely affected by the minimum wage.[8] We analyze the self-employed separately from informal salaried workers because they set their own wages. The private formal sector, by contrast, is comprised of workers with an official working permit (called the *carteira assinada*). Appendix Figure A1a shows that the formal sector expanded from 1995 to 2015, while the informal sector shrunk. In 1999, 54% of all prime-age workers in the private sector were employed in the formal sector, increasing to 62% by 2009 and to 68% by 2015. Appendix Figure A1b decomposes the evolution of informal employment into two parts. The share of informal workers employed in formal firms within the private sector increased from 44.4% in 1999 to 48.7% in 2009 while the share of informal workers employed in informal firms fell symmetrically from 55.6% in 1999 to 51.3% in 2009 (we define these groups in Section 2.3).

In Appendix Figures A2 and A3, we provide additional details on the evolution of all adults' work status and on the broader macroeconomic context during these years. Employment and labor force participation rose over this period while unemployment fell. GDP grew significantly around the same time as the minimum wage hikes, and the country gradually expanded social assistance through the introduction of the cash transfer program Bolsa Família. We discuss the importance of controlling for these macroeconomic factors and policy changes in Section 4.4.

2.2 Data

A rich set of data sources facilitates studying minimum wage effects on formal and informal workers in Brazil. We describe these sources below, as well as the long-run series we construct on informal workers distinguishing those likely employed by formal firms vs. informal firms. Appendix B provides additional details on the data sources we use and documents that the different sources are both consistent with each other and well-suited to study the effect of the minimum wage increases.

[8] Domestic service workers account for 17% of all informal employees in our sample.

PNAD and census data. We use and combine a variety of publicly available data on the Brazilian labor force. Our main analysis uses the *Pesquisa Nacional por Amostra de Domicílios* (PNAD), for the years 1995-2015. PNAD is an annual national household survey, similar to the Current Population Survey in the United States.[9] It contains information on all individuals regardless of their labor market status. The main advantage of this data source is that it contains information on workers employed in the informal sector, and since 2011, asks informal workers about the formality status of their firm, a question that we use to construct our gradients of informality. The measure of earnings we use is a measure of gross monthly wages earned in September each year. We also exploit Census micro-data in 2000 and 2010 to cross-check the pattern and magnitudes of our wage results with what we observe in PNAD.

Urban Informal Economy survey (ECINF) 1997 and 2003. ECINF is a survey of small establishments (up to five employees) with information on firms' formality status that was conducted in 1997 and 2003. We use these data to validate our new series on informal workers by margin of informality constructed in PNAD (details below).

Matched employer-employee data. This dataset is called *Relação Anual de Informações Sociais* (RAIS) and contains information on employment spells, earnings, and the number of contracted hours for the universe of workers employed in the formal sector in Brazil. We use this data source to cross-check that the monthly earnings distributions as reported by firms match well the monthly earnings distributions reported by workers in the household survey data.

Monthly employment survey data. This survey called *Pesquisa mensal de emprego* (PME) is a household survey conducted monthly in six metropolitan areas: Belo Horizonte, Porto Alegre, Recife, Rio de Janeiro, Salvador and São Paulo. We use PME-Nova from 2002 to 2015 and leverage its longitudinal format to document transitions in and out of the formal and the informal labor force, as well as in and out of employment.

Minimum wage database. We compile a database of minimum wages from 1940 (the introduction of the federal minimum in Brazil) to 2020. The database contains the values of the federal minimum wage each month in nominal terms using information published by the Brazilian Institute of Geography and Statistics (IBGE) website.[10]

[9] PNAD is not conducted during the year the Census is enumerated, so there is no survey in 2000 and 2010.
[10] At this address: https://www.ibge.gov.br/estatisticas/downloads-estatisticas.html.

Sample. Our sample includes all prime-age workers, aged 25 to 54. Workers younger than 25 may be enrolled in higher education; this share is small but increasing during our period of study (1995-2015). Table 1 shows that 10% of private formal workers in 1999 had completed a college education. This figure is 17% in 2015. We pool individuals into two ethnicities, white and non-white.[11] Monthly earnings are winsorized at the 1st and 99th percentiles and deflated using the price index published by the Brazilian Institute of Geography and Statistics (IBGE). We focus on full-time workers (i.e., working more than 40 hours a week) for our main results on the wage effects of the policy as the federal minimum wage is set in terms of monthly earnings for workers with full-time contracts of 44 hours a week. About 89% of formal employees worked full-time in 1999 (see Table 1).[12] When we study the employment effects of the policy, however, we consider the entire private workforce, including part-time workers.

2.3 Measuring the margins of informality

Brazil is one of the few countries where it is possible to observe the different gradients of informality to which workers belong.[13] Previous studies on the Brazilian informal sector have used the Urban Informal Economy survey (ECINF) conducted in 1997 and 2003 to make this distinction (see, e.g., Ulyssea (2018) and our description below). Our paper is the first to systematically compile this information in more recent years, using a new question that appears in the labor force survey (PNAD) starting in 2011. Using this information and the fact that industry closely approximates workers' type of informal employment, we construct a 20-year series (from 1995 to 2015) on the two margins of informality.

We use the same terminology as Ulyssea (2018) to describe these margins, referring to informal workers working in formal firms as being on the *intensive margin* of informality and those working in informal firms as being on the *extensive margin* of informality. We depart from Ulyssea (2018) in also studying domestic workers, as they are a key group for whom the minimum wage applies with a strong bite.[14] Thus, our use of the term "extensive margin"

[11] Following Gerard et al. (2021), we pool "Pretos" (i.e. Black persons) and "Pardos" (i.e. Brown persons or mixed race with African ancestry) together to form the "non-white" category. We exclude individuals identifying as "Amarelos" and "Indigenas" (less than 2% of the population).

[12] In principle, the minimum wage is adjusted proportionally for part-time workers. However, PNAD does not collect a measure of hours worked each month—only weekly—preventing us from measuring the bite of the policy without significant measurement error.

[13] Mexico is the only other developing country we are aware of where the statistical system allows one to observe workers on the intensive margin of informality, beginning in 2005 (Samaniego de la Parra and Fernández Bujanda, 2024).

[14] According to our data from PNAD, over a quarter of domestic workers are paid exactly the minimum wage.

includes private households employing these workers.

Starting in 2011, informal workers are asked in PNAD whether they work in a firm that is registered with a tax identification number (the CNPJ code). If their answer is "yes" ("no"), we label these workers as being on the intensive (extensive) margin of informality. One potential challenge is that among our main sample of interest (prime-age informal employees working full-time) the non-response rate to this question can reach up to 28%. However, because the probability of not responding is uncorrelated with the respondent's wage, we do not believe that this non-response introduces bias for our main outcome of interest. More precisely, non-response on the margin of informality reaches 28.4% in 2011 and 25.5% in 2015. The correlation coefficient between the respondent's non-response status and monthly wage varies between 0.021 at its highest in 2011 to 0.006 at its lowest in 2014.

Appendix Tables B1 and B2 compare the demographic and economic characteristics of intensive and extensive workers defined using our industry proxy versus the direct measure of their margin in 2011. Appendix Table B2 confirms that the industry of informal employees serves as a strong indication of their margin of informality: in 2011, 82% of informal employees on the extensive margin are employed in agriculture, construction, or domestic services, but this is only the case for 11% of those employed in formal firms.[15] This figure is stable over the 5 years for which we observe the margin of informality of the employee (see, e.g., Appendix Tables B3 and B4 for workers' characteristics in 2015). We thus assign informal employees working in these three sectors to be in the extensive margin of informality across all years in our study period, from 1995-2015.

The monthly earnings distributions of the different groups of informal workers categorized using our industry proxy versus those using the available question in PNAD from 2011 to 2015 match well, validating our imputation strategy (see Appendix Figure B1). The figure also confirms that the potential non-response bias is likely limited: the earnings distribution of the sample for which we directly observe the margin of informality (approximately 70-75% of respondents) closely overlaps with the full sample where margin is proxied with industry.

Finally, we further check that our constructed series for 1997 and 2003 are consistent with the information on the gradients of informality directly available in ECINF for these years. As

[15]Domestic workers were historically excluded from the 1946 Labor Code. Domestic work was defined as a "non-economic" activity and *de facto* excluded from labor regulation. In the 1988 Constitution, domestic workers obtained coverage by the minimum wage and the right to unionize. Only in the law 150/2015 passed in 2015 (the last year of our period of study) did domestic workers obtain labor rights such as a notice period and compensation for unfair dismissal, access to unemployment benefits, limitations on working time, and compensation for overtime. A report from DIEESE here estimates that in 2013, only 30% of domestic workers were formal.

ECINF only samples employers with up to five employees, to ease the comparison between the two data sources, we restrict the PNAD sample to workers employed in firms with 5 or fewer workers. Appendix Figures B2 and B3 show that they are reasonably well aligned in 1997 and 2003, respectively, on the intensive and the extensive margins of informality.

How do employees on the two margins of informality differ from each other? Table 1 reports characteristics of workers in different groups of employment in 1999. Workers on the extensive margin of informality typically earn lower wages than workers on the intensive margin, are predominantly non-white, are more likely to be women, and tend to work in smaller firms than other groups of salaried employees. Table 2 documents that the industry distribution of intensive margin workers closely mirrors that of the formal sector.[16] Extensive margin employees are also less likely to work full-time: in 1999, 54% of extensive-margin informal employees worked full time while 71% of intensive-margin informal employees and the self-employed did so.

Overall, we believe that our new series opens the possibility of studying the effect of many policies or shocks (e.g., trade liberalization) on the two margins of informality.

3 The bite of the minimum wage among informal workers

While compliance with the minimum wage is not a given in the informal sector, lighthouse effects (where wages of informal workers also bunch at the minimum) have been detected in select years in Brazil. We expand on this previous work by systematically documenting non-compliance with as well as the bite of the minimum wage within the informal earnings distribution during the large increases in the minimum wage in the 2000s. We also show this separately for the different margins of informality as well as for the self-employed.

Figure 1b plots the extent of non-compliance with the minimum wage—the share strictly below the minimum— over time across for the four groups of workers using PNAD. Figure 2 plots monthly earnings distributions for each group of workers for the years 1995, 1999, 2001, and 2009 in the same data.[17] The x-axis shows log monthly wage bins in R$2019 (the wage bins are 10 log points wide).

[16] Appendix Tables B1-B4 document similar patterns for informal workers using the direct measure of their margin of informality in 2011 (the first year we can directly observe these workers in PNAD) and in 2015 (the last year of our sample). Appendix Table B5 documents the industry distribution of formal and informal workers (along both margins) in 2015.

[17] Monthly earnings distributions for every year from 1995-2015 are available in our slides here.

Formal employees. In terms of compliance, virtually no workers report being paid below the minimum wage in the private formal sector. Figure 1b shows that non-compliance with the minimum wage does not exceed 1% among formal employees. Furthermore, the minimum wage causes a large spike in the monthly earnings distribution of formal workers (see Figure 2a). The share of workers paid within 10% of the federal minimum wage in the private formal sector fluctuated between 6.2% and 7.8% between 1995 and 1999; it sharply increased in the 2000s and peaked at 20% in 2009.[18] Appendix Figures B4 -B10 confirm that we find near-perfect compliance and a nearly identical spike using the monthly contracted wage in the universe of the matched employer-employee data (i.e., earnings reported by employers) at the national and regional levels.

Intensive-margin informal employees. Figure 1b shows that the share of intensive-margin informal workers paid strictly below the minimum wage went from 7.3% in 1999 to 15.7% in 2009. Figure 2b confirms this strong compliance and documents a large spike at the minimum wage among these workers that moves with minimum wage hikes and increases in magnitude over time. The share of workers paid within 10% of the minimum wage increased from 14% in 1999 to 24% in 2009.

Extensive-margin informal employees. Figure 1b shows that the share of extensive-margin informal workers paid strictly below the minimum wage went from 23% in 1999 to 40% in 2009.[19] Interestingly, the spike around the minimum wage is as high among informal employees working in informal firms (see Figure 2c) as among informal employees working in formal firms: around 25% (see Figure 2b). Non-compliance, however, is approximately three times as large on the extensive margin as on the intensive margin.

Self-employed workers. We find that the minimum wage is not as strong a reference wage among the self-employed. Figure 2d shows that the share of self-employed paid within 10% of the minimum wage is in the vicinity of 5% in the late 1990s. By 2009, the spike at the minimum wage reaches around 10%; however, it is of similar magnitude as that of other

[18] In 2009, the share of workers at exactly the minimum wage or below is 13.4%.

[19] Table B1 shows that non-white workers are overrepresented in the extensive margin of informality, where compliance with the minimum is lowest among all types of employees. We explore the consequences of the 2000s minimum wage increases on the long-run evolution of racial gaps in Brazil in a separate companion paper (Derenoncourt et al., 2025).

spikes along the earnings distribution, and it is not the largest one.[20]

Bite of the minimum among incumbent informal employees. The above evidence shows that the wage distributions of informal employees track the rising minimum wage in the 2000s. To what extent does the shifting spike at the minimum reflect the wages of incumbent informal workers as opposed to changes in the composition of workers? We leverage the panel aspect of the PME to shed light on this question. For each minimum wage change between 2002 to 2016, we identify workers paid within 10 log points of the initial minimum wage and examine where in the wage distribution they fall the following year. Appendix Table B6 reports the results. 81% of intensive-margin informal employees that were at the minimum wage in the first year they are surveyed are at or above the new minimum in the year after they are surveyed. The equivalent figure for extensive-margin employees is 74%. Thus, informal employees at the minimum wage experienced wage gains when the minimum increased, and the shifting spike at the minimum cannot be entirely explained by changes in the composition of employees.

Discussion. Compliance with the minimum wage even among informal employees is not entirely unexpected. The minimum wage applies to them by law, irrespective of their formality status or the formality status of their firm (see Section 2.1). Further, the minimum wage may serve as a reference wage in the economy (Maloney and Méndez, 2004).

The magnitude of the spike, however, is perhaps less expected and highlights the importance of the minimum wage for all informal employees. These simple illustrations of the earnings distribution demonstrate that the wages of informal employees respond to the minimum wage. Reallocation effects in this context may be more limited given widespread compliance with the policy even for informal workers.

4 Wage effects of the minimum wage

We study the effects of the 2001-2009 minimum wage increase on wages separately for each group of workers—formal employees, intensive-margin informal employees, extensive-margin informal employees, and the self-employed. Our unit of analysis is the local labor market, defined as state-by-industry cells. There are over 300 local labor markets in our data,

[20] We also observe in PNAD that a small fraction of the self-employed earn less than the minimum wage and that this fraction is concentrated among the "informal" self-employed, rather than those that declare paying their taxes to the government.

encompassing the 27 states of Brazil and 12 major industry classifications.[21] We use our sample of full-time, prime-age workers in PNAD that includes our reconstructed margins of informality and covers the years 1995 to 2015.

4.1 Identification strategy

Our empirical strategy is based on a difference-in-differences design with continuous treatment, in which we compare the evolution of workers' wages across local labor markets that were differentially affected by the policy change, due to variation in the proportion of workers paid at or below the 2009 minimum wage in the pre-reform period.

Treatment variables. We use the fraction of workers paid at or below the 2009 federal minimum wage in 1999 in each state-by-industry cell as our measure of exposure to the policy. We compute this treatment variable separately for each group of workers and use each group's respective treatment variable to measure the effect of the reform on wages.

Treatment at the state-by-industry level captures variation in bite across local labor markets for each group of workers, respectively. Separate treatment variables for formal, intensive-informal, extensive-informal, and self-employed workers reflect the fact that bite and compliance differ across these groups of workers, as seen in the monthly wage distributions in Figure 2. Appendix Figures C1a, C1b, C1c and C1d report summary statistics for each treatment variable. There is indeed variation in the shares of workers in 1999 paid at or below the 2009 minimum wage across workers of different employment types: the average share of affected workers 0.21 in the formal sector, 0.34 among intensive-margin informal employees, 0.60 among extensive-margin informal employees, and 0.37 among the self-employed. Further, there is substantial variation in the share affected across state-by-industry cells for each type of workers: the standard deviation is 0.19 for formal employees, 0.19 for intensive-margin informal employees, 0.22 for extensive-margin informal employees, and 0.24 among the self-employed. In all cases, the density distribution of our treatment variables is fairly dispersed, with the treatment variable for formal workers exhibiting right-skewness.[22]

[21] The industry groups are as follows: agriculture, forestry and fishing; mining and extraction; manufacturing; construction; wholesale and retail trade; hotels and restaurants; transportation, storage, and communications and Electricity, gas, water and waste management; financial services and insurance, business and repair services and real estate; public administration and defense; education, health and social work; private household services; entertainment, recreation and other services, or unknown or missing. We omit from our analysis any state-industry cells with 0 workers in that employment group in that cell. We also group together the following geographically close pairs of states Acre and Rondonia, Amazonas and Roraima, as well as Amapa and Para so as to have a sufficient number of observations at the state-group-by-industry level.

[22] We show the distribution of the standardized treatment variables that enter our calculations for the wage

Model. We estimate the following empirical model for each group of workers:

$$\text{Monthly Earnings}_{it} = a + \sum_{\substack{\tau=1995 \\ \tau \neq 1999}}^{2015} \beta_{\tau}^{\text{wage}} \text{Share Affected}_{s(i)j(i)} \times \mathbb{1}_{[t=\tau]} + \mathbb{X}_{it}'\Gamma + \rho_{s(i)j(i)} + \mu_{j(i)t} + \varepsilon_{it} \quad (1)$$

Monthly Earnings$_{it}$ is the log monthly earnings for individual i in industry j, state s, and year t. Share Affected$_{s(i)j(i)}$ is the share of private sector workers paid below the 2009 minimum wage at the state-by-industry level in 1999, which we interact with a yearly indicator, $\mathbb{1}_{[t=\tau]}$. $\beta_{\tau}^{\text{wage}}$, measures the effect of the reform in year τ (relative to 1999, the omitted year) and corresponds to the intention-to-treat (ITT) estimand. $\mathbb{X}_{isjt}$ includes a set of individual-level controls (gender, race, education, and experience and its square) and time-varying state-level controls (log GDP per capita by state and its square to account for potential differential effects of GDP growth across states). ρ_{sj} and μ_{jt} are state-by-industry and industry-by-year fixed effects.[23] ε_{it} is the error term, which we cluster at the state-by-industry level.

Our identifying assumption is that absent the minimum wage increases, wage growth would have been the same across local labor markets with different initial levels of workers paid at or below the 2009 minimum wage. Under this assumption, the coefficients of interest $\beta_{\tau}^{\text{wage}}$ identify the effect of the bite of the new minimum wage on average monthly earnings at time t, relative to 1999. The coefficients $\beta_{\tau}^{\text{wage}}$ for $\tau = 1995, ..., 1998$ allow us to test the parallel trends assumption that there is no differential monthly earnings' growth across local labor markets with different exposure to the minimum wage increase before the policy change. The coefficients $\beta_{\tau}^{\text{wage}}$ for $\tau = 2001, ..., 2015$ document the evolution of average monthly earnings during the minimum wage increase and up to 6 years after the 2009 peak, relative to 1999.

4.2 Results on average wages

Formal employees. Figure 3a shows the evolution of the estimated $\beta_{\tau}^{\text{wage}}$ coefficients from 1995 to 2015 (white circles), and the associated 95 percent confidence intervals. From 1995 to 1998, there is no differential wage growth between differentially exposed local labor markets. Starting in 2001, there is an immediate increase in the strongly exposed cells relative to the

and the employment effects in Appendix Figure C2.

[23] The inclusion of the industry-by-year fixed effects departs from the standard approach that only includes group-level fixed effects and time fixed effects. Controlling for industry-specific trends over time serves two purposes: (i) addressing potentially different trends due to industry-specific shocks (e.g., Brazil experienced an export boom in the early 2000s); (ii) correcting for potential treatment effect heterogeneity across industries (see Sun and Shapiro (2022) and Dube and Lindner (2024) for a discussion of this potential endogeneity problem in the context of the minimum wage). This heterogeneity could arise in particular if industries face different output demand elasticities (see p.20 in Krueger (1994)).

weakly exposed ones. The relative increase is gradual from 2001 to 2009 as the minimum wage continues to increase. After the minimum wage peaked in 2009, our point estimates level off. Table 3 reports the point estimate for the year 2009, when the minimum wage peaks. A one-standard-deviation increase in the share of formal workers paid at or below the minimum wage (corresponding to a 19 percentage point change on a basis of 21%) is associated with a 13.2 log point increase in monthly earnings among formal workers.

Intensive-margin informal employees. Figure 3b shows a similar pattern of estimated wage increases for informal workers in formal firms. From 1995 to 1998, we estimate no differential wage growth between more strongly versus more weakly treated local labor markets. Wage increases begin in 2001 and our point estimates level off by the end of the decade. Table 3 reports that in 2009, one-standard-deviation increase in the share of workers on the intensive margin of informality paid at or below the minimum wage (corresponding to a 19 percentage point change on a basis of 34%) is associated with an 11.6 log point increase in monthly earnings among these workers.

Extensive-margin informal employees. Figure 3c looks at average wage effects among informal employees working in informal firms. In contrast to the pattern among intensive-margin informal employees, the wage effect on the extensive margin takes several years to materialize. Only in 2004 do the point estimates become statistically distinguishable from zero. Table 3 shows that in 2009, a one-standard-deviation increase in the share of workers on the extensive margin of informality paid at or below the minimum wage (corresponding to a 22 percentage point change on a basis of 60%) is associated with a 9 log point increase in monthly earnings among these workers.

Self-employed workers. Figure 3d shows no clear evidence of wage increases among the self-employed following the minimum wage hikes in the 2000s. The point estimate in 2009 displayed in Table 3 is small and negative, but statistically indistinguishable from zero.

Passthrough of minimum wage increases from the formal to the informal sector. We quantify the passthrough of the federal minimum wage increases from formal into informal wages in 2009 using the coefficient estimates reported above. For an equivalent change in the share of affected workers, our estimates imply that intensive-margin informal employees see a wage increase that is 88% of the effect for formal workers (11.6 log points vs. 13.2 log

points). Among the extensive margin, an equivalent change in the share of affected workers (19 rather than 22 percentage points) would yield a 7.8 log point increase in wages, or 59% of the effect for formal workers.

4.3 Results on the distribution of wages

To add further evidence that our empirical strategy identifies the effect of the minimum wage rather than other forces acting on wages, we examine effects on the probability density of wages. Our results allow us to confirm that the increase in wages comes from a shift of workers around precisely the wage bins affected by the minimum wage. Advances in the minimum wage literature have highlighted this benefit of a "bunching" approach, particularly for studying employment effects, which we do in Section 5 (Harasztosi and Lindner, 2019; Cengiz et al., 2019).

Formally, we estimate the following model separately for each group of workers:

$$\mathbb{1}_{it} = \sum_{\substack{\tau=1995 \\ \tau \neq 1999}}^{2015} \sum_{\eta=-4}^{12} \tilde{\beta}_{\tau\eta}^{\text{wage}} \text{Share Affected}_{s(i)j(i)} \times \mathbb{1}_{[t=\tau]} \times \mathbb{1}_{[k(i)=\eta]} + \tilde{\rho}_{s(i)j(i)k(i)} + \tilde{\mu}_{j(i)tk(i)} + \tilde{\varepsilon}_{it} \quad (2)$$

with $\mathbb{1}_{it}$ being the probability that the wage of a worker i from state s, industry j, and year t falls in a specific wage bin k, defined in increments of 10 log points. Our treatment variable is Share Affected$_{sj}$, the share of affected workers at the state-by-industry level in 1999, as defined above. $\tilde{\beta}_{\tau\eta}^{\text{wage}}$ is the effect of the reform in year τ (relative to 1999, the omitted year) for wage bin η. $\tilde{\rho}_{sjk}$ and $\tilde{\mu}_{jtk}$ are state-by-industry-by-wage-bin and industry-by-year-by-wage-bin fixed effects. We cluster our standard errors $\tilde{\varepsilon}_{it}$ at the state-by-industry level. By design, for each year τ, the sum of the coefficients of interest across wage bins is 0: $\sum_{\eta=-4}^{\eta=12} \tilde{\beta}_{\tau\eta}^{\text{wage}} = 0$.

The results are shown in Figure 4 for the year 2009.[24] In 2009, a one-standard-deviation increase in the bite of the reform among formal employees is associated with an increase of 14 percentage points at exactly the 2009 minimum wage bin (see Figure 4a). This one-standard-deviation increase is not associated with any increase above the wage bin that contains the 2009 minimum wage, indicating that the wage effects are concentrated at the bottom of the distribution. The 14 percentage point increase at exactly the 2009 minimum wage bin comes entirely from workers working below the 2009 minimum wage pre-reform. This result

[24] The complete series of graphs for formal employees for the years 1995-2015 are available in our slides here. They confirm that, prior to the reform, there is no change in the distribution of wages across wage bins. Starting in 2001, higher bite of the minimum wage pre-reform is associated with greater probability of wages falling in the bin that contains that year's minimum wage. The complete series of graphs is also available in our slides for informal employees on the intensive margin of informality, informal employees on the extensive margin of informality, and for the self-employed.

highlights the full-compliance with the minimum wage in the formal sector even when the minimum wage peaks in 2009. The lack of upper-tail effects serves as a useful placebo check for the research design.

Results are similar among informal employees on the intensive margin, although the effects are smaller in magnitude: in 2009, a one-standard-deviation increase in the bite of the reform among intensive-margin informal employees is associated with an increase of nearly 7 percentage points at exactly the 2009 minimum wage bin (see Figure 4b). The effects on wage bins higher than the minimum wage are small in magnitude and not statistically different from zero, in further support of the research design.

Interestingly, Figure 4c shows that a higher bite of the reform among extensive-margin informal employees is associated with a higher probability of being right below the minimum wage. At the same time, there is movement out of bins significantly below the minimum wage. These results reconcile positive wage effects with growing non-compliance among extensive-margin employees: workers on this margin of informality do see a wage increase, but this increase reflects shifts from lower wage bins to those just below (as well as slightly above) the minimum wage.

Finally, Figure 4d shows that we find little evidence that the minimum wage strongly affected the wage distribution of self-employed workers.

4.4 Robustness checks.

We conduct an array of robustness tests to make sure that our wage increases capture the causal effect of the minimum wage and are of the correct magnitudes.

Consistency with other data sources and designs. Figure 3 overlays our wage effects using PNAD with comparable estimates using census data. Among formal employees, Figure 3a shows that wage effects using the Census are smaller than in PNAD, but are still the same order of magnitude. These wage effects must be understood relative to 2000—the omitted year when we use census data (only available in 2000 and 2010). A one-standard-deviation increase in the fraction of workers paid at or below the minimum wage in 2000 (corresponding to a 19 percentage point change on a basis of 24%) is associated with a 10.8 percent relative increase in the wages of strongly affected state-by-industry cells (see Appendix Table D1). We also leverage the precision of the census data to show similar effects when treatment is defined within microregion-by-industry, a finer aggregation of firms compared to state-by-industry

cells.[25]

Figure 3b shows our results using census data among informal employees on the intensive margin of informality. The wage effects appear well aligned for this sector as well. The orders of magnitudes are also similar when we use a microregion-by-industry design in the Census, suggesting that the spillover effects of the minimum wage to the informal sector happen within finer local labor markets. Figures 3c and 3d show similar consistency across data sources for the extensive margin of informality as well as the self-employed.

We also show consistent results on changes to the probability density of wages using census data in Appendix Figure D1. Changes to the wage density function in 2010 relative to 2000 among formal, intensive informal, and extensive informal employees are virtually identical. Among the self-employed, there is more evidence of a spike in the minimum wage; however, our results over time in PNAD suggest this spike does not consistently appear.

Robustness to other treatment variables. With a continuous treatment variable, one may worry that even the least affected state-by-industry cells are treated. If the effect of marginal increases in treatment intensity is not constant either within or between state-by-industry cells, our results estimated using Equation 1 may suffer from misspecification of the functional form and might be biased (see, e.g., Haanwinckel (2025)[26] and Callaway et al. (2025)). Following the logic of Callaway et al. (2025), we consider an alternative binary treatment specification in which we define the control group as the first quartile of the original treatment variable — so as to make the control as "clean" as possible in our setting — and treatment as belonging to the top three quartiles. Appendix Figure D2a shows that the wage effect among the formal workforce has exactly the same pattern as the wage effect in our baseline difference-in-differences. Reassuringly, Appendix Figure D2b also shows that the estimated wage effect is greater when comparing the top two quartiles (instead of the top three quar-

[25]There are 558 microregions defined in the census data, and in total we leverage variation across 6,536 microregion-by-industry cells in our regressions. A one-standard-deviation increase in the fraction of affected formal workers in this microregion-by-industry design corresponds to a 21 percentage point change on a basis of 24%—figures that are remarkably aligned with the respective figures using the fraction of affected workers at the state-by-industry level and with the shares computed in PNAD (see also Appendix Figure C1). For the intensive margin of informality, using the state-by-industry design (using the microregion-by-industry design), a one-standard-deviation increase in the fraction of affected workers corresponds to a 17 (20) percentage point change on a basis of 39% (39%). For the extensive margin of informality, using the state-by-industry design (using the microregion-by-industry design), a one-standard-deviation increase in the fraction of affected workers corresponds to a 23 (26) percentage point change on a basis of 55% (55%). Finally, for the self-employed, using the state-by-industry design (using the microregion-by-industry design), a one-standard-deviation increase in the fraction of affected workers corresponds to a 22 (24) percentage point change on a basis of 35% (35%).

[26]Note, however, that Haanwinckel (2025) focuses on potential misspecification arising from designs using the fraction of affected workers at the regional level, not at the state-by-industry level.

tiles) to the bottom quartile of the treatment intensity variable (20 log points vs. 15 log points in 2009).

Robustness to mean reversion. Mean reversion can arise if low-wage cells exhibit greater growth than high-wage cells simply by virtue of being in the bottom of the wage distribution. Alternatively, mean reversion can stem from measurement error in our treatment variable.

With regards to the first source of mean reversion, it is possible that lower wage jobs experienced faster relative wage growth in Brazil for reasons unrelated to the minimum wage (due to regional wage convergence, for example, as emphasized by Haanwinckel (2025)). Our bunching difference-in-differences design, which estimates changes in the probability of being in a given wage bin (see Equation 2), allows us to test whether our wage effects are directly related to minimum wage policy or if they simply reflect faster relative growth at the bottom of the wage distribution. Appendix Figure D3a and D3b document precise 0 effects in the probability of being in any given wage bin in the pre-period years 1995 and 1998 (relative to 1999) — when the minimum wage remained stable — and for all wage bins below the 2009 minimum wage and right above.[27] By contrast, for 2001 and 2009, Appendix Figures D3c and D3d show that our treatment variable is associated with an increased probability of being at the statutory minimum wage associated with each year.[28] Appendix Figures D4- D6 show these same results for intensive-informal, extensive-informal, and self-employed workers, respectively. The results in these figures show that our treatment variable—the share of workers below the 2009 minimum wage in 1999—is associated with an increased probability of being at the statutory minimum wage associated with each year, for the years 1995, 1998, 2001, and 2009, respectively. Because the mass tracks the various levels of minimum wages over the period of large increases, we view our design as capturing the effects of minimum wage policy on the wage distribution, rather than mere "catch-up" at the bottom of the wage distribution.

The second type of mean reversion may be a concern if some state-by-industry cells that are classified as strongly treated in 1999 are in fact weakly treated in some other year before the policy (say, 1995), due to measurement error in wages in PNAD.[29] If this is the case, then our estimated wage effects from the difference-in-differences model presented above do not capture the causal effect of the minimum wage but simply reflects mean reversion. In the spirit of Dustmann et al. (2022) and Derenoncourt and Weil (2025), we show in Appendix

[27] This result is also true for the pre-period years 1996 and 1997 that we report in our slides here.
[28] This result is true for all the post-period years 2001-2015 that we report in our slides here.
[29] The consistent results using census data also alleviate this concern, given the much larger sample size.

Figure D7 that defining the treatment variable in 1995 does not affect the pattern of our wage effects along the wage distribution. We find—as expected in the absence of measurement error—precise 0 effects in the probability of being in any given wage bin in 1995 and 1998, as in Appendix Figure D3a and D3b, and mass right in the bin that contains the minimum wage in 2001 and 2009. We show the exact same pattern of results when defining the treatment variable in 1996, 1997 and 1998 in Appendix Figures D8, D9 and D10 respectively, alleviating concerns regarding a possible measurement error in the treatment variable.

Sensitivity to exposure to subnational minimum wages. In Appendix A.2 (see the paragraph "State-level minimum wages since 2001"), we motivate our focus on federal as opposed to state minimum wages in Brazil. Four states had instituted regional minimum wages by 2009, varying by occupation. Only Rio Grande do Sul has regional minimum wages that also vary by industry—a feature that is the most directly related to our state-by-industry design. We collect all the regional minimum wage floors by fine industry categories (using CNAE 2.0 codes, a 5-digit classification system) and create a regional minimum wage database (see Appendix A.3). We map these 5-digits industry code into the (coarser) industry categories used in PNAD. We show that when assigning regional wage floors to the entire industry category we use in PNAD—therefore arguably leading to an upper bound of the fraction of affected formal workers—the treatment variable that uses the regional wage floors is highly correlated with the treatment variable that uses the federal minimum wage alone. The correlation coefficient is 0.96. We also note that the share of the formal private workforce in our sample in Rio Grande do Sul represents 7.6% of the Brazilian formal workforce in 1999, leading us to conclude that taking into account regional minimum wages would not greatly affect our results.

Robustness to potential confounding factors. In Table 3, we report our baseline wage estimates for the four groups of workers in 2009 and assess their robustness (in columns (2) to (4)) to three potential confounders that could affect wages at the same time as the minimum wage increases and that could differentially affect strongly versus weakly treated cells.

First, one may worry that our wage effects are confounded by the rise in educational attainment (Firpo and Portello, 2019; Haanwinckel, 2024) and differential changes in the skill composition of the workforce over time. If, for example, workers in the weakly treated state-by-industry cells experience a large increase in their level of education relative to workers in strongly treated cells, then we might worry that our baseline wage effect overestimates the

causal effect of the minimum wage as some of the increase may instead be attributable to shocks affecting the skill distribution. Our baseline specification in Equation 1 alleviates this concern by including a set of time-varying individual-level controls (gender, race, education, and experience and its square). Moreover, when we remove these individual-level controls (see Table 3 column (2)) from our regression equation, the wage effects among all types of workers remain fully aligned with our baseline estimates, suggesting that composition effects are unlikely to be at play.

Second, one may worry that Bolsa Família—the major Brazilian cash transfer program gradually scaled up during the 2000s—differentially affected workers' outside options across our highly vs. weakly exposed cells. Data on per-capita expenditures of Bolsa Família at the state level, and divided by state GDP, indeed show that the generosity of this transfer is much higher in the Northeast and the North—the poorest region in Brazil—than in the South or Southeast (see Appendix Figure A3b). If Bolsa Família leads to greater labor force withdrawal among high poverty households with low potential earnings, the earnings of workers in these state-by-industry groups may increase purely through compositional effects, leading to an upward bias in our baseline estimates. We find no evidence of this bias among formal employees, intensive-margin informal employees, or the self-employed when we include state level controls on the per-capita level of Bolsa Família transfers (see Table 3 column (3)). Our wage effect among workers on the extensive margin of informality increases compared to our baseline estimate—but the difference is not statistically significant.

Finally, one may worry that our wage effect is confounded by the rise of policies aimed at reducing informality—namely the increase in the number of labor inspections starting in the second half of the 1990s, combined with the fact that enforcement is not randomly allocated across the country.[30] We collect data on the number of inspectors by state in 2002 from Ponczek and Ulyssea (2022) and include this number interacted with a year fixed effect in our regression. Doing so does not affect the magnitudes of our wage effects for any of the four groups of workers (see Table 3 column (4)).

[30] Almeida and Carneiro (2012) stress in particular that enforcement may be stricter in places where violations of the law are more prevalent—as the bulk of inspections are triggered by anonymous reports of illegal activity (see also Cardoso and Lage (2005)) or in places with higher quality institutions. In both cases enforcement might be correlated with labor market outcomes.

5 Minimum wage effects on the allocation of employment

In the setting of a low- or middle-income country, the potential for minimum wages to benefit workers and reduce poverty hinges not only on the policy's effect on wages, but also on its effects on formalization, specifically the reallocation of employment away from the formal sector. We assess this using two different empirical strategies: a bunching difference-in-differences design adapted from Cengiz et al. (2019) and the approach we use in Section 4.3, and a linear probability model at the individual worker level. We use the first approach to examine changes in the number of formal jobs along the wage distribution. The second approach allows us to explicitly consider reallocation from the formal sector towards alternative modes of employment. We also use the second approach to compute the own-wage reallocation elasticity: the percent change in formal vs. other employment associated with a percent increase in the formal wage from the minimum wage.

The own-wage reallocation elasticity summarizes the extent of reallocation out of formal jobs, or changes in formalization, in response to minimum wage policy. This elasticity can be compared to the own-wage employment elasticity estimated in many high-income country settings to quantify the employment losses caused by minimum wage increases. In lower-income countries where compliance with labor law may be incomplete, a relevant displacement margin is the reallocation of jobs out of the compliant, formal sector into other sectors of the economy. We believe this parameter, if collected across many low- and middle-income country settings with minimum wage increases, can help assess the potential negative effects of minimum wages on the share of formal employment in the economy.

5.1 Estimating effects of the minimum wage on the allocation of employment

Reallocation effects using a bunching approach. To assess reallocation out of the formal sector using a bunching approach, we first aggregate the worker-level microdata to a yearly count of workers in each type of employment (formal, intensive-margin informal, extensive-margin informal, or self-employment) at the wage-bin-by-state-by-industry level. As in Section 4.3, wage bins are 10 log-point increments of monthly earnings. Our outcome variable is formal employment in a given wage-bin-by-state-by-industry cell divided by economy-wide employment in 1999 in that state-by-industry group. This normalization yields a straightforward interpretation of our results as reallocation towards or away from formal employment separately for each wage bin that is attributable to the minimum wage reform.

To quantify changes in the allocation of formal jobs along the earnings distribution, we estimate the following specification:

$$\frac{E^{\text{f}}_{sjtk}}{E^{\text{all}}_{sj,1999}} = \sum_{\substack{\tau=1995 \\ \tau\neq 1999}}^{2015} \sum_{\eta=-4}^{12} \alpha_{\tau\eta} \text{Share Affected}_{sj} \times \mathbb{1}_{[t=\tau]} \times \mathbb{1}_{[k=\eta]} + \zeta_{sjk} + \nu_{jtk} + \epsilon_{sjtk} \tag{3}$$

with $\frac{E^{\text{f}}_{sjtk}}{E^{\text{all}}_{sj,1999}}$ being the number of formal workers in state s, industry j, year t, and wage bin k, relative to 1999 total employment in that state-by-industry cell. Our treatment variable is Share Affected$_{sj}$, the share of workers below the 2009 minimum wage at the state-by-industry level in 1999. $\alpha_{\tau\eta}$ is the effect of the reform in year τ relative to base year 1999 in wage bin η. ζ_{sjk} and ν_{jtk} are state-by-industry-by-wage-bin and year-by-industry-by-wage-bin fixed effects. We cluster our standard errors at the state-by-industry level.

As with our wage analysis in Section 4, our identifying assumption is that changes in the frequency distribution of wages in less vs. more highly exposed cells would mirror each other in the absence of large minimum wage increases. We probe the plausibility of this assumption by examining pre-trends in the number of workers above and below the minimum wage, which we discuss in greater detail below.

We assess effects on reallocation in the part of the distribution at or below the 2009 minimum wage as well as overall reallocation across the whole distribution. By summing $\alpha_{2009,\eta}$ across the bins below the minimum wage, or bins -4 to -1, we capture the effect of increased exposure on the share of jobs below the 2009 minimum wage. The effect on the share of jobs at the minimum wage is $\alpha_{2009,0}$. Finally, for the whole distribution above the minimum, we sum the difference-in-differences coefficients across all wage bins 0 through 16: $\sum_{\eta=0}^{\eta=16} \alpha_{2009,\eta}$.

We follow notation in Cengiz et al. (2019) closely and define the missing formal jobs below the minimum wage as $\Delta b = \sum_{\eta=-4}^{\eta=-1} \alpha_{2009,\eta}$. We define the excess formal jobs at the minimum wage as $\Delta a = \alpha_{2009,0}$. All formal jobs at or above the minimum wage we define as $\Delta a^* = \sum_{\eta=0}^{\eta=16} \alpha_{2009,\eta}$.

From these definitions of missing and excess formal jobs, we define two reallocation effects. We define directly affected reallocation as $\Delta f = \frac{\Delta a + \Delta b}{\bar{\text{b}}_{1999}}$, where $\bar{b}_{1999}$ is the sample average share below the 2009 minimum wage in 1999, averaged across state-by-industry cells. The interpretation of Δf is the percent change in directly affected formal employment, that is reallocation from or to formal employment at or below the minimum wage. We further define an overall reallocation effect as $\Delta f^{\text{all}} = \sum_{\eta=-4}^{\eta=16} \alpha_{2009,\eta} - \alpha_{1999,\eta}$.

Reallocation effects using a linear probability model. Our bunching approach yields estimates of changes in the number of formal jobs both along and across the whole wage distribution. To more explicitly assess reallocation to other modes of employment or to non-employment, we turn to a linear probability model of the overall reallocation effect.

We estimate two separate models using PNAD data to quantify the reallocation effect out of the formal labor force. The first one quantifies reallocation out of the formal labor force towards other types of employment. Specifically, we estimate the following equation using labor force survey data:

$$\text{Formal employee}_{it} = a^{\text{emp}} + \sum_{\substack{\tau=1995 \\ \tau\neq 1999}}^{2015} \beta_{\tau}^{\text{emp}} \text{Share Affected}_{s(i)j(i)} \times \mathbb{1}_{[t=\tau]} + \mathbb{X}_{it}'\Gamma^{\text{emp}} + \rho_{s(i)j(i)}^{\text{emp}} + \mu_{j(i)t}^{\text{emp}} + \varepsilon_{it}^{\text{emp}} \tag{4}$$

where the outcome is an indicator for formal employee vs. informal employee (both intensive and extensive margin) or self-employed. We use the same treatment variable as above, at the state-by-industry level; as well as the same individual-level controls and state GDP controls $\mathbb{X}_{it}$ as for the estimation of the wage effects (see Equation 1). We also include the same fixed effects: state-by-industry $\rho_{s(i)j(i)}^{\text{emp}}$ and industry-by-year fixed effects $\mu_{j(i)t}^{\text{emp}}$. Standard errors are clustered at the state-by-industry level. Our coefficient of interest is $\beta_{\tau}^{\text{emp}}$ divided by the average formal employment share in 1999, i.e., the percent change in the share of formal employees among the total private workforce associated with a one-standard-deviation increase in the share of affected workers.

The second one quantifies reallocation out of the formal labor force towards other types of employment or towards non-employment, to capture potential responses on the extensive margin of employment. We use the following model:

$$\text{Formal employee}_{it} = a^{\text{epop}} + \sum_{\substack{\tau=1995 \\ \tau\neq 1999}}^{2015} \beta_{\tau}^{\text{epop}} \text{Share Affected}_{s(i)} \times \mathbb{1}_{[t=\tau]} + \mathbb{X}_{it}'\Gamma^{\text{epop}} + \rho_{s(i)}^{\text{epop}} + \mu_{t}^{\text{epop}} + \varepsilon_{it}^{\text{epop}} \tag{5}$$

where the outcome is an indicator for formal employee vs. informal employee, self-employed, unemployed or not in the labor force. Importantly, the treatment variable is now defined at the state level – as we cannot assign treatment to the non-employed, who do not have an industry. Accordingly, we include state and year fixed effects, and the standard errors are clustered at the state level. The set of individual-level controls is the same as above, except that it excludes experience and its square.

We adapt both models to be estimated with census data as well, where we only have the years 2000 and 2010. This allows us to probe the consistency of our results across data sources.

Own-wage reallocation elasticity. We use the estimates from the linear probability models described above to compute the own-wage reallocation elasticity, e.g.:

$$\frac{\Delta\%\text{Reallocation out of formal}}{\Delta\%\text{Formal Wage}} = \frac{\beta^{\text{emp}}_{2009}}{\beta^{\text{wage}}_{2009}}.$$

How do we assess and interpret the magnitude of empirically estimated reallocation elasticities? Reviewing evidence primarily in high-income countries, Dube (2019) characterizes own-wage employment elasticities of less than -0.4 as "small," those between -0.4 and -0.8 as medium, and those more negative than -0.8 as large. For lack of a more direct set of comparison estimates, we use the same benchmark to assess our reallocation elasticities.

5.2 Results on the allocation of employment

Effect of the minimum wage on the formal share of employment. Figure 5a examines the share of formal employment. The outcome is the number of formal employees in that wage bin in 2009 divided by total employment in that state-by-industry cell in 1999, aggregated across all sectors of employment. Reallocation in the part of the distribution that is very close to the minimum wage is effectively zero: -0.4%. The effect on reallocation across all wage bins is reported in the upper right corner of the figure in this panel: a statistically significant reduction in the share formal of -4.4%. This larger negative formal employment effect includes small declines in formal jobs across bins in the middle of the earnings distribution. These declines could reflect employment spillovers of the minimum wage up the distribution. Alternatively, they may indicate the presence of confounding shocks to state-industry cells with greater exposure to the minimum wage. In Appendix Figures E1 and E2, we probe which parts of the economy exhibit declines in formal employment in the middle of the distribution. Excluding each region sequentially from the analysis shows that the effects are driven by the Northeast. We re-estimate our results using census data, where we have sufficient power to include region-by-year fixed effects to absorb any confounding regional shocks. The results, reported in Appendix Figure E3, show that the total reallocation effect is similar after including region-by-year fixed effects, which control for these region-specific shocks.

Figure 5b shows the effect of the policy on missing and all excess (at or anywhere above the minimum wage) formal share of jobs dynamically. We define missing and excess mass relative to the 2001 minimum wage, the first minimum wage of the post-period. The figure shows flat pretrends in both missing and excess mass followed by a shift out of the bins below the 2001 minimum wage and into the bins above the 2001 minimum.

Estimation results on own-wage reallocation elasticities. Table 4 reports our results using the linear probability models described in equations 4 and 5. The table reports reallocation effects towards other types of employment (first column) and towards other types of employment, unemployment or non-employment (fourth column), across data sources. We combine these reallocation estimates with wage effects of the policy on formal workers (using the model from Equation 1 in Section 4 to estimate the own-wage reallocation elasticity for the formal sector.

Panel A reports our estimates of the overall reallocation effect, the wage effect on formal workers, and the own-wage reallocation elasticity (columns 1-3, respectively), using data from PNAD. We estimate a decline in the share of formal employment of 3.6%, highly consistent with the estimate from our bunching analysis above. Combining this estimate with the estimated wage effect for formal workers of 12.8 log points, we find an own-wage reallocation elasticity of -0.28 in 2009.[31]

That is, for a 10% increase in average wages as a result of the policy, there is a 2.8 percent shift into other modes of employment out of the formal salaried sector. Panel B (third column) reports a highly consistent reallocation elasticity of -0.29 using census data.

Columns 4 uses the linear probability model described in Equation 5, with treatment defined at the state level, to examine reallocation away from formal employment to both other forms of employment as well as non-employment. Effects on formal employment are extremely similar across the two designs. Using PNAD, we find a decrease in formal employment of -0.038 (Panel A, fourth column) as opposed to -0.036 and the two effects are not statistically distinguishable. Because of a smaller wage effect using the state design, we estimate a slightly larger reallocation elasticity of -0.37 (Panel A, sixth column). We also estimate the state design in census and once again find an extremely similar effect on employment: a decline of -0.025 (Panel B, fourth column) vs. -0.029, which are also statistically indistinguishable from each other. As in the PNAD data, the wage effect using the state design

[31] The reason the wage effect differs slightly from that reported in Table 3 is that here we estimate the effect for both full-time and part-time formal workers while Table 3 reports the wage effect for full-time formal workers only.

in census is smaller than that of the state-by-industry design. Because the employment effect is slightly less negative, we get a very similar own-wage reallocation elasticity of -0.28 (Panel B, sixth column) rather than -0.29. Our estimated own-wage reallocation elasticities are highly consistent with the bulk of the evidence from minimum wage studies in higher income countries. Dube (2019), surveying this literature, reports that over 70% of estimated own-wage employment elasticities, are smaller (more positive) than -0.40 and classifies these as "small" employment effects.

Across both our designs for assessing reallocation, our evidence points to modest reductions in formal employment after the minimum wage increases in Brazil. Where does formal employment shift to after the policy? The fact that we estimate similar effects when looking at reallocation among employed workers (first column of Table 4) versus reallocation inclusive of the non-working population (fourth column) suggests the policy had minimal effects on overall employment and labor force participation. We explore what specific type of non-formal employment the workforce shifted towards in Appendix Table E1, by estimating linear probability models where the outcome is employment of a given type vs. all others. We use the treatment variable specific to each group of workers, as in Section 4. Though we cannot trace reallocation within non-formal employment with great precision, our results point to increases in intensive-margin informal employment, no clear effect on extensive-margin informal employment, and decreases in self-employment.

Weekly hours elasticity. We also check for intensive-margin effects on employment, specifically examining the effects of the minimum wage on the number of hours worked, using the weekly hours variable available in PNAD. We estimate the effect on the log of weekly hours using the same specification as our baseline effect on wages (see Equation 1 in Section 4.1).

Effect of the minimum wage on weekly hours. Appendix Table E2 shows a precise zero effect of the large minimum wage increases on weekly hours worked in the formal sector—a result consistent with Engbom and Moser (2022) on contracted hours. Weekly hours elasticities are small and not statistically significant by 2009 in all other sectors. Appendix Figure E4 shows no pre-trends in our estimated effect on weekly hours.

5.3 Interpretation and implications for the formalization process

Interpretation and discussion. How can we explain our small reallocation effects? One hypothesis is that employers have limited incentives to switch their employees to informal

arrangements because the minimum wage is nearly universally applied in formal firms. This hypothesis is consistent with the precise zero average wage gap between formal and informal workers within firms documented in Ulyssea (2018).[32] In turn, this compliance has several potential explanations, which we discuss below.

First, it may be due to the relatively high penalties associated with violating labor laws. A formal employer that employs informal workers below the minimum wage needs to pay two fines if caught: one for violating the minimum wage law and one for evading taxes on social security contributions. In Brazil, both fines are levied per worker for whom a violation is detected.[33] We calculate that the penalty associated with paying below the 1999 minimum wage is large, amounting up to 7.5 times the monthly minimum wage per worker paid below the minimum wage for small firms (10 or fewer workers). For large firms (with 100+ workers), the penalty is up to 11 times the monthly minimum. The penalty is larger than the penalty associated with not registering informal workers and evading social security contributions. The minimum wage violation penalty is 1.1 larger than the tax evasion penalty for small firms (10- workers) for a primo-violation and 2.2 larger for a repeated minimum wage violation (see Appendix A.5 for more details).[34] This feature of enforcement policies may help explain the large passthroughs we observe in both margins of informality. They also help explain the spikes at the minimum wage in both margins of informality before the large minimum wage increases.

Second, fairness considerations within firms (as highlighted in Machin and Giupponi (2024)) may explain why there is a large spike at the minimum wage among informal employees in formal firms. More generally, Maloney and Méndez (2004) hypothesize that in Brazil and other Latin American countries such as Columbia and Mexico, the minimum wage could serve as an important benchmark for "fair" remuneration—a phenomenon that could also explain the spike at the minimum wage among informal employees in informal firms.

Third, competitive mechanisms might be at play. This hypothesis is consistent with the fact that informal employees working in formal firms at the minimum wage look like formal workers on observable characteristics (see Appendix Table B5). This limits workers

[32] See Table 2 column (3) in Ulyssea (2018).

[33] In the absence of a formal employment contract, labor inspectors may rely on indirect evidence, such as testimonies from the worker or third parties, documentation (receipts, messages, or photos), or on-site inspection reports. The lack of a written contract does not exempt the employer from compliance. The *Regulamento da Inspecao do Trabalho* (Decree 4.552/2002) explicitly mandates: (i) verification of employment registration (Art. 18, I, "a"); (ii) authority to interrogate workers/employers (Art. 18, III); and (iii) power to demand documents and examine digital or physical evidence (Art. 18, IV–VII).

[34] Corresponding figures are 1.6 and 3.2 for large firms (100+ workers).

heterogeneity around the minimum wage, which is the part of the distribution where most informal workers on the intensive margin of informality are located.

Lastly, previous work has explored the role of the minimum wage as a numeraire for the entire economy in Brazil. However, we find little evidence for this explanation during our period of study. Using matched employer-employee data for the formal labor force (see Appendix Figure F1) and census data for formal and informal workers (see Appendix Figure F2), we do not find strong evidence of bunching at multiples of the minimum wage over our period of interest (a period of relatively low inflation).

Implications for the formalization process. Given our estimates of reallocation away from the formal sector, we can ask the question: what would have been the formal share in the economy in the absence of the 2000s minimum wage increases? To answer this question we estimate yearly counterfactual formal and informal shares implied by our own-wage reallocation estimates.[35] These calculations rely on three assumptions, motivated by our findings: (i) the minimum wage did not have overall disemployment effects, consistent with our findings in Table 4; (ii) the shift out of formal employment is absorbed by informal salaried employment, consistent with our results in Appendix Table E1; and (iii) there are no general equilibrium effects of the minimum wage, i.e., the minimum wage doesn't interact with other economic forces that could influence the formal share of the economy.

Results are shown in Figure 6. Under these assumptions, we find that absent the 2000-2009 minimum wage increases, the formal share would have been 64.3% in 2009 instead of the actual share of 62.1%.[36] The counterfactual formal share of 64.3% in 2009 corresponds to the level that was observed in 2010.[37] Absent the minimum wage increases, the formalization process would have been sped up by one year for the entire private workforce of salaried workers.

[35] Annual reallocation elasticity estimates are displayed in Appendix Table E3.

[36] Specifically, our -0.28 own-wage reallocation elasticity in 2009 implies that the 70.9% minimum wage increase from 1999-20009 (as measured by the Kaitz index) is associated with a 13.2% increase in average formal wages and a 3.6% shift out of formal employment.

[37] More precisely, we do not directly observe the formal share in 2010, but this is the level at which this share would have been in 2010 in PNAD, under the assumption that the formalization process is linear between 2009 and 2011.

6 Conclusion

This paper studies how the minimum wage affects wages and the allocation of employment in a middle-income country with substantial and varying forms of informality. A key question in these settings is how minimum wages affect formalization. Our context is Brazil, which experienced large minimum wage increases in the 2000s and whose economy is characterized by a sizable and heterogeneous informal sector—a large fraction of which consists of salaried employees of firms—and the availability of detailed labor force surveys and administrative matched employer-employee data with information on formality status.

We provide evidence on the bite of the minimum wage across three clear margins of employment outside of the formal salaried sector: informal salaried employees of predominantly formal firms (intensive margin), informal salaried employees of predominantly informal firms (extensive margin), and the self-employed. We use differential bite of the 2009 minimum wage across state-by-industry cells to quantify the effect of the minimum wage increases on each of these groups. We find that informal workers also see large wage gains. In particular, informal workers in formal firms see about 88% of the increase that formal workers experience while informal workers in informal firms see about 59% of the formal wage increase. We find no clear evidence of increased wages for the self-employed.

We turn to the formal-to-informal reallocation effects of the minimum wage next. We estimate the own-wage reallocation elasticity—the extent to which employment shifts from the formal to the informal sector in response to wage increases in the formal sector. For a 10% increase in formal sector wages, 2.8% of formal workers are reallocated to the informal sector or self-employment. These effects are relatively modest in the context of minimum wage employment effects. We believe the substantial compliance with the minimum wage outside of formal sector employment undergirds these small reallocation effects.

New models of the labor market with wage passthrough to informal workers would be useful for understanding the economic effects of wage regulations in countries with a large informal workforce. Brazil's institutional setting with separate fines for minimum wage violations vs. tax evasion on social security contributions may contribute to wage passthrough. Models of the labor market integrating the design of enforcement policies might help us better understand the effects of minimum wage policies in similar settings.

A final caveat is that the period we study is one of economic growth, and wage effects in the informal sector might be more muted in worse economic conditions, leading to more reallocation away from the formal sector. Research on own-wage reallocation elasticities in

other low- and middle-income countries will deepen our understanding of when and why minimum wages bind outside of formal employment and will further our understanding of minimum wage effects in developing economies.

References

Almeida, R. and Carneiro, P. (2012). Enforcement of Labor Regulation and Informality. *American Economic Journal: Applied Economics*, 4(3):64–89.

Bacha, E. and Taylor, L. (1978). Brazilian Income Distribution in the 1960s: 'Facts', Model Results, and the Controversy. *Journal of Development Studies*, 109:271–297.

Bassier, I. (2022). Collective Bargaining and Spillovers in Local Labor Markets. Discussion Paper 1895, Centre for Economic Performance, London School of Economics and Political Science.

Bosch, M. and Manacorda, M. (2010). Minimum Wages and Earnings Inequality in Urban Mexico. *American Economic Journal: Applied Economics*, 4(2):128–49.

Breza, E. and Kaur, S. (2025). Labor Markets in Developing Countries. *The Annual Review of Economics*, 17:747–76.

Broecke, S., Forti, A., and Vandeweyer, M. (2017). The Effect of Minimum Wages on Employment in Emerging Economies: a Survey and Meta-Analysis. *Oxford Development Studies*, 45(3):366–391.

Brotherhood, L., Da Mata, D., Guner, N., Kircher, P., and Santos, C. (2023). Labor Market Regulation and Informality. Working Paper 2308, CEMFI.

Brown, C. (1999). Minimum Wages, Employment, and the Distribution of Income. In Ashenfelter, O. and Card, D., editors, *Handbook of Labor Economics*, volume 3B, pages 2101–2163. Elsevier.

Callaway, B., Goodman-Bacon, A., and Sant'Anna, P. H. C. (2025). Difference-in-Differences with a Continuous Treatment. Working paper.

Card, D. and Krueger, A. B. (1995). *Myth and Measurement: the New Economics of the Minimum Wage*. Princeton University Press, Princeton.

Cardoso, A. and Lage, T. (2005). A Inspecao do Trabalho no Brasil. *Dados*, 48(3):451–90.

Cengiz, D., Dube, A., Lindner, A., and Zipperer, B. (2019). The Effect of Minimum Wages on Low-Wage Jobs: Evidence from the United States Using a Bunching Estimator. *Quarterly Journal of Economics*, 134(3).

Corseuil, C. H., Foguel, M., and Hecksher, M. (2013). Efeitos dos Pisos Salariais Estaduais Sobre o Mercado de Trabalho: Uma Nova Abordagem Empírica. Discussion Paper 1887, Instituto de Pesquisa Econômica Aplicada - IPEA.

Derenoncourt, E., Gerard, F., Lagos, L., and Montialoux, C. (2025). Racial Inequality, Minimum Wage Spillovers, and the Informal Sector. Working paper.

Derenoncourt, E. and Montialoux, C. (2021). Minimum Wages and Racial Inequality. *Quarterly Journal of Economics*, 136(1):169–228.

Derenoncourt, E. and Weil, D. (2025). Voluntary Minimum Wages: The Local Labor Market Effects of National Retailer Policies. *Quarterly Journal of Economics*. Forthcoming.

Dube, A. (2019). Impacts of Minimum Wages: Review of the International Evidence. Independent report, HM Treasury.

Dube, A. and Lindner, A. (2024). Minimum Wages in the 21st Century. In Dustmann, C. and Lemieux, T., editors, *Handbook of Labor Economics*, volume 5, pages 261–383. Elsevier.

Dustmann, C., Lindner, A., Schönberg, U., Umkehrer, M., and vom Berge, P. (2022). Reallocation Effects of the Minimum Wage. *The Quarterly Journal of Economics*, 137(1):267–328.

Engbom, N. and Moser, C. (2022). Earnings Inequality and the Minimum Wage: Evidence from Brazil. *American Economic Review*, 112(12):3803–47.

Fajnzylber, P. (2001). Minimum Wage Effects Throughout the Wage Distribution: Evidence from Brazil's Formal and Informal Sectors. Working paper 151, CEDEPLAR.

Feinmann, J., Hsu Rocha, R., and Lauletta, M. (2024). Payments Under the Table. Working Paper 4270665, SSRN.

Fields, G. S. (1990). *The Informal Sector Revisited*, chapter Labor Market Modelling and the Urban Informal Sector: Theory and Evidence. OECD.

Firpo, S. and Portello, A. (2019). Decline in Wage Inequality in Brazil: A Survey. World Bank Policy Research Working Paper 9096.

Gerard, F., Lagos, L., Severnini, E., and Card, D. (2021). Assortative Matching or Exclusionary Hiring? The Impact of Firm Policies on Racial Wage Differences in Brazil. *American Economic Review*, 111(10):3418–3457.

Haanwinckel, D. (2024). Supply, Demand, Institutions, and Firms: A Theory of Labor Market Sorting and the Wage Distribution. *American Economics Review*. Forthcoming.

Haanwinckel, D. (2025). Does Regional Variation in Wage Levels Identify the Effects of a National Minimum Wage? Working paper.

Haanwinckel, D. and Soares, R. R. (2021). Workforce Composition, Productivity, and Labour Regulations in a Compensating Differentials Theory of Informality. *The Review of Economic Studies*, 88(6):2970–3010.

Harasztosi, P. and Lindner, A. (2019). Who Pays for the Minimum Wage? *American Economic Review*, 109(8).

Harris, J. and Todaro, M. P. (1970). Migration, Unemployment, and Development: A Two Sector Analysis. *American Economic Review*, 60(1):126–142.

Hazell, J., Patterson, C., Heather, S., and Taska, B. (2025). National Wage Setting. Working paper.

Hinojosa, P. G. (2019). The Role of the Minimum Wage on the Declining Wage Inequality in Latin America: Evidence from Brazil. *Review of Economic Analysis*, 1(11):39–82.

Hjort, Jonas, L. X. and Sarsons, H. (2025). Across-Country Wage Compression in Multinationals. *American Econoic Review*. Forthcoming.

Jales, H. (2018). Estimating the Effects of the Minimum Wage in a Developing Country: A Density Discontinuity Design Approach. *Journal of Applied Econometrics*, 1(33):29–51.

Krueger, A. B. (1994). The Effect of the Minimum Wage when it Really Bites: A Reexamination of the Evidence from Puerto Rico. Working Paper 4757, National Bureau of Economic Research.

La Porta, R. and Shleifer, A. (2014). Informality and Development. *Journal of Economic Perspectives*, 28(3):109–26.

Lemos, S. (2009). Minimum Wage Effects in a Developing Country. *Labour Economics*, 16(2):224–237.

Macedo, R. B. M. and Garcia, M. E. (1978). Salario Minimo E Taxa De Salarios No Brasil. *Pesquisa e Planejamento Economico*, 10:1013–1044.

Machado Parente, R., Brotherhood, L., and Iachan, F. S. (2025). Minimum Wages, Inequality, and the Informal Sector. Working paper.

Machin, S. J. and Giupponi, G. (2024). Company Wage Policy in a Low-Wage Labor Market. Working paper.

Maloney, W. F. and Méndez, J. (2004). Minimum Wages in Latin America. In *Law and Employment: Lessons from Latin America and the Caribbean*, pages 231–259. University of Chicago Press.

Meghir, C., Narita, R., and Robin, J.-M. (2015). Wages and Informality in Developing Countries. *American Economic Review*, 105(4):1509–1546.

Moura, R. L. d. and Neri, M. C. (2007). Efetividade do 'Salário Mínimo Estadual': uma Análise via regressões quantílicas para dados longitudinais. FGV EPGE Economics Working Papers (Ensaios Economicos da EPGE) 665, EPGE Brazilian School of Economics and Finance - FGV EPGE (Brazil).

Neri, M., Gonzaga, G., and Camargo, J. (1999). Distribuiçao Regional Da Efetividade Do Salário Mínimo No Brasil. *Nova Economia*, 9:9–38.

Neumark, D., Cunningham, W., and Lucas, S. (2006). The Effects of the Minimum Wage in Brazil on the Distribution of Family Incomes: 1996-2001. *Review of Economic Analysis*, 1(80):136–159.

Neumark, D. and Mungía Corella, L. F. (2021). Do Minimum Wages Reduce Employment in Developing Countries? A Survey and Exploration of Conflicting Evidence. *World Development*, 137.

OECD (2025). Earnings and Wages: Median Earnings (2000–2025). OECD Data Explorer, accessed 17 April 2025.

Pastore, J. (1996). A Batalha dos Encargos Sociais. *A Folha de São Paulo*.

Peattie, L. (1987). An Idea in Good Currency and How It Grew: The Informal Sector. *World Development*, 15(7):851–860.

Perry, G. E., Maloney, W. F., Arias, O. S., Fajnzylber, P., Mason, A. D., and Saavedra, J. (2007). The Informal Sector: What Is It, Why Do We Care, and How Do We Measure It? In *Informality: Exit or Exclusion*, pages 21–41. World Bank.

Ponczek, V. and Ulyssea, G. (2022). Enforcement of Labor Regulation and the Labor Market Effects of Trade: Evidence from Brazil. *The Economic Journal*, 132(641):361–390.

Portes, R. and Schauffler, R. (1993). Competing Perspective on the Latin American Informal Sector. *Population and Development Review*, 19(1):33–59.

Saltiel, F. and Urzúa, S. (2022). Does an Increasing Minimum Wage Reduce Formal Sector Employment? Evidence from Brazil. *Economic Development and Cultural Change*, 70(4).

Samaniego de la Parra, B. and Fernández Bujanda, L. (2024). Increasing the Cost of Informal Workers: Evidence from Mexico. *American Economic Journal: Applied Economics*, 16(1):377–411.

Soares, S. S. (2002). O Impacto Distributivo do Salário Mínimo: a Distribução Individual dos Rendimentos do Trabalho. Texto para Discussão 873, Instituto do Pesquisa Económica Aplicada.

Souza, A. P., Firpo, S. P., Ponczek, V. P., Zylberstajn, E., and Ribeiro, F. G. (2012). Custo do Trabalho no Brasil: Proposta de uma nova metodologia de mensuração, Relatório Final.

Souza, P. R. and Baltar, P. E. (1979). Salario Minimo ea Taxa de Salarios no Brasil. *Pesquisa e Planejamento Economico*, 9(3):629–60.

Sun, L. and Shapiro, J. M. (2022). A Linear Panel Model with Heterogeneous Coefficients and Variation in Exposure. *Journal of Economic Perspectives*, 36(4):193–204.

Tepedino, P. B. (2013). O Efeito dos Pisos Salariais sobre o Novel de Emprego no Brasil. Technical report, Pontifica Universidade Catolica de Rio de Janeiro.

Terrell, K. (2009). Minimum Wages, Enforcement and Informalization of the Labor Market: Evidence from Brazil. Working paper.

Tokman, V. E. (1992). *Beyond Regulation, The Informal Economy in Latin America*. Lynne Rienner Publishers.

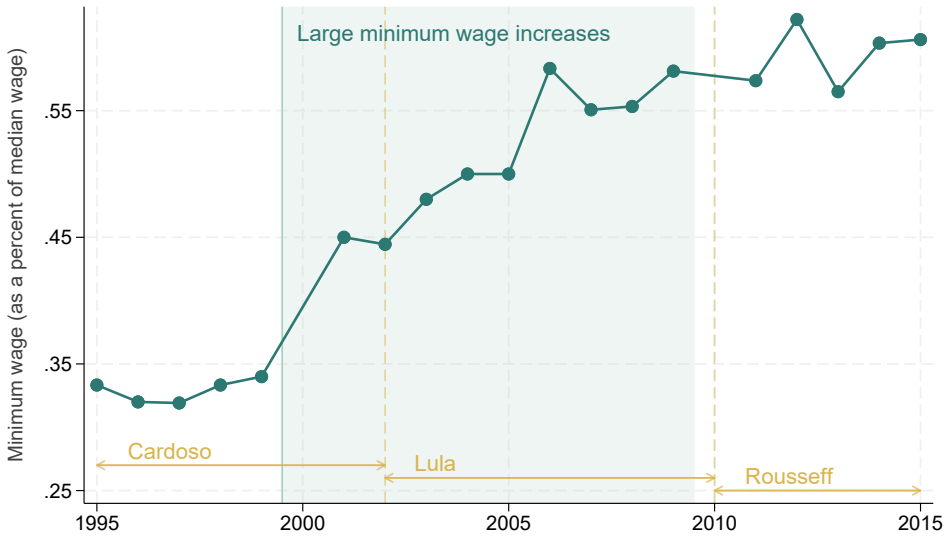
Turnham, D. and Erocal, D. (1990). Unemployment in Developing Countries, New Light on an Old Problem. Working paper, OECD Development Centre.

Ulyssea, G. (2018). Firms, Informality, and Development: Theory and Evidence from Brazil. *American Economic Review*, 108(8):2015–2047.

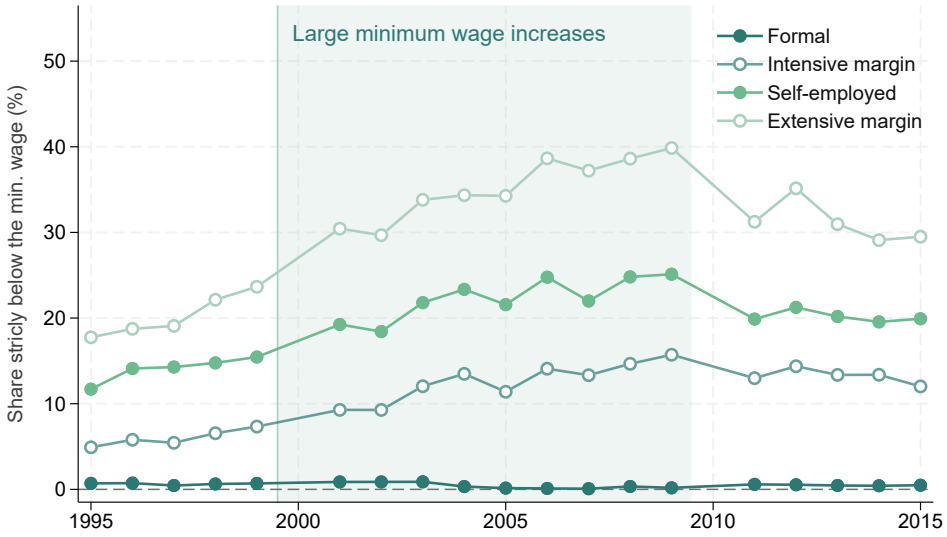
Ulyssea, G. (2020). Informality: Causes and Consequences for Development. *Annual Review of Economics*, 12(1):525–545.

Figure 1: Evolution of the minimum wage, as a share of the median wage (Kaitz index), and of the shares strictly below the minimum, 1995-2015

(a) Evolution of the minimum wage, as a share of the median wage (Kaitz index), 1995-2015



(b) Shares of workers strictly below the minimum wage, 1995-2015



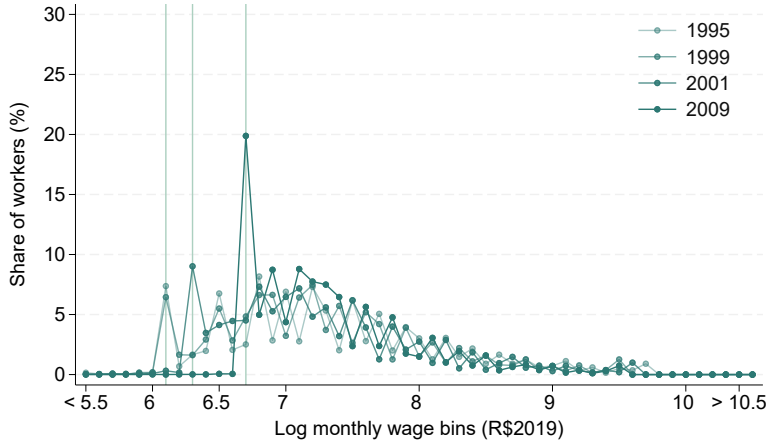
Sources: PNAD 1995-2015.

Sample: Adults aged 25-54 employed in the private sector, white or non-white, working full-time (i.e. 40 hours a week or more), with no missing monthly earnings variable, and with no missing experience variable. Panel (a): Formal employees only. Panel (b): Formal, informal employees and the self-employed.

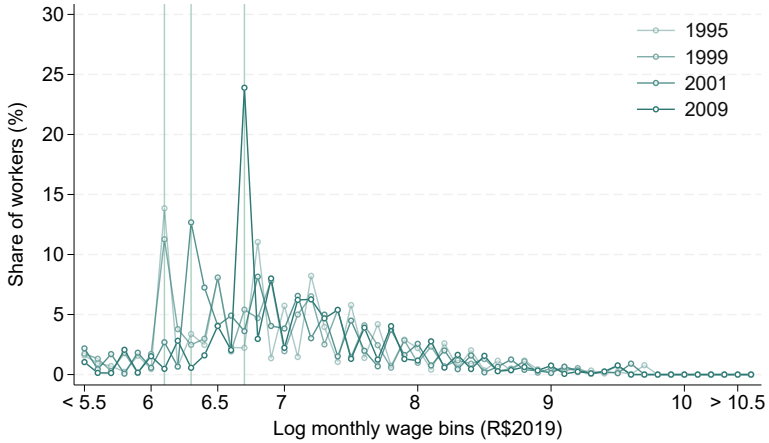
Notes: Panel (a): The Kaitz index calculated in the formal sector increases from 34% in 1999 to 58.1% in 2009. Panel (b): the share of formal employees strictly below the minimum wage is 0.7% in 1995, 0.7% in 1999, 0.9% in 2001, and 0.2% in 2009. The respective shares are 4.9%, 7.3%, 9.3%, and 15.7% for informal employees in formal firms (intensive margin of informality); 17.8%, 23.7%, 30.4%, and 40.0% for informal employees in informal firms (extensive margin of informality); and 11.7% , 15.5% , 19.2% and 25.1% for the self-employed.

Figure 2: Monthly earnings distributions among formal and informal employees

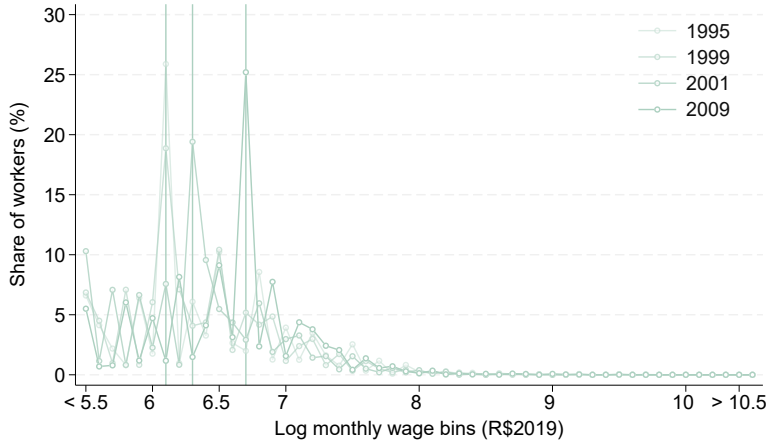
(a) Formal employees



(b) Informal employees in formal firms



(c) Informal employees in informal firms



(d) Among the self-employed

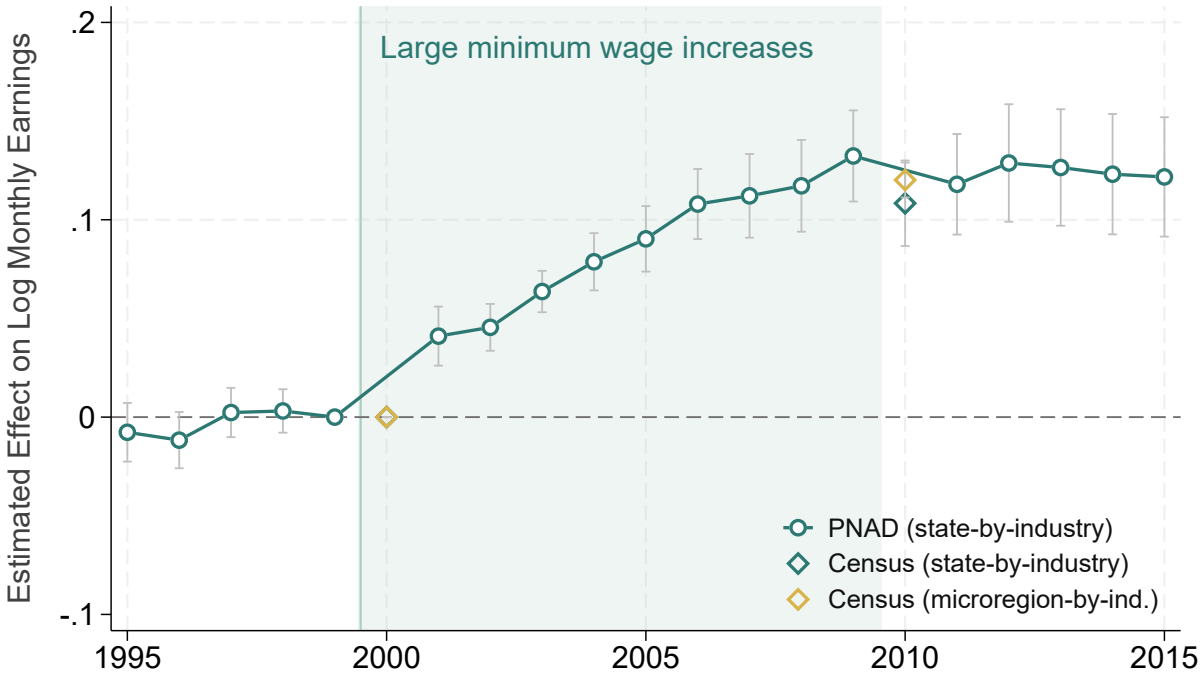
Sources: PNAD 1999-2015.

Sample: Adults aged 25-54, white or non-white, working full-time (i.e. 40 hours a week or more), with no missing monthly earnings variable, and with no missing experience variable. Sample further restricted to formal employees (a); informal employees in formal firms (b); informal employees in informal firms (c); and the self-employed (d).

Notes: The complete series of monthly earnings distributions from 1995 to 2015 is available in our slides here. The wage bin (10 log points wide) in which the minimum wage falls in each year is materialized by a vertical bar. The share of workers in the wage bin where the minimum wage falls and that can be directly read on the y-axis should therefore be understood as the share of workers within 10% of the minimum wage. The exact share of workers at or below the minimum wage are 7.8% in 1995, 6.2% in 1999, 8.4% in 2001, and 13.4% in 2009 among formal employees. The respective shares are 29.8%, 26%, 33% and 42.1% among all informal employees, 16.7%, 15.4%, 19.5%, 30.3% among informal employees in formal firms, and 38.2%, 34.5%, 45.1% and 53.2% among informal employees in informal firms.

Figure 3: Results on average wages

(a) Formal employees



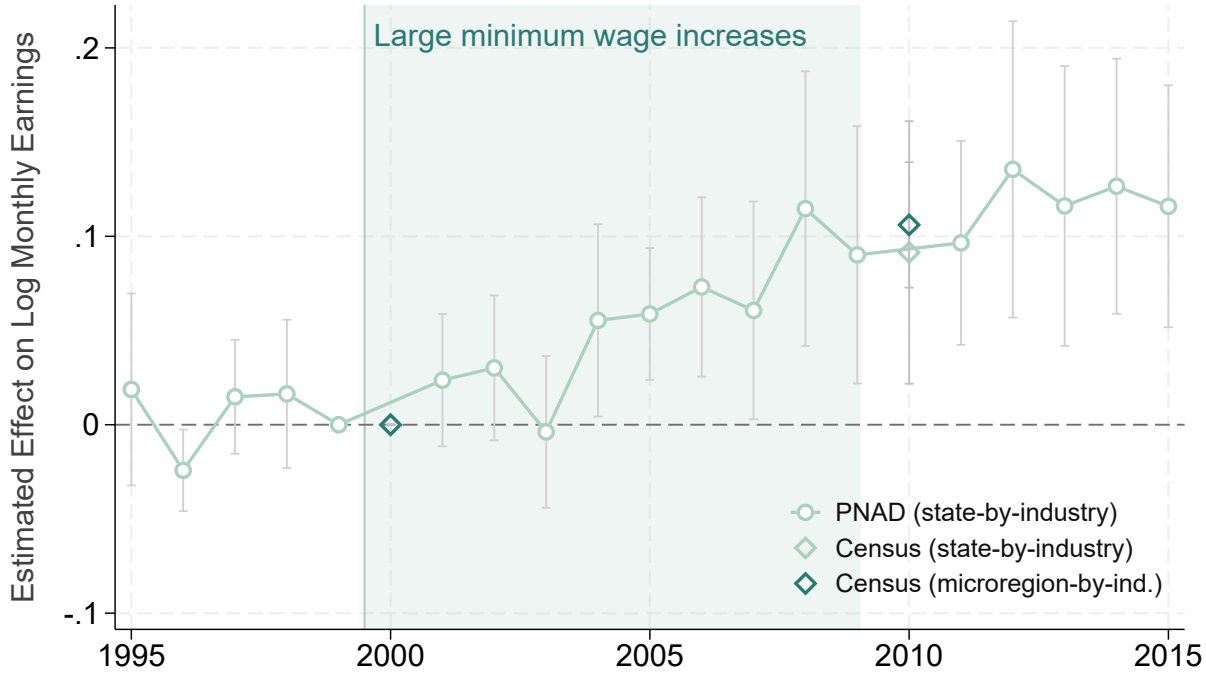
(b) Informal employees in formal firms (intensive margin)

Sources: PNAD 1995-2015.

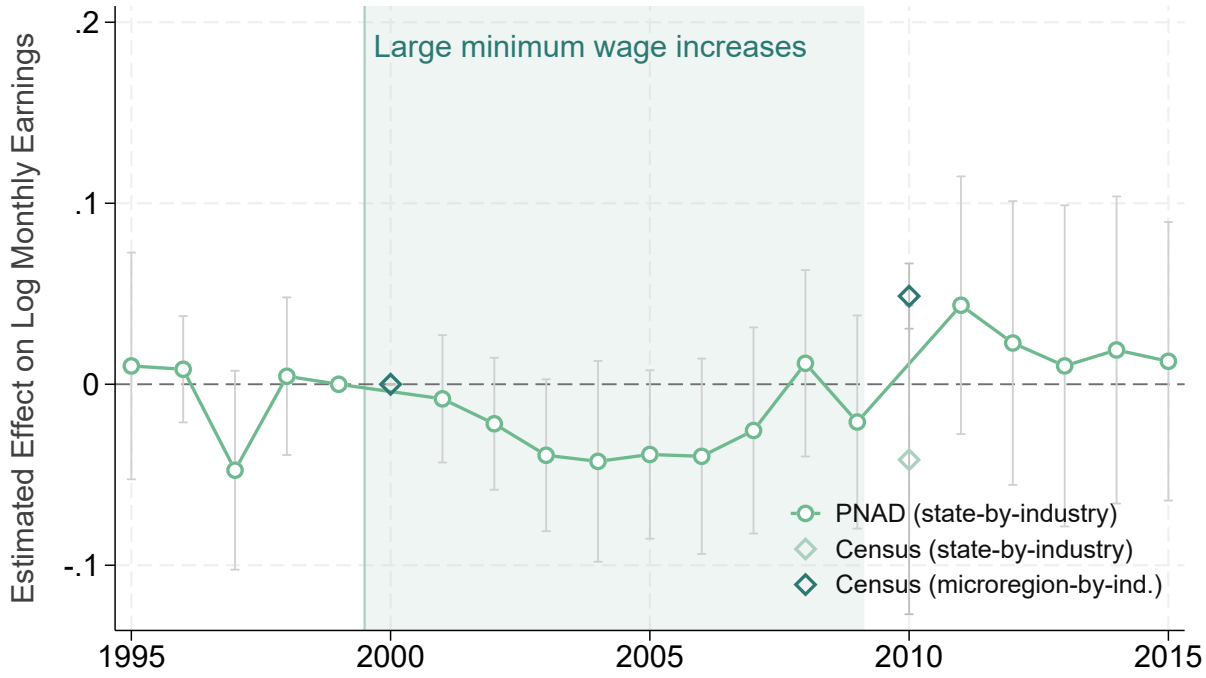
Sample: Adults aged 25-54, white or non-white, working full-time (i.e. 40 hours a week or more), with no missing monthly earnings variable, and with no missing experience variable. Panel (a) includes formal employees only; panel (b) includes informal employees working in formal firms only.

Notes: The figure shows the main results from our difference-in-differences design assessing the effect of the 2000-2009 minimum wage increases on average wages (see Equation 1 in Section 4.1 on PNAD data).

(c) Informal employees in informal firms (extensive margin)



(d) Self-employed



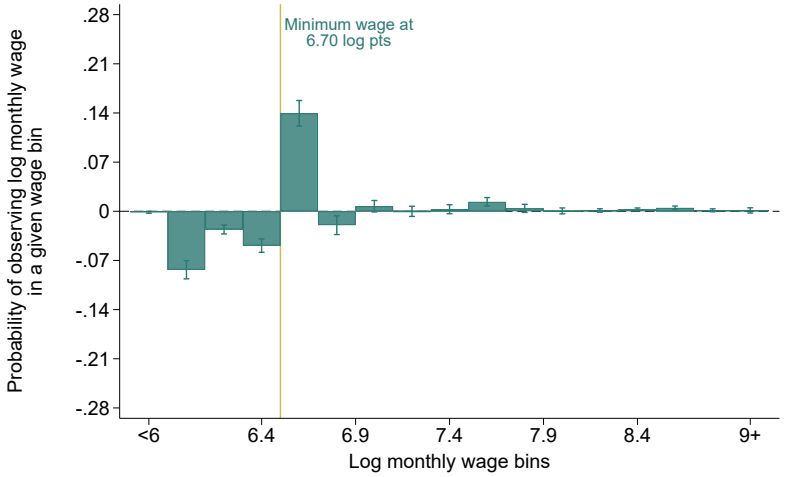
Sources: PNAD 1999-2015.

Sample: Adults aged 25-54, white or non-white, working full-time (i.e. 40 hours a week or more), with no missing monthly earnings variable, and with no missing experience variable. Panel (c) includes informal employees in informal firms only; panel (d) includes self-employed workers only.

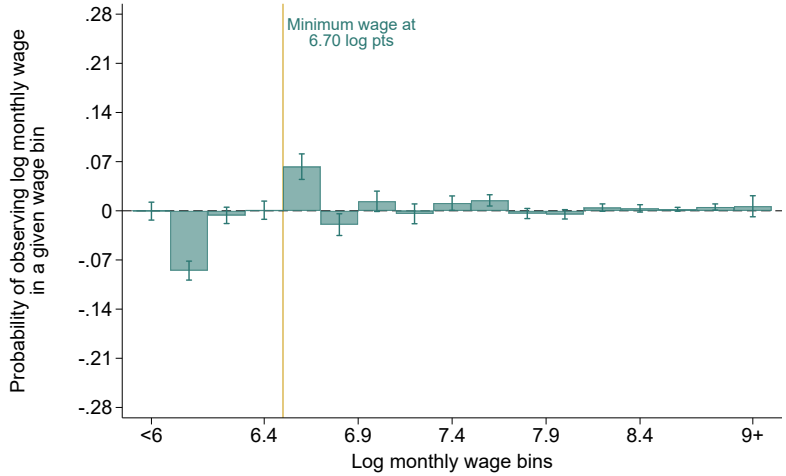
Notes: The figure shows the main results from our difference-in-differences design assessing the effect of the 2000-2009 minimum wage increases on average wages (see Equation 1 in Section 4.1 on PNAD data).

Figure 4: Effect of the minimum wage on the probability of being in a specific wage bin in 2009

(a) Formal employees

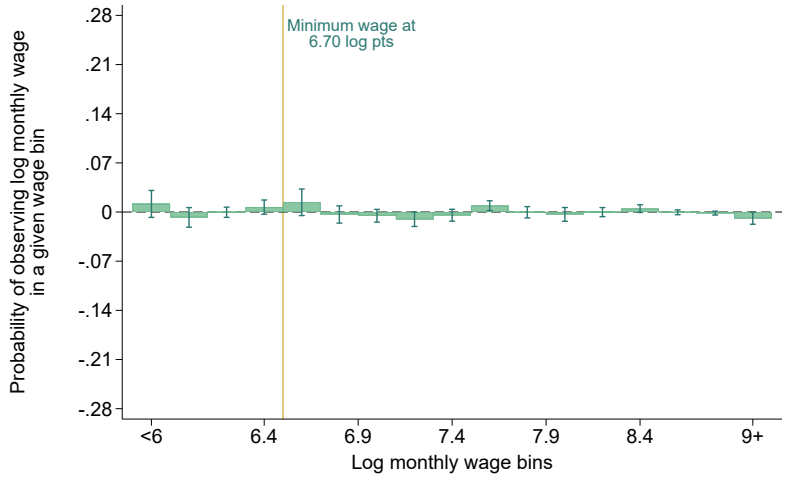


(b) Informal employees in formal firms (intensive margin)



(c) Informal employees in informal firms (extensive margin)

(d) Self-employed workers



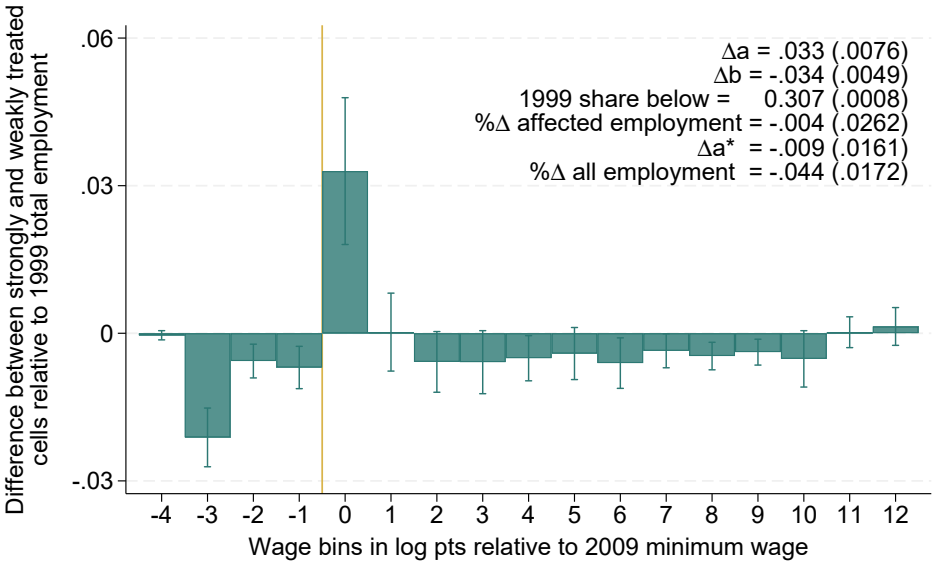
Sources: PNAD 1995-2015.

Sample: Adults aged 25-54, white or non-white, working full-time (i.e. 40 hours a week or more), with no missing monthly earnings variable, and with no missing experience variable. Formal employees only in panel (a); Informal employees working in formal firms only in panel (b); Informal employees working in informal firms only in panel (c); self-employed workers only in panel (d).

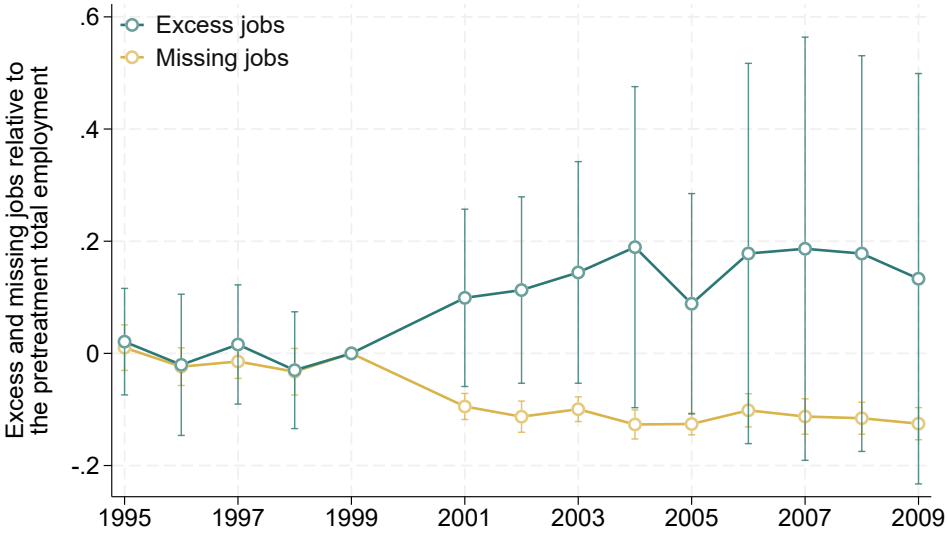
Notes: The figure shows the main results from our bunching difference-in-differences design assessing the effect of the 2000-2009 minimum wage increases on the distribution of wages (see Equation 2 in Section 4.3). The complete 1995-2015 series of graphs for all types of workers is available in our slides here.

Figure 5: Effect of the minimum wage on formal share of total employment

(a) Effect on the allocation of formal jobs, 2009



(b) Evolution of excess vs. missing formal mass, 1995-2015

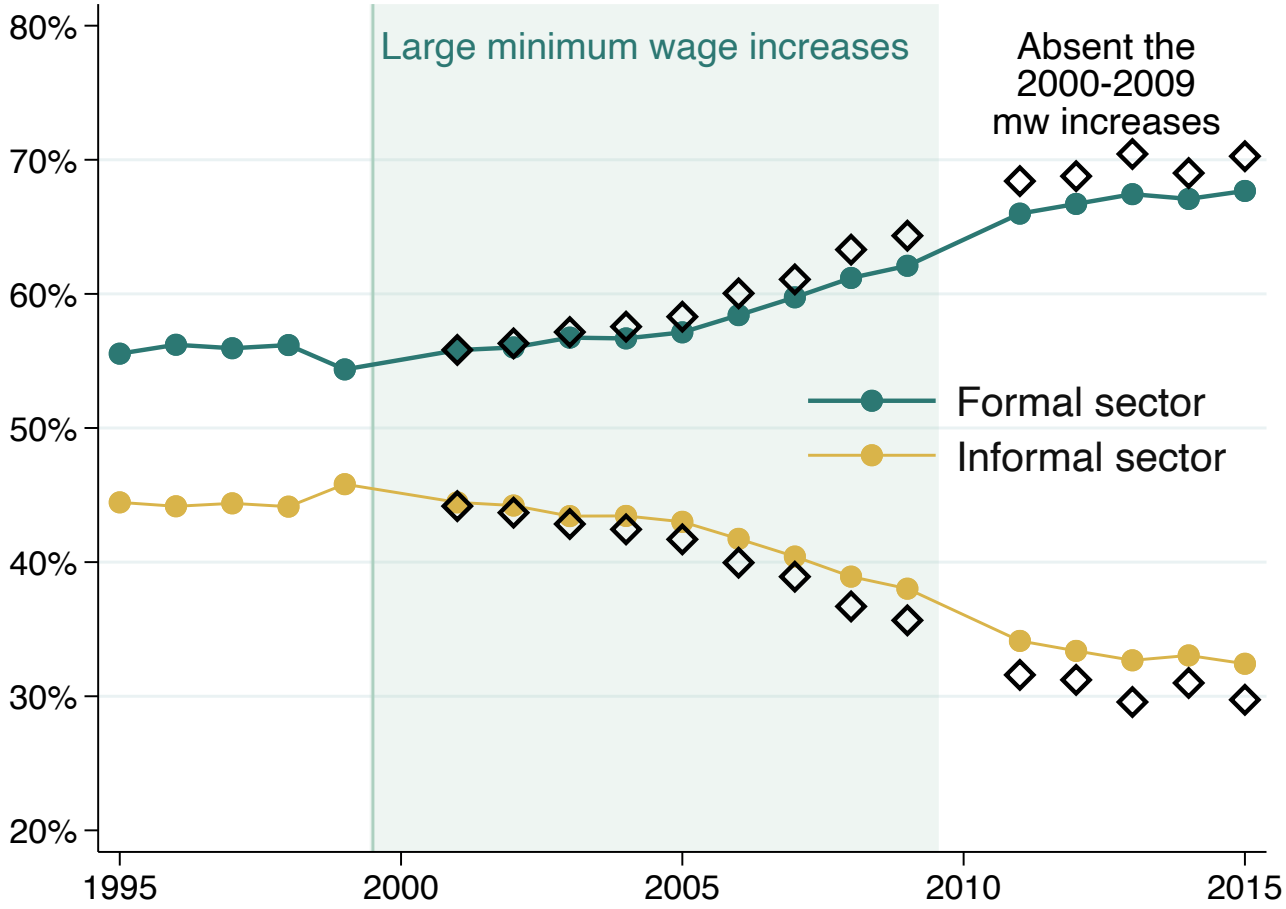


Sources: PNAD 1995-2015.

Sample: Adults aged 25-54, white or non-white, employed in the private sector, working either part-time or full-time, with no missing monthly earnings variable, and with no missing experience variable.

Notes: The figure shows the main results from our bunching difference-in-differences design assessing the effect of the 2000-2009 minimum wage increases on the distribution of jobs (see Equation 3 in Section 5.1). Panel (a): The figure documents the effect of the 2000-2009 increases on the reallocation of employment away from formal employment. The outcome variable is the number of formal employees in each state-by-industry-by wage bin in 2009 over the total number of workers in 1999 in that state-by-industry cell, across all sectors of employment (formal or informal employees, or self-employed). Panel (b): The figure shows the effect on missing formal jobs below the minimum wage (yellow line); and its effect on excess formal jobs at or above the minimum wage (green line) over 1995 to 2015, out of all 1999 employment. Here we define missing and excess jobs relative to the 2001 minimum wage (i.e. the first year of the minimum wage increase).

Figure 6: Evolution of the formal sector vs. informal sector, and counterfactual shares



Sources: PNAD 1995-2015.

Sample: Adults aged 25-54 employed in the private sector, white or non-white, working either part-time or full-time, with no missing monthly earnings variable, and with no missing experience variable. The formal sector is comprised of formal employees. The informal sector is comprised of informal employees working either in formal firms (intensive margin of informality) or in informal firms (extensive margin). Excludes the public sector and the self-employed and entrepreneurs (to see the evolution of overall employment, see Appendix Figure A2).

Notes: This is the exact same figure as Figure A1, with the counterfactual formal and informal shares overlaid post-1999, i.e. the formal and informal shares implied by our own-wage reallocation estimates absent the 2000s minimum wage increases (see Appendix Table E3 for our annual own-wage reallocation elasticity estimates and the discussion in Section 5.3). We estimate that, absent the minimum wage increases, the formal share in 2009 would be 64.3% instead of the observed 62.1%. See Section 5.3.

Table 1: Workers' characteristics – Part I , 1999

	Formal employees	Informal employees		Self-employed
		Intensive margin	Extensive margin	
Median monthly earnings (in R$2019)	2,029	1,310	401	1,610
Age	36.3	36.0	37.6	39.3
Work experience	22.6	22.8	28.3	27.7
Tenure	6.2	4.3	8.0	9.7
Gender				
Male	0.63	0.52	0.36	0.70
Female	0.37	0.48	0.64	0.30
Race				
White	0.62	0.57	0.44	0.55
Nonwhite	0.38	0.43	0.56	0.45
Education				
Less than high school	0.64	0.67	0.96	0.80
High school completed	0.26	0.24	0.03	0.15
College completed	0.10	0.08	0.01	0.05
Region				
North	0.03	0.06	0.04	0.05
Northeast	0.16	0.28	0.36	0.34
Southeast	0.56	0.43	0.34	0.38
South	0.19	0.14	0.17	0.16
Midwest	0.06	0.08	0.09	0.06
Full-time/part-time status				
Full-time	0.89	0.71	0.54	0.71
Part-time	0.11	0.29	0.46	0.29
Firm size				
Conditional on non-missing				
Small firm (9 workers or less)	0.22	0.61	0.77	n.a.
Large firm (10+ workers)	0.78	0.39	0.23	n.a.
Missing	0.23	0.32	0.91	1.00
Registration with tax authorities				
Yes	n.a.	n.a.	n.a.	0.18
No	n.a.	n.a.	n.a.	0.82

Source: PNAD 1999.

Sample:Adults aged 25-54, white or non-white, employed in the private sector, either formal employee, informal employee or self-employed, working either part-time or full-time.

Notes: Median monthly earnings in R$2019 winsorized at 1% and 99% levels, deflated using the inpc series.

Table 2: Workers' characteristics – Part II, 1999

	Formal employees	Informal employees		Self-employed
		Intensive margin	Extensive margin	
Workers near the minimum wage				
Strictly below 100% of the mw (%)	0.01	0.07	0.24	0.15
Strictly below 115% of the mw (%)	0.42	0.51	0.72	0.50
Between 105% and 115% of the mw (%)	0.30	0.27	0.23	0.24
Between 90% and 105% of the mw (%)	0.12	0.23	0.44	0.21
Strictly below 90% of the mw (%)	0.00	0.02	0.06	0.05
Industry				
Agriculture, forestry and fishing	0.06	0.00	0.59	0.23
Mining and extractive industries	0.01	0.01	0.00	0.00
Manufacturing	0.24	0.18	0.00	0.05
Construction	0.05	0.00	0.11	0.13
Wholesale and Retail Trade	0.13	0.22	0.00	0.19
Hotels and restaurants	0.03	0.08	0.00	0.05
Transportation, communication and electricity, gas, water	0.10	0.08	0.00	0.06
Finance, insurance, real estate and repair services	0.11	0.13	0.00	0.12
Public administration	0.03	0.08	0.00	0.00
Education, health and social work	0.11	0.14	0.00	0.02
Domestic services	0.07	0.00	0.30	0.00
Entertainment, recreation and other services	0.05	0.09	0.00	0.13
Occupation				
Managerial	0.05	0.05	0.01	0.00
Scientific and artistic	0.05	0.07	0.00	0.05
Mid-level technicians	0.06	0.09	0.00	0.04
Administrative service workers	0.15	0.09	0.00	0.00
Service workers	0.22	0.18	0.30	0.06
Retail service workers	0.06	0.16	0.00	0.26
Agriculture workers	0.06	0.01	0.57	0.23
Manufacturing, construction and repair workers	0.31	0.30	0.12	0.35
Armed forces and other occupations	0.03	0.06	0.00	0.01

Source: PNAD 1999.

Sample: Adults aged 25-54, white or non-white, employed in the private sector, either formal employee, informal employee or self-employed, working either part-time or full-time. Further restricted to workers working full-time (i.e. 40 hours a week or more) and no missing monthly earnings variable and no missing experience variable for the statistics presented in the section "Workers near the minimum wage."

Table 3: Wage effects of the minimum wage on formal and informal workers, 2009

	Baseline	Robustness checks		
	(1)	(2)	(3)	(4)
Strongly treated state × industry × 2009				
Formal employees	0.132***	0.134***	0.129***	0.135***
	(0.012)	(0.011)	(0.013)	(0.012)
	7.309	7.309	7.309	7.309
	705,536	705,536	705,536	705,536
Informal employees				
Intensive margin	0.116***	0.132***	0.107***	0.130***
	(0.015)	(0.018)	(0.018)	(0.017)
	7.014	7.014	7.014	7.014
	145,132	145,132	145,132	145,132
Extensive margin	0.090**	0.101***	0.150***	0.094**
	(0.035)	(0.034)	(0.032)	(0.036)
	6.367	6.367	6.367	6.367
	141,208	141,208	141,208	141,208
Self-employed	-0.021	-0.005	0.027	-0.009
	(0.030)	(0.031)	(0.031)	(0.028)
	7.055	7.055	7.055	7.055
	329,581	329,581	329,581	329,581
Individual-level controls	X		X	X
State GDP controls	X	X	X	X
State x industry FEs	X	X	X	X
Industry x year FEs	X	X	X	X
Bolsa Familia expenditures			X	
Nb of inspectors 2002 x year FEs				X

Sources: PNAD 1999-2015.

Sample: Adults aged 25-54, white or non-white, employed in the private sector, working full-time (i.e. 40 hours a week or more), with no missing monthly earnings variable, and with no missing experience variable.

Notes: The figure shows the main results from our difference-in-differences design assessing the effect of the 2000-2009 minimum wage increases on average wages (see Equation 1 in Section 4.1). For each category of workers, the first row represents the point estimate; the second row displays the standard error in parentheses; the third row is the mean dependent variable; and the fourth row is the number of observations used in the regression.

Table 4: Own-wage reallocation elasticities out of the formal labor force

	Towards other sectors of employment			Towards other sectors or non-employment		
	%Δ emp.	%Δ wage	Elast.	%Δ emp.	%Δ wage	Elast.
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. PNAD, 2009						
	-0.036**	0.128***	-0.282**	-0.038***	0.102***	-0.372**
	(0.015)	(0.011)	(0.123)	(0.014)	(0.020)	(0.189)
	1,835,377	790,389	1,835,584	2,564,493	791,288	2,564,493
Panel B. Census, 2010						
	-0.029**	0.099***	-0.290*	-0.025	0.088***	-0.283
	(0.013)	(0.010)	(0.152)	(0.023)	(0.017)	(0.299)
	9,791,319	4,463,483	9,791,319	14,997,254	4,463,483	14,997,254
State × industry treat. var.	X	X	X			
State treat. var.				X	X	X
Individual-level controls	X	X	X	X	X	X
State GDP controls	X	X	X	X	X	X
State × industry FEs	X	X	X			
Industry × year FEs	X	X	X			
State FEs				X	X	X
Year FEs				X	X	X

Source: Census 2000 & 2010.

Sample: Adults aged 25-54, white or non-white, employed in the private sector, either formal employee, informal employee or self-employed; workers working either part-time or full-time and no missing monthly earnings variable, no missing experience variable; Adults aged 25-54, white or non-white, who are either unemployed or not in the labor force.

Notes: The table shows the percent change in the share of formal employees among the total private workforce in column 1 (see equation 4 in Section 5.1) and corresponding wage effect (column 2) and reallocation elasticity (column 3). The table also shows the percent change in the share of formal employees out of the working age population in column 4 (see equation 5 in Section 5.1) and the corresponding wage effect (column 5) and reallocation elasticity (column 6). Panel A shows results estimated using PNAD, and panel B shows results using Census. Columns 1-3 use treatment defined at the state-by-industry level; columns 4-6 use treatment defined at the state level.

Appendix A Additional details on the minimum wage

A.1 Political and macroeconomic context of minimum wage increases

The 2000-2009 minimum wage increases were implemented during an exceptionally buoyant period for the Brazilian economy. The 1994 Plano Real spurred rapid growth in the Brazilian economy until a recession in 2014: GDP per capita was 50% higher in 2009 than in 1995 and 75% higher in 2014 than in 1995. During that period, the unemployment rate exhibits a steady decline, from 10.2% 1999 to 6.7% in 2014 (see Figure A3a).

On the demand side, trade is often considered a key factor that spurred economic growth during the 2000s. On the supply-side, many changes happened in the labor market from 1995 to 2015. The private labor force increased by 57%, as the population was growing. There was a relative increase in the share of non-white workers within this labor force and an increase in educational attainment for the entire population, with the gains most concentrated among non-white individuals.[1] There was a decline in the size of the informal sector (see Appendix Figure A1).[2] Additionally, there was a slight increase in the share of informal workers in formal firms (see Appendix Figure A1b). Finally, there was an increase in conditional cash transfer programs (with the creation of *Bolsa Famìlia* in 2004) (see Appendix Figure A3b).

We take all of these changes into account in our analysis of the effects of the minimum wage.

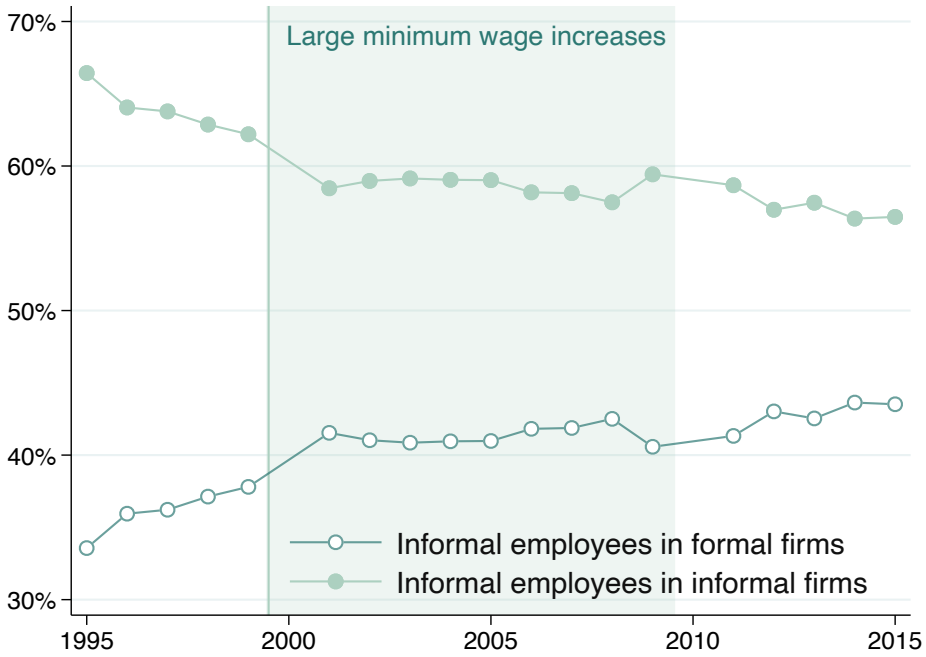
[1] The share of the private formal labor force with a college education increased from 10% in 1999 (see Table 1) to 17% in just 16 years.

[2] There are many reasons that can explain this decline. For example, Lula enacted enforcement policies at the beginning of the 2000s (in particular, among domestic service workers in 2003).

Figure A1: Evolution of the structure of employment, 1995-2015

(a) Evolution of the formal sector vs. informal sector

(b) Evolution of the two margins of informality



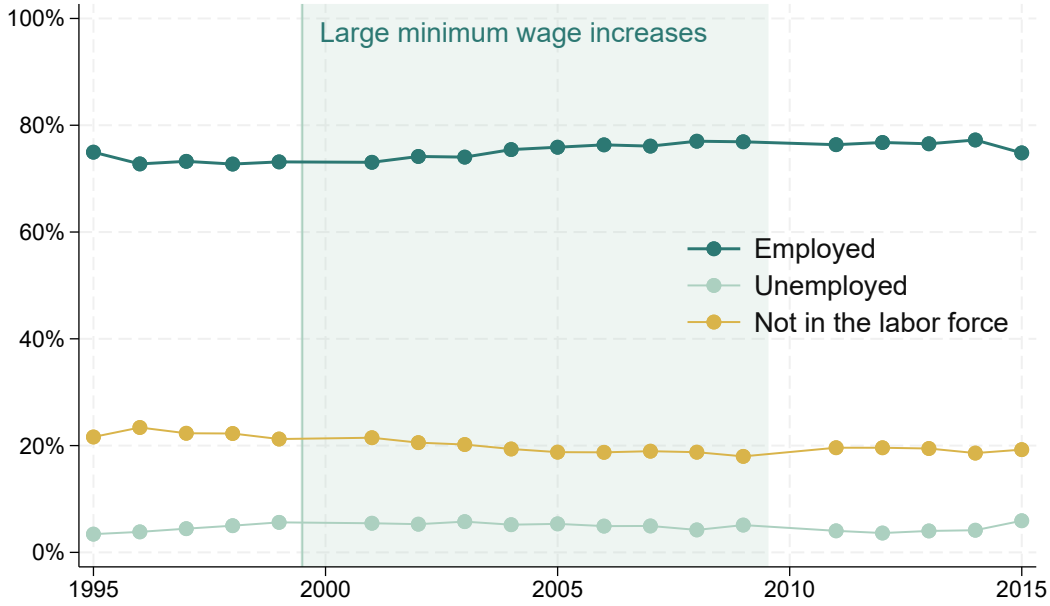
Sources: PNAD 1995-2015.

Sample: Adults aged 25-54 employed in the private sector, white or non-white, working either part-time or full-time, with no missing monthly earnings variable, and with no missing experience variable. The formal sector is comprised of formal employees. The informal sector is comprised of informal employees working either in formal firms (intensive margin of informality) or in informal firms (extensive margin). Excludes the public sector and the self-employed and entrepreneurs (to see the evolution of overall employment, see Appendix Figure A2).

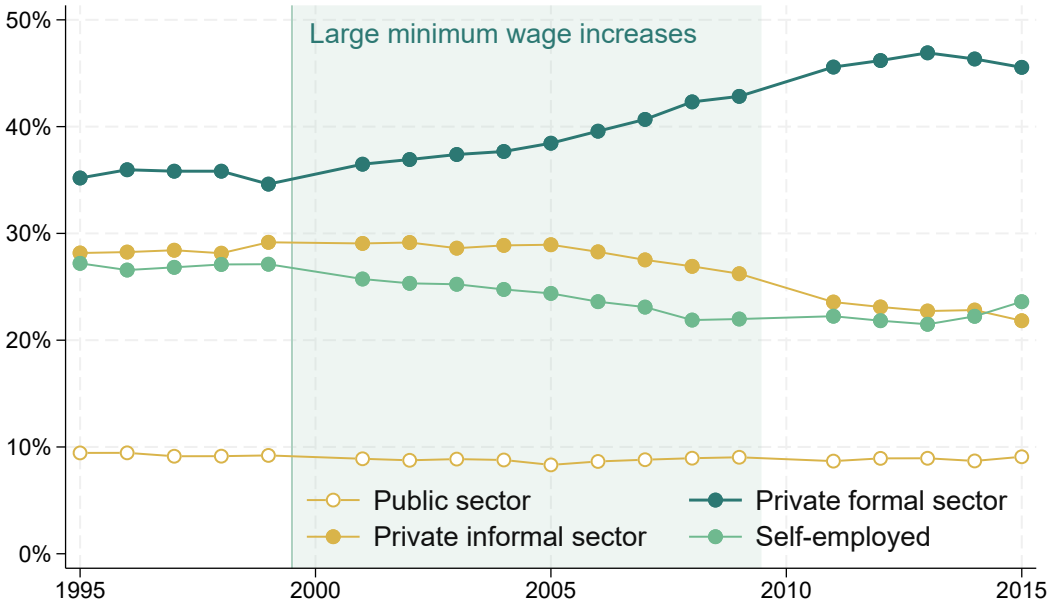
Notes: Panel (a): In 1999, the share of informal employees among employees in the private sector is 45.8%. This share is 38.0% in 2009. Panel (b): among informal employees, 37.8% work in formal firms in 1999 vs. 62.2% in

Figure A2: Evolution of employment in Brazil (1995-2015)

(a) Employment status



(b) Employment structure



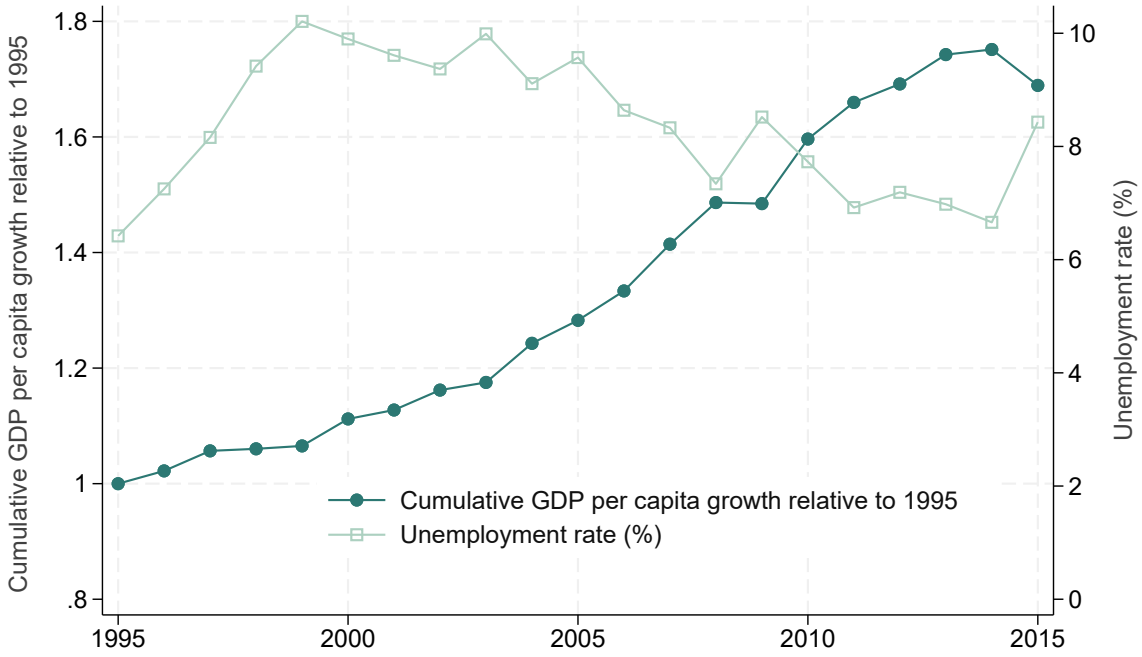
Sources: PNAD 1995-2015.

Sample: Panel (a): Adults aged 25-54, white or non-white. Panel (b): further restricted to employed individuals, with no missing monthly earnings variable, and with no missing experience variable.

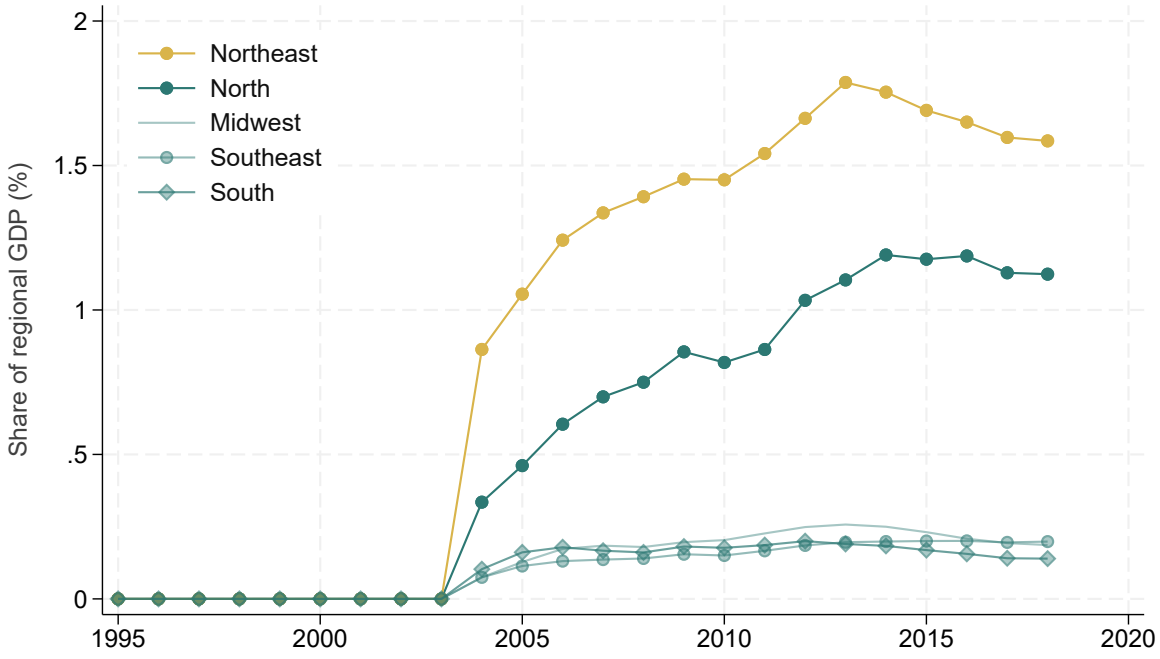
Notes: Panel (a): In 1999, 55.1% of adults were employed, 5.9% were unemployed and 39.0% not in the labor force. In 2009, these shares were 57.0%, 5.16% and 37.9% respectively. Panel (b): among employed adults, 34.6% were employed in the private formal sector, 29.2% in the private informal sector, and 9.2% in the public sector. 27.1% were self-employed. In 2009, these shares were 42.8%, 26.2%, 9.0% and 22.0% respectively.

Figure A3: Macroeconomic context of minimum wage increases (1995-2015), Brazil

(a) GDP growth and unemployment rates



(b) Bolsa Familia expenditures, by region



Sources: Panel (a): World Bank; Panel (b): Authors' database on Bolsa Família expenditures by region.
Notes: Panel (a): GDP per capita normalized to 1 in 1995. Panel (b): Bolsa Família expenditures, as a share of regional GDP.

A.2 History of the minimum wage legislation in Brazil

Introduction in the 1943 Labor code. The minimum wage was first introduced in the 1943 The Brazilian labor code (*Consolidacao das Leis Trabalhistas*, CLT). It stipulates that all employees should accordingly be paid at least the yearly minimum wage. The CLT also establishes that those workers who are paid below the minimum wage have the legal right to request the complement for wages not meeting the minimum value.

Importantly, the minimum wage applies to all workers, whether they have a signed a formal contract or not, as outlined by the following articles extracted from the 1943 Labor code:

- Art. 76: "The minimum wage is the minimum compensation owed and paid directly by the employer to every worker, including rural workers, without distinction of sex, for a normal working day, and must be sufficient to meet, at a given time and in a specific region of the country, the worker's basic needs for food, housing, clothing, hygiene, and transportation."
- Art. 118: "Any worker paid less than the minimum wage is entitled, notwithstanding any contract or agreement to the contrary, to claim from the employer the difference to the minimum wage established in the region, zone, or subzone where the work is performed."
- Art. 120: "Anyone who violates any provision regarding the minimum wage shall be subject to a fine of Cr$50.00 (fifty cruzeiros) to Cr$2,000.00 (two thousand cruzeiros), doubled in case of recurrence."

From its creation to 1984, the minimum wage varied across states.

In the 1988 Brazilian Federal Constitution. The Constitution unifies the minimum wage at the federal level. In particular:

- Art. 7: "The rights of urban and rural workers, in addition to others aimed at improving their social conditions, include: (...)"
- "IV - A minimum wage, established by law, nationally unified, sufficient to meet their basic vital needs and those of their family, including housing, food, education, health, leisure, clothing, hygiene, transportation, and social security, with periodic adjustments to maintain its purchasing power, and its use for any other purpose is prohibited."

State level minimum wages since 2001. Since 2001, states can institute their own state-level minimum wage. Over our period of study (1995-2015), five states have introduced state-level specific wage floors: Rio de Janeiro and Rio Grande de Sul starting in 2001, Paraná since 2006 São Paulo since 2007, and Santa Catarina since 2010. As we are interested in understanding the effect of the minimum wage on both the formal and informal sectors and therefore heavily rely on household survey data, we focus our analysis on the federal minimum wage only. We note that studies that exploit the fine-level matched employer-employee data—and thus focus only on the formal sector—fail to find bindingness of these wage floors. Tepedino (2013) found earnings spikes around the floors in the five states cited above, and Terrell (2009) documented that state minimum wages have increased wages for directly affected workers. However, Corseuil et al. (2013) reported non-compliance with the floor in Parana and São Paulo. More recently, Saltiel and Urzúa (2022) emphasize that these regional wage floors target mainly workers in the restaurant and accommodation industries. More generally, the enforcement of the regional minimum wage legislation faces some challenges. Although the institution responsible for regional minimum wages inspection is the same as for the national minimum wage, many argue that the enforcement is more complicated at the state level (Moura and Neri, 2007; Corseuil et al., 2013).

Our own analysis of these regional laws led us to conclude that the potential non-compliance with these regional wage floors may come from the fact that the text of the state laws did not cite precisely any industry or occupation official classification codes—leaving firms with leeway when assessing their exposure to the policy.

Indexation of the federal minimum wage on inflation and a measure of growth since 2008. Since 2008, the minimum wage has been determined by a formula that considers past inflation and GDP growth. In the case of inflation, the formula takes into account inflation accumulated during the previous year $(t-1)$, while for GDP, due to lags in data collection, they use the rate of increase of year $t-2$. The law stipulates that the minimum wage is increased each year following the rule:

$$\text{Min wage}_t = \text{Min wage}_{t-1} \cdot \text{inflation}_{t-1} + \max\{0, \text{GDP growth}_{t-2}\}$$

A.3 Minimum wage database (1940-2020)

Content and access. We build a database of minimum wages from 1940—i.e. when the federal minimum wage is introduced in Brazil—to 2020. The database contains the values of

the federal minimum wage at the month-by-year level in nominal terms using information published by the Brazilian Institute of Geography and Statistics (IBGE) website.[3] It also contains nominal values of regional minimum wages. Brazil implemented state-level minimum wages from 1940 to 1984. Since 2001, five states have implemented industry and occupation-specific minimum wages above the federal minimum: Rio Grande do Sul, Santa Catarina, Paraná, Rio de Janeiro and São Paulo.

Sources. *National level.* We report minimum wage rates at the national level since 1940

State level. We provide in Appendix Table A1 the links to the State Assembly laws that implemented regional minimum wages. We constructed two separate databases: i) one with variation by occupation when the minimum wage was defined by occupation; ii) another one by industry.

State-level minimum wage database by occupation. We used two occupation classifications to construct this database. We constructed the data using five-digits classification codes (CBO94) from 2001 to 2009[4] and six digits classification codes (CBO2002) codes from 2003 to 2020. For Rio de Janeiro (2001-2009), São Paulo (2007-2009) and Rio Grande do Sul (2001-2009) and Paraná (2006) both five-digits and six-digits occupational codes are used. In 2007 in Paraná minimum wage laws were only containing the information related to the six-digits occupation codes.

Using five-digits classification codes. The law, for the most part, designates occupations at the two or three digits level. Therefore, we included all the five-digits occupations contained inside the two- or three digits level code. In rare cases, we could not match the occupations listed in the law with the five-digits occupation classification codes. This was the case for *trabalhadores em serviços administrativos* (workers in administrative services), *dedetizadores* (fumigators), and *trabalhadores da indústria* (industry workers).

Using six-digits classification codes. Rio de Janeiro started to report the six-digits occupational classification codes (as opposed to the names of the occupations only) in the law in 2017. We proceeded backwards and used the exact match betwen the text of the law and the six-digits categories in 2017 in Rio de Janeiro and applied this match to all previous years

[3] At this address: https://www.ibge.gov.br/estatisticas/downloads-estatisticas.html.

[4] Although the six-digits classification codes went into effect in 2003, the matched employer-employee data we have access to contain the information on the five digits classification codes until 2009.

Table A1: Links to regional minimum wage laws

Year	Rio de Janeiro	São Paulo	Paraná	Rio Grande do Sul	Santa Catarina
2001	Link	—	—	Link	—
2002	Link	—	—	Link	—
2003	Link	—	—	Link	—
2004	Link	—	—	Link	—
2005	Link	—	—	Link	—
2006	Link	—	Link	Link	—
2007	Link	Link	Link	Link	—
2008	Link	Link	Link	Link	—
2009	Link	Link	Link	Link	—
2010	Link	Link	Link	Link	Link
2011	Link	Link	Link	Link	Link
2012	Link	Link	Link	Link	Link
2013	Link	Link	Link	Link	Link
2014	Link	Link	Link	Link	Link
2015	Link	Link	Link	Link	Link
2016	Link	Link	Link	Link	Link
2017	Link	Link	Link	Link	Link
2018	Link	Link	Link	Link	Link
2019	Link	Link	Link	Link	Link
2020	—	—	Link	Link	Link

Notes: Regional minimum wage laws start to be implemented in Rio de Janeiro and Rio Grande de Sul in 2001, 2006 in Paraná, 2007 in São Paulo, and 2010 in Santa Catarina. For the state of Santa Catarina, the occupations that are covered by the minimum wage law only appear in 2010. In subsequent years, the law lists only the changes relative to this initial law. In 2020, there was no adjustment of the minimum wage law in Rio de Janeiro, São Paulo, and Rio Grande do Sul. Therefore, we assign the 2019 value of the minimum wage in 2020 in these states in our database.

back to 2003. Since minimum wage laws in São Paulo and Paraná were inpired by minimum wage laws in Rio de Janeiro, we use the same matching system for these two states.

For the occupations that were designated in the law and for which we did not have a precise six-digits classification code, we made a manual matching using the similarity of words between the text of the law and the names used in the six-digits classification codes. This took care of the majority of these cases. However, there were remaining cases in which we could not link the text of the law to a classification code. [5] We were also unable to match

[5] Here is the list: *barboys, teleoperadores nível 1 a 1, operadores de call center, atendentes de cadastro, representantes de serviços empresariais, agentes de marketing, agentes de cobrança, agentes de venda, atendentes de call center, auxiliares técnicos de telecom nível 1 a 3, operadores de suporte CNS, representantes de serviços 103, atendentes de retenção, operadores de atendimento nível 1 a 3, representantes de serviços, assistentes de serviços nível 1 a 3, telemarketing ativos e receptivos, práticos de farmácia, empregados em empresas prestadoras de serviços de brigada de incêndio (nível básico), empregados em empresas prestadoras de serviços de brigada de incêndio (nível médio), bombeiro civil mestre, empregados em empresas*

the four occupations that are included in the law conditional on the worker beeing registered in their area´s council: *trabalhadores de nível técnico devidamente registrados nos conselhos de suas áreas; técnicos de nível médio regularmente inscritos nos Conselhos Regionais de Engenharia; Arquitetura e Agronomia; técnicos industriais inscritos no Conselho Regional de Técnicos Industriais*

State-level minimum wage database by industry. We used industry classifications to construct this database: the national classification of economic activities 1.0 (CNAE 1.0) to classify industries covered by state minimum wages from 2001 to 2006; and the national classification of economic activities 2.0 (CNAE 2.0) from 2007 to 2020.

Using CNAE 1.0 codes. Because the minimum wage laws did not refer to a specific industry code to define the industries covered by the minimum wage law, we matched the words contained in the law with the names of the industries contained in CNAE 1.0 codes. In rare cases, we were not able to find an exact match.[6]

Using CNAE 2.0 codes. We followed a similar strategy as for the match between the text of the law and CNAE 1.0 codes. In rare cases, we were not able to find an exact match. [7]

prestadoras de serviços de brigada de incêndio (nível superior), empregados não-especializados da indústria, empregados em escritórios de agências de navegação, empregados em terminais de contêineres e mestres e encarregados em estaleiros, trabalhadores marítimos do 1° grupo de Aquaviários que laboram nas secções de Convés, Máquinas, Câmara e Saúde, em todos os níveis (I, II, III, IV, V, VI, VII e superiores).

[6]Here are the categories listed in the law for which we could not find the correspondance in CNAE 1.0: *trabalhadores em estabelecimentos hípicos, empregados de agentes autônomos do comércio, indústria mecânica, indústrias de cristais, espelhos, cerâmica de louça e porcelana and auxiliares em administração escolar (empregados de estabelecimentos de ensino)*. As a result, these are ommitted in our database.

[7]Here are the categories listed in the law for which we could not find the correspondance in CNAE 2.0: *trabalhadores em estabelecimentos hípicos, empregados de agentes autônomos do comércio, indústria mecânica, indústrias de cristais, espelhos, cerâmica de louça e porcelana and auxiliares em administração escolar (empregados de estabelecimentos de ensino)*.

A.4 Net pay, gross pay and total labor cost for formal vs. informal employees, at the minimum wage

Monthly earnings in the labor force survey are reported in gross terms—as is the case in the administrative matched employer-employee data in RAIS, and in the ECINF survey data.

Among formal employees. Gross pay is the pay a formal employee receives, net of the employer contribution, and before paying the employee contribution and the income tax.

The gross monthly minimum wage in 1999 amounts to R$477.24 (in 2019 terms). This is the level at which we observe bunching among formal employees (see Appendix Figure A5) for monthly earnings in September in PNAD. In that graph, we "zoom in" around the minimum wage by plotting the monthly earnings distribution around the minimum wage in 1999 by 0.02 log point bins (i.e. five times smaller than in Figure 2.)

On the employer side, social contributions represent 90.28% of the gross pay at the level of the minimum wage in 1999. The total labor cost therefore amounts to R$908.09 (see Appendix Figure A4) in R$2019. Following Pastore (1996) and Souza et al. (2012), the employer contributions include 35.8% of social obligations related to the wage component, 40.8% in non-wage benefits and 13.68% in related social contributions. We set aside the 13th salary and associated contributions in the total labor cost as we only refer to the total labor cost at the minimum wage for the month of September 1999—the month for which pay is reported in PNAD. Including this element would bring the total labor cost at the level of the minimum wage in 1999 to 102.06% of the gross pay. The details of the non-wage benefits and social security contributions are provided in Appendix Table A2.

On the employee side, social contributions represent 7.65% of the gross pay at the level of the minimum wage, in 1999. This means that take-home pay—before income tax—is R$440.73 (in R$2019). The employee contribution is a contribution to the pension system (INSS) (see online tax schedules here).

Because there is no income tax at the level of the minimum wage in 1999, the monthly net pay (net of the income tax) is the monthly take-home pay (gross pay after employee social security contribution) for a formal employee.

Among informal employees. For an informal employee, there is no social security contributions paid on the monthly wage, neither by the employer nor the employee. Understanding the incidence of the employee contribution is key to unveiling the net pay for the informal employee. In Appendix Figure A5 (right panel) we show that there is bunching at the level of

Table A2: Employer social security contributions, 1999

Category	Item	% of Salary
A. Social contributions	INSS (Pension System)	20
	FGTS (Severance Fund)	8
	Education-salary	2.5
	Work accident insurance (average)	2
	Sesi (Social Service for Industry)	1.5
	Senai (Industrial Training Service)	1
	Sebrae (Small Business Support Service)	0.6
	Incra (Land Reform Institute)	0.2
	TOTAL	**35.8%**
B. Non-wage benefits	Weekly rest	18.91
	Paid vacation	9.45
	Holidays	4.36
	Vacation bonus	3.64
	Notice period	1.32
	Sick leave	0.55
	Severance expenses	2.57
	TOTAL	**40.8%**
C. Social contributions on B.	**TOTAL**	**13.68%**
D. All contributions	**TOTAL**	**90.28%**

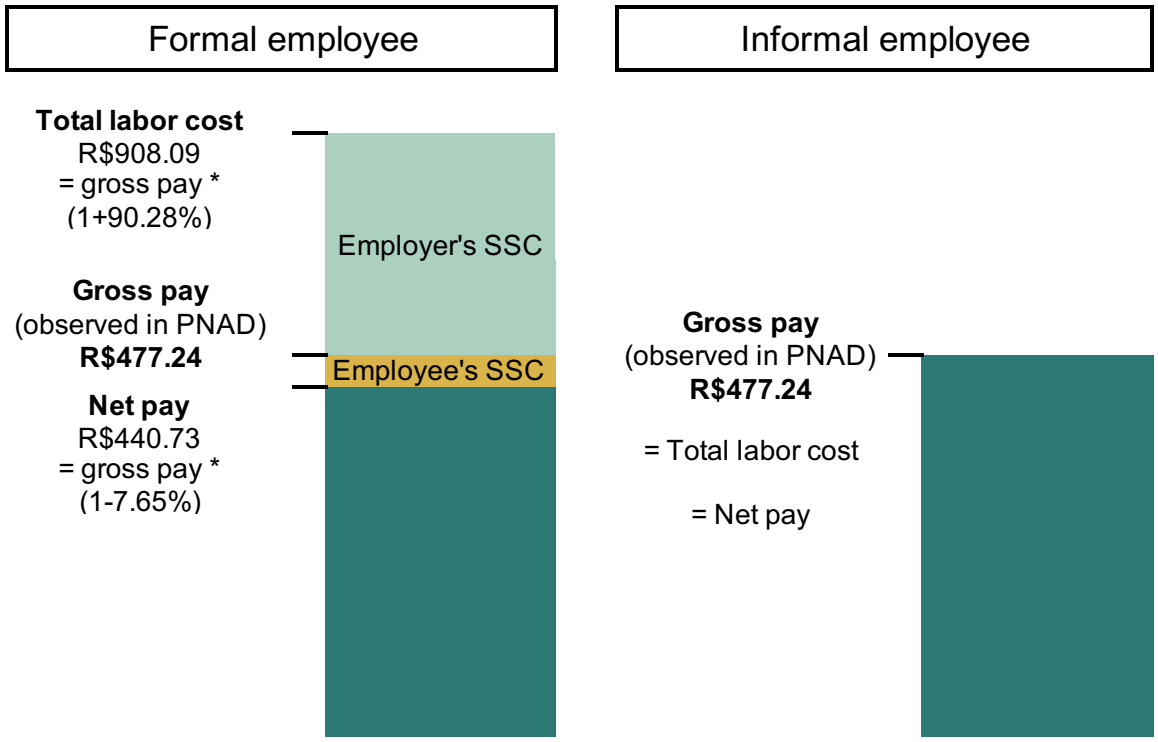
Source: Pastore (1996).

Notes: The legislation is unchanged between Pastore (1996)'s study and 1999. This excludes the 13th month salary (10.91%), and the FGTS incidence over the 13th salary (0.87%).

the gross minimum wage, but not at the level of the gross minimum wage net of the employee contribution of 7.65%. We interpret this as evidence that the informal employee "pockets" the employee contribution.

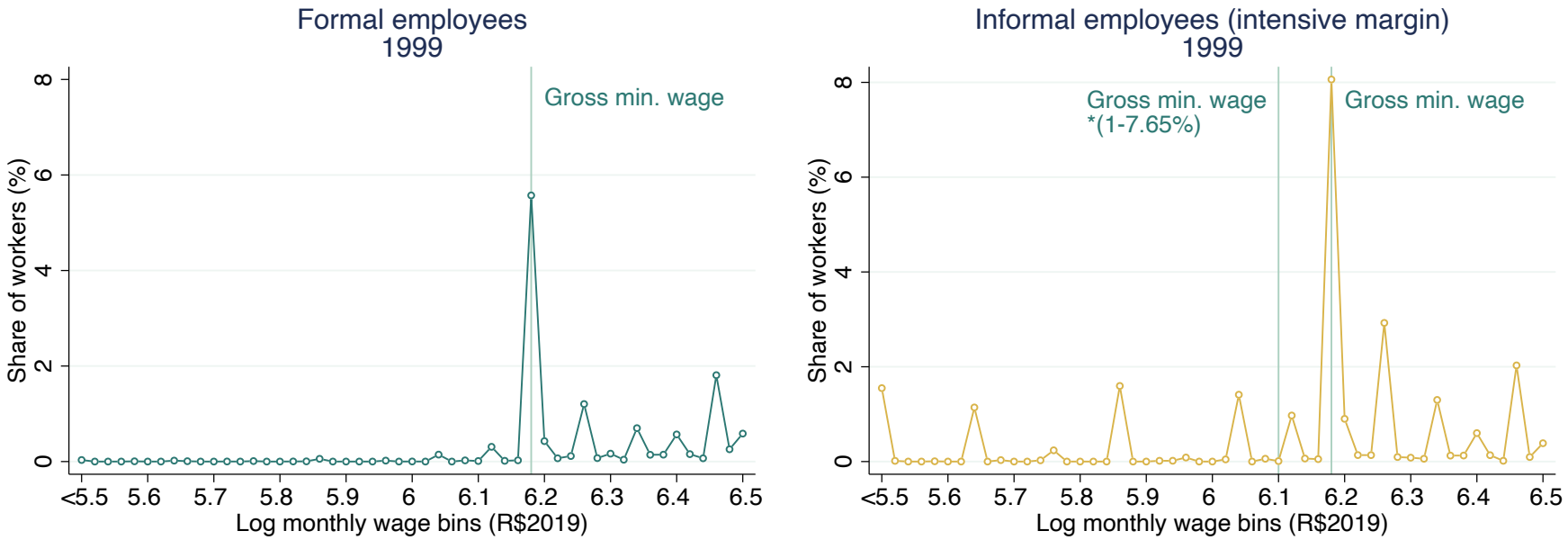
We also conclude that the net pay of the informal employee (after all social security contributions and income taxes) is 7.65% higher that that of a formal employee around the minimum wage in 1999. We note that this number is constant throughout our period of study as there is no change in the income tax schedule or the employee social contribution from 1995 to 2015.

Figure A4: Net pay, gross pay and total labor cost for formal vs. informal employees, at the minimum wage, in 1999



Sources: Authors' calculations based on Pastore (1996) and Souza et al. (2012).
Notes: Values are in R$2019, deflated using the inpc series. Because there is no income tax at the level of the minimum wage in 1999, the monthly net pay displayed above and understood as net of employee contributions is also the net of income tax pay for both formal and informal employees.

Figure A5: Incidence of the employee social security contribution in the informal sector



Sources: PNAD 1999.

Sample: Adults aged 25-54, white or non-white, employed, working full-time (i.e. 40 hours a week or more), with no missing monthly earnings variable, and with no missing experience variable. Left panel: formal employees. Right panel: informal employees.

Notes: 2 log points monthly wage bins in x-axis. Monthly earnings distribution is truncated on the right hand side (above 6.5 log points in $R2019 terms). Observations are binned together on the left of the distribution (5.5 log points or below).) Since there is bunching at the value of the gross minimum wage, and no bunching at the value of the net minimum wage among informal employees on the intensive margin, we conclude that informal employees "pocket" the employee social security contribution.

A.5 Penalties associated with minimum wage violations vs. tax evasion

Penalties associated with minimum wage violations. The 1943 the Brazilian labor code (CLT) establishes a penalty to the employer that is found under non-compliance with the minimum wage.

The penalty varies by firm size (according to a coefficient ρ_s comprised between .08 and .4, see Table A3):

$$\begin{aligned}\text{Penalty}_{\text{mw}} &= (.6 + \rho_s) * \text{fine} \\ &= (.6 + \rho_s) * 1,513.14 \text{ UFIR} \\ &= (.6 + \rho_s) * 11 \times \text{gross monthly minimum wage (in 1999)}\end{aligned}$$

The fine associated with the minimum wage violation corresponds to the maximum fine of all infractions in the labor code (see chapters II and III of Title II of the CLT). The amount of 1,513.14 UFIR is defined in Article 120 of Portaria MTE nº 290/1997 (see here). In 1999, one unit of UFIR is equivalent to R$0.9970.[8] The fine associated with the minimum wage is therefore equivalent to 1,508.60R$ in 1999 terms. Since in September 1999, the nominal value of the minimum wage is 136R$, the fine amounts to 11 times the gross monthly minimum wage.

The value of the penalty depends on a coefficient that comprises three components: (i) a fixed component of 20% that corresponds to the nature of the infraction; (ii) a variable component that depends on the firm size, ρ_s; (iii) a fixed component of 40% that corresponds to the extent of the infraction.

As a result of the variable component, the per-worker penalty varies from 7.5 times the monthly minimum wage for small firms (1-10 workers) to 11 times the monthly minimum wage for large firms (100+ workers).

We view these costs as a lower bound of the cost associated with the minimum wage violation for non-complying firms for four reasons:

1. First, the amount of the fine is doubled in case of recidivism, meaning that the penalty varies from 15 times to 22 times the monthly minimum wage if the firm happens to be caught for such a violation for the second time (or third time, etc.). In practice, Brotherhood et al. (2023) show that there is an increase in the probability of an audit after a firm is caught;

[8] See the conversion between UFIR and reals from 1995 to 2000 at this address.

Table A3: Value of the coefficient ρ_s that enters the calculation of the minimum wage penalty, by firm size

Number of employees	Value of ρ_s
1-10	8%
11-30	16%
31-60	24%
61-100	32%
Above 100	40%

Source: Portaria/MTP Nº 667, de 8 de novembro de 2021, avaialble here.

2. Second, workers can claim the difference between the salary they received and the minimum wage through judicial proceedings. This comes on top of the penalty described above. There is evidence that such claims exist (see here for a recent case).

3. Third, we note the existence of "indirect costs" associated with the minimum wage violation. Firms have an incentive to keep workers happy in order to be less likely to be inspected (and therefore less likely to be caught for other violations such as tax evasion on social security contributions), since there is evidence that the bulk of labor inspections are triggered after workers or unions' whistle blowing (Cardoso and Lage (2005)). Paying the minimum wage to workers, whether they are employed on a formal contract or not, is a good way to do that. We show in particular that informal workers at the minimum wage receive on net a higher wage than formal workers paid at the minimum wage, since it seems that the informal worker pockets the employee social security contribution of 7.65% (see Appendix Section A.4 and Appendix Figure A5). That, plus other advantages informal workers can find in being employed informally in terms e.g. of flexibility in their labor supply (see Breza and Kaur (2025)), might make informal workers in particular (whether on the intensive or extensive margin of informality) less likely to wistle blow on tax evasion.

4. Finally, there are non-monetary associated with minimum wage violations (e.g. reputational costs).

Penalties associated with tax evasion on social security contributions. Formal firms caught employing informal workers must pay a penalty according to the following formula

(see Brotherhood et al. (2023)):[9]

$$\begin{aligned}\text{Penalty}_{\text{te}} &= \alpha + 3 \times \text{gross monthly salary} \times (1 + \text{employer payroll taxes}) \\ &= 1 \times \text{gross monthly minimum wage} \\ &\qquad + 3 \times \text{gross monthly salary} \times (1 + \text{employer payroll taxes}) \\ &= 6.7 \times \text{gross monthly minimum wage (in 1999 for a min. wage worker)}\end{aligned}$$

The fixed component α is the equivalent of one monthly gross minimum wage. For informal workers around the minimum wage, and since the employee social security contributions represent 90.28% of the gross monthly wage, we conclude that the three gross monthly salary and associated contributions amount to 3 $\times$ 1,9028 = 5.7 gross monthly minimum wage.

The total value of the penalty is therefore 6.7 times the gross monthly minimum wage per informal worker at the level of the minimum wage.

[9]This formula applies in case the informal worker is found to be paid at or above the minimum wage. The firm must pay in addition the specific penalty related to minimum wage violation if the informal worker is paid below the minimum wage.

Appendix B Additional details on data sources

B.1 Census (1960-2010)

The Census is collected every ten years by the Brazilian institute of geography and statistics called *Instituto Brasileiro de Geografia e Estatistica* (IBGE). Microdata are available since 1960. The census has two different questionnaires. One for the universe of households and one for a representative sample. We use the sample one because it contains detailed information about labor market outcomes of individuals.

Access. The data were accessed through IPUMS International here. Minnesota Population Center. Integrated Public Use Microdata Series, International: Version 7.2 [Census]. Minneapolis, MN: IPUMS, 2019. https://doi.org/10.18128/D020.V7.2. Full documentation available here for harmonized variables, and here for source variables.

The data from the 2000 and 2010 Census were downloaded from the IBGE website (available here). The files were cleaned and prepared for analysis using the Stata ado files as available from Datazoom (full information here).

B.2 Labor force and establishment surveys

B.2.1 *Pesquisa Nacional por Amostra Domiciliar* (PNAD) (1976 - 2015)

The Pesquisa Nacional por Amostra Domiciliar is a yearly national household survey, similar to the Current Population Survey in the US. There are two different questionnaires: one about households' characteristics, one about individuals' characteristics. We only use the questionnaire containing the individual-level characteristics. The sample is drawn from 1,500 municipalities.

We focus on demographic variables (such as age, gender, education attainment, position in the household, etc.) and labor market outcomes (such as employment, wages, earnings, industry and occupations) that are collected consistently across years.[10]

Regarding earnings, the PNAD questionnaire asks, "How much were your earning in this job over the last month?" This is a measure of gross monthly earnings, as mentioned on p.2 of the PNAD methodological note here. This measure of earnings must be understood as being after payroll taxes remitted by employers, but before payroll taxes paid by workers. Since social security contributions amount to 7.65% of the gross monthly wage on the worker side,

[10] In some years, the individual-level questionnaire is complemented by other questionnaires, e.g. on health, migration, or fertility. We do not use this information in this project.

and since the income tax is 0% at the level of the minimum wage, take-home pay at the level of the minimum wage for a formal employee is 0.9235 times the gross value of the minimum wage over 1995-2015. By contrast, for informal workers gross monthly pay equals take-home pay (see Appendix A.4 for more details).

We exploit the survey files from 1995 to 2015, i.e. one year after the *Plano Real* stabilized inflation.

In all years, we use the labor market information for the main job of the worker (earnings, weekly hours, etc.)—the most relevant for our study, and the only information that is collected across all years in the survey. It is only in the most recent years that the survey added questions about the other jobs in the reference week and about previous jobs during the year. Finally, we observe monthly earnings (i.e. wages in the main job in the last month), and the number of weeks worked last week, but we do not directly observe the hourly wage variable. Since the minimum wage is set in terms of monthly earnings for full-time workers, we focus on full-time workers in our study, i.e. those who report working 40 hours or more during the week. Close to 90% of workers in the private formal sector are working full-time vs. 71% in the intensive margin of informality and 54% in the extensive margin of informality in 1999 (see Table 1).

The information on race is collected across all years between 1995 an 2015.

Individuals self select into 5 different racial categories: "Branco" (White), "Preto" (Black), "Amarelo" (Asian), "Indigena" (Indigenous) and "Pardos." This latter category is the most difficult to translate: "Pardos" translates to brown or mixed race with African ancestry. It refers to individuals with Black and white parentage, or Black and indigenous parentage. Following Gerard et al. (2018), we pool "Pretos" and "Pardos" together to form the "non-white" category. non-white individuals account for about 40-45% of the total population. We restrict our sample to white and non-white individuals, effectively setting aside Amarelos and Indigenas (less than 2% of the population).

Access. Accessed through data zoom here starting in 1986.

B.2.2 Monthly Employment Survey, *Pesquisa mensal de emprego* (PME) (1980-2016)

The Monthly Employment Survey is a household survey conducted monthly by IBGE since 1980 in six metropolitan areas: Belo Horizonte, Porto Alegre, Recife, Rio de Janeiro, Salvador and São Paulo. There are two versions of PME: PME-Antiga (1980-2001) and PME-Nova (2002-2016), which has larger questionnaires and a new definition of labor market participation,

as well as new rotation schemes of the samples. In March 2014, PME's sample consisted of 33,809 households with 95,122 individuals. PME is a panel survey, in which each household is interviewed 8 times over a 16-months period (the household is surveyed for 4 consecutive months, out for 8, and then returns for another 4 months of interviews).

PME-Nova was discontinued in February 2016 and replaced by PNAD Continuous, a quarterly survey started in the first quarter of 2012. The two surveys coexisted between 2012 and 2016.

Access. Accessed through data zoom here.

B.2.3 Urban Informal Economy survey (ECINF)

This establishment survey was conducted by IBGE in 1997 and 2003 to investigate the informal sector in Brazil. It contains information on both the self-employed and informal employees in businesses of 5 employees or fewer. We use this survey only for informal employees, and exploit the information contained to disentangle the two margins of informality. More specifically, there are three variables that contain information on the margin of informality of the worker in ECINF: (i) a direct question that asks whether the firm is "an informal sector entreprise" both in 1997 (variable v4901) and 2003 (variable v5901); (ii) a question that asks whether the establishment has a tax identification number, the CNPJ code (variable v4340 in 2003 and variable v4346 in 1997)—this variable is used by Ulyssea (2018); (iii) and a question that asks whether the "company has a legal constitution" (variable v4344) in 1997, and whether the business has a legal entity (variable v4338 in 2003). All three variables lead to exactly the same results. For consistency across ECINF and PNAD, we use the third definition.

Access. Accessed through data zoom here.

B.3 Descriptive statistics on the new long-run database on informal employees

We use the household survey data PNAD and ECINF to construct a new database on informal employees that contains the information on the margin of informality (i.e. whether the informal employee works at a formal firm—on the intensive margin) or whether he works at an informal firm—on the extensive margin) for 1995-2015.

We show below a number of descriptive statistics to document demographic (see Appendix Figures B1 and B3) and labor market characteristics (see Appendix Figures B2 and B4) of informal employees across the two margins in PNAD. We also compare the monthly earnings distributions between the proxied and observed series in PNAD in Appendix Figure B1. These series match very well—thus validating our imputation strategy for the years for which we do not directly observe the margin of informality (1995-2009). Finally, we compare the monthly earnings distributions between the proxied series in PNAD and observed series in ECINF 1997 in Appendix Figure B2 (respectively in 2003 in Appendix Figure B3). Note that we adjusted the sample in the PNAD proxied series to match as closely as possible the ECINF sample. In particular the monthly earnings distributions proxied series in PNAD are shown only for firms that employ 5 workers of fewer, and excludes domestic services. Finally, we show the evolution of the shares of workers strictly below the minimum wage among formal employees, and along the two margins of informality in Appendix Figure 1b.

Access. Our new series are available on our websites.

Table B1: Comparison of workers' characteristics among informal employees in observed vs. proxied series (Part I), 2011

	Intensive margin		Extensive margin	
	Observed	Proxied	Observed	Proxied
Median monthly earnings (in R$2019)	2,129	1,765	973	825
Age	36.5	36.4	38.0	38.6
Work experience	21.4	21.5	26.5	27.6
Tenure	4.8	5.0	6.2	8.3
Gender				
Male	0.63	0.55	0.53	0.59
Female	0.37	0.45	0.47	0.41
Race				
White	0.50	0.47	0.34	0.33
Nonwhite	0.50	0.53	0.66	0.67
Education				
Less than high school	0.45	0.47	0.81	0.85
High school completed	0.41	0.40	0.17	0.13
College completed	0.14	0.13	0.02	0.01
Region				
North	0.08	0.10	0.10	0.09
Northeast	0.25	0.30	0.36	0.38
Southeast	0.43	0.39	0.36	0.33
South	0.14	0.12	0.10	0.13
Midwest	0.10	0.09	0.08	0.07
Firm size				
Conditional on non-missing				
Small firm (9 workers or less)	0.55	0.66	0.90	0.80
Large firm (10+ workers)	0.45	0.34	0.10	0.20
Missing	0.23	0.27	0.61	0.75

Source: PNAD 2011.

Sample: Adults aged 25-54, informal employees, white or non-white, working full-time (i.e. 40 hours a week or more), with no missing monthly earnings variable, and with no missing experience variable.

Notes: Median monthly earnings in R$2019 winsorized at 1% and 99% levels, deflated using the inpc series.

Table B2: Comparison of workers' characteristics among informal employees in observed vs. proxied series (Part II), 2011

	Intensive margin		Extensive margin	
	Observed	Proxied	Observed	Proxied
Workers near the minimum wage				
Strictly below 100% of the mw (%)	0.09	0.13	0.38	0.31
Strictly below 115% of the mw (%)	0.70	0.70	0.93	0.78
Between 105% and 115% of the mw (%)	0.30	0.26	0.19	0.17
Between 90% and 105% of the mw (%)	0.38	0.42	0.62	0.51
Strictly below 90% of the mw (%)	0.02	0.03	0.12	0.10
Industry				
Agriculture, forestry and fishing	0.05	0.00	0.23	0.44
Mining and extractive industries	0.00	0.01	0.00	0.00
Manufacturing	0.12	0.15	0.04	0.00
Construction	0.06	0.00	0.17	0.22
Wholesale and Retail Trade	0.20	0.21	0.03	0.00
Hotels and restaurants	0.07	0.10	0.02	0.00
Transportation, communication and electricity, gas, water	0.06	0.08	0.03	0.00
Finance, insurance, real estate and repair services	0.13	0.14	0.04	0.00
Public administration	0.19	0.12	0.00	0.00
Education, health and social work	0.04	0.12	0.00	0.00
Domestic services	0.00	0.00	0.42	0.34
Entertainment, recreation and other services	0.07	0.08	0.02	0.00
Occupation				
Managerial	0.05	0.04	0.00	0.00
Scientific and artistic	0.08	0.10	0.01	0.00
Mid-level technicians	0.08	0.09	0.01	0.00
Administrative service workers	0.10	0.09	0.01	0.00
Service workers	0.18	0.22	0.46	0.34
Retail service workers	0.14	0.16	0.03	0.00
Agriculture workers	0.05	0.00	0.22	0.44
Manufacturing, construction and repair workers	0.26	0.27	0.26	0.22
Armed forces and other occupations	0.05	0.03	0.00	0.00

Source: PNAD 2011.

Sample: Adults aged 25-54, informal employees, white or non-white, working full-time (i.e. 40 hours a week or more), with no missing monthly earnings variable, and with no missing experience variable.

Table B3: Comparison of workers' characteristics among informal employees in observed vs. proxied series (Part I), 2015

	Intensive margin		Extensive margin	
	Observed	Proxied	Observed	Proxied
Median monthly earnings (in R$2019)	2,184	1,896	1,095	968
Age	36.9	36.8	38.7	39.1
Work experience	21.3	21.1	26.5	27.5
Tenure	4.7	4.9	6.4	8.1
Gender				
Male	0.65	0.56	0.57	0.64
Female	0.35	0.44	0.43	0.36
Race				
White	0.46	0.44	0.31	0.32
Nonwhite	0.54	0.56	0.69	0.68
Education				
Less than high school	0.42	0.40	0.76	0.81
High school completed	0.42	0.43	0.22	0.17
College completed	0.16	0.17	0.02	0.02
Region				
North	0.09	0.11	0.12	0.11
Northeast	0.26	0.32	0.36	0.36
Southeast	0.43	0.38	0.36	0.33
South	0.13	0.10	0.09	0.13
Midwest	0.09	0.09	0.07	0.07
Firm size				
Conditional on non-missing				
Small firm (9 workers or less)	0.58	0.68	0.90	0.81
Large firm (10+ workers)	0.42	0.32	0.10	0.19
Missing	0.26	0.30	0.59	0.74

Source: PNAD 2015.

Sample: Adults aged 25-54, informal employees, white or non-white, working full-time (i.e. 40 hours a week or more), with no missing monthly earnings variable, and with no missing experience variable.

Notes: Median monthly earnings in R$2019 winsorized at 1% and 99% levels, deflated using the inpc series.

Table B4: Comparison of workers' characteristics among informal employees in observed vs. proxied series (Part II), 2015

	Intensive margin		Extensive margin	
	Observed	Proxied	Observed	Proxied
Workers near the minimum wage				
Strictly below 100% of the mw (%)	0.09	0.12	0.36	0.29
Strictly below 115% of the mw (%)	0.78	0.77	0.96	0.82
Between 105% and 115% of the mw (%)	0.31	0.27	0.20	0.19
Between 90% and 105% of the mw (%)	0.45	0.48	0.65	0.54
Strictly below 90% of the mw (%)	0.01	0.03	0.11	0.08
Industry				
Agriculture, forestry and fishing	0.06	0.00	0.22	0.44
Mining and extractive industries	0.00	0.01	0.00	0.00
Manufacturing	0.11	0.13	0.03	0.00
Construction	0.06	0.00	0.21	0.25
Wholesale and Retail Trade	0.19	0.20	0.04	0.00
Hotels and restaurants	0.08	0.09	0.03	0.00
Transportation, communication and electricity, gas, water	0.06	0.08	0.03	0.00
Finance, insurance, real estate and repair services	0.13	0.13	0.04	0.00
Public administration	0.20	0.13	0.00	0.00
Education, health and social work	0.05	0.15	0.01	0.00
Domestic services	0.00	0.00	0.37	0.31
Entertainment, recreation and other services	0.06	0.07	0.02	0.00
Occupation				
Managerial	0.06	0.05	0.00	0.00
Scientific and artistic	0.09	0.12	0.01	0.00
Mid-level technicians	0.08	0.09	0.01	0.00
Administrative service workers	0.11	0.10	0.01	0.00
Service workers	0.19	0.23	0.43	0.31
Retail service workers	0.11	0.12	0.03	0.00
Agriculture workers	0.07	0.00	0.22	0.43
Manufacturing, construction and repair workers	0.26	0.25	0.29	0.25
Armed forces and other occupations	0.04	0.03	0.00	0.00

Source: PNAD 2015.

Sample: Adults aged 25-54, informal employees, white or non-white, working full-time (i.e. 40 hours a week or more), with no missing monthly earnings variable, and with no missing experience variable.

Table B5: Comparison of workers' characteristics around the minimum wage in the formal vs. informal sector, 2015

	Formal employees	Informal employees	
		Intensive margin	Extensive margin
Industry			
Agriculture, forestry and fishing	0.06	0.08	0.31
Mining and extractive industries	0.00	0.00	0.00
Manufacturing	0.20	0.13	0.06
Construction	0.08	0.06	0.36
Wholesale and Retail Trade	0.24	0.22	0.07
Hotels and restaurants	0.07	0.10	0.05
Transportation, communication and electricity, gas, water	0.08	0.06	0.05
Finance, insurance, real estate and repair services	0.14	0.10	0.06
Public administration	0.01	0.15	0.00
Education, health and social work	0.09	0.04	0.01
Entertainment, recreation and other services	0.03	0.06	0.04
Occupation			
Managerial	0.02	0.02	0.01
Scientific and artistic	0.02	0.04	0.01
Mid-level technicians	0.06	0.06	0.01
Administrative service workers	0.17	0.13	0.02
Service workers	0.23	0.25	0.10
Retail service workers	0.13	0.13	0.05
Agriculture workers	0.06	0.08	0.31
Manufacturing, construction and repair workers	0.31	0.29	0.50
Armed forces and other occupations	0.00	0.00	0.00

Source: PNAD 2015.

Sample: Adults aged 25-54, informal employees, white or non-white, working full-time (i.e. 40 hours a week or more) between 95% and 110% of the minimum wage, no missing monthly earnings variable, no missing experience variable; excludes domestic services.

Table B6: Transition matrices of minimum wage workers, by employment type

	(1) Formal	(2) Informal-Intensive	(3) Informal-Extensive	(4) Self-Employed
Non-employment	4.3	5.7	4.8	2.8
Strictly below the minimum wage	5.8	13.7	21.6	23.0
Around the minimum wage or above	89.9	80.6	73.6	74.3

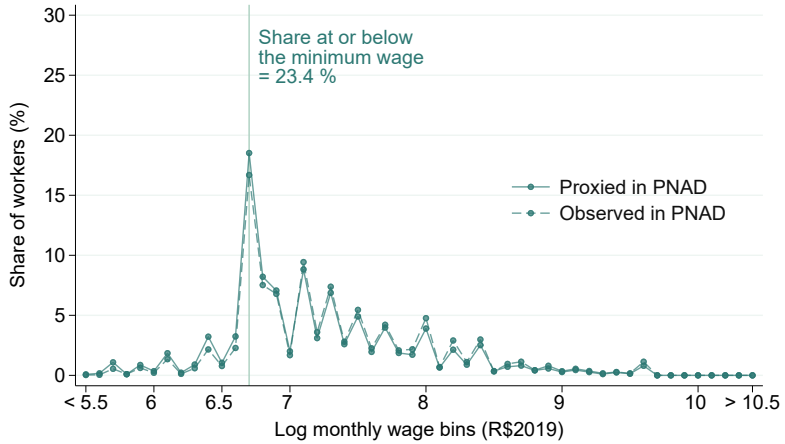
Source: PME 2002-2015.

Sample: Adults aged 25-54, no missing experience variable, white or non-white.

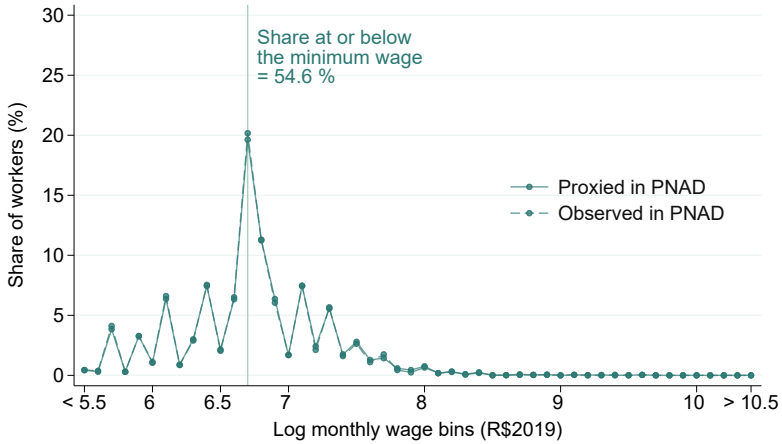
Notes: The table reports transitions of minimum wage workers observed in year t into non-employment, employment below the minimum wage, or employment at or above the minimum wage in year $t+1$. "Strictly below the minimum wage" is defined as strictly below 10 log points below the contemporaneous minimum wage. Outcomes are shown separately by employment type: formal employees, informal employees in formal firms (intensive margin of informality), informal employees in informal firms (extensive margin), and the self-employed. For example, among formal minimum wage employees observed in any given year t between 2002 and 2014, 4.3% of them were not employed in the following year, 5.8% were employed strictly below 90% of the contemporaneous minimum wage (in employment of any type), and 89.9% were employed at or above 90% of the contemporaneous minimum wage (in employment of any type).

Figure B1: Comparison between observed and proxied series on two margins of informality in PNAD

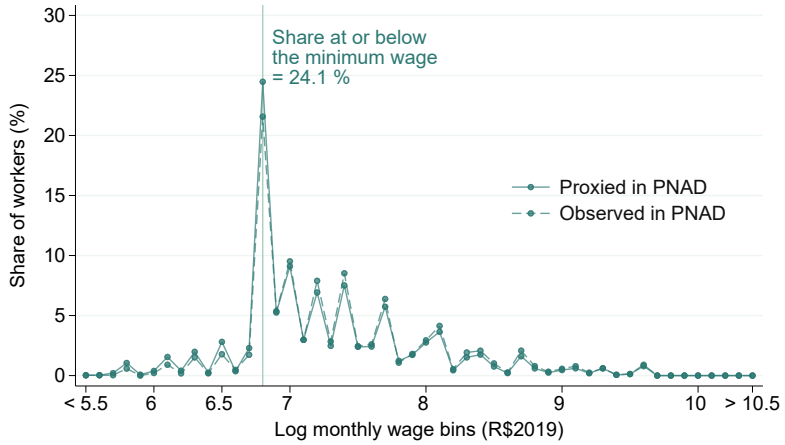
(a) Intensive margin, 2011



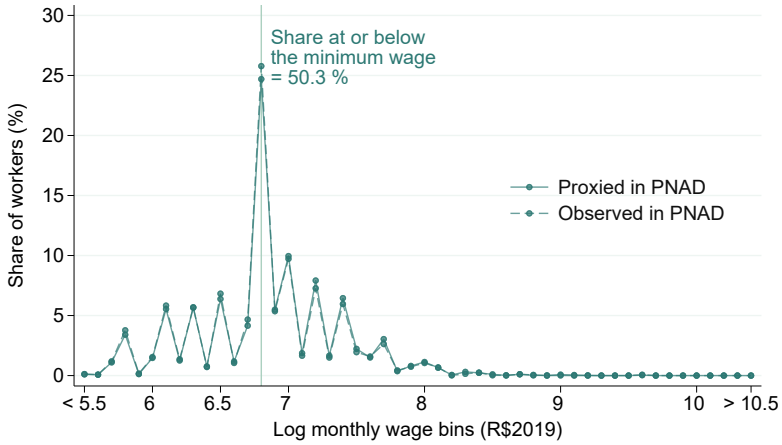
(b) Extensive margin, 2011



(c) Intensive margin, 2015



(d) Extensive margin, 2015



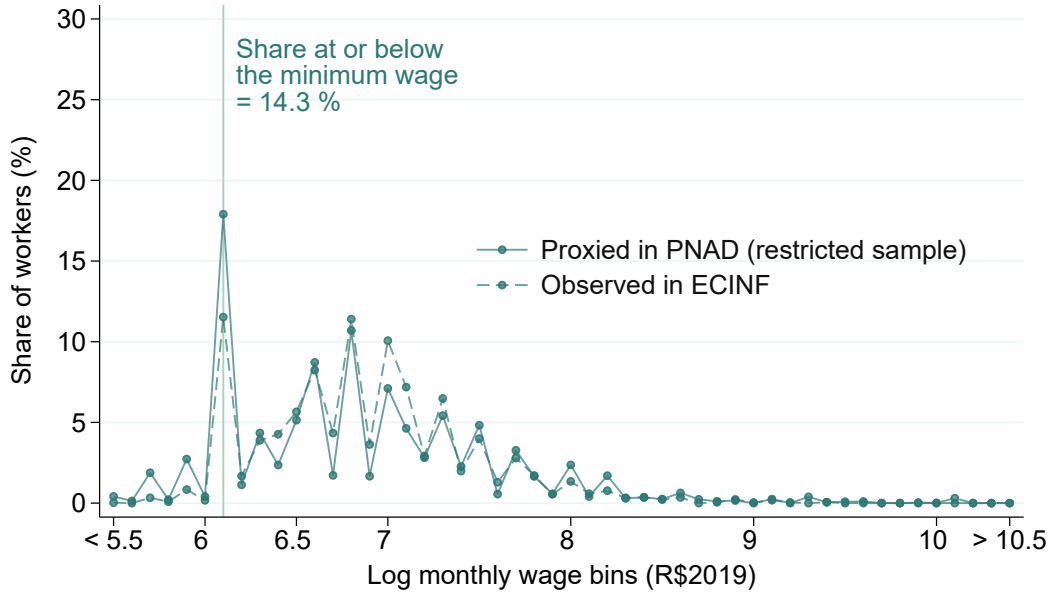
Source: PNAD 2011 & 2015.

Sample: Adults aged 25-54, informal employees, white or non-white, working full-time (i.e. 40 hours a week or more), with no missing monthly earnings variable, and with no missing experience variable.

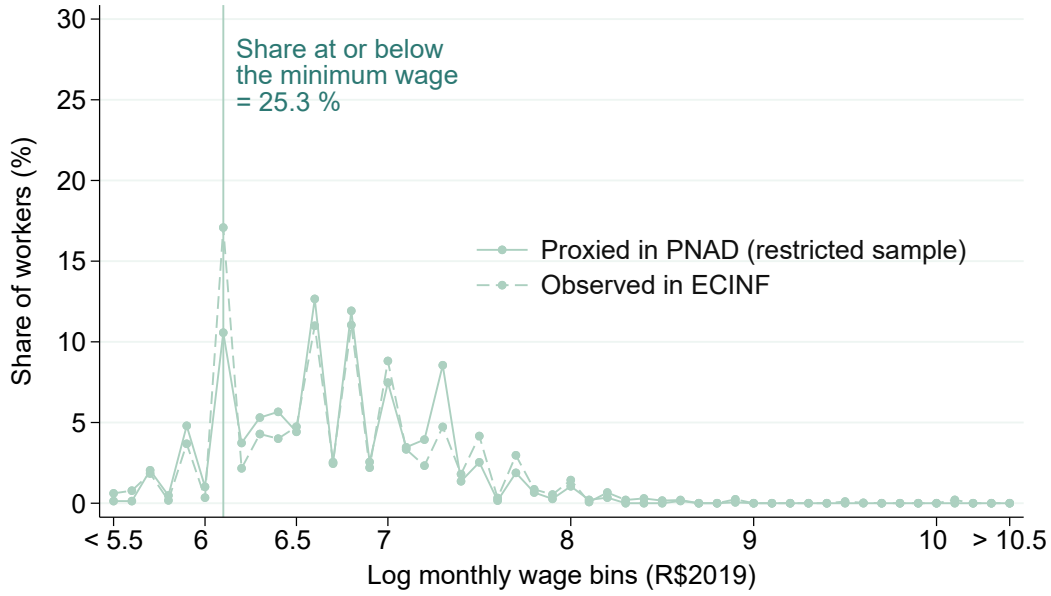
Notes: All four panels report the shares of workers at exactly the minimum wage or below in the observed series in PNAD. The Figure shows that the observed and proxied wage distributions in PNAD on the intensive and extensive margins of informality are well aligned in 2011 and 2015. It is also the case for the years 2012, 2013 and 2014, as shown in our slides here.

Figure B2: Comparison between observed monthly earnings distributions in ECINF and proxied series in PNAD on two margins of informality, 1997

(a) Informal employees in formal firms (intensive margin)



(b) Informal employees in informal firms (extensive margin)



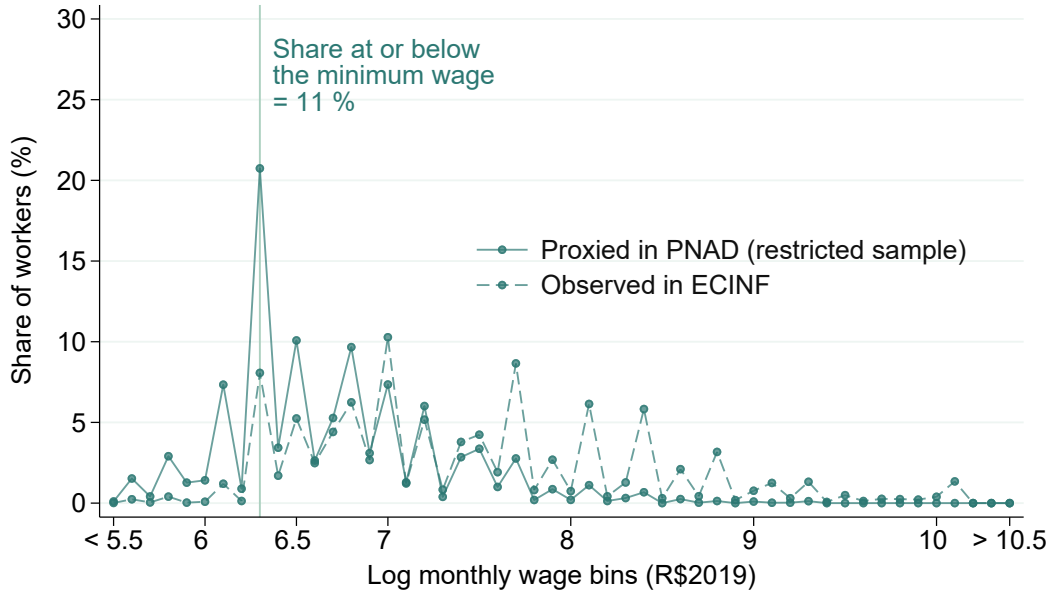
Sources: PNAD 1997 and ECINF 1997.

Sample: Adults aged 25-54, informal employees, white or non-white, working full-time (i.e. 40 hours a week or more), with no missing monthly earnings variable, and with no missing experience variable. The PNAD sample is further restricted to workers employed in firms of size 5 workers or fewer, and excludes domestic workers from the sample—so that the PNAD and ECINF samples are made closest to each other.

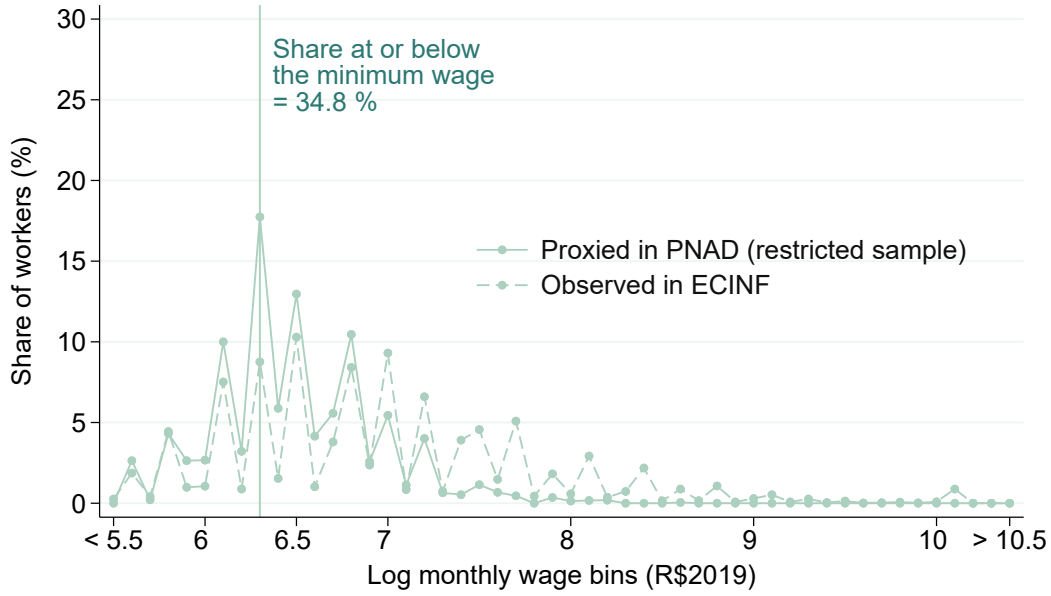
Notes: The two panels report the shares of workers at exactly the minimum wage or below in the observed series in ECINF.

Figure B3: Comparison between observed monthly earnings distributions in ECINF and proxied series in PNAD on two margins of informality, 2003

(a) Informal employees in formal firms (intensive margin)



(b) Informal employees in informal firms (extensive margin)



Sources: PNAD 2003 and ECINF 2003.

Sample: Adults aged 25-54, informal employees, white or non-white, working full-time (i.e. 40 hours a week or more), with no missing monthly earnings variable, and with no missing experience variable. The PNAD sample is further restricted to workers employed in firms of size 5 workers or fewer, and excludes domestic workers from the sample—so that the PNAD and ECINF samples are made closest to each other.

Notes: The two panels report the shares of workers at exactly the minimum wage or below in the observed series in ECINF.

B.4 Data with restricted access: linked employer-employee data (RAIS) (1995-2017)

Content. We have access to the linked employer-employee data from 1995 to 2017. It contains information on the universe of workers employed in the formal sector in Brazil. The data set contains a worker identifier, and a firm identifier. We have information on three types of earnings: i) earnings in December each year ("December earnings" in what follows); ii) earnings as stipulated in the employment contract at the end of the year or at the end of the relationship for spells that ended during the year ("contracted wage" in what follows), starting in 2002 only; From 2015 to 2017, we also have monthly earnings for each month of the year, not just December ("monthly earnings" in what follows). In some of the graphs, we report the wage distribution for September earnings in 2015, to be as close as possible to the earnings concept used in PNAD.[11]

The dataset also contains a series of workers' characteristics (gender, age, education, tenure, occupation, type of labor contract, contracted hours, hiring date, separation date, type of separation) and firms' characteristics (location, industry, legal status).

Access and documentation. The full documentation can be accessed here. An example dictionary of variables for 2019 available at this address.

Consistency between RAIS and PNAD. We investigate the consistency between the linked employer-employee data (RAIS) and the labor force surveys (PNAD) for workers in the private formal sector.

We show that the spike at the minimum wage in monthly earnings distributions in PNAD (i.e., earnings reported by workers) is nearly identical to the spike observed using the contracted wage in the universe of the matched employer-employee data (i.e. earnings reported by employers). Appendix Figure B4 compares the share of workers within each wage bin (using the concept of monthly earnings distributions in PNAD and monthly contracted wage distributions in RAIS).[12] We believe these two wage concepts are close. In 2009, at the peak of the minimum wage, both data sources show that 16.5% of workers are paid within 10% of the minimum wage. By contrast, the spike at the minimum wage using the December earnings variable—that takes into account bonuses and overtime pay—is much smaller.

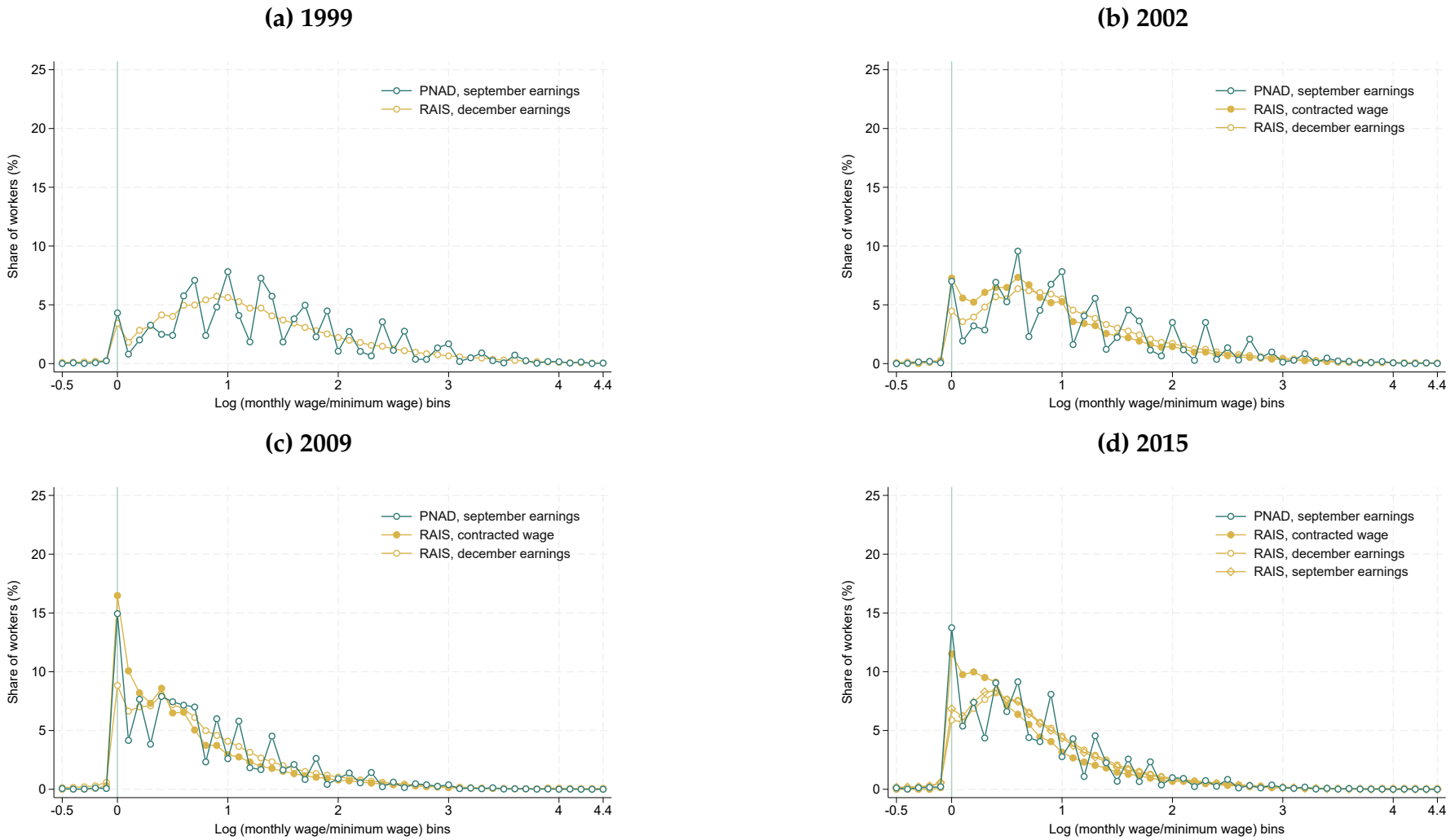
[11] There is also an average monthly earnings over the employment spell in each year available in RAIS, that we do not use in our analysis.

[12] Note that in this series of figures, we've excluded agricultural and domestic services workers from our analysis sample to make the two data sources more comparable.

Virtually no workers report being paid below the minimum wage in the private formal sector. This nearly perfect compliance with the minimum wage is also confirmed in the RAIS data.

This consistency between RAIS and PNAD is true in terms of share of workers (see Appendix Figure B4), but also in terms of number of workers (see Appendix Figure B5). We show similar consistency across the two data sources by region (see Appendix Figure B6 for the North, Appendix Figure B9 for the South, Appendix Figure B8 for Southeast, Appendix Figure B10 for Central-West), including in the Northeast (Appendix Figure B7), a region where the spike within 10% of the minimum wage is above 35% in 2009.

Figure B4: Monthly earnings distributions in PNAD vs. RAIS, Brazil (share of workers in y-axis)

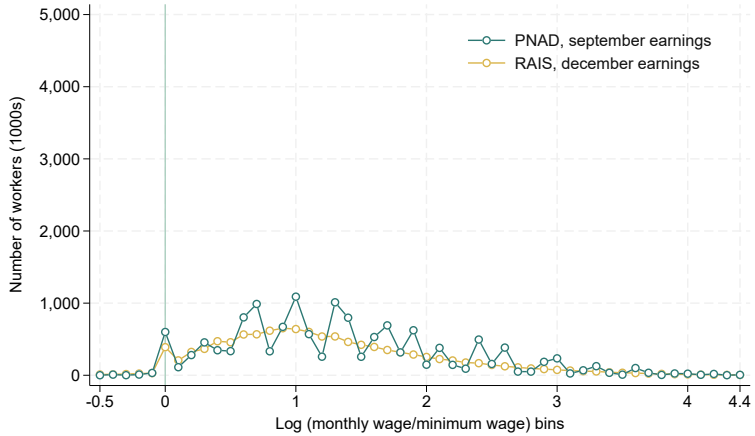


Sources: PNAD 1999-2015. RAIS 1999-2015.

Sample: Adults aged 25-54, white or non-white, employed in the private sector (formal sector only), working full-time (i.e. 40 hours a week or more), with no missing monthly earnings variable, and with no missing experience variable. Excludes agricultural workers and domestic workers.

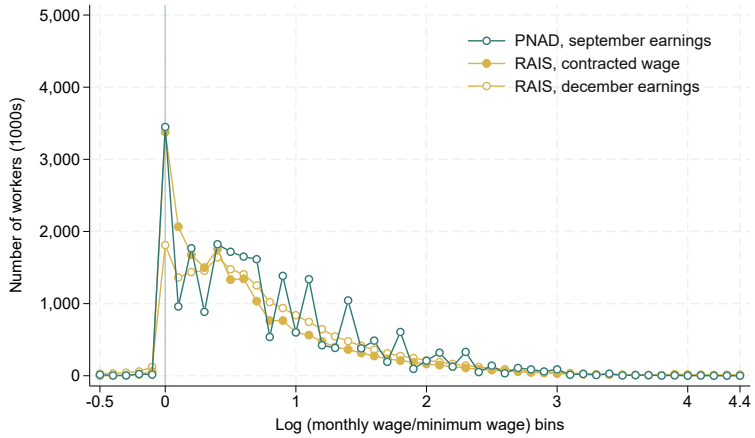
Figure B5: Monthly earnings distributions in PNAD vs. RAIS, Brazil (number of workers in y-axis)

(a) 1999

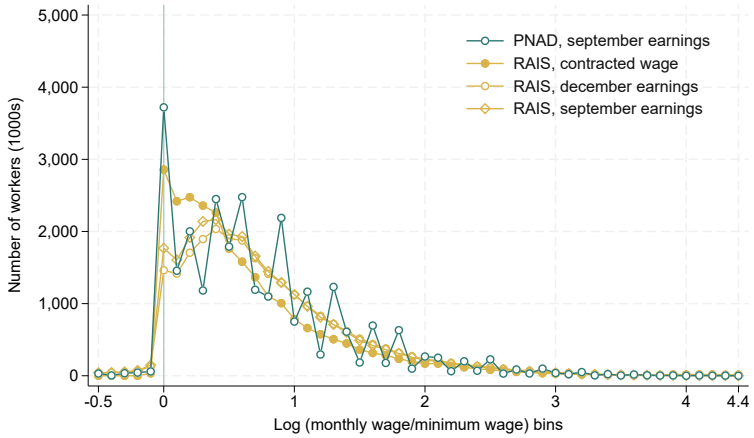


(b) 2002

(c) 2009



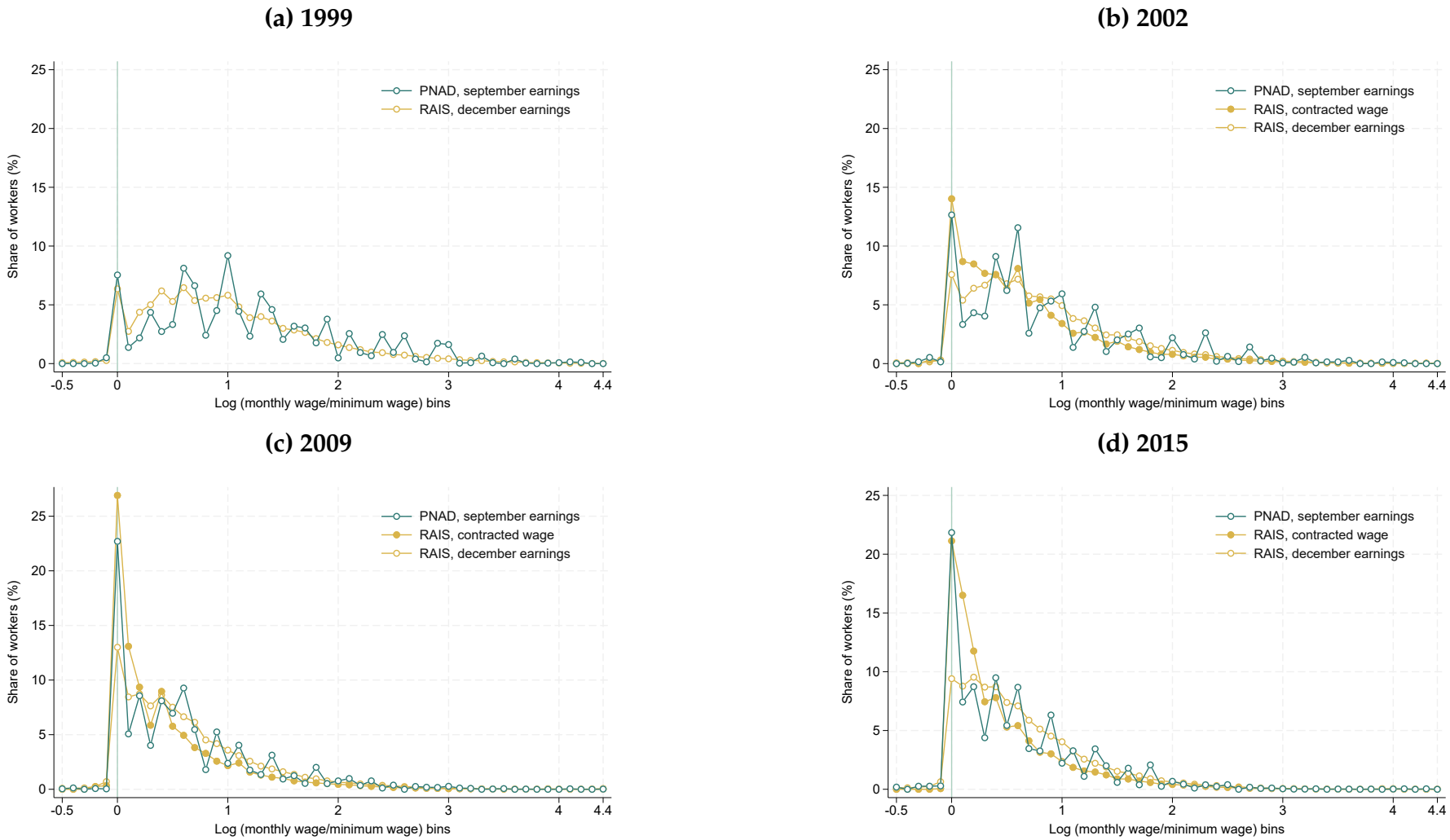
(d) 2015



Sources: PNAD 1999-2015. RAIS 1999-2015.

Sample: Adults aged 25-54, white or non-white, employed in the private sector (formal sector only), working full-time (i.e. 40 hours a week or more), with no missing monthly earnings variable, and with no missing experience variable. Excludes agricultural workers and domestic workers.

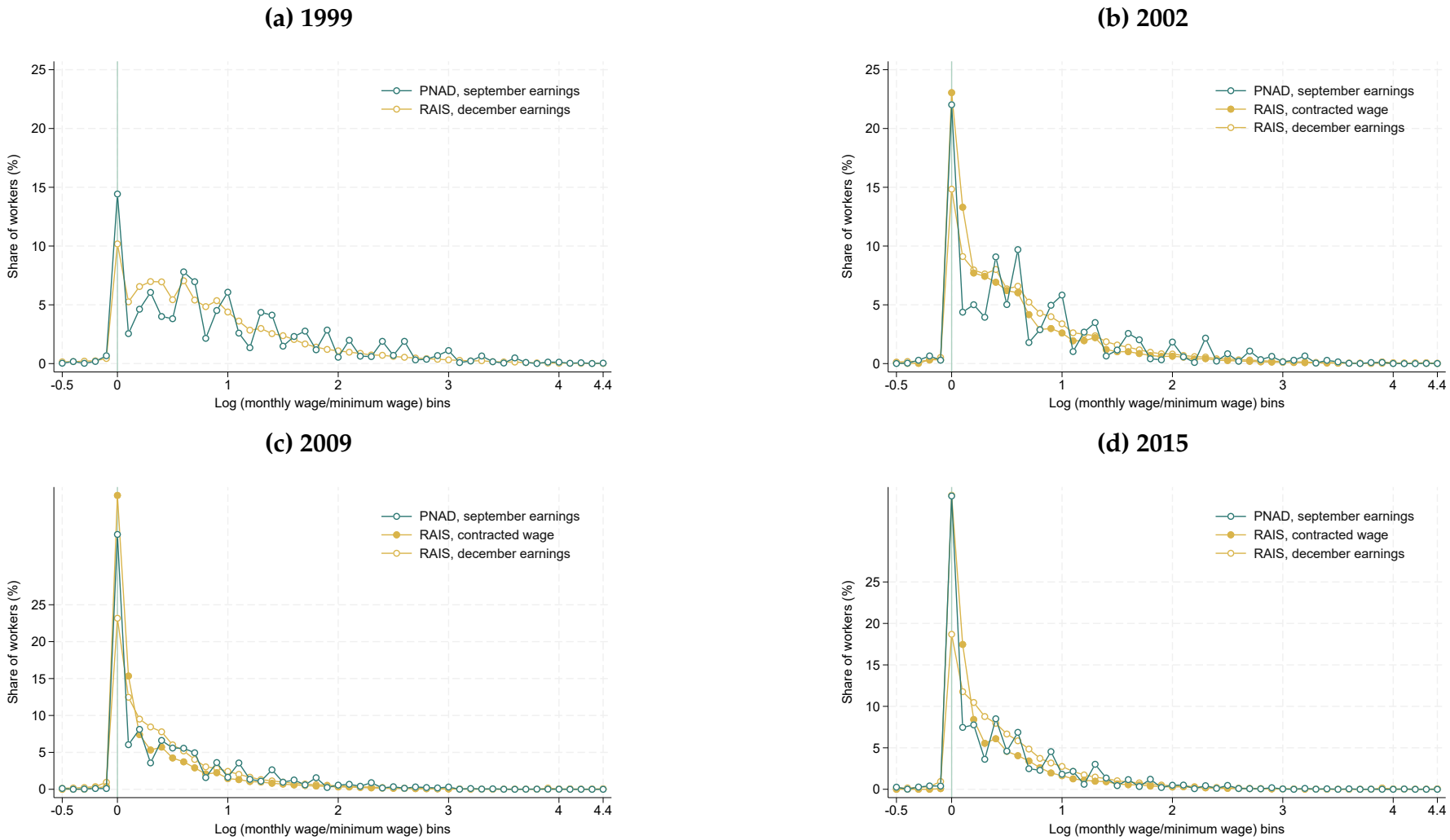
Figure B6: Monthly earnings distributions in PNAD vs. RAIS in the North



Sources: PNAD 1999-2015. RAIS 1999-2015.

Sample: Adults aged 25-54, white or non-white, employed in the private sector (formal sector only), working full-time (i.e. 40 hours a week or more), with no missing monthly earnings variable, and with no missing experience variable. Excludes agricultural workers and domestic workers.

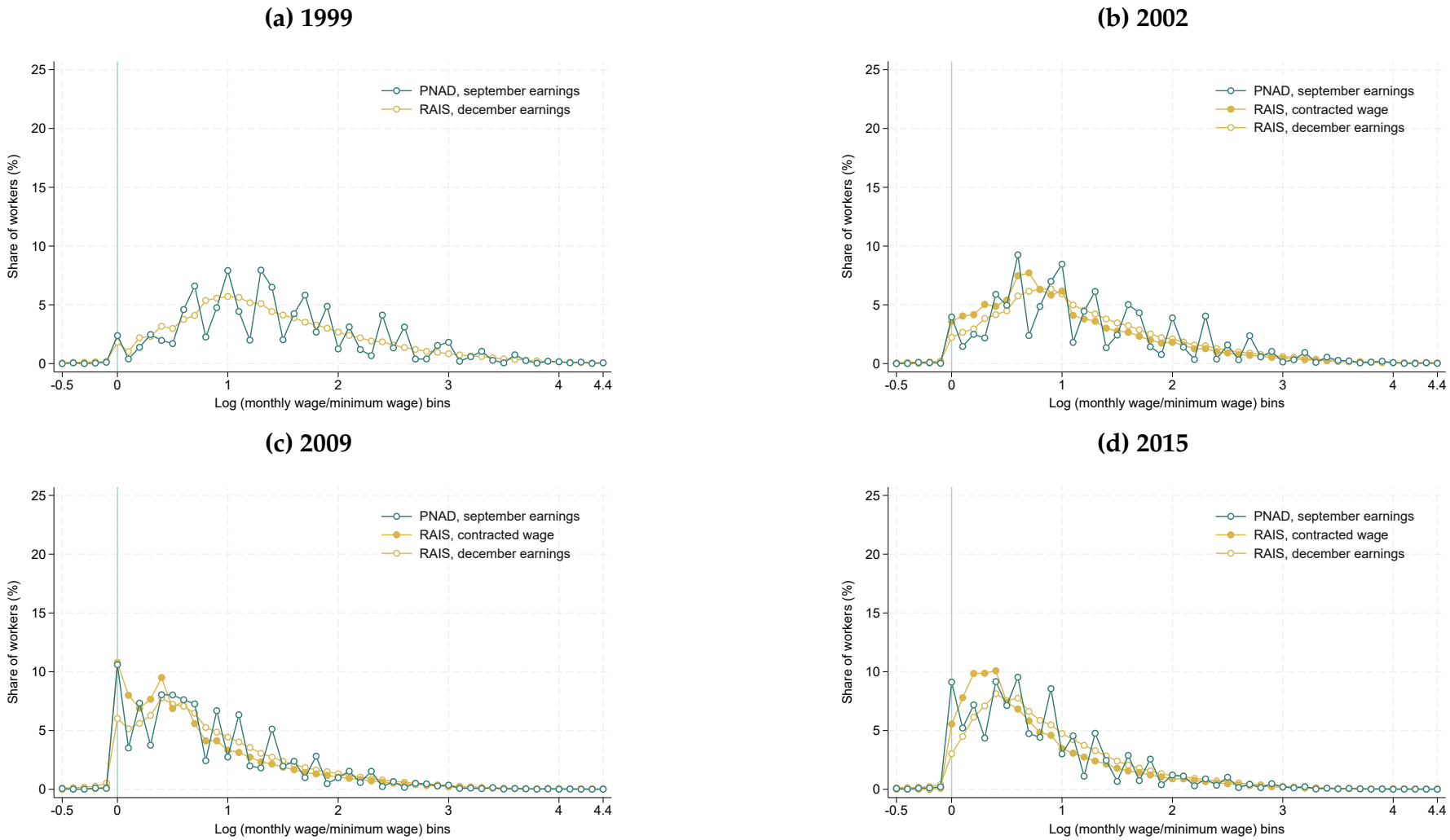
Figure B7: Monthly earnings distributions in PNAD vs. RAIS in Northeast



Sources: PNAD 1999-2015. RAIS 1999-2015.

Sample: Adults aged 25-54, white or non-white, employed in the private sector (formal sector only), working full-time (i.e. 40 hours a week or more), with no missing monthly earnings variable, and with no missing experience variable. Excludes agricultural workers and domestic workers.

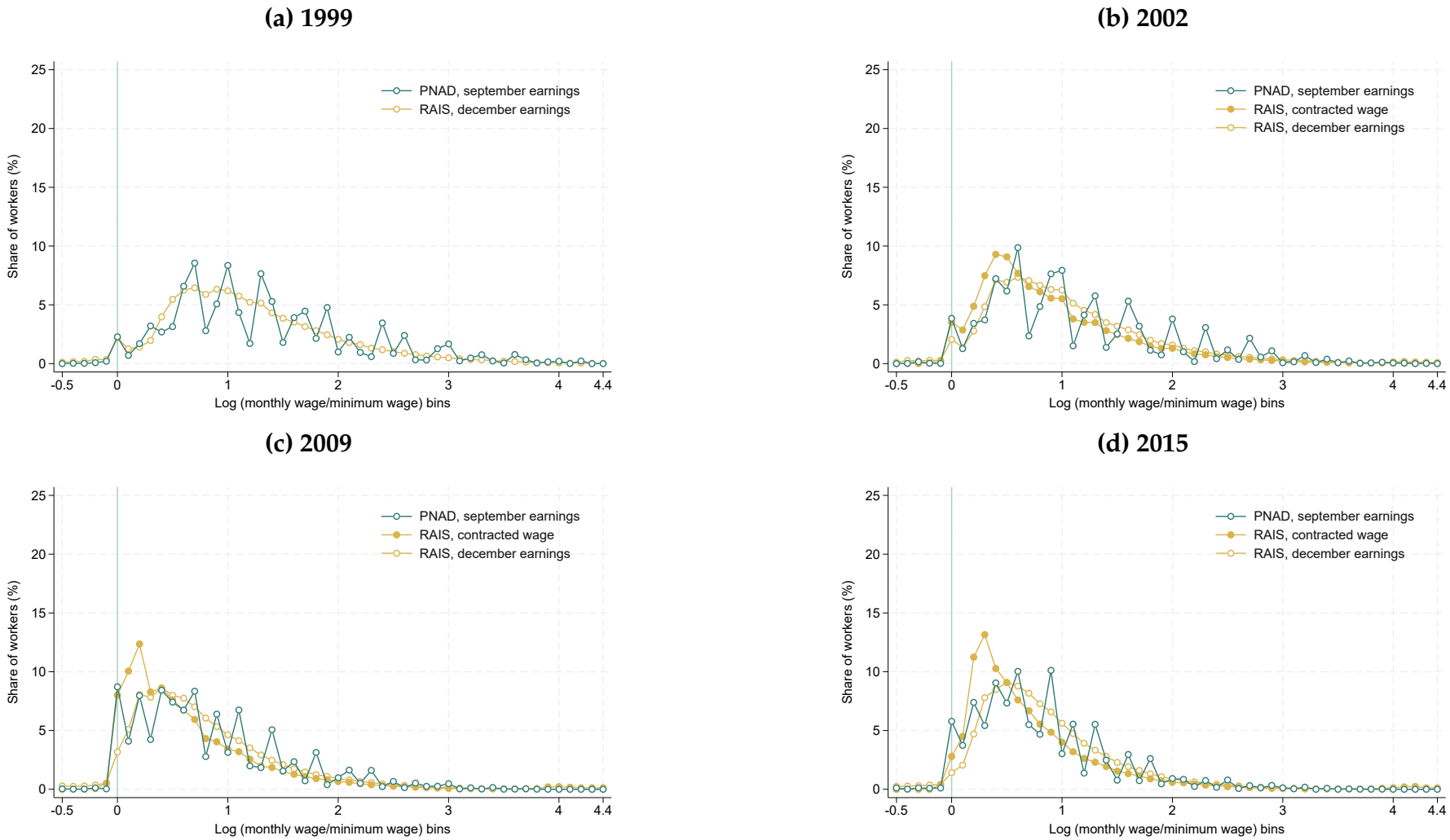
Figure B8: Monthly earnings distributions in PNAD vs. RAIS in Southeast



Sources: PNAD 1999-2015. RAIS 1999-2015.

Sample: Adults aged 25-54, white or non-white, employed in the private sector (formal sector only), working full-time (i.e. 40 hours a week or more), with no missing monthly earnings variable, and with no missing experience variable. Excludes agricultural workers and domestic workers.

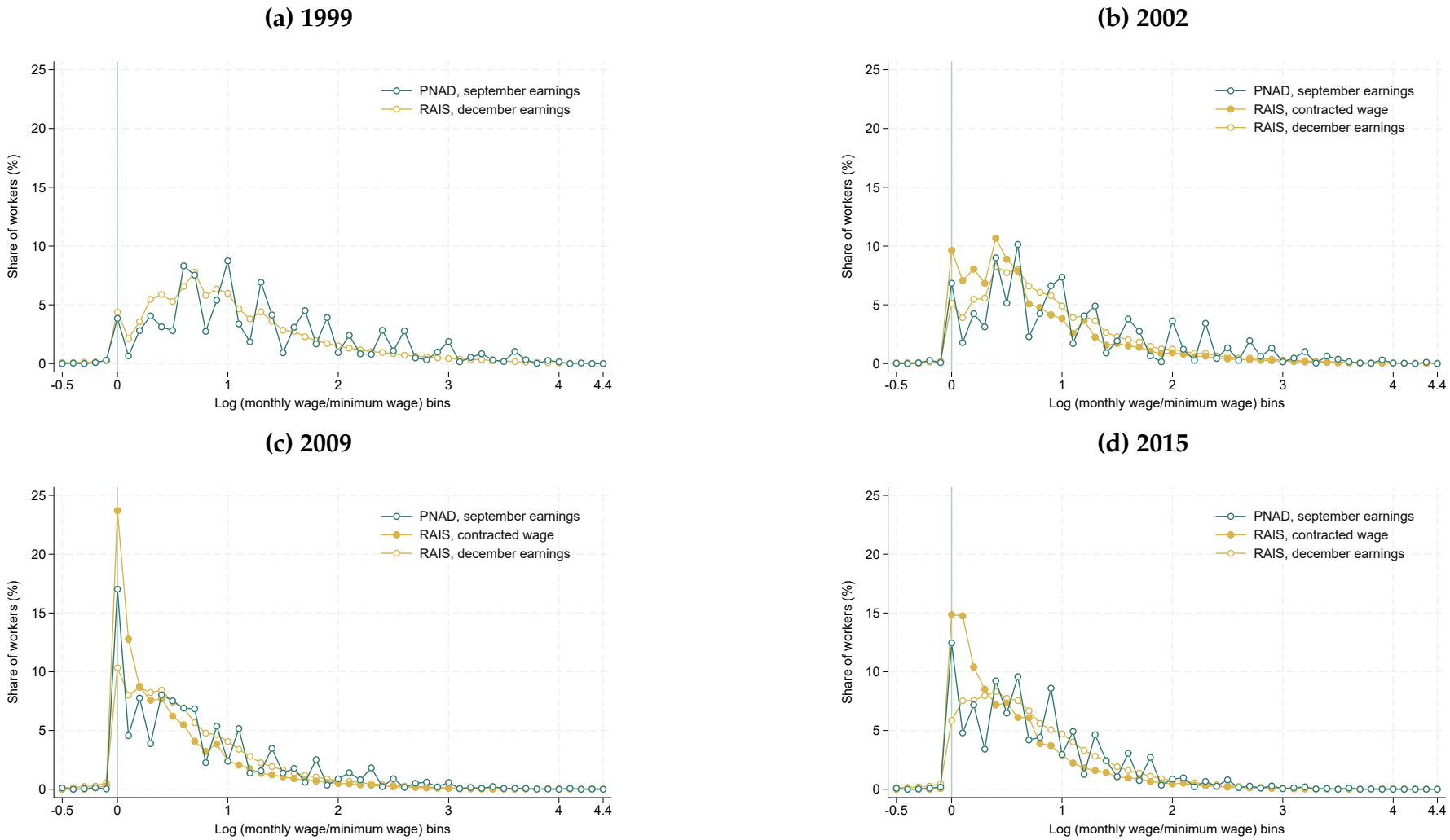
Figure B9: Monthly earnings distributions in PNAD vs. RAIS in the South



Sources: PNAD 1999-2015. RAIS 1999-2015.

Sample: Adults aged 25-54, white or non-white, employed in the private sector (formal sector only), working full-time (i.e. 40 hours a week or more), with no missing monthly earnings variable, and with no missing experience variable. Excludes agricultural workers and domestic workers.

Figure B10: Monthly earnings distributions in PNAD vs. RAIS in Central-West

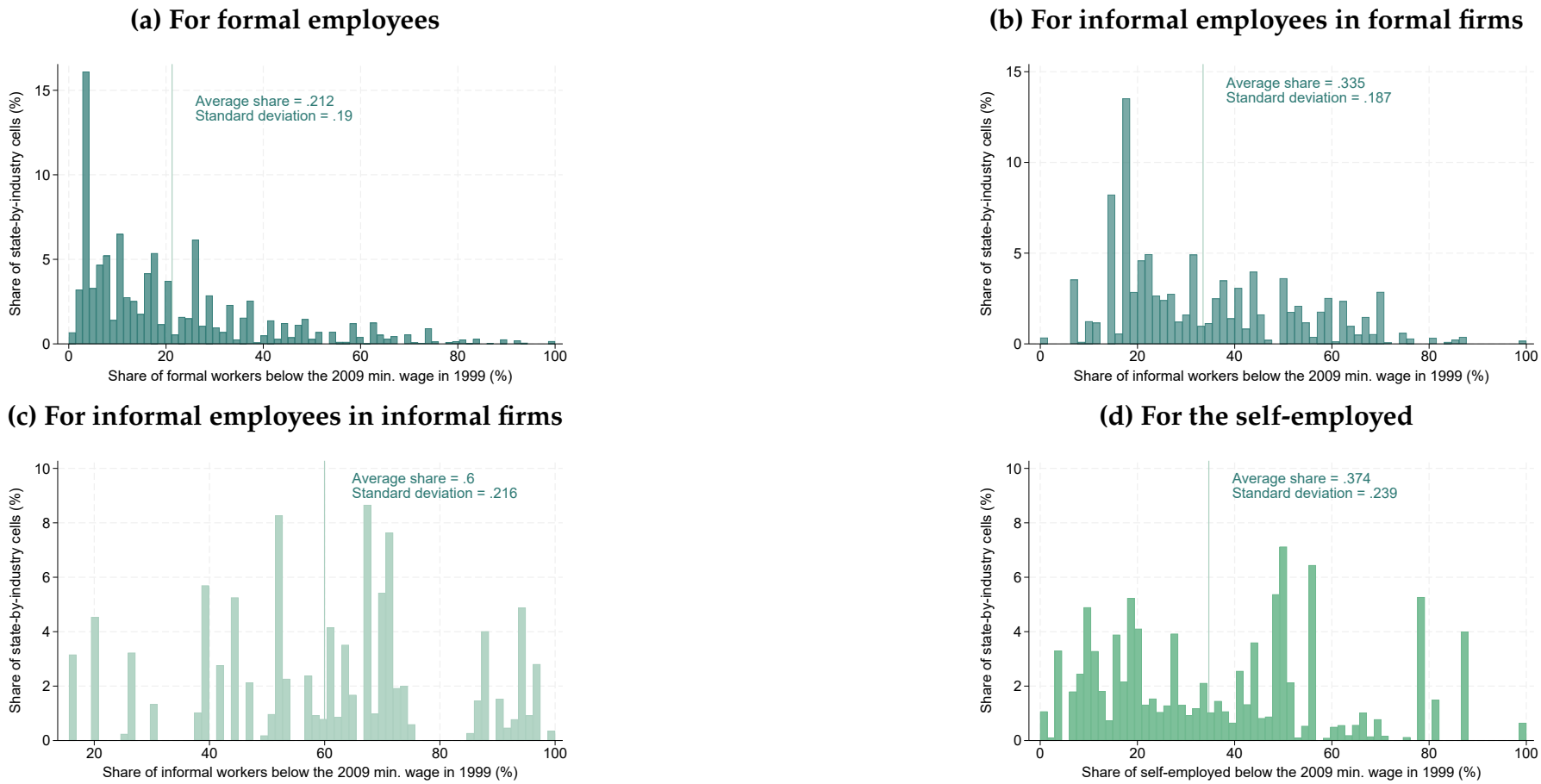


Sources: PNAD 1999-2015. RAIS 1999-2015.

Sample: Adults aged 25-54, white or non-white, employed in the private sector (formal sector only), working full-time (i.e. 40 hours a week or more), with no missing monthly earnings variable, and with no missing experience variable. Excludes agricultural workers and domestic workers.

Appendix C Distribution of share of affected workers

Figure C1: Distribution of share of affected workers



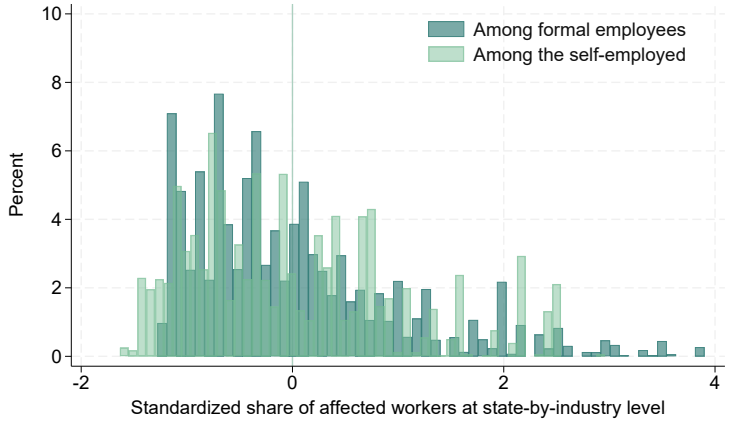
Sources: PNAD 1995-2015.

Sample: Adults aged 25-54 employed full-time. Panel (a): restricted to formal employees in the private sector; panel (b): restricted to informal employees on the intensive margin of informality; panel (c): restricted to informal employees on the extensive margin of informality; panel (d) restricted to the self-employed. These shares are computed across 279 state-by-industry cells in panel (a), 209 in panel (b), 72 in panel (c) and 230 in panel (d).

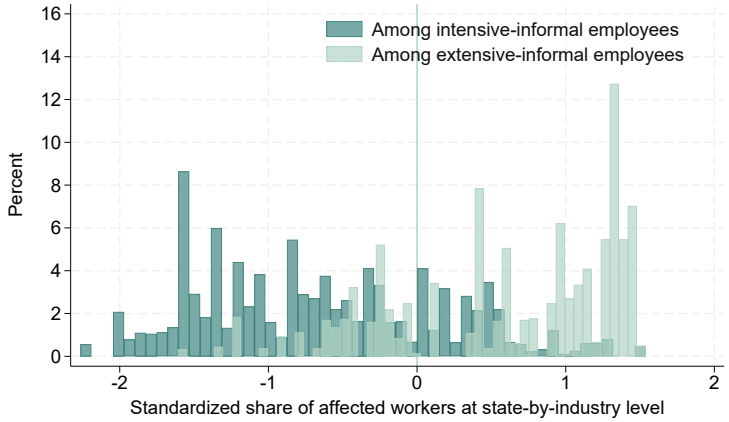
Notes: On average across all state-by-industry cells, the share of affected workers is 21.2% among formal employees, and 33.5% (60%) among intensive (extensive)-informal employees. This share is 37.4% among the self-employed. These average shares are weighted by the number of workers in each type of employment in each cell. The standard deviation is 0.19 in the formal sector. It is 0.19 (0.22) for intensive (extensive)-informal employees, and 0.24 for the self-employed. In the formal sector: p25 is 5.9%, p50 is 15.9%, and p75 is 28.9%. In the intensive-informal sector: p25 is 17.4%, p50 is 28.8%, and p75 is 45.6%. In the extensive-informal sector: p25 is 43.8%, p50 is 62.5%, and p75 is 71.7%. Among the self-employed: p25 is 15.3%, p50 is 27.5%, and p75 is 49.3%.

Figure C2: Distribution of standardized treatment variables

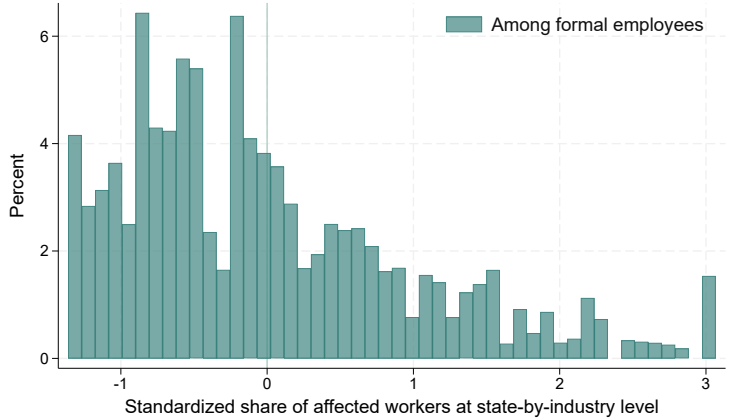
(a) For wage effects, individual-level dataset



(b) For wage effects, individual-level dataset



(c) For employment effects, state-by-industry panel



Sources: PNAD 1995-2015.

Sample: In panels (a) and (b): distribution of the standardized treatment variable that is used for assessing the effect on wages using the individual-level dataset; the treatment variable is computed separately among formal employees and the self-employed in panel (a); and among each margin of informality in panel (b). Panel (c) shows the distribution of the standardized treatment variable used to assess the employment effects using the state-by-industry-by wage bin panel. We only use this treatment variable among formal employees in our study.

Appendix D Additional results on wage effects and robustness checks

D.1 Results on average wages for informal employees on the extensive margin and the self-employed

Appendix Figure D11 overlays our main average wage effect as computed using our baseline difference-in-differences in PNAD over 1995-2015 (1999 is the omitted year) with:

1. The average wage effect calculated in Census 2000 and 2010 (2000 is the omitted year) using our baseline difference-in-differences design at the state-by-industry level, as in PNAD. The treatment variable—i.e. the share of workers earning below the 2010 minimum wage by state-industry cells—is computed in the Census 2000, and is therefore slightly different from the one used in PNAD.

2. The average wage effect calculated in PNAD using our industry proxy for firm formality, but restricted to the sample of workers who directly report their firm's formality status. The wage effect is recalculated independently for each year between 2011 (the first year in which firm formality is directly measured) and 2015, and the difference between the full sample and partial sample is added to the baseline coefficient to yield the estimated effect with respect to the (out of sample) 1999 omitted year.

3. The average wage effect calculated in PNAD using the direct response for their firm formality status. The wage effect is recalculated independently for each year between 2011 (the first year in which firm formality is directly measured) and 2015, and the difference between the proxied estimate and direct-response estimated is added to the baseline coefficient to yield the estimated effect with respect to the (out of sample) 1999 omitted year.

Overall, we find that the point estimates are well aligned between PNAD and Census in the formal sector, using the state-by-industry design. The wage effect appears slightly smaller in census data, possibly coming from the fact that the omitted year is 2000—a year in which the minimum wage had already started to increase. We also find that our estimates do not change meaningfully between the direct-response and proxied version of our informality margin. The consistency of our results suggest that neither the selection effect to respondents who report firm margin nor measurement error drive our estimates.

Table D1: Wage effects of the minimum wage in Census 2010 and across state and microregion by industry designs

	State-by-industry design	Microregion-by-industry design
Formal employees	0.108***	0.120***
	(0.011)	(0.005)
	3,857,316	3,856,495
Informal employees		
Intensive margin	0.115***	0.143***
	(0.019)	(0.007)
	745,957	744,587
Extensive margin	0.091**	0.106***
	(0.036)	(0.017)
	846,245	843,242
Self-employed	-0.042	0.049***
	(0.044)	(0.009)
	2,043,143	2,022,690
Individual-level controls	X	X
State GDP controls	X	X
State × industry FEs	X	
Microregion × industry FEs		X
Industry × year FEs	X	X

Sources: Census 2000 & 2010.

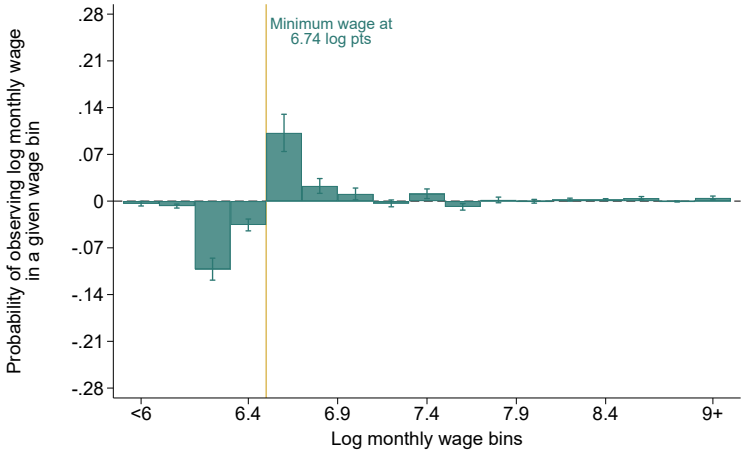
Sample: Adults aged 25-54, white or non-white, employed in the private sector, working full-time (i.e. 40 hours a week or more), with no missing monthly earnings variable, and with no missing experience variable.

Notes: The figure shows in the first row the average wage effects computed in 2010 using a difference-in-differences design (see Equation 1 in Section 4.1) adapted to census data, in which the omitted year is 2000. Column (1) refers to estimates using variation in the bite at the state-by-industry level; column (2) refers to estimates using variation in the bite at the microregion-by-industry level.

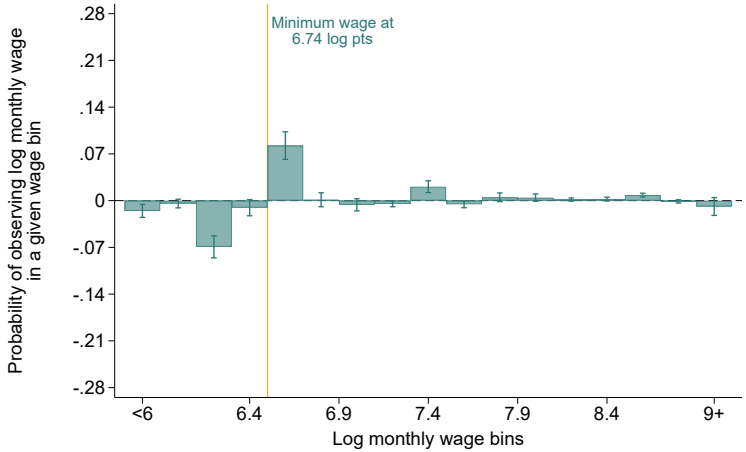
D.2 Consistent wage effects across data sources.

Figure D1: Effect of the min. wage on the probability of being in a specific wage bin in 2010, census data

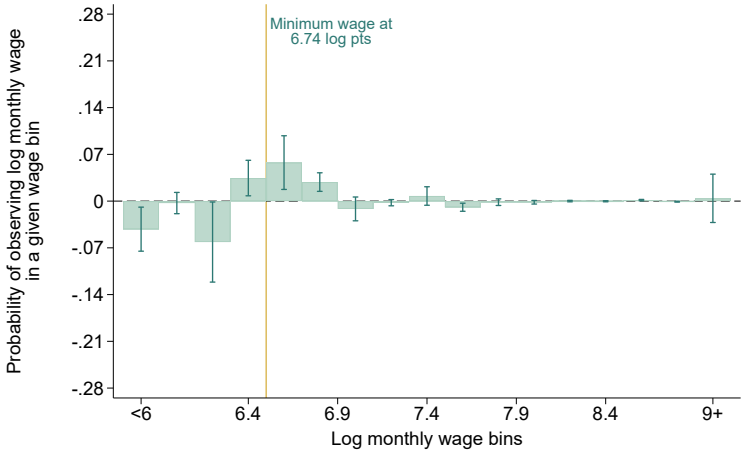
(a) Formal employees



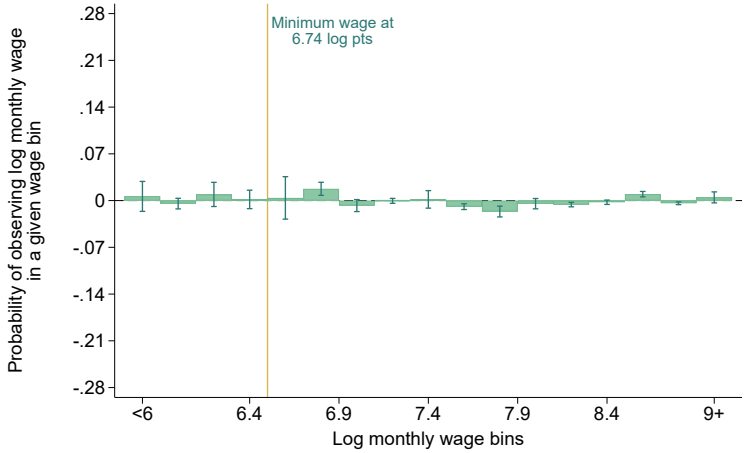
(b) Informal employees in formal firms (intensive margin)



(c) Informal employees in informal firms (extensive margin)



(d) Self-employed



Sources: Census 2000 & 2010.

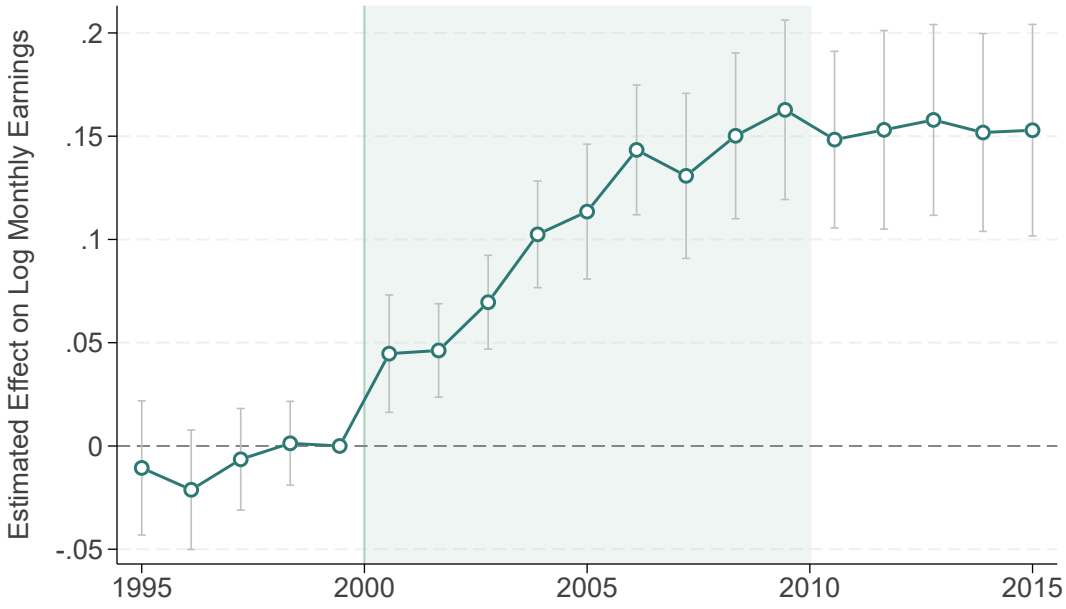
Sample: Adults aged 25-54, white or non-white, formal employees, working full-time (i.e. 40 hours a week or more), with no missing monthly earnings variable, and with no missing experience variable. Formal employees only in panel (a); Informal employees working in formal firms only in panel (b); Informal employees working in informal firms only in panel (c); self-employed workers only in panel (d).

Notes: The figure shows additional results from our bunching difference-in-differences design shown in Figure 4 using census data. The figure assesses the effect of the 2000-2009 minimum wage increases on the change in the probability density of wages between the 2000 and 2010 Census enumerations by levels of informality (see Equation 2 in Section 4.3).

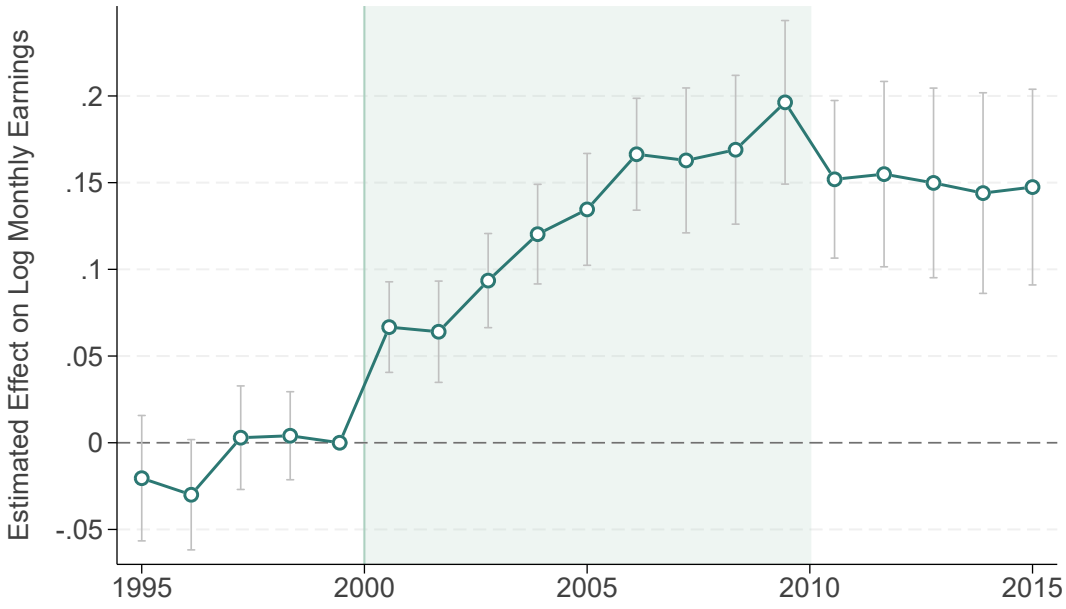
D.3 Robustness to alternative definitions of the treatment variables.

Figure D2: Results on average wages with alternative treatment variables

(a) Q2, Q3, Q4 vs. Q1



(b) Q3, Q4 vs. Q1

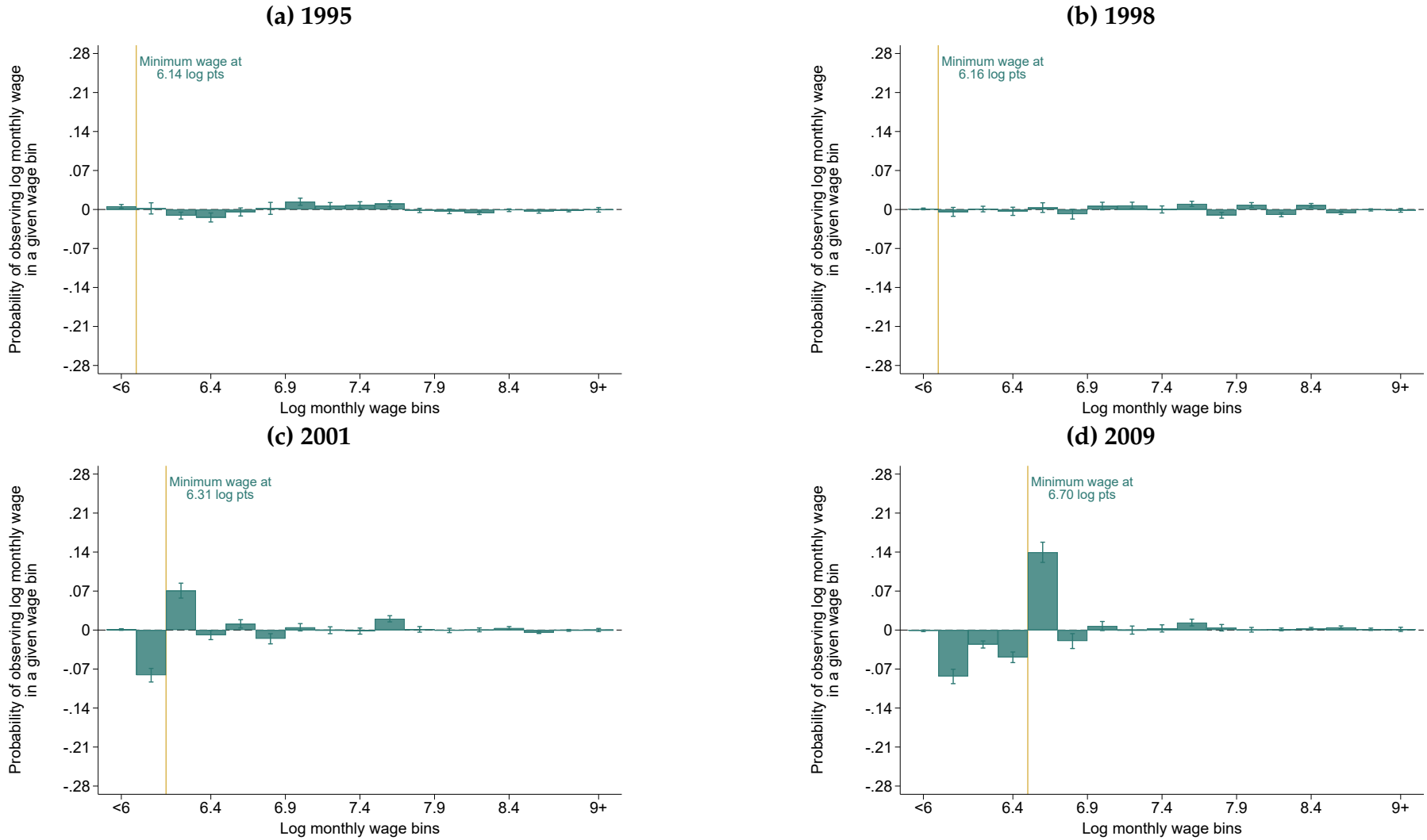


Sources: PNAD 1995-2015.

Sample: Adults aged 25-54, white or non-white, employed in the private sector (formal sector only), working full-time (i.e. 40 hours a week or more), with no missing monthly earnings variable, and with no missing experience variable.

D.4 Robustness to mean reversion.

Figure D3: Evolution of the probabilities to be in a specific wage bin in pre- and post-reform years among formal employees

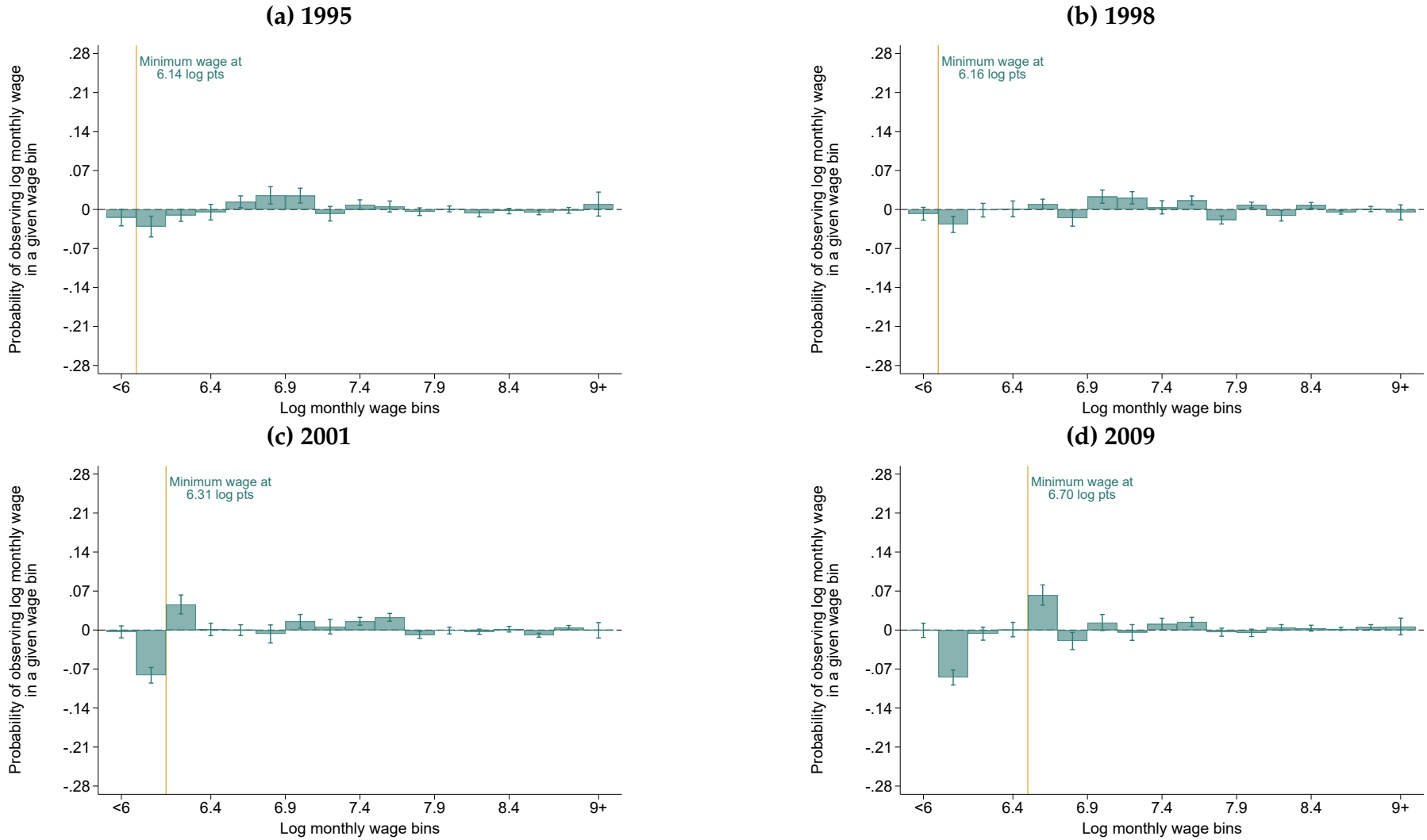


Sources: PNAD 1999-2015.

Sample: Adults aged 25-54, white or non-white, formal employees, working full-time (i.e. 40 hours a week or more), with no missing monthly earnings variable, and with no missing experience variable.

Notes: The figure shows the main results from our bunching difference-in-differences design assessing the effect of the 2000-2009 minimum wage increases on the distribution of wages (see Equation 2 in Section 4.3). The complete 1995-2015 series of graphs is available in our slides here.

Figure D4: Evolution of the probabilities to be in a specific wage bin in pre- and post-reform years among informal employees in formal firms

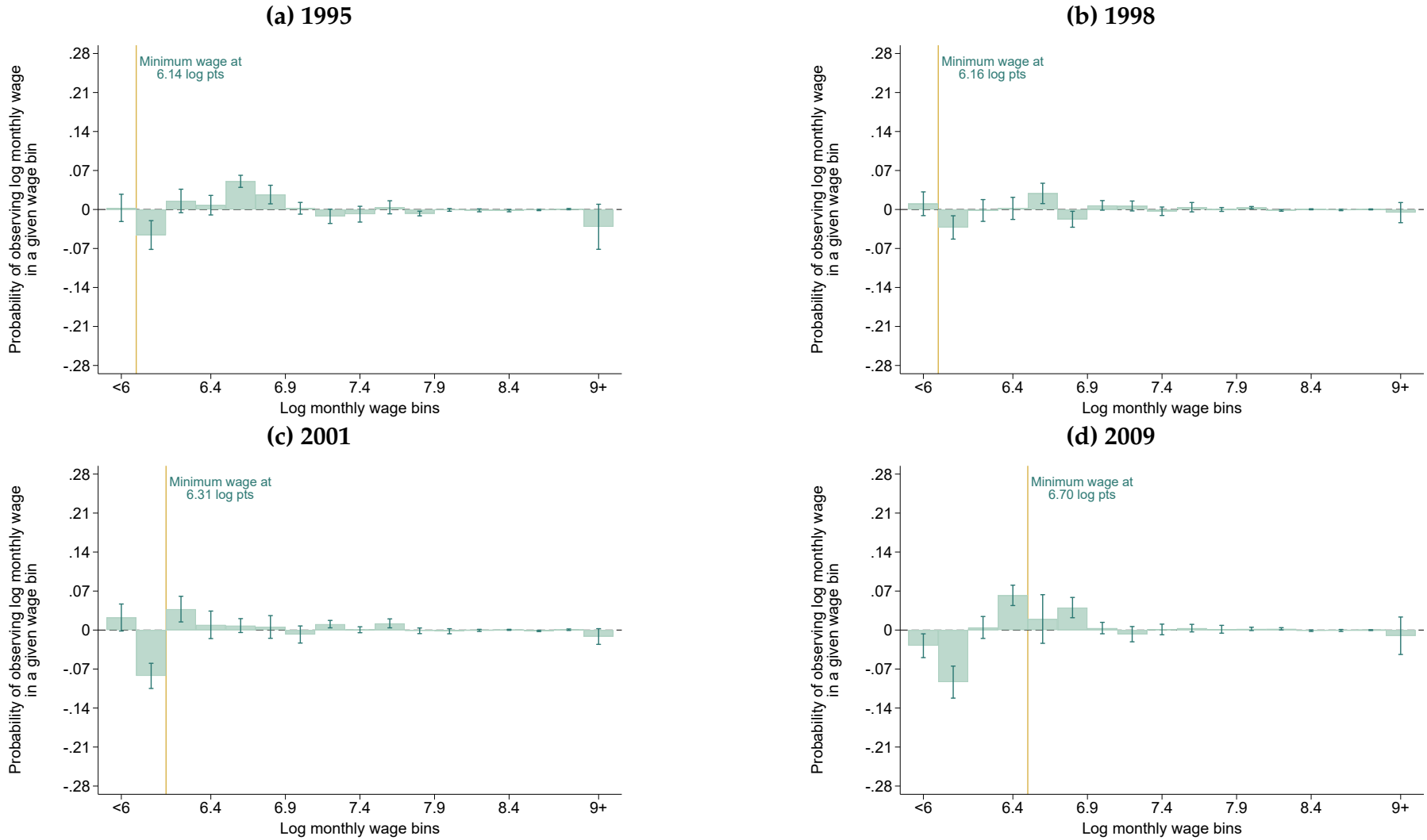


Sources: PNAD 1999-2015.

Sample: Adults aged 25-54, white or non-white, informal employees on the intensive margin of informality, working full-time (i.e. 40 hours a week or more), with no missing monthly earnings variable, and with no missing experience variable.

Notes: The figure shows the main results from our bunching difference-in-differences design assessing the effect of the 2000-2009 minimum wage increases on the distribution of wages (see Equation 2 in Section 4.3). The complete 1995-2015 series of graphs is available in our slides here.

Figure D5: Evolution of the probabilities to be in a specific wage bin in pre- and post-reform years among informal employees in informal firms

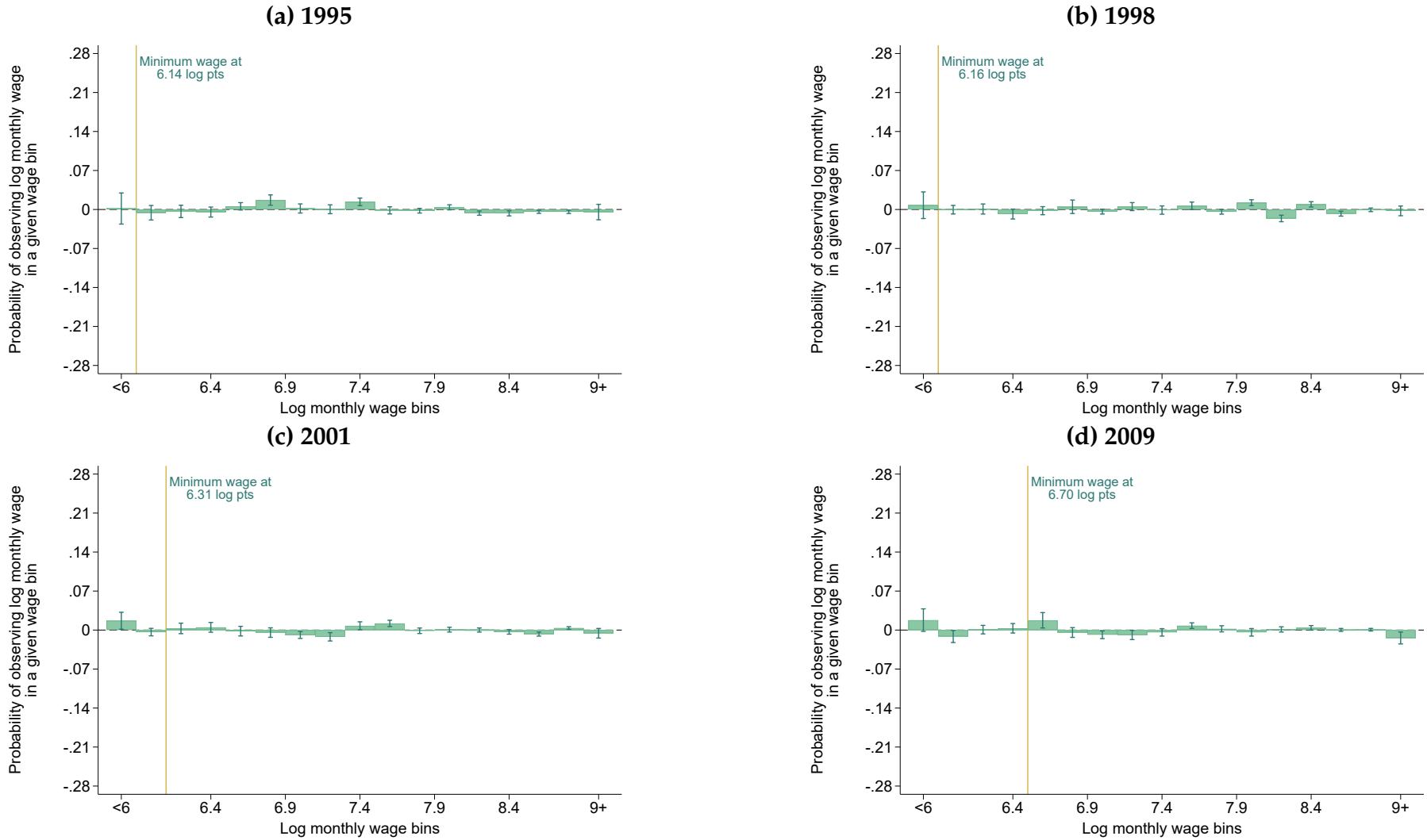


Sources: PNAD 1999-2015.

Sample: Adults aged 25-54, white or non-white, informal employees on the extensive margin of informality, working full-time (i.e. 40 hours a week or more), with no missing monthly earnings variable, and with no missing experience variable.

Notes: The figure shows the main results from our bunching difference-in-differences design assessing the effect of the 2000-2009 minimum wage increases on the distribution of wages (see Equation 2 in Section 4.3). The complete 1995-2015 series of graphs is available in our slides here.

Figure D6: Evolution of the probabilities to be in a specific wage bin in pre- and post-reform years among the self-employed

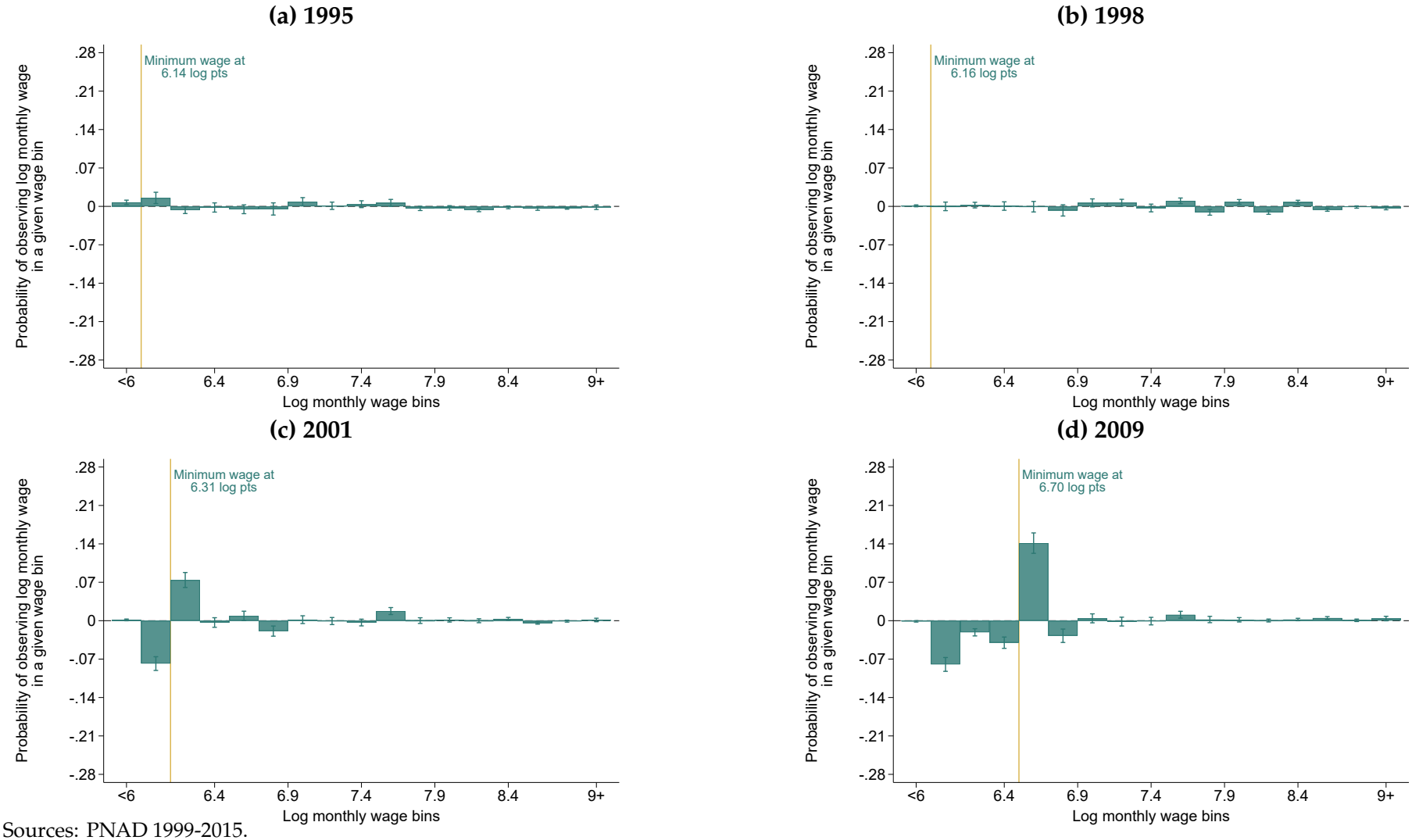


Sources: PNAD 1999-2015.

Sample: Adults aged 25-54, white or non-white, self-employed employees, working full-time (i.e. 40 hours a week or more), with no missing monthly earnings variable, and with no missing experience variable.

Notes: The figure shows the main results from our bunching difference-in-differences design assessing the effect of the 2000-2009 minimum wage increases on the distribution of wages (see Equation 2 in Section 4.3). The complete 1995-2015 series of graphs is available in our slides here.

Figure D7: Effect of the minimum wage on the probability of being in a specific wage bin using treatment variable defined in 1995 among formal employees

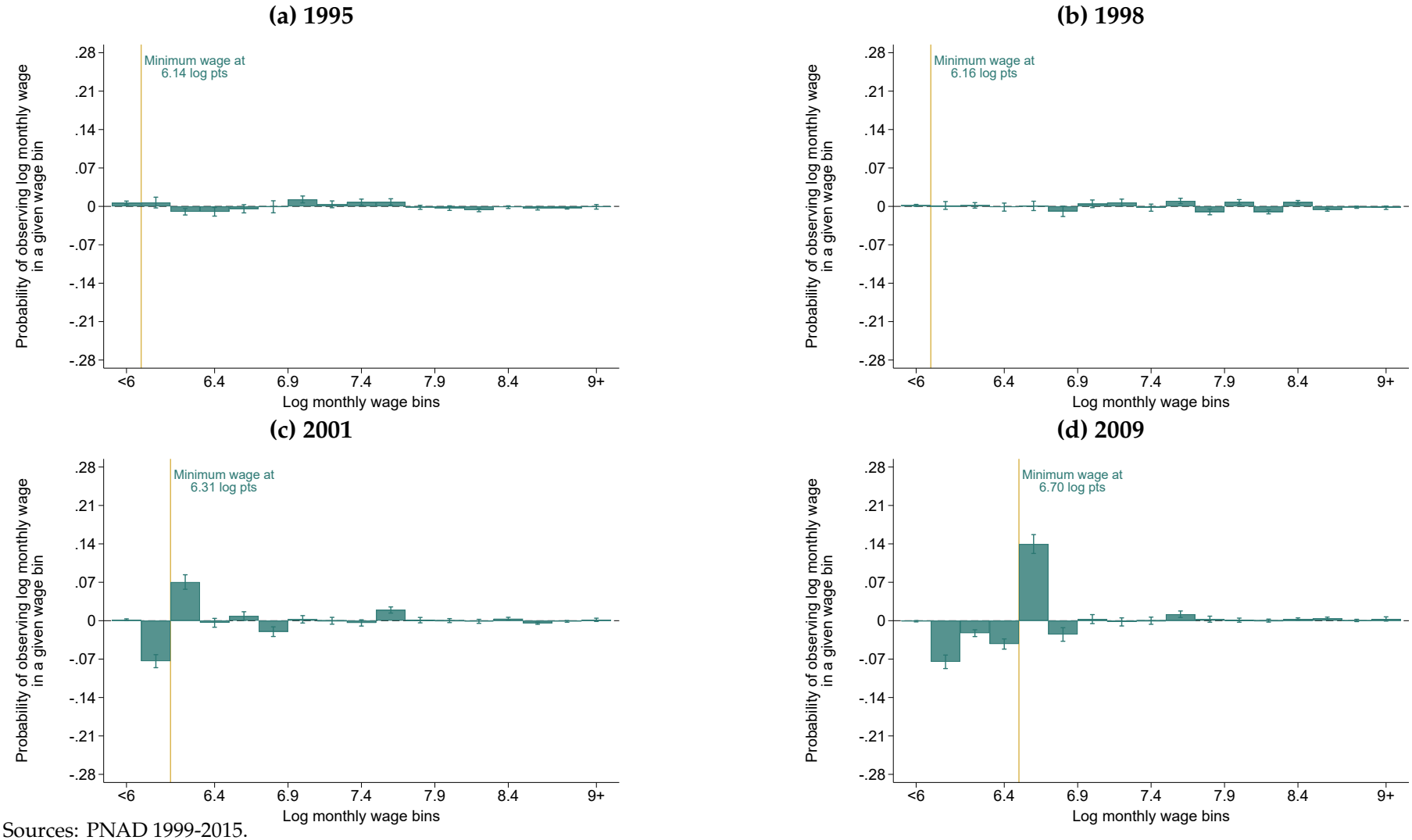


Sources: PNAD 1999-2015.

Sample: Adults aged 25-54, white or non-white, formal employees, working full-time (i.e. 40 hours a week or more), with no missing monthly earnings variable, and with no missing experience variable.

Notes: The figure shows the main results from our bunching difference-in-differences design assessing the effect of the 2000-2009 minimum wage increases on the distribution of wages (see Equation 2 in Section 4.3) using our treatment variable defined in 1995 instead, i.e. the share of workers below the 2009 minimum wage in 1995. The complete 1995-2015 series of graphs is available in our slides here.

Figure D8: Effect of the minimum wage on the probability of being in a specific wage bin using treatment variable defined in 1996

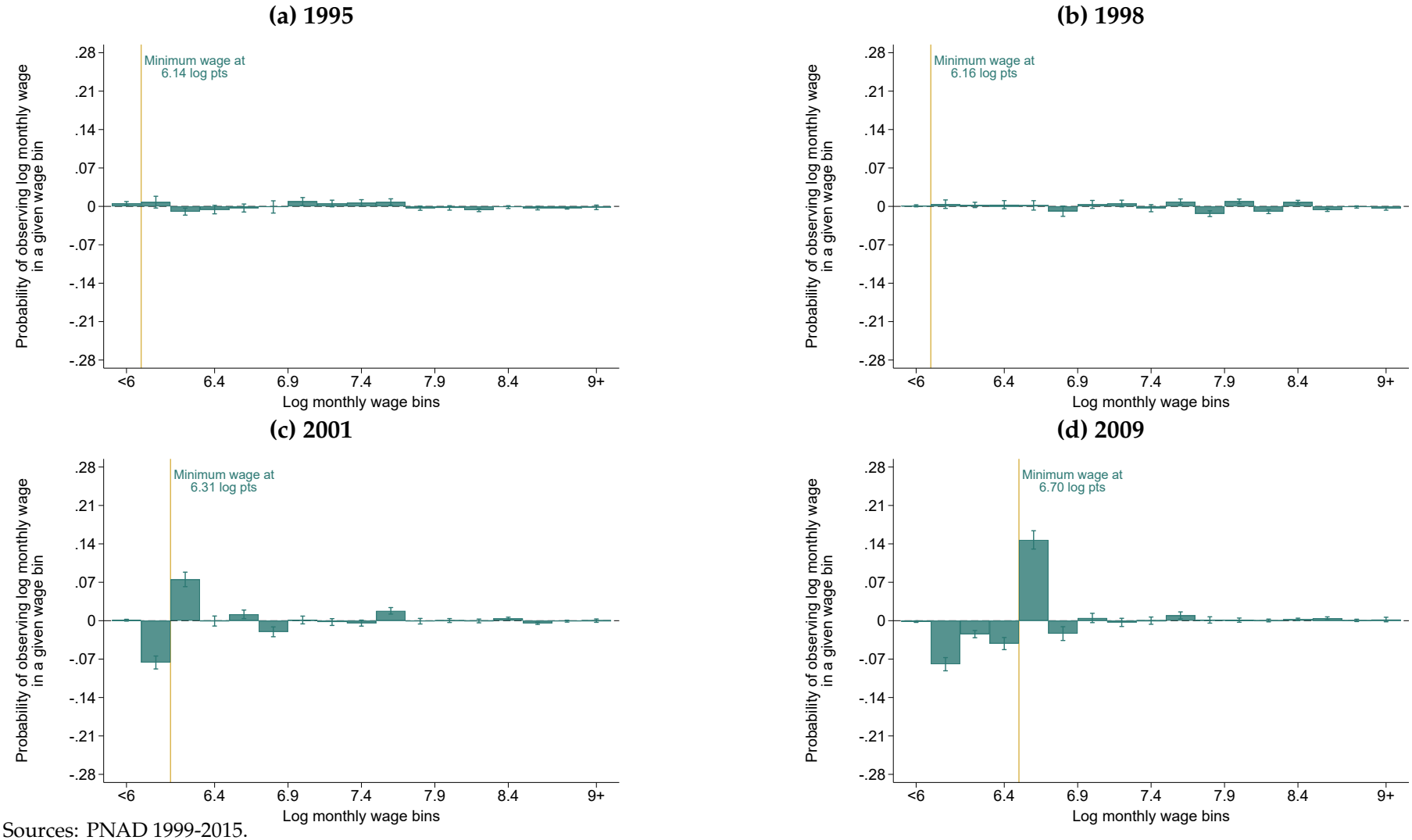


Sources: PNAD 1999-2015.

Sample: Adults aged 25-54, white or non-white, formal employees, working full-time (i.e. 40 hours a week or more), with no missing monthly earnings variable, and with no missing experience variable.

Notes: The figure shows the main results from our bunching difference-in-differences design assessing the effect of the 2000-2009 minimum wage increases on the distribution of wages (see Equation 2 in Section 4.3) using our treatment variable defined in 1996 instead, i.e. the share of workers below the 2009 minimum wage in 1996. The complete 1995-2015 series of graphs is available in our slides here.

Figure D9: Effect of the minimum wage on the probability of being in a specific wage bin using treatment variable defined in 1997

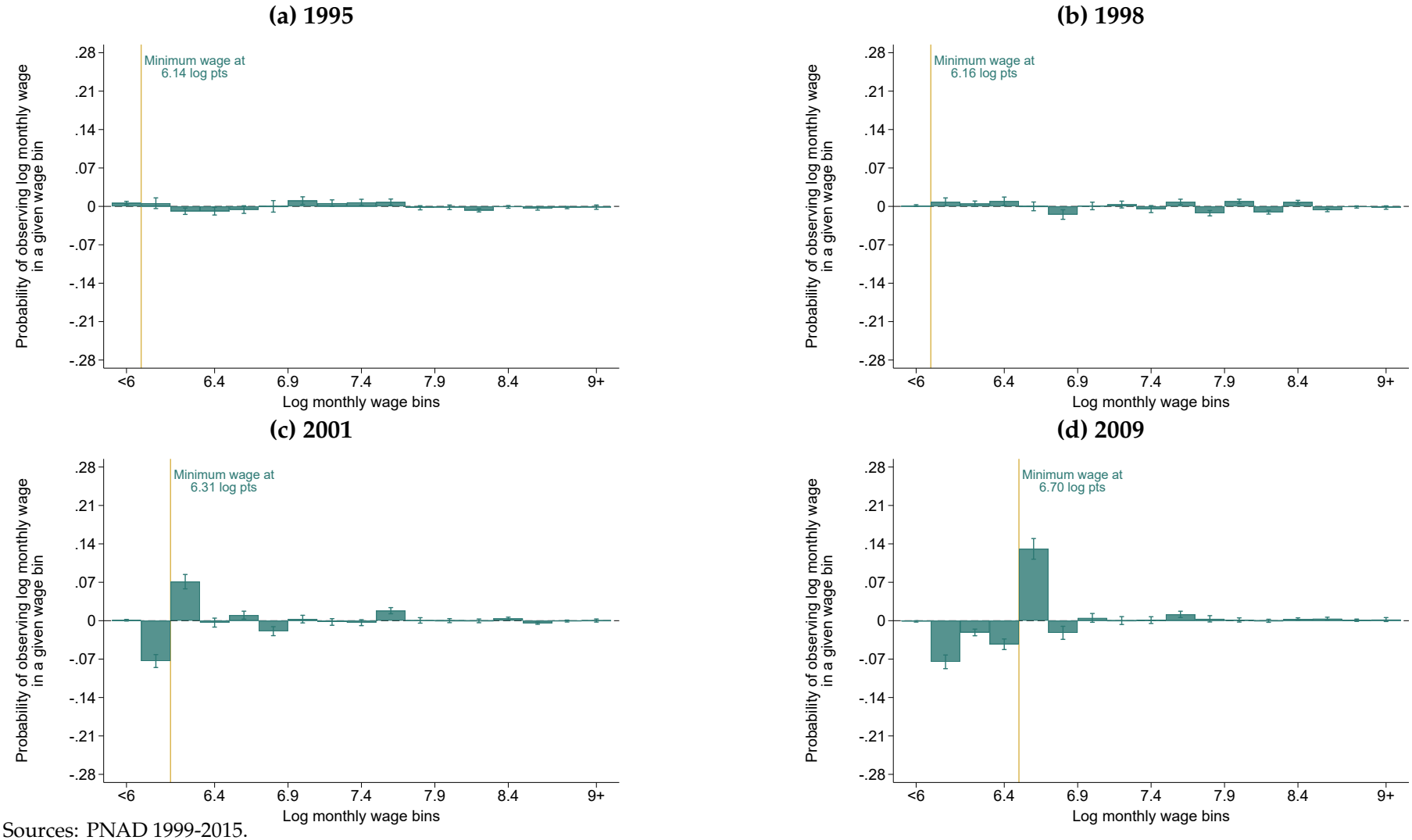


Sources: PNAD 1999-2015.

Sample: Adults aged 25-54, white or non-white, formal employees, working full-time (i.e. 40 hours a week or more), with no missing monthly earnings variable, and with no missing experience variable.

Notes: The figure shows the main results from our bunching difference-in-differences design assessing the effect of the 2000-2009 minimum wage increases on the distribution of wages (see Equation 2 in Section 4.3) using our treatment variable defined in 1997 instead, i.e. the share of workers below the 2009 minimum wage in 1997. The complete 1995-2015 series of graphs is available in our slides here.

Figure D10: Effect of the minimum wage on the probability of being in a specific wage bin using treatment variable defined in 1998



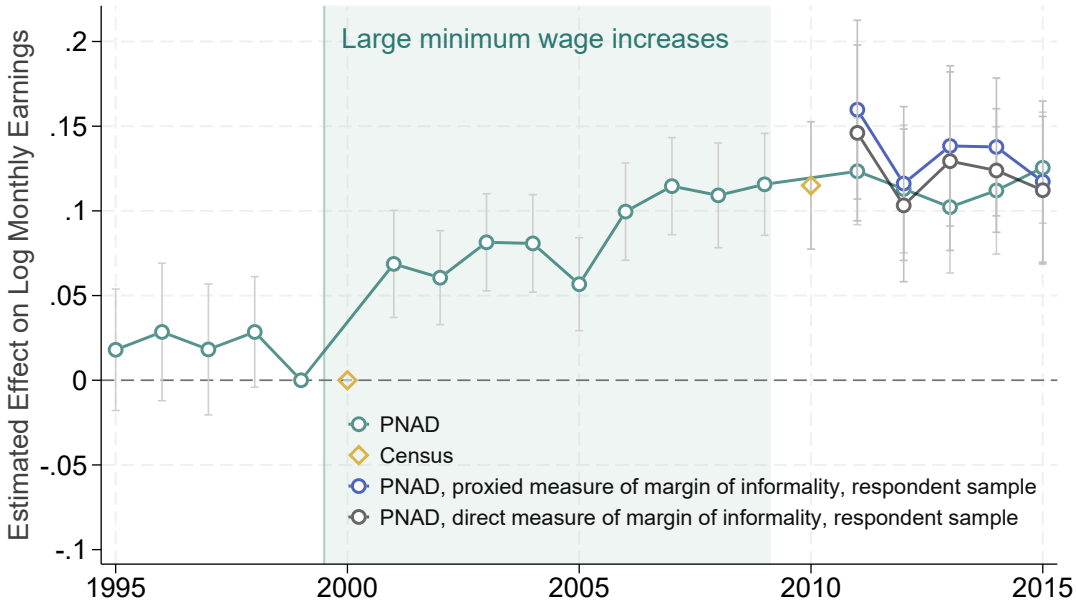
Sources: PNAD 1999-2015.

Sample: Adults aged 25-54, white or non-white, formal employees, working full-time (i.e. 40 hours a week or more), with no missing monthly earnings variable, and with no missing experience variable.

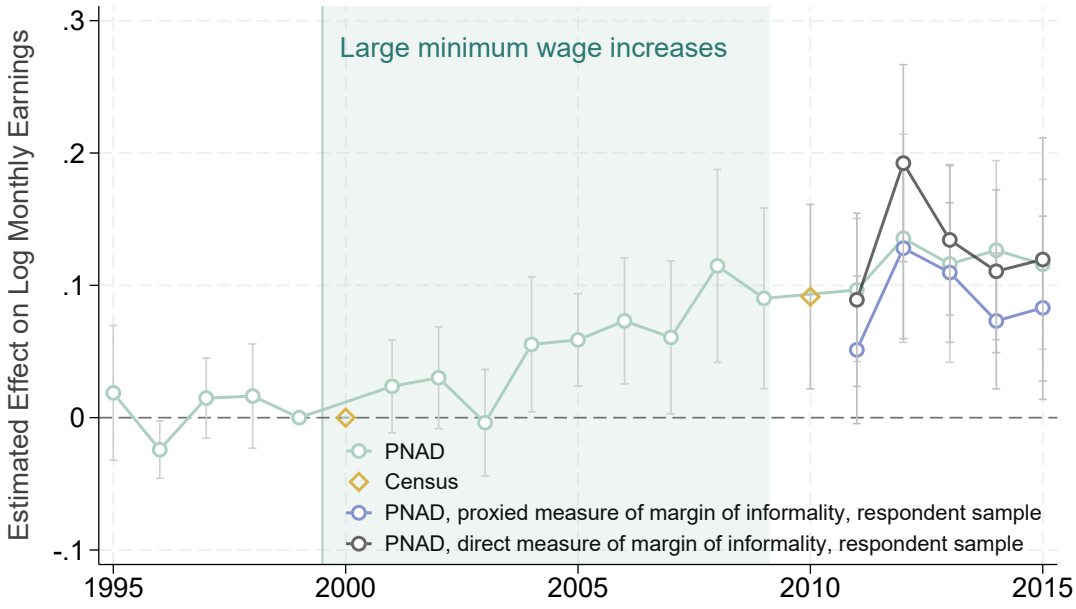
Notes: The figure shows the main results from our bunching difference-in-differences design assessing the effect of the 2000-2009 minimum wage increases on the distribution of wages (see Equation 2 in Section 4.3) using our treatment variable defined in 1998 instead, i.e. the share of workers below the 2009 minimum wage in 1998. The complete 1995-2015 series of graphs is available in our slides here.

Figure D11: Results on average wages among informal employees: consistency across measures of margin of informality

(a) Informal employees in formal firms (intensive margin)



(b) Informal employees in informal firms (extensive margin)



Sources: PNAD 1999-2015.

Sample: Adults aged 25-54, white or non-white, working full-time (i.e. 40 hours a week or more), with no missing monthly earnings variable, and with no missing experience variable. Panel (a) includes informal employees working in formal firms only; panel (b) includes informal employees in informal firms only.

Notes: The figure shows supplemental results from our difference-in-differences design assessing the effect of the 2000-2009 minimum wage increases on the distribution of wages (see Equation 1 in Section 4.1). It reports the main specification from 1995-2015 using our industry-based proxy for firm formality along with the series using a direct question on firm formality that began in 2011, along with a series showing proxied firm formality but for the sample of respondents with a direct measure of firm formality. Supplemental estimates are relative to our baseline estimates for the years 2011-2015.

Appendix E Additional results on employment effects

Table E1: Percent change in the share of employees among the total private workforce, by employment category, 2009

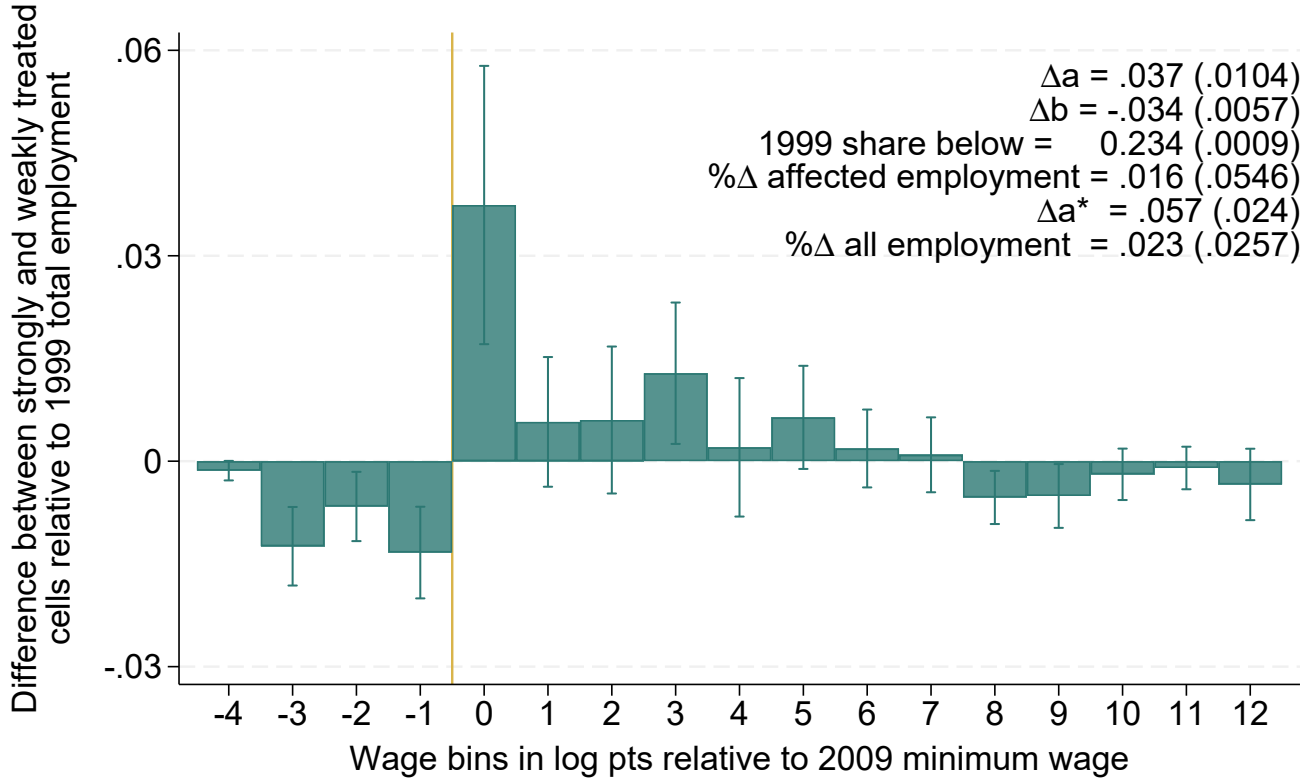
	%Δ emp.
Formal employees	-0.033**
	(0.016)
	1,851,404
Informal employees	
Intensive margin	0.045*
	(0.027)
	1,851,404
Extensive margin	-0.024
	(0.048)
	1,851,404
Self-employed	-0.046**
	(0.022)
	1,650,515

Source: PNAD 1995-2015.

Sample: Adults aged 25-54, white or non-white, employed in the private sector, either formal employee, informal employee or self-employed; workers working either part-time or full-time and no missing monthly earnings variable, no missing experience variable.

Notes: The table shows the percent change in the share of formal employees (respectively informal employees and self-employed) among the total private workforce as estimated using equation 4 in Section 5.1 separately for each category of worker. A one standard deviation in the share of affected workers as defined in our treatment variable is associated with a 3.6% decline in the share of formal employees in the private workforce.

Figure E1: Effect of the minimum wage on total share of formal employment, 2009 – without Northeast



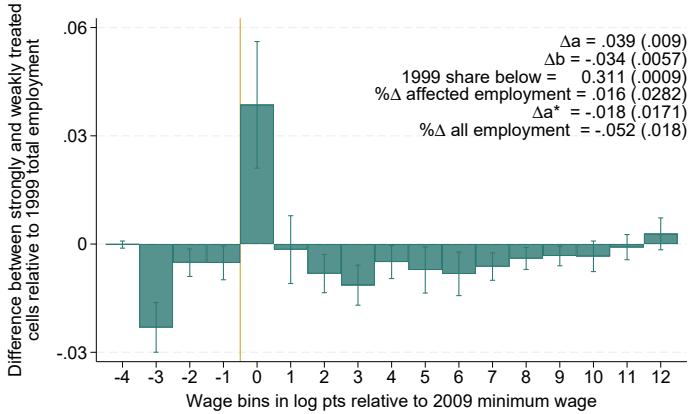
Sources: PNAD 1999-2015.

Sample: Adults aged 25-54, white or non-white, employed in the private sector, with no missing monthly earnings variable, and with no missing experience variable. Excludes adults from Northeast.

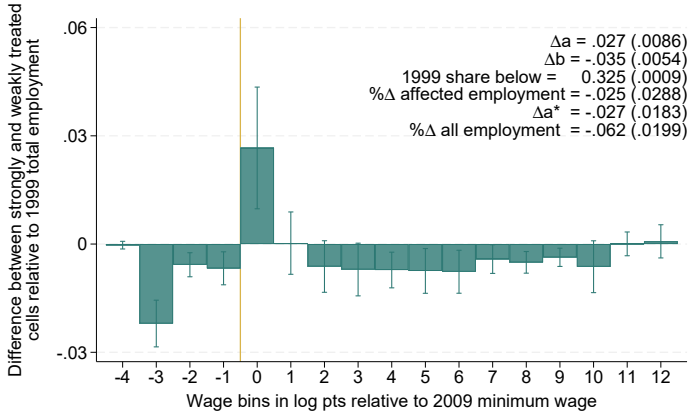
Notes: The figure shows the main results from our bunching difference-in-differences design assessing the effect of the 2000-2009 minimum wage increases on the distribution of jobs (see Equation 3 in Section 5.1). The outcome variable is the number of formal employees in each state-by-industry-by wage bin in 2009 over the total number of workers in 1999 in that state-by-industry cell, across all sectors of employment (formal or informal employees, or self-employed). The figure documents the effect of the 2000-2009 increases on the reallocation of employment away from formal employment.

Figure E2: Effect of the minimum wage on total share of formal employment, 2009 – excluding one region

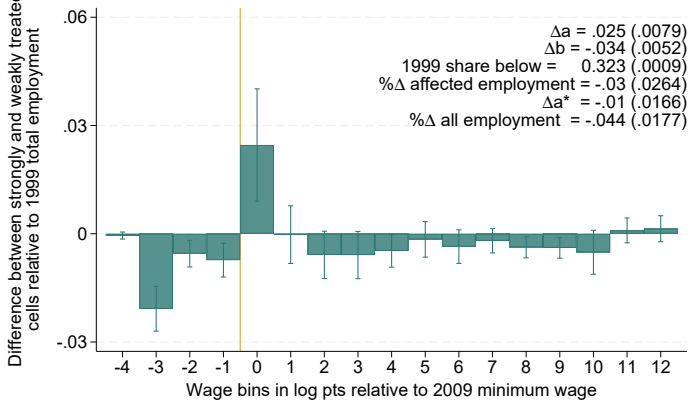
(a) Without North



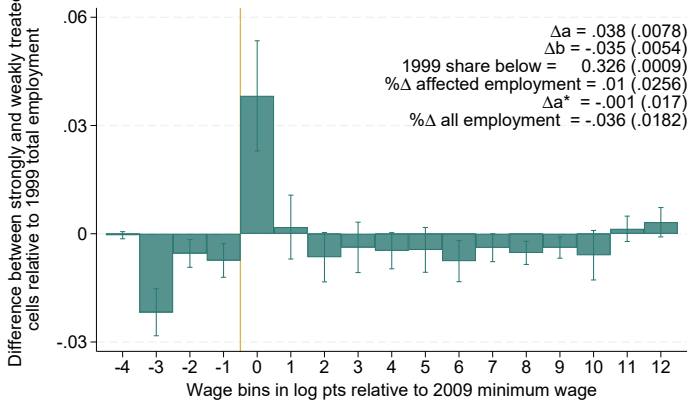
(b) Without Southeast



(c) Without South



(d) Without Central-West

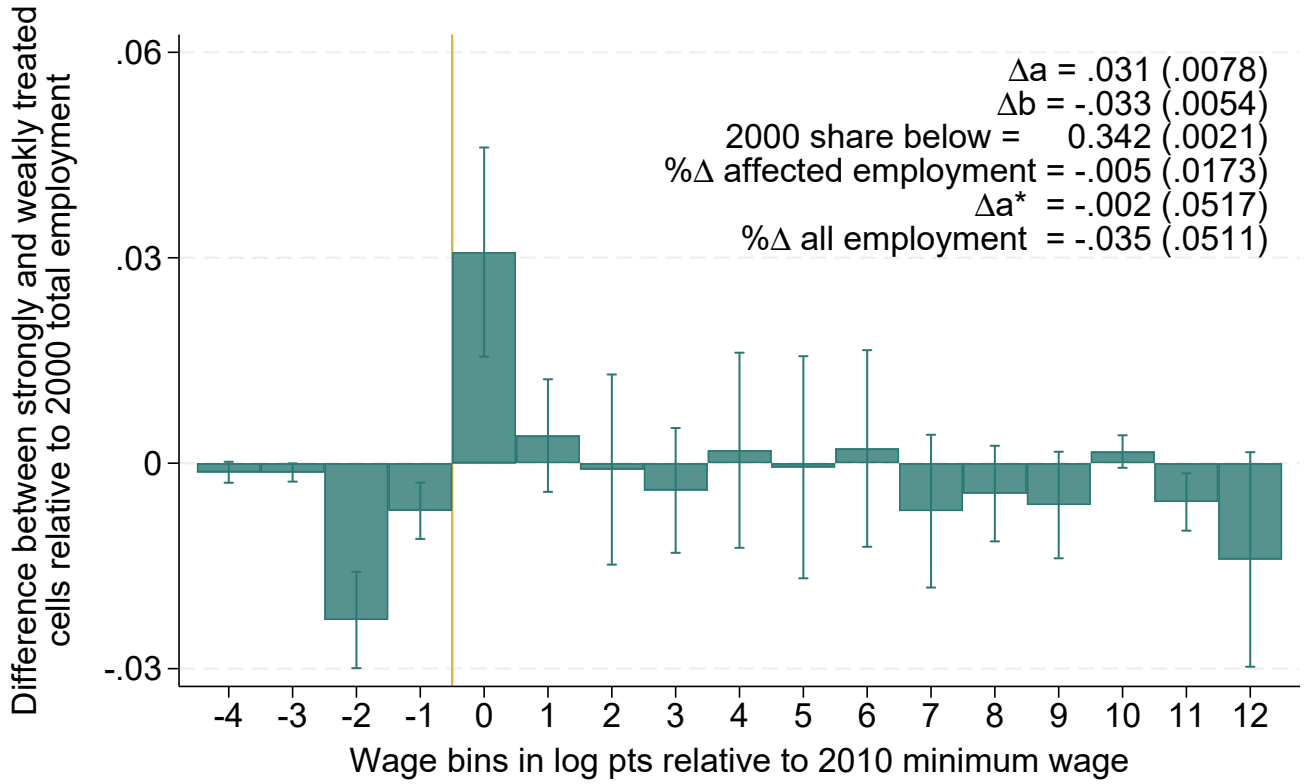


Sources: PNAD 1999-2015.

Sample: Adults aged 25-54, white or non-white, employed in the private sector, with no missing monthly earnings variable, and with no missing experience variable. Excluding adults from the region mentioned in the caption of each subfigure.

Notes: The figure shows the main results from our bunching difference-in-differences design assessing the effect of the 2000-2009 minimum wage increases on the distribution of jobs (see Equation 3 in Section 5.1). The outcome variable is the number of formal employees in each state-by-industry-by wage bin in 2009 over the total number of workers in 1999 in that state-by-industry cell, across all sectors of employment (formal or informal employees, or self-employed). The figure documents the effect of the 2000-2009 increases on the reallocation of employment away from formal employment.

Figure E3: Effect of the minimum wage on total share of formal employment in 2010, using census data

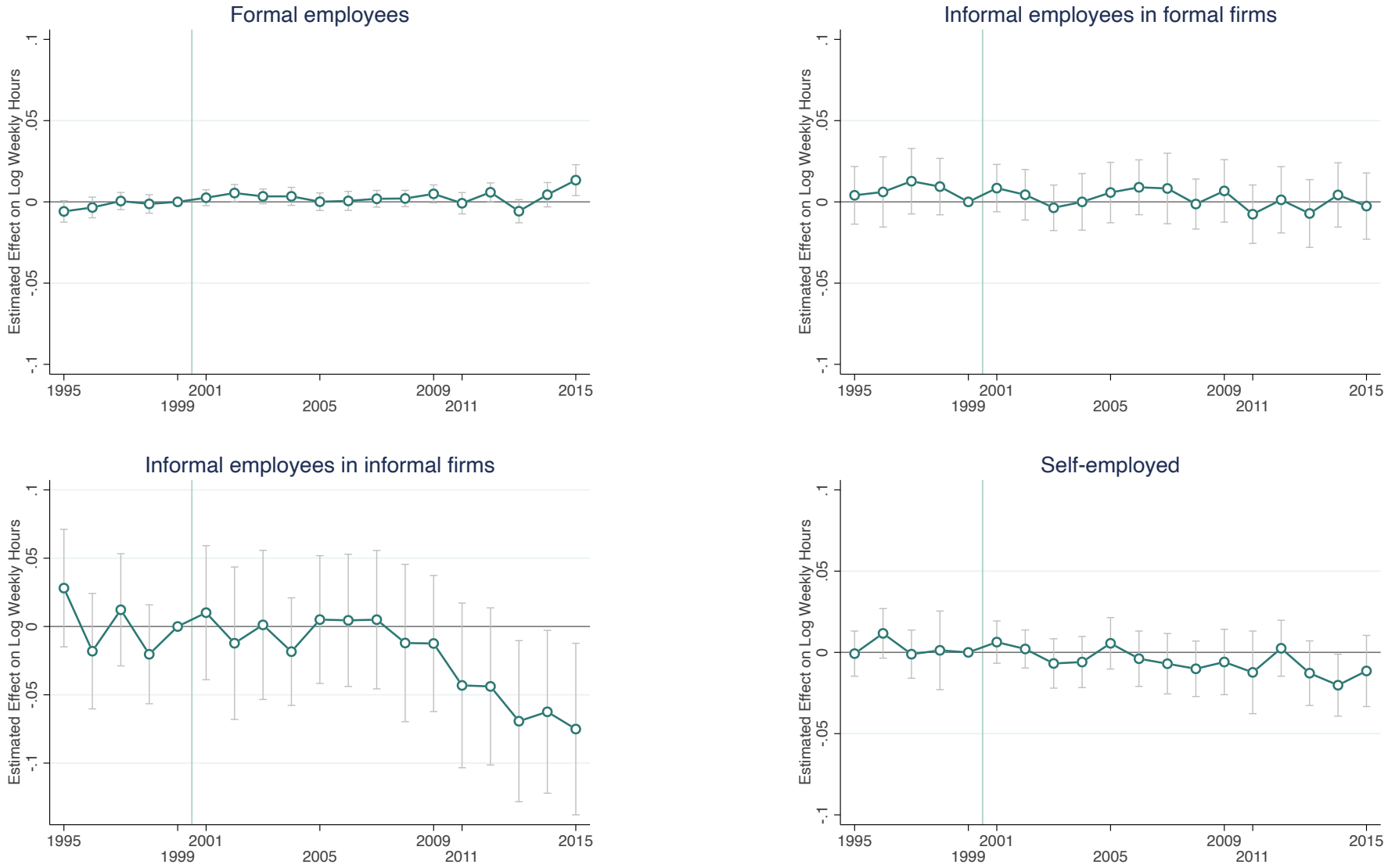


Sources: Census 2000 & 2010.

Sample: Adults aged 25-54, white or non-white, employed in the private sector, with no missing monthly earnings variable, and with no missing experience variable.

Notes: The figure shows results from our bunching difference-in-differences design assessing the effect of the 2010 minimum wage increase on the distribution of jobs (see Equation 3 in Section 5.1) with region-by-year fixed effects. The outcome variable is the number of formal employees in each state-by-industry-by-wage bin in 2010 over the total number of workers in 2000 in that state-by-industry cell. The figure documents the effect of the 2010 increase on the reallocation of employment across the formal wage distribution while controlling for potential confounding regional shocks.

Figure E4: Effect of the minimum wage on the log of weekly hours



Source: PNAD 1995-2015.

Sample: Adults aged 25-54, white or non-white, employed in the private sector, either formal employee, informal employee or self-employed, with no missing monthly earnings variable, and with no missing experience variable.

Notes: The figure plots the coefficient of main interest for each year from 1995-2015 using our baseline specification from Equation 1 in Section 4.1, except that the outcome is log weekly hours (bottom and top winsorized at the 1.5% level).

Table E2: Weekly hours elasticities, 2009

	%Δ hours	%Δ wage	Hours elasticity
Formal employees	0.003	0.128***	0.020
	(0.003)	(0.011)	(0.025)
Informal employees			
Intensive margin	0.015	0.100***	0.149
	(0.010)	(0.015)	(0.103)
Extensive margin	-0.002	0.121***	-0.016
	(0.026)	(0.042)	(0.216)
Self-employed	0.009	-0.017	-0.508
	(0.010)	(0.022)	(0.818)

Source: PNAD 1995-2015.

Sample: Adults aged 25-54, white or non-white, employed in the private sector, either formal employee, informal employee or self-employed, with no missing monthly earnings variable, and with no missing experience variable.

Notes: the table shows in column (1) the main results from our baseline specification from Equation 1 in Section 4.1, except that the outcome is log weekly hours (bottom and top winsorized at the 1.5% level). We show in Appendix Figure E4 that there are no pre-trends in the pre-period, and that the effects on weekly hours are centered around zero from 1999-2009 for all types of workers.

Table E3: Own-wage reallocation elasticities out of the formal labor force, by year (2001-2015)

	%Δ emp.	%Δ wage	Reallocation elast.
2001	-0.000	0.037***	-0.008
	(0.009)	(0.007)	(0.256)
2002	-0.005	0.044***	-0.123
	(0.009)	(0.006)	(0.216)
2003	-0.007	0.060***	-0.122
	(0.010)	(0.005)	(0.162)
2004	-0.015	0.073***	-0.212
	(0.011)	(0.007)	(0.148)
2005	-0.020*	0.086***	-0.238*
	(0.011)	(0.008)	(0.136)
2006	-0.028**	0.105***	-0.265**
	(0.012)	(0.009)	(0.121)
2007	-0.022	0.105***	-0.214
	(0.014)	(0.010)	(0.145)
2008	-0.035**	0.109***	-0.317**
	(0.015)	(0.011)	(0.155)
2009	-0.036**	0.128***	-0.282**
	(0.015)	(0.011)	(0.123)
2011	-0.037**	0.108***	-0.340*
	(0.018)	(0.013)	(0.183)
2012	-0.031	0.120***	-0.258
	(0.021)	(0.015)	(0.181)
2013	-0.044**	0.117***	-0.379**
	(0.020)	(0.014)	(0.193)
2014	-0.029	0.112***	-0.256
	(0.021)	(0.015)	(0.200)
2015	-0.038*	0.112***	-0.341*
	(0.021)	(0.015)	(0.205)

Source: PNAD 1995-2015.

Sample: Adults aged 25-54, white or non-white, employed in the private sector, either formal employee, informal employee or self-employed; workers working either part-time or full-time and no missing monthly earnings variable, no missing experience variable.

Notes: The table shows yearly results from our estimation of the linear probability model version of the total reallocation effect in PNAD (see panel A, columns 1-3, and notes for Table 4)).

Appendix F Bunching at multiples of the minimum wage

We evaluate here whether there is bunching at multiples of the minimum wage, as a test for the importance of the minimum wage as a norm in the wage distributions of formal and informal employees, as well as of the self-employed.

Methodology. We use bins of R$10 in nominal values to more easily separate bunching at multiples of the minimum wage and at round numbers (multiples of 50 and 100). In all graphs, red vertical lines indicate values equal to 1, 2, or 3 times the minimum wage; "mist" vertical lines indicate multiples of 100 (solid lines) and multiples of 50 (dashed lines). Using RAIS, we created graphs both for monthly earnings and for the contracted wage in all years from 1995 or 2002 to 2017. Using census data, we created graphs for monthly earnings in the main job in 2000 and 2010, separately for formal employees, informal employees, and the self-employed. Note that in some years, the minimum wage is close to a round number, making it hard to separate bunching at round numbers to bunching at multiples of the minimum wage. This is the case for the 2000 Census, so using the 2010 Census is more useful in this case.

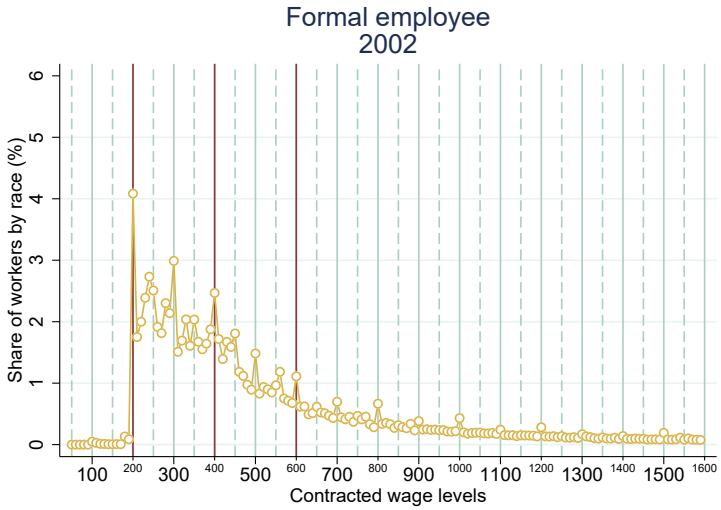
Results. Appendix Figure F1 displays the monthly contracted wage distribution in RAIS in 2002, 2009, 2011 and 2015. There is a small spike at 2 times and 3 times the minimum wage in 2002 among formal employees. However, we note that the magnitude of the spike at multiples of the minimum wage is similar to spikes appearing throughout the distribution at round numbers. We make the same conclusion for 2009, 2011 and 2015 when the minimum wage is much higher. In fact, we note that if anything, the spike at multiples of the minimum wage vanishes over this period of large minimum wage increases.

Appendix Figure F2a displays the monthly earnings distribution in the 2010 Census for formal employees, and confirms the analysis we conducted for formal employees in RAIS over 2002-2015. Using census data, we reach similar conclusions for informal employees (see Appendix Figure F2b) and the self-employed (see Appendix Figure F2c).

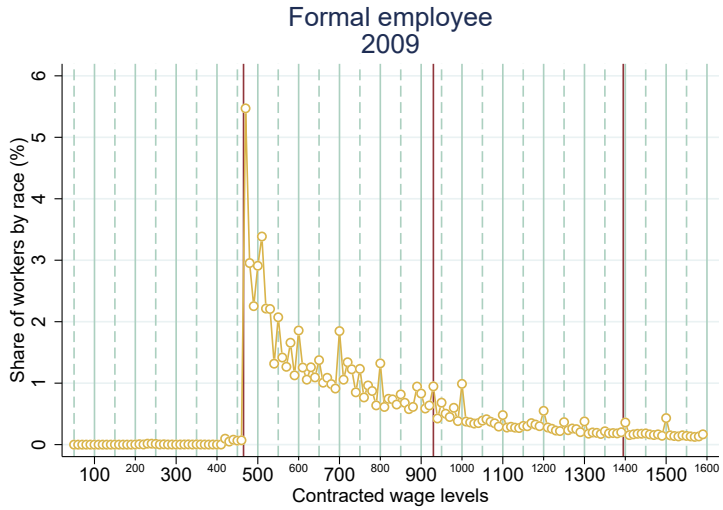
Taken together, our results are not indicative that the minimum acts as a strong social norm shaping the wage distribution during our period of study. This is consistent with the fact that we do not find spillover effects of the minimum wage higher up in the wage distribution (see Figure 4).

Figure F1: Bunching around multiples of the minimum wage in monthly earnings distributions, RAIS

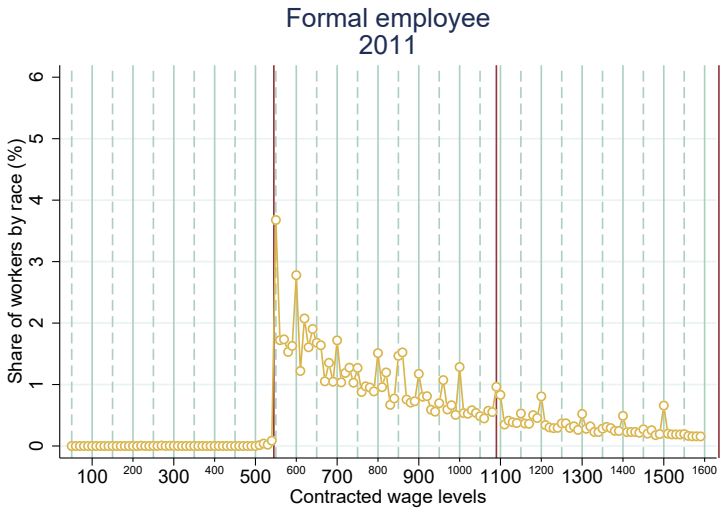
(a) 2002



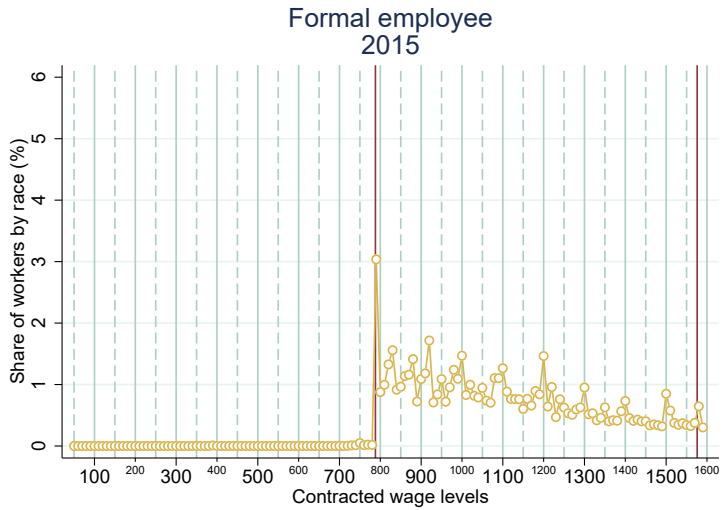
(b) 2009



(c) 2011



(d) 2015

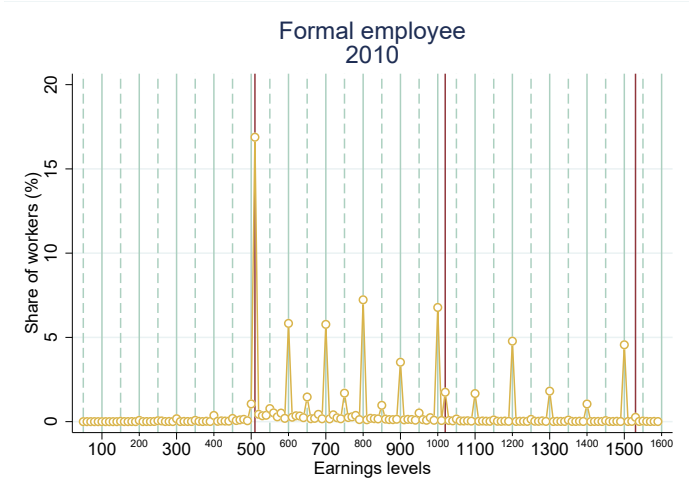


Sources: RAIS 2002, 2009, 2011 and 2015.

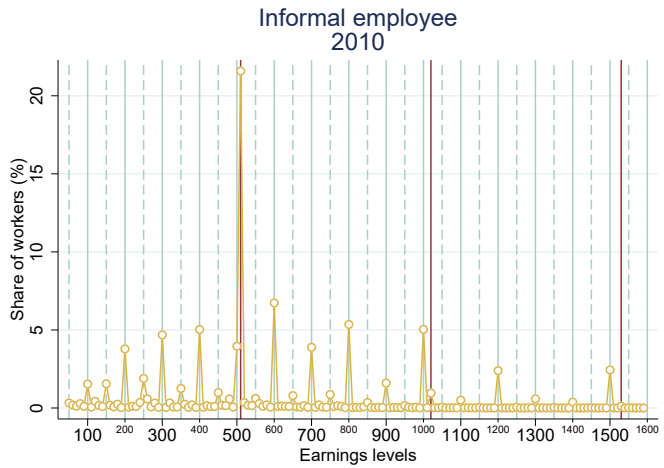
Sample: Adults aged 25-54, employed full-time in private-sector job on December 31st, all race categories. We use bins of R$10 in the nominal value of the monthly contracted wage. 2002 is the first year for which the contracted wage variable is available in RAIS. Red vertical lines indicate values equal to 1, 2, or 3 times the minimum wage; light green vertical lines indicate multiples of 100 (solid lines) and multiples of 50 (dash lines). Distributions are truncated on the right hand side.

Figure F2: Bunching around multiples of the minimum wage in monthly earnings distributions, Census 2010

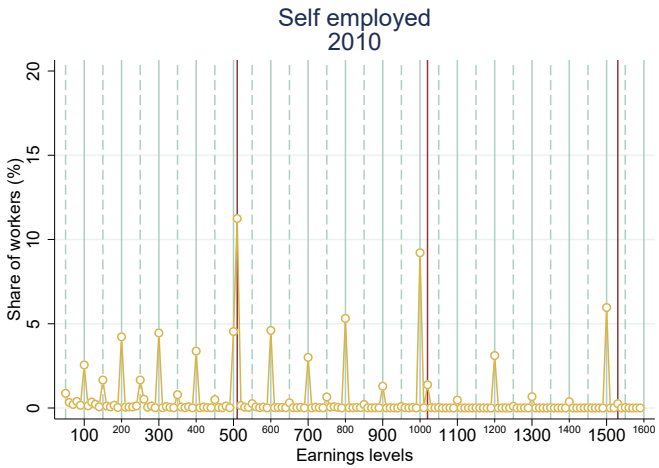
(a) Formal employees



(b) Informal employees



(c) Self-employed



Sources: Census 2010.

Sample: Adults aged 25-54, employed full-time in private-sector job, all race categories. We use bins of R$10 in nominal value of monthly earnings. Red vertical lines indicate values equal to 1, 2, or 3 times the minimum wage; light green vertical lines indicate multiples of 100 (solid lines) and multiples of 50 (dash lines). Distributions are truncated on the right hand side.