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The Role of the Minimum Wage on the Declining Wage Inequality in Latin America: Evidence from Brazil

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After a period of hyperinflation and the adoption of the Brazilian Real in 1994, Brazil has experienced a significant decline in income inequality along with a rapid recovery of the real minimum wage. There is no empirical consensus on whether the increase in the minimum wage contributed to the declining inequality because of disagreements about its potential adverse effects on employment. I document the effectiveness of the minimum wage on compressing wage inequality throughout the wage distribution and its effects on employment by using Brazilian regional data from 1995 to 2015. A counterfactual exercise shows that 35 percent of the decline in lower-tail inequality among all workers is attributable to the increase in the minimum wage and this effect is as large as 50 percent when only formal employees are considered. There is evidence of potential spillover effects of the minimum wage; however, its effects on upper-tail inequality are negligible. Finally, I find small but significant adverse effects of the minimum wage on formal employment.

Keywords: wage inequality, employment, minimum wage.
JEL classification: J31, J38, K31, O17

1 Introduction

Over the last decade, income inequality has decreased in most Latin American countries, and an extensive debate has taken place on the causes of this phenomenon. There are several factors behind this downward trend and these differ across countries.[1] In Brazil, the decline in income inequality began during the 1990s with the adoption of the Brazilian Real in 1994 which stopped the rampant inflation that Brazil had experienced during the 1980s and the early 1990s. Most of the literature on the subject for Brazil, as well as for other Latin American economies, points out

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[1] A compilation of literature on this subject can be found in Lopez-Calva and Lustig (2010) and Cornia (2014).

that labour market forces and public policies in favour of the poorest are the driving factors of the declining income inequality.[2] Less attention has been paid to the role played by institutional factors such as minimum wages and labour unions despite the extensive literature on this subject for more developed regions.

Do institutional factors shape wage inequality in Latin American countries? The empirical evidence for more developed regions suggests that the minimum wage could have played a more significant role in shaping wage inequality and employment in Latin America, particularly in Brazil, for two reasons. First, the Brazilian labour market is characterized by a large dispersion of wages and a significant binding minimum wage (Maloney and Nuñez, 2004), thus the effects of the minimum wage on wage setting may be far beyond those contemplated in developed economies. Second, minimum wage earners are more evenly distributed across the workforce in Latin American countries than in more industrialized economies (Kristensen and Cunningham, 2006), thus a change in the minimum wage may affect wage inequality throughout the wage distribution.

Most of the empirical work on institutional factors in Latin America has focused on the effects of the minimum wage on average wages and employment rather than its distributional effects on wage inequality. In contrast to the view that the minimum wage is an ineffective tool to reduce inequality in developing economies, this appears to explain a significant part of the variation in wage inequality (Lemos, 2009 for Brazil; Bosch and Manacorda, 2010 for Mexico and, Maurizio and Vazquez, 2016 for several Latin American economies). The literature is more ambiguous with respect to the effects of the minimum wage on employment, particularly in Brazil. Lemos (2004a, 2004b) state that the minimum wage has small adverse effects on employment while Fajnzylber (2002) and; Maloney and Nuñez (2004) find a significant decline in employment following an increase in the minimum wage. The latter findings are in line with those of Neumark *et al*. (2006) who find that an increase in the minimum wage decreases employment among household heads. The potential adverse effect of the minimum wage on employment is perhaps the main reason why the literature has overlooked its distributional effects on wage inequality because any potential benefit of the minimum wage on the labour earnings of those workers who remain employed may be offset by disemployment effects. Another plausible reason is that changes in the minimum wage affect a relatively small proportion of workers directly, thus a significant change in wage inequality relies on spillover effects —effects on the part of the wage distribution in which the minimum wage is non-binding— which are more difficult to quantify because of their indirect nature.

Another issue arises from an identification perspective. The identification of the effects of the minimum wage on wage inequality in Latin American countries is challenging. For example,

[2] See Barros *et al.* (2010) for an analysis of the effects of social policies on income inequality in Brazil and Gasparini *et al.* (2011) for a study of the effects of labour market forces on income inequality for 16 Latin American economies including Brazil.

Brazil has experienced dramatic changes in the skill composition of the labour force, the return to education, trade liberalization policies and commodity prices that could have also contributed to a greater or lesser extent to shape inequality. Regarding the lack of empirical work on the subject and the disagreement in findings of the available research, I estimate the effects of the minimum wage on wage inequality from a regional level panel data set.[3] It is important to point out that the minimum wage in Brazil is set nationally; thus this only varies across time, not across regions. With that in mind, I follow Lee (1999), who identifies the effects of the minimum wage on wage inequality in the U.S. over the 1980s —a period with little cross-statutory variation in the minimum wage—. This approach uses a well-known economic indicator the “Kaitz index" or the “effective minimum wage" (Kaitz, 1970), which is measured by the difference between the minimum wage and a regional centrality measure —typically the regional median wage—. The design of this index enables the identification of the effects of the minimum wage on the wage distribution across regions through its level of bindingness.

This paper contributes to the existing literature as follows: First, I quantify the effects of the minimum wage on the declining wage inequality and employment in Brazil over the post-inflationary period (1995-2015). This is important because most of the literature on inequality in Brazil (Foguel, 1998; Foguel *et al*., 2001; Fajnzylber, 2002 and Lemos, 2004a, 2004b) uses microdata from the period of hyperinflation in which the minimum wage was adjusted to the rampant increase in prices, thus these estimates are likely to be biased from an identification perspective. Although there are a few papers that provide information on the subject over the first years of the post-inflationary period (1994-2002), such as Neumark *et al*. (2006) and Lemos (2009), these in turn do not use data from the middle and the end of the 2000s in which wage inequality fell sharply while there were unprecedented increases in the minimum wage. Second, I compare estimates from two of the most important microdata sources available in Brazil, PNAD (Pesquisa Nacional por Amostra de Domicilios) which provides cross-sectional data from 26 regions and PME (Pesquisa Mensal de Emprego) which provides data from 6 major metropolitan areas in Brazil. The latter data source has been extensively used in the literature, including by Neumark *et al*. (2006) and Lemos (2009); however, estimates from PME are likely to be affected by the exclusion of non-metropolitan areas in which the minimum wage is potentially more binding. Consequently, the estimates from PNAD will provide additional information on the relative importance of the inclusion of non-metropolitan regions in the sample. Finally, I construct instrumental variables to tackle plausible endogeneity issues recorded in previous studies. This procedure provides reliable estimates of the effects of the minimum wage on wage inequality and employment.

I uncover three main results. First, around 35 percent of the decline in lower-tail inequality among all workers is attributable to minimum wage increases over the post-inflationary period.

[3] I use the term “wage inequality" even when referring to changes in inequality of non-wage workers to be consistent throughout the paper.

This effect is even larger, approximately 50 percent, when only formal employees were accounted for. Second, the equalizing effect of the minimum wage extends to high percentiles in the wage distribution which implies significant spillover effects; however, its effects on upper-tail inequality appear to be the result of a spurious relationship. Finally, although the estimates suggest some adverse effects of the minimum wage on formal employment, these are small. Thus, it is not expected that small disemployment effects outweigh the large equalizing effect of the minimum wage on income inequality.

The rest of the paper is structured as follows. Section 2 provides a literature review on the subject. Section 3 provides non-conditional evidence of the effects of the minimum wage on wage inequality in Brazil. Section 4 describes the methodology to assess the conditional effects of the minimum wage on both wage inequality and employment. Section 5 provides estimates of these conditional effects over the post-inflationary period and Section 6 concludes.

2 Literature Review

Institutional factors, such as minimum wages and labour unions, have become widely accepted in the literature as plausible causes of the changes in wage inequality that cannot be explained entirely by labour market forces. A clear example is the influential literature published during the 1990s about the effects of the decline in the real minimum wage on the widening of lower-tail inequality in the U.S. (DiNardo *et al.*, 1996; Fortin and Lemieux, 1997; and Lee, 1999). Despite differences in methodology, these studies suggest that institutional factors contribute as much as labour market forces to shaping wage inequality. These findings, along with extensive literature on small adverse effects of the minimum wage on employment (Card *et al*., 1994; Card and Krueger, 1995 and Freeman, 1996), suggest that the minimum wage is an effective tool to compress wage inequality without harming employment significantly.

There is also extensive literature that fails to reconcile findings on this matter and suggests that an increase in the minimum wage may not always benefit those it is intended to help. The intuition behind this is that an increase in the minimum wage leads firms to reduce working hours or the number of jobs as an attempt to realign the marginal productivity of their workers with the new minimum (Neumark *et al*., 2004 and 2014; Neumark and Wascher, 2008). The disagreement about the effects of the minimum wage on wages and employment in the literature arises from the exclusion of long-run minimum wage effects because contemporaneous effects of the minimum wage overstate wage gains and understate adverse effects on employment. Furthermore, identification issues are commonly mentioned in the literature. For example, Autor *et al*. (2016) state that Lee's approach overestimates the effects of the minimum wage on wage inequality because of endogeneity issues in his specification.

The literature for Latin America is more extensive on the effects of the minimum wage on average wages and employment rather than on its distributional effects on wage inequality. In Brazil, Foguel *et al*. (2000) find positive effects of the minimum wage on average wages of both formal and informal workers in the short-run. Fajnzylber (2002) also finds positive effects on average wages, even of those workers who are not covered by the minimum wage legislation, such as informal workers and the self-employed. The most striking findings in these papers are the significant spillover effects, not only above the minimum wage level but also below it. Moreover, these spillover effects are also present in the labour earnings of uncovered workers who are not supposed to be affected by changes in the minimum wage. Cunningham (2007) finds that the minimum wage is a benchmark for fair wages in several Latin American countries, thus employers voluntarily offer this fair wage not only to attract labour force but also to minimize labour turnover.

Regarding the effects of the minimum wage on employment, Fajnzylber (2002) finds negative elasticities of employment with respect to the minimum wage, particularly among informal workers. Maloney and Nuñez (2004) observe significant estimates of the probability of becoming unemployed following an increase in the minimum wage by using data from several Latin American economies, including Brazil. Neumark *et al*. (2006) find that increases in the minimum wage decrease employment of minimum wage earners, particularly among household heads. Lemos (2004a) points out that increases in the minimum wage do not cause significant adverse effects on Brazilian employment because firms pass this increased cost on through prices. Lemos (2004b) uses political variables as instruments for the minimum wage to tackle endogeneity issues in previous studies and concludes that an increase in the minimum wage has small adverse effects on employment. It is important to mention that Fajnzylber (2002) and Lemos (2004a, 2004b) use PME data from the 1980s and the 1990s which include the hyperinflation period, unlike Neumark *et al*. (2006) that use the same dataset but only from the first years of the post-inflationary period (1996-2001). Consequently, the disagreement between findings can be generated not only from the use of different sample periods but also from an identification perspective over two periods that differ significantly in terms of price volatility.

Most of the literature on the distributional effects of the minimum wage on wage inequality in Latin America has been released over the last decade. Barros *et al*. (2010) and Gasparini *et al*. (2011) state that the effects of the minimum wage on income inequality are small in comparison to the effects of labour market forces and public policies. Undoubtedly, labour market forces such as changes in the labour demand and the supply of skills are the most straightforward explanation for changes in wage inequality because of their quantifiable nature. However, there is still much disagreement about whether these changes are driven by demand-side or supply-side factors.[4] Moreover, labour market forces cannot account for the entire decline in wage inequality. On the

[4] Gasparini *et al.* (2011) state that most of the decline in wage inequality was driven by changes in demand-side factors such as changes in the labour demand of skills. Barros *et al.* (2010) instead argue that the decline in wage inequality is driven by the rapid increase in the supply of skills and the subsequent decrease in the returns to education. The authors also mentioned other plausible factors that contribute to the decline in income inequality in Brazil such as non-contributory government transfers to the poorest.

contrary, Lemos (2009) find significant effects of the minimum wage on the compression of wage inequality and suggests that the minimum wage could be an effective policy tool against poverty in Brazil. Bosch and Manacorda (2010), following Lee (1999), find that the minimum wage played an important role in shaping lower-tail inequality in Mexico during the 1990s. Maurizio and Vazquez (2016), following the semi-parametric analysis performed by DiNardo *et al*. (1996), find significant effects of the minimum wage on the compression of the lower-tail inequality in some Latin American countries, particularly in Argentina, Brazil, and Uruguay.

3 Trends in Wage Inequality and the Minimum Wage

3.1 Data

I use two of the most relevant data sources in Brazil to provide evidence of the potential "bite" of the minimum wage on the wage distribution: the Brazilian national household sample survey (PNAD) and the Brazilian monthly employment survey (PME).[5] PNAD is the largest national household survey that provides annual cross-sectional data for 26 regions, and is the most disaggregated data source in terms of regions after the Brazilian Census. I analyse 31 annual household surveys that cover the period 1981-2015.[6] PME is a data source with a longitudinal format and covers 6 metropolitan regions: Recife, Salvador, Belo Horizonte, Rio de Janeiro, Sao Paulo and Porto Alegre. Households are visited for two periods of four consecutive months, with eight months between each period. I use all monthly household surveys available from March 2002 to February 2016 as a sequence of cross-sectional data.[7] The data for the minimum wage are obtained from the Brazilian Ministry of Labour (MTE).

I construct the following three samples to assess the effects of the minimum wage on wage inequality: i) the "formal workers" sample comprises workers who have signed a legal employment contract and thus are more likely to be covered by minimum wage laws, ii) the "salary workers" sample includes both formal and informal workers, iii) "all workers" sample comprises both salaried workers and self-employed. Although informal workers and self-employed are not legally covered by the minimum wage legislation, it has been well established in the literature that the minimum wage acts as a benchmark for their labour earnings. The unconditional effects of the minimum wage on wage inequality in the next section are obtained by

[5] Both microdata sources are available on the Brazilian Institute of Geography and Statistics (IBGE, in its Portuguese acronym) website.

[6] No data are available for 1991, 1994, 2000 and 2010 which are the years in which the Census took place in Brazil.

[7] PME has been available since the early 1980s, however, this underwent a major change in the questionnaire design and the rotation scheme in the early 2000s. The new PME replaced the original PME which was close down in 2002, thus it is not possible to compare them.

using mainly the “salary workers" sample, whereas, the conditional effects in the “Results" section are estimated for the three samples. All samples comprise workers aged 16 to 64 years old who worked at least 35 hours in the reference week.[8] The number of individual observations per region-year in PNAD and per region-month in PME varies according to the sample studied (See Appendix B-Table 4). Detailed information of each sample can be found in the footnote of each graph and table.

PNAD and PME only provide data on monthly labour earnings, thus I construct a measure for hourly labour earnings by using monthly income from all jobs and the number of weekly working hours per individual. I also use the number of working hours and the sample weights provided by PNAD and PME to calculate adequate weights for different samples. Analogously, the hourly minimum wage is constructed by using the national minimum wage and the number of working hours per week for a full-time worker which is established by Brazilian legislation. All nominal labour earnings and the nominal minimum wage are deflated by using the corresponding CPI index provided by IBGE.

3.2 Stylized Facts

Brazil has one of the highest Gini coefficients in the world which has fluctuated significantly over the last 30 years. Data from SEDLAC (Socio-Economic Database for Latin America and the Caribbean, July 2017) show that income inequality measured by the Gini coefficient fell around 4 points during the 1990s and 8 points from 2001 to 2015. This sharp decline in income inequality has been accompanied by an unprecedented increase in the real minimum wage, particularly since the 2000s. This section is devoted to providing evidence on the relationship between the minimum wage and the declining wage inequality in Brazil. Although the present study focuses on the post-inflationary period (1995-2015), this section also provides an analysis of this relationship during the 1980s and the early 1990s by using PNAD data. This data set allows us to compare the inflationary and the post-inflationary period in which both the minimum wage and wage inequality patterns changed.

The minimum wage in Brazil is national and covers all workers in the formal sector. Initially, the minimum wage was region-specific; however, the inflationary crisis that took place in the 1980s and the early 1990s led to the setting up of a national minimum wage which was adjusted whenever the inflation rate was higher than 20 percent. Over the inflationary-period, both the real minimum wage and labour earnings dropped sharply, and not surprisingly, wage inequality

[8] The samples are less restrictive in terms of age and education than those in the traditional literature on the subject because minimum wage earners in Brazil are more evenly distributed throughout the age and education distribution than in more developed regions. In fact, there are no obvious restrictions to obtain a reliable sample of minimum wage workers, thus I only restrict the sample to full-time workers because these are more likely to generate labour earnings above or near the minimum wage than their counterparts.

increased. The four-digit inflation rates came to an end after the adoption of the Brazilian Real in 1994 as an attempt to stabilize the Brazilian currency. The minimum wage has been adjusted yearly since then. Following monetary stabilization, wage inequality began its downward trend along with a remarkable recovery in the real value of the minimum wage. According to data from MTE, the real minimum wage grew by approximately 155 percent between 1994 and 2015. To put this information into context, Figure 1 shows the evolution of the real minimum wage along with lower and upper-tail wage inequality measured by the difference between the *log(10th/50th)* and the *log(90th/50th)* wage percentiles, respectively.

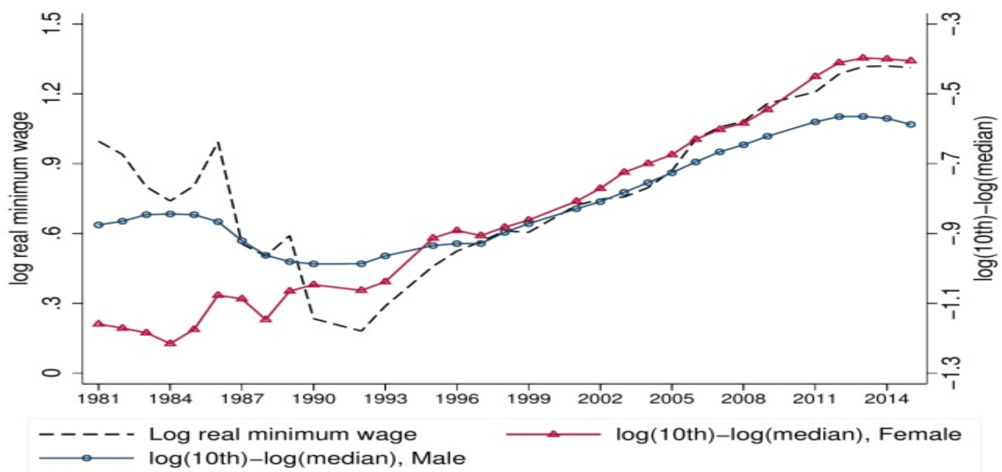
Figure 1 shows that the real minimum wage fell around 82 log points from 1981 to 1992. The spikes in the minimum wage are the result of changes in the Brazilian currency in 1986 and 1989 in order to control the rampant inflation rate and currency depreciation over this period. The erosion of the minimum wage was accompanied by an increase in lower-tail inequality, particularly among males.

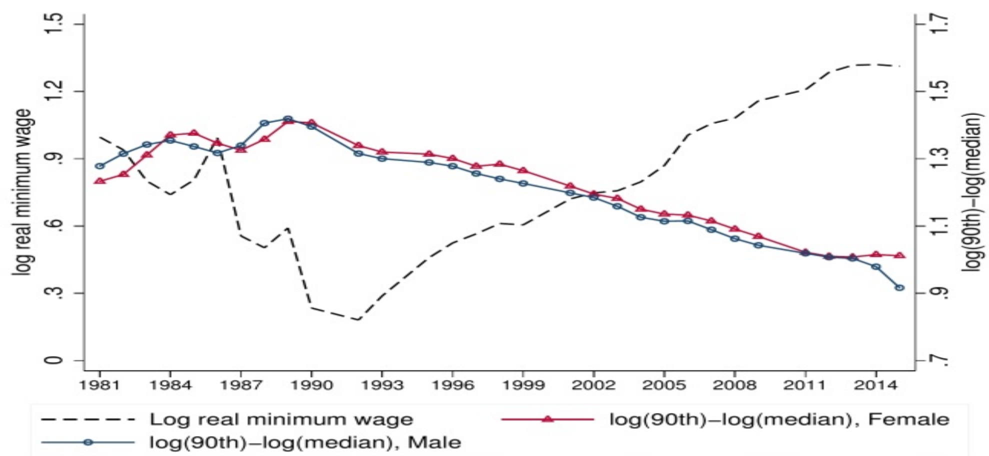
Upper-tail inequality also increased during the 1980s for both genders. Lower and upper-tail inequality fell sharply after the adoption of the Brazilian Real in 1994 and the subsequent price stabilization led to the rapid recovery of the real minimum wage. The real minimum wage increased by approximately 85 log points from 1994 to 2015 along with a decline in lower-tail inequality. The positive trend of lower-tail inequality in Figure 1 implies that the *10th* percentile grew at a faster rate than the *50th* percentile over this period. It is worth noticing the reversal of this positive trend over the last years in the sample which may be explained by the increase in the inflation rate. It appears that lower-tail inequality decreased more significantly among females than among males, by approximately 50 versus 35 log points, respectively. The negative pattern of upper-tail inequality instead implies that the *50th* percentile grew faster than the *90th* percentile over the post-inflationary period. Upper-tail, unlike lower-tail inequality, seems to fall in a similar proportion for both genders.

The high correlation between lower-tail inequality and the minimum wage is not surprising. The intuition behind this is that the minimum wage truncates the lower-tail of the wage distribution, affecting wages of workers earning at or below the minimum wage. We can also observe a strong negative correlation between the minimum wage and upper-tail inequality.

Perhaps the simplest explanation is that there is a spurious relationship between the minimum wage and upper-tail inequality; however, the literature on the subject suggests that this may be a genuine relationship which is caused by the presence of spillover effects of the minimum wage. For example, an increase in the minimum wage may affect the individuals' education decisions through a change in their expected labour earnings and the price of skills. In such a scenario, a change in the minimum wage would affect the skill composition in the labour market and thus

Figure 1: Trends in National Real Minimum Wage and Lower and Upper-Tail Inequality, PNAD 1981-2015.



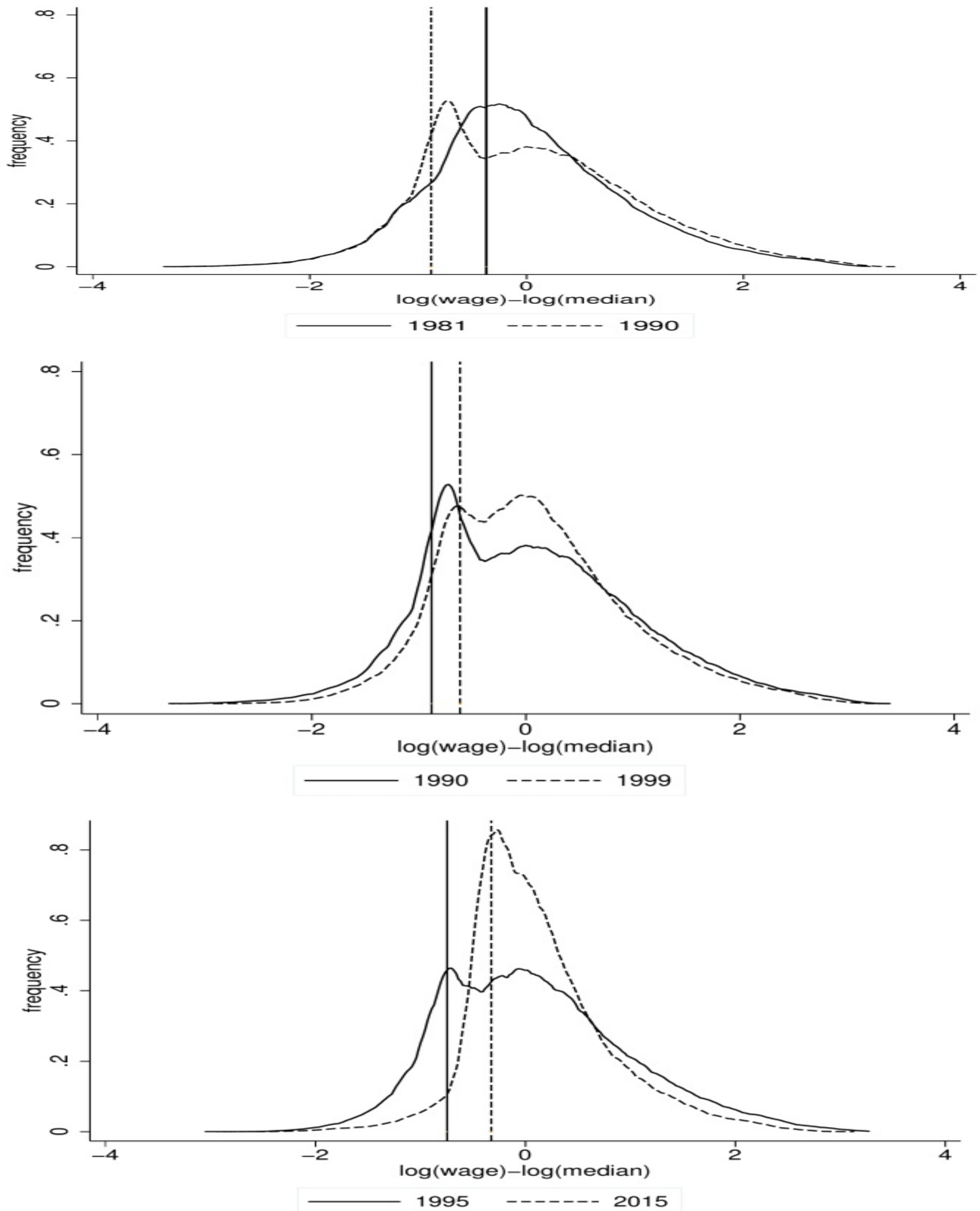


Source: PNAD and MTE data from 1981 to 2015. The sample includes full-time salary workers. The left-hand side and the right-hand side figures depict the evolution of the gap between the *10th/50th* and the *90th/50th* percentiles of the log wage distribution along with the log of the real minimum wage, respectively.

the entire wage distribution.[9] The general equilibrium effects of the minimum wage are beyond the scope of this study, but it is important to mention that the role played by the minimum wage on the declining wage inequality may be over- or underestimated without taking them into account.

[9] See Barany (2016) for an analysis of the spillover effects of the minimum wage on the wage distribution, generated by changes in educational decisions and the price of skills.

Figure 2: Changes in Inequality and the Effective Minimum Wage by Selected Years, PNAD.



Source: PNAD and MTE data for 1981, 1990, 1995, 1999 and 2015. The sample includes full-time salary workers. The figures compare kernel density estimates of the log wage distribution between two years. All series are standardized to the contemporaneous median wage. The vertical lines report the effective minimum wage, *log(min.wage)-log(median wage)*, for each year.

Although it is tempting to assign the decline in wage inequality to the increase in the minimum wage, there are other factors that could also have contributed to this behaviour as was mentioned previously. Thus, it is important to use a well-suited strategy to identify the nature of this relationship. Most of the empirical work on the effects of the minimum wage on wage inequality uses the minimum wage as the shock variable for a time series or for panel data analysis. The standard approach regresses the variation in labour earnings on changes in the minimum wage, inflation rate, unemployment rate, individual observable characteristics and fixed-effect controls. However, the sample period in the case of Brazil is not long enough to obtained reliable estimates from a time series specification. A panel data analysis instead would require that the minimum wage varied across regions but the minimum wage in Brazil is set nationally. Due to these issues, I use the Kaitz index or the effective minimum wage, which is measured by the gap between the log of the minimum wage and the log of a centrality measure of the wage distribution, *log(min.wage)-log(median wage)*. This measure has been used in the literature to identify the effects of the minimum wage on the wage distribution over periods with little variation in statutory minimum wages in more developed economies. Figure 2 provides a first insight of the relationship between this measure and the wage distribution in Brazil for selected periods of time.

A large proportion of wage observations below the effective minimum wage in Figure 2 belongs to workers in the informal sector who are not covered by the legal minimum wage. Observations below the minimum wage were also recorded among formal workers which can be interpreted as measurement error or non-compliance with the minimum wage law. The left-hand side figure on the top panel shows the inflationary period over the 1980s. Notice the spike in the wage distribution in 1990. This appears to be driven by the erosion of the effective minimum wage which is represented by the leftward shift of the vertical line. The right-hand side figure instead shows how the wage distribution begins to shrink during the 1990s along with the recovery of the real minimum wage after the adoption of the Brazilian Real. The same behaviour can be observed in the figure at the bottom panel which represents the entire post-inflationary period (1995-2015). There are two important features from these graphic representations. First, the effective minimum wage offers some support to the wage distribution, particularly from 1990 onwards. Second, there are evident spillover effects on the wages of those earning just above the minimum wage while the upper-tail of the wage distribution appears not to be affected.[10]

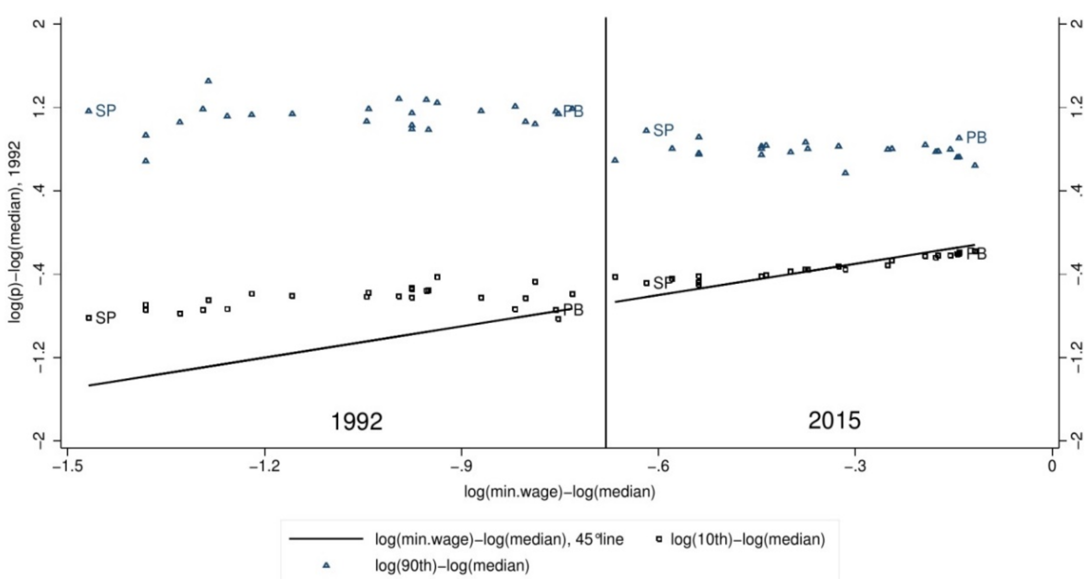
The relative support of the minimum wage, the spikes of the wage distribution around the minimum and its spillover effects can also be observed when we split the sample into groups of workers who are, or are not, covered by minimum wage laws (See Appendix A-Figure 6). It appears that the minimum wage has significant effects on the labour earnings of both informal workers and the self-employed. It has been well established in the literature for Latin America countries that the minimum wage acts as a benchmark for setting wages, particularly in the

[10] Analogous figures on the “bite" of the minimum wage on the wage distribution of metropolitan regions for PME data can be found in the Appendix A-Figure 5.

informal sector. What is striking is the effect of the minimum wage on the labour earnings of the self-employed. There is no theoretical explanation for why the distribution of these workers is affected by the minimum wage. Lemos (2009) suggests that the minimum wage is also a signal when the self-employed set their labour earnings because these are willing to work for an income near to or above it.

Although Figure 2 provides more reliable information about the relationship between the minimum wage and wage inequality over time, this is not informative about the effects of the minimum wage on wage inequality across regions. It is expected that a binding minimum wage has more significant effects on the wage distribution of low-wage regions. Figure 3 provides information on this matter by comparing the effective minimum wage and wage inequality across regions for two years, 1992 and 2015, which are the years with the lowest and the highest real minimum wage in the sample, respectively. For this analysis, I restrict the sample to formal workers because these are affected directly by changes in the minimum wage and provide a less ambiguous representation of the "bite" of the minimum wage on the wage distribution.

Figure 3: Changes in Inequality and the Effective Minimum Wage across Regions, PNAD 1992 and 2015.



Source: PNAD and MTE data for 1992 and 2015. The sample comprises full-time salary workers who have a legal employment contract. The plots depict the gaps between the *10th/50th* and *90th/50th* percentiles of the log wage distribution across regions for 1992 and 2015. The 45-degree line represents the effective minimum wage in each year. The Federal District was eliminated from the sample for being an atypical value. *SP* and *PB* are abbreviations for regions: Sao Paulo and Paraiba, respectively.

Figure 3 shows the relationship between the effective minimum wage, which is represented by the 45-degree line with both lower and upper-tail inequality, in 1992 (on the left-hand side of the vertical line) and 2015 (on the right-hand side of the vertical line). Notice that most of the observations lie above the 45-degree line in 1992 which implies that the minimum wage lost its “bite" on the wage distribution across regions in that year. This behaviour agrees with the substantial decline in the real value of the minimum wage that reached its lowest point in the early 1990s. On the other hand, the effective minimum wage tracks the dispersion of lower-tail inequality across regions remarkably well in 2015. There is a significant correlation between lower-tail inequality and the effective minimum wage across regions, particularly among those with low median wages —those with a less negative effective minimum wage—.

There are three general conclusions that can be drawn by comparing these two years. First, the effective minimum wage (horizontal axis) becomes less negative and less dispersed in 2015 which implies that the minimum wage grew at a faster pace than the median wage, particularly across high-median-wage regions. Second, the gap between upper- and lower-tail inequality (vertical axis) shrinks in 2015 which implies that the *10th* percentile grew faster than the *90th* percentile within regions. Finally, the positive trend of lower-tail inequality in 2015 suggests that the minimum wage is more likely to affect wage inequality in low-wage regions. To see this, consider two regions with a high and a low median wage in Figure 3: Sao Paulo, *SP*, and Paraiba, *PB*, respectively. The horizontal axis in Figure 3 shows that the gap in the effective minimum wage, *log(min.wage)-log(median wage)* , between *SP* and *PB* was 71 log points in 1992 while this shrinks to 48 log points in 2015. Since the minimum wage is the same across regions, the decline in the effective minimum wage gap suggests that the median wage in *PB* grew at a faster pace than the median wage in *SP*. Although the growth in median wages can be driven by several factors, the minimum wage could have played a significant role in the growth of median wages, particularly among low-wage regions because this is more binding on their wage distributions.

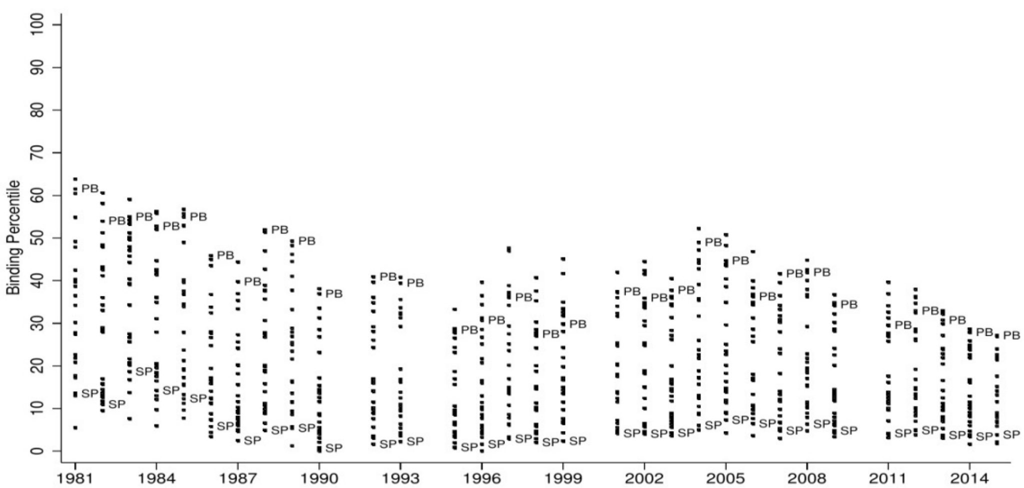
The gap between lower and upper-tail inequality, which is basically the gap between the 90*th* and the *10th* percentile, decreases for both regions. The vertical axis in Figure 3 shows that this gap is practically the same for *PB* and *SP* in 1992, which is consistent with a non-binding minimum wage, while the same gap is evidently smaller in *PB* than in *SP* in 2015. In fact, the gap decreases by 80 log points in *PB* and by only 52 log points in *SP* from 1992 to 2015. These results are consistent with the previous statement that the minimum wage is more likely to affect wage dispersion in low-wage regions.[11] These results are also consistent with those obtained from PME data for metropolitan regions. By comparing the first and last year available in this sample (2002

[11] The average decrease in the 90th/10th gap of the five regions with the lowest median wage and the five regions with the highest median wage from 1992 to 2015 is 81 and 53 log points, respectively.

and 2016), the *90th/10th* gap in low-wage regions such as Recife and Salvador decreases by approximately 64 log points while the same gap in high-wage regions such as Sao Paulo and Rio de Janeiro decreases by approximately 41 log points.[12]

Finally, Figure 3 shows that there is a weak correlation between the effective minimum wage and upper-tail inequality which is something expected and desirable for identification, I will go back to this in the methodology section. Notice that upper-tail inequality across regions also decreases from 1992 to 2015 which suggests that the median wage grew faster than the *90th* percentile. The literature for more developed countries finds that median wages are not affected by changes in the minimum wage. For instance, Lee (1999) and Autor *et al.* (2016) find that the minimum wage binds up to the *10th* percentile of the wage distribution in the U.S., thus most of the equalizing effect of the minimum wage on wage inequality in the U.S. comes from spillover effects which do not extend through the median. In the case of Brazil, the minimum wage is much more binding, particularly when we include informal workers in the sample. Perhaps this is the reason why upper-tail inequality also decreases. Figure 4 shows that the minimum wage binds above the median wage in some regions, particularly during the 1980s.

Figure 4: Bindingness of the Minimum Wage on the Wage Distribution across Regions, PNAD 1981-2015.



Source: PNAD and MTE data from 1981 to 2015. The sample comprises full-time salary workers. The figure shows the lowest and the highest percentile at which the minimum wage binds across 26 regions per year. *SP* and *PB* are abbreviations for regions: Sao Paulo and Paraiba, respectively.

[12] A graphic representation of the changes in inequality across regions for PME data can be found in the Appendix A-Figure 7.

The sample comprises regions in which the minimum wage barely binds the wage distribution and others in which the minimum wage binds above the median wage.[13] The large variation in the bindingness of the minimum wage on the wage distributions across regions is the result of differences in their wage levels which is a desirable condition for identification. However, it is also desirable that the centrality measure —the median wage— is not affected by changes in the minimum since this is used to construct wage inequality measures and the effective minimum wage. To see why this is an issue, consider an increase in the minimum wage that increases both the *10th* percentile and the median wage in the same proportions, other variables *ceteris paribus*. In this extreme case, lower-tail inequality, *log(10th)-log(median wage)*, would not be affected, implying that the minimum wage is not effective in compressing wage inequality even when this did increase wages below the median. Consequently, I use a centrality measure above the median wage, which is less likely to be affected directly by changes in the minimum wage, I will come back to this in the following section.

4 Methodology

This section is divided into three parts. The first part describes the general specification for this study, the remaining two propose the strategy to obtain robust estimates of the effects of the minimum wage on wage inequality and employment.

4.1 General Specification

I follow Lee (1999) who proposes an empirical model to identify the effects of the minimum wage on the wage distribution through its level of bindingness. The intuition behind the model is that in absence of a minimum wage, the structure of the wage distribution would have evolved identically across regions, hence any deviation from this pattern is attributed to changes in the minimum wage. Formally:

$$\begin{cases} w_{rt}^{p} - w_{rt}^{\mu} = w_{rt}^{p*} - w_{rt}^{\mu*} & \text{if} \quad \text{min. wage}_t - w_{rt}^{\mu} < w_{rt}^{p*} - w_{rt}^{\mu*} \\ w_{rt}^{p} - w_{rt}^{\mu} = min.wage_t - w_{rt}^{\mu} & \text{otherwise} \end{cases} \tag{1}$$

where w_{rt}^{p} and w_{rt}^{μ} are the p-th percentile and the centrality measure of the actual log wage distribution in region *r* at time *t*, respectively. The start denotes latent log wage percentiles, those which would have been observed in the absence of a binding minimum wage. Consequently, actual wage inequality equals latent wage inequality whenever the effective minimum wage, $min.wage_t - w_{rt}^{\mu}$, is below the latent wage differential, $w_{rt}^{p*} - w_{rt}^{\mu*}$. On the other hand, actual

[13] See Appendix A-Figure 8 for information on how binding the minimum wage is on the wage distribution across metropolitan regions by using PME data.

wage differential equals the effective minimum wage in a region with an effective minimum wage larger or equal than the latent wage differential.

Lee's model relies on several assumptions that allows us to separate the average growth in latent wage inequality from the effects of the minimum wage on actual wage inequality. First, the centrality measure and the percentiles above are not affected by changes in the minimum wage, thus $w_{rt}^{p} - w_{rt}^{\mu} = w_{rt}^{p*} - w_{rt}^{\mu*} \ \ \forall_{p},\ p \geq \mu$. Second, latent wage inequality is the same across regions such as $w_{rt}^{p*} - w_{rt}^{\mu*} = w_{st}^{p*} - w_{st}^{\mu*} \ \ \forall_{r,s}$. Finally, the regional centrality measure is systematically uncorrelated with the latent wage dispersion such as $cov[w_{rt}^{p*} - w_{rt}^{\mu},\ min.wage_t - w_{rt}^{\mu}|t] = 0$. Consequently, a significant association between the effective minimum wage and lower-tail inequality is only possible because of a change in the minimum wage, whereas a significant association between the effective minimum wage and upper-tail inequality implies a violation of the main assumptions of the model. However, Lee's approach allows for the possibility of spillover effects such as, $w_{rt}^{p} - w_{rt}^{\mu} = \mathrm{f}(min.wage_t - w_{rt}^{\mu})$, that is, the wage inequality measure is an increasing function of the effective minimum wage as long as spillover effects diminish monotonically higher up in the wage distribution. Lee (1999) suggests the following specification to estimate the effects of the minimum wage throughout the wage distribution.

$$w_{rt}^{p} - w_{rt}^{\mu} = \beta_1 mw_{rt} + \beta_2 mw_{rt}^2 + \alpha_t + \varepsilon_{rt} \tag{2}$$

Equation (2) suggests that the change in the differential between the log wage percentile, w_{rt}^{p}, and the log of the centrality measure, w_{rt}^{μ}, depends on the log of the effective minimum wage, $mw_{rt} = log(min.wage_t) - log(w_{rt}^{\mu})$, its square, mw_{rt}^2, and time fixed effects, α_t. The latter captures the latent wage differential which is indexed only across time because is assumed to be the same across regions. Equation (2) also relies on the assumption that, ε_{rt}, is orthogonal to the effective minimum wage and its square. The quadratic term captures the idea that the minimum wage has a larger effect on the wage distribution of low-wage regions in which this is more binding. Notice that the marginal effect of the effective minimum wage is given by, $\beta_1 + 2\beta_2 mw_{rt}$, which is obtained by differentiating equation (2) with respect to mw_{rt}.

This simple specification is restrictive because it assumes that latent wage inequality is identical across regions, which is certainly false in practice. Moreover, Autor *et al*. (2016) point out that the violation of the assumption of zero correlation between the centrality measure and other latent wage percentiles would imply that estimates from equation (2) are likely to be biased from the exclusion of region-fixed effects and region-specific trends. This assumption can be tested by using a measure of wage inequality which is not likely to be affected by the minimum wage as a plausible proxy for latent wage inequality. I regress the mean *log(90th)-log(70th)* across years as a measure for latent wage inequality on two potential centrality measures, the mean *log(50th)*, and the mean *log(60th)* by region, separately. I also perform an analogous analysis by regressing instead the trend of *log(90th)-log(70th)* across years on the trends of their respective centrality measures by regions. The results of these tests show a significant negative correlation between the latent log wage inequality with both centrality measures, though this is less significant when I use the *60th* percentile as a centrality measure.[14] Autor *et al.* (2016) propose the following specification to allow for differences in latent wage dispersion across regions and within regions over time. Formally:

$$w_{rt}^{p} - w_{rt}^{\mu} = \beta_1 mw_{rt} + \beta_2 mw_{rt}^2 + \alpha_t + \alpha_r + \alpha_r t + \nu_{rt} \quad (3)$$

where α_r and $\alpha_r t$ are time-invariant region effects and region-specific trends, respectively. Regarding the previous findings from the data, I consider this specification to be more appropriate to estimate the effects of the effective minimum wage on wage inequality in Brazil. I also use the *60th* percentile as a centrality measure because this seems to be a more suitable centrality measure than the median wage for this specification.

Although it is expected that the inclusion of regional dummies and region-specific trends tackle any spurious relationship between the effective minimum wage and wage inequality, there is still a potential endogeneity problem in Lee's specification given by the mechanical nature of the relationship between the dependent and independent variables. Notice that the centrality measure is used to construct both the wage inequality measure (left-hand side of equation (3)) and the effective minimum wage (right-hand side of equation (3)), thus if sampling error is an important part of the variability in the centrality measure, then a spurious relationship between the dependent and the independent variables is expected. Although this is a valid concern, the sample sizes for PNAD and PME are large, in average 4000 and 5000 observations for each unit of time and region, respectively. The estimated sampling error for the centrality measure is around 1 percent which implies that 1 percent of the variation in the effective minimum wage is attributable to sampling error. However, this becomes important when we split the sample into genders or into smaller groups of workers.

Autor *et al.* (2016) deal with this issue by instrumenting the effective minimum wage with the statutory minimum wage which is assumed to be exogenous. This instrument is not available for Brazil because minimum wages are set nationally. In fact, the identification of the effects of the minimum wage on wage inequality relies entirely on the variation of the centrality measure across regions. Consequently, we require an instrument that captures the variation in wage inequality driven by changes in the minimum wage and not by changes in the centrality measure, I discuss this in more detail in the following subsection.

[14] A graphical representation of these tests along with their respective OLS estimates can be found in Appendix A-Figure 9.

4.2 Identification

Full identification of the effects of the minimum wage on wage inequality requires addressing the endogeneity issue that arises from the use of a contemporaneous centrality measure in both sides of equation (3). It is of interest to obtain an effective minimum wage that is driven by the contemporaneous fluctuations of the minimum wage and not by changes in the contemporaneous wage levels. I propose to instrument the contemporaneous effective minimum wage by using instrumental variables which are constructed with wage distributions from previous periods, in hope that the span of time tackles any possible correlation between the error components on both sides of equation (3). The span of time must be short enough to ensure a significant correlation between the effective minimum wage and the instrument, but not too short to ensure its exogeneity. Unfortunately, PNAD data are collected annually, thus, the span of time is not suitable to construct such instruments. Consequently, I only use data from PME because its monthly structure allows us to do so.

The first instrument uses a centrality measure of, *t-s*, periods prior to the contemporaneous minimum wage, thus the effective minimum wage and its square in equation (3) are instrumented by using the difference between the log of the contemporaneous minimum wage and the log of the centrality measure of, s, months earlier, $log(min.wage_t) - log(w^{\mu}_{r,t-s})$, and its square, respectively. The second instrument uses the percentile at which the minimum wage binds the wage distribution across regions at time, *t-s*, to estimate the probability of earning at or below the contemporaneous minimum wage. I define this instrument as the fraction of hourly wages at or below this percentile, formally: $F_{rt} = Pr(w_{r,t-s} \leq min.wage_t)$.[15] To instrument the two endogenous variables in equation (3), I propose a set of three instruments: F_{rt}, its square and an interaction between, F_{rt}, and the average log of the centrality measure by region across time, w^{μ}_{r}. Notice that the identification of mw_{rt} comes from the linear, F_{rt} and the identification of mw^2_{rt} comes from both the square F_{rt} and the interaction term, $F_{rt}w^{\mu}_{r}$, because the quadratic structure of the effective minimum wage, $(min.wage_t - w^{\mu}_{rt})^2$, yields three terms, one of which is the interaction between the minimum wage and the centrality measure.[16]

The OLS estimates for PNAD and PME along with the 2SLS estimates for PME will be discussed in the "Results" section. To conclude this section, I present the strategy to estimate the effects of the minimum wage on employment below.

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[15] Different measures for the probability of being affected by changes in the minimum wage have been used in the literature mainly to identify the effects of the minimum wage on employment. Some examples include Card, 1992 ("fraction affected" defined as the fraction of workers between the old and the new minimum wage); Card and Krueger, 1995 ("fraction at" defined as the fraction of workers earning at the minimum wage); and Neumark *et al.,* 2006 ("fraction below" defined as the fraction of workers earning strictly below the minimum wage).

[16] Although the average log of the centrality measure, w^{μ}_{r}, is not completely exogenous with respect to the factors that affect the effective minimum wage, it is expected that the endogenous component between the instrument and the instrumented variable is small enough to not bias the estimates significantly.

4.3 The Effects of the Minimum Wage on Employment

There is extensive literature on the adverse effects of the minimum wage on the employment of workers who were intended to benefit. In this case, the equalizing effect of the minimum wage on the wage distribution of those who remain employed may be outweighed by negative effects on the labour earnings of those who become unemployed. A loss in the sample following an increase in the minimum wage would lead to a mechanical change in the observed percentiles of the wage distribution. We are not able to observe the lost part of the wage distribution because the samples only comprise employed workers.

To shed light on the possible adverse effects of the minimum wage on employment, I include in the PME data samples, unemployed workers who are actively looking for jobs in the reference week. I use three different measures of employment as dependent variables: i) employment rate, E_{rt}: number of employed workers divided by the number of individuals in the labour force in region *r* at time *t*, ii) working hours, T_{rt}: total working hours per week divided by the number of individuals in the labour force in region *r* at time *t*, and iii) working hours if employed, H_{rt}: total working hours per week divided by the number of employed workers in region *r* at time *t*. I use the fraction of hourly wages at or below the minimum wage, F_{rt}, as was defined previously, as the explanatory variable along with time-fixed effects, region-fixed effects and region-specific trends. Following Neumark *et al*. (2006), I include lags of the shock variable in order to capture the long-run effects of the minimum wage on employment. Formally:

$$E_{rt}, T_{rt}, H_{rt} = \sum_{s=0}^{S} \beta_s F_{r,t-s} + \alpha_t + \alpha_r + \alpha_r t + \nu_{rt} \tag{4}$$

5 Results

In this section, I report OLS and 2SLS estimates of the relationship between the minimum wage and wage inequality in Brazil by using both PNAD and PME data for different groups of workers. I also perform a counterfactual exercise to quantify the decline in wage inequality driven by changes in the minimum wage over the post-inflationary period (1995-2015). Finally, I estimate the effects of the minimum wage on employment by using PME data and propose an exercise for robustness check. I begin this section by presenting the estimates for three groups of workers: “all workers" comprises both salary workers and self-employed, “salary workers" comprises both formal and informal workers and “formal workers" comprises workers who have a legal employment contract in the reference week. I report estimates for the sample period 2002-2016 to make PNAD and PME comparable.

The OLS estimates for PNAD in Table 1 suggest significant effects of the minimum wage throughout the wage distribution; however, these are smaller in magnitude in the upper half of the distribution. Notice there is no evidence of significant effects of the minimum wage on upper-tail inequality when only formal workers are considered. The significant estimates above the centrality measure, *60th*, for the other groups of workers, may in principle suggest very significant spillover effects. According to the model specification, spillover effects are expected to decrease monotonically higher up in the wage distribution; however, this is not the case for these groups of workers, thus we have to be suspicious of the significant OLS estimates, particularly in the upper tail of the distribution. Recall that OLS estimates are likely to be biased because of the mechanical dependence of both sides of equation (3). The OLS estimates from PME data show a similar behaviour; however, these are smaller than those obtained from PNAD data. Recall that PME data, unlike PNAD data, do not provide information on non-metropolitan areas in which the minimum wage may be potentially more binding, this is perhaps why PME estimates are smaller. Endogeneity is also an issue for OLS estimates from PME data, thus I perform 2SLS procedures by using the instrumental variables that I described in the previous section.

The 2SLS* in Table 1, instruments the effective minimum wage by using the difference between the log of the minimum wage and the log of the centrality measure from a three-month-earlier wage distribution, $log(min.wage_t) - log(60_{r,t-3})$. The 2SLS** instead uses the fraction of hourly wages at or below the contemporaneous minimum wage from a three-month-earlier wage distribution, F_{rt}, as an instrument for the effective minimum wage.

Both 2SLS specifications appear to eliminate the significant effects of the minimum wage above the centrality measure which supports the suspicion of a spurious relationship between the minimum wage and the compression of upper-tail inequality. Notice that 2SLS* specification provides more conservative estimates of the effects of the minimum wage on lower-tail inequality; however, these suggest significant spillover effects higher up in the wage distribution. For example, 2SLS* estimates suggest significant spillover effects of the minimum wage up to the median wage for all groups of workers while, 2SLS** estimates suggest significant spillover effects as follows: up to median wage when all workers are considered in the sample, up to the *40th* percentile when self-employed are excluded and up to the *30th* percentile when both informal workers and self-employed are excluded from the sample. These results imply that the minimum wage has positive effects on the labour earnings of uncovered workers, otherwise, the lowest percentiles would not be affected when we account for this type of workers. In fact, both 2SLS estimates suggest a larger equalizing effect of the minimum wage on lower-tail inequality when we pool formal and informal workers in the sample than when we account only for formal workers. I do not split the sample into smaller groups such as informal workers and self-employed because the estimates from these samples might be seriously biased for two reasons. First, each group of these workers represents around 20 percent of the sample, thus the mean cell size is not large enough and sampling error is a serious source of concern. Second, the minimum wage is significantly more binding in the labour earnings distribution of these workers. In fact, this binds above the *60th* percentile in some regions, therefore, the selected centrality measure would not be appropriate to produce reliable estimates.

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Table 1: OLS and 2SLS Estimates between Log(p)-Log(60th) and Log(min.wage)-Log(60th) by Groups of Workers, for Selected Percentiles.

Percentiles	10th	20th	30th	40th	50th	70th	80th	90th
All workers								
OLS (PNAD)	0.53***	0.49**	0.46***	0.28***	0.32***	0.17***	0.28**	0.23**
	(0.19)	(0.23)	(0.14)	(0.08)	(0.08)	(0.06)	(0.11)	(0.10)
OLS (PME)	0.43***	0.42***	0.27***	0.24***	0.12***	-0.001	0.11*	0.16**
	(0.08)	(0.06)	(0.02)	(0.03)	(0.01)	(0.03)	(0.05)	(0.05)
2SLS* (PME)	0.42***	0.40***	0.24***	0.20***	0.08***	-0.03	0.07	0.11
	(0.09)	(0.07)	(0.02)	(0.04)	(0.02)	(0.04)	(0.07)	(0.06)
2SLS** (PME)	0.55***	0.49***	0.25***	0.13	0.06**	-0.01	0.11	0.12
	(0.08)	(0.06)	(0.05)	(0.08)	(0.02)	(0.04)	(0.08)	(0.08)
Salary workers								
OLS (PNAD)	0.76***	0.72***	0.63***	0.44***	0.43***	0.25***	0.32***	0.19*
	(0.16)	(0.14)	(0.08)	(0.07)	(0.09)	(0.05)	(0.07)	(0.10)
OLS (PME)	0.55***	0.44***	0.28***	0.20***	0.12***	-0.01	0.05	0.12*
	(0.05)	(0.04)	(0.03)	(0.03)	(0.01)	(0.03)	(0.08)	(0.06)
2SLS* (PME)	0.53***	0.41***	0.24***	0.14***	0.06***	-0.05	-0.01	0.04
	(0.05)	(0.04)	(0.03)	(0.03)	(0.01)	(0.03)	(0.10)	(0.06)
2SLS** (PME)	0.65***	0.49***	0.21***	0.10**	0.03	-0.07	-0.003	-0.002
	(0.05)	(0.06)	(0.05)	(0.04)	(0.03)	(0.06)	(0.10)	(0.12)
Formal workers								
OLS (PNAD)	0.51***	0.34***	0.43***	0.45***	0.30***	0.14*	0.04	-0.20
	(0.06)	(0.10)	(0.10)	(0.13)	(0.07)	(0.08)	(0.08)	(0.17)
OLS (PME)	0.52***	0.38***	0.31***	0.20***	0.15***	0.01	0.10	0.13*
	(0.02)	(0.03)	(0.05)	(0.02)	(0.01)	(0.02)	(0.07)	(0.06)
2SLS* (PME)	0.49***	0.33***	0.25***	0.12***	0.08***	-0.02	0.05	0.07
	(0.02)	(0.04)	(0.05)	(0.04)	(0.02)	(0.04)	(0.07)	(0.08)
2SLS** (PME)	0.44***	0.24***	0.15***	0.05	-0.01	-0.03	0.04	0.02
	(0.03)	(0.03)	(0.06)	(0.04)	(0.06)	(0.02)	(0.06)	(0.07)

Source: PNAD, PME and MTE data from 2002 to 2016. The coefficients are the marginal effects of $\log(min.wage_t) - \log(60_{rt})$. Regressions are weighted by the product between weekly working hours and PNAD/PME sample weights. The number of observations for OLS estimation is 338 (26 regions and 13 years) for PNAD, and 1008 (6 regions and 168 months) for PME per each percentile. The span used for both 2SLS estimation is 3 months *(s=3)*. 2SLS* and 2SLS** estimates use the, $\log(min.wage_t) - \log(60_{r,t-3})$, and the, F_{rt}, as instruments, respectively. The first stage of the 2SLS procedures can be found in the Appendix B-Table 7. Standard errors in parenthesis are clustered by region. Significant at 1 percent ***, at 5 percent ** and at 10 percent *.

The expected positive sign of the 2SLS estimates suggests that the minimum wage is effective to compress lower-tail inequality. For example, the 2SLS* estimate for "all workers" suggest that an increase in 1 percent of the effective minimum wage, shrinks the gap between the *10th/60th* —becomes less negative— by 0.42 percent. This positive effect decreases monotonically up to the median as expected. Separate estimates for males and females are reported in Appendix B-Table 5 and Table 6, respectively. There are three important features that we can observe from the analysis by gender. First, the 2SLS estimates are larger for females than for males which suggest that the minimum wage plays a more significant role in the decline of wage inequality among women. Second, the spillover effects of the minimum wage are also more significant among females, particularly when uncovered workers are considered. Finally, 2SLS** estimates suggest that there is no evidence of significant effects of the minimum wage on upper-tail inequality at 5 percent level of significance. However, we have to be cautious when interpreting estimates by gender groups because sampling error is an important part of the variability in the centrality measure for small samples, thus our preferred estimates are those obtained from pooled samples.

The estimates in Table 1 suggest that the minimum wage plays an important role in the compression of lower-tail inequality, whereas, the effects of the minimum wage on upper-tail inequality are negligible. In order to provide a more concise picture of the effects of the minimum wage on the declining wage inequality in Brazil over the post-inflationary period, I perform a reduced form of counterfactual estimates of the change in latent wage inequality by following Lee (1999) and Autor *et al*. (2016). I essentially simulate what would be the labour earnings of individuals at the p-th percentile in region *r*, at time t_1, if the minimum wage had remained at its t_0 level by adding or subtracting the following amount to the log wage of each worker.

$$\Delta w_{rt}^{p} = \beta_1(mw_{rt_0} - mw_{rt_1}) + \beta_2(mw_{rt_0}^2 - mw_{rt_1}^2) \qquad (5)$$

where mw_{rt_0} is the observed effective minimum wage at time t_0, mw_{rt_1} is the observed effective minimum wage at time t_1, and β_1 and β_2 are OLS and 2SLS estimates from Table 1. The idea behind this procedure is to construct a counterfactual wage distribution absent the increase in the minimum wage by adjusting each wage observation in the data by the quantity in equation (5).[17] Table 2 compares observed changes in lower-tail inequality with those from the simulated distribution.

The observed and the counterfactual change in lower-tail inequality in Table 2 are measured by the gap *10th/60th* from the observed and the counterfactual wage distributions, respectively. Although OLS estimates are reported in Table 2, the favourite specification is given by 2SLS estimates as was mentioned previously. There is a slight difference between 2SLS* and 2SLS** counterfactual estimates when we pooled males and females in the sample; however, it appears that 2SLS** estimates give an extra weight to the effect of the minimum wage on the declining wage inequality when we split the sample into genders. As

[17] For example, to simulate what a worker would earn in 2016 if the minimum wage had remained at its 2002 level. I add or subtract the following quantity to the hourly wage of that individual in 2016: $w_{r,2016}^{*} = w_{r,2016} + \beta_1 mw_{r,2002} - \beta_1 mw_{r,2016} + \beta_2 (mw_{r,2002})^2 - \beta_2 (mw_{r,2016})^2$.

was previously mentioned, we have to be cautious when interpreting estimates from smaller samples. I provide an interpretation of the results in Table 2 by using the 2SLS* estimates which are the most conservative estimates of the effects of the minimum wage on lower-tail inequality.

Table 2: Observed and Counterfactual Changes in Wage Inequality over the Post-Inflationary Period, PNAD and PME.

	PME (2002-2016)				PNAD (1995-2015)			
	Observed Change	Counterfactual Change OLS	2SLS*	2SLS**	Observed Change	Counterfactual Change OLS	2SLS*	2SLS**
All workers								
Pooled	-34.6	-22.3***	-22.3***	-23.4***	-45.6	-26.9***	-28.6***	-27.7***
		(3.32)	(3.56)	(1.76)		(10.02)	(10.12)	(4.34)
Males	-32.9	-20.1***	-19.7***	-13.6***	-43.2	-19***	-21.2***	-11.8
		(2.45)	(2.95)	(2.96)		(4.90)	(6.55)	(8.54)
Females	-38.5	-22.8***	-23***	-16.6***	-53.8	-37.4***	-37.4***	-30.2***
		(7.89)	(8.17)	(4.24)		(11.22)	(12.01)	(6.15)
Salary workers								
Pooled	-31.7	-18.5***	-18.1***	-15.1***	-49.1	-31***	-31.5***	-26.5***
		(1.73)	(1.94)	(2.05)		(4.13)	(4.38)	(2.66)
Males	-29.2	-17.8***	-17.9***	-12.8***	-44.8	-26.1***	-28.3***	-22.8***
		(1.49)	(1.58)	(2.92)		(3.03)	(4.35)	(5.21)
Females	-33.4	-19.6***	-18.9***	-14.4***	-56.0	-39.5***	-39.3***	-31.6***
		(4.41)	(5)	(3.36)		(7.52)	(8.03)	(5.03)
Formal workers								
Pooled	-29.2	-15***	-15.2***	-14.4***	-45.4	-27.7***	-28.3***	-26.3***
		(1.20)	(1.03)	(4.94)		(3.59)	(3.51)	(4.25)
Males	-24.3	-8.4***	-9.1***	-10***	-48.7	-30.8***	-32.1***	-32.7***
		(1.64)	(2.18)	(3.37)		(2.74)	(3.50)	(6.75)
Females	-31.5	-16.6***	-15.6***	-13.7***	-48.7	-22.4***	-21.7***	-16.8***
		(2.16)	(2.14)	(4.73)		(4.52)	(4.40)	(6.11)

Source: PNAD data from 1995 to 2015 and PME data from March 2002 to February 2016. Actual and counterfactual changes are measured by the gap between the *60th* and *10th* percentiles from the observed and the counterfactual wage distributions, respectively. The reported marginal effects and standard errors in parenthesis are obtained by bootstrapping with replacement taking regions as the sampling unit as follows: I run regressions by using equation (3) and obtain OLS, 2SLS* and 2SLS** estimates from PME data (Table 1), then I use these coefficients to simulate a wage distribution for PME and PNAD by adding or subtracting the amount specified in equation (5) to the hourly wages in the last year of each respective sample. I perform 1000 replications of this counterfactual exercise to improve accuracy. Significant at 1 percent ***, at 5 percent ** and at 10 percent *.

PME estimates for “all workers" sample show that lower-tail inequality decreases by 35 log points from 2002 to 2016. To see this, consider the 2SLS* estimate for this group of workers, this suggests that lower-tail inequality would decrease by 22.3 log points if the real value of the minimum wage had remained at its level in 2002. Thus, the difference between the observed change in inequality and the change in latent inequality, (34.6-22.3), is attributed to the increase in the minimum wage, around 12 log points which represent 35 percent of the decline in lower-tail inequality. The effect of the minimum wage on the decline of lower-tail inequality is larger when self-employed are excluded from the sample, around 43 percent, and this is even larger when we exclude both informal workers and self-employed, around 48 percent. The estimates by gender also suggest that the effects of the minimum wage on the compression of lower-tail inequality are more significant when we account only for formal workers.

PNAD data allow us to repeat this exercise by taking into account non-metropolitan regions and the entire post-inflationary period (1995-2015). The change in lower-tail inequality from 1995 to 2015 is approximately 45 log points. The 2SLS* estimates from the pooled sample suggest that approximately 37 percent of this decline is driven by the increase in the minimum wage and this effect is similar among different groups of workers. PNAD estimates by gender suggest that the equalizing effect of the minimum wage on lower-tail inequality is more significant among males when uncovered workers are included in the sample. In turn, this effect is significantly larger among females when only formal workers are considered.

In summary, the results so far show that the increase in the minimum wage is responsible for slightly less than 40 percent of the decline in lower-tail inequality in Brazil after the adoption of the Brazilian Real. Of course, this analysis only accounts for the effects of the minimum wage on the labour earnings of those who remain employed. In that sense, these results provide information on the compression of labour earnings inequality but nothing can be said about changes in income inequality that accounts for non-labour income and for changes in employment. Regarding the latter, Table 3 provides information on the effects of the minimum wage on employment by estimating equation (4) for PME data.

Table 3 provides information on the contemporaneous and the long run effects of the minimum wage on the number of jobs and the number of working hours for both total and formal employment. The only contemporaneous adverse effect of the minimum wage on total employment is observed in the decline of “working hours if employed" which is the most sensitive measure of employment because this is normalized only to the number of workers

Table 3: OLS Estimates of the Minimum Wage Effects on Employment, Working Hours and Working Hours if Employed, PME 2002-2016.

Effects	Total Employment			Formal Employment		
	Employment	Working Hours	Hours if Employed	Employment	Working Hours	Hours if Employed
Contemporaneous						
F_{rt}	0.0058	0.0018	-0.0007**	-0.0020	-0.0006	-0.0018
	(0.0038)	(0.0016)	(0.0003)	(0.0046)	(0.0022)	(0.0017)
L. one quarter						
F_{rt}	0.0059	0.0019	-0.0006*	-0.0031	-0.0009	-0.0022
	(0.0042)	(0.0019)	(0.0003)	(0.0050)	(0.0024)	(0.0023)
Summed effect	-0.0017	-0.0012	-0.0005	-0.0098**	-0.0043**	-0.0029**
	(0.0037)	(0.0014)	(0.0004)	(0.0048)	(0.0019)	(0.0014)
L. two quarters						
F_{rt}	0.0061	0.0022	-0.0004	-0.0021	-0.0005	-0.0015
	(0.0041)	(0.0019)	(0.0003)	(0.0048)	(0.0023)	(0.0022)
Summed effect	-0.0066	-0.0022	0.0007	-0.0192***	-0.0089***	-0.0041***
	(0.0051)	(0.0028)	(0.0014)	(0.0054)	(0.0022)	(0.0014)
L. three quarters						
F_{rt}	0.0070	0.0024	-0.0006	-0.0002	0.0001	-0.0007
	(0.0044)	(0.0020)	(0.0004)	(0.0048)	(0.0023)	(0.0019)
Summed effect	-0.0170*	-0.0064	0.0009	-0.0299***	-0.0137***	-0.0059*
	(0.0089)	(0.0045)	(0.0022)	(0.0051)	(0.0026)	(0.0033)

Source: PME data from March 2002 to February 2016. The sample comprises all economically active individuals aged 16-64. The first row in the table reports estimates from regressions of three employment measures on the fraction below or at the minimum wage, F_{rt},, fixed time and region effects, and region-specific trends for total employment and formal employment. Lags of F_{rt} are added to the basic specification in the remaining panels, thus the summed effect is the sum of the contemporaneous effect and the lag effects. Regressions are weighted by the product between weekly working hours and PME sample weights. Standard errors in parenthesis are clustered by region. Significant at 1 percent ***, at 5 percent ** and at 10 percent *.

who remain employed following the increase in the minimum wage. We can observe; however, that this adverse effect vanishes after two quarters. In the long run, it appears that the only adverse effect of the minimum wage is on the number of jobs after three quarters; however, this is only significant at 10 percent level. It is important to highlight that these estimates provide information on total employment including informal employment and self-employment which have a highly volatile nature, thus identification issues are a matter of concern.

The adverse effects of the minimum wage on employment becomes more evident when we account only for formal jobs. Although there is no evidence of significant contemporaneous effects, these become significant after the first quarter for all employment measures. Although the adverse effects of the minimum wage on formal employment are significant in the long-run, these are relatively small.

Consider the last row in Table 3, the summed effect of the minimum wage on formal employment suggests that an increase in the minimum wage that binds an additional 10 percent of the wage distribution, decreases formal employment by 0.30 percentage points and working hours by 0.14 after three quarters. These findings differ from those of Neumark *et al.* (2006) who find that the adverse effect of the minimum wage on employment is as large as 1.6 percentage points among household heads; however, their sample only comprises the first 6 years after the adoption of the Brazilian Real (1996-2001) which were characterized by large fluctuations in the inflation rates.[18] The previous findings also differ from those of Lemos (2009) who does not find statistically significant effects of the minimum wage on formal employment. Perhaps the difference in these results is because of the sample choice that in case of Lemos includes the inflationary period and excludes the mid-2000s in which the minimum wage increased sharply. There are also findings that fall between the previous ones, such as Foguel (1998), Foguel *et al.* (2001) and Fajnzylber (2002) who find small but significant adverse effects of the minimum wage on employment. The findings in this paper are in line with the latter ones.

Table 8 and Table 9 in the Appendix section show the estimates of the effects of the minimum wage on employment by gender. The contemporaneous effects of the minimum wage on formal employment are only significant among females; however, these vanish in the long-run. The adverse effects of the minimum wage on employment are more significant when we account for informal employment and self-employment for both genders. The summed effect after three quarters suggest that an increase in the minimum wage that binds an additional 10 percent of the labour earnings distribution decreases total employment by 0.37 percentage points among males and by 0.27 percentage points among females.

In summary, the significant but small adverse effects of the minimum wage on employment suggest that the minimum wage is an effective tool to compress wage inequality without affecting employment significantly. It is important to keep in mind that the effects of the minimum wage on wage inequality and employment in the present study are estimated at

[18] Aside from the differences in the sample choice, Neumark et al. (2006) omit regional-specific trends in their specification which may lead to biased estimates as was demonstrated previously.

the individual level. In that sense, further study must be done to determine if minimum wage workers belong to poor households and claim that the minimum wage is a welfare-improving instrument.

5.1 Robustness Checks

A potential limitation in the specification of equation (3) is that this does not account for worker mobility across regions. Although it is expected that worker mobility would be generated by sources others than changes in the minimum wage, because the minimum wage is set nationally in Brazil, the effects of the minimum wage on inequality and employment may be estimated with bias without taking it into account. Previous literature on worker mobility in Brazil has pointed out that most of the internal migration is generated from non-metropolitan areas to metropolitan ones (Fiess and Verner, 2003 and, Hering and Paillacar, 2016). In such a scenario, estimates from PNAD data are more vulnerable to be biased than those from PME data which only comprises geographically separated metropolitan regions. Moreover, Ferreira-Filho and Horridge (2016) state that internal migration has decreased dramatically during the 2000s in Brazil. Thus, the estimates in Table 1 and 3 for PME data are not likely to be significantly affected by regular worker mobility across regions. Although PME data do not provide information on worker mobility and PNAD data provides limited information on this matter, it is still possible to control for changes in the labour market composition in each region generated by either within-region changes or migration across regions. I propose to perform this exercise by adding labour supply controls in the specification of equation (3) in order to check the robustness of the estimates in Table 1. The labour supply controls are estimated by region and unit of time and these are the proportion of the total population who are between 16 and 24 years of age, between 55 and 64 years of age, illiterate, living in urban areas, out of the labour force, informal workers, self-employed; and the mean years of education.

The results can be found in Table 10 in the Appendix section. Neither the OLS nor the 2SLS estimates are significantly affected in the lower tail of the wage distribution. However, it appears that the inclusion of labour supply controls ascribes some variation in upper-tail inequality to changes in the minimum wage, particularly for the OLS specifications. The 2SLS estimates instead suggest that this relationship is likely to be spurious as was previously. The 2SLS estimates are qualitatively similar to those in Table 1, thus the main conclusion from before is basically the same. I also perform this analysis for the estimates of the effects of the minimum wage on employment by adding the labour supply controls to equation (4). The results can be found in Table 11 in the Appendix section. These estimates lead to the same conclusions, small but significant adverse effects of the minimum wage on employment.

Finally, it is important to mention that the identification of the effects of the minimum wage on wage inequality in equation (3) and on employment in equation (4), relies only on within regional variation. Thus, we have to be cautious with the inclusion of additional controls to avoid reducing true variation in the independent variable resulting from eliminating the permanent regional effects. Perhaps this is the reason why estimates from the robust specification suggest slightly smaller effects of the minimum wage on both wage inequality and employment.

6 Conclusion

This paper estimates the effects of the minimum wage on wage inequality and employment in Brazil over the post-inflationary period (1995—2015), by using two of the most important microdata sources available in the country: PNAD and PME. Following Lee (1999) and Autor *et al*. (2016), I use an empirical approach that identifies the effects of the minimum wage on wage inequality through its “bite" on the wage distribution at the regional level. I construct instrumental variables from wage distributions prior to the increase in the minimum wage in order to tackle endogeneity issues in the model specification. This allows us to ascribe changes in wage inequality to changes in the minimum wage.

Consistent with the findings in previous literature, the minimum wage is shown to have positive effects on the labour earnings of workers at the lower tail of the wage distribution. The OLS estimates obtained from PNAD data suggest that the equalizing effect of the minimum wage is present throughout the wage distribution, whereas, 2SLS estimates from PME data, which provides information only on metropolitan regions, suggest that these effects are only significant up to the median wage. These results imply that the significant spillover effects of the minimum wage on upper-tail inequality for PNAD are the result of either the inclusion of non-metropolitan regions in the sample or a spurious relationship between the minimum wage and the decline in upper-tail inequality; it seems that the latter is a more plausible explanation. I use the OLS and the 2SLS estimates to simulate a latent wage distribution —wage distribution in absence of a minimum wage— for different groups of workers. The change in lower-tail inequality from the observed and the latent wage distributions suggests that around 35 percent of the decline in lower-tail inequality is attributable to the increase in the minimum wage from 2002 to 2016 when all worker are considered in the sample. This decline becomes more significant when only formal workers are considered, approximately 50 percent.

These results are consistent with those obtained from PNAD data for the entire post-inflationary period (1995-2015). It is important to mention that, unlike previous studies for other Latin American economies, the decline in lower-tail inequality in Brazil is not entirely explained by changes in the minimum wage. In fact, around two-thirds of this decline may be attributed to other factors. Finally, I find evidence of small but significant adverse effects of the minimum wage on employment, particularly on formal employment. The estimates from the pooled sample (males and females) suggest that the minimum wage must bind an additional 30 percent of the workforce to decrease formal employment by approximately 1 percent.

In conclusion, these findings suggest that the minimum wage is an effective tool to compress wage inequality in Brazil without harming employment significantly. However, the increase in the minimum wage is not the only contributing factor to the decline in lower-tail inequality, there is still a significant proportion of this decline that was certainly driven by other factors. Moreover, these findings only provide information on the effects of the minimum wage on wage inequality and employment at the individual level. Thus, further examination is required of the welfare-improving effects of the minimum wage on family income and employment at the household level.

7 Appendix

7.1 Appendix A-Figures

Figure 5: Changes in Inequality and the Effective Minimum Wage by Selected Years, PME.

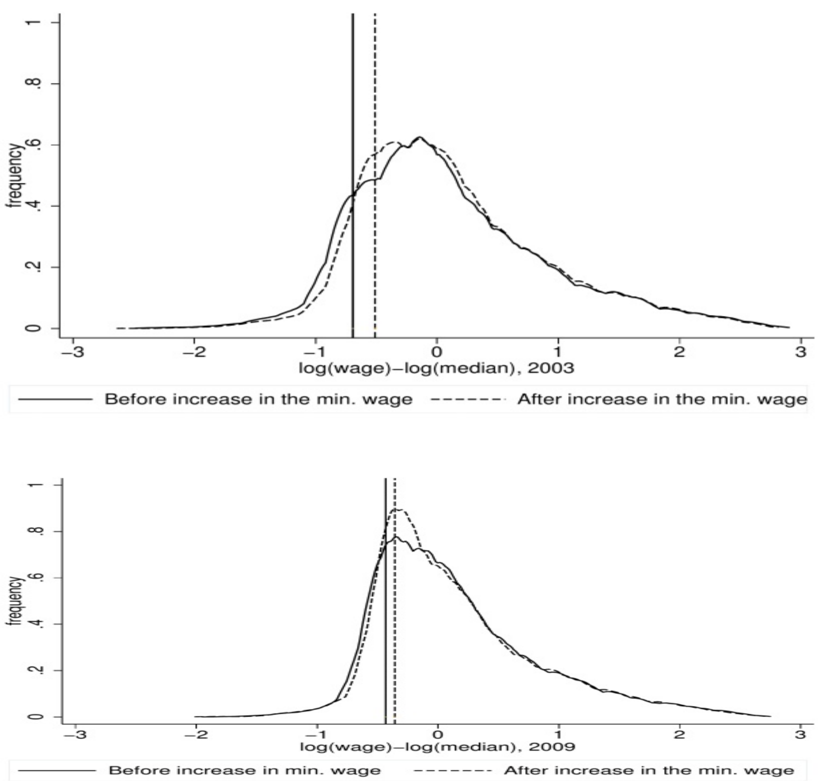
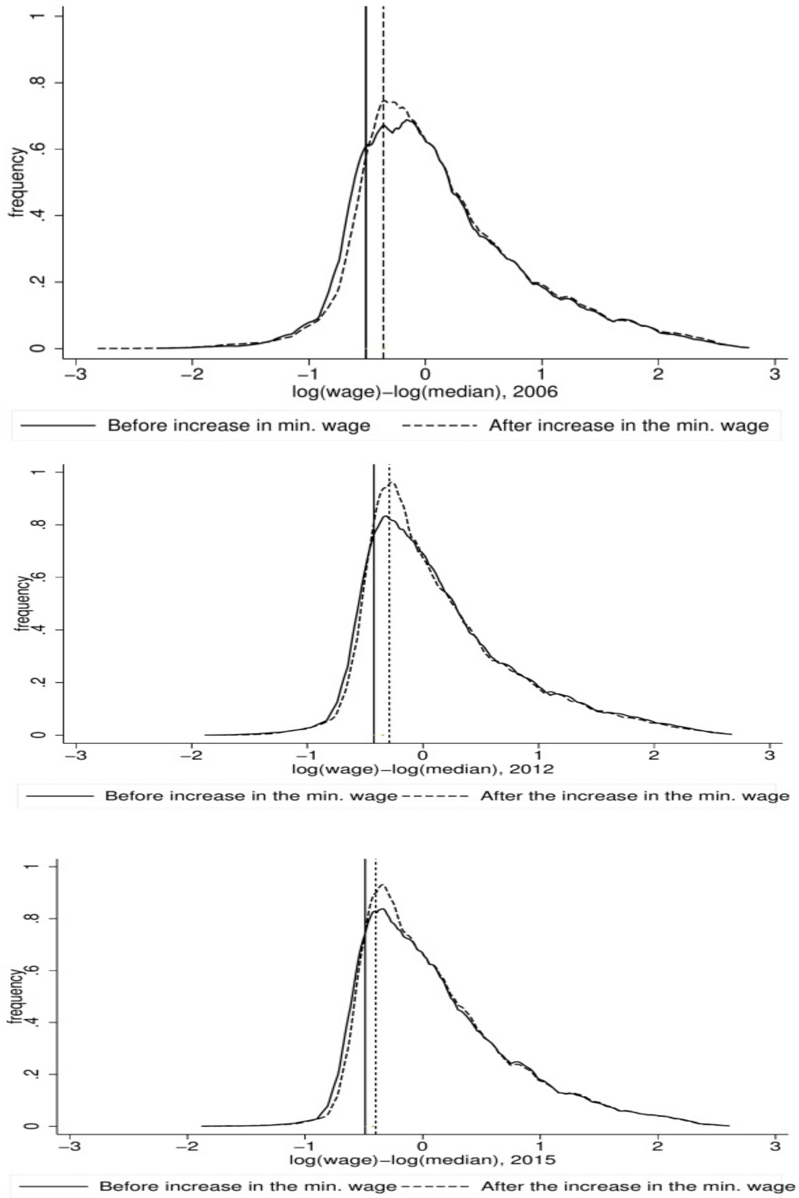
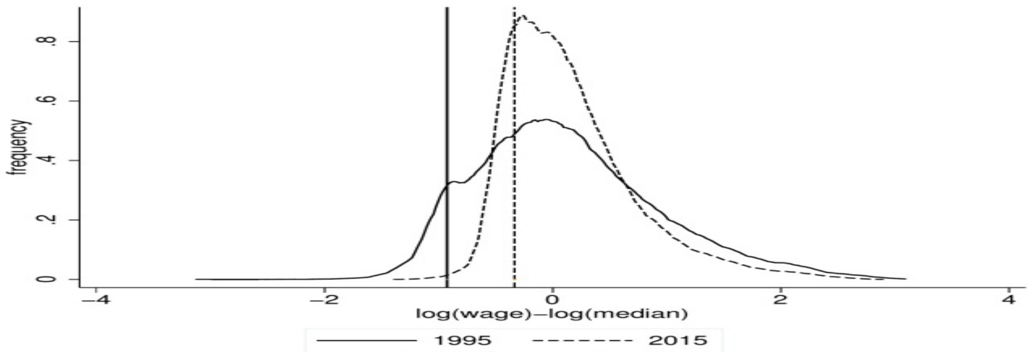


Figure 5 continued

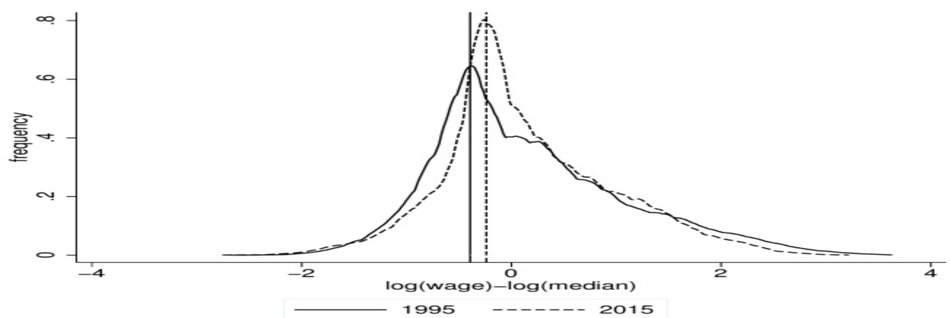


Source: PME and MTE data for 2003, 2006, 2009, 2012 and 2015. The sample includes full-time salary workers. The figure compares kernel density estimates of the log wage distribution between two months: before and after the increase in the minimum wage. All series are standardized to the contemporaneous monthly median wage. The vertical lines report the effective minimum wage, *log(min.wage)-log(median wage)*, for each month.

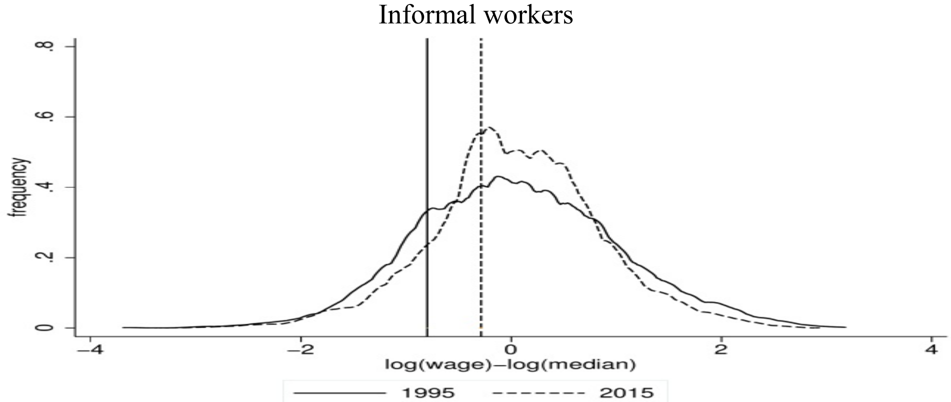
Figure 6: Changes in Inequality and the Effective Minimum Wage By Groups of Workers, PNAD 1995 and 2015.



Formal workers



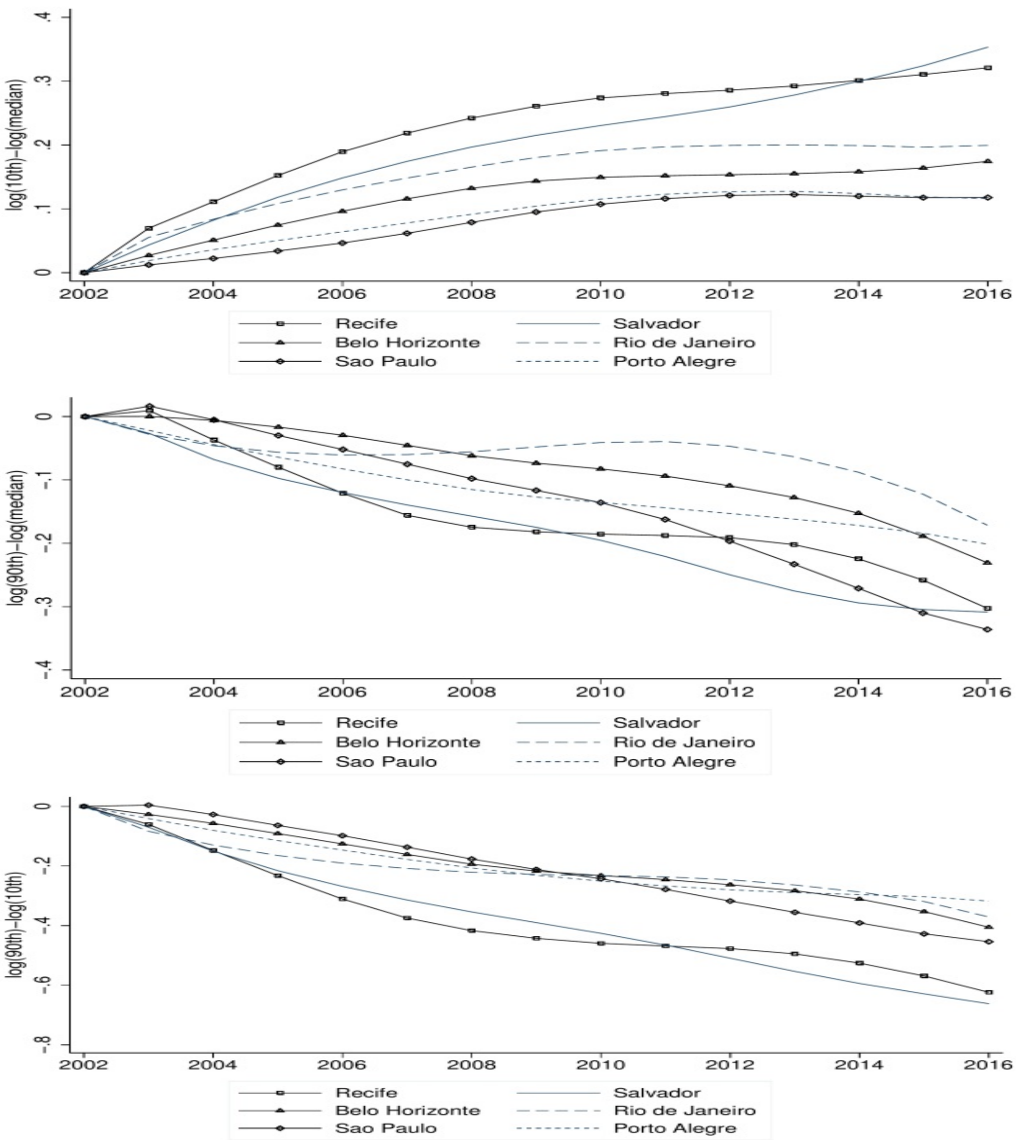
Informal workers



Self-employed

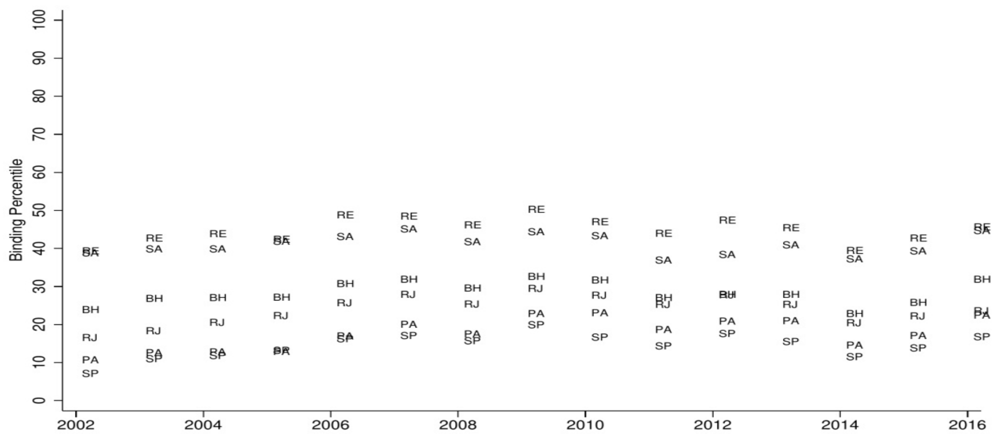
Source: PNAD and MTE data for 1995 and 2015. The figures compare kernel density estimates of the log wage distribution between two years. All series are standardized to the contemporaneous median wage. The vertical lines report the effective minimum wage, *log(min.wage)-log(median wage),* for each year.

Figure 7: Changes in Inequality and the Effective Minimum Wage across Regions, PME 2002-2016.



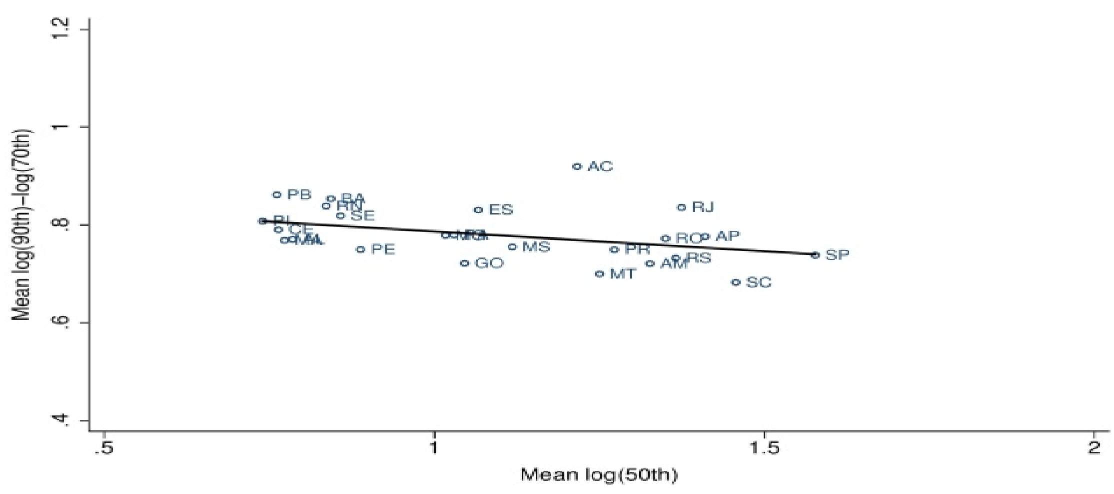
Source: PME and MTE data from March 2002 to February 2016. The sample comprises full-time salary workers who have a legal employment contract. The left and the right-hand-side figures on the top depict the change in lower and upper-tail inequality, respectively. The figure on the bottom depicts the change in the *90th/10th* gap of the log wage distribution. All inequality measures are normalized to 2002.

Figure 8: Bindingness of the Minimum Wage on the Wage Distribution across Regions, PME 2002-2016.



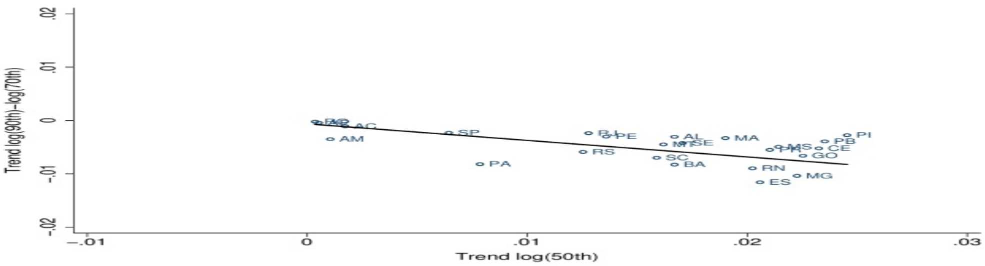
Source: PME and MTE data from 2002 to 2016. The sample comprises full-time salary workers. The figure shows the lowest and the highest percentile at which the minimum wage binds across 6 metropolitan regions. See Appendix B-Table 4 for information on the respective abbreviation of each region's name.

Figure 9: OLS Estimates of the Relationship between Latent Wage Inequality and the Centrality Measure.

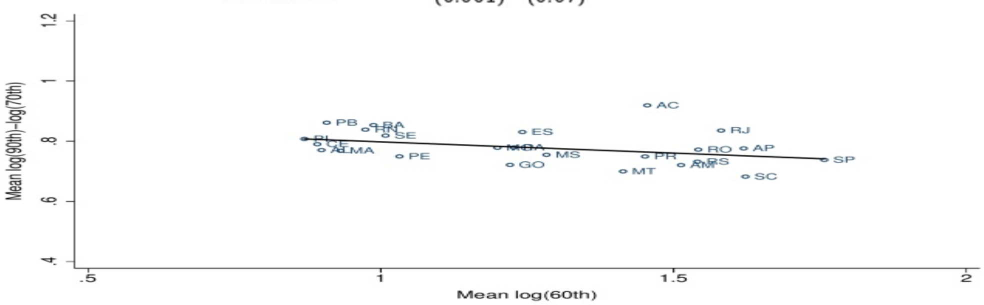


$$\text{mean log}\left(\frac{90th}{70th}\right) = \underset{(0.05)}{0.88} - \underset{(0.04)}{0.09} \times mean\ log(50th)$$

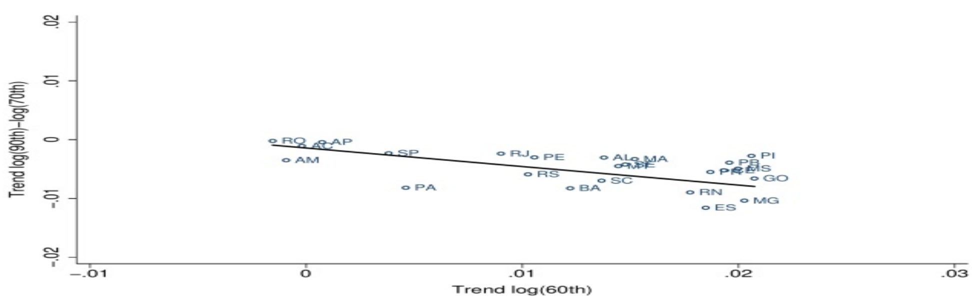
Figure 9 continued



$$\text{trend log}\left(\frac{90th}{70th}\right) = \underset{(0.001)}{-0.002} - \underset{(0.07)}{0.20} \times \textit{trend log}(50th)$$



$$\text{mean log}\left(\frac{90th}{70th}\right) = \underset{(0.05)}{0.87} - \underset{(0.04)}{0.07} \times \textit{mean log}(60th)$$



$$\text{trend log}\left(\frac{90th}{70th}\right) = \underset{(0.001)}{-0.002} - \underset{(0.07)}{0.22} \times \textit{trend log}(60th)$$

Source: PNAD and MTE data from 1981 to 2015. The sample comprises full-time salary workers. The right-hand-side figures show the OLS estimates of the relationship between the mean *log(90th)-log(70th)* with two centrality measures, the mean *log(50th)* on the top and the mean *log(60th)* on the bottom. The left-hand-side figures show analogous estimates between the trend of *log(90th)-log(70th)* and the respective trends of the centrality measures. The Federal District, *DF*, and Roraima, *RR*, were eliminated from the sample for being atypical values. See Appendix B-Table 4 for information on the respective abbreviation of each region's name.

7.2 Appendix B-Tables

Table 4: Regions and Mean Cell Sizes for All, Salary and Formal Workers, PNAD and PME.

Regions	Abbreviation	All Workers	Salary Workers	Formal Workers
PNAD				
Rondônia	RO	1880	1489	768
Acre	AC	995	744	324
Amazonas	AM	2653	1986	1078
Roraima	RR	604	468	171
Pará	PA	5600	4238	2016
Amapá	AP	766	586	251
Maranhão	MA	1681	1121	441
Piauí	PI	1227	875	356
Ceará	CE	5952	4769	2472
Rio Grande do Norte	RN	1452	1166	585
Paraíba	PB	1607	1248	553
Pernambuco	PE	5895	4809	2885
Alagoas	AL	1220	966	505
Sergipe	SE	1466	1157	617
Bahia	BA	8680	6943	3677
Minas Gerais	MG	11054	9444	6129
Espírito Santo	ES	2173	1837	1162
Rio de Janeiro	RJ	7846	6657	4391
São Paulo	SP	14661	12941	9323
Paraná	PR	6464	5433	3766
Santa Catarina	SC	3436	2873	2140
Rio Grande do Sul	RS	9562	8019	5617
Mato Grosso do Sul	MS	2237	1881	1133
Mato Grosso	MT	2499	2036	1175
Goiás	GO	6831	5653	2959
Distrito Federal	DF	3447	3134	1866
PME				
Recife	RE	3889	3163	2125
Salvador	SA	3941	3214	2241
Belo Horizonte	BH	6939	5850	4365
Rio de Janeiro	RJ	6151	4922	3347
São Paulo	SP	8053	6857	5004
Porto Alegre	PA	5408	4526	3369

Source: PNAD data from 2002 to 2015 and PME data from March 2002 to February 2016. Mean cells are simple average across years for PNAD and across months for PME by region. The observations in each cell are used to estimate the percentiles that comprise the region-level panel data set. “All workers" sample comprises formal workers, informal workers and self-employed, “salary workers" sample excludes self-employed. Formal workers are defined as workers who have a legal employment contract in the reference week.

Table 5: OLS and 2SLS Estimates between Log(p)-Log(60th) and Log(min.wage)-Log(60th) by Groups of Workers, Males.

Percentiles	10th	20th	30th	40th	50th	70th	80th	90th
All workers								
OLS (PNAD)	0.30*	0.36**	0.49***	0.31***	0.30***	0.19***	0.26***	0.27**
	(0.17)	(0.16)	(0.11)	(0.09)	(0.05)	(0.04)	(0.06)	(0.11)
OLS (PME)	0.42***	0.33***	0.25***	0.16***	0.09***	-0.002	0.07	0.09*
	(0.06)	(0.02)	(0.01)	(0.02)	(0.01)	(0.02)	(0.06)	(0.04)
2SLS* (PME)	0.38***	0.28***	0.19***	0.10***	0.02	-0.03	0.02	0.03
	(0.07)	(0.03)	(0.03)	(0.02)	(0.02)	(0.02)	(0.07)	(0.05)
2SLS** (PME)	0.49***	0.39***	0.30***	0.16***	0.07	0.02	-0.08	0.04
	(0.03)	(0.05)	(0.04)	(0.02)	(0.04)	(0.05)	(0.07)	(0.15)
Salary workers								
OLS (PNAD)	0.57***	0.54***	0.52***	0.42***	0.27***	0.13**	0.23***	0.22*
	(0.10)	(0.08)	(0.05)	(0.08)	(0.04)	(0.06)	(0.05)	(0.13)
OLS (PME)	0.46***	0.33***	0.26***	0.17***	0.09***	0.02	0.07	0.06
	(0.03)	(0.02)	(0.03)	(0.03)	(0.02)	(0.03)	(0.07)	(0.05)
2SLS* (PME)	0.42***	0.27***	0.20***	0.09***	0.03*	-0.01	0.004	0.01
	(0.04)	(0.03)	(0.04)	(0.02)	(0.02)	(0.02)	(0.07)	(0.05)
2SLS** (PME)	0.62***	0.37***	0.27**	0.08*	-0.01	-0.04	-0.07	-0.03
	(0.04)	(0.05)	(0.08)	(0.04)	(0.03)	(0.06)	(0.08)	(0.12)
Formal workers								
OLS (PNAD)	0.33***	0.45***	0.42***	0.38***	0.20***	0.15***	0.14**	0.10
	(0.08)	(0.09)	(0.08)	(0.10)	(0.05)	(0.05)	(0.06)	(0.11)
OLS (PME)	0.50***	0.33***	0.27***	0.19***	0.12***	0.002	0.04	0.113
	(0.02)	(0.03)	(0.04)	(0.02)	(0.03)	(0.02)	(0.02)	(0.10)
2SLS* (PME)	0.46***	0.26***	0.19***	0.10***	0.04*	-0.06**	-0.04**	0.06
	(0.02)	(0.04)	(0.05)	(0.02)	(0.02)	(0.02)	(0.01)	(0.10)
2SLS** (PME)	0.53***	0.43***	0.25*	0.26***	0.10**	-0.03	-0.10	0.03
	(0.06)	(0.11)	(0.11)	(0.06)	(0.03)	(0.05)	(0.09)	(0.07)

Source: PNAD, PME and MTE data from 2002 to 2016. Detailed information on the procedure to obtain these estimates can be found in the footnote of Table 1. For all samples, the instruments are jointly significant and pass SW (Sanderson and Windmeijer (2015)) test for weak instruments and underidentification. Standard errors in parenthesis are clustered by region. Significant at 1 percent ***, at 5 percent ** and at 10 percent *.

Table 6: OLS and 2SLS Estimates between Log(p)-Log(60th) and Log(min.wage)-Log(60th) by Groups of Workers, Females.

Percentiles	10th	20th	30th	40th	50th	70th	80th	90th
All workers								
OLS (PNAD)	0.87***	0.80***	0.55***	0.37***	0.26***	0.27***	0.12	0.27**
	(0.17)	(0.21)	(0.12)	(0.11)	(0.07)	(0.08)	(0.11)	(0.11)
OLS (PME)	0.48***	0.44***	0.36***	0.26***	0.16***	-0.01	0.06	0.13**
	(0.10)	(0.06)	(0.04)	(0.04)	(0.04)	(0.01)	(0.05)	(0.05)
2SLS* (PME)	0.48***	0.41***	0.32***	0.21***	0.10*	-0.04**	0.02	0.10
	(0.12)	(0.06)	(0.04)	(0.05)	(0.05)	(0.02)	(0.04)	(0.06)
2SLS** (PME)	0.51***	0.52***	0.38***	0.22***	0.13	-0.01	0.10	0.14
	(0.10)	(0.09)	(0.05)	(0.05)	(0.07)	(0.03)	(0.06)	(0.08)
Salary workers								
OLS (PNAD)	1.19***	1.04***	0.53***	0.38***	0.32***	0.32***	0.23**	0.38***
	(0.24)	(0.20)	(0.15)	(0.14)	(0.08)	(0.09)	(0.11)	(0.14)
OLS (PME)	0.56***	0.50***	0.37***	0.30***	0.14***	-0.04*	0.07	0.21**
	(0.04)	(0.09)	(0.03)	(0.05)	(0.03)	(0.02)	(0.05)	(0.07)
2SLS* (PME)	0.54***	0.47***	0.32***	0.24**	0.07	-0.09**	0.01	0.13
	(0.04)	(0.10)	(0.05)	(0.07)	(0.04)	(0.03)	(0.05)	(0.09)
2SLS** (PME)	0.61***	0.45***	0.31***	0.22***	0.06	-0.08	0.03	0.18
	(0.02)	(0.08)	(0.05)	(0.05)	(0.04)	(0.06)	(0.09)	(0.10)
Formal workers								
OLS (PNAD)	0.50***	0.40***	0.39***	0.29***	0.23***	-0.08	-0.06	-0.17
	(0.08)	(0.08)	(0.08)	(0.05)	(0.06)	(0.09)	(0.13)	(0.15)
OLS (PME)	0.62***	0.50***	0.37***	0.30***	0.17***	0.02	0.10	0.14**
	(0.05)	(0.05)	(0.03)	(0.05)	(0.03)	(0.04)	(0.09)	(0.06)
2SLS* (PME)	0.58***	0.44***	0.29***	0.20***	0.08***	-0.06	0.02	0.02
	(0.05)	(0.05)	(0.05)	(0.06)	(0.03)	(0.04)	(0.11)	(0.07)
2SLS** (PME)	0.60***	0.43***	0.37***	0.14	0.07	0.02	0.15	0.16*
	(0.09)	(0.11)	(0.03)	(0.08)	(0.05)	(0.08)	(0.08)	(0.08)

Source: PNAD, PME and MTE data from 2002 to 2016. Detailed information on the procedure to obtain these estimates can be found in the footnote of Table 1. For all samples, the instruments are jointly significant and pass SW (Sanderson and Windmeijer (2015)) test for weak instruments and underidentification. Standard errors in parenthesis are clustered by region. Significant at 1 percent ***, at 5 percent ** and at 10 percent *.

Table 7: First Stage Estimates for 2SLS Specifications, PME.

Specification	**All Workers**		**Salary Workers**		**Formal Workers**	
	mw_{rt}	mw_{rt}^2	mw_{rt}	mw_{rt}^2	mw_{rt}	mw_{rt}^2
2SLS*						
$log(min.wage_t) - log(w_{r,t-3}^{60})$	0.73***	-0.04	0.74***	-0.02	0.81***	-0.07
	(0.09)	(0.06)	(0.08)	(0.06)	(0.10)	(0.07)
$[log(min.wage_t) - log(w_{r,t-3}^{60})]^2$	0.10	0.88***	0.10	0.86***	0.05	0.87***
	(0.07)	(0.07)	(0.06)	(0.06)	(0.07)	(0.06)
$F\ statistic$	101.0***	57.7***	91.9***	61.4***	198.7***	109.8***
$p\ value$	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
$SW\ Chi\ sq\ Underid.\ test$	210.8***	162.2***	169.4***	149.5***	548.1***	465.4***
$p\ value$	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
$SW\ F\ Weak\ id.\ test$	171.43***	131.91***	137.8***	121.6***	445.8***	378.5***
$p\ value$	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
2SLS**						
F_{rt}	-0.30	0.95**	-0.25	0.90**	-0.45**	1.18***
	(0.22)	(0.38)	(0.24)	(0.37)	(0.18)	(0.30)
F_{rt}^2	-0.26	0.19	-0.21	0.12	0.15	-0.39
	(0.30)	(0.47)	(0.36)	(0.58)	(0.29)	(0.51)
$F_{rt} \times mean\ log(w_r^{60})$	0.30***	-0.64***	0.26***	-0.58***	0.26***	-0.60***
	(0.04)	(0.10)	(0.05)	(0.07)	(0.06)	(0.09)
$F\ statistic$	1080.7***	463.4***	1615.2***	901.6***	192.6***	196.9***
$p\ value$	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
$SW\ Chi\ sq\ Underid.\ test$	139.0***	91.8***	47.1***	34.2***	47.6***	33.2***
$p\ value$	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
$SW\ F\ Weak\ id.\ test$	56.5***	37.3***	19.1***	13.9***	19.3***	13.5***
$p\ value$	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.01)

Source: PME and MTE data from March 2002 to February 2016. The dependent variables are the log of the effective minimum wage, *mw=log(min. wage)-log(60th),* and its square. All regressions include time and region fixed effects, and region-specific trends. Regressions are weighted by the product between weekly working hours and PME sample weights. F-statistics and SW (Sanderson and Windmeijer (2015)) tests for underidentification and weak identification along with their associated p-values are reported. Standard errors in parenthesis are clustered by region. Significant at 1 percent ***, at 5 percent ** and at 10 percent *.

Table 8: OLS estimates of the Minimum Wage Effects on Employment, Working Hours and Working Hours if Employed, Males.

Effects	Total Employment			Formal Employment		
	Employment	Working Hours	Hours if Employed	Employment	Working Hours	Hours if Employed
Contemporaneous						
F_{rt}	0.0090**	0.0025	-0.0017*	-0.0028	-0.0002	-0.0015
	(0.0035)	(0.0022)	(0.0010)	(0.0122)	(0.0052)	(0.0049)
L. one quarter						
F_{rt}	0.0090**	0.0024	-0.0018**	-0.0017	0.0001	-0.0008
	(0.0043)	(0.0023)	(0.0008)	(0.0114)	(0.0050)	(0.0047)
Summed effect	-0.0057***	-0.0043***	-0.0019**	-0.0002	-0.0001	0.0001
	(0.0016)	(0.0013)	(0.0009)	(0.0039)	(0.0017)	(0.0013)
L. two quarters						
F_{rt}	0.0085**	0.0022	-0.0017**	-0.0007	0.0005	-0.0004
	(0.0037)	(0.0019)	(0.0007)	(0.0111)	(0.0049)	(0.0045)
Summed effect	-0.0218***	-0.0122***	-0.0027**	-0.0103	-0.0051	-0.0025
	(0.0068)	(0.0039)	(0.0012)	(0.0103)	(0.0047)	(0.0043)
L. three quarters						
F_{rt}	0.0090**	0.0025	-0.0016***	0.0023	0.0017	0.0008
	(0.0042)	(0.0020)	(0.0005)	(0.0110)	(0.0049)	(0.0044)
Summed effect	-0.0368***	-0.0207***	-0.0047***	-0.0240	-0.0113	-0.0073
	(0.0103)	(0.0058)	(0.0016)	(0.0156)	(0.0072)	(0.0057)

Source: PME data from March 2002 to February 2016. Detailed information on the procedure to obtain these estimates can be found in the footnote of Table 3. Standard errors in parenthesis are clustered by region. Significant at 1 percent ***, at 5 percent ** and at 10 percent *.

Table 9: OLS estimates of the Minimum Wage Effects on Employment, Working Hours and Working Hours if Employed, Females.

Effects	Total Employment			Formal Employment		
	Employment	Working Hours	Hours if Employed	Employment	Working Hours	Hours if Employed
Contemporaneous						
F_{rt}	0.0046*	0.0005	-0.0014*	-0.0097***	-0.0038***	-0.0054***
	(0.0026)	(0.0014)	(0.0008)	(0.0026)	(0.0012)	(0.0010)
L. one quarter						
F_{rt}	0.0051*	0.0005	-0.0016***	-0.0078***	-0.0029***	-0.0045***
	(0.0026)	(0.0012)	(0.0004)	(0.0017)	(0.0006)	(0.0005)
Summed effect	-0.0068***	-0.0039***	-0.0013***	-0.0007	-0.0001	-0.0000
	(0.0025)	(0.0012)	(0.0004)	(0.0071)	(0.0026)	(0.0031)
L. two quarters						
F_{rt}	0.0061**	0.0010	-0.0015***	-0.0038	-0.0014***	-0.0031***
	(0.0026)	(0.0010)	(0.0004)	(0.0025)	(0.0005)	(0.0007)
Summed effect	-0.0152***	-0.0063***	-0.0003	0.0016	0.0004	0.0028
	(0.0037)	(0.0018)	(0.0008)	(0.0128)	(0.0050)	(0.0056)
L. three quarters						
F_{rt}	0.0058**	0.0013	-0.0011***	-0.0043**	-0.0017	-0.0037***
	(0.0029)	(0.0011)	(0.0004)	(0.0019)	(0.0011)	(0.0012)
Summed effect	-0.0268***	-0.0082***	0.0026**	0.0006	-0.0004	0.0033
	(0.0047)	(0.0022)	(0.0012)	(0.0088)	(0.0038)	(0.0039)

Source: PME data from March 2002 to February 2016. Detailed information on the procedure to obtain these estimates can be found in the footnote of Table 3. Standard errors in parenthesis are clustered by region. Significant at 1 percent ***, at 5 percent ** and at 10 percent *.

Table 10: Robustness Checks: OLS and 2SLS Estimates between Log(p)-Log(60th) and Log(min.wage)-Log(60th) by Groups of Workers, for Selected Percentiles.

Percentiles	**10th**	**20th**	**30th**	**40th**	**50th**	**70th**	**80th**	**90th**
All workers								
OLS (PNAD)	0.63***	0.54**	0.50***	0.35***	0.39***	0.23***	0.34***	0.40***
	(0.16)	(0.21)	(0.10)	(0.06)	(0.07)	(0.06)	(0.10)	(0.09)
OLS (PME)	0.47***	0.42***	0.25***	0.24***	0.15***	0.04***	0.17***	0.21***
	(0.05)	(0.04)	(0.03)	(0.02)	(0.02)	(0.01)	(0.03)	(0.03)
2SLS* (PME)	0.42***	0.39***	0.20***	0.15***	0.09***	-0.01	0.08	0.05
	(0.05)	(0.06)	(0.02)	(0.02)	(0.02)	(0.02)	(0.05)	(0.05)
2SLS** (PME)	0.49***	0.47***	0.24**	0.11	0.07	0.02	0.12	0.08
	(0.08)	(0.06)	(0.07)	(0.09)	(0.05)	(0.08)	(0.09)	(0.07)
Salary workers								
OLS (PNAD)	0.81***	0.75***	0.66***	0.45***	0.43***	0.28***	0.41***	0.33***
	(0.15)	(0.14)	(0.06)	(0.06)	(0.08)	(0.06)	(0.07)	(0.10)
OLS (PME)	0.55***	0.43***	0.28***	0.20***	0.15***	0.02*	0.11**	0.14***
	(0.06)	(0.04)	(0.03)	(0.02)	(0.02)	(0.01)	(0.04)	(0.03)
2SLS* (PME)	0.50***	0.36***	0.22***	0.10***	0.07***	-0.01	0.01	-0.01
	(0.06)	(0.04)	(0.04)	(0.02)	(0.02)	(0.02)	(0.05)	(0.05)
2SLS** (PME)	0.62***	0.48***	0.18*	0.08	0.04	-0.08	-0.02	-0.08
	(0.08)	(0.07)	(0.09)	(0.06)	(0.05)	(0.10)	(0.06)	(0.13)
Formal workers								
OLS (PNAD)	0.50***	0.28***	0.34***	0.44***	0.30***	0.24***	0.12	0.07
	(0.07)	(0.09)	(0.09)	(0.12)	(0.06)	(0.07)	(0.09)	(0.16)
OLS (PME)	0.50***	0.36***	0.30***	0.22***	0.18***	0.03**	0.11***	0.15**
	(0.01)	(0.03)	(0.05)	(0.02)	(0.01)	(0.01)	(0.02)	(0.06)
2SLS* (PME)	0.43***	0.27***	0.20***	0.10**	0.09**	-0.07	0.02	0.04
	(0.01)	(0.03)	(0.05)	(0.04)	(0.03)	(0.04)	(0.04)	(0.08)
2SLS** (PME)	0.40***	0.17**	0.10	0.01	-0.03	-0.05	-0.05	-0.09
	(0.04)	(0.07)	(0.08)	(0.05)	(0.09)	(0.05)	(0.05)	(0.14)

Source: PNAD, PME and MTE data from 2002 to 2016. The estimates in the table are obtained by adding labour supply controls to the specification in equation (3). Detailed information on the procedure to obtain these estimates can be found in the footnote of Table 1. Standard errors in parenthesis are clustered by region. Significant at 1 percent ***, at 5 percent ** and at 10 percent *.

Table 11: Robustness Checks: OLS Estimates of the Minimum Wage Effects on Employment, Working Hours and Working Hours if Employed, PME 2002-2016.

Effects	Total Employment			Formal Employment		
	Employment	Working Hours	Hours if Employed	Employment	Working Hours	Hours if Employed
Contemporaneous						
F_{rt}	0.0030	0.0007	-0.0006	-0.0003	-0.0006	-0.0007
	(0.0031)	(0.0011)	(0.0008)	(0.0010)	(0.0005)	(0.0005)
L. one quarter						
F_{rt}	0.0029	0.0004	-0.0009	-0.0001	-0.0004	-0.0006
	(0.0035)	(0.0013)	(0.0008)	(0.0010)	(0.0004)	(0.0005)
Summed effect	0.0003	0.0000	-0.0001	-0.0027*	-0.0012*	-0.0000
	(0.0029)	(0.0011)	(0.0006)	(0.0015)	(0.0006)	(0.0005)
L. two quarters						
F_{rt}	0.0030	0.0005	-0.0008	0.0006	-0.0000	-0.0004
	(0.0035)	(0.0014)	(0.0009)	(0.0013)	(0.0005)	(0.0004)
Summed effect	-0.0078***	-0.0037***	-0.0005	-0.0086***	-0.0033***	0.0000
	(0.0020)	(0.0011)	(0.0008)	(0.0025)	(0.0008)	(0.0007)
L. three quarters						
F_{rt}	0.0039	0.0010	-0.0006	0.0006	-0.0001	-0.0004
	(0.0034)	(0.0014)	(0.0009)	(0.0012)	(0.0005)	(0.0005)
Summed effect	-0.0117***	-0.0059***	-0.0010	-0.0138**	-0.0052***	0.0004
	(0.0029)	(0.0018)	(0.0010)	(0.0055)	(0.0018)	(0.0005)

Source: PME data from March 2002 to February 2016. The estimates in the table are obtained by adding labour supply controls to the specification in equation (4). Detailed information on the procedure to obtain these estimates can be found in the footnote of Table 3. Standard errors in parenthesis are clustered by region. Significant at 1 percent ***, at 5 percent ** and at 10 percent *.

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