

Minimum Wage Policy and Employment Effects: Evidence from Brazil

The aim of minimum wage increases is to change the shape of the wage distribution without destroying jobs. While it is well established in the international literature that the minimum wage compresses the wage distribution, there is no consensus on the direction and size of the effect on employment.¹ This literature greatly lacks empirical evidence for Latin America. The present paper provides evidence on the minimum wage effect using a key Latin American country. I estimate the effects of the minimum wage on wages and employment using panel data techniques and monthly Brazilian household data from 1982 to 2000 at the individual and regional levels. The paper applies modern econometrics techniques to Brazilian data and extends the current understanding on the effects of minimum wages in Latin America. This paper also provides some guidance to policymaking, especially in light of the recent promises by several South American governments to increase the minimum wage.²

Minimum wage policy is a distinctive and central feature of the Brazilian economy. It has been used not only as a social policy, but also as an

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1. Brown (1999).

2. "Talking Victory," *Economist*, 24 October 2002; "Fixing the Finances," *Economist*, 20 February 2003.

anti-inflationary policy. For example, the minimum wage has served as an axis for coordinating the government's centralized wage policy and also as a signal for price and wage bargains.³ The minimum wage thus affects employment both directly and indirectly, through wages, pensions, benefits, inflation, and the public deficit. This confirms the importance of studying the minimum wage in Brazil. Furthermore, minimum wage increases in Brazil are large and frequent, unlike the typically small increases studied in most of the literature.⁴ Studying such increases opens the possibility of observing the negative effects predicted by standard theory and thus verifying the link between empirical data and theoretical models of the minimum wage.

This paper discusses three key conceptual and identification issues. First, it summarizes various minimum wage variables available in the literature and uses them to estimate wages and employment effects. Second, it estimates nonparametric kernel wage distributions before and after a minimum wage hike to illustrate the minimum wage compression effect; it then uses regression models to estimate the wage effect across different percentiles of the distribution. Third, it estimates the effect of the minimum wage on both hours per worker and the number of jobs, which together make up the total hours effect.

Robust results indicate that an increase in the minimum wage strongly compresses the wage distribution with small negative effects on employment in Brazil. The total effect is no more than -0.05 percent in the long run, and it appears to be dominated by the hours effect. In the short run, a 10 percent increase in the minimum wage was found to decrease total hours by no more than 0.16 percent, which decomposes into a 0.14 percent decrease in hours per worker and a 0.02 percent decrease in jobs. These last two estimates, however, are not statistically different from zero. A cautious reading is that the minimum wage does not have an adverse employment effect and to the extent it does, the effect is small. First, it is small when compared with the -1.0 percent effect in the international literature, especially considering that Brazil has larger wage effects than other countries. Second, the minimum wage affects workers primarily through the number of hours per worker, not the number of jobs; this

3. Camargo (1984); Carneiro and Faria (1998).

4. Deere, Murphy, and Welch (1996); Hamermesh (2002); Castillo-Freeman and Freeman (1992).

implies that any negative effects of a minimum wage are not focused where they would hurt the most—namely, through increased layoffs. The main policy implication of these results is that the minimum wage can be used as a policy against inequality without causing large job losses in Brazil.

The paper is organized as follows. The next section provides a brief literature review. The subsequent section presents the minimum wage institutional background and describes the data. The following section defines minimum wage variables and presents wage models, which motivate a discussion on identification and robustness checks. A section on employment effects opens with a decomposition of the total effects into an hours-per-worker effect and a jobs effects, and then presents the employment models and robustness checks. A discussion of the evidence follows, and a final section concludes.

Literature Review

The effect of the minimum wage on other wages is positive because workers bargain to maintain their relative wages and because firms demand an increased level of skill.⁵ Its magnitude varies across the wage distribution because different occupations have different comparison groups.⁶ The effect is larger at lower percentiles than at higher levels, such that the minimum wage compresses the distribution.⁷

While the literature clearly establishes the compression effect, no consensus has been reached on the direction of the effect of the minimum wage on employment. The old debate between the neoclassical Stigler and the revisionist Lester has recently been reawakened after lying dormant since the early 1980s in an apparent consensus.⁸ The 1980s consensus, in line with standard theory, centered on a modest negative significant effect: increasing the minimum wage by 10 percent would decrease employment by 1–3 percent.⁹ Now, however, a number

5. Grossman (1983).

6. Grossman (1983); Akerlof (1982, 1984).

7. Brown (1999).

8. Stigler (1946); Lester (1946).

9. Brown, Gilroy, and Kohen (1982).

of studies estimate negative effects, while others report nonnegative effects.¹⁰

The current literature also addresses the international evidence for developing countries.¹¹ Comparisons across studies are not straightforward, not only because they use different techniques, data periods, and data sources—as is also the case in the literature on developed countries—but also because the effect of the minimum wage on wages and employment depends on the minimum wage level (and enforcement) and on the labor market particularities and institutions in each country. The observed wage distribution compression effect is a lot stronger in Latin America than in developed countries.¹² As a result, the employment effect is also stronger: a 10 percent increase in the minimum wage decreases employment by up to 12 percent across the available studies.¹³ This is substantially larger than the U.S. employment effect. Nevertheless, while it is relatively safe to conclude that employment effects are larger in Latin America than in developed countries, care should be taken when considering their magnitude. Few point estimates are available (only one or two studies for each country), and the variance across the range of estimates is high (as a result of substantial institutional differences).

Studies for Brazil find that an increase in the minimum wage compresses the wage distribution and has a small adverse employment effect.¹⁴ A 10 percent increase in the minimum wage decreases employ-

10. For example, Neumark and Wascher (1992, 2000), Deere, Murphy, and Welch (1995, 1996), and Burkhauser, Couch, and Wittenburg (2000) find negative effects; Card and Krueger (1995, 2000), Machin, Rahman, and Manning (2003), and Dickens, Machin, and Manning (1999) find nonnegative effects.

11. Card and Krueger (1995); Ghellab (1998); Cunningham (2002); Saget (2001); Maloney and Mendez (2004).

12. See Maloney and Mendez (2004) for evidence across South American countries; Gregory (1981) and El-Hamidi and Terrell (2001) for Costa Rica; and Angel-Urdinola (2002) for Colombia.

13. For evidence on Mexico, see Villarreal (1998); Bell (1997); Feliciano (1998). For Puerto Rico, see Reynolds and Gregory (1965); Rottenberg (1981); Castillo-Freeman and Freeman (1992). For Costa Rica, see Gregory (1981); Gindling and Terrell (2002). For Chile, see Corbo (1981); Cowan and others (2004); Montenegro and Pagés (2004). For Colombia, see Bell (1997); Maloney and Mendez (2004).

14. Neri (1997); Carneiro (2000); Foguel, Ramos, and Carneiro (2001); Foguel and others (2000); Corseuil and Morgado (2001); Corseuil and Carneiro (2001); Fajnzylber (2001); Carneiro, (2002); Soares (2002); Corseuil and Servo (2002); Neumark, Cunningham, and Siga (2003).

ment by no more than 5 percent—and typically by no more than 1 percent (not always statistically significant)—across studies.¹⁵ Most of this literature uses national aggregate data to estimate average wage and employment effects by imposing restrictions on time modeling (for example, through trends), which does not ensure full identification of the minimum wage effect.

The Minimum Wage in Brazil

The minimum wage was introduced in Brazil in 1940 as a social policy to provide subsistence income (that is, diet, transport, clothing, and hygiene) for an adult worker. The associated bundle varied across regions; this was reflected in the establishment of fourteen different minimum wages, with the highest in the southeast and the lowest in the northeast.¹⁶ Wells holds that they were “generous relative to existing standards,” since about 60 to 70 percent of workers earned less than the new minimum, whereas Sabóia and Oliveira both argue that the minimum wage legitimated the low wages of unskilled workers.¹⁷ In 1984 the minimum wage became national, after slow regional convergence. The coverage of Brazil’s minimum wage legislation is full; there are no legal subminimum or differentiated minimum wage rates for specific demographic groups or labor market categories.¹⁸

After a steep decrease early on, the real minimum wage was adjusted and reached its peak during the boom of the 1950s, when productivity was high, the unions were strong, and the government was populist. It then decreased again as a result of the subsequent recession, rising inflation, and nonaggressive unions. The dictatorship that took power in 1964 associated high inflation with wage adjustments; the government limited labor organization and implemented a centralized wage policy. One of the strategies of this policy was underindexation of the real minimum wage, which transformed it “from a social policy designed to protect the worker’s living

15. This is less than 1.0 percent when I drop estimates by Corseuil and Carneiro (2001) and Corseuil and Morgado (2001).

16. Gonzaga and Machado (2002).

17. Wells (1983, p. 305); Sabóia (1984); Oliveira (1981).

18. Up to 70 percent of the minimum wage can be deducted to pay for accommodation and food costs. This accounts for some workers earning below the minimum wage, but most of these are informal sector workers.

standard into an instrument for stabilization policy.”¹⁹ The so-called lighthouse effect associated the subsequent increase in inequality revealed in the 1970 census with the post-1964 real minimum wage decrease.²⁰ With the end of the military regime, the 1988 constitution redefined the subsistence income to include diet, housing, education, health, leisure, clothing, hygiene, transport, and retirement for an adult worker and his or her family, even though this bundle was unaffordable at the prevailing minimum wage. The union movement reemerged and quickly gained strength, establishing a high union density for a developing country.²¹

According to Carneiro and Faria, the nominal minimum wage was used not only as a stabilization policy, but also as a coordinator of the wage policy.²² For example, other wages were set as multiples of the minimum wage. Another example is a policy implemented in the early 1980s, in which wages between one and three times the minimum wage were adjusted semiannually by 110 percent of the inflation rate. The goal was to create a cascade effect: the higher the worker’s position in the wage distribution, the lower was the percentage adjustment. The increases, however, immediately spilled over higher up in the wage distribution. In the presence of high inflation and distorted relative prices, rational agents took increases in the minimum wage as a signal for price and wage bargains, even after the law forbade its use as a numeraire in 1987.²³ Studies show that the lighthouse and numeraire effects are a general phenomenon in Latin America.²⁴

The real minimum wage was underindexed not only because it was associated with high inflation, but also because of its impact on the public deficit via benefits, pensions, and the government wage bill. The impact on the public deficit, along with that on inflation, were often the criteria for the affordable increase in the minimum wage.²⁵ When pressure grew, however, the government allowed increases in the nominal minimum wage, which were inflationary. This resulted in an inflation spiral. In this context, the minimum wage was alternately used as social and anti-inflationary

19. Camargo (1984, p. 19).

20. On the lighthouse effect (or *teoria do farol* in Portuguese), see Souza and Baltar (1979); Macedo and Garcia (1980).

21. Carneiro and Henley (2001).

22. Carneiro and Faria (1998).

23. Gramlich (1976); Card and Krueger (1995); Freeman (1996).

24. Maloney and Mendez (2004); Marinakis (1998).

25. Foguel, Ramos, and Carneiro (2001).

policy. The social role is most associated with populist governments, strong unions, and periods of low inflation.²⁶

The real hourly minimum wage decreased between 1982 and 2000, from a high in November 1982—before the acceleration of inflation—to a low in August 1991 (see the data section, below). The 1980s and 1990s witnessed an exhausting battle against inflation. Five stabilization plans outlined different nominal minimum wage indexation rules depending on the inflation level. Nominal minimum wage increases were large and frequent, but they were quickly eroded by the subsequent inflation. The minimum wage has not explicitly been used as an anti-inflationary policy since the mid-1990s, when inflation became reasonably stable.

The Data

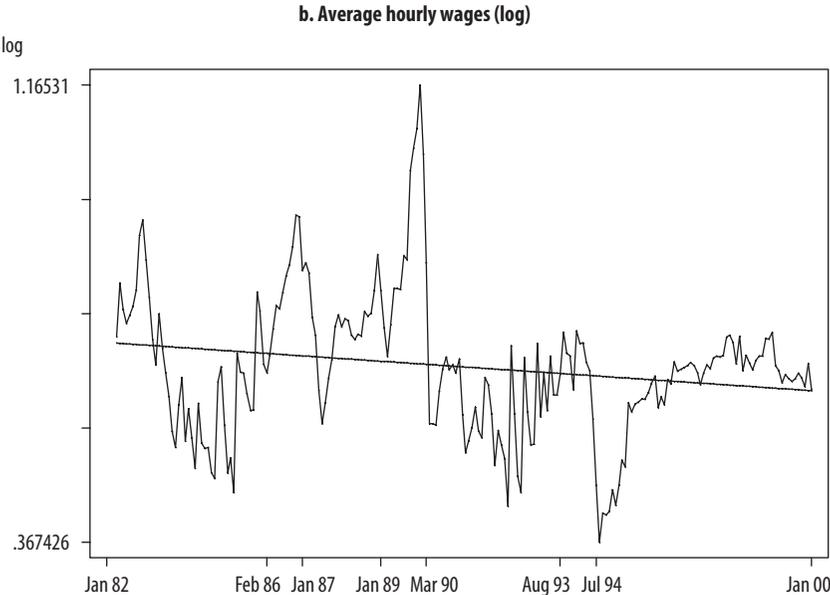
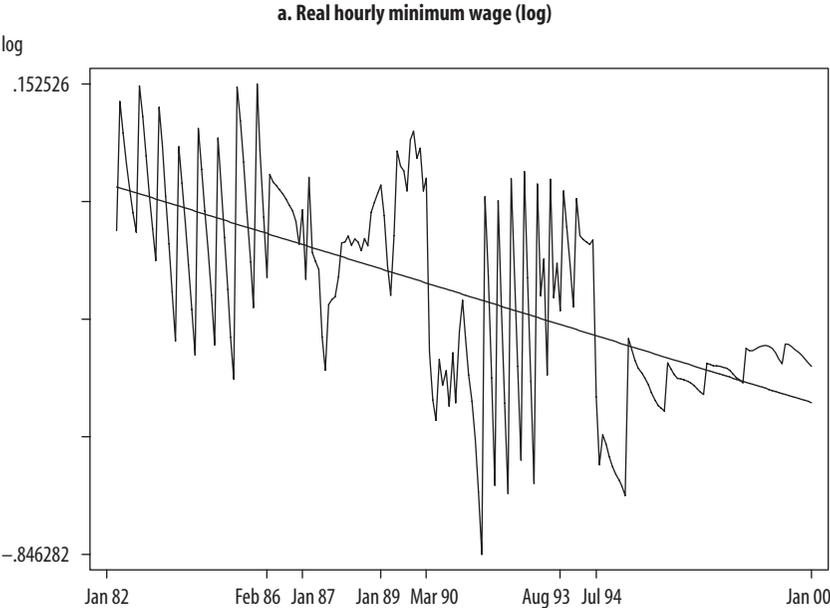
The data I use are from Brazil's monthly employment survey (PME), which is similar to the U.S. Current Population Survey. For the survey, the Brazilian Geographical and Statistical Institute (IBGE) collected over 21 million observations between 1982 and 2000, across the six main Brazilian metropolitan regions: Bahia, Pernambuco, Rio de Janeiro, São Paulo, Minas Gerais, and Rio Grande do Sul. The monthly periodicity is important because wage bargains during the sample period occurred annually, semiannually, and monthly. The regional consumer price index (IPC) is used as the deflator.

Figure 1 plots the real minimum wage and the average wage for the average of the wage distribution over time.²⁷ (The horizontal axis in figures 1, 3, 4, and 5 shows the timing of the various stabilization plans.) The minimum wage is most strongly correlated with the lower percentiles; this is confirmed by correlations in the national aggregate of 0.78 and 0.73 for the twenty-fifth and seventy-fifth percentiles. Regional variation is considerable: these correlations in the poor Pernambuco region are 0.95 and 0.36 for the twenty-fifth and seventy-fifth percentiles, respectively, versus 0.78 and 0.55 in the rich São Paulo region. Figure 2 plots the employment

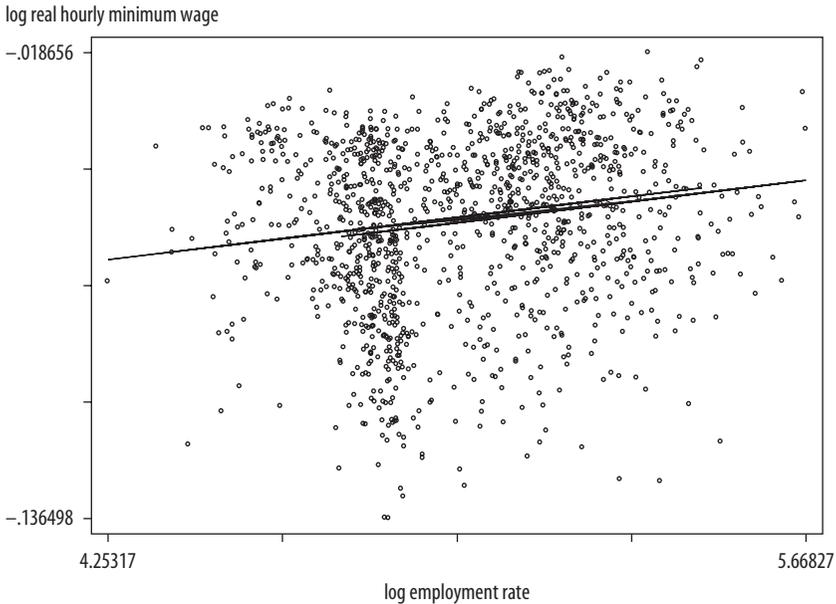
26. Velloso (1990).

27. The hourly minimum wage rate is obtained by dividing the monthly minimum wage by 48×4.3 through September of 1988 and by 44×4.3 thereafter, because the new constitution shortened the work week. The hourly wage rate is the quotient of monthly earnings and the number of hours worked per week multiplied by 4.3.

FIGURE 1. The Minimum Wage and the Average Hourly Wages in Brazil, 1982–2000



Source: Author's calculations.

FIGURE 2 . The Employment Rate and the Minimum Wage

Source: Author's calculations.

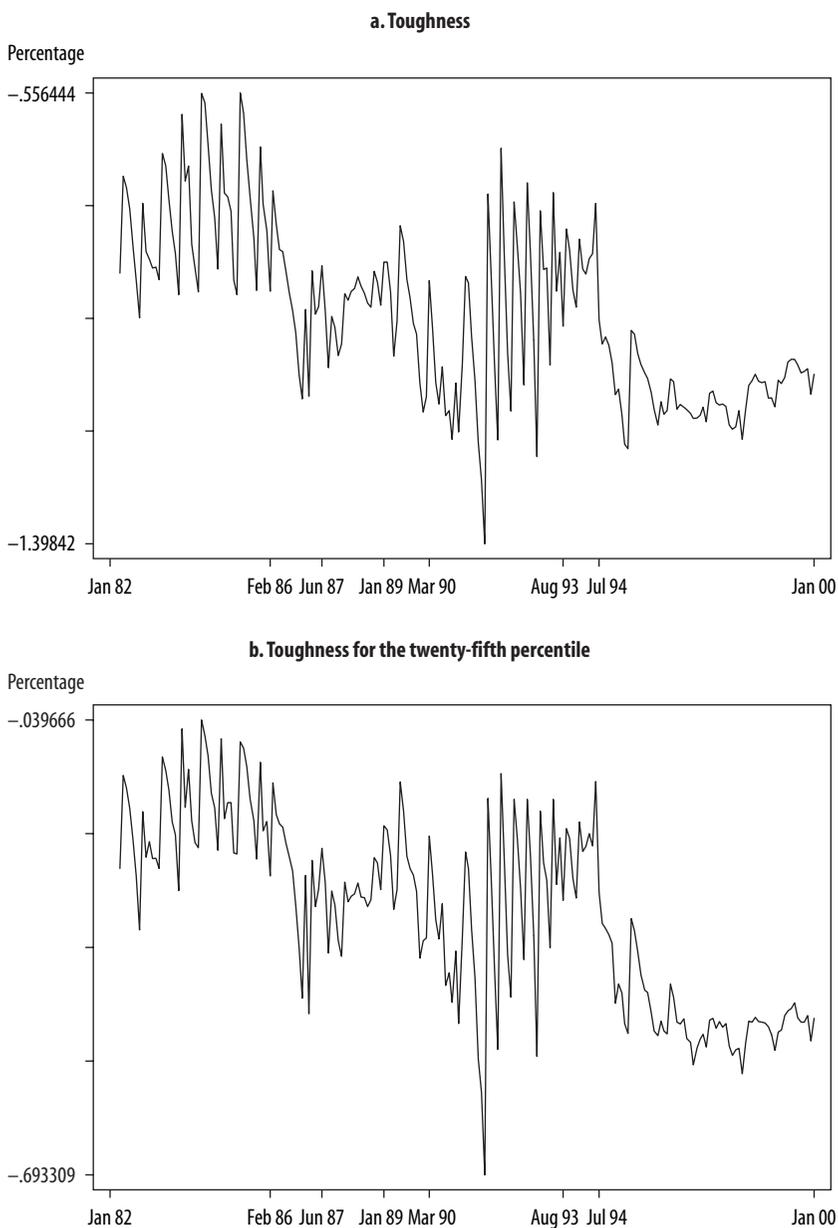
rate against the real minimum wage. The positive correlation between the two in levels (0.16) remains robust when the data are first differenced (0.12). For Pernambuco and São Paulo, the correlations in first difference are 0.12 and 0.07, respectively.

The Minimum Wage Effect on the Wage Distribution

The most common technique in the literature for relating the minimum wage to other wages is to use the ratio of the minimum wage to the average wages adjusted for coverage of the minimum wage. This measure is called the Kaitz index, although some authors also refer to it, intuitively, as a measure of the toughness of the minimum wage.²⁸ Figure 3 plots the log of toughness, whose correlation with the log of the real minimum wage

28. Kaitz (1970); Machin and Manning (1994).

FIGURE 3 . Minimum Wage Variables in Brazil, 1982–2000: Toughness^a



Source: Author's calculations.

a. The toughness variable represents the ratio of the minimum wage to the average wage adjusted for coverage of the minimum wage (the Kaizt index); its correlation with the log of the real minimum wage in the national aggregate is 0.81. Toughness for the twenty-fifth percentile is the ratio of the minimum wage to the average wage for the twenty-fifth percentile of the wage distribution; its correlation with the log of the real minimum wage in the national aggregate is 0.80.

in the national aggregate is 0.81. Card and Krueger find that in the United States the ratio follows a path similar to that of the minimum wage, while Dickens, Machin, and Manning get the same result for the United Kingdom.²⁹ The Kaitz index was 0.39 and 0.40 for the United States and the United Kingdom, respectively, in 1993.³⁰ It was 0.27 for Brazil, although 0.45 in Pernambuco.

I further define the ratio of the minimum wage to the median wage distribution (that is, the fiftieth percentile) and to the twenty-fifth percentile of the wage distribution. The log of median toughness is a good central measure of the distribution if wage inequality is substantial (as it is in Brazil), in which case the average fails to be representative.³¹ The correlation with the log of the real minimum wage in the national aggregate is 0.81 (see figure 3, panel a). At the same time, the minimum wage affects the low-wage worker far more than workers earning the average or median wage.³² This is confirmed by the 0.80 correlation of the log of toughness for the twenty-fifth percentile with the log of the real minimum wage in the national aggregate (see figure 3, panel b).

The literature also suggests other minimum wage variables, which are called degree-of-impact measures because they focus on the proportion of workers directly affected by increases in the minimum wage.³³ The first panel of figure 4 shows the fraction of workers affected—that is, the proportion of people earning a wage between the old and the new minimum wage.³⁴ The correlation with the log of the real minimum wage in the national aggregate is 0.57. The fraction affected was 7.4 percent for the United States in 1990.³⁵ It was 8.0 percent for Brazil in the same year, although it reached 49.0 percent in Pernambuco. Because the fraction is zero when the nominal minimum wage is constant, I also measured the fraction of workers affected using real wages. This real fraction is positive when the nominal minimum wage increases, such that the real minimum wage also increases, but it is negative when the nominal minimum wage is constant, meaning that the real minimum wage decreases (via inflation

29. Card and Krueger (1995); Dickens, Machin, and Manning (1999).

30. Dolado and others (1996).

31. Fernandes and Menezes-Filho (2000).

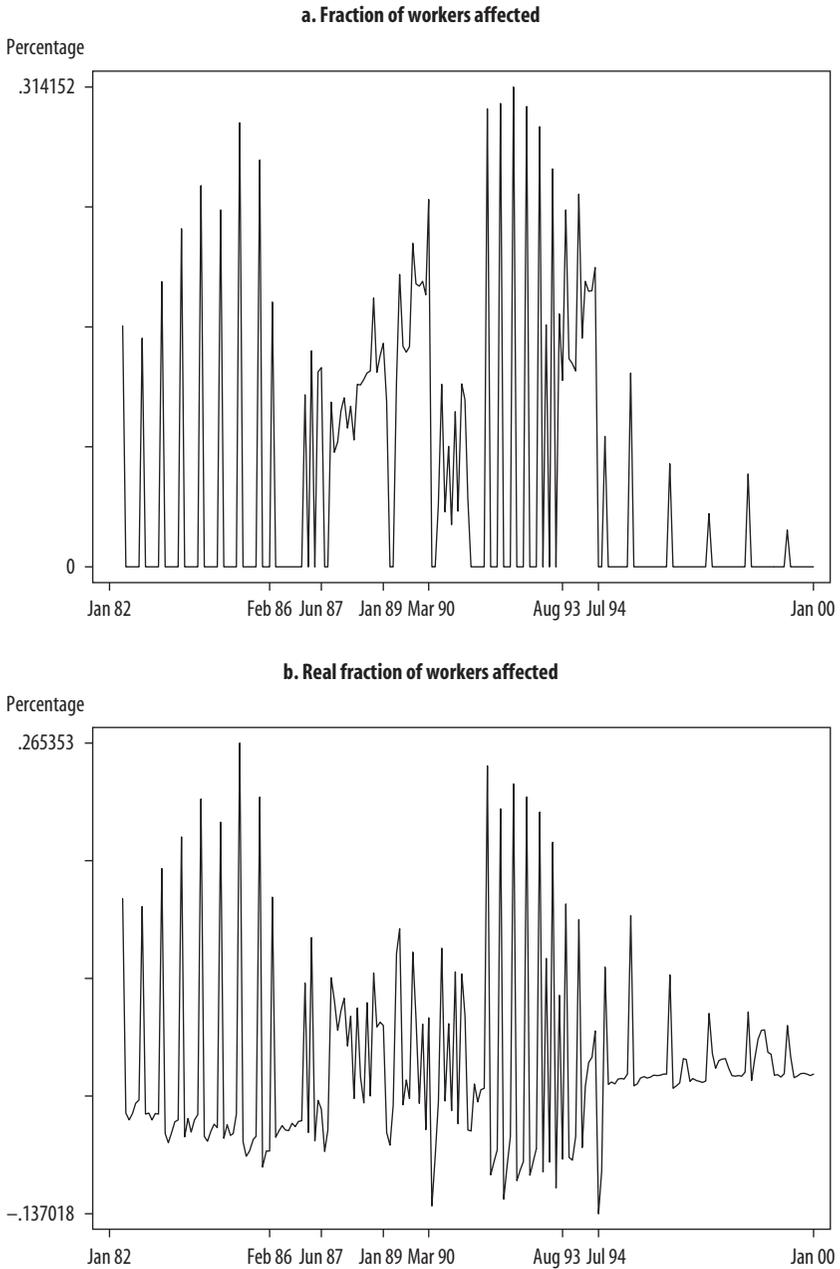
32. Deere, Murphy, and Welch (1996).

33. Brown (1999).

34. Card (1992).

35. Card and Krueger (1995).

FIGURE 4. Minimum Wage Variables in Brazil, 1982–2000: Fraction of Workers Affected^a



Source: Author's calculations.

a. The correlation of the fraction of workers affected with the log of the real minimum wage in the national aggregate is 0.57; that of the real fraction is 0.36.

erosion). The second panel of figure 4 shows that the real fraction varies more than the nominal fraction, although it has a lower correlation with the log of the real minimum wage in the national aggregate (0.36).

A measure closely related to the fraction of workers affected is the spike in the wage distribution generated by the minimum wage. The first panel of figure 5 plots the spike, that is, the proportion of people earning one minimum wage.³⁶ The correlation with the log of the real minimum wage in the national aggregate is 0.64. The spike moves in response to the minimum wage: it increases following a rise in the minimum wage and is then reduced as different categories of workers bargain to pull out of the minimum wage.³⁷ This is particularly the case if inflation is high and the minimum wage is constant. Whereas figure 5 (panel a) shows the spike over time for the full sample, figure 6 shows the monthly spike in the earnings distribution for Pernambuco in May and September 1992. The spike was 4 percent for the United States in 1993.³⁸ It was 12 percent for Brazil as a whole that year, but it was 25 percent in Pernambuco.³⁹

Because Brazilian workers use the minimum wage as a numeraire and price index, Neri, Gonzaga, and Camargo expand the spike measure to encompass those earning 0.5, 1.0, 1.5, 2.0, 2.5, and 3.0 times the minimum wage.⁴⁰ I call this measure multiples (see figure 5, panel b). Its correlation with the log of the real minimum wage in the national aggregate is 0.31. Figures almost as large as 20 percent are observed. A related measure is the proportion of people earning the minimum wage or below, which I call the spike and below (see figure 5, panel c).⁴¹ The correlation of this measure with the log of the real minimum wage in the national aggregate is 0.77. This measure closely tracks the real minimum wage. It also varies widely by region, for example, the poor region of Bahia registers a figure of 44 percent.

36. Dolado and others (1996).

37. Card and Krueger (1995).

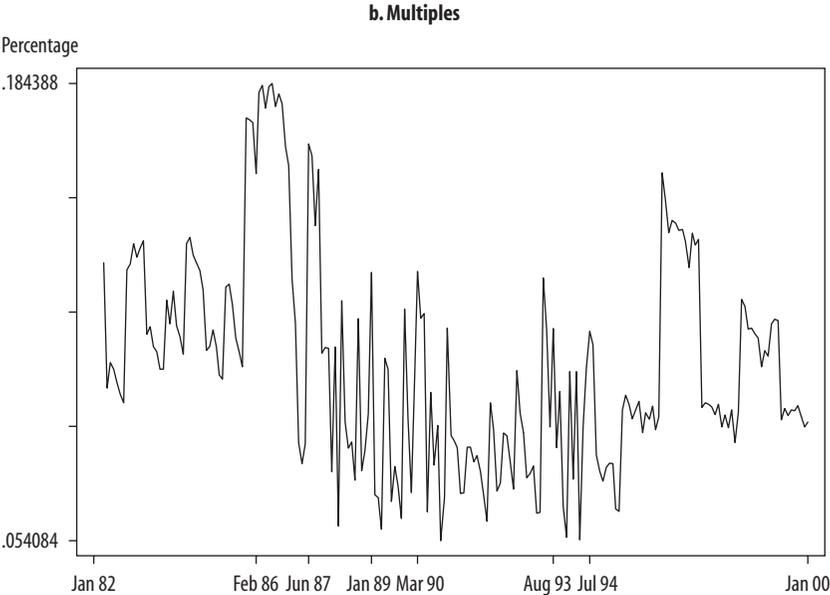
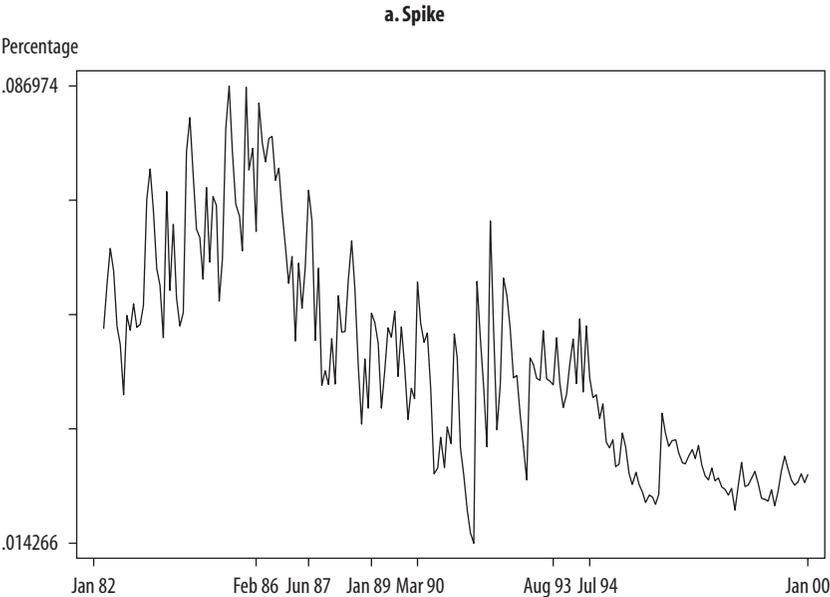
38. Dolado and others (1996).

39. As in figures 4 and 5, spike is here defined using real earnings rather than real hourly wages, which is used elsewhere in the paper. The monthly definition produces larger spikes because workers earning one monthly minimum wage but working shorter (longer) hours than the typical work week earn above (below) one hourly minimum wage. The associated measurement error was not severe, and the estimation results were robust to either definition.

40. Neri, Gonzaga, and Camargo (1999)

41. Dolado and others (1996).

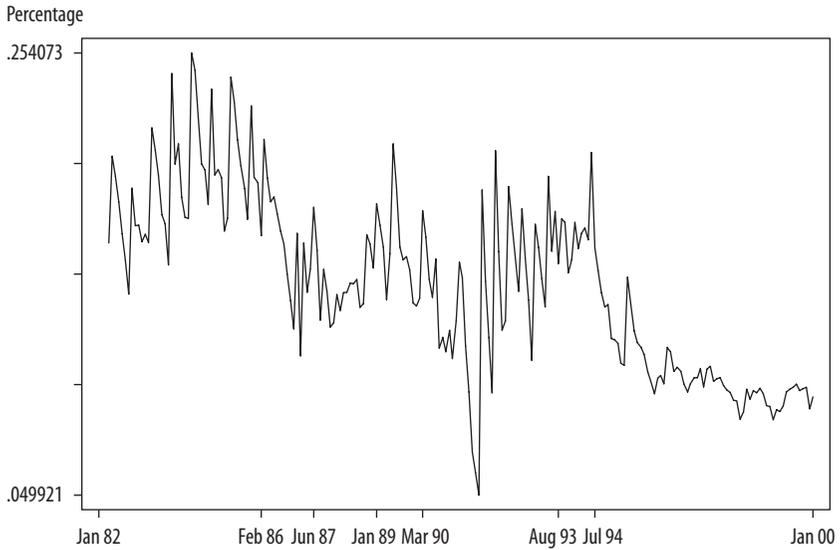
FIGURE 5. Minimum Wage Variables in Brazil, 1982–2000: Spike, Multiples, Spike and Below, and Percentage^a



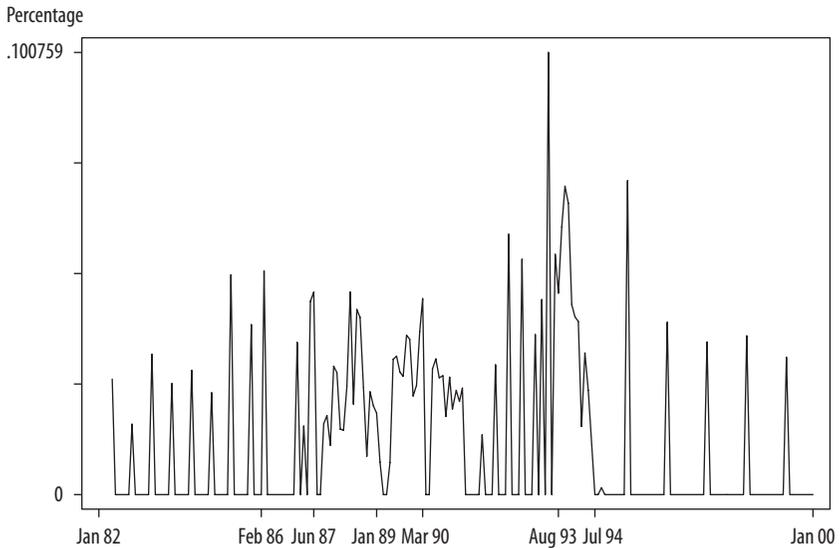
(continued)

FIGURE 5 . Minimum Wage Variables in Brazil, 1982–2000: Spike, Multiples, Spike and Below, and Percentage^a (continued)

c. Spike and Below



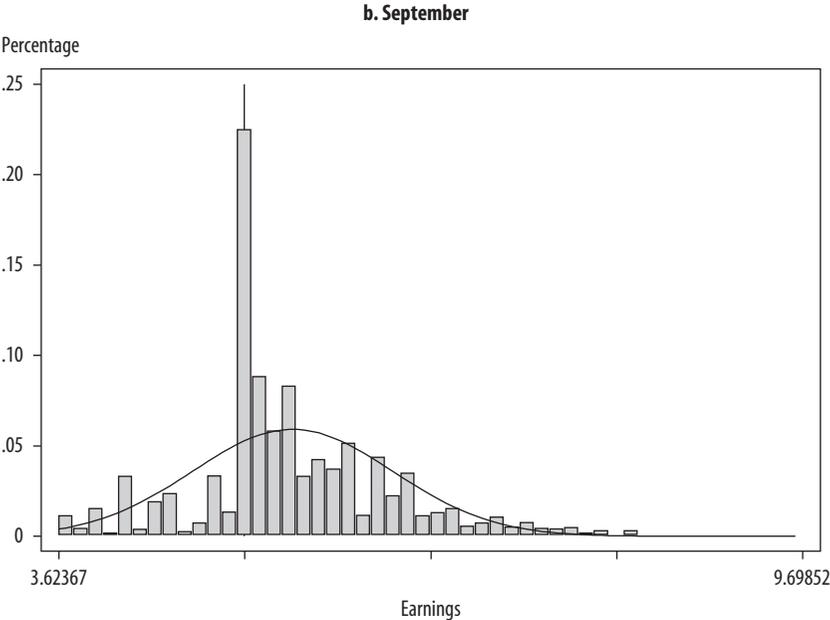
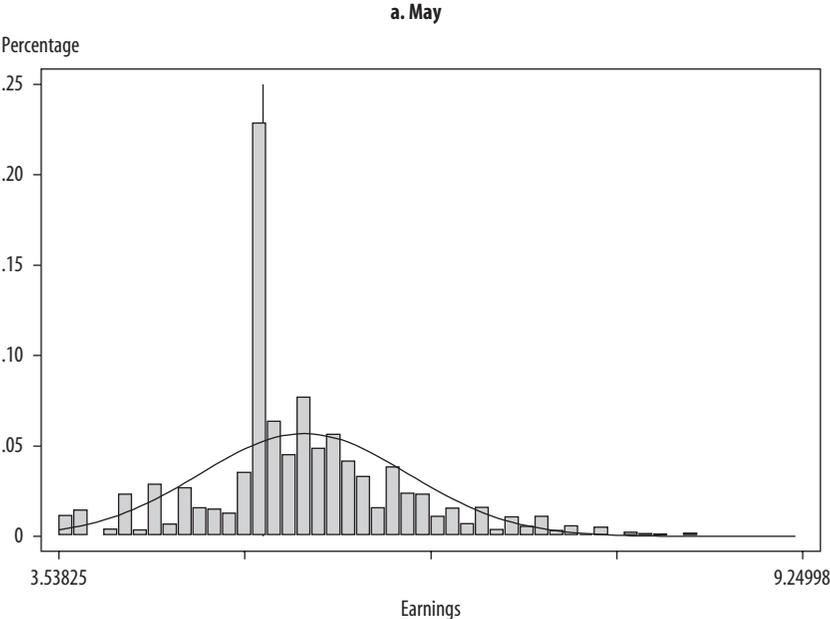
d. Percentage



Source: Author's calculations.

a. The spike variable represents the proportion of people earning one minimum wage; its correlation with the log of the real minimum wage in the national aggregate is 0.64. The multiples variable expands the spike to encompass those earning 0.5, 1.0, 1.5, 2.0, 2.5, and 3.0 times the minimum wage; its correlation is 0.31. Spike and below measures the proportion of people earning the minimum wage or below; its correlation is 0.77. The percentage variable represents the proportion of workers with a percentage wage increase equal to the percentage increase in the minimum wage. Its correlation is 0.39.

FIGURE 6 . Monthly Distribution of Log of Real Earnings in Pernambuco, 1992^a



Source: Author's calculations.
a. The vertical line plots the minimum wage.

Finally, the numeraire and lighthouse effects motivated both Foguel and Neri, Gonzaga, and Camargo to define a measure of the effect of a minimum wage throughout the wage distribution.⁴² Panel d of figure 5 shows the proportion of workers with a percentage wage increase equal to the percentage increase in the minimum wage, a measure I call percentage. Its correlation with the log real minimum wage in the national aggregate is 0.39.

Descriptive Wage Models

The compression in the earnings distribution following a minimum wage increase is illustrated by estimating nonparametric kernel distributions before and after the minimum wage increase. Figure 7 shows the change in the shape of the distribution after minimum wage increases in May 1992, September 1992, and January 1993 in Pernambuco. This can be formalized with regression models. The simplest model of wages as a function of the minimum wage is as follows:

$$(1) \quad \Delta \ln W_{rt} = \alpha^w + \beta^w \Delta \ln MW_{rt} + \gamma^w \pi_{rt-1} + \delta^w \Delta u_{rt-1} + \lambda^w \Delta \mathbf{X}_{rt} + f_r^w + f_t^w + \varepsilon_{rt}^w$$

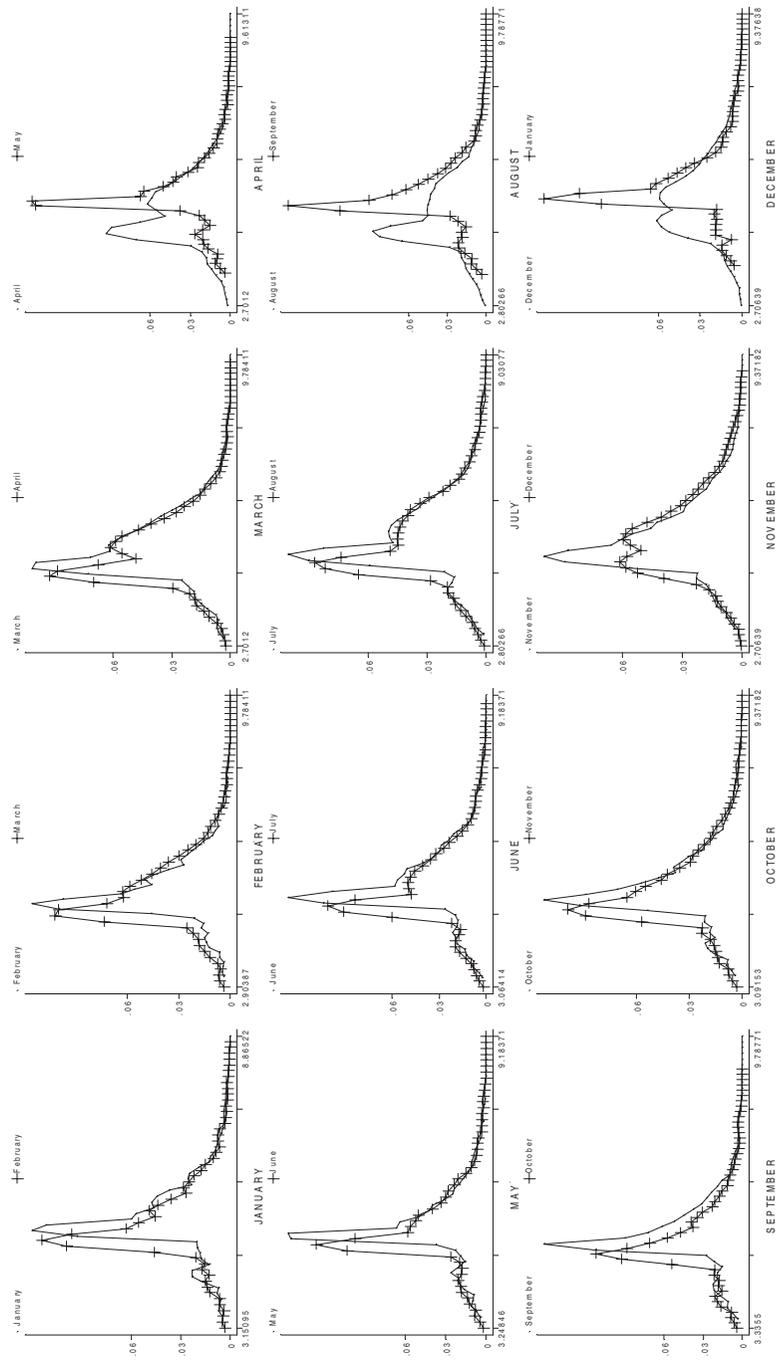
where W_{rt} denotes average real wages; MW_{rt} , represents the real minimum wage; π_{rt-1} is past inflation; u_{rt-1} denotes the past unemployment rate; \mathbf{X}_{rt} is a set of controls; f_r^w and f_t^w are regional and time fixed effects; and ε_{rt}^w is the error term for $r = 1, \dots, 6$ and $t = 1, \dots, 214$. I estimate this model using not only average wages, but also the tenth, twentieth, thirtieth, fortieth, fiftieth, and ninetieth percentiles of the wage distribution to capture the effect of the minimum wage at different points across the distribution.⁴³

I define a full set of regional and time dummies to model regional and time fixed effects. Regional dummies capture regional effects, while time dummies separate out the effects of other macroeconomic variables from the effect of the minimum wage on wages. One macroeconomic variable that is explicitly included is past inflation, for two reasons. First, macroeconomic policy in Brazil, including the minimum wage policy, was aimed at stabilizing inflation; inflation is thus driving other variables. Second, workers used the minimum wage as an index, so past inflation captures the portion of the minimum wage increase that merely compensates for past

42. Foguel (1997); Neri, Gonzaga, and Camargo (1999).

43. See Dickens, Machin, and Manning (1999).

FIGURE 7 . Monthly Kernel Distributions of Log of Real Earnings in Pernambuco, 1992



inflation. Another explicitly included macroeconomic variable is the past unemployment rate. Analysts commonly use this variable as a measure of the demand for labor, to control for region-specific shocks that might be correlated with the minimum wage.⁴⁴

The standard neoclassical model underlies the above empirical equation. I assume perfect competition in the input and output markets, as well as a production function, Y , that depends on skilled and unskilled labor, with input and output prices denoted W , MW , and p . Profit maximization at the firm level delivers the aggregate demand function for labor, $L^d = L(p, W, MW)$, which is the theoretical ground for the definition of employment (equations 2 and 2', defined later in the paper). If all prices are normalized by W , employment is modeled as a function of the toughness of the minimum wage and inflation.⁴⁵ The demand function can also be written as $W = W(p, L, MW)$, which is the theoretical ground for the wage equation (equation 1) above. Wages are modeled as a function of the minimum wage, inflation, and unemployment rate.

Given labor demand, if the labor supply is positively sloped, I have to estimate a reduced form, which includes supply shifters. The following variables are included as controls for region-specific demographics correlated with the minimum wage: namely, the proportion of the total population corresponding to children younger than ten years old, youngsters between ten and twenty-four years of age, women, illiterates, retirees, students, in urban areas, with completed basic and high school education; the average years of schooling in the total population; the proportion of the working population corresponding to workers holding two jobs, workers in the informal, public, construction and metallurgy sectors.⁴⁶

Equation 1 was sample-size weighted to account for the relative importance of each region (and for heteroskedasticity arising from aggregation) and White corrected. Table 1 reports my results. The first column shows robust and significant estimates for β^w that are more robust for lower than

44. See Card and Krueger (1995); Brown (1999).

45. Card and Krueger (1995).

46. Analysts generally agree that demand-side variables should be held constant, but the literature offers no consensus on whether supply-side variables should be included as controls and if so, which ones. The debate centers on whether a reduced-form or demand equation is estimated (Card and Krueger, 1995).

TABLE 1. Coefficients of the Minimum Wage Variables on Wages Models^a

Percentile or ratio	Minimum wage (1)		Fraction affected (2)		Real fraction affected (3)		Spike (4)		Multiples (5)		Spike and below (6)		Percentage (7)	
	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.	Coef.	S.E.
	10th	8.68	3.18	1.74	0.37	2.12	0.53	0.02	0.03	0.11	0.08	0.52	0.15	0.16
20th	8.68	3.10	3.33	0.34	5.32	0.41	0.02	0.03	0.15	0.08	0.07	0.17	0.42	0.06
30th	8.61	3.24	2.80	0.28	4.33	0.37	0.06	0.03	0.22	0.07	0.11	0.14	0.35	0.06
40th	9.76	2.81	1.83	0.24	2.82	0.31	0.06	0.03	0.23	0.06	0.26	0.13	0.22	0.04
50th	9.59	2.60	1.33	0.22	2.20	0.29	0.06	0.03	0.21	0.07	0.21	0.13	0.15	0.04
90th	9.36	3.63	0.32	0.24	0.49	0.32	0.04	0.04	0.10	0.09	0.16	0.14	0.01	0.04
Mean	8.10	2.14	1.37	0.17	2.11	0.22	0.02	0.02	0.19	0.05	0.23	0.10	0.16	0.03
90th/10th	4.43	4.96	-1.41	0.44	-1.61	0.61	0.03	0.05	0.24	0.11	-0.15	0.19	-0.15	0.06
90th/50th	-0.25	2.15	-0.99	0.25	-1.69	0.29	-0.02	0.03	-0.11	0.08	0.15	0.13	-0.15	0.04
50th/10th	4.68	4.56	-0.42	0.35	0.07	0.53	0.05	0.04	0.34	0.09	-0.30	0.17	0.00	0.05
Std. dev.	1.00	1.05	-0.59	0.10	-0.94	0.13	0.00	0.01	0.02	0.03	0.00	0.04	-0.09	0.01

Source: Author's calculations.

a. Percentile regressions are shown for selected percentiles, followed by the percentile ratio and standard deviation regressions. The dependent variable is the identified percentile, ratio of percentiles, or standard deviation of the wage distribution. Other regressors are past inflation, past unemployment rate, regional and time effects, and controls for the proportion of the total population corresponding to children younger than ten years old, youngsters between ten and twenty-four years of age, women, illiterates, retirees, students, in urban areas, with completed basic and high school education; the average years of schooling in the total population; the proportion of the working population corresponding to workers holding two jobs, workers in the informal, public, construction and metallurgy sectors. Time and regional effects are modeled with a full set of time and regional dummies. To obtain the equivalent of a 10 percent increase in the minimum wage, the estimates and associated standard errors of the minimum wage were multiplied by 10; those of fraction affected by 3.0; those of real fraction affected by 4.5; those of spike by 0.1; those of multiples by 0.6; those of spike and below by 0.9; and those of percentage by 0.2.

for higher percentiles. This is the counterpart of the compression effect in figure 7. A number of studies find similar evidence of a compression effect for Brazil, the United Kingdom, and the United States.⁴⁷ Equation 1 can be reestimated using percentile ratios and the standard deviation of the wage distribution as dependent variables. Nonetheless, the results in table 1 show estimates not significantly different from zero.

47. On Brazil, see Neumark, Cunningham, and Siga (2003); Soares (2002); Fajnzylber (2001); Corseuil and Morgado (2001); Corseuil and Carneiro (2001). On the United Kingdom and the United States, see Dickens, Machin, and Manning (1999); Card and Krueger (1995).

Cross-Regional Variation and Model Respecification

The above estimates do not fully identify the effect of the minimum wage on the wage distribution, although they are in line with previous evidence for Brazil and other countries. Since the nominal minimum wage is constant across regions, any regional variation in the real minimum wage stems from the variation in the regional deflators, and the effect of the inverse of the deflator on wages is what is ultimately estimated.⁴⁸

To circumvent this empirical problem, the literature suggests several minimum wage variables with regional variation. The most common variable is toughness, but it suffers from the same drawback as the real minimum wage. Other options include the variables defined earlier: the fraction of workers affected, the real fraction of workers affected, the spike, the spike and below, multiples, and percentage.⁴⁹ In this exercise, I collect all these variables in a menu of minimum wage variables and then use each of them in turn to replace the difference of the log of the real minimum wage in equation 1. Because the spike variable is in levels and is endogenously determined with wages in equation 1, I use the first lag of the difference of the spike. The same is true for multiples and for the spike and below.

Table 1 shows that the estimates of β^w are larger and more robust at lower percentiles. At higher percentiles, they are not only smaller, but also sometimes insignificant, which suggests that this end of the distribution is not hit by spillover effects. The estimates show a very similar pattern regardless of the minimum wage variable used. An increase in the minimum wage sufficient to increase the fraction of workers affected by 1.0 percentage point increases the wages of those in the tenth and twentieth percentiles of the wage distribution by 0.58 percent and 1.11 percent, respectively. Card and Krueger find estimates of 0.18 to 0.30 using average wages, which is comparable here with a figure of 0.45.⁵⁰ I multiplied the estimates by the approximate elasticity of the fraction of workers affected with respect to the real minimum wage (that is, 3.0) to represent

48. Welch and Cunningham (1978).

49. Lee (1999) and Green, Dickerson, and Arbache (2001) suggest trimmed toughness; Deere, Murphy, and Welch (1996) suggest costs of the increase on the firm's side; and a number of authors suggest some variation of a wage gap measure (for example, Linneman, 1982; Deere, Murphy, and Welch, 1996; Currie and Fallick, 1996).

50. Card and Krueger (1995).

the effect of a minimum wage increase. Card and Krueger interpret their estimates similarly.⁵¹ A 10.0 percent increase in the real minimum wage increases the fraction of workers affected by 3.0 percentage points and thus increases the wages of those in the tenth and twentieth percentiles by 1.74 percent and 3.33 percent, respectively.⁵² The corresponding figures for the tenth and twentieth percentiles, respectively, for each of the other variables are as follows: 2.12 percent and 5.32 percent for the real fraction of workers affected; 0.02 percent and 0.02 percent for the spike; 0.11 percent and 0.15 percent for multiples; 0.52 percent and 0.07 percent for the spike and below; and 0.16 percent and 0.42 percent for the percentage variable. The range of estimates produced across all specifications is expected to embrace the true coefficient. A 10.0 percent increase in the real minimum wage increases the wages of those in the tenth and twentieth percentiles by 0.02–2.12 percent and 0.02–5.32 percent, respectively, across models. Table 1 includes percentile ratios and standard deviation regressions that confirm the compression effect.

These spillover effects are weaker than those of the previous section. One would expect extensive spillovers in Brazil, given the use of the minimum wage as an index and numeraire, and in Latin America in general.⁵³ However, the extensive spillovers found earlier might result from an artificial correlation between the real minimum wage and real wages, driven by the common (deflator) denominator. The spillover estimates based on the degree-of-impact measures ensure full identification of the minimum wage effect and are thus more reliable than the earlier results.

This section has exhaustively measured the effect of the minimum wage on the wage distribution using a variety of specifications and variables. I started by modeling the mean, the median, various percentiles, their ratios, and the variance of the wage distribution as a function of the minimum wage. I then respecified the models to encompass several alternative minimum wage variables defined to capture the effect of the mini-

51. Card and Krueger (1995).

52. This was obtained by regressing the fraction of workers affected on the difference of the log of the real minimum wage and controls associated with equations 1, 2, and 2'. These estimates were robust across specifications. A 10 percent increase in the minimum wage increased the fraction of workers affected by 3 percentage points, the real fraction of workers affected by 4.5, the percentage variable by 0.2, the spike by 0.1, spike and below by 0.6, and multiples by 0.9 (the last three variables were in differences).

53. Maloney and Mendez (2004).

imum wage on different parts of the wage distribution: at, below, and above the minimum wage, as well as across the distribution. All the above pieces of evidence consistently suggest that the minimum wage compresses the wage distribution, which is in line with theory and with the international and Brazilian empirical literature.

The Preferred Minimum Wage Variable

The preferred specifications are those using the real fraction of workers affected and the spike. They are better minimum wage variables than either toughness or the nominal fraction of workers affected (the most common minimum wage variables in the literature), and they are also better than multiples, spike and below, and the percentage variable, which are all simply extended versions of the spike. As already mentioned, using toughness ultimately produces an estimate of the effect of the inverse of the average wage on wages. Brown compares the degree-of-impact measures (for example, the fraction of workers affected) and the relative minimum wage variable (that is, toughness) and concludes that the former are “conceptually cleaner,” although they are not well suited for studying periods when the minimum wage is constant because the fraction of workers affected is constant at zero, regardless of how unimportant the minimum wage might become.⁵⁴ The real fraction of workers affected and the spike are conceptually related to the nominal fraction and are thus methodologically clean; they do not, however, suffer from the same drawback, since they can be defined when the minimum wage is constant.

As discussed earlier, the spike is endogenously determined with wages in equation 1, and I therefore use the first lag of the difference of spike, although the correlation between the difference and the first lag of the difference is low (-0.12). The estimates using the former are larger and robust (though biased), whereas the estimates based on the latter are smaller and less robust, in particular at the low end of the distribution, where the effect of the minimum wage is expected to be strongest (see column 4 of table 1). Consequently, the real fraction of workers affected is my preferred minimum wage variable. It is not endogenously determined with wages in equation 1, and it produces robust estimates that are in line with theory and

54. Brown (1999).

with the international and Brazilian empirical literature (see column 3 of table 1). Furthermore, the real fraction of workers affected is relatively uncontaminated by measurement error, as it is computed over an interval of the wage distribution (not over a point, as in the case of the spike). This issue is particularly important during periods of hyperinflation, when the minimum wage varies within a month, making it difficult to capture the spike.

Robustness Checks

The minimum wage variables described above might not capture all the relevant variation in the real minimum wage, thereby introducing measurement error and possibly omitted variable bias. Furthermore, equation 1 does not control for regional shocks correlated to changes in the real minimum wage and wages. To account for these potential problems, I modified equation 1 to include the interaction of the real fraction of workers affected (F_{rt}) with the real minimum wage. This not only reintroduces the variation of the real minimum wage into the model, but also ensures that the effect of minimum wage shock on wages is not confounded with the effect of other region-specific or macroeconomic shocks. The new equation is as follows:

$$(1') \quad \Delta \ln W_{rt} = \alpha^w + \beta^m \Delta MW_t + \beta^w F_{rt} + \beta^{wm} \Delta MW_{rt} * F_{rt} + \gamma^w \pi_{rt-1} + \delta^w \Delta u_{rt-1} \\ + \lambda^w \Delta \mathbf{X}_{rt} + f_r^w + f_t^w + \varepsilon_{rt}^w.$$

Table 2 shows that the estimates for β^w are more robust and larger at lower percentiles than at higher percentiles of the wage distribution (see column 1). They are only marginally smaller than the corresponding estimates in column 2 of table 1 (with the exception of the ninetieth percentile, in which case it is marginally larger but not significant). The estimates are not qualitatively different, however. Table 2 also reports significant β^{wm} estimates (see column 2). This confirms that the effect of the minimum wage on wages depends both on the size of the change in the minimum wage itself and on the size of the fraction of workers affected, which in turn depends on the minimum wage change and on the shape of the distribution across regions. Given that changes in the shape of the distribution caused by variables other than the minimum wage are captured by the interaction term and time effects, β^w captures solely the effect of the minimum wage on wages.

TABLE 2. Coefficients of Real Fraction of Workers Affected on Wage Models with Interactions^a

Percentile	<i>Real fraction affected</i> (1)		<i>Interaction term</i> (2)	
	<i>Coefficient</i>	<i>Std. error</i>	<i>Coefficient</i>	<i>Std. error</i>
10th	1.21	0.40	8.19	2.49
20th	4.00	0.34	10.34	1.91
30th	2.97	0.33	8.00	1.87
40th	2.18	0.31	5.96	1.49
50th	1.94	0.30	3.16	1.56
90th	0.57	0.38	-0.70	1.61
Mean	1.67	0.23	3.71	1.12

Source: Author's calculations.

a. Percentile regressions are shown for selected percentiles, followed by the percentile ratio and standard deviation regressions. The dependent variable is the identified percentile of the wage distribution. Other regressors are past inflation, past unemployment rate, regional and time effects, and controls for the proportion of the total population corresponding to children younger than ten years old, youngsters between ten and twenty-four years of age, women, illiterates, retirees, students, in urban areas, with completed basic and high school education; the average years of schooling in the total population; the proportion of the working population corresponding to workers holding two jobs, workers in the informal, public, construction and metallurgy sectors. Time and regional effects are modeled with a full set of time and regional dummies. To obtain the equivalent of a 10 percent increase in the minimum wage, the estimates and associated standard errors of the real fraction affected and the interaction term were multiplied by 4.5.

This is the most demanding specification presented so far, and the results are remarkably robust. The exercise supports the main conclusion of previous sections, that the minimum wage strongly compresses the wage distribution.

The Effect of the Minimum Wage on Employment

Employment can be adjusted along two margins following a minimum wage increase: the number of jobs and the number of hours per worker. The total effect of a minimum wage increase on employment can thus be decomposed into an hours-per-worker effect and a jobs effect. If the first is positive and the second is negative, the total effect might be nonnegative. This might explain why the total effect clusters around zero in the literature. This issue traditionally did not receive much attention.⁵⁵ Recent research, however, suggests that nonnegative jobs effects are a subproduct

55. Barzel (1973); Gramlich (1976); Linneman (1982); Brown, Gilroy, and Kohen (1982); Brown (1999).

of adjustments in hours.⁵⁶ A number of studies estimate job and hours-per-worker effects, but they do not formalize that as a decomposition of the total effect.⁵⁷

Let the average hours worked for the total population (T) equal the product of the average hours of those working (H) and the employment rate (E). Brown, Gilroy, and Kohen noted that “to measure the employment effect of the minimum wage, the ratio of employment to population (E) is used most often as the dependent variable.”⁵⁸ The above decomposition, however, suggests not only E , but also T and H as dependent variables. Consequently, I estimate equations 2 and 2' below three times, using each of the three employment variables in turn as dependent variables. Since the set of regressors is the same, the estimate in the T equation equals the sum of the estimates in the H and E equations (that is, $\beta_T^e = \beta_H^e + \beta_E^e$).⁵⁹

Descriptive Employment Models

The simplest model of employment as a function of the minimum wage is

$$(2) \quad \Delta \ln N_{rt} = \alpha^n + \beta^n \Delta \ln MW_t + \gamma^n \pi_{rt-1} + \lambda^n \Delta \mathbf{X}_{rt} + f_r^n + f_t^n + \varepsilon_{rt}^n,$$

where N_{rt} is, in turn, E_{rt} , T_{rt} , or H_{rt} ; f_r^n and f_t^n are regional and time fixed effects (as in equation 1); and ε_{rt}^n is the error term. A minimum wage increase might affect employment in future periods rather than contemporaneously, so I added dynamics allowing for a two-year adjustment.⁶⁰ The new equation is as follows:

$$(2') \quad \Delta \ln N_{rt} = \alpha^n + \beta^n \Delta \ln MW_t + \gamma^n \pi_{rt-1} + \lambda^n \Delta \mathbf{X}_{rt} + \sum_{l=1}^{24} \rho_l^n \Delta \ln N_{rt-l} \\ + f_r^n + f_t^n + \varepsilon_{rt}^n.$$

56. Michl (2000); Zavodny (2000); Card and Krueger (2000); Neumark and Wascher (2000).

57. Zavodny (2000); Machin, Rahman, and Manning (2003); Neumark, Cunningham, and Siga (2003).

58. Brown, Gilroy, and Kohen (1982, p. 497).

59. In the dynamic models, the set of regressors is not the same and the OLS additivity property does not hold exact.

60. See Brown, Gilroy, and Kohen (1982); Layard, Jackman, and Nickell (1991).

As before, equations 2 and 2' were White corrected and sample-size weighted. I assume that the error term, ε_{it}^n , follows a first-order moving average, or MA(1), process and therefore instrument $\Delta \ln N_{it-1}$ using $\ln N_{it-2}$ to account for potential endogeneity arising from the correlation between the first lag of the dependent variable and the error term.

Table 3 reports insignificant estimates for β_T^n , β_H^n , and β_E^n , which suggests that the minimum wage does not affect employment. Neumark, Cunningham, and Siga, however, estimate small negative (but not always significant) hours-per-worker and jobs effects for Brazil using formal sector data in low inflation periods. One explanation is that more adverse employment effects are expected.⁶¹

Cross-Section Variation and Model Respecification

As in the previous exercise, these last estimates do not fully identify the effect of the minimum wage on employment (and the same applies to my use of toughness below). I therefore use each of the alternative minimum wage variables in turn to replace the difference of the log of the real minimum wage in equations 2 and 2'.

Table 3 presents these estimates for β_T^n , β_H^n , and β_E^n . When I substitute the log of the real minimum wage with the fraction of workers affected, a 10 percent increase in the minimum wage increases total hours by 0.18 percent, which decomposes into a 0.15 percent increase in the number of hours per worker and a 0.03 percent increase in the number of jobs, where the total effect is dominated by the hours effect. Card and Krueger find estimates of 0.03 to 0.36 when regressing a change in the employment-population ratio on fraction, which is comparable here with 0.00 to 0.03.⁶² Next, when I use the real fraction of workers affected, a 10 percent increase in the minimum wage increases total hours by 0.34 percent. For the spike and below variable the change is -0.16 percent; for the spike, -0.05 percent; for multiples of the spike, -0.08 percent; and for the percentage variable, 0.01 percent. The results for the set of toughness variables is as follows: average toughness, 1.31 percent; median toughness (fiftieth percentile), 0.72 percent; and toughness for the twenty-fifth

61. Neumark, Cunningham, and Siga (2003).

62. Card and Krueger (1995).

TABLE 3. Coefficients of the Minimum Wage Variables on Employment Models^a

<i>Minimum wage variable and dependent variable</i>	<i>Controls</i>		<i>Dynamics</i>		<i>Long run</i>
	<i>(1)</i>		<i>(2)</i>		<i>(3)</i>
	<i>Coefficient</i>	<i>Std. error</i>	<i>Coefficient</i>	<i>Std. error</i>	<i>Coefficient</i>
Real minimum wage					
Total employment	-0.12	1.12	-0.25	1.43	-0.08
Hours worked	0.26	1.08	0.18	1.33	0.05
Employment rate	-0.38	0.32	-0.58	0.47	-0.31
Fraction affected					
Total employment	0.05	0.08	0.18	0.11	0.06
Hours worked	0.05	0.07	0.15	0.08	0.05
Employment rate	0.00	0.02	0.03	0.04	0.02
Real fraction affected					
Total employment	0.15	0.11	0.34	0.19	0.11
Hours worked	0.15	0.10	0.32	0.16	0.10
Employment rate	0.00	0.04	0.04	0.05	0.02
Spike and below					
Total employment	0.01	0.01	-0.16	0.08	-0.05
Hours worked	0.01	0.01	-0.14	0.09	-0.04
Employment rate	0.00	0.00	-0.02	0.02	-0.01
Spike					
Total employment	0.00	0.00	-0.05	0.03	-0.02
Hours worked	0.00	0.00	-0.04	0.02	-0.01
Employment rate	0.00	0.00	0.00	0.01	0.00
Multiples					
Total employment	0.01	0.01	-0.08	0.05	-0.02
Hours worked	0.01	0.01	-0.06	0.04	-0.02
Employment rate	0.00	0.00	-0.02	0.01	-0.01
Percentage					
Total employment	0.01	0.01	0.01	0.01	0.00
Hours worked	0.01	0.01	0.01	0.01	0.00
Employment rate	0.00	0.00	0.00	0.01	0.00
Average toughness of minimum wage					
Total employment	1.14	0.23	1.31	0.33	0.48
Hours worked	0.90	0.22	1.05	0.30	0.36
Employment rate	0.24	0.07	0.27	0.10	0.14
Median toughness (50th percentile)					
Total employment	0.67	0.17	0.72	0.22	0.25
Hours worked	0.58	0.16	0.64	0.21	0.21
Employment rate	0.09	0.05	0.08	0.07	0.04

(continued)

TABLE 3 . Coefficients of the Minimum Wage Variables on Employment Models (continued)

<i>Minimum wage variable and dependent variable</i>	<i>Controls</i> (1)		<i>Dynamics</i> (2)		<i>Long run</i> (3)
	<i>Coefficient</i>	<i>Std. error</i>	<i>Coefficient</i>	<i>Std. error</i>	<i>Coefficient</i>
Toughness for the 25th percentile					
Total employment	0.44	0.13	0.33	0.17	0.11
Hours worked	0.31	0.12	0.19	0.15	0.06
Employment rate	0.13	0.04	0.12	0.05	0.07

Source: Author's calculations.

a. The dependent variable is, respectively, average hours worked for the working population, average hours worked for those employed, and the employment rate. Hours and job elasticities sum to total elasticity for the static but not the dynamic model. In column 1, other regressors are past inflation, regional and time effects, and controls for the proportion of the total population corresponding to children younger than ten years old, youngsters between ten and twenty-four years of age, women, illiterates, retirees, students, in urban areas, with completed basic and high school education; the average years of schooling in the total population; the proportion of the working population corresponding to workers holding two jobs, workers in the informal, public, construction and metal-lurgy sectors. In column 2, twenty-four lags of the dependent variable are added, in which the first lag is instrumented with further lags, as the errors are assumed to follow an MA(1) process. Column 3 shows the long-run coefficient associated with the model. Time and regional effects are modeled with a full set of time and regional dummies. To obtain the equivalent of a 10 percent increase in the minimum wage, the estimates and associated standard errors of the minimum wage were multiplied by 10; those of fraction affected by 3.0; those of real fraction affected by 4.5; those of spike by 0.1; those of multiples by 0.6; those of spike and below by 0.9; those of percentage by 0.2; and those of average toughness, median toughness (fiftieth percentile), and toughness for the twenty-fifth percentile by 10.

percentile, 0.33 percent. Finally, column 3 of the table reports long-run estimates, none of which are larger than -0.05 percent.

Bracketing the total effect below -0.16 percent in the short run, and below -0.05 percent in the long run, across such a variety of models is reassuring. Nonetheless, the estimates in the main are not statistically different from zero, and the evidence can be taken to mean that the minimum wage does not affect employment. A cautious reading, however, is that the minimum wage does not have an adverse employment effect, and to the degree that it does have one, this effect is small.

This section has exhaustively measured the employment effect, and the results were remarkably robust to various alternative specifications and minimum wage variables. The above pieces of evidence suggest that an increase in the minimum wage does not always have a significant effect on employment and it is not always negative—but if anything, it is small. This is in line with the international and Brazilian literature.

Robustness Checks

To verify the robustness of the results, I modified equation 2' to include the interaction of the real fraction of workers affected with the real minimum wage, as before. The new equation is the following:

$$(2'') \quad \Delta \ln N_{it} = \alpha^n + \beta^m \Delta \ln MW_{it} + \beta^n F_{it} + \beta^{nm} \Delta MW_{it} * F_{it} + \gamma^n \pi_{it-1} \\ + \lambda^n \Delta \mathbf{X}_{it} + \sum_{i=1}^{24} \rho_i^n \Delta \ln N_{it-1} + f_r^n + f_i^n + \varepsilon_{it}^n.$$

As before, equation 2'' was White corrected and sample-size weighted and $\Delta \ln N_{it-1}$ was instrumented using $\ln N_{it-2}$. Column 1 of table 4 gives the estimates for β_T^n , β_H^n , and β_E^n , which are now larger in absolute terms than the corresponding estimates in table 3. The estimates for total hours and number of jobs are still positive and significant, but the number of hours per worker is now statistically insignificant. Table 4 also reports insignificant estimates for β_T^{nm} , β_H^{nm} , and β_E^{nm} (see column 2). This suggests that the interaction term does not explain any variation in employment over and above the variation already explained by the real fraction of workers affected.

As in the wage exercise, these are the most demanding employment specifications so far. The results strongly support the previous conclusion that the minimum wage does not have an adverse employment effect. If anything, the results here suggest less adverse effects than those of the earlier specifications.

Further Evidence of Employment Effects

The main message in this study is that wage effects in Brazil are large, whereas employment effects are small when compared with the -1.0 percent effect found in the international literature. This is the case despite the large minimum wage increases; despite the large proportion of minimum wage workers directly affected by the increases; and despite the large proportion of workers below and above the minimum wage, indirectly affected by the increases via spillovers.

Beyond robustness checks that ensure statistical identification, robustness checks that focus on underlying specificities in the Brazilian economy might offer explanations for such small effects. This section thus reviews evidence on the employment effect for key subsamples. The

TABLE 4. Coefficients of Real Fraction of Workers Affected on Employment Models with Interaction^a

<i>Dependent variable</i>	<i>Real fraction affected</i> (1)		<i>Interaction term</i> (2)	
	<i>Coefficient</i>	<i>Std. error</i>	<i>Coefficient</i>	<i>Std. error</i>
Total employment	0.48	0.21	-0.33	0.57
Hours worked	-0.52	0.65	0.06	0.06
Employment rate	0.44	0.19	-0.24	0.23

Source: Author's calculations.

a. The dependent variable is, respectively, average hours worked for the working population, average hours worked for those employed, and the employment rate. Hours and job elasticities sum to total elasticity for the static but not the dynamic model. Other regressors are past inflation, regional and time effects, twenty-four lags of the dependent variable—in which the first lag is instrumented with further lags, as the errors are assumed to follow an MA(1) process—and controls for the proportion of the total population corresponding to children younger than ten years old, youngsters between ten and twenty-four years of age, women, illiterates, retirees, students, in urban areas, with completed basic and high school education; the average years of schooling in the total population; the proportion of the working population corresponding to workers holding two jobs, workers in the informal, public, construction and metallurgy sectors. Time and regional effects are modeled with a full set of time and regional dummies. To obtain the equivalent of a 10 percent increase in the minimum wage, the estimates and associated standard errors of the real fraction affected and the interaction term were multiplied by 4.5.

reading of this evidence is that small employment effects might make sense when several explanations are combined. For example, employment effects are not easy to find if noncompliance is large and the public sector has an inelastic labor demand. Additionally, employment effects are difficult to find if inflation is high and firms do not adjust employment because they perceive the minimum wage increase as temporary. Employment effects are even harder to find if the analysis is not restricted to low-wage workers. Such specificities suggest that the economics of the minimum wage in developing countries might be very different from that of developed countries—which are the subject of most of the available literature.

Employment Effects across Sectors

The standard two-sector model predicts that an increase in the minimum wage will cause wages to fall in the uncovered sector, which must accommodate displaced workers from the covered sector. In other words, the uncovered sector's labor demand curve should not slope downwards, and its wage distribution should not register a spike.⁶³ If employment effects

63. Welch (1976); Gramlich (1976); Mincer (1976).

are negative in the covered sector and positive in the uncovered sector, this might explain the nonnegative total effect found in the literature.

The two-sector model's predictions for the uncovered sector need not hold for the informal sector. Unlike workers in the uncovered sector, informal sector workers are covered by the legislation. A minimum wage is still paid in the informal sector, but firms do not comply with other aspects of the labor contract, such as social security taxes, paid holidays, and health insurance.⁶⁴ For example, both sectors exhibit a large spike in the wage distribution—as well as spillover effects—in Brazil and other Latin America countries.⁶⁵ The presence of a spike and spillover effects in both the formal and informal sectors suggests that employment decreases in both sectors. Several authors estimate negative job effects in both sectors in Brazil.⁶⁶

With regard to the public and private sectors, if the public sector has an inelastic labor demand, it will finance the higher wage bill associated with a minimum wage increase via public deficit. If employment effects are negative in the private sector and positive in the public sector, this could help explain the nonnegative total effect found in the literature. Investigating the employment effects in the public sector is particularly relevant if the public sector is overpopulated by minimum wage workers, with non-negligible spike and spillover effects, as in Brazil. In an earlier work, I estimate negative total long-run effects in the private sector, but positive effects in the public sector in Brazil.⁶⁷

Employment Effects across Time

The response of firms and workers to a minimum wage increase depends on the inflation level. In periods of high inflation, firms perceive the increase as temporary, anticipate the subsequent accommodating monetary policy and wage-price spiral, and do not adjust employment to avoid adjustment costs. Conversely, periods of low inflation display adverse employment effects. If employment effects are negative under low inflation and nonnegative under high inflation, this could contribute to explain-

64. Amadeo, Camargo, and Gonzaga (1995).

65. On Brazil, see Lemos (2004c); Maloney and Mendez (2004); Neri, Gonzaga, and Camargo (1999); Foguel (1997); Carneiro (2000). On other Latin America countries, see Maloney and Mendez (2004).

66. Lemos (2004c); Foguel (1997); Neri, Gonzaga, and Camargo (1999).

67. Lemos (2004b).

ing the nonnegative total effect found in the literature—at least for countries exposed to high inflation, like Brazil. An earlier paper of mine finds that the total long-run effect is more adverse under low inflation than under high inflation in Brazil.⁶⁸ Neumark, Cunningham, and Siga estimate moderately negative job effects for Brazil based on formal sector data in a period of low inflation, whereas Fajnzylber estimates smaller negative job effects for Brazil using formal sector data in periods mainly characterized by high inflation.⁶⁹

Associated with this is the minimum wage effect on prices. Firms do not incur employment adjustment costs if they are able to pass through the higher costs associated with a minimum wage increase to prices. In an earlier work, I estimate a partial pass-through effect of the minimum wage on prices in Brazil.⁷⁰ Small employment effects make sense if coupled with positive price effects.

Employment Effects across Demographic Groups

Most of the estimates of employment effects in the Brazilian literature—like the ones in this study—are based on the entire working population. This dilutes the adverse employment effects for low-wage workers. Estimations for low-wage groups should produce substantially larger employment effects. The most obvious strategy is to restrict the analysis to teenagers or workers with low levels of education, as is usually done in the U.S. literature. If the employment effects are negative for low-wage workers and positive for high-wage workers, it might help explain the nonnegative total effect found in the Brazilian literature. Previous work of mine estimates a more negative long-run total effect for teenagers and workers with a low level of education than for the entire working population in Brazil.⁷¹

Conclusion

This paper estimates the effects of minimum wage on wages and employment using Brazilian household data for the 1980s and 1990s. Results indicate that an increase in the minimum wage strongly compresses the

68. Lemos (2004e).

69. Neumark, Cunningham, and Siga (2003); Fajnzylber (2001).

70. Lemos (2004d).

71. Lemos (2004a).

wage distribution, with small negative effects on employment in Brazil. The total effect is no more than -0.05 percent in the long run, and it appears to be dominated by the hours effect. In the short run, a 10 percent increase in the minimum wage appears to reduce total hours worked by no more than 0.16 percent, which decomposes into a 0.14 percent decrease in hours per worker, and a 0.02 percent decrease in jobs. Nonetheless, the last two estimates are not statistically different from zero. A cautious reading is that the minimum wage does not have an adverse employment effect, and that if anything, this effect is small. It is small when compared with the -1.0 percent effect in the international and Brazilian literature, and it is even more so in the light of the sizeable wage effects reported here. The main policymaking implication deriving from these results is that the minimum wage is an effective policy against inequality and poverty in Brazil. Because the main effect of the minimum wage is via hours per worker and not via the number of jobs, the minimum wage may be used to increase the earnings of the poor without hurting where it hurts most: causing disemployment.

Small employment effects might be expected, however, when a number of explanations are combined. For example, employment effects are not easy to find if noncompliance is large and the public sector has an inelastic labor demand. Employment effects are similarly difficult to find if inflation is high and firms do not adjust employment because they perceived the minimum wage increase as temporary. Employment effects are even harder to find if the analysis is not restricted to low-wage workers.

Such specificities suggest that the economics of the minimum wage might be very different in developing countries than in developed countries. Results for Brazil might not directly apply to other developing countries, however, because of differences in the structure of the labor market and the economy more generally. Even for Brazil, the result of a small employment effect needs to be qualified. First, more adverse employment effects are expected under low inflation than under high inflation, because a generous minimum wage increase that is not immediately eroded by the subsequent inflation might cause large disemployment effects. Second, while the aggregate effects might not be large, the effects for low-wage groups might be substantial.

Comments

Roberto Rigobon: This paper studies the effect of minimum wages on the distribution of wages and on overall unemployment. This is an extremely important question, and one that has barely been analyzed in emerging markets. Brazil's minimum wages provide a unique opportunity to study this question because changes in minimum wages have been large and frequent.

The paper mainly consists of two parts: a study of the impact of minimum wages on the wage distribution and an analysis of the implications of minimum wages for unemployment.

To study the influence of minimum wages on the wage distribution, Lemos examines different measures of the tightness of minimum wages. The specification that she uses is the following:

$$\begin{aligned}\Delta \ln W_{rt} = & \alpha^w + \beta^w \Delta \ln MW_{rt} + \gamma^w \pi_{rt-1} + \delta^w \Delta u_{rt-1} + \lambda^w \Delta \mathbf{X}_{rt} \\ & + f_r^w + f_t^w + \varepsilon_{rt}^w.\end{aligned}$$

All her results are well summarized in table 1.

To study the impact on employment, Lemos uses the same measures and evaluates the impact of its changes on total employment, total hours, and jobs. This is done to appraise the different margins in which minimum wages can work. For instance, an increase in the minimum wage could produce a decline in the hours worked while keeping the same number of jobs, or it could reduce the number of jobs while keeping the hours per worker intact. Her specification is

$$\begin{aligned}\Delta \ln N_{rt} = & \alpha^n + \beta^n \Delta \ln MW_t + \gamma^n \pi_{rt-1} + \lambda^n \Delta \mathbf{X}_{rt} + \sum_{l=1}^{24} \rho_l^n \Delta \ln N_{rt-l} \\ & + f_t^n + \varepsilon_{rt}^n.\end{aligned}$$

The results for this specification for the different measures of minimum wages and employment are presented in table 3.

Her main findings are threefold. First, the wage distribution experiences significant compression regardless of the measures of minimum wage tightness used in the specification. Second, employment measures are almost unaffected—and if they are at all, the effects are very small. Third, the preferred measures for evaluating the impact of the minimum wage are the real fraction of workers affected and the spike.

I organize my comments along two lines. First, although I have no problems in principle with the spike variable, I have severe doubts that the real fraction of workers affected should be used at all. Second, I examine what type of robustness tests should be performed to ensure that the results are not driven by unobservable variables.

The objective of the fraction of workers affected variable is to measure the proportion of workers for whom the minimum wage wasn't binding at time $t - 1$, but is binding at time t . This is measured as the mass of workers who have a wage that satisfies equation 1:

$$(1) \quad 0.98 * MW_{t-1} < w_{t-1} < 1.02 * MW_t,$$

where MW is the nominal minimum wage and w is the wage. The idea of the real fraction of workers affected is to use real wages instead of nominal ones:

$$(2) \quad 0.98 * RMW_{t-1} < RW_{t-1} < 1.02 * RMW_t.$$

Equation 1 measures the proportion of workers who have wages close to the minimum wage and who are likely to find it binding. Therefore, this is a clear measure of how tight the minimum wage is. This interpretation does not apply to real minimum wages, however. For example, movements in the inflation rate will imply changes in the real minimum wage that are not necessarily associated with changes in the tightening of the minimum wage. Moreover, the presence of inflation changes the interpretation of the results. If inflation has different effects on the nominal wages of individuals along the distribution, then changes in real wages could be the result of these differences and not the outcome of the tightening of the minimum wage. In particular, if inflation increases the nominal wages of individuals in the bottom of the distribution more than those in the top of the distribution, then the compression of the wage distribution could be explained by the omitted variable and not by the tightening of the

constraint—especially if the relation is nonlinear. If employment depends negatively in real wages, then increases in inflation together with increases in minimum wages will make the average effect on employment small, and possibly with the wrong sign. Lemos understands this inconvenience, and she introduces inflation on the right-hand side of the specification. Her specification is insufficient, however, if the relation between wages and inflation is not linear.

One way to test for this is to compare the level and first-difference estimates, for instance by estimating the following equations:

$$\ln W_{rt} = \alpha^w + \beta^w \ln MW_{rt} + \gamma^w p_{rt-1} + \delta^w u_{rt-1} + \lambda^w \mathbf{X}_{rt} + f_r^w + f_t^w + \varepsilon_{rt}^w$$

and

$$\begin{aligned} \Delta \ln W_{rt} = & \alpha^w + \beta^w \Delta \ln MW_{rt} + \gamma^w \pi_{rt-1} + \delta^w \Delta u_{rt-1} + \lambda^w \Delta \mathbf{X}_{rt} + f_r^w \\ & + f_t^w + \varepsilon_{rt}^w. \end{aligned}$$

If both equations are valid, then the estimates of these two regressions should be statistically the same. If there is a specification error, then these estimates are statistically different from zero. In other words, the ordinary least squares (OLS) coefficients are statistically different if the fixed effects in the level regression (the first one) are correlated with the residual, if the right-hand side variables are correlated with the residuals in both equations, or if the model is nonlinear.

For example, if this exercise is performed for the minimum wage and the real fraction of workers affected, the result is a rejection of the null hypothesis that the estimates are the same across both specifications. One alternative is that the decile fixed effects are correlated with the residuals, and this misspecification is causing the rejection. However, I do not see why this would be a more valid possibility than the fact that inflation has a nonlinear effect on nominal wages at the different deciles of the distribution. The paper would benefit if Lemos included a discussion of the robustness of the results and presented a series of specification tests that would make a more convincing case for using the real fraction of workers affected. Possibilities include first differences versus the level regression, between versus within regressions, and long versus short differences (to determine the presence of an error-in-variables problem).

Finally, the fact that the results on wage compression are much weaker when the spike or the other measures of the minimum wage are used illus-

trates that the strong results found using the real fraction of workers affected may be driven by imperfectly controlling for inflation. While I am sympathetic to Lemos's results, and I believe they will survive a battery of robustness tests, I also consider that the real fraction of workers affected should not be the preferred variable, especially in Brazil where the minimum wage is part of the anti-inflationary policy.

Kevin Lang: A reasonable, although possibly controversial, summary of the research on the effects of minimum wages in the United States is that they compress the wage distribution, have only a small disemployment effect, may reduce income inequality a little, and may redistribute employment among groups, possibly toward young workers in at least some industries. These results are undoubtedly time and location specific. There is some evidence that the disemployment effect has declined over time and some evidence that when the minimum wage is high relative to prevailing wages, it reduces employment more substantially, although both results have been questioned.

Against this background, Sara Lemos makes three important contributions. First, she shows the sensitivity of the results to the choice of different measures of the minimum wage. Second, she measures the wage and employment effects of minimum wage laws in a very different institutional setting while meeting current standards for identification. Third, she distinguishes between the effect of the minimum wage on hours worked and its effect on employment. Let me take these in turn.

If one ignores the other controls in the equations, the basic estimating equation is

$$(1) \quad \text{OUTCOME} = a + b \text{ MWPROXY} + u.$$

Since the various measures of the minimum wage do not share a common metric, Lemos makes them comparable by regressing the minimum wage proxy on the real minimum wage:

$$(2) \quad \text{MWPROXY} = c + d \text{ REALMW} + e.$$

The reported coefficient in the tables is $b*d$.

I want to suggest a somewhat different way of interpreting these results. Think of the first equation as the ordinary least squares (OLS) estimate of the effect of the minimum wage proxy on the outcome. Think

of the second equation as the first stage in two-stage estimation of the effect of the proxy on the outcome, using the real minimum wage as an instrument. In the case in which the minimum wage proxy is the real minimum wage, the first equation gives us the reduced form of this system, which I will write as

$$(3) \quad \text{OUTCOME} = f + g \text{ REALMW} + v.$$

When the system is just identified,

$$(4) \quad g_{\text{OLS}} = b_{\text{IV}} * d_{\text{OLS}}.$$

Compare this with

$$(5) \quad g_m = b_{\text{OLS}} * d_{\text{OLS}},$$

where g_m is the coefficient reported in the tables. Comparing equations 4 and 5 shows that when g_m is bigger than g_{OLS} , the OLS regression of the outcome on the proxy provides a bigger coefficient estimate than if the real minimum wage is used as an instrument for the proxy.

The estimated effect of the real minimum wage on wages is much more positive than the estimated effect of the other minimum wage proxies in every case. In other words, $g_m > g_{\text{OLS}}$ and $b_{\text{OLS}} > b_{\text{IV}}$. Similarly, the estimated effect of the real minimum wage on total employment and the employment rate is much more negative using the real minimum wage than using the other proxies. No such consistent pattern arises with hours worked.

This comparison shows that if both the proxy and real minimum wage are uncorrelated with the error term, then OLS and instrumental variables (IV) estimations should give the same answer. The fact that they do not establishes that at least one and perhaps both estimators are biased. At the very least, this exercise establishes econometrically that not all of the proxies should be used.

Table 1 provides some clues as to which of the proxies is most suitable. It shows that the real minimum wage is associated with approximately equal and large changes in wages at all points in the distribution. This is implausible. Moreover, since the estimate is much more positive when the real minimum wage is used, the IV is biased upward relative to the OLS estimators. I would not be surprised if the real minimum wage and the error in the wage equation were positively correlated. Any error in the

price index will have the same effect on real wages and the real minimum wage. This, of course, does not demonstrate that the results are biased using any of the other indicators, but it points to the need for caution.

The approach in table 2 is much more compelling. It is comparable to the approach used in many recent papers in which authors examine a single change in the minimum wage. Those papers use some measure of how binding the minimum wage increase is and regress the outcome variable (for example, the change in employment) on that measure. The expectation under standard theory is that the employment change will be more negative (or less positive) in localities where the minimum is more binding. If, instead, the minimum wage fell, the employment change should be more positive (or less negative) in localities where the minimum wage is more binding. When the minimum wage does not change, there is no reason to expect the employment change to be greater or smaller when the minimum wage is more binding.

When one simultaneously examines periods of increase and decrease in the minimum wage, then the parallel to the modern approach is to regress the outcome measure (in this case, the wage change) on the measure of how binding the minimum wage is (in this case, the real fraction of workers affected), *interacted with the change in the minimum wage*. The analysis should thus focus on the column that shows the interaction between the real fraction of workers affected and the change in the minimum wage. I do not focus on the direct effect of the real minimum wage, which is biased, or on the direct effect of the measure of how binding the minimum wage is, for which there is no theoretical prediction.

The results indicate that an increase in the minimum wage raises wages more when the minimum wage is more binding (that is, the real fraction of workers affected is greater), which is what I would expect, and that this effect is greater at lower percentiles of the wage distribution, which is also what I would expect. The fact that a similar pattern arises for the coefficients on the real fraction of workers affected (that is, when the change in the minimum wage is zero) is somewhat disturbing. As noted, there is no obvious reason for the wage distribution to be compressing more when the minimum wage is more binding if the minimum wage is not changing.

All told, the paper makes a convincing case that the minimum wage in Brazil significantly compresses the wage distribution and that the ripple effects probably extend further up the wage distribution than in the United

States. This fits the fact that the minimum wage is often a benchmark wage for indexing in Brazil. Armed with this knowledge, I now turn to the employment effects.

I will not present the arguments for focusing on table 4 rather than table 3, which are similar to those for preferring table 2 to table 1—although the evidence for bias in table 3 is admittedly weaker than the evidence for table 1. This is largely because the estimates of the employment coefficients using the real minimum wage are very imprecise.

As with the wage effects, I focus on the interaction term in table 4. The results are similar to what I have claimed is the evidence for the United States. The effect on the employment rate is small and only significant at the 0.1 level. We can exclude an elasticity of employment with respect to the minimum wage of -0.1 , a traditional estimate of the U.S. elasticity, but not smaller elasticities consistent with more recent evidence.

This is the employment effect for all workers, many of whom are not affected by the minimum wage. Based on table 2, roughly half of Brazilian workers see a wage increase as a result of a minimum wage increase. For most of these workers, the increase is smaller than the minimum wage increase, but it appears that roughly half of workers get an increase averaging about 70 percent of the minimum wage increase. Using standard estimates of the elasticity of demand for labor, a 10 percent increase in the real minimum wage should generate an employment reduction on the order of one to two percent, which is much higher than the paper estimates. Thus this paper extends the U.S. finding that employment effects are smaller than implied by the simple labor demand model to a very different institutional setting.

The results show that the minimum wage law may have a modest effect on hours worked. The coefficient falls just short of significant at the 0.1 level. The total employment effect is significant at the 0.1 level and is noticeably larger than the effect on the employment rate. Because they are so marginally significant, I do not put too much faith in these results. If they hold up in other studies, however, they may help us better understand the mechanisms through which minimum wage laws affect the labor market.

My interpretation of the results is clearly somewhat different from the interpretation in the paper. This is, in part, because I believe that Sara Lemos has been more effective than she gives herself credit for in casting doubt on the range of minimum wage indicators by showing differences

in the results based on the range of indicators. It is also, in part, because I believe that a priori the interaction specification is the correct one and that the coefficient on which to focus is the interaction term. In any event, she has made the information available so that others can draw their own conclusions, making her contribution particularly valuable.

Finally, the paper does not seek to address the issue of winners and losers. We know that, as in the United States, the minimum wage compresses the wage distribution and that the overall employment effects are small. It is important to learn whether the minimum wage causes significant displacement and, if so, whether the workers who gain jobs are from more or less favored circumstances than those they displace.

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