Does an Increasing Minimum Wage Reduce Formal Sector Employment? Evidence from Brazil*

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Abstract

During the economic boom of the early 2000s, most Latin American countries increased their minimum wages. In Brazil, it increased by 62 percent (real) from 2003 through 2012. In this paper, we take advantage of matched employer-employee administrative data for this period to explore whether a rising minimum wage resulted in negative employment impacts in Brazil's formal sector. We first exploit the introduction of a 2000 law which allowed states to implement regional wage floors targeting workers in the accommodation and restaurant sector. As these floors vary in scope and size, we adapt Dube, Lester and Reich's (2010) empirical strategy and estimate the impact of the new law on employment by exploiting variation in micro-regions straddling state borders. We find no significant negative formal sector employment impacts, but note these floors were only introduced in a few states. We then explore different measures of the incidence of the national minimum wage across microregions and estimate its impact on formal sector employment, employment of affected groups and industries. We document negative aggregate elasticities, varying in statistical significance. We also exploit the longitudinal component of our data and find negative effects on low-skilled workers' intensive margin participation in the formal sector. Lastly, we uncover that microregions potentially less exposed to the 2000s commodities boom had larger, and statistically significant, disemployment effects. We note that the negative effects from the minimum wage may have grown as Brazil entered a recessionary period.

Keywords: Minimum Wage, Labor Market Regulations, Employment Effects.

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1 Introduction

Labor markets in Latin America are characterized by high employment costs and extensive regulations (Heckman and Pages 2000). A common feature in the region is the existence of legislated minimum wages, which, while varying in scope and extent across countries, directly affect wages of formal sector workers (Kristensen and Cunningham 2006). While this tool is also prevalent in developed countries, the estimated effects of the minimum wage on employment may differ across developed and developing countries, given the existence of a large informal sector in the latter (Welch 1976, Gramlich 1976).

In this paper, we examine the impacts of the minimum wage on various employment measures in Brazil, the seventh largest economy in the world, with an estimated total labor force well above 100 million individuals. Between 2003 and 2012, its real national minimum wage grew by 62 percent, far exceeding the country's cumulative economic growth in this time period (48 percent based on GDP, PPP constant 2011 dollars). Nonetheless, as Brazil's economic growth was fueled by a large commodity price increase and not all regions were able to benefit equally from this boom Benguria et al. (2018), the minimum wage increase could have had heterogeneous employment impacts across regions differentially exposed to this phenomenon. As a result, Brazil provides an interesting case study for exploring how a nationally-set minimum wage can have disparate impacts within a country.

To explore the effects of the minimum wage, we take advantage of matched employee-employer data (RAIS), which covers the universe of workers and firms in Brazil for the 2003-2012 period, allowing us to track workers' employment outcomes over times. Moreover, RAIS includes firms' sector classification as well as rich geographic information. Following the developed country literature, our initial empirical strategy takes advantage of the passage of a 2000 law which allowed Brazilian states to implement wage floors higher than the national minimum wage. Since then, five states have adopted such floors, which at times have exceeded the national minimum by 25 percent. These floors affect workers in specific occupations and industries, and the five states' laws cover different categories of workers, making it difficult to compare their impact across states. Nonetheless, all existing floors include provisions directly aimed towards workers in the restaurant

and accommodation industry.[1] As a result, we estimate the effect of the state-level wage floor on employment in this sector, by adapting the cross-state county-pair strategy proposed by Dube, Lester and Reich (2010) to the Brazilian context. We first identify microregions which lie on state borders and then estimate the effects of the wage floors on hotel and restaurant employment, by exploiting the introduction and subsequent increases in these floors after 2003. Although our final sample includes 89 microregions and 69 microregion-pairs, we also carry out our analysis at the municipal level, which expands our sample to include 1,109 municipalities.[2] To the best of our knowledge, this is the first paper which relies on sub-national variation to identify the effects of the minimum wage in Latin America. We find employment elasticities which are not statistically different from zero at both the microregion and the municipal level.[3] However, as this policy was only introduced in five states, this analysis may not fully capture the impact of the minimum wage on employment.

Given the limited scope of the regional wage floors, we extend our analysis to explore the effects of the minimum wage on state-level formal sector employment. We also examine its impact on particularly exposed groups, focusing on high school dropouts and on the accommodation and restaurant industry. Furthermore, we take advantage of the longitudinal component of RAIS by exploring the effect on employment transitions of low-educated workers. We carry out our empirical analysis using two different measures of the bite of the minimum wage at the microregion level, including the Kaitz index (ratio of the minimum wage to the average wage), and the toughness ratio (ratio of minimum wage to the median wage), and estimate the impacts across different fixed effect specifications. In our aggregate empirical results, we find negative elasticities of varying magnitudes on aggregate employment and employment of affected groups/industries. In our individual analysis, we identify all high school dropouts employed in Brazil's formal sector in 2003. We estimate their propensity of remaining in the formal sector in subsequent years and the number of months worked as a function of the different minimum wage bite measures. We do not find a significant effect

[1] The accommodation and restaurant industry is defined as a one-digit sector in Brazil.

[2] We exploit detailed geographic information in RAIS to estimate the impacts across Brazil's 559 microregions, which "group together economically integrated contiguous municipalities [in the same state] with similar geographic and productive characteristics" (Dix-Carneiro and Kovak 2017).

[3] Since the detail offered by maps of Brazilian states does not allow us to create a set of contiguous-border municipalities, we define the cross-border pairs at the micro-regional level even when estimating the model using municipal level data. There is further reason to believe that focusing on the microregional level is preferable, as this unit of analysis is similar across states in Brazil and avoids the large heterogeneity in Brazil's municipalities' population and employment patterns.

on formal sector participation, but we find a large negative effect on the intensive margin, though the point estimate is not significant. These results may potentially be explained by the interaction of the minimum wage and other regulations affecting formal sector firms in Brazil, such as high severance costs (Alaimo et al. 2017). As a result, Brazilian firms may find it optimal to reduce their workers' hours and/or months worked instead of incurring onerous severance payments. Lastly, we examine whether the concurrent commodity boom may mask the effect of the minimum wage on employment by exploring heterogeneous impacts across regions differentially exposed to the commodity boom. As we document larger negative elasticities in less exposed microregions, we argue that is possible that the minimum wage could have larger impacts during a recessionary period, like the one currently taking place in Brazil.

The paper proceeds as follows: Section 2 presents a brief discussion of relevant papers in this literature. Section 3 discusses the institutional context in Brazil, the relevant minimum wage and wage floor increases, the administrative data sources used in the paper and summary statistics. Section 4 first describes our contiguous microregion border pair strategy and displays our estimated results of wage floors on employment in the accommodation-restaurant sector. Section 5 presents our empirical strategy and results of the impacts of the national minimum wage on various employment measures. Lastly, Section 6 discusses the results and concludes.

2 Literature Review

The employment effects associated with minimum wages have long interested economists. Stigler (1946) argued that in a homogeneous labor market, this policy change would lead perfectly competitive employers to cut employment, particularly that of directly affected workers. Welch (1976) extended this analysis to include an uncovered sector with no minimum wage in place, where the imposition of a wage floor in the covered sector would reduce employment in this sector, yet increase it in the uncovered sector through the transition of displaced covered sector workers. This extension is particularly relevant for developing countries like Brazil, where the existence of a large informal sector, covering 49 percent of employment (Dix-Carneiro and Kovak 2017), allows firms to skirt compliance with the salary floor. In a context with heterogeneous workers, firms could additionally respond to the policy change by substituting away from low-wage workers towards

more productive ones, implying larger negative employment elasticities for lower paid workers.

In most developing countries, minimum wages are set at the national level and the the ability of sub-national governments to implement larger floors is often limited. As a result, the empirical literature exploring employment effects of minimum wages has largely relied on measures of the policy's "bite", using variables such as the Kaitz index or different toughness ratios. Both Lemos (2006) and Broecke et al. (2017) have conducted reviews of the literature in developing countries and found mixed results with respect to negative employment impacts. For instance, while Martinez et al. (2001) and Miranda (2013) find no direct effect of the Chilean minimum wage on aggregate employment, Wedenoja (2013) argues the policy had pushed workers to the informal sector. In Colombia, Arango and Pachon (2004) find negative effects on youth employment, whereas Gindling and Terrell (2007a) find negative employment effects in Costa Rica and Gindling and Terrell (2007b) find similar effects in Honduras.

An extensive literature has also analyzed the effects of the minimum wage on employment in Brazil. The minimum wage was initially implemented in 1940 at the state level, becoming uniform at the national level in 1984, with no sub-minimum or differentiated minimum wage rates for specific groups of workers. Various papers focused on the time period following the introduction of the national policy. For instance, Fajnzylber (2001) examined the 1982-1997 period and found a small employment elasticity in the range of -0.10, with larger effects for younger workers. Carneiro (2001) similarly found modest dis-employment effects of minimum wages and Lemos (2004) found a small negative impact on employment. More recently, Neumark, Cunningham and Siga (2006) found an employment elasticity of -0.07 using survey data from 1996 through 2001. In short, the early literature found the minimum wage resulted in modest to no dis-employment effects. In recent years, as inflation stabilized and economic growth picked up, the national minimum wage has increased significantly. Two recent papers have examined the employment impacts of the recent increases in Brazil. Jales (2017) using survey data follows a density discontinuity design and finds that the minimum wage increase over the 2001-2009 period resulted in the informal sector expanding by an additional 39 percent relative to a counterfactual without such increases.[4] On the other hand, Broecke and Vandeweyer (2016) estimate the impact of the minimum wage in six metropolitan

[4]As noted by Broecke et al. (2017), this paper follows a different empirical strategy than most of the existing literature, which may explain the large difference in its estimated effects.

regions and find no discernible impacts on youth employment and a small negative impact on formality, particularly for low-skilled workers. We extend these results by exploiting administrative information covering the entire country and alternative empirical methods. We next describe how the Brazilian minimum wage has changed in recent years and discuss the introduction of state-level wage floors.

3 Institutional Context and Data Sources

National Minimum Wage. As noted above, the Brazilian national minimum wage has undergone a significant increase in recent years: between 2003 and 2012, the real minimum wage grew by a total of 62 percent, reaching a value of 622 Brazilian Reais (410 PPP-adjusted U.S. dollars) per month by the end of the period. In fact, in 2006, the government introduced a rule to increase the minimum wage by the sum of inflation in the previous year and the average GDP growth rate in the two previous years. This rule has been renewed twice since and the minimum wage increases have often exceeded the minimum mandated by law. Furthermore, the Ministry of Labor often carries out inspections to ensure that firms are in compliance with minimum wage regulation (Almeida and Carneiro 2009). As a result of these changes, the minimum wage as a fraction of median earnings increased from 54 percent in 2003 to 65 percent by 2012.

Despite the recent increases, few formal sector workers are directly affected by the minimum wage. Engbom and Moser (2017) show that only five percent of workers had earnings within 5 percent of the minimum wage in the early 2000s, and this value had increased to just 6.1 percent by 2012. Nonetheless, as the authors show, the policy has had significant spillover effects across the wage distribution, thereby explaining part of the reduction in inequality in the early 2000s. Moreover, as first noted by Souza and Baltazar (1979), the minimum wage may have also affected informal sector wages through the "lighthouse effect". In fact, Camargo, Gonzaga, Neri (2001) have found the minimum wage to be more binding in the informal sector, where 15 percent of workers earn exactly one minimum wage. As a result, any negative employment effects in the formal sector may be potentially attenuated due to the lighthouse effect.

On the other hand, the minimum wage directly affects certain industries and groups in the population. For instance, cursory examination of RAIS data shows that 24 percent of low-skilled

workers in the formal sector (with less than a High School diploma) have monthly earnings at less than 110 percent of the minimum wage. Similarly, at the industry level, the low-wage nature of the tasks required in the accommodation and restaurant sector implies that workers in this sector are most exposed to the minimum wage. In fact, 39 percent of workers in the hotel and restaurant industry have earnings below 110 percent of the minimum wage. Lastly, as minimum wage changes directly increase labor costs, firms' entry and exit margins could be directly affected (Rohlin 2011). As a result, our empirical analysis also examines the impacts of this policy on firm entry and exit rates, a first in the developing country literature.

State-Level Wage Floors. In 2000, the Federal Government instituted a law which allowed states to introduce wage floors above the national minimum wage, which could selectively apply to certain occupations and/or industries. Since then, five states have introduced such policies: Rio de Janeiro in 2000, Rio Grande do Sul in 2001, Paran in 2006, So Paulo in 2007 and Santa Catarina in 2009. These states are all located in the Southeast region of the country and are among the richest states in Brazil. While this policy could theoretically allow us to exploit within-country variation in wage floors in our empirical analysis, estimating their impact is not straightforward, as the occupations and industries covered by the floors have varied across states and over time. For instance, while Rio de Janeiro's law defines the wage floor by occupational categories, Rio Grande do Sul's policy is defined at the industry level. Moreover, these policies include various wage floors for different categories of workers, and these categories have shifted over time, with Rio de Janeiro initially implementing three different wage floors but eventually moving to nine, and Paran going from five floors down to three (Corseuil et al. 2013).

Despite the heterogeneous implementation of the wage floor across states, all policies include explicit provisions affecting employment in the accommodation and restaurant industry.[5] Rio Grande do Sul, Sao Paulo and Santa Catarina include floors which directly affect workers in the "food" industry, and Rio de Janeiro and Paran include a floor for busboys, cooks and servers, which account for a large share of employment in restaurants.[6] As a result, we focus our empirical analysis

[5]Terrell (2009) provides extensive evidence as to the different wage floors implemented in each state and the extent to which they cover different occupations and/or industries. In our work, we have carefully parsed the provisions included in each of these floors and found that they all include provisions directly affecting workers in the accommodation and restaurant industry.

[6]Since other workers in this sector earn higher wages than busboys and servers (such as managers), we consider

on the employment effects of the wage floors which directly apply to workers in the accommodation and restaurant industry. We create a state-level wage floor variable, presented in Table 1, which tracks the relevant floor in each state for workers employed in this one-digit industry and compare it to the national minimum wage. Note that in the specific cases in which two different provisions apply to workers in this sector (such as in Rio de Janeiro, where one floor applies to busboys and a higher one applies to servers), our variable includes the lower of the two, though our empirical results are not sensitive to this choice. We also examine the effect of wage floors on employment in directly affected occupations within this sector, focusing on waiters, cleaning staff, hotel staff, busboys and dishwashers. We carry out our empirical analysis on a quarterly basis, further exploiting within-year variation in the minimum wage and the wage floors.

While our focus on this industry allows us to examine a context which should be directly affected by the policy, there is an ongoing debate in the literature about the effectiveness of the wage floors. Tepedino (2013) has found earnings spikes around the floors in the five states and Terrell (2009) has argued that state minimum wages have increased wages for directly affected workers. On the other hand, Corseuil et al. (2013) have found non-compliance with the floor in Parana and Sao Paulo. The potential lack of compliance with state-level wage floors is not in contrast with the application of minimum wages across the region. Maloney and Mendez (2004) have shown there is significant heterogeneity in the extent to which minimum wages are binding in Latin America.

Data Sources. We use data from the Relao Anual de Informaes Sociais (RAIS) database for the 2003-2012 period. RAIS contains linked employee-employer data from a mandatory annual survey filled by all registered firms in the formal sector in Brazil, thus covering all states in the Brazilian economy. Our empirical analysis at the state level uses data from 26 of the 27 states in Brazil (*unidades federativas*).[7] We further exploit the rich geographic information included in RAIS and also estimate our results at the microregion level, a similar level to Metropolitan Statistical Areas in the United States. This represents an important advantage over survey data, as we are able to correctly observe employment in finely defined geographic areas, which is a critical component of our main empirical strategy. The survey has been administered by the Brazilian Ministry of Labor

these floors as binding for any formal employment in the restaurant industry.

[7]Since we have missing data for the state of Pernambuco in 2010, we exclude it from the empirical analysis.

since 1986, and reached complete coverage of all firms by the national level by 1994. By 2003, the survey covered more than 95 percent of the formal universe of formal sector workers and firms. As the Ministry of Labor has been known to levy fines on late and/or inaccurate reports, firms tend to hire specialized accountants to ensure the correct completion of the RAIS survey, resulting in highly accurate data.

RAIS includes unique, time-invariant person identifiers, which allows us to construct a panel of workers over the relevant time period. We observe the start and end month for each job for each worker as well as individual-level characteristics such as their age, gender, educational level, and occupation. As a result, we are able to track individual workers' employment trajectories, both in the extensive and intensive margins, over the ten years covered by RAIS. Given their direct exposure to the minimum wage, we identify all high school dropouts who were employed in the formal sector for at least three months in 2003. We then track their employment outcomes through 2012, classifying them as not participating in the formal sector if they are not observed in RAIS, and by the number of months employed in their main job if observed. We note that this analysis is only possible with longitudinal data, as is the case with RAIS, providing an important advantage over cross-sectional data sources.[8] In terms of earnings measures, RAIS includes information on average gross monthly labor earnings including regular salary payments, holiday bonuses, performance-based and commission bonuses, tips, and profit-sharing agreements. Moreover, the data includes a unique establishment-level identifier, which allows us to construct a panel representing the universe of establishments and firms in Brazil, including information on their economic sector.[9] Furthermore, despite the fact the RAIS data is collected on an annual basis, we observe the dates of entry and exit for all workers, so we construct measures of all relevant employment indicators at the quarterly level. We note that our empirical results are robust across annual or quarterly specifications. For our aggregate employment measure, we use the number of full-time equivalent workers during the reference quarter, which adjusts for workers who were not employed for all three months in the quarter and/or for those working less than the standard 44 hours per week. For our measure of low-skilled employment, we use the number of full-time equivalent workers who have attained less

[8] Recent papers, including Clemens and Withers (2016), have explored the effect of the minimum wage on employment trajectories.

[9] We exclude observations which are missing either the firm or the individual-level identifier or those with missing values for earnings or dates of employment.

than a high school diploma. Furthermore, as noted above, our industry-level analysis focuses on all employment in the accommodation and restaurant sector.[10]

4 Employment Impacts of State-Level Wage Floors

The passage of the 2000 Law allowing Brazilian states to implement wage floors enables us to exploit variation in this policy within Brazil to examine employment impacts. Nonetheless, as only five states had implemented a floor prior to 2012, there is limited variation to carry out our analysis at the state level. Furthermore, there is significant heterogeneity in the potential effects of the wage floor within each state. For instance, within the state of *Sao Paulo*, in the microregion of Santos, 1.3 percent of formal sector workers earn wages lower than 1.1 times the minimum wage, whereas 14 percent do so in the *Capao Bonito* microregion. As a result, any empirical strategy analyzing the employment impacts of the minimum wage needs to correctly account for differences in employment levels and trends across microregions within each state. Ours does.

Our identification and empirical strategy directly follows Dube, Lester and Reich (2010). The authors propose exploiting variation in the minimum wage of counties sharing common state borders in the United States, which allows them to identify employment impacts under the assumption that bordering counties are appropriate controls for treated units. By focusing on contiguous counties, this approach directly controls for regional economic shocks affecting both counties across the border, a potential concern for empirical strategies including all counties. In this paper, we adapt their approach to the Brazilian context by identifying bordering microregions in states with wage floors between 2003 and 2012. While microregions represent a coarser level of geography than counties, an important advantage of focusing on this geographical level is that we can compare employment effects across units of similar economic importance, which is not possible at the municipal level, as there is vast heterogeneity in the size of these units across Brazil.

Figure 1 displays the location of the microregions included in our sample. The states with wage floors as well the bordering non-implementing states are both located in the Southeastern part of Brazil. As a result, our empirical analysis focuses on this region of the country. Bordering microregions are more similar to each other in terms of population, formal sector employment and

[10]This sector includes four different six-digit restaurant industries and four different six-digit hotel types.

employment in the hotel and restaurant industry vis-a-vis all microregions in states which have implemented a wage floor. Note that since each unit may belong to more than one pair, our final sample includes 89 microregions and 69 pairs. Moreover, our sample includes a microregion as many times as it borders contiguous units across the border, resulting in a final sample of 5,520 total observations.[11] Our estimating equation is as follows:

$$\ln\ y_{mpt} = \beta_0 + \beta_1 \ln floor_{mt} + \beta_2 \ln pop_{mt} + \theta_m + \tau_{pt} + \varepsilon_{mpt}. \tag{1}$$

In equation (1), the subscript m refers to a microregion, and y_{mpt} measures formal employment in the accommodation and restaurant industry in microrregion m, belonging to border-pair p in year t. θ_m is a microregion fixed effect and τ_{pt} represents pair-year fixed effects, which absorb regional economic shocks in each bordering pair. The first wage floor variable ($floor_{st}$) equals the lowest wage floor applicable to workers in the restaurant and accommodation industry. We also examine the effect of the wage floor on formal sector accommodation and restaurant employment in occupations whose average wages are either below 110 percent and 150 percent of the national minimum wage.[12] We follow Dube, Lester and Reich (2010) and cluster standard errors at the state and border-pair level, allowing us to account for serial correlation at the microrregion level. Furthermore, to confirm the robustness of our results, we estimate a standard minimum wage regression as follows:

$$\ln\ y_{mt} = \beta_0 + \beta_1 \ln floor_{mt} + \beta_2 \ln pop_{mt} + \theta_m + \lambda_t + \eta_m \times t + \varepsilon_{mt}. \tag{2}$$

We estimate (2) using two different samples: all microregions in Brazil and only microregions pertaining to the eight states which have either implemented a wage floor or border a state which has. Lastly, as noted above, we re-estimate equation (1) at the municipal level, which allows us to expand our sample to include 1,109 municipalities belonging to a microregion border pair.

[11] The 89 microregions belong to 138 unique cross-state border pairs. We examine employment impacts across ten years, for four quarters in each year, thus reaching a sample size with 5,520 observations.

[12] The set of relevant occupations in this sector earning below 110 percent of the minimum wage include cleaning staff, janitors, watchmen and hotel staff (miscellaneous). Occupations below 150 percent of the minimum wage include those above as well as cooks, chefs, waiters, barmen, tour guides and ticket operators.

Results. Table 2 presents the estimated employment effects of state wage floors on employment in the accommodation and restaurant sector. We follow a log-log specification to interpret the coefficients as employment elasticities. In Column (1) we show the results from our preferred strategy, which exploits differences in the wage floor across state borders. The estimated effect of the regional wage floor on microregion-level employment is not statistically different from zero. In fact, we find a very small positive employment elasticity, where a 10 percent increase in the wage floor is associated with an employment increase of 0.4 percent at the microregion. Similar to Dube, Lester and Reich (2010), we note that the estimated elasticity allows us to rule out negative employment elasticities lower than -0.15 at the 95 confidence level. As noted above, we also examine the effect of wage floors of directly affected occupations in this sector. Again, we find no evidence of a significant disemployment impact either for workers employed in occupations with average wages below 110 percent of the minimum wage or 150 percent of the minimum wage. The estimated elasticities are of a similar magnitude as those found in the first column.

While our results seem to indicate that there are no significant disemployment impacts associated with wage floors, we note the cross-border approach has been criticized by Neumark, Salas and Wascher (2017), who have argued this strategy fails to account for potential cross-border spillovers and at the same time may not include the appropriate set of counties as controls. Moreover, as ours is the first paper to estimate the impacts of wage floors at the sub-national level in Brazil, we further test the robustness of our results by estimating equation (2). The results presented in Column 4 include all microregions in Brazil. We find similar point estimates as in the first two columns, with an estimated elasticity not statistically different from zero. In fact, we can also reject employment elasticities lower than -0.26 at the 95 percent confidence interval. Nonetheless, as only five states had implemented a wage floor during the time period of interest, this specification includes a large number of microregions with no variation in the floor during 2003-2012. Therefore, we re-estimate equation (2) in column (5), only including microregions in the eight states which either implemented a wage floor or border one which has. Unsurprisingly, we find no evidence that state-level wage floors are associated with reductions in employment rates at the microregion level. In the last column, we provide further robustness of our results by re-estimating our cross-border pair strategy at the municipal level. This allows us to expand our sample, given the few microregions included in the original sample. In Column 6, we present the estimated employment impacts

from equation (1), and find a similar employment effects, which, while slightly larger in magnitude, are not statistically significant. As with the microregion level estimates, the results from Column 6 allow us to rule out employment elasticities lower than -0.26.

The empirical approach presented in this section has allowed us to follow the recent minimum wage literature by exploiting sub-national variation in minimum wages to estimate its impact on employment measures. However, these wage floors only affect a small share of workers in five states in Brazil and they may not be directly binding, as is common in the region. As a result, our empirical results may not be indicative of the aggregate impact of the minimum wage on formal sector employment in Brazil. We next explore the impact of this policy on various employment measures at the national level.

5 Employment Effects of National Minimum Wage

Since the minimum wage does not vary within Brazil, we identify its impact on employment by exploiting over time variation of different measures of its incidence within each microregion. By focusing on incidence measures at the microregion level, we are better able to capture the "bite" imposed by the minimum wage relative to measures at the state level, which would mask significant within-state heterogeneity in economic conditions. Moreover, to ensure the robustness of our results, we use two different measures of incidence, including the Kaitz index and the toughness ratio, as well as multiple outcomes of interest.[13] Our empirical equation is as follows:

$$\ln\ y_{mt} = \beta_0 + \beta_1 \ln mw_{mt} + \beta_2\ X_{mt} + \theta_m + \lambda_t + \varepsilon_{mt} \tag{3}$$

where ln y_{mt} represents each employment outcome, including microregion-level employment, employment in the accommodation and restaurant industry, and low-skilled worker employment. mw_{mt} denotes the two incidence variables and X_{mt} is the log of the state's population. θ_m represents microregion-level fixed effects and λ_t captures time fixed effects. Across all specifications, we cluster our standard errors at the microregion level.

[13] Estimating the effect of the minimum wage using different measures of incidence is of critical importance in the context of national-level variation in the minimum wage since variation in the incidence ratios is driven solely by variation in the denominator. As a result, comparing the effect across two incidence ratio allows us to better capture the effect of the "bite" of the minimum wage (Lemos 2006).

While equation (3) allows us to control for differences in employment levels across microregions, it does not control for heterogeneity in the evolution of employment outcomes across these units. To do so, we follow the existing literature and re-estimate the model including microregion-specific linear time trends:

$$\ln\ y_{mt} = \beta_0 + \beta_1 \ln mw_{mt} + \beta_2\ X_{mt} + \theta_m + \lambda_t + \delta_m \times t + \varepsilon_{mt} \tag{4}$$

Meer and West (2016) have argued that the inclusion of these trends ($\delta_m \times t$) attenuate the estimated impacts of the minimum wage if the policy directly affects employment growth rates rather than levels. As a result, by estimating both equations (3) and (4) we can check the robustness of our results against this concern.

We extend this empirical strategy to analyze how the minimum wage affects low-skilled workers' formal sector outcomes, focusing on a sample of low-wage workers who had high formal sector attachment in 2003. Our empirical strategy exploits variation in the minimum wage's incidence across microregions, thus creating counterfactuals for exposed workers' employment trajectories had they resided in areas with a lower "bite" of the minimum wage. We estimate the following regression:

$$y_{imt} = \beta_0 + \beta_1 \ln mw_{mt} + \beta_2\ X_{mt} + \theta_i + \lambda_t + \varepsilon_{imt} \tag{5}$$

where y_{imt} represents a dummy variable for low-skilled worker i's formal sector participation in year t, capturing extensive margin participation, and the number of months employed in the formal sector for intensive margin effects (equaling zero for those not in the formal sector). θ_i captures individual fixed effects. We note that the aggregate effects on low-skilled employment are a combination of the effect on workers who were initially employed in the formal sector in 2003, as in equation (5), and on formal sector entry rates for workers not in RAIS in 2003. Our longitudinal analysis focuses on the former of these two effects.

Results. The first panel of Table 3 presents the estimated impacts of the minimum wage on formal sector employment at the state level. The first two columns present the results from equation (3), where we find that a 10 percent increase in the Kaitz index implies a fall in state-level employment

of 2 percent, a result which is not statistically significant. Similarly, the estimated elasticity falls to -0.09 when defining the incidence variable as the minimum wage to median wage ratio, and the coefficient is not significant either. In columns (3) and (4), we present the results from equation (4), in which we find similar results to those in the baseline specification. For both the Kaitz index and the toughness ratio, the estimated elasticities are negative, in the range of -0.15, but not statistically significant. All in all, while the point estimates presented above are sizable and negative, they are not statistically different from zero.

In Panel B, we present the estimated impact of the minimum wage on employment in the accommodation and restaurant industry. As noted above, we focus on this sector for various reasons. First, starting with Card and Krueger (1994), a large share of the developed country literature has focused on employment in restaurants, allowing us to provide a better comparison of our estimated impacts to those in the existing literature. Furthermore, a large share of workers in this sector are directly exposed to minimum wage increases. Lastly, we can compare the national minimum wage results to those found for regional wage floors. Our estimates from equation (3), presented in the first two columns, show that a 10 percent increase in the Kaitz ratio is associated with a drop in employment in this sector of 5 percent, which is larger than the estimated elasticity for overall employment, and is statistically significant at the 5 percent level. However, when we focus on the ratio of the minimum wage to the median wage, the estimated coefficient falls to -0.39 and is no longer significant. In our estimates from equation (4), we also find negative, yet smaller and non-significant elasticities. We note that the existing literature has largely estimated models such as equation (4), which implies that the negative impact presented in Column (1) likely represents an over-estimate on the employment effects arising from the minimum wage in this sector. To the best of our knowledge, this is the first paper which has analyzed the effects of the minimum wage on this industry in Latin America, allowing us to examine its impact on a sector directly exposed to this policy, as in the developed country literature (Card and Krueger 1992, Card and Krueger 2000, Dube, Lester and Reich 2010).

By exploiting information on observable characteristics in our data, we examine the impacts of the minimum wage on the employment of workers with less than a high school degree, who are more likely to be directly affected by changes in this policy. In our estimates from equation (3), presented in Panel C, we find large negative impacts of the minimum wage, such that across both the

Kaitz and toughness ratio, the estimated employment elasticity exceeds -0.18. The point estimate associated with the Kaitz index is significant at the 10 percent level. Upon including linear trends, the estimated coefficients become slightly smaller in magnitude and are no longer significant. The results presented in Table 3 are in line with our aggregate employment estimates: across various specifications we document negative elasticities, although, in general, there is no evidence the major increase in minimum wage had a statistically significant effect on formal sector employment, even for particularly exposed groups. Our results are also consistent with Broecke and Vandeweyer's (2016) finding of no significant impacts on either formal sector or teenage employment using PME data. Engbom and Moser (2017) find similar results on formal and informal sector employment over the 1996-2012 period. At the same time, after we control for state specific time trends, we find no large disemployment effects in the hotel and restaurant industry.

We extend our analysis by exploring the effect of the minimum wage on individual workers' employment trajectories during our period of interest. As noted above, equation (5) allows us to capture part of the aggregate employment effect by focusing on the consequences for workers with high formal sector attachment in the baseline year. We present our results in Table 4. The first two columns present the effect on low-skilled workers' formal sector participation. Analyzing the effect on extensive margin participation is of critical importance in Brazil, given the various benefits associated with formal sector employment, including social security and unemployment insurance benefits, annual bonuses and annual leave. We do not find a significant effect on this margin, however: neither of the incidence measures indicates that the minimum wage reduced low-skilled workers' formal sector participation. In the last two columns, we focus on a measure of intensive margin participation, defined as the number of months employed in the formal sector. This analysis has previously interested the minimum wage literature, as firms may find it easier to adjust workers' hours or months worked rather than directly firing workers. We find sizable effects on the intensive margin, where a one percent increase in the Kaitz ratio is associated with an average reduction in 0.18 months worked per year, with the toughness ratio delivering similar results. While the results are not statistically significant, as we cluster our standard errors at the microregion level, we highlight their economic significance since an important part of the aggregate effects presented in Table 3 can be explained by a drop in low-skilled workers' intensive margin participation, with

no discernible effect on their overall participation in the formal sector.[14] As Brazil imposes large severance payments on formal sector firms, we note that the results in Table 4 may be explained by firms being unwilling to incur these costs as a response to the minimum wage, but instead opt for reducing low-skilled workers months worked or hours.[15]

While we have so far found negative employment elasticities for the effect of the minimum wage on aggregate and exposed-group employment, the statistical significance and economic magnitude of these results varies across specifications. During our time period of interest, Brazil's economy underwent a significant economic boom, which may mute the potential effects of the minimum wage during a downturn. While equations (3) and (4) directly control for time trends in the economy, these specifications do not allow us to discern whether there are heterogeneous effects across regions with differential exposure to the boom in commodities. As a result, we follow Benguria et al. (2018) and re-estimate these two equations at the microregion level, interacting minimum wage incidence measures with a variable which exploits regional variation in exposure to commodity prices.[16] Our measure of exposure follows from Brazil's 1996 Agricultural Census, where we observe the share of each microregion's land area used in the agricultural sector, allowing us to split the sample of 559 microregions into a low- and a high-commodity-exposure group given the share of land used in this sector.[17]

We present our empirical results in Table 5 for aggregate formal sector employment, low-skilled employment and employment in the restaurant and accommodation industry, as in Table 3. We estimate the results using both the Kaitz ratio and the toughness ratio. Across the three employment indicators, we find larger negative employment elasticities is microregions which which were less exposed to the commodity boom in Brazil during 2003-2012. This result holds across both minimum wage definitions. For instance, we find that a 10 percent increase in the Kaitz ratio in column (1)

[14] The results become significant once we cluster standard errors at the individual level, however. These results are available upon request.

[15] An additional path through which the minimum wage could affect labor markets is by through firm entry and exit rates. As there are limited data sources with information on firm dynamics, few papers have explored the impact of minimum wages on this employment margin. We have estimated regressions following the structure of equations (3) and (4), using annual firm entry and exit rates as the outcome variables and found no significant effects on this dimension. The results are available upon request.

[16] Benguria, Saffie and Urzua (2018) examine both theoretically and empirically the role of labor markets in the transmission of commodity price super cycles. Our results are consistent with their findings, although we do not directly study the effect of the cycle in the context of the Brazilian economy.

[17] A microregion is defined as a low(high)-commodity-exposure area if its share of land used in this sector in 1996 was below (above) the overall median.

is associated with a drop in formal sector employment of 3.5 percent in less exposed microregions, but only with an insigificant employment fall of one percent in more exposed ones. We find larger estimated elasticities for high school dropouts, who were most exposed to the minimum wage. In Column (3), we find that a 10 percent increase in the Kaitz ratio resulted in a 5.5 percent reduction in employment for this group, in less exposed microregions. The estimated impact is larger than for highly exposed microregions, though the effect for the latter group is still significant. The final two columns show the estimated impacts in the accommodation and restaurant industry. We find larger employment effects in less exposed microregions, which again indicates that a minimum wage which is set nationally may have disparate impacts within a country, depending in particular on local economic conditions. While the results presented in Table 5 do not offer conclusive evidence as to the source of limited employment impacts arising from the minimum wage increase, they suggest that it is possible that there will be larger impacts as Brazil has recently entered a recessionary period, partly driven by a sudden drop in commodity prices. These results correspond with recent findings by Clemens and Wither (2016) who find larger negative employment elasticities in U.S. states which were harder hit by the Great Recession.

6 Conclusion

Latin American countries have an extensive number of regulations in place aimed at protecting formal sector workers. Chief among them is the minimum wage, which, while varying in size across the region, underwent significant increases in most countries during the sustained economic expansion of the early 2000s. Brazil is a prime example of this trend, with an almost-doubling of the real minimum wage from 2003 through 2012, coupled with the introduction of regional wage floors. In this paper, we have taken advantage of administrative data to explore whether the minimum wage or the regional wage floors have resulted in negative employment effects in the formal sector. We carried the first sub-national analysis of the minimum wage in Latin America, by exploiting variation in wage floors across states in Brazil. While these floors vary in scope across states, we have found that all states include provisions directly targeting workers in the accommodation and restaurant sector. By correctly identifying microregions straddling state borders with differential wage floors from 2003 through 2012, we have been able to adapt the empirical framework proposed

by Dube, Lester and Reich (2010) to the Brazilian context. The lack of limited employment impacts we found using this strategy may be explained by the limited scope and incidence of the regional wage floors.

As a result, we have examined the effect of the national minimum wage on various formal sector employment measures, including low-wage workers' employment transitions, a first in the developing country literature. We found negative employment elasticities in the microregion-level analysis as well in our longitudinal estimates, with varying statistical significance. Nonetheless, Brazil's sustained economic expansion during our time period of analysis brings into question whether these effects would be larger during a downturn. The estimates showing that employment impacts were significantly larger in microregions less exposed to the economic boom experienced in the early 2000s (see also Benguria et al. 2018) indicates that as the country's external shocks have changed in the past few years, it is possible that formal sector employment will suffer due to the large minimum wage. While there is still further work needed in this area, this paper has provided an important advance towards better understanding the impact of minimum wages in Latin America.

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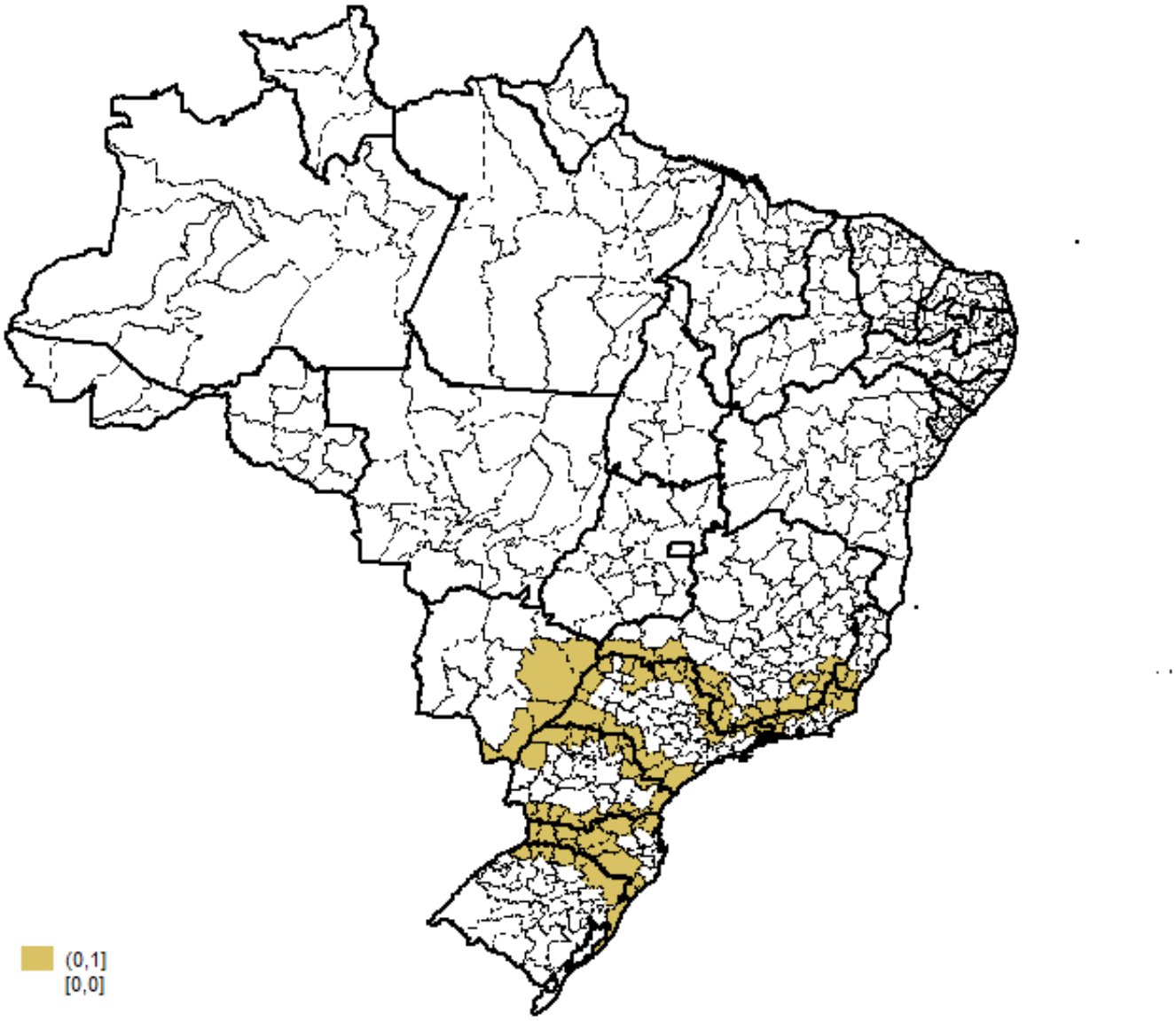
Figure 1: Microregions Included in Cross-Border Sample



Note: Figure 1 presents a map of all microregions in Brazil. As discussed in the text, microregions are a combination of municipalities in the same state and are commonly used as definitions of local labor markets. The highlighted microregions represent the sample included in our cross-border microregion-pair empirical strategy.

Table 1: National Minimum Wage and State Wage Floors in the Accommodation-Restaurant Sector

Year	Minimum Wage	Rio de Janeiro	Rio Grande do Sul	Sao Paulo	Santa Catarina	Parana
2003	240	275	312	240	240	240
2004	260	305	338	260	260	260
2005	300	326	374	300	300	300
2006	350	370	406	350	350	429
2007	380	424	430	415	380	464
2008	415	470	477	450	415	531
2009	465	512	511	505	465	610
2010	510	582	546	560	587	688
2011	545	640	610	600	630	736
2012	622	730	700	690	700	814

Note: Table 1 presents the evolution of the national minimum wage alongside the wage floor applicable to workers in the hotel and restaurant sectors for states which implemented a floor by 2012. For the years in which one of these five states had not yet implemented a wage floor, we national minimum wage to bind wages from below. The values presented in this table represent the annual average of the minimum wage and the wage floors over four quarters in each year. As discussed in the text, in the specific cases in which two different wage floors apply to workers in this industry, this table includes the lowest value. We note, however, the empirical results are not sensitive to this choice.

Table 2: Estimated Elasticities of Wage Floor on Employment in Accommodation and Restaurant Industry

	Microregion Estimates					Municipal Estimates
Sample	Cross-Border Pair			All States	Eight States	Cross-Border Pair
	Equation (1)			Equation (2)		Equation (1)
Outcome	Employment	110% Occs.	150% Occs.	Employment	Employment	Employment
	(1)	(2)	(3)	(4)	(5)	(6)
Wage Floor	0.045	0.030	0.067	0.040	0.039	0.112
	(0.092)	(0.097)	(0.096)	(0.158)	(0.133)	(0.183)
Population	0.823	1.082	1.007	-0.084	0.481	-0.598
	(0.506)	(0.596)	(0.471)	(1.144)	(0.733)	(1.005)
Observations	5,520			21,360	10,600	70,360

Standard errors in parentheses: * p < 0.1, ** p < 0.05, *** p < 0.01.

Note: Table 2 presents the estimated impacts of the state-level wage floors on employment in the accommodation and restaurant industry on a quarterly basis from 2003 through 2012. The results presented in the first three columns follow the cross-border microrergion-pair empirical strategy. These results include 89 different microregions which belong to 69 different pairs, resulting in a full sample with 5,520 observations. As discussed in the text, occupations included in the 110% sample include cleaning staff, janitors, watchmen and hotel staff (miscellaneous). Occupations in the 150% include those in the 110% sample as well as cooks, chefs, waiters, barmen, tour guides and ticket operators. The second set of results includes 539 of the 559 microregions in Brazil for which we have information on formal sector employment. Column 5 includes 265 microregions in the eight states which have either implemented wage floors or border a state which has. The final column re-estimate the cross-border microregion-pair approach at the municipal level, expanding our sample to include 70,360 observations. Both the minimum wage measures and the employment variables are defined as natural logarithm variables. Standard errors are robust and clustered at the state and border-pair level.

Table 3: Employment Impacts of the National Minimum Wage

Panel A. Microregion-Level Formal Sector Employment

	Baseline Specification Equation (3)		Linear Trend Specification Equation (4)	
Variable	(1)	(2)	(3)	(4)
Kaitz Index	-0.217		-0.103	
	(0.186)		(0.106)	
Toughness Ratio		-0.094		-0.179
		(0.246)		(0.121)
Population	1.040	1.539	-1.135	-1.465
	(1.125)	(1.613)	(0.589)	(0.662)**
Observations	21,560		21,560	

Panel B. Hotel and Restaurant Employment

Variable	(1)	(2)	(3)	(4)
Kaitz Index	-0.514		-0.108	
	(0.206)**		(0.134)	
Toughness Ratio		-0.390		-0.053
		(0.235)		(0.132)
Population	0.020	0.466	-2.086	-1.857
	(0.989)	(1.289)	(0.716)***	(0.690)**
Observations	21,560		21,560	

Panel C. Low-Skilled Employment

Variable	(1)	(2)	(3)	(4)
Kaitz Index	-0.313		-0.095	
	(0.174)*		(0.141)	
Toughness Ratio		-0.178		-0.078
		(0.206)		(0.150)
Population	1.834	2.385	-0.676	-0.607
	(0.824)**	(1.122)**	(0.793)	(0.917)
Observations	21,560		21,560	

Standard errors in parentheses: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Note: Table 3 presents the estimated impacts of the national minimum wage on formal sector employment at the microregion level on a quarterly basis from 2003 through 2012. The results include 26 of the 27 states in Brazil. Both the minimum wage measures and the employment variables are defined as natural logarithm variables. Standard errors are robust and clustered at the microregion level. Panel B measures total employment in the accommodation and restaurant sector, and Panel C estimates the effect on formal sector employment of workers with less than a high school degree.

Table 4: Effects of Minimum Wage on Low-Skilled Workers' Labor Market Transitions

	Formal Sector Employment		Months Employed	
Variable	(1)	(2)	(3)	(4)
Kaitz Index	0.008		-0.175	
	(0.037)		(0.300)	
Toughness Ratio		-0.006		-0.191
		(0.031)		(0.275)
Population	-0.596	-0.615	-3.578	-3.944
	(0.116)***	(0.128)***	(1.600)**	(1.582)**
Individual FE	✓	✓	✓	✓
Year FE	✓	✓	✓	✓
Observations	19,185,720		19,185,720	

Standard errors in parentheses: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Note: Table 4 presents the estimated impacts of the national minimum wage on formal sector employment outcomes for workers who had not completed high school in 2003. The empirical strategy tracks subsequent employment outcomes for these workers through 2012, both in the extensive and intensive margins. The results include 26 of the 27 states in Brazil. The minimum wage measures are defined as natural logarithm variables. Standard errors are robust and clustered at the microregion level.

Table 5: Estimated Elasticities of Minimum Wage on Microregion Employment by Commodity Exposure

Employment Measures	Formal Sector		Low-Skilled		Hotel and Restaurant	
Variable	(1)	(2)	(3)	(4)	(5)	(6)
Low Exposure × Kaitz	-0.336		-0.566		-0.367	
	(0.112)***		(0.155)***		(0.190)*	
High Exposure × Kaitz	-0.097		-0.401		-0.032	
	(0.166)		(0.173)**		(0.349)	
Low Exposure × Toughness		-0.368		-0.581		-0.276
		(0.089)***		(0.140)***		(0.159)*
High Exposure × Toughness		-0.163		-0.338		0.073
		(0.133)		(0.151)**		(0.296)
Population	-0.046	-0.048	0.069	0.071	0.625	0.629
	(0.119)	(0.118)	(0.312)	(0.313)	(0.517)	(0.515)
Observations	21,560		21,560		21,560	

Standard errors in parentheses: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Note: Table 5 presents the estimated impacts of the national minimum wage on formal sector employment at the microregion level on a quarterly basis from 2003 through 2012. The results include 539 of the 559 microregions in Brazil for which we have information on formal sector employment. Both the minimum wage measures and the employment variables are defined as natural logarithm variables. The results follow from the estimation of equation (4). The results are similar in equation (3) and are available upon request. We define exposure to the commodity boom by the microregion's land area used actively in agriculture, as in Benguria, Saffie and Urzua (2017), and split the sample in half by lowly- and highly- exposed microregions. Standard errors are robust and clustered at the state level.