Slum Dwellings and the Minimum Wage:

An Analysis Using Evidence from Brazil*

Santiago Robertson-Lavalle
Department of Economics
Princeton University
Advisor: Professor Leah Boustan
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This paper represents my own work in accordance with University Regulations.

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Abstract

In this paper, I study whether the consistent increase in the minimum wage in Brazil from 2000 and 2010 has reduced slum dwelling. To do so, I exploit regional variation in the impact of national minimum wage increases, which arise from differences in wage distributions across Brazilian municipalities. I find that poorer municipalities see a larger impact from the national minimum wage increase and thus more slum reduction than wealthier municipalities. This supports the economic intuition central to this paper that housing condition is a normal good and when wage increases, slum dwellers seek better living conditions. Spillover effects seem to be rather small, which is in line with existing literature.

I. Introduction

In 2016, the United Nations (UN) determined that one in eight people live in slums, for a total of slightly under one billion people on the planet. While the percentage of the urban population living in slums decreased from 39% to 30% between 2000 and 2014, in absolute terms the number of people living in these conditions continues to increase (UN 2016). Slums are overcrowded living communities, usually made of substandard materials, that lack basic urban services such as running water, electricity, and sewage disposal, leading to dangerous and unsanitary living conditions. In the hopes of creating a formal framework to define slum-like dwellings, the United Nations (2003) uses various characteristics such as lack of basic services, inadequate building structures, and social exclusion as parameters. It is most often the poor and the marginalized who reside in slums; the billion aforementioned people are quite literally pushed to the margins of cities and forced "to occupy places…unfit for habitation – for example, the rubbish dumps in Manila, the Philippines; flood-prone lands in Dhaka City, Bangladesh or Mumbai; the polluted shorefronts of Asuncion, Paraguay; or the steep hillside *favelas* of Rio de Janeiro, Brazil" (UN 2003). Brazil presents an interesting case because *favela* growth does not discriminate in terms of location. In the 1970s and 1980s, *favelas* swept into all parts of the country. In areas wealthy and poor, coastal and inland, "favelas sprout[ed]…wherever there [was] an empty and unprotected lot" (UN 2003). In major cities like São Paulo, the slums often consist of buildings with rented rooms in areas near the city center. Since the proliferation of *favelas* in 1970s and 1980s, the wealthy and public authorities have pushed many slum dwellers to the poorest, most destitute areas of the country. Still, many *favelas* including the two largest, Heliópolis and Paraisópolis, remain near major cities as slum dwellers resist being forced out, gripping to the benefits and job possibilities that come with being near a city (UN 2003).

Brazil is also particularly interesting from an economic point of view because since 2000, Brazil has seen a consistent and meaningful increase in real minimum wage. Lemos (2004) writes that minimum wage adjustment is the Brazilian government's main mechanism to impact wage distribution without harmfully affecting jobs. "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 anti-inflationary policy" (2004).

In this paper, I study the effect that raising the statutory minimum wage has on slum dwelling. This paper will answer the following research question: Has the consistent increase in minimum wage in Brazil in the years between 2000 and 2010 caused a reduction in slum-like living? If it does, this would imply that Brazilian policymakers could use the minimum wage as a tool to alleviate poor living conditions for their people. The economic intuition is as follows: housing is a normal good and, thus, as long as minimum wage increases the income of slum-dwellers, it is likely that raising the minimum wage will reduce slum dwelling. Of course, it could also be that the higher minimum wage causes some workers to lose their jobs and thus be pushed further away from the economic opportunity that would allow them to escape slum-like conditions. This would imply that if the government wants to improve living conditions for its people, minimum wage would not be the appropriate mechanism to do so.

To answer the research question, I exploit the fact that low-wage municipalities are more impacted by a statutory minimum wage increase than are higher-wage municipalities. The interaction of municipal variation in wage levels and a national statutory minimum wage creates variation across municipalities in "effective" regional minimum wage, which enables a distinction between a national growth trend and a minimum wage effect. Through a difference-in-differences approach, I use the differential impact of the federal minimum wage across

municipalities in Brazil to estimate the contribution that the large increase in minimum wage from 2000 to 2010 has had on slum dwelling in four distinct simulations. First is the scenario where there are spillover effects, meaning that the minimum wage affects those below the new wage floor and also "spillover" causes the new wage to affect some people above the new minimum wage. Secondly is the case where only those below the new wage floor are affected by the change. Third is the scenario where anyone below the 2000 minimum wage is not affected by the change in the minimum wage; this would mean that only those above that 2000 wage level and below the 2010 wage are affected by the change in the minimum wage. Finally, I look at the extreme case where only those below the 2000 minimum wage are affected by the change in minimum wage. Given the extent to which Brazilian municipalities were affected by the change in wage, I look to see if there is a relationship between those who are most affected and how their living conditions change in the ten-year period studied. Results are statistically and economically significant: those municipalities who were most affected by the increase in the minimum wage were those who saw the greatest reduction in slum-like dwelling.

II. Literature Review

Though minimum wage and slum living has been frequently studied in Brazil, very little research has been done regarding the connection between the two; this paper aims to fill that gap.

II.A Slum Dwelling in Brazil

This paper is the first to study the connection or lack thereof between minimum wage and slum dwelling. Current research uses macro-level statistics to examine Brazilian housing; by contrast, this paper adds a micro-level study to the conversation regarding slum trends in Brazil as it considers variables that define Brazilian living conditions like building structure and access to piped water. Tiago Cavalcanti, Daniel Da Mata, and Marcelo Santos (2019) – henceforth

referred to as CDS – construct a model city to explain the determinants of slums; they "show that urban poverty, inequality and rural–urban migration explain much of the variation in slum growth in Brazil from 1980 to 2000." To do so, CDS consider variables such as land supply, real interest rate, labor share in production, total factor productivity, income ratio, income tax rate, and property tax rate among other factors to create a model city – a model city that aims to shed light on real trends in *favela* growth. Juan Pablo Chuavin, Edward Glaeser, Yueran Ma, and Kristina Tobio (CGMT) examine factors such as population density, wages, and city size to compare Brazil, China, India, and the USA's urbanization. CGMT's (2016) main finding is on population density across city sizes: urban economists have previously accepted Zipf's Law, which states that the most populous city is two times more populated than the second most populous city and three times more populated than the third most populous city, but CGMT find that, "standard statistical tests reject the hypothesis that China, India and the U.S. are characterized by the same power law distribution" (2016). This type of observation is particularly relevant when slum dwellers are considered in economic studies. Researchers often challenge whether or not census surveyors undercount the residents of urban slums, impacting the calculation necessary to consider Zipf's Law (CGMT 2016).

II.B Minimum Wage in Brazil

This paper looks to minimum wage and its connection to well-being, but more specifically it is the first to measure well-being in the form of living conditions, which is largely a result of inequality and marginalization. Engbom and Moser (2018) write about minimum wage, but only as it relates to inequality in Brazil. The authors write that the nominal minimum wage in Brazil is set at the federal level and is given in the form of a floor payment a laborer earns in a month's

time. It is adjusted once a year using a formula that takes into account realized inflation from the previous year and realized GDP growth from two years prior.

This paper makes an advance in the literature as it looks beyond inequality, more specifically to the effect of minimum wage on slum dwelling. It reveals the connection between minimum wage effects and living condition in Brazil. This is a question that follows from existing literature: Lemos (2004) finds that an increase in minimum wage compresses the wage distribution in Brazil with only small negative effects on national employment. She writes, "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." She goes on to say that this may be counterintuitive because "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." My paper adds to this conversation by illuminating whether or not these spillover effects are seen when studying slum dwelling.

III. Data

III.A Data Description

The data for this paper is from the Brazilian Institute of Geography and Statistics (*Instituto Brasileiro de Geographia e Estatística,* IBGE). It is microdata at the household/dwelling level from the census of Brazil and the best information on living conditions of the population in all of the nation's municipalities. It is a decennial survey that collects information on housing units, international emigration, characteristics of residents, and composition of housing units. The IBGE describes the microdata as, "the lowest level of disaggregation of the data of a survey,

representing, in the form of numerical codes, the content of the questionnaires and preserving the statistical confidentiality aiming at the non-individualization of the information." The data set used for this paper is taken from Integrated Public Use Microdata Series (IPUMS) International and contains two time periods of census data, specifically the 2000 and the 2010 censuses. This ten-year period is the most recent data available and captures a large increase in the minimum wage. The households observed in 2000 serve as the "untreated group," while the 2010 households serve as the "treated group." Data on the minimum wage, both nominal and real, is from the Institute of Applied Economic Research (*Instituto de Pesquisa Econômica Aplicada*, IPEA) website, which has official government economic and financial data from Brazil.

III.B Relevant Variables

To define a slum, I adapt the UN's and the IBGE's definition to the census data available. As such, this paper necessitates variables that meaningfully characterize slum-living. Specifically, the census data in 2000 and 2010 categorize households by dwelling type, wall material, water provisioning type, and whether or not the dwelling has electricity. The census also divides Brazil into twenty-five regions and over 2,000 municipalities, grouping small bordering municipalities together. Important to this paper is the municipality-level division, for reasons discussed in the "Literature Review" and "Methodology" sections. Finally, variables regarding wage and number of hours worked by each individual are relevant to the analysis in this paper. Since the Brazilian minimum wage is determined as an amount per month, the hourly minimum wage is computed from the data. The calculation is adjusted for inflation using 2000 as the base year, and it assumes forty-four hours per week to be the full work week, as defined by the Brazilian constitution since September 1988 (Lemos 2004).

As mentioned in the "Introduction," the United Nations defines "slum" through various specific characterizations. Similarly, for the first time in the 2010 census, the IBGE deemed whether a household was a slum or not. The IBGE used water supply system, sanitary sewage type, garbage disposal and electric services to make the determination. This is important to this paper because the IBGE, for the first time in history, gave indication as to what the Brazilian government deemed adequate and inadequate living conditions for its people. For example, for water supply, it deemed the following inadequate: "well or source on the property; well or spring off property; carro pipa; rainwater stored in a cistern; rainwater otherwise stored; rivers, dams, lakes and streams" (IBGE). The IBGE wrote, "this approach has made it possible to set up a general framework for services provided to households in 'subnormal clusters.'" In a similar way, the United Nations (2003) uses construction materials to determine a slum: slums are "often built with non-permanent materials unsuitable for housing given local conditions of climate and location." Much like the IBGE and the UN, this paper adapts these specific definitions to the available Brazilian census data to determine slum-like conditions at the household level. To implement this approach, this paper uses a dummy variable to determine whether a household can be deemed a slum-like dwelling. Utilizing variables like water provisioning, electricity, and wall material, I determine whether the household, with its unique household ID, can be deemed a slum dwelling (1) or not (0). More specifically, if a household has no walls, no access to piped water (at all or in the building), or no electricity at all, I deem it a slum. Summary statistics at the national level of important variables are found in Table 1. For the purpose of the table, I assume that those who are below the 2000 minimum wage or those who are making an average hourly income between the 2000 minimum wage and the 2010 minimum wage are individuals who are affected by the change in the minimum wage.

Table 1: Summary Statistics – Using National-Level Census Data*

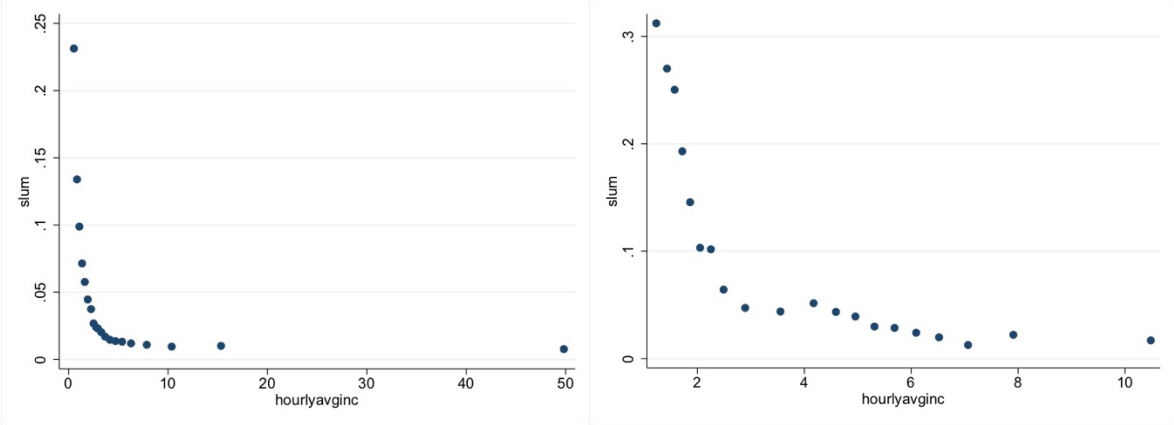
	2000		2010	
	(n=9,875,625)		(n=8,792,018)	
	(1) Mean	(2) SD	(3) Mean	(4) SD
% of People Living in a Slum Dwelling	9.57	29.4	2.10	14.3
Average Hourly Income (*reais*)	3.85	15.1	6.99	59.3
% of People Unemployed	8.79	28.3	3.37	18.0
% of People Who are Wage Workers	37.9	48.5	53.3	49.8
% of People Affected by a Change in Minimum Wage	70.0	45.8	-	-

*Note: Hourly minimum wage for 2000 is .7897879 *reais* and 2.667496 *reais* in 2010. The calculation is adjusted for inflation using 2000 as the base year, and it assumes forty-four hours per week to be the full work week, as defined by the Brazilian constitution since September 1988. **Table 1** assumes that those who are below the 2000 minimum wage or those who are making an average hourly income between the 2000 minimum wage and the 2010 minimum wage are individuals who are affected by the change in the minimum wage.

Figures 1.a and 1.b show the probability that a household is a slum-like dwelling at a given income level. More specifically, Figure 1.a looks at individual households and buckets households into groups based on the household's earned average hourly income. Figure 1.a then plots those buckets against the probability that the households in their respective income buckets are slum-like dwellings. Fig 1.b depicts the exact same procedure but rather than bucketing households into groups of similar average hourly income, it buckets based on the average hourly income of a municipality. Both at the household and the municipality level, one can see a trend that resembles that of exponential decay. This is what one would expect: as average hourly income increases, the probability of a household being a slum-like dwelling decreases drastically.

Fig. 1.a Bin-Scatter at the Household Level*

Fig. 1.b Bin-Scatter at the Municipality Level*



*Note: The graphs above are bin-scatter plots with probability of living in a slum-like dwelling on the y-axis and average income at an hourly rate on the x-axis. Data points are grouped into bins and an aggregate statistic is used to summarize each bin. **Fig. 1.a** reflects the procedure done at the household level, whereas **Fig. 1.b** reflects the procedure done at the municipality level.

The kernel density graphs in Fig 2.a and Fig. 2.b compare just three municipalities (out of over 2,000 municipalities in the data set) in the years 2000 and 2010, two of which are fairly low-income, and one which is relatively wealthy. Fig 2.a shows the three municipalities before the minimum wage increase and 2.b shows the three after the minimum wage increase. The plots are included to help visualize the methodology used in this paper: municipalities that have kernel density peaks at or left of the vertical line on the left (that represents 2000 minimum wage), are municipalities where, in theory, one would expect to see the greatest impact of a change in the minimum wage. This paper answers the following question: Are those municipalities that are most affected by a change in the minimum wage the municipalities that have seen the largest amount of slum dwelling reduction in the years 2000 through 2010?

Figure 2.a*:

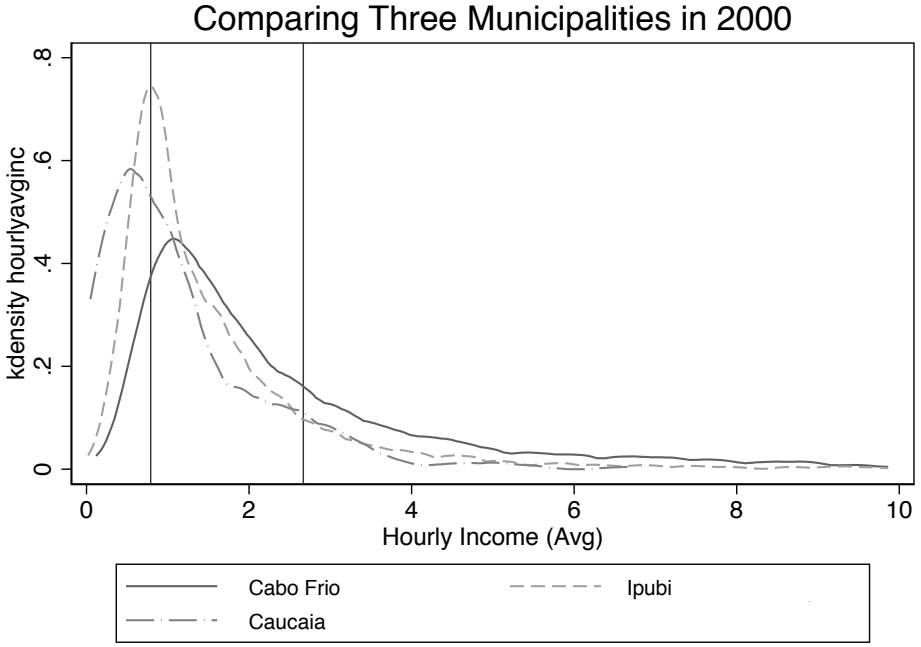
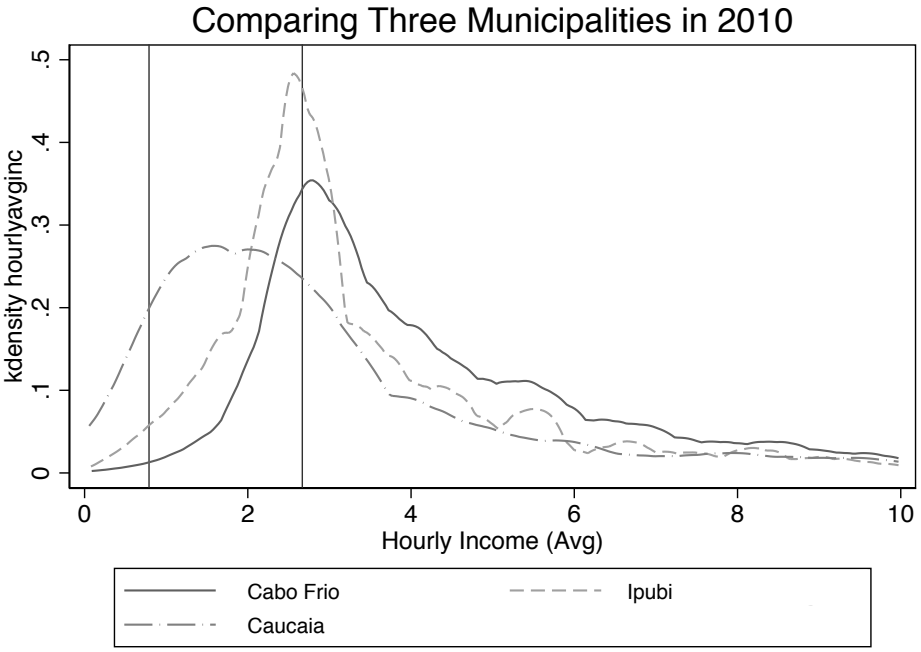


Figure 2.b*:



*Note: **Fig 2.a** and **Fig 2.b** are kernel density graphs with the kernel density of hourly average income on the y-axis and average income at an hourly rate on the x-axis. The vertical lines denote the minimum wage. The line to the left is the 2000 minimum wage and the line to the right is the 2010 minimum wage. Average wages exceeding a value of ten *reais* an hour are excluded from the graph.

From the Fig 2.a and Fig. 2.b, we can see that Caucaia and Ipubi have quite a high concentration of citizens who earn near or below the minimum wage level. Should the economic intuition of this paper hold – in which I consider housing as a normal good – we would expect those two municipalities to see a more dramatic reduction in slum dwelling over the ten-year period than a municipality like Cabo Frio.

Table 2 below shows summary statistics for the same three regions shown in Fig 2.a and Fig. 2.b. It includes the average hourly income of that region, the percentage of respondents with an inadequate – as defined by the UN and the IBGE – place of dwelling, and finally a statistic for the percentage of people who would be affected by the change in minimum wage. Again, for the purpose of the table, I assume that those who are below the 2000 minimum wage or those who are making an average hourly income between the 2000 minimum wage and the 2010 minimum wage are individuals who are affected by the change in the minimum wage. As seen from Table 2 below, Cabo Frio started at the lowest rate of slum-like dwellings of the three, which is expected given an average hourly income of the municipality that is about two *reais* higher than Caucaia and Ipubi. Moreover, when we compare Ipubi and Caucaia to Cabo Frio, we note that there are many more people who are affected by the change in minimum wage in the former two municipalities than in the latter. The reason for this is seen in Fig 2.a and Fig. 2.b, as Cabo Frio stands out in as the municipality with the least density below or at the 2000 minimum wage level. The change to the "effective" minimum wage increase in Ipubi and Caucaia is more dramatic than that in Cabo Frio. It is important to note that of the three municipalities, Ipubi had the largest share of its population affected by the change in the minimum wage, then Caucaia, and lastly Cabo Frio. In terms of reduction of slum dwelling the same order holds; Ipubi sees the most dramatic decrease and Cabo Frio sees the least dramatic decrease – approximately a 43%

decrease as compared to a 15% decrease. In short, Table 2 suggests that low-wage municipalities are indeed more highly impacted by the minimum wage increase than higher-wage municipalities, confirming the economic intuition presented in this paper. And it is this variation that is exploited to report empirical results on a national scale.

Table 2: Summary Statistics – Three Municipalities*

	2000			2010	
	Average Hourly Income	% of People Living in a Slum Dwelling	% of People Affected by a Change in Minimum Wage	Average Hourly Income	% of People Living in a Slum Dwelling
Cabo Frio	3.21	18.4	67.7	8.72	3.85
Caucaia	1.78	30.9	85.9	5.41	5.06
Ipubi	1.19	69.2	90.1	4.67	26.1

*Note: Hourly minimum wage for 2000 is .7897879 *reais* and 2.667496 *reais* in 2010. The calculation is adjusted for inflation using 2000 as the base year, and it assumes forty-four hours per week to be the full work week, as defined by the Brazilian constitution since September 1988. **Table 2** assumes that those who are below the 2000 minimum wage or those who are making an average hourly income between the 2000 minimum wage and the 2010 minimum wage are individuals who are affected by the change in the minimum wage.

IV. Methodology

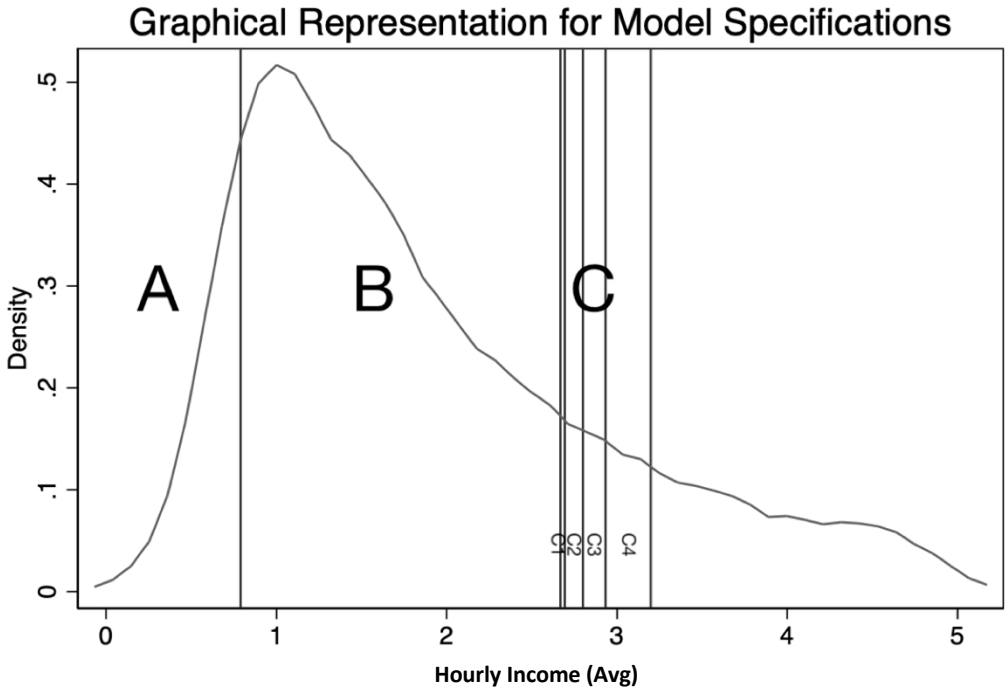
IV.A Model Explanation: General Regression Specification

As aforementioned, this paper aims to contribute to existing literature by considering the connection or lack thereof between the federal minimum wage and slum-living. However, given that the minimum wage is set at the national level and the census is taken every ten years, the research question presented requires a distinction between growth trends and minimum wage effects. To offset for the lack of variation, I look to Lee's (1999) paper about wage inequality in the United States, which uses cross-state variation to overcome this same issue: "The interaction of state variation in overall wage levels and a uniform federal minimum wage generates cross-state variation in 'effective' minimum wage levels." Lee continues, "the assumption that this

variation is not systematically related to the shape of the 'underlying' wage distribution—the distribution of wage rates that would prevail in the absence of any minimum wage—permits the data to separately identify the impact of the minimum wage from nationwide growth…" Similarly, this paper uses the differential impact of the federal minimum wage across municipalities in Brazil to estimate the contribution that the large increase in minimum wage from 2000 to 2010 has had on slum dwelling. In essence, the methodology of this paper relies on the notion that the federal minimum wage greatly impacts low-wage municipalities, while it has little to no effect at all on high-wage municipalities. This added dimension of an "effective" regional minimum wage, which was presented in Fig. 2.a, Fig. 2.b, and Table 2, enables a distinction between a national growth trend and a minimum wage effect.

To evaluate the validity and strength of the relationship between minimum wage and slum-like living conditions, I consider four distinct cases which are enumerated below. For all four cases, I use a difference-in-differences approach to study the effects of raising the minimum wage on slum dwelling. Using the pre- and post-treatment groups, I exploit regional variation in the impact of national minimum wage increases which arise from differences in wage distributions across regions. Fig. 3 below shows a representative Brazilian municipality in 2000. "A" denotes the area under the curve up to the 2000 minimum wage level. "B" is the area under curve from the 2000 minimum wage level to the 2010 minimum wage. C represents spillover effects, or in other words where wage workers above the minimum wage see an effect to their wage as a result of the national wage increase. "C1," "C2," "C3," and "C4" represent a 1%, 5%, 10%, and 20% spillover respectively. Table 3 considers the share of the Brazilian population that lives below the wages depicted at each level of Figure 3. Over 80% of Brazil's population made below the 2010 minimum wage level in 2000.

Fig. 3: Representative Municipality in 2000*



*Note: **Fig. 3** is a kernel density graph with the kernel density of hourly average income on the y-axis and average income at an hourly rate on the x-axis, for a representative Brazilian municipality in 2000. The vertical lines denote different wage levels. Left to right: 2000 minimum wage, 2010 minimum wage, 2010 minimum wage with a 1% spillover, 2010 minimum wage with a 5% spillover, 2010 minimum wage with a 10% spillover, and 2010 minimum wage with a 20% spillover. Average wages exceeding a value of five *reais* an hour are excluded from the graph.

Table 3: Summary Statistics – 2000 Nation-wide Income Levels of the Population*

1. Share of the Population under 2000 Minimum Wage Level (Area A)	27.01%
2. Share of the Population under the 2010 Minimum Wage Level (Area A+B)	81.17%
3. Share of the Population under the 2010 Minimum Wage Level +1% (Area A+B+ C1)	81.43%
4. Share of the Population under the 2010 Minimum Wage Level +5% (Area A+B+ C1+C2)	82.24%
5. Share of the Population under the 2010 Minimum Wage Level +10% (Area A+B+ C1+C2+C3)	83.89%
6. Share of the Population under the 2010 Minimum Wage Level +20% (Area A+B+ C1+C2+C3+C4)	85.57%

*Note: Using the areas specified in **Fig. 3**, **Table 3** shows the percentage of the population in 2000 living under a given wage level. These are the same wage levels shown in **Fig. 3** which shows a representative municipality in 2000.

To model the relationship between municipality effective minimum wage and slum dwelling, I collapse household data into a set of repeated cross-sections, which gives multiple observations on each Brazilian municipality (at the municipal level). Therefore, at the municipal level, the SlumDwelling variable should be interpreted as the proportion of people in a given municipality in a given year living in slum-like conditions. In regression specifications, $\Delta SlumDwelling_m$ is the dependent variable, for each municipality, m. β_s is the coefficient on what I will hereafter call "the ShareAff variable," which is the variable that corresponds to the share of the municipality affected by the change in the minimum wage. I control for demographics in a given municipality; that is, I control for differences in racial composition. To do so, I create the variable RacialMinority which captures the percentage of the population that belongs to a racial minority (people who self-identify as Black, Indigenous, or Asian) in a given municipality.[1] β_0 is a constant and the final term in the regression (u) is the error term.

The general model, thus, is as follows:

$$\Delta SlumDwelling_m = \beta_0 + \beta_s ShareAff_m + \beta_1 RacialMinority_m + u_m \qquad (1)$$

The ShareAff variable changes in regression specifications to capture the different shares of the population affected by the minimum wage. Simply put, there is a ShareAff variable corresponding to each of the areas shown in Fig. 3. The four scenarios I consider are when the ShareAff variable captures a minimum wage that affects everyone below the *p*th[2] percentile above the minimum wage (area A+B+C in Fig. 3) , everyone below the 2010 minimum wage (area A+B in Fig. 3), everyone between the 2000 and the 2010 minimum wage (area B in Fig. 3),

[1] I choose to control for racial difference like so because when I had separated each race as a separate control, certain races had remarkably high variance inflation factors (over 30,000) and all the race variables displayed low tolerance values, illustrating high correlation and linear combinations with each other and with the parameter of interest. To address this collinearity issue, RacialMinority controls for whether an individual that belongs to a racial minority or not.

[2] Where *p* can be 1%, 5%, 10%, or 20%.

and lastly everyone below the 2000 minimum wage (area A in Fig. 3). In sections IV.B – IV.F, I explain in more detail the intuition behind the different models.

IV.B Regression Specification: The Spillover Model

The first scenario this paper considers is the case of spillover effects, a common consideration that economists take into account when thinking about minimum wage policy and its effects. The intuition behind considering spillover effects is that a portion of the population above the minimum wage will inevitably also be affected by an increase in the federal minimum wage. In other words, it is not uncommon for an individual who makes slightly above the wage floor to also see an increase in their wage when the federal minimum wage is increased to a level just slightly below the individual's wage. ShareAffSpill is the ShareAff variable created to determine the proportion of the population that would be affected by an increase in minimum wage given a spillover. More specifically, ShareAffSpill assumes that those who are below the 2000 minimum wage or those who are making an average hourly income between the 2000 real minimum wage and p percent over the 2010 real minimum wage are individuals who are affected by the change in the minimum wage in the years studied. This is to account for the effect the increase in minimum wage has on the *p*th percentile above the minimum wage. For robustness of the regression, I run the spillover model considering income level 1%, 5%, 10%, and 20% over the 2010 floor, which are the areas specified in numbers 3-6 in Table 3. Spillovers are represented in area C of Fig. 3. In terms of the share of the population affected by the minimum wage increase, a less optimistic scenario is presented in IV.C, IV.D, and IV.E.

IV.C Regression Specification: The No Spillover Model

The second scenario this paper considers is the case where there are no spillover effects as a result of the increase in the minimum wage. This scenario models that a smaller share of the

population is affected by a change in minimum wage than in the spillover model. It is the area specified in number 2 of Table 3; this scenario specifies the case when the increase in the minimum wage only affects those people who are making below the 2010 minimum wage. I create the ShareAff variable ShareAffNoSpill to run the no spillover model, which assumes that those who are below the 2000 minimum wage or those who are making an average hourly income between the 2000 real minimum wage and the 2010 real minimum wage are individuals who are affected by the change in the minimum wage in the years studied.

IV.D Regression Specification: The Partially Truncated Model

The third scenario this paper considers is the extreme case where there are no spillover effects and only the people above the 2000 minimum wage are affected by the change in minimum wage, where any person with a wage below the 2000 minimum wage is not affected by the new price floor. This could be because the people who are below the 2000 minimum wage do not work in the formal sector or because they experience disemployment effects. In short, this partially truncated model includes only those under the curve denoted by area "B" in Fig. 3. To run the partially truncated model, I create the variable ShareAffPartialTrunc to capture the share of population above the 2000 minimum wage but below the 2010 minimum wage.

IV.E Regression Specification: The Truncated Model

The final scenario this paper considers is the truncated model where, for robustness, I consider those whose wage never reached above the 2000 level minimum wage, which is area "A" in Fig. 3. In this regression specification, only those below the 2000 minimum wage affect my estimation in this scenario. To run the truncated model, I create the variable ShareAffTrunc to capture the share of population that would be affected by the change in the minimum wage, which are those below the 2000 minimum wage level.

IV.F Regression Specification: Controlling for Government Transfers

Next, I consider government transfers because as of 2003, in an aim to reduce hunger and inequality, then-president Lula da Silva introduced a revolutionary government program called *Programa Bolsa Família (Bolsa Família)*, a program that rewarded low-income parents for making sure their children were attending school classes and were properly vaccinated. Simply put, *Bolsa Família* is a cash transfer given to parents conditional on the completion of certain tractable responsibilities that come with being a parent. The Centre for Public Impact (2019) case study reveals that the program was largely successful; today *Bolsa Família* is the world's largest conditional cash transfer (CCT) and is widely accepted as a major policy success, so much so that nation leaders all over the globe have attempted to replicate it. Hart and Compton (2019) write, "[*Bolsa Família*] accounts for just above 15 per cent of the fall in the Gini coefficient during the first decade of the twenty first century." The success of *Bolsa Família* crowded out municipality CCT programs and has become an important contributor in the reduction of extreme poverty in Brazil.

In an attempt to empirically isolate the impact of government transfers, like *Bolsa Família*, from that of minimum wage on slum dwelling, I run regressions for the spillover model, the no spillover model, the partially truncated model, and the truncated model but with two new parameters of interest. I bucket people into two different ShareAff variables, the share affected by the change in the minimum who also qualified for government transfers and those affected by the change in the minimum wage but did not qualify for government transfers, respectively, ShareAffQualGT and ShareAffNotQualGT. I need to use a proxy to control for government transfers for three reasons. Firstly, government transfers are distributed by local governments, so it is not a standard transfer across the nation. Next, *Bolsa Família*, which largely crowded out

local transfers, was instituted in 2003, which is between the two census years studied. Finally, census data does not offer information regarding whether or not a family received a transfer. Thus, I use *Bolsa Família* requirements and apply them to data available on income earned and total income of a given household.[3] If a household has the qualifications necessary to receive *Bolsa Família* and total income is larger than income earned (from waged work), I consider them a family who received a government transfer. I create the dummy variable GT which is (1) if they received a transfer and (0) if they did not. I then bucket households in each ShareAff category by whether or not they qualified for government transfers. Next, I run the four simulations enumerated above with the two new parameters of interest. Here, for example, is the spillover model when separating those who qualified for government transfers and those who did not:

$$\Delta SlumDwelling_m = \beta_0 + \beta_1 ShareAffSpillQualGT_m + \beta_2 ShareAffSpillNotQualGT_m + \beta_3 Racial\ Minority_m + u_m \quad (2)$$

V. Empirical Results

The empirical analysis in this paper estimates the effect of minimum wage increase on slum dwelling in Brazil. As discussed in the "Methodology" section of this paper, I estimate the relationship using four models. I model the relationship between the effective regional minimum wage and the observed wage distribution across municipalities such that I can separately identify the growth/reduction in slum living in each municipality. Below, I discuss results for the models explained in the "Methodology" section of this paper.

[3] To qualify, a family must have a monthly per capita income lower than R$154.00 (Hellman 2015). Applying this proxy controls for forms of unearned income that may be received by wealthy citizens, like dividends from stock.

V.A Preliminary Results

Table 4 reports the least squares estimates of the spillover model at four different levels, a 1%, 5%, 10%, and 20% spillover level. Table 5 reports the least square estimates of the no spillover model, the partially truncated model, and the truncated model. Column (1)-(4) in Table 4 show that the estimated slope in the spillover model ranges between -0.459 to -0.553, and is highly significant, implying that a 1 percent increase in the ShareAff variable by the increase in the minimum wage in a given municipality leads to an approximately 0.5 percentage-point reduction in the slum-like dwelling in a given municipality. Table 4 and Table 5 show that spillover effects do indeed exist, though they are quite small. The results support that the poorer municipalities see more improvement in their housing conditions following an increase in minimum wage than a wealthier municipality, as all of the ShareAffSpill coefficients are larger (less negative) than the ShareAffNoSpill coefficient of -.554. In other words, the results reported in Tables 4 and 5 show a stronger relationship in the improvement of housing conditions for those who make below minimum wage than those who make slightly above minimum wage. The 1% spillover regression specification in column (4) of Table 4 shows approximately the same relationship as the no spillover case in column (1) of Table 5. This is consistent with what Lemos (2004) finds: spillover effects in Brazil are smaller than one might expect given international standards. Additionally, column (2) of Table 5 shows that even in the case of the partially truncated model, the reduction on slum dwelling is economically and statistically significant. The coefficient on ShareAffPartialTrunc being more negative than ShareAffNoSpill, -0.615 compared to -0.554 respectively, does however mean that a portion of the people in the area A in Fig. 3 see living conditions either stay the same or worsen when there is an increase in the statutory minimum wage. We would expect this to be true because some of the poorest

individuals in Brazil likely work in the informal sector and we can expect some disemployment due to the statutory minimum wage increase. Yet, overwhelmingly, when we consider municipalities nationally, the relationship between the ShareAff variables and ΔSlumDwelling is negative and statistically significant, indicating improvements in living conditions. Moreover, overwhelmingly the truncated model reveals a dramatic improvement in living conditions with a coefficient in column (3) of Table 5 of -2.264. Figure 4 is a coefficient plot that plots all the coefficients of the parameters of interest in Tables 4 and 5, which can be used to visualize statistical significance and confidence intervals.

Table 4:
Results: Impact of Minimum Wage on Slum-Like Dwelling Using the Spillover Model*

Dependent Variable:	(1)	(2)	(3)	(4)
ΔSlumDwelling	20% Spillovers	10% Spillovers	5% Spillovers	1% Spillovers
ShareAffSpill(20%)	-0.459***			
	(0.0146)			
ShareAffSpill(10%)		-0.455***		
		(0.0137)		
ShareAffSpill(5%)			-0.459***	
			(0.0136)	
ShareAffSpill(1%)				-0.553***
				(0.0174)
RacialMinority	-0.250***	-0.218***	-0.206***	-0.291***
	(0.0464)	(0.0459)	(0.0456)	(0.0440)
Constant	0.111***	0.0864***	0.0797***	0.0659***
	(0.00544)	(0.00457)	(0.00437)	(0.00423)
Observations	2,040	2,040	2,040	2,040
R-squared	0.280	0.303	0.310	0.319

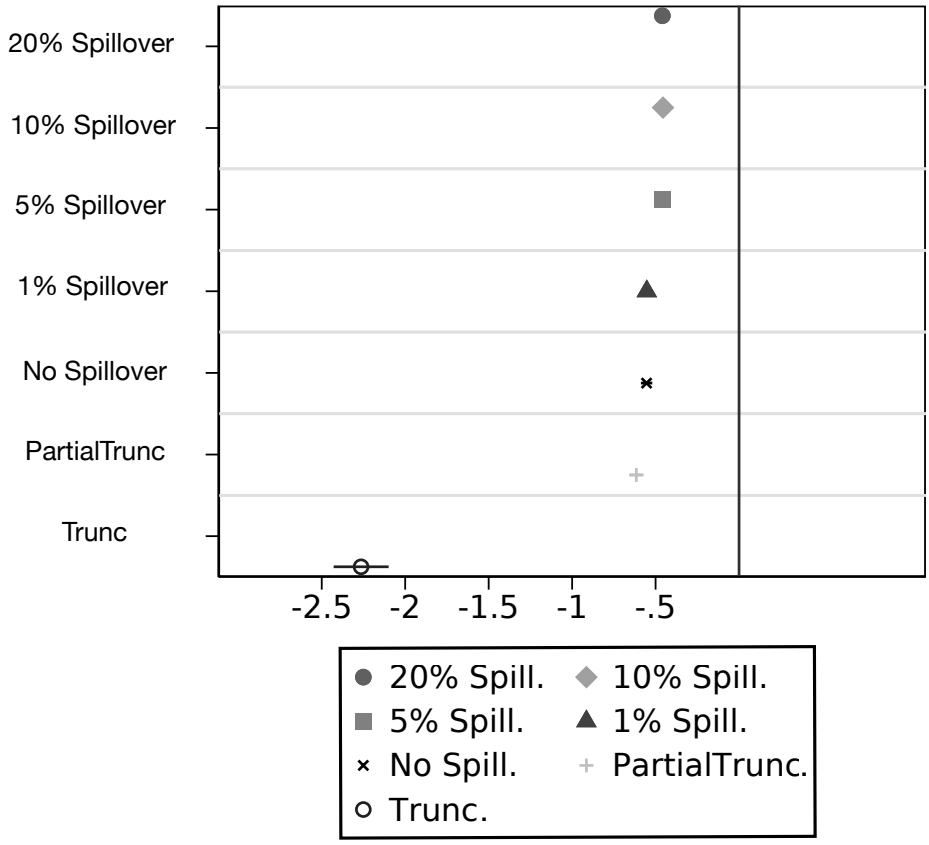
*Note: **Table 4** shows the results of the spillover model. Those who do not belong to a racial minority serve as a reference for the control RacialMinority in the above models. Robust standard errors are expressed in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 5:
Results: Impact of Minimum Wage on Slum-Like Dwelling Model Using the No Spillover Model, the Partially Truncated Model, and the Truncated Model*

Dependent Variable: ΔSlumDwelling	(1) No Spillovers	(2) PartialTrunc	(3) Trunc
ShareAffNoSpill	-0.554***		
	(0.0174)		
ShareAffPartialTrunc		-0.615***	
		(0.0217)	
ShareAffTrunc			-2.264***
			(0.0840)
RacialMinority	-0.290***	-0.293***	-0.448***
	(0.0440)	(0.0456)	(0.0454)
Constant	0.0650***	0.0638***	-0.0109***
	(0.00420)	(0.00462)	(0.00406)
Observations	2,040	2,040	2,040
R-squared	0.320	0.265	0.365

*Note: **Table 5** shows the results of the no spillover model, the partially truncated model, and the truncated model. Those who do not belong to a racial minority serve as a reference for the control RacialMinority in the above models. Robust standard errors are expressed in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Fig. 4: Coefficient Plot for Tables 4 and 5 *



*Note: **Fig. 4** is a coefficient plot that plots all the coefficients (and confidence intervals) of the parameters of interest in **Table 4** and **Table 5**. From top to bottom is ShareAffSpill(20%), ShareAffSpill(10%), ShareAffSpill(5%), ShareAffSpill(1%), ShareAffNoSpill, ShareAffPartialTrunc, and ShareAffTrunc. A vertical line is shown where the x-axis = 0 to visualize statistical significance.

V.B Results controlling for Government Transfers

Table 6 and Table 7 show regression specification results for regression specification (2), which is the specfication when I run the spillover model, the no spillover model, the partially truncated model, and the truncated model specifying those who qualified for government transfers and those who did not. Both government transfers and the increased minimum wage work together to reduce slum dwelling. The results show that the impact of the change in the minimum wage on the reduction of slum-like dwelling is smaller for those who do not receive government transfers than for those who receive government transfers. This is logically sound because we would expect those who receive government transfers and are affected by the minimum wage to see the largest increase in their income level as a result of the two exogenous changes to the status quo. All results are statistically significant at the 1 percent level, and coefficients on the ShareAffNotQualGT variables generally range from about -0.07 to -0.12 meaning a 1 percentage-point increase in the share of the population affected by the minimum wage leads to a 0.07 to 0.12 percentage-point slum reduction when one does not qualify for a government transfer. The outlier from this range is the truncated model, which shows a more dramatic reduction in slum dwelling with a coefficient on the ShareAff variable of -1.869. The R-squared coefficients with the control for the cash transfers generally increased when compared to R-squared coefficients in the models without the control for government transfers. However, given existing literature, the results are surprising. The Centre for Public Impact (2019) writes that, while it is greatly accepted that *Bolsa Família* greatly reduced hunger in Brazil, there have always been questions around why the program "does nothing to improve the quality of public services, which is widely regarded as low, though this was not the aim of the [program]."[4]

[4] The public services referred to include water supply, garbage disposal, and electric, which are the same services used to deem a household a slum-like dwelling or not in this paper.

Results, however, say otherwise quite strongly: when compared to Table 4 and Table 5, Table 6 and Table 7 point to a very large impact of government transfers on slum reduction.

While the R-squared coefficients are higher than R-squared coefficients in the four model specifications without the government transfer control, variance inflation factors (VIF) values when controlling for government transfers more than double in some cases, indicating a moderate to low degree of correlation between GT and the ShareAff variables. ShareAffNoSpillQualGT and ShareAffNoSpillNotQualGT have a correlation of 0.458, and ShareAffTruncQualGT and ShareAffTruncNotQualGT have a correlation of 0.299. Therefore, given current literature on *Bolsa Família* and a moderate to low degree of correlation, it may be that the coefficients on ShareAffQualGT variables are inflated due to a correlation between GT and the ShareAff variables. However, statistically significant results in all regression specifications indicate government transfers and the increase in minimum wage work together to decrease slum dwelling. Figure 5 plots all the coefficients of the parameters of interest in Tables 6 and 7, which can be used to visualize statistical significance and confidence intervals.

Table 6:
Results: Impact of Minimum Wage on Slum-Like Dwelling Using the Spillover Model Controlling for Government Transfers*

Dependent Variable:	(1)	(2)	(3)	(4)
ΔSlumDwelling	20% Spillovers	10% Spillovers	5% Spillovers	1% Spillovers
ShareAffSpill(20%)QualGT	-2.470***			
	(0.129)			
ShareAffSpill(20%)NotQualGT	-0.0727***			
	(0.0253)			
ShareAffSpill(10%)QualGT		-2.495***		
		(0.144)		
ShareAffSpill(10%)NotQualGT		-0.104***		
		(0.0250)		
ShareAffSpill(5%)QualGT			-2.508***	
			(0.151)	
ShareAffSpill(5%)NotQualGT			-0.118***	
			(0.0253)	
ShareAffSpill(1%)QualGT				-2.739***
				(0.169)
ShareAffSpill(1%)NotQualGT				-0.111***
				(0.0338)
RacialMinority	-0.335***	-0.320***	-0.314***	-0.345***
	(0.0453)	(0.0457)	(0.0459)	(0.0446)
Constant	0.0192***	0.0203***	0.0206***	0.0103*
	(0.00715)	(0.00581)	(0.00551)	(0.00544)
Observations	2,040	2,040	2,040	2,040
R-squared	0.420	0.417	0.416	0.414

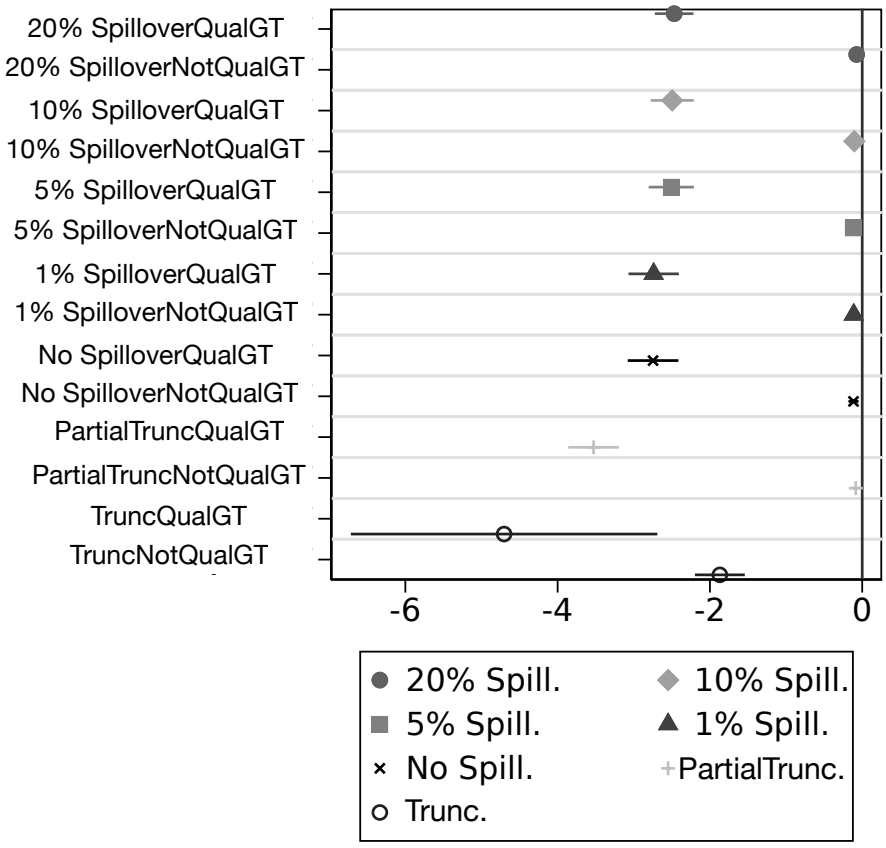
*Note: **Table 6** shows the results of the spillover model controlling for government transfers. Those who do not belong to a racial minority serve as a reference for the control RacialMinority in the above models. Robust standard errors are expressed in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 7:
Results: Impact of Minimum Wage on Slum-Like Dwelling Using the No Spillover Model, the Partially Truncated Model, and the Truncated Model Controlling for Government Transfers*

Dependent Variable:	(1)	(2)	(3)
ΔSlumDwelling	No Spillovers	PartialTrunc	Trunc
ShareAffNoSpillQualGT	-2.747***		
	(0.170)		
ShareAffNoSpillNotQualGT	-0.114***		
	(0.0339)		
ShareAffPartialTruncQualGT		-3.528***	
		(0.170)	
ShareAffPartialTruncNotQualGT		-0.0845**	
		(0.0335)	
ShareAffTruncQualGT			-4.703***
			(1.026)
ShareAffTruncNotQualGT			-1.869***
			(0.167)
RacialMinority	-0.346***	-0.338***	-0.450***
	(0.0446)	(0.0443)	(0.0459)
Constant	0.0105*	0.00597	-0.0119***
	(0.00538)	(0.00529)	(0.00408)
Observations	2,040	2,040	2,040
R-squared	0.414	0.408	0.372

*Note: **Table 7** shows the results of the no spillover model, the partially truncated model, and the truncated model controlling for government transfers. Those who do not belong to a racial minority serve as a reference for the control RacialMinority in the above models. Robust standard errors are expressed in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Fig. 5: Coefficient Plot for Tables 6 and 7*



*Note: **Fig. 5** is a coefficient plot that plots all the coefficients (and confidence intervals) of the parameters of interest in Tables 6 and 7. From top to bottom is ShareAffSpill(20%)QualGT, ShareAffSpill(20%)NotQualGT, ShareAffSpill(10%)QualGT, ShareAffSpill(10%)NotQualGT, ShareAffSpill(5%)QualGT, ShareAffSpill(5%)NotQualGT, ShareAffSpill(1%)QualGT, ShareAffSpill(1%)NotQualGT, ShareAffNoSpillQualGT, ShareAffNoSpillNotQualGT, ShareAffPartialTruncQualGT, ShareAffPartialTruncNotQualGT, ShareAffTruncQualGT, and ShareAffTruncNotQualGT. A vertical line is shown where the x-axis = 0 to show statistical significance.

V.C Limiting Factors

It is important to note that this paper only takes into account wage workers. Self-employed workers are not included in the empirical analysis. The gig economy or self-employed citizens are very difficult to track with census data. It is reasonable to believe that many people who do indeed live in Brazilian *favelas* take part in the gig economy. To control for government transfers, as mentioned in "Methodology," I use the difference in earned income and total income for people who would qualify for *Bolsa Família*. In a way, therefore, given the census data available, this paper partially controls for income coming from the gig economy but is not able to do so in a fully robust manner. However, economic intuition maintains that the gig economy only strengthens results presented in this paper for two reasons. Firstly, slum dwellers who are active in the gig economy likely do not see an increase in their income from the gig economy as a result of an increase in the statutory minimum wage. Therefore, those slum dwellers who partake in the gig economy affect the regression specifications by increasing the coefficient on the ShareAff variable (making the coefficient less negative). Secondly, macroeconomic theory tells us that when there is a temporary change in income, present consumption increases and future consumption increases. Moreover, with a permanent change in income, present consumption, and future consumption also increase but much more significantly than in the case of a temporary change. The gig economy exemplifies a temporary change in income, because, by definition, gigs are not long-term and thus cannot be relied on. On the other hand, a national increase in the statutory minimum wage can indeed be relied on as a permanent increase in income, which is more suitable for increased saving and investment (in living conditions, for example). This same reasoning could be applied to argue why government transfers likely have less of an impact on living conditions than empirical results point to in this

paper. Not only is *Bolsa Família* not meant to improve living conditions, but it is also a temporary form of increased income because, like any conditional cash transfer, once a condition is not met the transfer is taken away.

Additionally, I do not attempt to adjudicate between the partially truncated model and the spillover model. Likely, the most realistic representation of what truly occurs is a hybrid where some citizens keep the same wage (because they work in the informal sector) while others who made slightly more than the new minimum wage likely were affected positively by the new wage floor. Therefore, the partially truncated model is important to understand what happens when minimum wage is increased but does not affect the poorest Brazilians. Still, for this case, when the ShareAff variable increases 1 percentage-point the resulting effect is a 0.6 of a percentage-point reduction in slum dwelling that is economically and statistically significant.

Finally, a clear limiting factor is the fact that this paper uses census data that is only available every ten years. Over the ten-year period, the nation of Brazil could have seen a reduction in slum dwelling for a variety of reasons, not all of which have to do with the minimum wage or government transfers. Additionally, we would expect that the poorest municipalities tend to be the ones with the highest baseline rates of slum dwelling, which means improvement in living conditions is likely to affect them more in percentage-point terms to begin with simply because they have more room for improvement. Over the years, too, *favelas* have become very formalized. Therefore, since I deem a household a slum dwelling or not based on the household-level appliances, utilities, and materials, it is possible, for example, that a dwelling that attains piped water over the ten-year period studied is no longer considered a slum-dwelling in my analysis. One can argue this is simply a more formalized *favela,* however, I argue this is indeed a living-condition improvement.

VI. Conclusion

There are two main findings that follow from the empirical analysis done in this paper. First and foremost, the Brazilian minimum wage has had a strong effect in reducing the nation's slum-like dwellings in the years from 2000 to 2010. Estimates that exploit cross-state variation in the effective minimum wage imply that low-wage municipalities are more affected by the change in minimum wage than high-wage municipalities. Consequently, the statistically and economically significant results show that those municipalities that were most affected by the increase in the minimum wage were those that saw the greatest reduction in slum-like dwelling. This paper thus supports Lemos' (2004) finding that wage effects are large in Brazil.

Secondly, empirical results confirm the economic intuition central to the paper: when wages go up, slum dwellers seek better living conditions. In other words, low-earning Brazilians do indeed consider housing a normal good and thus when income increases, investment in living conditions does too. Empirical results have significantly shown that the increase in minimum wage has lifted a portion of the Brazilian population out of slum-like dwelling. Whether or not Lemos (2004) is correct when she finds that elasticity of demand for labor is inelastic, even in the truncated model there were significant effects of the minimum wage on slum-like dwelling reduction. Thus, it is likely that disemployment is not a common occurrence because even if demand for labor were elastic, the results reported in this paper would show that, in municipalities where a change in minimum wage impacts the municipality dramatically, the number of inhabitants of *favelas* would stagnate or increase.

Further research on slum-like dwelling in Brazil is promising. As noted in "Data," for the first time in 2010, the Brazilian Institute of Geography and Statistics categorized what they called 'subnormal clusters,' which refer to housing structures that are insufficient. With new data

from the 2020 census, one could extend the research from this paper by studying the first ten-year period (2010-2020) where the Brazilian government has explicitly identified slum-like dwellings in the nation. Additionally, as the *Bolsa Família* program has continued to gain in prominence and largely crowd out local governments' cash transfer programs, future research can more precisely control for the role of *Bolsa Família* in improving slum-like conditions. The crowding out effect has a very important policy implication, because while, without a doubt, the program has succeeded in its goal to aid those who cannot afford to feed themselves, by wiping out other transfers, *Bolsa Família* has done away with programs that had different aims. With ten more years of data, further research would allow one to see if the crowding out of transfers by *Bolsa Família* has caused a decrease in housing condition improvement. In other words, can it be that those who live in poverty are better nourished in large part due to *Bolsa Família*, but more likely to live a slum given the fact that *Bolsa Família* crowds out of other transfers?

As revealed in empirical results of this paper, an increase in the statutory minimum wage has an economically and statistically significant impact on the reduction of slum dwelling. Slum growth in Brazil has been an issue for the nation for decades and this study reveals that the minimum wage may be a tool for living condition improvement. The strong relationship between the increase in the statutory minimum wage and an improvement of living conditions compel me to argue that the Brazilian government should begin to use the minimum wage more purposefully to improve living condition for its people in the years to come.

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