Do Institutions Dry Up Inflation's Grease? Evidence from Brazil's Indexed Minimum Wage*

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Abstract

We present new evidence on upward nominal wage rigidity in a context with high inflation and a minimum wage that is indexed once a year. First, we document that workers who are exposed to the policy have more rigid wages. Before the indexation event, they are less likely to experience a month-to-month wage increase than those who are not exposed. Second, we find that firms anticipate the minimum wage increase. Workers who are not bound by the current minimum wage but will be bound by the upcoming one also have more rigid wages. Overall, the evidence suggests that labor market institutions matter for how an inflation shock propagates. We evaluate this hypothesis by introducing an indexed minimum wage in a standard New Keynesian model with heterogeneous labor. In between indexation events, we find that a cost-push news shock has competing effects on output due to intertemporal substitution, which lowers it, and precautionary pricing, which raises it. After the indexation event takes place, the policy introduces cyclicality in output since the cost-push shock never dissipates.

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1 Introduction

Understanding the nature of nominal wage rigidity is a fundamental question in macroeconomics since it is one of the key mechanisms by which nominal shocks have real effects on output. For example, if nominal wages are rigid then an inflationary shock will lower the prevailing real wage and lead to an expansion of employment. This is popularly referred to as inflation "greasing the wheels" of the labor market (Tobin, 1972), and is an argument often used in favor of targeting a positive inflation rate. However, to the extent that institutions determine nominal rigidities, and are themselves affected by inflation, they also play an important role in mediating the real effects of nominal shocks.

An important example of such an institution is the inflation-indexed minimum wage. This policy has become increasingly popular in recent years, with President Obama for example declaring in his 2013 State of the Union address that he would support indexing the federal minimum wage to inflation. In theory, such a policy would in fact "dry up" inflation's grease altogether since it explicitly preserves the real minimum wage. However, in practice the indexation events do not take place in real-time with the inflation shocks, rather they do so on a pre-determined schedule. This creates stretches of time between indexation events where nominal shocks may still have real effects.

Brazil between 2015-2016 is a unique opportunity to evaluate how an inflation indexed minimum wage interacts with the real effects of nominal shocks. It is a national minimum wage that indexes once a year in January. During this time period the country experienced one of the largest recessions in its history coupled with high inflation. Real gdp fell on average 3.4% each year, and inflation averaged 8.9% per annum. The "inflation as grease" mechanism is particularly useful in this setting since it allows real wages to adjust downwards in response to the negative real shock without nominal wage cuts. Moreover, nearly 4% of all full time registered workers earn exactly the current minimum wage, while an additional 7% of them earn less than the following year's minimum wage.[1]

First, we find that minimum wage workers have more rigid earnings in between indexation events. Second, we show that firms set wages in a way that is consistent with them foreseeing the upcoming minimum wage increase. These empirical results imply that a nominal shock will additionally have distributional and anticipatory effects because of the policy. To understand how the policy affects the propagation of nominal shocks in equilibrium, we introduce a cost-push news shock to a standard New Keynesian model augmented with heterogeneous labor types and a time-dependent, backward-looking, inflation-indexed minimum

[1] An additional 60% of registered full time workers earn less than two multiples of the following year's minimum wage.

wage. First, we show that the shock has competing effects on output due to intertermporal substitution and precautionary pricing. Second, it has distributional effects via both income and substitution effects. Third, it has persistent effects in the long run because each indexation event generates its own inflation and subsequent minimum wage increase. Overall, the policy amplifies the effect of a nominal shock by introducing nominal rigidities, albeit unequally. While the foreseeable indexation may dampen its effects in the short run due to anticipation, it also supports persistent effects in the long run.

The empirical analysis focuses on the two indexation events in January of 2016 and 2017 respectively. For each result we first analyze the evidence in a non-parametric framework, and then in a regression framework. We observe monthly worker-level earnings using RAIS, an employer-employee level dataset of all registered workers.

In the first part of the non-parametric analysis we find direct evidence that workers bound by the minimum wage have more rigid earnings throughout the year than workers not bound by it. We measure wage rigidity as the frequency of wage increases and find that between February and November it is 12% on average for minimum wage workers, and 19% on average for non-minimum wage workers. This means that non-minimum wage worker are much more likely to receive a wage increase throughout the year. However, this relationship flips in January when the minimum wage is indexed. 60% of minimum wage workers receive a wage increase compared to only 40% of non-minimum wage workers. The fraction of minimum wage workers who recieve an increase in January is not 100% because we classify workers in February so it is possible that they are above the threshold by the time the indexation event occurs.

Next, we find similar evidence on differential wage rigidity in a two-way fixed effects framework at the state-level. This strategy allows us to account for possible confounders such as a worker's relative position in the earnings distribution. Specifically, we measure variation in minimum wage bindingness at the state level using the Kaitz index. The Kaitz index is defined as the distance between the current national minimum wage and the state-specific median. Then, we estimate how the frequency of wage increases varies at each earnings decile across states with different levels of minimum wage bindingness. On the one hand, we find that workers at the second decile of earnings, who are more likely to be exposed to the policy, are 9 percentage points less likely to receive a wage increase between February and November in states where the minimum wage is one standard deviation more binding. On the other hand, they are 25 percentage points more likely to receive a wage increase in January. Higher earners, who are not exposed to the policy regardless of the state they live in, are a placebo test. As expected, their wage rigidity exhibits almost no difference across more versus less exposed states. As a robustness check, we also estimate a worker-level version of the same regression which allows us to control for additional individual-level characterstics such as age, gender, education, region, and sector. We find similar results.

Then, we move to the evidence on anticipation. In the second part of the non-parametric analysis we focus on the behavior of workers who earn more than the current minimum wage but less than the upcoming minimum wage to establish whether firms anticipate the minimum wage increase. We refer to them as "non-binding minimum wage" workers. This group is special because their marginal product lies above the current minimum wage. Therefore, it cannot be the case that their wages are rigid because their competitive wage lies below the mandated nominal floor. Moreover, we would expect their wages to behave similarly to those of workers who earn more than the upcoming minimum wage. However, we find that non-binding minimum wage workers also experience more rigid wages throughout the year relative to workers unexposed to the increase. On average, only 14% of them experience a wage increase each month. Since the only thing that differentiates them from workers who are just above the upcoming minimum wage is the fact that they lie below it, this fact is consistent with firms anticipating the upcoming increase and adjusting their wage setting behavior accordingly. While we remain agnostic as to why these workers do not experience wage increases on par with unexposed workers, a possible explanation could be the "inflation as conflict" hypothesis. Guerreiro et al. (2024) find that workers must take costly actions to ensure that nominal wages keep up with inflation. This is consistent with the idea that minimum wage workers, who know that their wages will catch up at the turn of the year, may be less willing to engage in these actions before then.

Next, we establish that firms anticipate the upcoming minimum wage increase in an event study framework at the firm-level. This allows us to control for firm fixed-effects and other confounders such as a firm's region, industry, and its serial exposure to the minimum wage. We measure firm-level exposure to the minimum wage as the share of workers who earn less than the upcoming minimum wage, weighted by the distance between their earnings in the base year and the value of the minimum wage in the following year. We find that the average earnings of workers at less exposed firms *rise* relative to more exposed firms, *before* the policy comes into effect. This downward-sloping pre-trend indicates that firms anticipate the policy. Unfortunately, it also means that we cannot interpert the results causally. Additionally, we test an alternative explanation for the pre-trend, namely that a firm's exposure is correlated over time and therefore the estimates capture it responding to past exposure. However, we find no support for this hypothesis.

Motivated by these facts, we incorporate this type of minimum wage policy into a New Keynesian model to study its effects on output, inflation, and employment. In the model we assume the extreme version of the empirical findings: low skill labor is paid exactly the minimum wage which is rigid unless an indexation event occurs, and high skill labor is paid a completely flexible competitive wage. There is a representative household that supplies both high and low skill labor. The production side of the economy is composed of n competitive input firms, a continuum of monopolistically competitive intermediate firms, and a representative final good firm. The input firms hire high and low skill labor in different proportions, and sell their production at marginal cost to intermediate firms. Intermediate firms face nominal rigidities in price setting.

Due to the nominal price rigidities faced by intermediate firms, there is an aggregate price Phillips curve to which the minimum wage is indexed. In the model, a period is defined at the quarterly level. The minimum wage updates once a year during the first quarter. This introduces a non-linearity in the model since the indexation rule is time-dependent.

In this setup, we study the impact of an inflationary shock to the Phillips curve. Consistent with the findings in Olivei and Tenreyro (2007), its effects are stronger when they occur right after the first quarter, since the nominal minimum wage stays fixed for longer. We assume that the shock occurs at the end of a given period, when all the other outcomes for that period have been determined. Since the nominal minimum wage is the only outcome that depends on past inflation, it is the only variable that responds directly to the shock. Thus, the effects we observe in the model are the direct result of the future indexation event.

A future nominal minimum wage increase raises marginal costs on impact by raising the low skill real wage. This directly lowers output and raises inflation. This will have short-run effects, which occur prior to the next indexation event, and long-run effects, which occur after the next indexation event.

In the present, there are two competing effects on output. On the one hand, output falls because of intertemporal substitution. This raises the nominal interest rate and lowers inflation. On the other hand, firms anticipate future inflation by setting higher prices today due to nominal rigidities that prevent them from updating their prices every period. This price increase lowers real wages and boosts output. There are also important distributional effects. Since low-skill nominal wages are fixed, their real wages fall by more. So, firms substitute towards them, effectively lowering demand for high skill workers and raising their real wage. In our calibration, the anticipation effect dominates the substitution effect and output rises in the present.

In the long run, output will fall. After the nominal minimum wage increase, low skill worker's real wage rises and demand for them falls. Firms substitute back towards high skill workers but not by enough to raise output. Then, the inflation caused by the nominal wage increase will begin to erode the real wages of low skill workers. This causes the previous dynamics to reverse. Firms will substitute towards low skill workers and away from high skill workers. However, the initial bout of inflation will deterministically increase next year's minimum wage. This kicks off a cycle whereby firms anticipate the future increase by setting higher prices and effectively contribute to an even higher minimum wage increase. Since the economy does not have time to return to steady state in between indexation events, an oscillating dynamic emerges.

Overall, the model highlights three important conclusions from the introduction of a backward-looking and time-dependent inflation-indexed minimum wage when there are inflationary shocks. First, the future minimum wage increase has competing effects on output in the present via intertemporal substitution and anticipation. Its overall impact will depend on the model's calibration. Second, there are distributional effects. Low skill workers receive higher real wages on average and their employment falls in the long run. High skill worker's real wages fall and their employment rises in relative terms. Finally, the deterministic nature of the minimum wage rule means that any inflationary shock will never dissipate. Since it raises the nominal wage and this in turn generates inflation, the nominal wage will continue to experience positive indexation forever.

Literature: This paper contributes to three main strands of the literature. These are the literature on nominal wage rigidities and how it mediates shocks, the literature on indexation, and the literature on minimum wage policies.

The literature that directly measures nominal wage rigidities has mostly focused on developed economies. Some prominent examples include Le Bihan et al. (2012) who, using a large representative survey in France, find that the frequency of nominal wage adjustments is 38% at the quarterly frequency. Using the Survey of Income and Program Participation (SIPP), Barattieri et al. (2014) find a range between 21.1-26.6% for the probability that a US worker will experience a wage change in a given quarter. Finally, Sigurdsson and Sigurdardottir (2011) find that the frequency of monthly wage changes is 10.8% in Iceland. On average, these papers find that the monthly frequency of wage adjustment is approximately 10%. Our findings contribute to the literature on nominal wage rigidity by providing, to our knowledge, the first direct evidence of high-frequency micro-wage setting behavior in a large middle-income country. In our context, the average frequency of adjustments is approximately 20% throughout the year, and much higher at the turn of the year.

There is also a literature that studies the importance of nominal wage rigidities by evaluating the impact of monetary policy in differently rigid environments. For example, Olivei and Tenreyro (2007) leverage variation in wage rigidity over time in the US. Based on suggestive evidence from different surveys, they argue that wage contracts are more likely to adjust at the end of the fiscal year. Consistent with this fact, they find that monetary policy shocks have less impact on output when they take place right before this period of contract renewal and a larger one when they occur right after it. Minton and Wheaton (2022) leverage variation in wage rigidity across US states. They argue that states with a more binding minimum wage will have more rigid wages. Consistent with this, they find that employment responds more to monetary policy shocks in states with a relatively higher minimum wage. Finally, Faia and Pezone (2024) leverage variation in wage rigidity across firms in Germany. They find that firm's stock prices and employment respond more to monetary policy shocks in firms with more rigid wages as measured by their collective bargaining activity. Our paper relates most closely to Minton and Wheaton (2022) in that it leverages variation in wage rigidity arising from the minimum wage. However, we emphasize how the inflation-indexed minimum wage policy generates additional wage rigidity via an anticipation channel, and that its effects are stronger the greater is the inflationary shock. This indicates that the policy exposes low-skill workers by more to the very shock it was designed to protect them from.

Seminal papers on wage indexation include Gray (1976) and Fischer (1977). They argue that indexation protects workers from nominal shocks but exposes them to real ones since it mechanically preserves the real wage. However, as highlighted by Jadresic (1996), this conclusion depends on the specific indexation rule used. Recent theoretical work has focused on determining what are the optimal indexation rules. Carrillo et al. (2022) find that workers prefer to index to past inflation when real shocks dominate, but they prefer to index to trend inflation when nominal shocks dominate. Recent empirical work has focused on evaluating indexation schemes in practice. For example, Manacorda (2004) finds that the *Scala Mobile* indexation scheme in Italy had a significant impact on wage inequality. Bijnens et al. (2023) finds that a temporary suspension of wage indexation in Belgium had positive employment effects in 2015. Our paper contributes to this literature by emphasizing that indexation events generally occur sporadically, and not continuously. Therefore, it is important to study how wage setting and other outcomes evolve in between and vis a vis indexation events.

While economy-wide indexation is less prevalent than in the late 20th century, the policy survives in many places in the form of partial indexation schemes. Jaeger et al. (2024) highlight the importance of two wage setting institutions that often embed indexation policies. These are collective bargaining agreements and the minimum wage. Koester and Grapow (2021), who provide a recent survey of the prevalence of different wage indexation policies in the euro area, find that 18% of euro area private sector workers work in countries where the minimum wage is indexed to inflation. The partial nature of these schemes allow researchers to leverage differential exposure to it within the same economy to identify its effects (Tito, 2011). Our paper fits into this tradition, and brings in evidence from a middle-income country context. We highlight the distributional impact of such policies, both for the workers that are directly affected by them and for firms that are differentially exposed to them.

Finally, our paper also contributes to the literature on the minimum wage. The vast majority of it focuses on the effect of unexpected and large increases in the minimum wage (Dube and Lindner, 2024). This is largely because it is easier to identify causal effects in this context. However, there is a broad swath of both local and national governments, such as California, France, and Canada, that have adopted or are moving towards adopting some form of inflation-indexed minimum wage policy (Karlamangla, 2024; Campbell, 2024). Thus, it is important to study them, despite the identification challenges that arise from the foreseeable increases.

Outline: Our paper proceeds as follows. Section 2 provides background on the Brazilian minimum wage policy. Section 3 describes the data and presents descriptive evidence, including the non-parametric analysis. Section 4 analyzes how wage rigidity varies based on the bindingness of the minimum wage at the state- and worker-level in a two-way fixed effects framework. Section 5 presents the event studies that capture firm-level anticipation. Section 6 presents the model and discusses the implications of a backward-looking time-dependent inflation-indexed minimum wage for the propagation of inflationary shocks. Section 7 concludes.

2 Background

2.1 The minimum wage in Brazil

Brazil has a long history of actively using minimum wage policy. There has been a nationwide minimum wage since 1984 which is closely watched because it also establishes the floor for pensions, welfare payments, and unemployment benefits. However, its use as an index for other contracts is forbidden.

There are two other main wage-setting institutions that we set aside primarily because the national minimum wage acts as a wage floor for both of them. These are (1) individual state's minimum wages, and (2) collective bargaining agreements. So far, five states set their own higher minimum wages[2]. However, their application is irregular both in terms of who it applies to, and when they are updated. Collective bargaining agreements are negotiated and therefore respond endogeneously to the specific conditions of the sector or firm to which they apply. In contrast, the national minimum wage is updated on a regular schedule and applies to all full time workers. It does not take any individual sector or firm's characteristics into

[2]These are Rio de Janeiro, Rio Grande do Sul, Paraná, Sao Paulo and Santa Catarina.

account.

Prior to 2008, the minimum wage was determined via negotiations between trade union centrals and the central government. As part of his platform, President Lula proposed that minimum wages should automatically adjust every January based on a rule that accounted for inflation over the previous 12 months and GDP growth with a two-year lag. This rule was signed into law in 2011 and used until 2019. A notable exception occurred in 2017 and 2018 when the two-year lag of GDP growth was negative. In these cases, the law was interpreted to mean that the minimum wage would only ever *increase* (and never decrease) based on these two factors. After 2019, the new government reverted to updating the minimum wage exclusively based on inflation. However, they maintained the regularity of updating it every January.

Every year at the beginning of September, the Brazilian government publishes its own forecast of the following year's minimum wage as part of its annual budget law (Lei Orcamentaria Anual, or LOA). This is necessary since so many social programs and other government payouts are tied to the minimum wage. While the minimum wage increase is already predictable since it relies on a fixed and transparent formula, this is yet another instance where the public is made aware of the expected upcoming increase.

2.2 The analysis period: July 2015-June 2017

Our analysis focuses on the period between January 2015 and January 2017. It encompasses two minimum wage hikes which we examine separately. In January of 2016, the monthly minimum wage for full-time workers rose from 788R$ to 880R$, implying an 11.67% increase. This was the result of an 11.27% inflation rate in 2015, and a 0.5% real GDP growth rate in 2014. The forecast published in the annual budget law proposal of September 2015 was 865R$. In January of 2017 the minimum wage rose to 937R$, a 6.5% increase from the year prior. It reflected the 6.6% inflation rate in 2016 but, as explained above, it disregarded the -3.5% real GDP growth rate in 2015. The government's forecast published in September 2016 as part of the annual budget law proposal was 945R$.

3 Data and Descriptive Evidence

3.1 Data on Earnings and Employment

We obtain labor market data from RAIS (*Relaçao Anual de Informacões Sociais*). This is an employer - employee matched annual mandatory survey for all registered firms in Brazil. We create three differente datasets. Section 4 uses a worker-level and a state-level dataset, while section 5 uses a firm-level dataset. In our sample we restrict to private sector workers with a standard 44 hour workweek aged 18 to 54, employed by firms with more than 5 workers. The final worker-level sample contains approximately 4 million workers per year, in roughly 300,000 firms, spread across 27 states.

In addition to a worker's characteristics such as age, gender, race and education, we observe their earnings in two ways. First, firms directly report a worker's annual average monthly earnings. For worker l in year t, we label this variable $\hat{y}_t^l$. Second, firms also report worker's monthly earnings in each month. For worker l in month m and year t we label this variable as y_{mt}^l. Firms are required to report how much they effectively pay each worker, including overtime but excluding the 13th salary.[3].

In our dataset, sometimes a worker's directly reported annual average monthly earnings $\hat{y}_t^l$ does not match the annual average predicted by averaging monthly earnings y_{mt}^l. This is likely due to measurement error in the monthly earnings, not in the directly reported annual average, since it is the latter that dictates eligibility for welfare benefits. See appendix B.1 for a fuller discussion. To address this issue, we restrict the sample to workers whose directly reported annual average monthly earnings are consistent with their monthly earnings.

Wage rigidity. In the analysis, we measure how wage rigidity varies with exposure to the minimum wage. This requires us to measure wage changes at the worker level. To proxy for wage changes, we rely on sustained positive changes in earnings. This is a suitable proxy for two reasons. First, sustained earnings changes are less likely to reflect transitory changes in earnings due to factors such as changes in hours worked, or one-off bonus payments. Second, it is illegal for firms to unilaterally lower a worker's nominal wages.[4] We define a sustained earnings increase as a month-to-month increase in earnings that is at least maintained the following month regardless of whether a worker switches employers.

Summary Statistics. To get a better understanding of the characteristics of workers exposed and unexposed to the minimum wage, Table 1 describes workers along the wage distribution for the 2015-2016 sample.[5] We use their annual average monthly earnings in 2015 $\hat{y}_t^l$, to sort them. Each column corresponds to one of three groups: those earning less than the following year's minimum wage, those earning between the following minimum wage and less than two multiples of the following year's minimum wage, and those earning more than that.

Workers who earn less than the following year's minimum wage are surprisingly similar to

[3]The 13th salary is an annual bonus that is paid out in two parts. The first half must be paid before November, and the second half must be paid before December.

[4]See Article 7, item VI of the 1988 constitution, and article 468 of the labor code (*Consolidação das Leis do Trabalho, CLT*).

[5]See appendix B.2 for the table corresponding to the 2016-2017 sample.

those who earn up to two times the minimum wage. They are more likely to work in services, have a high school degree or less, and work in smaller establishments. In contrast, workers who earn more than two times the minimum wage are more likely to work in manufacturing, have a college degree, and work in larger establishments. Overall, as earnings increase the likelihood of living in the northeast decreases, and that of living in the southeast increases.

[Table 1 about here.]

3.2 Non-parametric analysis

[Figure 1 about here.]

We start with a non-parametric analysis of wage-setting at the worker level. The objective is twofold. First, to establish that minimum wage workers have more rigid wages, and second, to show that firms anticipate the upcoming increase.

We measure wage-setting using the frequency of sustained earnings increases. It is defined as the share of workers who experience a sustained earnings increase in a given month. For example, if 20% of workers experience a sustained earnings increase each month, this implies that the average duration between sustained earnings increases is 5 months. A higher frequency of sustained earnings increases implies more flexible wages, while a lower frequency implies more rigid wages.

Figure 1 plots the frequency of sustained earnings increases for four types of workers at the monthly level. Each worker-type has varying degrees of exposure to the minimum wage. To capture possible anticipation, we focus on the period before each minimum wage increase. Panel 1a reports the results for 2015, while panel 1b reports the results for 2016.

Workers are classified into one of four types based on the first observation of their monthly nominal earnings. On the one hand, "Binding MW" and "Non-binding MW" workers are both exposed to the minimum wage increase in the sense that they earn less than the following year's minimum wage. The difference between them is that binding MW workers (orange line) earn exactly the current minimum wage while non-binding MW workers (red line) earn more than it.

"Mid-wage" and "High-wage" workers are both unexposed to the minimum wage increase in the sense that they earn more than the following year's minimum wage. Mid-wage workers (green lines) earn less than two multiples of next year's minimum wage while high-wage workers (blue lines) earn more than that. These unexposed worker types are additionally sorted into one of two firm types: exposed or unexposed. Exposed firms (solid lines) employ at least one exposed worker, while unexposed firms (dashed lines) employ none.

Evidence on differential wage rigidity:

The most important fact that emerges from Figure 1 is that exposed workers experience significantly more rigid wages throughout the year than unexposed workers. This is true in both sample periods. In general, binding MW and non-binding MW workers experience a frequency of sustained earnings increases of around 12-14% throughout most of the year, while mid-wage and high-wage workers experience a frequency of around 18-20%. This relationship flips at the turn of the year, when exposed workers are much more likely to experience a sustained earnings increase than unexposed workers.

To make progress on what may explain the correlation of minimum wage exposure and wage rigidity, we compare wage setting behavior across worker types. We find little evidence that it is the worker's level of earnings or their firm type that drives the results.

We compare the wage setting behavior of mid-wage relative to high-wage workers to support the hypothesis that a worker's level of earnings does not drive the difference in earnings rigidity. While these two groups have significantly different earnings levels, they exhibit a strikingly similar frequency of earnings changes. This is especially meaningful given that these two types of workers are very different in terms of their characteristics, as reported in Table 1.

Then, we contrast workers in different firm types to explore whether firm characteristics explain the results. We find that mid-wage and high-wage workers at both exposed and unexposed firms have a similar earnings rigidity. This implies that other firm characteristics that may be correlated with firm-level minimum wage exposure, such as a firm's region or sector, do not drive the result. It further supports the hypothesis that worker-level exposure is the most important determinant of earnings rigidity.

Evidence on Anticipation:

The behavior of the non-binding MW workers suggests that firms anticipate the upcoming minimum wage increase. This group of workers is special because their competitive wage lies above the current minimum wage, so it cannot be that the rigidity of their earnings is explained by the policy's mechanical bindingness. Instead, what separates them from unexposed workers and ties them to binding MW workers, is the fact that they will be affected by the upcoming minimum wage increase. Thus, any similarities in their wage setting behavior can be attributed to this future exposure. Although we remain agnostic as to why exposure lends wage-setting power to firms, the empirical patterns are consistent with this being true. A possible explanation put forward by Guerreiro et al. (2024) suggests that workers must take costly actions to ensure that nominal wages keep up with inflation.

Minimum wage workers, who know that their wages will catch up at the turn of the year, may be less willing to engage in these actions before then.

4 Wage Rigidity varies under the Minimum Wage

Exposure to the minimum wage may be correlated with wage setting practices for reasons other than the policy. To explore this possibility, we estimate a regression version of the non-parametric analysis to better address possible unobserved confounders. The biggest concern is that differential wage-setting across exposed and unexposed workers is due to a worker's relative position in the earnings distribution and not their exposure to the minimum wage. These two characteristics are correlated since it is low-wage workers that are exposed to the policy. The comparison of mid-wage and high-wage workers in the non-parametric analysis begins to address this concern by showing that the earnings rigidity of unexposed workers is similar at different points in the earnings distribution. However, it is not conclusive because there may be a non-linear relationship between a worker's position in the earnings distribution and how their wages are set.

To directly address this concern we rely on two empirical strategies. First, we directly compare wage-setting within the same earnings percentile across states where the minimum wage is more versus less binding. This allows us to isolate the effect of minimum wage bindingness from a worker's relative position in the earnings distribution. Throughout the year, we find that workers at the 2nd decile of earnings have a 9pp lower frequency of adjustment in areas with a one standard deviation more binding minimum wage. At the turn of the year, they have a 25pp higher frequency of adjustment in areas with a one standard deviation more binding minimum wage.

Second, we estimate a worker-level version of the same regression. This allows us to control for additional individual-level characterstics such as age, gender, education, region, and sector. We find similar results.

4.1 State-level Analysis

Econometric Framework

To correlate the minimum wage with the frequency of sustained earnings increases, we estimate a state-level two-way fixed effects model relying on state-level variation in minimum wage exposure. Since figure 1 shows that wage-setting behaves differently throughout the year versus at the turn of the year, we estimate the model separately for the period between February to November and the period from December to January. We pool the data prior to each minimum wage increase from the 2015-2016 and 2016-2017 event-windows. In the regression, the event-window is indexed by t. So, for example, January of 2016 belongs to the 2015-2016 event-window, while February of 2016 belongs to the 2016-2017 event-window.

We measure state-level minimum wage exposure using the Kaitz index (Lee, 1999; Autor et al., 2016). The Kaitz index in state s is defined as the difference between the log national minimum wage and the log state-median wage: $Kaitz_s = log(mw) - log(\hat{y}_s^{median})$. The measure captures how binding the minimum wage is in each state.

We specify the model as follows:

$$F^d_{smt} = \sum_{k=1}^{10} \beta^d (\mathbb{1}_{d=k} \times Kaitz_{st}) + \gamma_{sd} + \delta_{td} + \epsilon_{smtp}, \tag{1}$$

Where F^d_{smt} is the frequency of sustained earnings increases in state s at month m-event window t for earnings decile d. ρ_d are decile fixed effects. γ_{sd} are state-by-decile fixed effects and δ_{td} are event-window-by-decile specific time fixed effects. The sample includes all workers in firms with more than 5 employees. In each sample, workers are categorized into each earnings decile based on their first observed monthly earnings. Standard errors are clustered at the state level.

We control for unobserved state-level characteristics that are fixed over time with state-level-by-decile specific fixed effects. An important example is sectoral composition. If poorer states also have a greater share of their economic activity in a specific area, such as agriculture, then wage-setting practices specific to that economic activity will correlate with the minimum wage. However, since we do not expect aggregate sectoral composition to change significantly over the short two-year period under consideration, the fixed effects will account for this correlation.

The event-window-by-decile specific time fixed effects account for aggregate shocks that are common across states but may correlate with the bindingness of the minimum wage. Since the bindingness is constant within each event-window, only event-window specific time fixed effects are necessary. An important example of an aggregate shock this accounts for is the inflationary environment. Since inflation mechanically leads to a higher minimum wage, it is also associated with greater bindingness. The fixed effects account for any correlation between such aggregate shocks and wage setting practices.

Thus, this design allows us to compare workers in the same position of the earnings distribution in states where the minimum wage is more versus less binding. The coefficients of interest are the β^d coefficients which isolate the effect of minimum wage bindingness accounting for permanent differences across states within each event window and decile and across event windows within each state and decile. Higher earnings deciles are a natural placebo group for lower earnings deciles since the minimum wage is less likely to matter for them, regardless of the state-specific minimum wage bindingness.

Engbom and Moser (2022) also use an empirical strategy that relies on the Kaitz index in the context of Brazil. They study the correlation between the minimum wage and wage inequality. They do two things differently. First, they find that the minimum wage has positive and significant spillovers up to the 90th percentile of the earnings distribution. Thus, they argue that a Kaitz index built around the 90th percentile of earnings instead of the median is more appropriate. We conduct the analysis using this version of the Kaitz index and find similar results. Second, they include a quadratic term of the Kaitz index to capture non-linear effects of minimum wage bindingness. Our results are robust to this specification as well.

State-level Results on Differential Wage Rigidity

Figure 2 shows the results from estimating equation 1 for each time period. Panel 2a plots each β^d coefficient from pooling the months between February and November, while panel 2b reports the β^d coefficients from pooling together December and January. The standard deviation of the Kaitz index is 0.1. Thus, $\beta^d \times 0.1$ describes the percentage point change in the frequency of sustained earnings increases when the minimum wage bindingness increases by one standard deviation.

Panel 2a shows that workers at the bottom of the wage distribution have more rigid earnings in states where the minimum wage binds more. The negative and significant β^2 coefficient implies that a one standard deviation increase in the Kaitz index is associated with a 9 percentage point decrease in the frequency of sustained earnings increases for workers at the 2nd decile of the earnings distribution. This effect is economically significant. Given that the average frequency of sustained earnings increases for these workers is 12.6%, this implies a 71% decrease relative to the mean.

Panel 2b shows that this relationship flips at the turn of the year. Workers at the bottom of the earnings distribution have more flexible earnings in states where the minimum wage binds more. The positive and significant β^2 coefficient implies that a one standard deviation increase in the Kaitz index is associated with a 25 percentage point increase in the frequency of sustained earnings increases for workers at the 2nd earnings decile. Given that the average frequency of sustained earnings increases for these workers is 61.3%, this implies a 40% increase relative to the mean.

In both panels, the effect on deciles higher up in the distribution is not significantly different from zero. This is consistent with higher earnings deciles not being exposed to the minimum wage regardless of the state-level minimum wage bindingness.

Overall, both the direction and magnitude of the results for the lower earnings deciles and the higher earnings deciles are consistent with the non-parametric evidence presented in figure 1. They provide further evidence that nominal wage setting is more rigid for workers exposed to the minimum wage between February and November, but more flexible at the turn of the year.

[Figure 2 about here.]

4.2 Robustness: Worker-level Analysis

Econometric Framework

To further address concerns about unobserved confounders, we estimate a worker-level version of equation 1. This allows us to control for other worker-specific characteristics in addition to their earnings decile. We proceed by regressing a dummy variable indicating whether a worker l experiences a sustained earnings increase on the interaction of the Kaitz index with the worker's state-specific earnings decile.

$$D^F_{lsmt} = \sum_{k=1}^{10} \lambda^d \left(\mathbb{1}_{d=k} \times Kaitz_{st}\right) + \gamma_{sd} + \delta_{td} + X'_l + \epsilon_{lsmt}, \tag{2}$$

Where D^F_{lsmt} is a dummy variable that equals one if worker l in state s at month m event-window t experiences a sustained earnings increase. As before, ρ_d are earnings decile fixed effects, γ_{sd} are state-decile fixed effects and δ_{td} are event-window-decile specific time fixed effects. X'_l is a vector of worker-specific controls. This includes age, education, gender, sector, and region. The sample includes all workers in firms with more than 5 employees. Standard errors are clustered at the state level.

The coefficient of interest is λ^d. It describes how the likelihood of a sustained earnings increase differs for each earnings decile d in states where the minimum wage is more versus less binding.

Worker-level Results on Differential Wage Rigidity

Figure 2c plots the λ^d coefficients from estimating equation 2 pooling together the months between February and November. The blue circles represent the coefficients from a baseline regression that includes controls for age, education, and gender. The orange triangles represent the coefficients from a regression that additionally includes sector and region fixed effects. The results are practically unchanged between the two specifications.

The results are consistent with the state-level analysis. Workers at the 2nd earnings decile in states where the minimum wage binds more are less likely to experience a sustained earnings increase relative to workers in the first earnings decile. The point estimates imply that a 2nd earnings decile worker in a state where the minimum wage binds by 1 standard deviation more, is 9pp less likely (32pp more likely) to experience a sustained earnings increase throughout the year (at the turn of the year).

5 Anticipation of the Minimum Wage

In this section, we build on the evidence presented in the non-parametric analysis showing that firm's anticipate the upcoming minimum wage. Specifically, we leverage an event study framework to evaluate how wage setting varies at the firm level in firms that are more versus less exposed to the minimum wage increase, before and after it occurs. We find that the average earnings of workers at more exposed firms increase relative to those at less exposed firms before the minimum wage increase. This presents as a downward slope in the coefficients prior to the indexation event and is consistent with a story where firms anticipate the increase. We start by constructing a firm-level measure of exposure to the minimum wage which we denote Z_f. Then, we describe the empirical specification we use to evaluate its impact during the two 24-month event windows spanning from January 2015 to December 2016 and January 2016 to December 2017. Finally, we discuss the results.

The Firm-level Exposure Measure

The exposure measure Z_f captures the predicted average earnings change at firm f due to the minimum wage increase. It is the analog to what Harasztosi and Lindner (2019) call the Wage Gap measure. If there is full compliance, no spillovers, and no disemployment effects, or if these exactly cancel each other out, it will exactly predict the actual change in a firm's average earnings in January.

Equation 3 describes how Z_f is calculated. It takes the average of exposed and unexposed worker's expected earnings changes. Exposed workers are those whose annual average monthly earnings fall below the following year's new minimum wage. Since the minimum wage always updates in January, we use the calendar annual average in the previous year to avoid endogeneity concerns arising from earnings fluctuations in any specific month (especially December). The max operator takes on the value of zero for unexposed workers.

Thus, the instrument incorporates information both on the extensive margin of exposure, how many workers at a firm are exposed, and the intensive margin, by how much.

$$Z_f = \frac{1}{N_f} \times \sum_{l \in N_f} \max\{(mw_{t+1} - \hat{y}^l_{ft}), 0\}, \tag{3}$$

N_f is the total number of workers employed in firm f in December right before the minimum wage increase. mw_{t+1} is the new log minimum wage the following January. $\hat{y}^l_{ft}$ is the log directly reported annual average monthly earnings of worker l in firm f and year t who is employed in December.

We calculate Z_f separately for the two event windows. Both in the 2015-2016 and 2016-2017 samples, approximately 20% of firms have a positive value of treatment. For them, the average value of exposure is 1.6%.

[Figure 3 about here.]

Figure 3 shows how the instrument varies across regions and industries. Panel 3a shows the average value of the instrument at the microregion level between 2015-2017. On average, the northeast region of the country is much more exposed (darker colors) than the southeast (lighter colors). This is consistent with the fact that the southeastern region is more economically developed.

Panel 3b shows the average value of treatment at the broad industry level between 2015-2017. On average, the service sector is very exposed to the minimum wage, especially in cases like the accommodation and food services industry, or the wholesale and retail trade industry. The agricultural sector is also relatively highly exposed. As might be expected, the least exposed industries are the financial and insurance activity industry, and the mining and quarrying sector.

Empirical Framework

A firm-level event-study model, described in equation 4, isolates how exposure correlates with the minimum wage over time in each 24-month event window. Since the minimum wage increase is predictable, we cannot interpret these coefficients causally. We interact the exposure measure Z_f with month-by-year-specific event time dummies $\mathbb{1}_{m=k}$, and include firm γ_f and month-by-year δ_m fixed effects separately. The period $m = 0$ corresponds to the month where the minimum wage increases. In the 2015-2016 sample this is January 2016, and in the 2016-2017 sample this is January 2017. In the baseline analysis, we normalize the

$\beta_{m=0}^{Firm}$ coefficient to 0. Thus, the coefficients of interest β_m^{Firm} capture the change in outcome y_{ft} in more versus less exposed firms relative to their baseline difference in December of the pre-period.

$$y_{fm} = \sum_{\substack{k \neq -1 \\ k=-12}}^{k=11} \beta_m^{Firm} (\mathbb{1}_{m=k} \times Z_f) + \gamma_f + \delta_m + \varepsilon_{fm}, \tag{4}$$

When the outcome is log average earnings, the benchmark value of the coefficient β_0^{Firm} is one. This happens when the exposure measure Z_f perfectly predicts the actual change in average earnings. It is also important to note that the nature of the instrument's construction normalizes the expected effect of the minimum wage. For example, whether the increase is large or small, whether a unit is very exposed or not, the baseline expected effect on log average earnings is one. In this sense, the coefficient is more comparable to an elasticity than to an absolute effect. While it can be informative of the underlying mechanisms, it may mask the actual impact of the minimum wage in reality. To obtain a sense of the actual impact, we must account for the underlying value of the instrument itself.

Firm-level Results on Anticipation

Figure 4 plots the β_m^{Firm} coefficients from estimating equation 4 using log average earnings as an outcome for each pair of years separately between 2015-2017. Panel 4a plots the results for 2015-2016 and Panel 4b plots the results for 2016-2017. The blue circles correspond to the baseline specification, while the light blue triangles correspond to the specification that additionally includes sector and region time-varying fixed effects. In the results presented here, we weight the regressions by the average number of workers in each firm.

The first takeaway is that in January log average earnings increase significantly in more exposed versus less exposed firms relative to their baseline difference in December prior. This suggests that our exposure measure captures some relevant aspect of how the minimum wage policy correlates with firm wage setting. This difference remains positive and significant throughout the year. Also, the patterns are quite similar across the two samples. This suggests that the effects are not coincidental, or explained by another concurrent event, but rather a feature of the minimum wage policy.

Second, prior to the indexation event the estimates are significant and they slope downward. This suggests that there are anticipation effects. The trend implies that log average earnings at less exposed firms are increasing compared to exposed firms and relative to their difference in the base period. This is consistent with a story where unexposed workers are more likely to receive earnings increases throughout the year relative to exposed workers. To account for the possibility that specific regions and sectors correlate with minimum wage exposure and also have different wage setting behavior, we re-estimate the model including region-by-month-year and sector-by-month-year fixed effects. The results, represented by the light blue triangles, are very similar to the baseline. This suggests that other firm characteristics correlated with exposure do not drive our findings.

[Figure 4 about here.]

Robustness: Past exposure does not explain the downward trend.

An alternative explanation for the downward sloping trend in the coefficients is that firms exposed to the upcoming indexation event were also exposed to the previous one. In this world, the coefficients only reflect firm's reaction to past shocks. Stated differently, it could be the case that serial correlation in minimum wage exposure explains firm's wage setting behavior prior to the indexation event. To explore this, we estimate equation 4 but additionally control for the one, two and three year lag of the exposure measure by interacting it with month-year-specific event time dummies.

Panels 5a and 5c report the coefficients on the current value of the shock while controlling for its lags in teal triangles, they also report the baseline coefficients in dark blue circles for comparison. The results show that there is almost no difference between the two specifications. In both, the downward trend is present, and average log earnings respond strongly and positively to the indexation event.

Panels 5b and 5d report the coefficients on the lagged values of the shock from the same regressions reported in the other two panels. While lagged exposure has some predictive power, it is much smaller in magnitude than the current exposure variable, and doesn't do so in a consistent manner. These results support the view that the downward slope prior to the event is more likely due to anticipation than to serial corelation in exposure.

[Figure 5 about here.]

6 Model

In this section, we present a minimum wage augmented New Keynesian model where the minimum wage is indexed to past inflation and updates once every four quarters. The model is based on Glover (2016) but extended to include n input firms that combine high and low skill labor differently. Thus, these input firms are differently exposed to the minimum wage and will aid us in understanding the distributional impact of minimum wage hikes. We use the model to understand how such a minimum wage policy affects the propagation of an exogenous shock to inflation on output and employment.

6.1 Model Setup

Formally, our economy is composed of n competitive input firms, a continuum of monopolistically competitive intermediate goods producers, a representative final good producer, and a representative household that provides both high and low skill labor. Input firms produce competitively using high and low skill workers and differ in their relative demand for each type of labor. The monopolistically competitive intermediate goods firms produce differentiated output using the n inputs. Then, a competitive final good producer aggregates the intermediate goods. The household supplies its labor freely across sectors. Low skill labor is remunerated by the minimum wage, while high skill labor is compensated by a competitive wage rate.

Households and Wage Setting

A representative household derives utility from consumption, C_t, and disutility from labor. It supplies both high and low skill labor, denoted by H_t and L_t, freely across sectors. Their disutility of labor is given by ψ_H and ψ_L respectively. ν is the inverse Frisch elasticity. High skill labor is paid a competitive high-skill wage, denoted W_{Ht}, and low skill labor is paid the minimum wage, denoted W_{Lt}. Following Glover (2016), we incorporate the minimum wage by imposing an upper-bound constraint on low-skill labor. Additionally, households have access to a bond market. Households maximise:

$$\max_{C_t,H_t,L_t,B_{t+1}} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[\frac{C_t^{1-\sigma}}{1-\sigma} - \psi_H \frac{H_t^{1+\nu}}{1+\nu} - \psi_L \frac{L_t^{1+\nu}}{1+\nu}\right] \tag{5}$$

subject to:

$$P_t C_t + B_{t+1} = B_t R_{t-1} + W_{Ht} H_t + W_{Lt} L_t + \Gamma_t \tag{6}$$

$$L_t \leq \bar{L}_t \tag{7}$$

As in Glover (2016) and Schmitt-Grohé and Uribe (2016), the minimum wage constraint on low-skill labor is exogenous. This implies that low-skill labor is demand-determined. We define the stochastic discount factor as $Q_{t+k|t} = \beta(C_{t+k}/C_t)^{-\sigma}$. Optimization determines high skill labor supply and intertemporal substitution of consumption as follows

$$\frac{W_{Ht}}{P_t} = \psi_H H_t^{\nu} C_t^{\sigma} \tag{8}$$

$$1 = R_t \mathbb{E}_t \left[Q_{t+1|t} \frac{P_t}{P_{t+1}} \right] \tag{9}$$

Minimum Wage Policy

The minimum wage is indexed to past inflation and updates once every four quarters. The minimum wage rule is given by

$$W_{Lt} = \begin{cases} W_{L,t-1} + \pi_{t-1} + \pi_{t-2} + \pi_{t-3} + \pi_{t-4} & \text{if } t \text{ is the first quarter,} \\ W_{L,t-1} & \text{otherwise} \end{cases} \tag{10}$$

Firms and Price Setting

Final good producer

A competitive final good firm aggregates intermediate goods $Y_t(j)$ using a CES aggregator. The profit maximisation problem is

$$\max_{Y_t(j)} P_t Y_t - \int_0^1 P_t(j) Y_t(j) dj \quad \text{s.t. } Y_t = \left(\int_0^1 Y_t(j)^{\frac{1}{\lambda^p}} dj \right)^{\lambda^p} \tag{11}$$

Where P_t is the final good price index, $P_t(j)$ is the price of intermediate good j, and $\lambda^p > 1$ is the elasticity of substitution across intermediate goods. Profit maximisation yields the standard expression for demand of variety j in terms of overall demand for the final good, price of variety j, and the final good price.

$$Y_t(j) = \left(\frac{P_t(j)}{P_t} \right)^{\frac{\lambda^p}{1-\lambda^p}} Y_t \tag{12}$$

Imposing zero profits, the final price index given by:

$$P_t = \left(\int_0^1 P_t(j)^{\frac{1}{1-\lambda^p}} dj \right)^{1-\lambda^p} \tag{13}$$

Intermediate goods producers

A continuum of monopolistically competitive intermediate goods producers indexed by $j \in [0, 1]$ use inputs $\{X_{it}(j)\}_{i=1,\ldots,n}$ from each input firm to produce a differentiated good $Y_t(j)$

using a constant returns to scale technology. Their profit maximisation problem is given by

$$\max_{\{X_{it}(j)\}_{i=1,\dots,n}} P_t(j)Y_t(j) - \sum_{i=1}^{n} P_{it}X_{it}(j) \quad \text{s.t. } Y_t(j) = \prod_{i=1}^{n} X_{it}(j)^{\lambda_i} \tag{14}$$

Where the elasticity of substitution across inputs is given by λ_i such that $\sum_{i=1}^{n} \lambda_i = 1$. The cost of each input i, given by P_{it}, dictates its relative demand by each intermediate producer. It is given by

$$\frac{X_{i't}(j)}{X_{it}(j)} = \frac{P_{it}}{P_{i't}} \tag{15}$$

Intermediate producer j's absolute demand for input i will depend on overall demand for variety j. The nominal marginal cost $MC^{(n)}$ faced by intermediate producer j will also be equal across intermediate producers and is given by

$$MC^{n} = \prod_{i=1}^{n} \lambda_i^{-\lambda_i} P_{it}^{\lambda_i} \tag{16}$$

Price Setting

We assume that the intermediate goods producers are subject to a a Calvo-style friction and can only change their prices infrequently. Each period, a fraction $1 - \xi_p$ of firms can reset their price. Intermediate good producer j sets its price $P_t(j)$ to maximise profits as follows

$$\max_{P_t(j)^*} \sum_{k=0}^{\infty} \xi_p^k \mathbb{E}_t \left\{ Q_{t+k|t} \left(P_t(j)^* Y_{t+k|t}(j) - TC^{n}_{t+k|t}(Y_{t+k|t}(j)) \right) \right\} \tag{17}$$

subject to

$$Y_{t+k|t}(j) = \left(\frac{P_t(j)^*}{P_{t+k}} \right)^{\frac{\lambda_p}{1-\lambda_p}} Y_{t+k} \qquad \forall k \tag{18}$$

Where $Q_{t+k|t}$ is the stochastic discount factor for nominal payoffs. And $Y_{t+k|t}(j)$ denotes demand for output in period $t + k$ of firm j that last reset its price in period t. Note that, given our assumptions, all intermediate firms that re-optimize will set the same price.

Input goods producers

Each input firm, indexed by $i \in \{1, ..., n\}$, produces and input X_{it} competitively using a CES aggregate of high and low skill labor. They maximise profits subject to their production function:

$$\max_{L_{it}, H_{it}} P_{it}X_{it} - W_{Lt}L_{it} - W_{Ht}H_{it} \quad \text{s.t. } X_{it} = \left[\alpha_i \theta L_{it}^{\frac{\eta-1}{\eta}} + (1-\alpha_i) H_{it}^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}} \tag{19}$$

η is the elasticity of substitution between labor types, θ governs the efficiency of low skill workers relative to high skill workers and is always less than 1. α_i is the share of low skill workers (per efficiency units) used in production, it is input firm-specific.

The solution to the input firm problem gives demand for each type of labor H_{it} and L_{it} as a function of wages, and the quantity of input produced as follows

$$L_{it} = \left[\frac{(W_{Ht}\theta\alpha_i)^{\eta-1}}{(\theta\alpha_i)^{\eta} W_{Ht}^{\eta-1} + (1-\alpha_i)^{\eta} W_{Lt}^{\eta-1}}\right]^{\frac{\eta}{\eta-1}} X_{it} \tag{20}$$

$$H_{it} = \left[\frac{((1-\alpha_i)W_{Lt})^{\eta-1}}{(\theta\alpha_i)^{\eta} W_{Ht}^{\eta-1} + (1-\alpha_i)^{\eta} W_{Lt}^{\eta-1}}\right]^{\frac{\eta}{\eta-1}} X_{it} \tag{21}$$

Finally, this implies that marginal cost for input producers can be expressed as a function of wages as follows

$$MC_{it} = W_{Lt}W_{Ht}\left[(\theta\alpha_i)^{\eta} W_{Ht}^{\eta-1} + (1-\alpha_i)^{\eta} W_{Lt}^{\eta-1}\right]^{\frac{1}{1-\eta}} \tag{22}$$

Since input producers are competitive, we have that $P_{it} = MC_{it}$.

Policy and Market Clearing

The central bank sets the nominal interest rate $\tilde{R}_t$ according to a Taylor-type reaction function:

$$\tilde{R}_t = \rho\tilde{R}_{t-1} + (1-\rho)(\phi_\pi \hat{\pi}_t + \phi_y \hat{y}_t) \tag{23}$$

where ϕ_π and ϕ_y are the Taylor rule coefficients for inflation and output, respectively.

Market clearing gives us the final equilibrium conditions that must hold in the model. First, the final goods market clearing condition states that the supply of final good Y_t equals the demand from households C_t.

$$Y_t = C_t \tag{24}$$

Input market clearing requires that the supply of each input X_{it} equal total demand from all the intermediate goods producers.

$$X_{it} = \int_0^1 X_{it}(j)dj \qquad \forall i \in \{1, ..., n\} \tag{25}$$

Finally, the labor market clears for each labor type. All the supply of high and low skill labor from households equals demand for each of the labor types from the inputs goods producers.

$$L_t = \sum_{i=1}^{n} L_{it}, \quad H_t = \sum_{i=1}^{n} H_{it} \tag{26}$$

Equilibrium

An equilibrium is prices $\{P_t(j), MC_t^n, \{P_{it}\}_{i=1}^n, W_{Lt}, W_{Ht}, R_t\}$ and quantities $\{Y_t, C_t, Y_t(j), \{X_{it}\}_{i=1}^n, \{X_{it}(j)\}_{i=1}^n, H_t, L_t, \{H_{it}\}_{i=1}^n, \{L_{it}\}_{i=1}^n, B_t\}$ such that, given the exogenous processes and government policy, all agents are optimizing and all markets clear.

6.2 Model Solution and Calibration

To solve the model, we set N=2 and log-linearize the equilibrium conditions around the steady-state. The full set of equations is presented in Appendix C. Special attention should be given to the minimum wage indexation rule which is described by the following law of motion:

$$w_t^{min} = \left(1 - \sum_{k=1}^{4} q_{kt} * a_k\right) * (w_{t-1}^{min} + \pi_{t-1} + \pi_{t-2} + \pi_{t-3} + \pi_{t-4}) \tag{27}$$

$$+ \left(\sum_{k=1}^{4} q_{kt} * a_k\right) * w_{t-1}^{min} \tag{28}$$

where $(1 - a_k)$ is the fraction of workers whose wage adjusts in each quarter k with $k = 1, ..., 4$, and q_{kt} are dummy variables that take on the value of one when period t is equal to quarter k. As in Olivei and Tenreyro (2007), this implies that wage setting is time-dependent. Therefore, the system is nonlinear and we use the nonlinear solution method of Fuhrer and Bleakley (1996) to solve the model.

Table 2 presents the calibration of the model. We set the minimum wage to update once a year in the first quarter. Accordingly $1-a_k$, the probability that the minimum wage resets in quarter k, is equal to 1 if $k=1$ and equal to 0 if $k \neq 1$. The parameter α_i governs the level of exposure of input firm i to the minimum wage. We set $\alpha_1 < \alpha_2$ such that input firm 1 is more high skill intensive relative to input firm 2. In the linearized conditions, α_i enters the parameter s_L^i which describes the share of firm-level output paid to low skill labor. We set $s_L^1 = 0.1$ and $s_L^2 = 0.9$.

The remaining parameters are standard in the New Keynesian literature. The discount factor β is equal to $1.04^{-\frac{1}{4}}$ which corresponds to an annualized real interest rate of 4%. The intertemporal elasticity of substitution σ is equal to 2, the inverse frisch elasticity ν is equal to 1, the price stickiness parameter ξ_p is equal to 0.35, and the taylor rule coefficients ϕ_π and ϕ_y are equal to 2 and 0.6 respectively.

[Table 2 about here.]

6.3 Propagation of an inflationary shock

Figures 6 to 9 present impulse response functions to a 25 basis point increase in aggregate inflation on other aggregate and input-firm specific outcomes. The aggregate outcomes are the nominal minimum wage, aggregate inflation, aggregate output, the nominal interest rate, and real wages. The input-firm specific outcomes are employment, output and prices. Recall that in our calibration there are two input firms, where input firm 1 is high-skill intensive while input firm 2 is low skill intensive. Each figure separately plots the response to four different realizations of the shock, each taking place in a different quarter. We assume that the shock takes place at the end of period t, after all variables for that period have been determined.

Figure 6b presents the IRF of the nominal minimum wage in response to the inflationary shock. As expected, the nominal minimum wage evolves as a step function. Following the shock, it updates every first quarter by the amount of accumulated inflation in the past four periods. The first increase we observe takes place in the fifth quarter, which corresponds to the first "first quarter" after the shocks.

Figure 6a describes the behavior of aggregate inflation. Due to the timing of the shocks, the initial increase in inflation has no contemporaneous effect on other variables. So, the shock to inflation will only have a direct effect on outcomes that depend on past inflation. The nominal minimum wage is the only outcome that does so. The first indexation event after the shock takes place in the fifth quarter, so all the effects we observe are the result of it's anticipation.

As is usual in New Keynesian frameworks, the two forward looking variables are aggregate output and aggregate inflation. Aggregate output depends directly on future output because of consumption smoothing, and directly on future inflation through its dampening effect on the real interest rate. Aggregate inflation depends directly on future inflation due to nominal price rigidities. Price setters incorporate their expectation of inflation into today's prices since they do not know whether they will be able to re-adjust their prices in the future. However, it also depends indirectly on future output through the marginal cost. Lower output in the future lowers output today which lowers input demand and ultimately input prices. Lower input prices translate into lower marginal costs. Finally, the nominal interest rate will react to contemporaneous inflation and output through the taylor rule. It will rise in response to higher inflation, and fall in response to lower output.

Now turning to the indexation event, and how it filters through the economy, what happens is the following: an increase in the nominal minimum wage directly raises the real wage of low skill workers. This raises concurrent marginal costs, and therefore aggregate inflation. The input-firm level marginal cost rises by more for firms that are more low-skill intensive. Thus, input firm 2's prices will rise relative to input firm 1. This has two effects on output. First, overall demand falls due to the price increase, and second, demand for input firm 2's output falls relative to input firm 1. Finally, the overall decline in demand indirectly lowers the real wages of high skill workers.

As described above, the future increase in inflation and decline in output in response to the nominal minimum wage indexation event will affect outcomes in the economy today. Higher future inflation unambiguously raises inflation today, while in combination with lower output it will have an ambiguous effect on output today. Therefore, the response of the nominal interest rate is also ambiguous. If the impact of lower output is greater than the impact of higher inflation, then the nominal interest rate will fall. If the impact of higher inflation is greater, it will rise.

Figure 6 suggests that in this calibration, the impact of lower future output dominates. Figures 6c and 6a show that output and inflation fall in response to the anticipated indexation event. The nominal interest rate reacts contemporaneously by falling (Figure 6d), but it is not sufficient to overturn the negative impact of lower future output. Ultimately, while inflation returns to its steady state level, the nominal minimum wage is permanently higher and output remains permanently lower.

There are also important distributional consequences. Figure 7 shows that low skill real wages are permanently higher while high skill real wages are permanently lower. Figure 8 shows that the resulting low skill employment decline is larger in magnitude than the corresponding high skill employment increase. Consequently, figure 9 output is lower (higher) and prices are higher (lower) in input firm 2 (1).

Overall, the analysis shows that staggered and backward looking indexation rules have significant effects even before the indexation event takes place. In particular, it has a strong negative effect on output which consequently lowers inflation. Since the policy only affects one portion of the population, it also has important distributional effects. Specifically, workers exposed to the indexation event experience an increase in their real wages and a decline in their employment relative to unexposed workers. The effects are stronger the further away in time the occurence of the shock is from the indexation event. It is important to note that this analysis does not incorporate any contemporaneous effects of the initial shock. Arguably, since an inflationary shock likely has a contemporaneous dampening effect on low skill real wages in this environment, its possible that some of these conclusions would be overturned.

[Figure 6 about here.]

[Figure 7 about here.]

[Figure 8 about here.]

[Figure 9 about here.]

7 Conclusion

References

Autor, David H., Alan Manning, and Christopher L. Smith, "The Contribution of the Minimum Wage to US Wage Inequality over Three Decades: A Reassessment," *American Economic Journal: Applied Economics*, January 2016, *8* (1), 58–99.

Barattieri, Alessandro, Susanto Basu, and Peter Gottschalk, "Some Evidence on the Importance of Sticky Wages," *American Economic Journal: Macroeconomics*, January 2014, *6* (1), 70–101.

Bihan, Hervé Le, Jérémi Montornès, and Thomas Heckel, "Sticky Wages: Evidence from Quarterly Microeconomic Data," *American Economic Journal: Macroeconomics*, July 2012, *4* (3), 1–32.

Bijnens, Gert, Shyngys Karimov, and Jozef Konings, "Does Automatic Wage Indexation Destroy Jobs? A Machine Learning Approach," *De Economist*, March 2023, *171* (1), 85–117.

Campbell, Fiona, "Canada's Minimum Wage Explained," October 2024. Section: Personal Finance.

Carrillo, Julio A., Gert Peersman, and Joris Wauters, "Endogenous wage indexation and aggregate shocks," *Journal of Macroeconomics*, June 2022, *72*, 103417.

Dube, Arindrajit and Attila Lindner, "Chapter 4 - Minimum wages in the 21st century," in Christian Dustmann and Thomas Lemieux, eds., *Handbook of Labor Economics*, Vol. 5, Elsevier, January 2024, pp. 261–383.

Engbom, Niklas and Christian Moser, "Earnings Inequality and the Minimum Wage: Evidence from Brazil," *Working Paper*, 2022.

Faia, Ester and Vincenzo Pezone, "The Cost of Wage Rigidity," *The Review of Economic Studies*, January 2024, *91* (1), 301–339.

Fischer, Stanley, "Wage-indexation and macro-economic stability," *Institue for Advanced Studies*, 1977.

Fuhrer, Jeffrey C. and C. Hoyt Bleakley, "Computationally Efficient Solution and Maximum Likelihood Estimation of Nonlinear Rational Expectations Models," August 1996.

Glover, Andrew, "Minimum Wages in a Monetary Economy," *Working Paper*, 2016.

Gray, Jo Anna, "Wage indexation: A macroeconomic approach," *Journal of Monetary Economics*, April 1976, *2* (2), 221–235.

Guerreiro, Joao, Jonathon Hazell, Chen Lian, and Christina Patterson, "Why Do Workers Dislike Inflation? Wage Erosion and Conflict Costs," *NBER Working Paper*, September 2024.

Harasztosi, Peter and Attila Lindner, "Who Pays for the Minimum Wage?," *American Economic Review*, August 2019, *109* (8), 2693–2727.

Jadresic, Esteban, "Wage Indexation and the Cost of Disinflation," *Staff Papers*, December 1996, *43* (4), 796–825.

Jaeger, Simon, Suresh Naidu, and Benjamin Schoefer, "Collective Bargaining, Unions, and hte Wage Structure: An International Persperctive," *National Bureau of Economic Research*, 2024, (No. w33267).

Karlamangla, Soumya, "California's Statewide Minimum Wage Is Now $16 an Hour," *The New York Times*, January 2024.

Koester, Gerrit and Helen Grapow, "The prevalence of private sector wage indexation in the euro area and its potential role for the impact of inflation on wages," November 2021.

Lee, David S., "Wage Inequality in the United States During the 1980s: Rising Dispersion or Falling Minimum Wage?*," *The Quarterly Journal of Economics*, August 1999, *114* (3), 977–1023.

Manacorda, Marco, "Can the Scala Mobile Explain the Fall and Rise of Earnings Inequality in Italy? A Semiparametric Analysis, 1977–1993," *Journal of Labor Economics*, July 2004, *22* (3), 585–613. Publisher: The University of Chicago Press.

Minton, Robert and Brian Wheaton, "Minimum Wages and the Rigid-Wage Channel of Monetary Policy," *Working Paper*, 2022.

Olivei, Giovanni and Silvana Tenreyro, "The Timing of Monetary Policy Shocks," *American Economic Review*, June 2007, *97* (3), 636–663.

Schmitt-Grohé, Stephanie and Martín Uribe, "Downward Nominal Wage Rigidity, Currency Pegs, and Involuntary Unemployment," *Journal of Political Economy*, October 2016, *124* (5), 1466–1514. Publisher: The University of Chicago Press.

Sigurdsson, Jósef and Rannveig Sigurdardottir, "Evidence of Nominal Wage Rigidity and Wage Setting from Icelandic Microdata," *Economics*, August 2011. Number: wp55 Publisher: Department of Economics, Central bank of Iceland.

Tito, Boeri, "Institutional Reforms and Dualism in European Labor Markets*," in David Card and Orley Ashenfelter, eds., *Handbook of Labor Economics*, Vol. 4, Elsevier, January 2011, pp. 1173–1236.

Tobin, James, "Inflation and Unemployment," *The American Economic Review*, 1972, *62* (1/2), 1–18. Publisher: American Economic Association.

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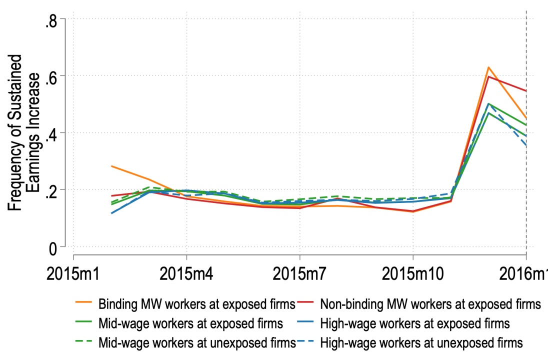
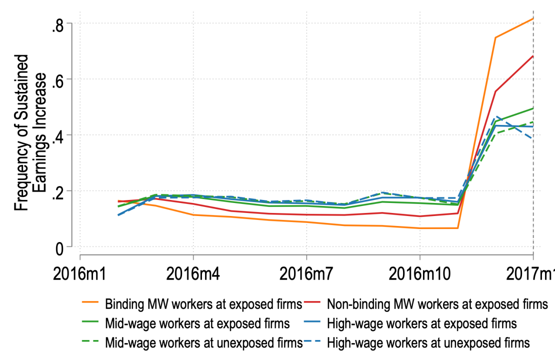
Figures

Figure 1: Non-parametric Frequency of Sustained Earnings Increases

(a) 2015-2016



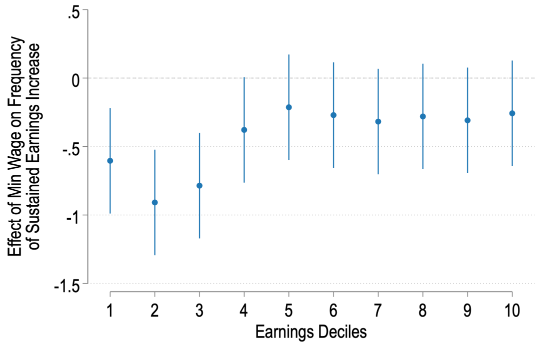
(b) 2016-2017



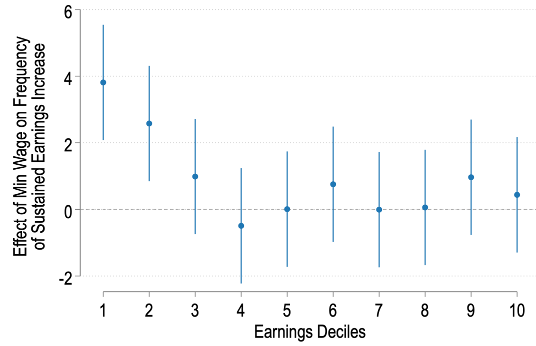
Notes: This figure presents non-parametric evidence on the frequency of sustained earnings increases at the worker-level. The frequency of sustained earnings increases is defined as the share of workers with a month-to-month earnings increase that is at least maintained the following month. Workers are classified when they enter the sample. Binding MW workers are those that earn exactly the curent minimum wage. Non-binding MW workers are those that earn more than the current min wage but less than the following year's minimum wage. Mid-wage workers are those that earn more than the following year's minimum wage but less than two multiples of it. High-wage workers are those that earn more than two multiples of the following year's minimum wage.

Figure 2: State-level Regressions

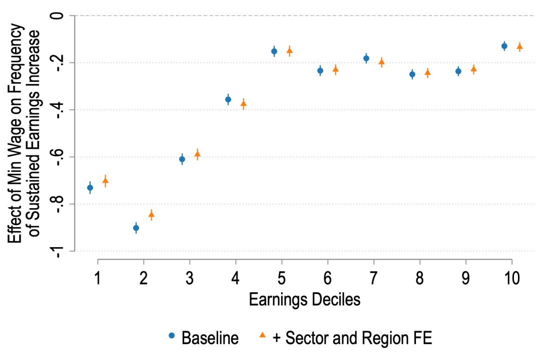
(a) State-level: February to November



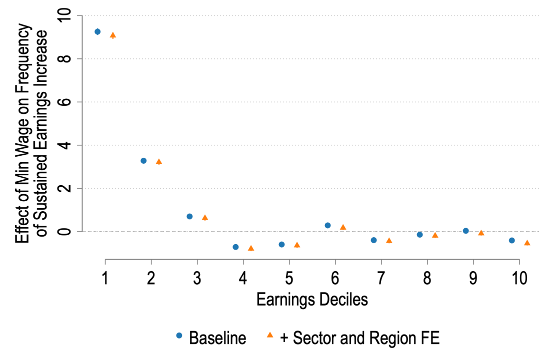
(b) State-level: December to January



(c) Worker-level: February to November

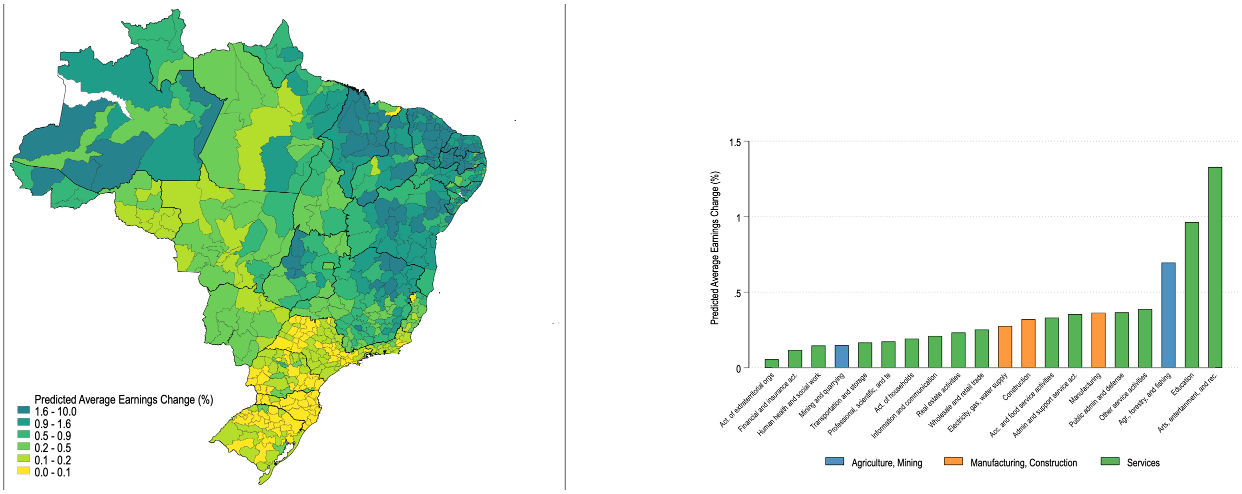


(d) Worker-level: December to January



Notes: Panels 2a and 2b figure plots the β^d coefficients from estimating equation 1 of the frequency of sustained earnings increases on the Kaitz index at each earnings decile, controlling for state-decile and time-decile fixed effects. The frequency of sustained earnings increases is defined as the share of workers with a month-to-month earnings increase that is at least maintained the following month. Standard errors clustered at the state level. Panels 2c and 2d plot the results from a single worker-level regression. The blue circles represent the λ^d coefficients described by equation 2. Specifically, the coefficients describe the change in the probability that a worker experiences a sustained earnings increase at each earnings decile as the state-level bindingness of the minimum wage increases. We control for worker characteristics such as age, education, gender and earnings deciles. The orange triangles represent the same λ^d coefficients from a regresssion that additionally controls for industry and region fixed effects.

Figure 3: Exposure to the minimum wage in Brazil

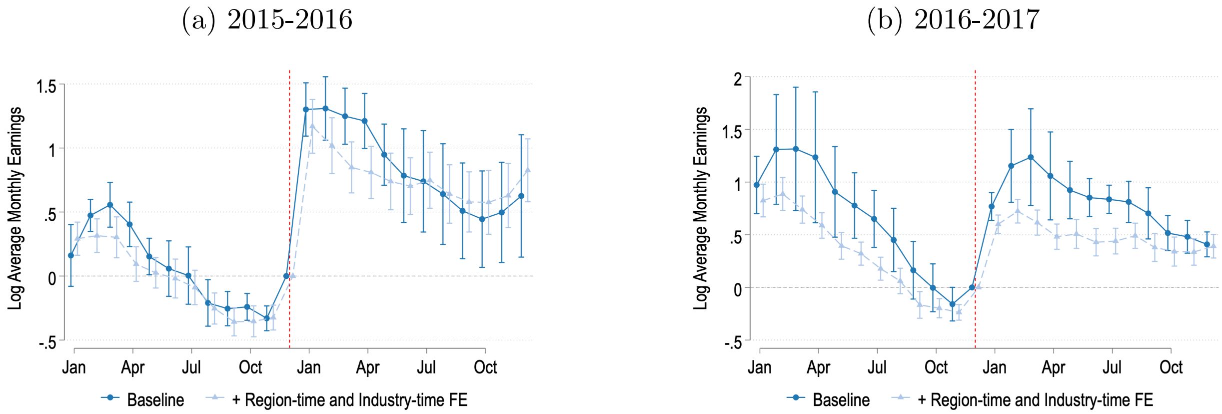


(a) Geographic variation

(b) Industry variation

Notes: The figures show the average variation in the exposure instrument Z_u from 2015-2018 separately at the geographic and industrial levels. Panel (a) shows the average value of the treatment at the microregion level. Microregions, of which there are 558 in Brazil, are broader geographical units than the municipalities that we use in the analysis. Panel (b) shows the average value of the treatment across industries. Industries, of which there are 20, are broader than the 5-digit industries we use in the analysis.

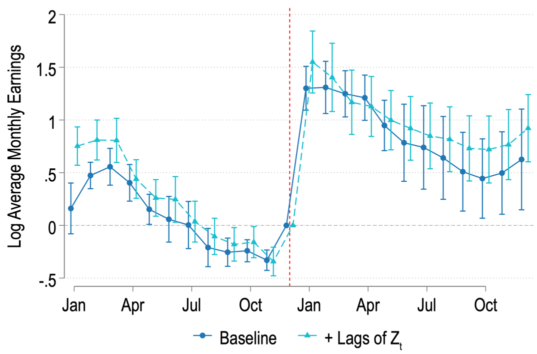
Figure 4: Earnings at the Firm level



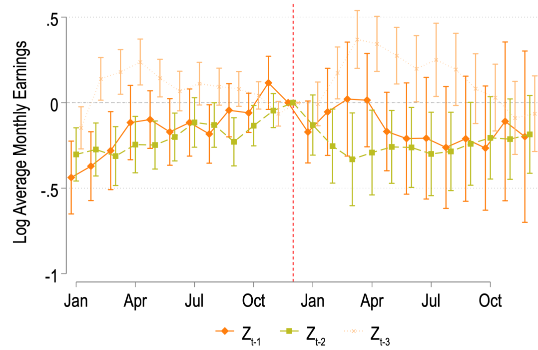
Notes: The figure plots the event study coefficients β_m^{Firm} from estimating equation 4 using firm-level average earnings as the outcome.In dark blue circles we report the coefficients from the baseline regression, and in light blue triangles we report the coefficients from the regression controlling for firm's region and sector. The regressions are weighted by each firm's average employment during the sample period.

Figure 5: Serial correlation does not explain downward pre-trend

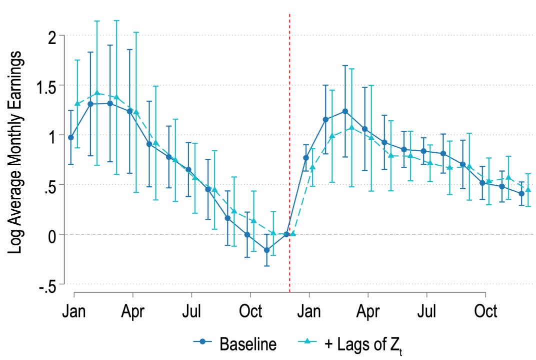
(a) 2015-2016: Effect of Exposure



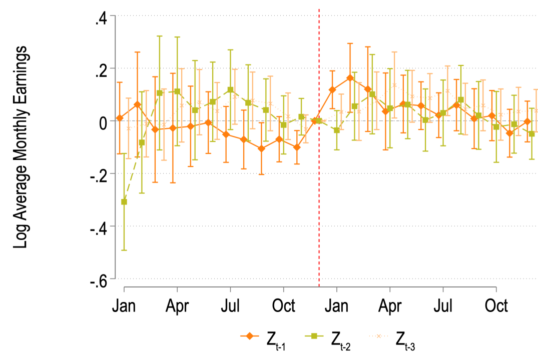
(b) 2015-2016: Effect of Lagged Exposure



(c) 2016-2017: Effect of Exposure



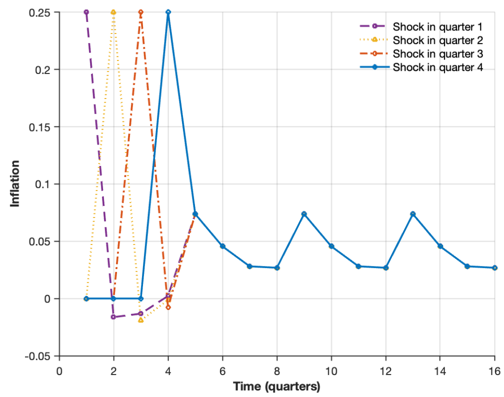
(d) 2016-2017: Effect of Lagged Exposure



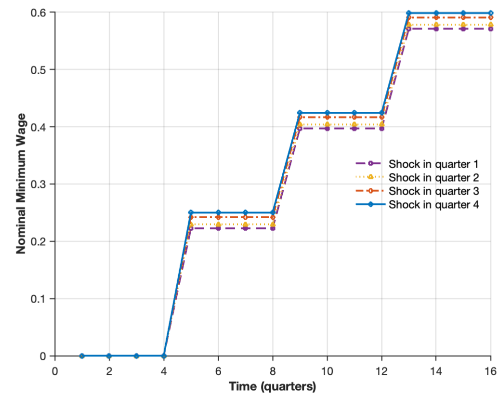
Notes: The figure plots the coefficients from estimating equation 4 using log average monthly earnings as the outcome, and controlling for the 1-, 2-, and 3-year lag of treatment. Panels 5a and 5c report the event study coefficients β_m^{Firm} showing the effect of the treatment, while panels 5b and 5d report the effect of the lags themselves. The regressions are weighted by the average employment in each firm.

Figure 6: Impulse Response Functions of Inflation, Nominal Minimum Wage, Output, and Nominal Interest Rate

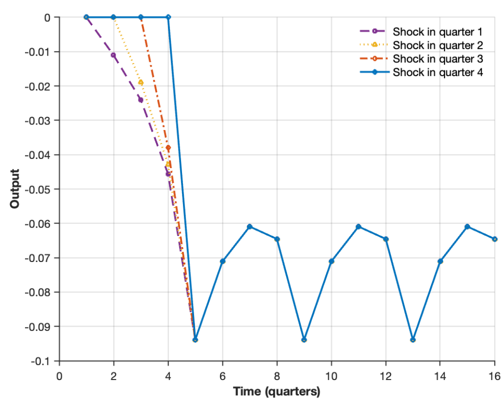
(a) Inflation



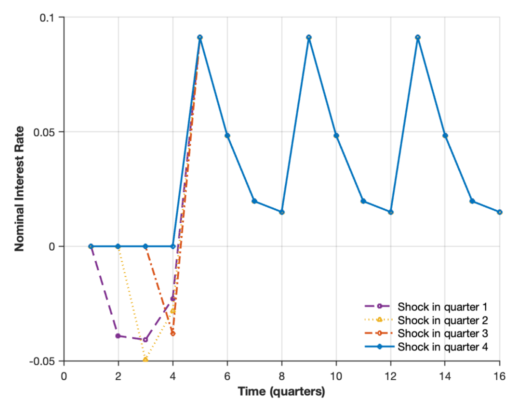
(b) Nominal Minimum Wage



(c) Output



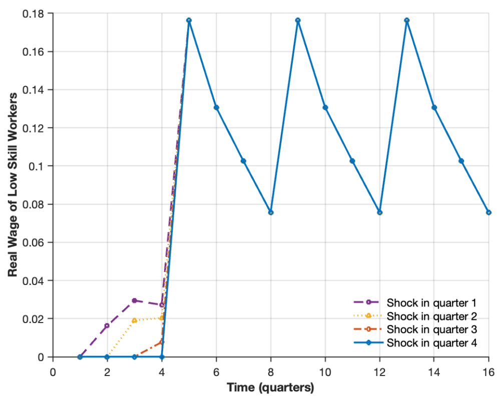
(d) Nominal Interest Rate



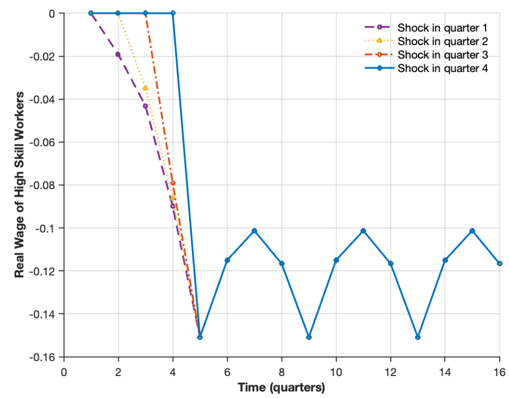
Notes: This figure plots the four impulse responses to a 25 basis point increase in aggregate inflation in the first, second, third and fourth quarters separately. We assume the shock occurs at the end of the quarter, when the other variables have already been determined.

Figure 7: Impulse Response Functions of High and Low Skill Real Wages

(a) Low Skill Real Wage



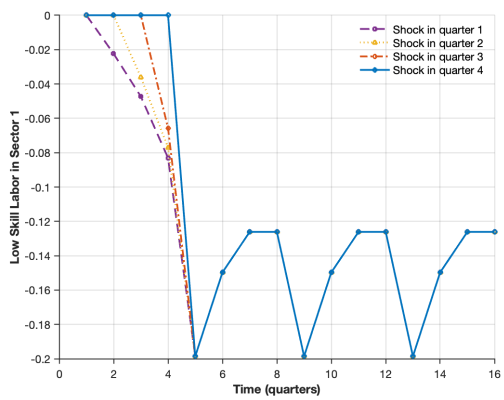
(b) High Skill Real Wage



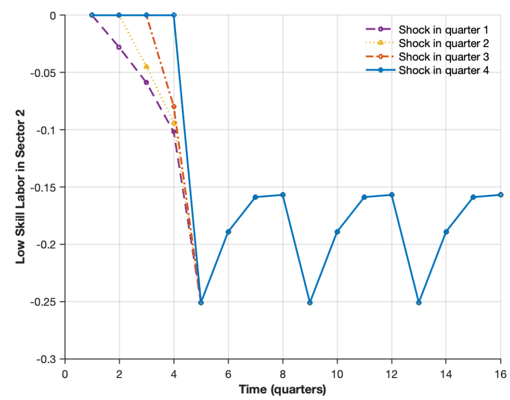
Notes: This figure plots the four impulse responses to a 25 basis point increase in aggregate inflation in the first, second, third and fourth quarters separately. We assume the shock occurs at the end of the quarter, when the other variables have already been determined.

Figure 8: Impulse Response Functions of Input Firm's High and Low Skill Labor

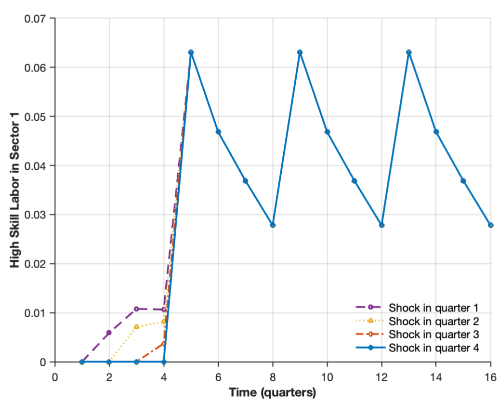
(a) Low Skill Labor in Input Firm 1



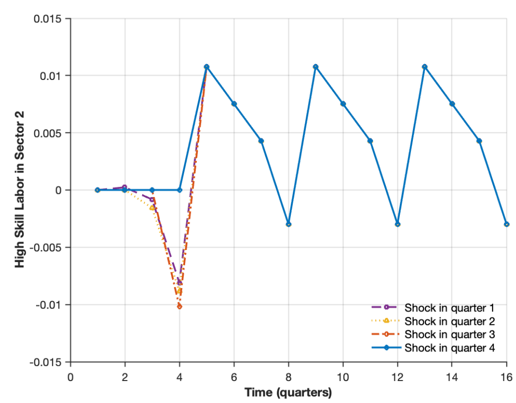
(b) Low Skill Labor in Input Firm 2



(c) High Skill Labor in Input Firm 1



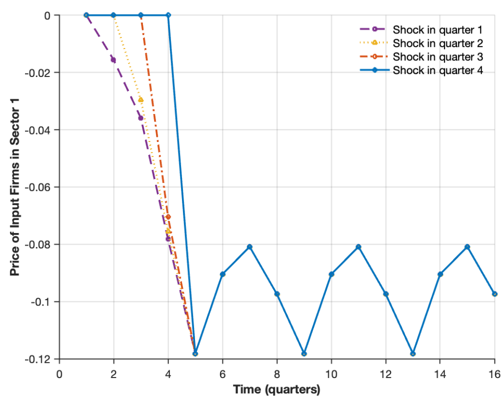
(d) High Skill Labor in Input Firm 2



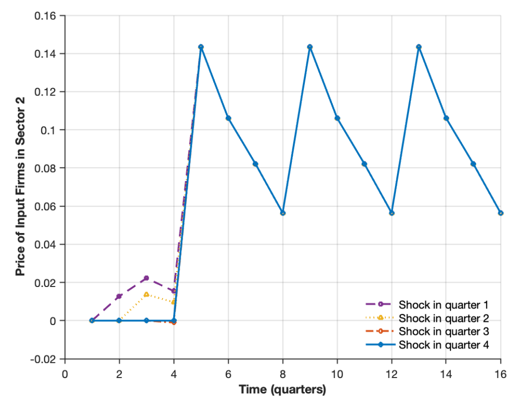
Notes: This figure plots the four impulse responses to a 25 basis point increase in aggregate inflation in the first, second, third and fourth quarters separately. We assume the shock occurs at the end of the quarter, when the other variables have already been determined. Input firm 1 is more high skill intensive while input firm 2 is more low skill intensive.

Figure 9: Impulse Response Functions of Input Firm's Price and Output

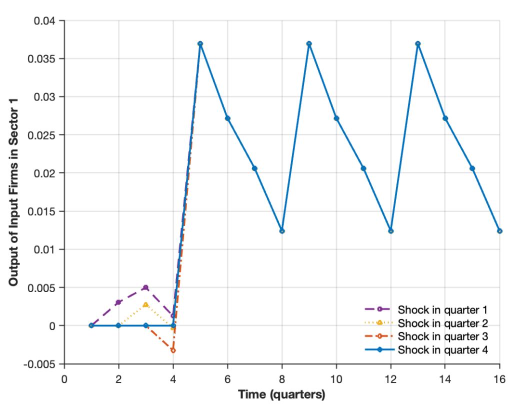
(a) Price of Input Firm 1



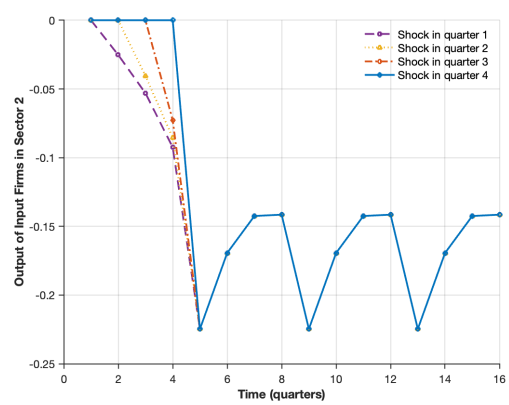
(b) Price of Input Firm 2



(c) Output of Input Firm 1



(d) Output of Input Firm 2



Notes: This figure plots the four impulse responses to a 25 basis point increase in aggregate inflation in the first, second, third and fourth quarters separately. We assume the shock occurs at the end of the quarter, when the other variables have already been determined. Input firm 1 is more high skill intensive while input firm 2 is more low skill intensive.

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Tables

Table 1: Summary Statistics by Earnings Percentiles (2015)

	$\hat{y}_t < mw^{t+1}$	$mw^{t+1} < \hat{y}_t < 2 \cdot mw^{t+1}$	$2 \cdot mw^{t+1} < \hat{y}_t$
Observations	1000101	6288112	3068607
Female	0.45	0.40	0.23
Age	32.19	34.07	37.80
Education			
Less than High School	0.53	0.43	0.29
High School	0.45	0.52	0.45
More than High School	0.02	0.05	0.27
Establishment Size			
Small (<20)	0.19	0.22	0.16
Medium (20–250)	0.37	0.39	0.41
Large (>250)	0.44	0.39	0.44
Regions			
North	0.08	0.05	0.05
Northeast	0.37	0.16	0.10
Southeast	0.37	0.51	0.57
South	0.08	0.19	0.20
Centerwest	0.09	0.08	0.08
Sectors			
Agr. and Mining	0.17	0.08	0.05
Manuf. and Constr.	0.30	0.31	0.41
Services	0.53	0.60	0.52

Table 2: Model Calibration

Parameter	Description	Value	Source
β	Discount factor	0.99	Standard
σ	Intertemporal elasticity of substitution	2.0	Standard
ν	Inverse Frisch elasticity	1.0	Standard
ϕ_π	Taylor rule inflation coefficient	2.0	Standard
ϕ_y	Taylor rule output coefficient	0.6	Standard
ξ_p	Price stickiness parameter	0.35	Standard
λ	Elasticity of substitution across input goods	0.5	Standard
η	Elasticity of substitution between labor types	0.8	Standard
s_L^1	Low skill labor share in input firm 1	0.1	Assumed
s_L^2	Low skill labor share in input firm 2	0.9	Assumed
$1-a_1$	Probability that minimum wage resets in quarter 1	1	Assumed
$1-a_2, 1-a_3, 1-a_4$	Probability that minimum wage resets in quarter 2, 3, 4	0	Assumed

List of Appendix Figures

A Appendix: Institutional Details

B Appendix: Data

B.1 Measurement Error in Earnings and Treatment

There are two versions of RAIS. One of them is publicly available,[6] and the second is accessed through a data use agreement with the Ministry of Labour. The public version of RAIS tracks workers within a year, but not across them. For this reason, we aggregate this dataset to the region-industry level when conducting the analysis across years. We call this the de-identified dataset. In contrast, the private version identifies workers and firms with their national identification numbers. For firms, this number is known as the CNPJ, and for workers it is known as CEP. We refer to it as the identified dataset.

The key information in RAIS is a worker's earnings, which is recorded in two ways. First, firms report earnings for worker l in year t in each month m, y^l_{mt}. The survey required this information for the first time in 2015. From this, we can calculate the predicted annual average monthly earnings as $\hat{y}^{l,pred}_t = \frac{\sum_{m=1}^{m=12} y^l_{mt}}{12}$. Second, firms also directly report a worker's annual average monthly earnings $\hat{y}^l_t$. By common sense, the predicted average should coincide with the reported average: $\hat{y}^{l,pred}_t = \hat{y}^l_t$. We tag the workers for whom it does as having verified earnings.

Appendix Figures

Figure C.1 reports, for each dataset, the percent of observations with verified earnings. For the de-identified data (orange line), the percent of verified earnings is close to 100% up until the COVID pandemic in 2020. Then, it falls to roughly 80% and subsequently climbs back up to approximately 90%. The identified data suffers from measurement error in the earnings data to a much greater extent (blue line). There, the percent of verified earnings oscillates between 70% and 50%. Moreover, there is a striking seasonal pattern. The value jumps in January, and then falls steadily until December. Within a year, the percent of

[6] We access the public version of RAIS through Base dos Dados, https://basedosdados.org/.

verified earnings can vary across months because of workers' entry into and exit out of the formal labor market.

Appendix Figures

Given this evidence, figures C.2 and C.3 focus on the prevalence of measurement error in the identified data. Figure C.2 compares, for workers whose earnings are unverified, the distribution of their directly reported annual average monthly earnings $\hat{y}_t^l$ in blue, with the distribution of their predicted annual average monthly earnings $\hat{y}_t^{l,pred}$ in red. In all three years, the distribution of $\hat{y}_t^{l,pred}$ exhibits a long left tail. This reveals that when monthly earnings are mis-reported, they are consistently recorded to be "too low".

Appendix Figures

Figure C.3 compares the distribution of treatment for workers with verified earnings in blue, with the distribution of treatment for workers with unverified earnings in red. Treatment is calculated as the predicted earnings increase due to the minimum wage: $ln(mw_{t+1}) - ln(\hat{y}_t^l)$. The figure restricts to workers whose treatment value is greater than zero. Although different in magnitude, the value of treatment across the two sets of workers is distributed similarly. This suggests that using the directly reported annual average monthly earnings $\hat{y}_t^l$ to calculate treatment ameliorates any concerns that it may be affected by measurement error in the earnings variable.

B.2 Summary Statistics by Earnings Percentiles

Table C.1 reports the summary statistics by earnings percentiles for the sample 2016-2017. It is similar to Table 1, which reports the same statistics for the year 2015. Appendix Tables

C Appendix: Model with 2 Input Firms

The system of log-linearized equations is giving by:

<u>Household Block</u>

$$\text{Intertemporal Euler equation :} \qquad y_t = y_{t+1} - \frac{1}{\sigma}(r_t - \pi_{t+1})$$

$$\text{High-skill wage determination :} \qquad w_t^H = \nu h_t + \sigma y_t$$

Firm Block

$$\begin{aligned}
\text{New Keynesian Phillips Curve}: \quad & \pi_t = \frac{(1-\xi_p\beta)(1-\xi_p)}{\xi_p} mc_t + \beta\pi_{t+1} + \varepsilon_t^\pi \\
\text{Cost minimization condition}: \quad & x_t^2 - x_t^1 = q_t^1 - q_t^2 \\
\text{Final goods production function}: \quad & y_t = \lambda x_t^1 + (1-\lambda)x_t^2 \\
\text{Marginal cost of final goods producers}: \quad & mc_t = \lambda q_t^1 + (1-\lambda)q_t^2 \\
\text{Sector 1, low-skill labor demand}: \quad & w_t^L = q_t^1 + \frac{1}{\eta}\left(x_t^1 - l_t^1\right) \\
\text{Sector 1, high-skill labor demand}: \quad & w_t^H = q_t^1 + \frac{1}{\eta}\left(x_t^1 - h_t^1\right) \\
\text{Sector 2, low-skill labor demand}: \quad & w_t^L = q_t^2 + \frac{1}{\eta}\left(x_t^2 - l_t^2\right) \\
\text{Sector 2, high-skill labor demand}: \quad & w_t^H = q_t^2 + \frac{1}{\eta}\left(x_t^2 - h_t^2\right) \\
\text{Sector 1 - marginal cost}: \quad & q_t^1 = s_{L,1}w_t^L + (1-s_{L,1})\, w_t^H \\
\text{Sector 2 - marginal cost}: \quad & q_t^2 = s_{L,2}w_t^L + (1-s_{L,2})\, w_t^H
\end{aligned}$$

Market Clearing Conditions

$$\begin{aligned}
\text{Goods market clearing condition}: \quad & y_t = c_t \\
\text{High-skill labor market}: \quad & h_t = H_1 h_{1,t} + H_2 h_{2,t}
\end{aligned}$$

Policy block and Definitions

$$\begin{aligned}
\text{Monetary policy}: \quad & r_t = \phi_\pi \pi_t + \phi_y y_t \\
\text{Inflation}: \quad & \pi_t = p_t - p_{t-1} \\
\text{Low skill real wage}: \quad & w_t^L = w_t^{min} - p_t \\
\text{Law of motion min wage}: \quad & w_t^{min} = \left(1 - \sum_{k=1}^{4} q_{kt} * a_k\right) * \left(w_{t-1}^{min} + \pi_{t-1} + \pi_{t-2} + \pi_{t-3} + \pi_{t-4}\right) \\
& \quad + \left(\sum_{k=1}^{4} q_{kt} * a_k\right) * w_{t-1}^{min}
\end{aligned}$$

Note that the parameters s_L^1 and s_L^2 govern the share of low skill labor in each input firm. They represent the share of output of firm i that is attributable to low skill labor. They are given by:

$$s_L^i = \frac{(\theta\alpha_i)L_i^{\frac{\eta-1}{\eta}}}{(\theta\alpha_i)L_i^{\frac{\eta-1}{\eta}} + (1-\alpha_i)H_i^{\frac{\eta-1}{\eta}}} \tag{29}$$

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Figure C.1: Percent of verified earnings over time

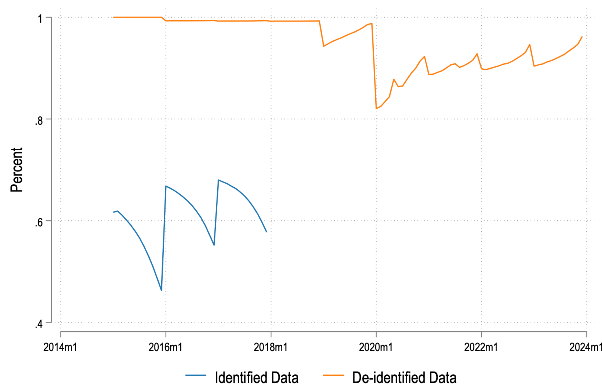
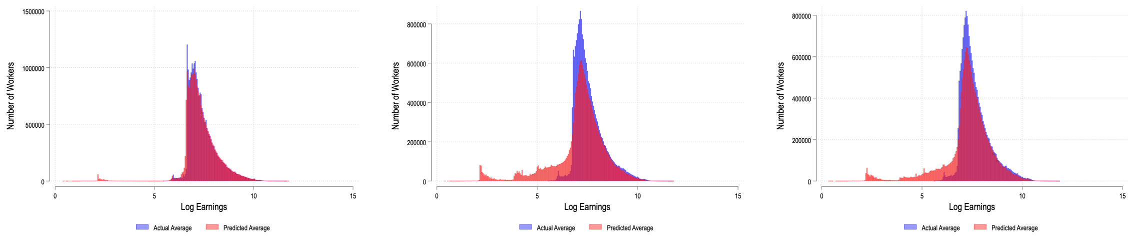
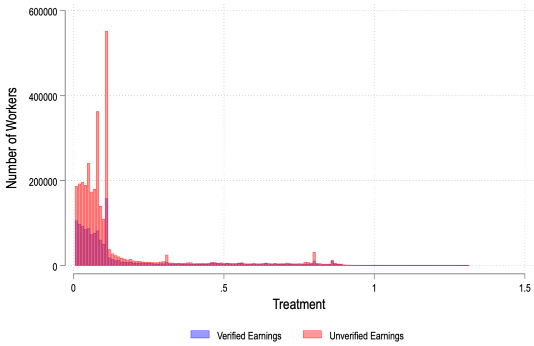


Figure C.2: Distribution of Measurement Error in Earnings (Identified Data)

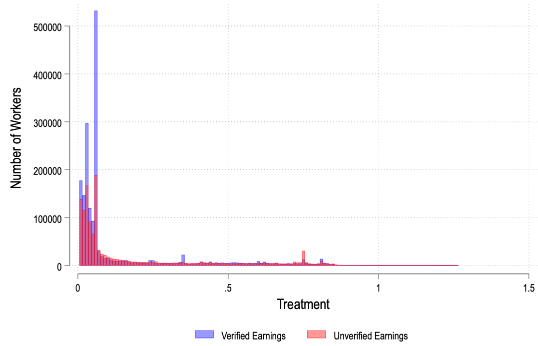


(a) 2015 (b) 2016 (c) 2017

Figure C.3: Distribution of Measurement Error in Treatment (Identified Data)



(a) 2015



(b) 2016

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Table C.1: Summary Statistics by Earnings Percentiles (2016)

	$\hat{y}_t < mw^{t+1}$	$mw^{t+1} < \hat{y}_t < 2 \cdot mw^{t+1}$	$2 \cdot mw^{t+1} < \hat{y}_t$
Observations	1035718	6928745	3252501
Female	0.42	0.40	0.24
Age	33.41	34.51	38.15
Education			
Less than High School	0.49	0.40	0.26
High School	0.47	0.53	0.45
More than High School	0.04	0.07	0.28
Establishment Size			
Small (<20)	0.26	0.26	0.18
Medium (20–250)	0.32	0.36	0.40
Large (>250)	0.42	0.38	0.42
Regions			
North	0.08	0.05	0.04
Northeast	0.41	0.18	0.10
Southeast	0.36	0.50	0.58
South	0.07	0.18	0.20
Centerwest	0.09	0.09	0.08
Sectors			
Agr. and Mining	0.22	0.09	0.06
Manuf. and Constr.	0.24	0.27	0.38
Services	0.53	0.63	0.55