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# Minimum Wage, Business Dynamism, and the Life Cycle of Firms*

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**Abstract**

This paper studies the effects of the minimum wage on the life cycle of firms. We start by building a tractable model where heterogeneous firms have labor market power, invest in innovation, and choose formal or informal sectors. The model predicts that a minimum wage hike not only shrinks the young and lower-productivity firms but also decreases the incentives to innovate, resulting in slower life-cycle growth. We show that these predictions hold in Brazilian administrative and census data, leveraging the variation in exposure to the minimum wage between 1999 and 2010. An increase in the minimum wage (i) decreases the growth rates of small and young establishments and (ii) increases the growth rates of old and large establishments. At the municipal level, we observe an increase in informal employment and in the earnings of both formal and informal workers. Lastly, we augment our simple model into a full quantitative general equilibrium model with monopsonistic firms, endogenous innovation, and formal-informal choice, calibrated to the Brazilian economy. A counterfactual minimum wage increase generates reallocation from young to old firms, dampens innovation at low-productivity firms, and expands the informal sector. Our findings suggest that the minimum wage is a possible explanation for the decline in the importance of young establishments and business dynamism in Brazil.

**Keywords:** Minimum Wage, Business Dynamism, Monopsony, Firm Heterogeneity, Informality
**JEL Classifications:** J38, J42, E24, E26, L25

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# 1 Introduction

The minimum wage is a widely adopted policy across both advanced and emerging market economies. In part, this popularity stems from the view that it can raise the earnings of low-wage workers while having limited effects on aggregate employment (Cengiz et al., 2019; Engbom and Moser, 2022). Beyond its effects on the wage distribution, the minimum wage can also curtail firms' labor market power and reallocate workers from low-paying to high-paying firms (Dustmann et al., 2022).

These effects are, however, not costless. Young firms tend to be small and to pay lower wages (Babina et al., 2019; Brown and Medoff, 2003; Michelacci and Quadrini, 2009; Dinlersoz et al., 2019), making them particularly exposed to increases in the minimum wage. At the same time, young firms account for a disproportionate share of net job creation and invest relatively more than their older counterparts (Decker et al., 2014). Thus, while a minimum wage can improve the allocation of labor by limiting firms' labor market power, it may also reallocate economic activity away from young, dynamic firms and toward older, less dynamic ones.

In this paper, we study how the minimum wage affects firms over their life cycle. We focus on Brazil, where the real minimum wage almost doubled in the 15 years following the end of hyperinflation in 1995. Over this period, we document a broad reallocation of employment from young to old establishments and a decline in the importance of young firms. Such declines in business dynamism can have important consequences for productivity growth, wage growth, and job creation (Akcigit and Ates, 2021).[1]

Our paper consists of three parts. First, we develop a tractable two-period model of heterogeneous monopsonistic firms in the spirit of Berger et al. (2025), augmented with investment in productivity and an endogenous choice into the formal or informal sector.

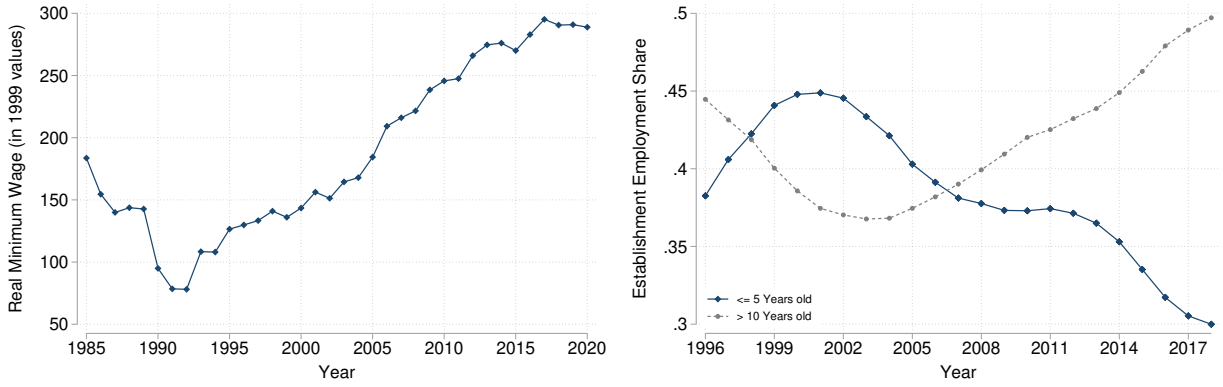
[1] In the United States, several studies document declines in business entry, job reallocation, and the employment share of young firms (Davis and Haltiwanger, 2014; Decker et al., 2016b). Proposed explanations include rising markups and market concentration, demographic changes, and technological change (Karahan et al., 2019; Hopenhayn et al., 2022; Ridder, 2024; Weiss, 2020).

The model highlights two channels through which the minimum wage affects firm dynamics. The first is a reallocation channel. By limiting labor market power, the minimum wage induces intermediate firms to expand employment, while smaller firms contract or leave the formal sector as the wage floor raises their labor costs. The second is a life-cycle channel. The minimum wage changes the returns to productivity investment and therefore firms' subsequent employment growth. In particular, small firms invest less and grow more slowly over their life cycle. If young firms are disproportionately small, these forces imply that minimum wages reallocate activity not only across the firm size distribution but also across the firm *age* distribution, from younger toward older firms.

In the second part of the paper, we test these predictions using the decade-long increase in Brazil's federal minimum wage. Between 1999 and 2010, the real minimum wage rose by more than 80 percent through successive annual increases.[2] Over the same period, establishment entry declined and employment shifted from young toward older establishments, as shown in Figure 1. We combine administrative matched employer-employee records with census data to study whether differential exposure to the minimum wage contributed to this reallocation.

[2]Recent research shows that minimum wage increases accounted for a substantial share of the decline in earnings inequality in Brazil, with muted effects on aggregate employment and output due in part to worker reallocation toward more productive firms (Engbom and Moser, 2022).

Figure 1: Rise of Federal Minimum Wage (left) and Employment Shares by Establishment's Age (right)




*Notes:* The left panel shows the real federal minimum wage in Brazil from 1985 to 2020 (values in 1999 BRL). The right panel shows the employment share from 1996 to 2018 for establishments more than 10 years of age in grey and less than five years in blue. Data are from the RAIS dataset and consider only formal, private, and non-financial establishments.

Our empirical strategy exploits differences in exposure to the national minimum wage generated by pre-policy wage distributions. Our approach is twofold. First, we study the impact of the minimum wage on the universe of formal private non-financial establishments founded before 2000, following their employment growth and exit decisions through 2010. Second, using census data, we exploit variation in minimum wage exposure across Brazilian municipalities to study the effects of the policy on unemployment, labor force participation, and firm entry. Importantly, the census data allow us to observe workers with informal contracts and self-employed individuals who are absent from the administrative data used in the establishment-level analysis.

In the spirit of Card and Krueger (2000), we use a gap design that exploits differences in pre-policy wage distributions, which generate differential exposure to the national minimum wage increase. At the establishment level, we measure exposure using the wage gap, the proportional increase in the 1999 wage bill required to bring all workers initially paid below the 2010 minimum wage up to that level. An analogous measure is constructed at the municipality level. Since the measured gap is based on wages observed before a decade-

long increase in the minimum wage, it is predetermined with respect to firms' subsequent adjustment to the policy.

We estimate the effects of minimum wage exposure on wages, employment, and firm exit from 2000 to 2010. A 1 percentage point increase in the minimum wage gap reduces establishment employment growth between 1999 and 2010 by 0.15 percentage points and increases the probability of exit by about 0.06 percentage points. An establishment with the average exposure of 21 percent is therefore about 1.2 percentage points more likely to have exited by 2010 than an unexposed one. These average effects mask substantial heterogeneity across firms. More exposed small establishments grow less, while larger establishments grow more relative to their less exposed counterparts. We find a similar pattern over the life cycle: young exposed establishments grow less than older ones and initially face a higher probability of exit. Among those that survive, however, the effect on exit eventually reverses, consistent with positive selection among surviving establishments. Together, these responses reallocate employment from young toward older establishments.

The regional-level approach addresses some of the limitations of the establishment-level analysis by incorporating informal firms and workers and capturing local equilibrium effects. Consistent with the establishment-level evidence, more exposed municipalities experience a shift toward older and smaller firms and higher firm exit. We also find that a 1 percentage point increase in the minimum wage gap raises the informal employment share by 0.16 percentage points. Earnings increase in both sectors, with the increase in informal earnings about half as large as that in formal earnings.

In the third part of the paper, we extend the simple model to a quantitative general equilibrium framework calibrated to the Brazilian economy. The model incorporates several features needed for the quantitative analysis. An infinite horizon with endogenous entry, exit, and innovation generates realistic firm life-cycle dynamics. We introduce substantial heterogeneity in firm productivity, with permanent and transitory components that allow age and size to be imperfectly correlated and generate "gazelles" that start small but grow rapidly. Firm-level labor supply shifters further generate wage dispersion independently of

productivity. Finally, we introduce a Kimball-type labor aggregator that allows markdowns to vary systematically with firm size and respond endogenously to policy changes.

We calibrate the model to the Brazilian economy before the large increase in the minimum wage, combining administrative and survey data on firm size, entry and exit, life-cycle growth, wages, and informality. The calibration targets key features of the firm distribution and firm dynamics, as well as the prevalence of informality and the wage distribution. We then compare the model's response to a minimum wage increase with our quasi-experimental estimates, which are not targeted in the calibration. The model generates an increase in firm exit and a shift toward older establishments that are consistent with the empirical estimates.

We then increase the real minimum wage by 80 percent, mirroring the Brazilian experience. The policy generates significant reallocation across firms despite relatively small aggregate employment effects. The share of formal firms falls by 3.9 percentage points, while surviving formal firms become larger. First-year exit increases from 28.1 to 40.5 percent, as marginal entrants increasingly sort into informality or exit shortly after entry. The minimum wage therefore changes not only employment levels, but also which firms operate formally and survive, reallocating economic activity toward larger and older firms.

We decompose these effects into the reallocation and life-cycle channels highlighted by the tractable model. The reallocation channel accounts for most of the adjustment and more than the entire decline in output and welfare. The endogenous life-cycle response partly offsets these losses, as stronger selection leaves a more productive set of surviving formal firms with greater incentives to innovate. Despite this positive selection, aggregate TFP falls by 0.7 percent. The minimum wage weakens the allocation of employment toward more productive formal firms and shifts activity toward the less productive informal sector. These forces dominate the gains from limiting labor market power. Welfare falls by 0.53 percent in consumption-equivalent terms following the 80 percent increase and declines monotonically once the minimum wage becomes binding. Thus, within our efficiency-focused framework, we find no range in which a binding minimum wage improves welfare. Importantly, these efficiency losses coexist with higher earnings among formal workers, highlighting the trade-off

between the productive and distributional effects of the policy.

**Related literature.** Our paper contributes to different strands of the economic literature. In particular, our work is at the intersection of the literatures that study minimum wages, labor market power, firms' and business dynamism, and economic development. First, we add to the literature focusing on models of monopsony in the labor market. Labor market power is typically generated by search frictions (Burdett and Mortensen, 1998; Meghir et al., 2015; Jarosch et al., 2019), heterogeneous preferences over workplaces (Card et al., 2018; Lamadon et al., 2022), or imperfect substitutability across jobs, as in Berger et al. (2022) and Hurst et al. (2022), an approach we adopt here. Much of this literature studies the effects of minimum wages on employment and the wage distribution (Engbom and Moser, 2022; Haanwinckel, 2025), with less attention to their allocative effects. An important exception is Berger et al. (2025), where misallocation arises because the strategic interactions among firms generate dispersion in markdowns. They find that a small minimum wage can improve allocative efficiency by reducing markdown dispersion, although the quantitative gains are small. At moderate minimum wages, including their welfare-maximizing policy, efficiency declines and welfare gains instead arise from redistribution. Our framework innovates and contributes to the literature by introducing additional margins of adjustment through innovation, entry, and firms' choice between formal and informal production. We similarly find that, at quantitatively relevant levels, minimum wages generate efficiency losses, with these additional margins contributing to the decline in aggregate productivity.[3]

A related literature studies the aggregate consequences of labor market power in developing economies. Armangué-Jubert et al. (2025) show that differences in labor market power can account for a substantial share of productivity differences across countries. In developing economies, informality and self-employment provide additional margins of adjustment for both workers and firms.[4] Amodio et al. (2025) show that self-employment provides work-

[3] Armangué-Jubert et al. (2026) study a monopsony model with endogenous productivity-enhancing investment and show that labor market power distorts firms' innovation incentives and life-cycle growth. They do not study how minimum wages affect these margins.

[4] A large literature studies informality without labor market power, including de Paula and Scheinkman

ers with an outside option that limits firms' wage-setting power in Peru. Haanwinckel and Soares (2021) study how labor market frictions interact with informality and labor market regulations in Brazil. Bils et al. (2025) emphasize heterogeneous responses to minimum wages across workers, while Machado Parente et al. (2025) and Lehr et al. (2026) study how informality shapes their distributional and welfare effects. Relatedly, Martinez and Santos (2026) study the interaction between informality and product market power, showing that formalization induces substantial reallocation among firms. Our paper complements this literature by focusing on how minimum wages affect allocative efficiency, total factor productivity, and the macroeconomic aggregates through firm dynamics, including entry, formalization, and investment in innovation.

Our work is also related to the large empirical literature on the effects of minimum wages (Card and Krueger, 2000; Cengiz et al., 2019; Aaronson et al., 2012; Dube et al., 2016). More specifically, it is related to studies of firm adjustment to minimum wage increases. Dustmann et al. (2022) document that the introduction of the German minimum wage reallocated low-wage workers toward more productive, higher-paying establishments, while Harasztosi and Lindner (2019) and Draca et al. (2011) show that firms adjust through prices, capital substitution, profits, and exit.[5] In Brazil, Derenoncourt et al. (2025a) study worker reallocation between formal and informal employment and find only modest movements out of formal employment despite large minimum wage increases. We complement this evidence by studying firm-level adjustment over a decade of minimum wage increases in Brazil, with particular emphasis on firm dynamics and heterogeneity over firms' life cycle. We find stronger effects among young establishments, which account for a disproportionate share of firm growth and are among the most dynamic establishments in the economy.

Finally, we contribute to the literature on the decline in business dynamism in the United States (Decker et al., 2016a; Haltiwanger, 2015) and elsewhere (Calvino et al., 2020; Criscuolo et al., 2014). Among the proposed explanations, several emphasize rising markups and mar-

(2011); La Porta and Shleifer (2014); Ulyssea (2018); Erosa et al. (2023).

[5] In a developing-country context, Garita (2021) finds that minimum wages reduce firm entry and increase exit among small firms in Costa Rica.

ket concentration (Akcigit and Ates, 2021; De Loecker et al., 2021; Ridder, 2024). We document a decline in the importance of young firms in Brazil and provide a quantitative model that highlights labor market institutions, particularly the minimum wage, as a potential contributor to declining business dynamism and lower aggregate productivity.

# 2 Simple Model

This section presents a tractable two-period model of heterogeneous monopsonistic firms where we introduce a minimum wage policy. It is a single-market version of Berger et al. (2025), extended to incorporate informality and investment in innovation. The purpose of this model is to illustrate how a minimum wage affects firm dynamics in a simplified and intuitive way. We focus on firms' decisions in a partial equilibrium setting, leaving the quantitative general equilibrium model to Section 4.

The economy consists of a unitary household and a continuum of firms indexed by $j$. Firms differ in their productivity, $z_j \in \mathbb{R}_+$, and produce a homogeneous good that serves as the numeraire and is traded in a competitive product market. Upon entry, firms choose whether to operate formally or informally, hire labor and produce, and invest to improve their future productivity.

We assume that the household views employment at different firms as imperfect substitutes. For the purposes of this section, the household side can be summarized by the inverse labor supply curve faced by firm $j$:

$$w_j = \left(\frac{n_j}{N}\right)^{\frac{1}{\varepsilon}} W, \tag{1}$$

where $n_j$ and $w_j$ denote firm-level employment and wages, while $N$ and $W$ denote aggregate employment and the aggregate wage index. The parameter $\varepsilon > 0$ is both the elasticity of substitution across employers and the labor supply elasticity faced by an individual firm. We assume it is constant across firms to obtain analytical results, but relax this assumption in the quantitative model.

## 2.1 Firms

Firms live for two periods. Upon entry, they can choose whether to operate formally or informally, but cannot change sectors later. In both sectors, firms pay a fixed cost of operation and produce a homogeneous output using labor as the only factor of production. Formal firms pay taxes on labor and are subject to a minimum wage, if the policy is in place. Informal firms do not pay taxes nor are they subject to a minimum wage. Instead, they face a convex and increasing cost of labor, which captures the fact that the probability that informal firms are discovered and fined by authorities increases with their size (de Paula and Scheinkman, 2011; Ulyssea, 2018).

### 2.1.1 Static Profit Maximization

**Formal firms.** A formal firm $j$ chooses employment $n_j$ to maximize profits taking as given its productivity, $z_j$, and the household inverse labor supply function. In the absence of the minimum wage, the profit maximization problem reads:

$$\max_{n_j} \quad z_j n_j^{\alpha} - (1+\tau) w_j n_j - \kappa \qquad \text{s.t.} \quad w_j = \left(\frac{n_j}{N}\right)^{\frac{1}{\varepsilon}} W,$$

where $\alpha \in (0,1)$, $\tau$ is the payroll tax, and $\kappa$ is the fixed cost in units of the final good. The solution yields a labor demand function, $n_U(z_j)$, and an unconstrained optimal wage function, $w_U(z_j)$, both increasing in firm productivity (see Appendix A).

**Informal firms.** Informal firms do not pay taxes but are subject to an increasing convex cost of labor $\zeta w_j n_j^{1+\phi}$, where $\zeta > 0$ and $\phi > 0$. The problem of the informal firm is:

$$\max_{n_j} \quad z_j n_j^{\alpha} - \zeta w_j n_j^{1+\phi} - \kappa \qquad \text{s.t.} \quad w_j = \left(\frac{n_j}{N}\right)^{\frac{1}{\varepsilon}} W.$$

**Introducing a minimum wage.** A minimum wage $\overline{w}$ imposes a lower bound on wages paid by formal firms. As $w_U(z_j)$ is increasing in $z_j$, the minimum wage binds only for firms

with productivity below $\overline{z}$, implicitly defined by $w_U(\overline{z}) = \overline{w}$. These firms face the problem

$$\max_{n_j} \quad z_j n_j^{\alpha} - (1+\tau)\overline{w} n_j - \kappa \qquad \text{s.t.} \quad n_j = \min\left\{\left(\frac{\overline{w}}{W}\right)^{\varepsilon} N, \overline{n}(z_j)\right\},$$

where $\overline{n}(z_j) = \left(\frac{\alpha}{\overline{w}}\frac{z_j}{1+\tau}\right)^{\frac{1}{1-\alpha}}$ is the competitive labor demand of a firm with productivity $z_j$. As in Berger et al. (2025), the constraint captures the fact that, at a given minimum wage, there is a maximum level of employment that a firm is willing to take, over which it is no longer optimal to hire more workers. In equilibrium, households internalize that firms will not hire workers beyond this level and ration the labor supplied to each firm so that it does not exceed $\overline{n}_j$.

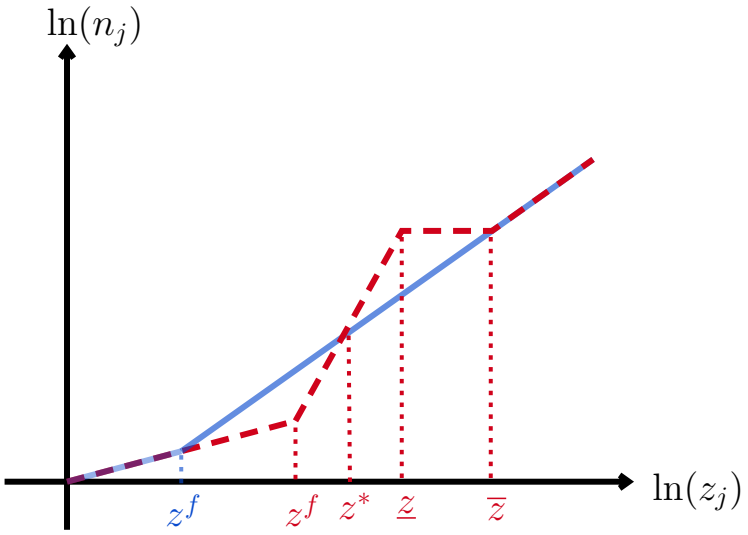
The solution for a firm constrained by the minimum wage is split between two cases. For sufficiently productive firms, the rationing constraint does not bind, and firms retain some labor market power: employment is determined by the labor supplied at the minimum wage, $n_j = \left(\frac{\overline{w}}{W}\right)^{\varepsilon} N$. When the rationing constraint binds, firms behave as if they operate in a competitive labor market, with employment given by $n_j = \overline{n}(z_j)$.

The choices of formal firms can therefore be characterized by three productivity regions. The formalization threshold $z^f$, defined below, is the minimum productivity at which firms choose to formalize. The threshold $\underline{z}$ is implicitly defined by $\overline{n}(\underline{z}) = (\overline{w}/W)^{\varepsilon} N$. Formal firms with productivity below $\underline{z}$ are constrained by the minimum wage and behave as if they operate in a competitive labor market. For firms with productivity between $\underline{z}$ and $\overline{z}$, the minimum wage also binds, but employment is constant at $(\overline{w}/W)^{\varepsilon} N$. Finally, firms with productivity above $\overline{z}$ are not directly affected by the minimum wage.

Figure 2 summarizes these results, formally stated in Proposition 1. Holding aggregate prices and quantities ($W$ and $N$) fixed, unconstrained firms above $\overline{z}$ do not change their behavior, whereas constrained firms below $\overline{z}$ may expand or contract in the short run. Specifically, there is a cutoff $z^*$ such that firms with $z_j > z^*$ expand, while those with $z_j < z^*$ contract (see Appendix A for the proof and further discussion).

**Proposition 1.** *Let $n_j^{\text{MW}}$ and $n_j^{\text{No MW}}$ denote the optimal employment of firm $j$ with and*

Figure 2: Optimal Firm Size With and Without a Minimum Wage




*Notes:* The figure illustrates optimal firm size in the static problem. The horizontal and vertical axes report log productivity, $\ln z_j$, and log employment, $\ln n_j$, respectively. The solid blue line represents employment in the absence of a minimum wage, while the dashed red line represents employment under the minimum wage. The vertical lines indicate the thresholds $z^f$, $z^*$, $\underline{z}$, and $\overline{z}$, as characterized in Proposition 1.

*without a minimum wage, respectively. Suppose a minimum wage* $\overline{w} > 0$ *is introduced and that* $z^* > z^f$*. Holding* $N$ *and* $W$ *fixed, optimal employment satisfies*

$$\begin{aligned} n_j^{\text{MW}} &< n_j^{\text{No MW}} \quad \text{if } z_j \in [z^f, z^*), \\ n_j^{\text{MW}} &= n_j^{\text{No MW}} \quad \text{if } z_j = z^*, \\ n_j^{\text{MW}} &> n_j^{\text{No MW}} \quad \text{if } z_j \in (z^*, \overline{z}), \\ n_j^{\text{MW}} &= n_j^{\text{No MW}} \quad \text{if } z_j \geq \overline{z}. \end{aligned}$$

### 2.1.2 Investment Decision

We follow Atkeson and Burstein (2010) and model firm productivity evolving through investment in innovation. After the formalization and production decisions in the first period, a firm with productivity $z$ chooses an innovation probability $p \in [0, 1]$ at cost $c(p; z) = \mu z^{\psi}(\exp\{\eta p\}\text{-}1)$. If innovation succeeds, productivity increases to $\lambda z$, where $\lambda > 1$; otherwise, it remains at $z$.[6] The cost is denominated in units of the final good and scales up

[6]For simplicity, we omit negative idiosyncratic shocks, as they are inconsequential for our theoretical results. We include them in the quantitative model.

with firm productivity when $\psi > 0$. The parameters $\mu > 0$ and $\eta > 0$ govern its scale and convexity, respectively. Firms discount future profits by $\beta \in (0, 1)$.

The value function of a firm operating in the formal sector is

$$V_F(z) = \max_{p \in [0,1]} \pi_F(z; \overline{w}) - z^{\psi}\mu(\exp\{\eta p\} - 1) + \beta \left[ p\pi_F(\lambda z; \overline{w}) + (1-p)\pi_F(z; \overline{w}) \right], \quad (2)$$

where the continuation value uses the fact that the firm only lives for two periods and thus has no incentives to innovate in the second period. The value function of an informal firm, $V_I(z)$, is defined analogously. Assuming an interior solution, the optimal innovation decision is characterized by the following first-order condition:

$$p^*(z) = \frac{1}{\eta} \log \left\{ \frac{\beta}{z^{\psi}\mu\eta} \left[ \pi_F(\lambda z; \overline{w}) - \pi_F(z; \overline{w}) \right] \right\}. \quad (3)$$

Equation (3) highlights that the incentives to innovate are related to expected future profits. By changing the returns to productivity, the minimum wage discourages innovation among the least productive formal firms and lowers their life-cycle productivity growth. As productivity is not directly observed, it is useful to characterize the impact of the introduction of a minimum wage via its effect on the expected employment growth rate. Let $g_n(z; \overline{w})$ denote the expected employment growth of a firm with productivity $z$:

$$g_n(z; \overline{w}) = \mathbb{E}_t \left[ \frac{n_{t+1} - n_t}{n_t} \right] = p^*(z; \overline{w}) \frac{n(\lambda z; \overline{w}) - n(z; \overline{w})}{n(z; \overline{w})}. \quad (4)$$

Equation (4) illustrates that the minimum wage policy may impact the expected growth rate of firms through both the probability of innovation, $p^*$, and the firm's optimal employment size, $n$. Proposition 2 characterizes how changes in the minimum wage affect the growth rate of employment across firms.

**Proposition 2.** *Consider a minimum wage $\overline{w} > 0$ such that $\underline{z} > z^f$. Assume $\lambda$ is such that $\lambda z^f < \underline{z}$ and $\lambda \underline{z} < \overline{z}$, so that each relevant productivity region contains a positive measure of firms that remain within it after successful innovation. Suppose that $p^*(z; \overline{w})$ is interior for all $z \geq z^f$. Holding $W$ and $N$ fixed, a marginal increase in $\overline{w}$ affects expected employment*

*growth as follows:*

$$\frac{\partial g_n(z;\overline{w})}{\partial \overline{w}} = \begin{cases} 0, & \text{if } z > \overline{z}, \\ 0, & \text{if } z, \lambda z \in (\underline{z}, \overline{z}), \\ < 0, & \text{if } z, \lambda z \in (z^f, \underline{z}). \end{cases} \tag{5}$$

Once again, the proof is provided in Appendix A. Proposition 2 shows that a higher minimum wage reduces expected employment growth among the least productive formal firms. For large firms with $z > \overline{z}$, neither profits nor optimal employment depends directly on the minimum wage. Their growth is therefore affected only through general equilibrium effects. Firms for which $z, \lambda z \in (\underline{z}, \overline{z})$ increase their innovation expenditure following a higher minimum wage. However, as employment is constant within this productivity region, successful innovation does not translate into employment growth. Finally, for small formal firms with $z, \lambda z \in (z^f, \underline{z})$, the minimum wage reduces the profit gain from innovation, $\pi_F(\lambda z; \overline{w}) - \pi_F(z; \overline{w})$, thereby lowering both innovation and expected employment growth. As young firms tend to be small, this mechanism slows employment growth over the firm life cycle.

### 2.1.3 Formality Choice

Finally, we characterize the firm's choice between operating formally and informally. Since the relative value of formality, $V_F(z) - V_I(z)$, increases with productivity, the formality decision satisfies a single-crossing condition. There is therefore a productivity threshold $z^f$ such that firms with $z_j \geq z^f$ choose to formalize. This threshold is implicitly defined by

$$V_F(z^f) = V_I(z^f). \tag{6}$$

An increase in the minimum wage lowers the value of operating formally relative to informally and therefore raises $z^f$, increasing the incentives to operate informally.

### 2.1.4 Predictions of the Theoretical Model

Despite its simplicity, the model delivers several testable predictions that guide our empirical analysis. In particular, an increase in the minimum wage implies that:

1) the least productive formal firms contract in the short run;
2) more productive firms either expand or remain unchanged;
3) the least productive formal firms reduce innovation, slowing their life-cycle employment growth;
4) the formalization threshold increases, strengthening the incentives to operate informally; and
5) since young firms tend to be smaller and less productive, the effects of the minimum wage are more pronounced among young firms.

# 3 Empirical Evidence

This section presents our empirical analysis of the impact of the minimum wage increase on Brazilian establishments and municipalities. We first describe the institutional context and the data. We then lay out the establishment-level and regional approaches and discuss their results.

## 3.1 Institutional Context

**The minimum wage policy.** The analysis focuses on Brazil, an emerging market economy with a large informal sector. Brazil's federal statutory minimum wage is set by the federal government and expressed as the monthly wage of a full-time worker. It applies across states, industries, and occupations and has historically been adjusted annually.[7] As shown in the

[7]Since 2000, states have also been allowed to set state-specific minimum wages. Five states instituted their own wage floors: Rio de Janeiro and Rio Grande do Sul in 2001, Paraná in 2006, São Paulo in 2007,

left panel of Figure 1, after declining during the hyperinflation period between 1985 and 1993, the Brazilian real minimum wage increased substantially following the stabilization in 1994. This increase accelerated in the 2000s, beginning at the end of Cardoso's presidency and continuing under Lula, and persisted until 2014. Between 1999 and 2010, the real minimum wage increased from 136 BRL to 245 BRL (in 1999 values), an increase of more than 80 percent in real terms over the course of one decade. The minimum wage as a fraction of the median wage also increased, from around 30 percent in 1996 to roughly 55 percent in 2018. This large increase in the real minimum wage is unmatched among developing economies and has made Brazil an important case study in the minimum wage literature (Engbom and Moser, 2022; Haanwinckel, 2025; Derenoncourt et al., 2025b).

The increase in the minimum wage between 1999 and 2010 coincided with a period of strong economic growth in Brazil. GDP per capita grew by an average of 2.8 percent per year, while the urban worker informality rate declined from more than 35 percent to below 25 percent (see Appendix Figure B.1). Earnings inequality also declined, particularly at the lower end of the distribution. This decline has been partially attributed to the minimum wage and its spillovers to both the formal wage distribution and the informal sector (Engbom and Moser, 2022; Haanwinckel, 2025).

Until 2008, the minimum wage was set annually through the federal budget process, typically involving a political decision by Congress and the president. Starting in 2008, adjustments followed a rule based on past inflation and real GDP growth. The large increase during the 2000s therefore reflected a combination of political support for higher wage floors by the ruling Workers' Party (*Partido dos Trabalhadores*), favorable fiscal conditions, and strong economic growth. The growth episode itself was influenced by both external and domestic forces, including increased demand for Brazilian commodities from China and rising educational attainment. As discussed below, these developments suggest that the large increase in the minimum wage over the following decade could not have been fully expected

and Santa Catarina in 2010. In practice, although their wage floors are higher than the federal minimum wage, their growth tracks it closely.

by firms and individuals in 1999.

**Business dynamism.** A lesser-known fact is that Brazil experienced a substantial decline in business dynamism over the 2000s. As shown in the right panel of Figure 1, the share of employment in private formal establishments younger than five years fell from 45 percent in 2000 to 30 percent in 2018, while the share in establishments older than ten years rose from 37 to 50 percent. This shift toward older establishments reflects both weaker entry and slower growth among young establishments. Appendix Figure B.3 shows that the employment share of entrants declined from nearly 10 percent to less than 6 percent over the same period, reflecting both lower entry and smaller entrant size. Young establishments also experienced slower growth, while the growth of mature establishments increased (Appendix Figure B.4).

The decline in the importance of young establishments coincided with the large increase in the federal minimum wage, but several other features of the Brazilian economy changed over the same period. In particular, as mentioned above, worker informality declined substantially, while firm informality changed much less (see Appendix B.1 for a discussion). The following sections examine whether the minimum wage can account for part of the decline in business dynamism.[8]

## 3.2 Data

Our empirical analysis uses two main datasets. The first is RAIS (*Relação Anual de Informações Sociais*), an administrative matched employer-employee panel covering the universe of workers and establishments in Brazil's formal sector. It reports individual characteristics such as earnings, gender, age, education, hours, and occupation, as well as establishment characteristics, including location, industry, and legal status. We aggregate workers employed in December of each year to construct establishment-level measures of employment and the wage bill.

[8]Some papers link the decline in business dynamism in the United States to a falling labor share, rising concentration, and greater market power. Appendix Figure B.2 shows that the Brazilian labor share increased during the 2000s, while average markups remained roughly constant.

We use these data to construct a panel of non-financial private establishments. We define an establishment as an entrant in $t$ if it records positive employment for the first time in the sample, and as a permanent exit if it has positive employment in $t-1$ but none in $t$ or thereafter. Establishment age is measured as the number of years since entry.

RAIS does not cover informal businesses or employment. We therefore complement it with the 2000 and 2010 population censuses, which identify workers in formal and informal employment, as well as self-employed individuals and small employers, who are predominantly associated with informal businesses. The census is used primarily to construct municipality-level measures of informality and unemployment. We restrict the census sample to individuals aged 15-66.

## 3.3 Establishment-level Approach

In this subsection, we outline the methodology used to estimate the impact of minimum wage increases on individual establishments. Our objective is to identify the effects of these increases on establishment-level growth based on the potential exposure of establishments to the increase in the federal minimum wage policy. Building upon the existing literature on the minimum wage (Card and Krueger, 2000; Dustmann et al., 2022; Draca et al., 2011), we construct a measure that captures potential exposure based on the establishment's wage distribution in the pre-policy year.

Unlike most of the literature, which focuses on short-run minimum wage hikes, our treatment captures the long-run exposure to a decade of increase in the minimum wage and compares the establishment's wage distribution in December 1999 with the minimum wage in 2010. As the minimum wage policy is readjusted annually to at least account for inflationary losses, firms might anticipate some wage increases from year to year. However, as discussed in the previous section, it was unlikely that establishments anticipated an 80 percent increase in the real minimum wage over 10 years, as it was driven by exogenous

political and economic factors.[9]

The establishment-level exposure measure, $\text{GAP}_j$, captures the proportional increase in the establishment's wage bill required to raise all workers employed in 1999 to the 2010 minimum wage:

$$\text{GAP}_j = \frac{\sum_{i \in j} \max\{0, \text{MW}_{2010} - w_i\}}{\sum_{i \in j} w_i}, \tag{7}$$

where $\text{MW}_{2010}$ is the national monthly minimum wage in 2010, expressed in 1999 values, and $w_i$ is the monthly wage of worker $i$ in establishment $j$ in 1999.

**Empirical strategy.** We restrict the sample to establishments with at least one employee in 1999 and follow their outcomes in subsequent years. Smaller and younger establishments tend to have greater exposure to the minimum wage increase, and this relationship persists conditional on the average wage (see Appendix Table B.1). Following Draca et al. (2011) and Harasztosi and Lindner (2019), we estimate

$$\frac{y_{jt} - y_{j1999}}{y_{j1999}} = \alpha_t + \beta_t \text{GAP}_j + \gamma_t X_{j1999} + \varepsilon_{jt}, \tag{RS1}$$

where $y_{jt}$ denotes the outcome of establishment $j$ at time $t$ (employment or average wage), and $X_{j1999}$ contains pre-policy establishment characteristics. Specifically, we include a cubic polynomial in the 1999 average wage, pre-1999 wage growth, and interactions of industry, year, size, age, and region fixed effects.[10] The coefficient $\beta_t$ captures the differential change in the outcome between establishments with greater and lower exposure to the minimum wage increase. We use the same specification across alternative samples and outcomes to study heterogeneous effects on establishment characteristics (e.g., size and age) and adjustment mechanisms.

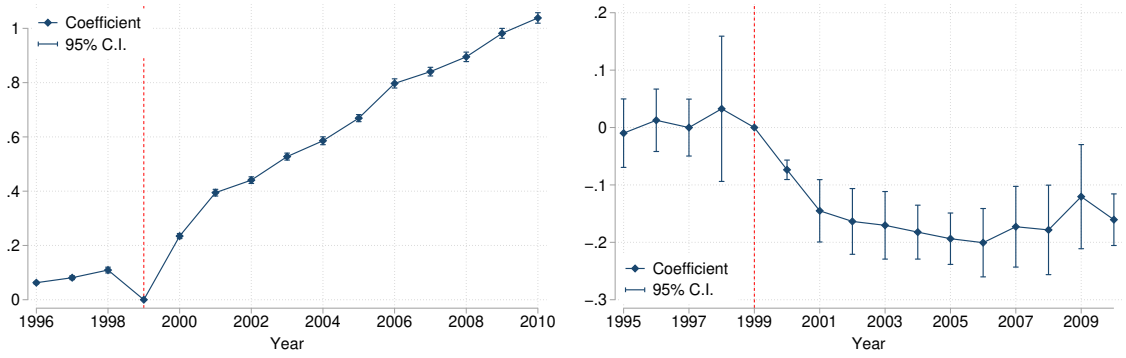
The empirical strategy relies on the fact that establishments differ in their pre-policy

[9]The analysis is restricted to 1999-2010 for two reasons: (i) in the municipality-level analysis the treatment requires the use of the census, which is available only up to 2010; (ii) in 2008 the government passed a bill tying the changes to the MW to real GDP growth, increasing firms' ability to forecast future changes in the policy.

[10]Industry is defined at the 3-digit level, while region is defined as the micro-region, a group of municipalities akin to a US commuting zone. There are seven size categories and six age categories.

wage distributions and, therefore, in their exposure to the national policy. The identifying assumption is that, absent the minimum wage increase, establishments with different levels of exposure would have experienced parallel changes in outcomes conditional on their pre-policy characteristics. Given our set of pre-period fixed effects, the specification effectively compares establishments within narrow groups defined by age, size, industry, and location. As usual, identification also requires that the treatment of one establishment does not affect the outcomes of others, i.e., that there are no spillovers across establishments (SUTVA).

Figure 3: Coefficients $\beta_t$: Wage (left) and Employment Growth (right)




*Notes:* The figure shows, in the left panel, the estimated coefficient $\beta_t$ of regression (RS1) with average wage growth as the outcome variable. The right panel shows the estimated coefficient on a regression with establishment employment growth rates as an outcome variable.

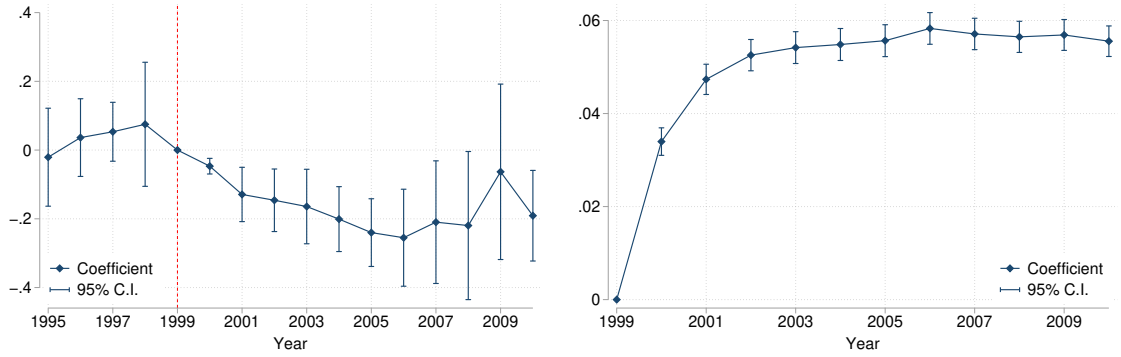
**Results.** We estimate specification (RS1) separately for each year and report the $\beta_t$ coefficients and their confidence intervals in Figure 3.[11] The figures also report coefficients for the years before 1999, estimated relative to 1999. For employment growth, these pre-period coefficients are small and statistically indistinguishable from zero, which supports the parallel-trends assumption. For wage growth, they are positive but an order of magnitude smaller than the post-period coefficients, indicating only mild mean reversion in 1999 wages.

The left panel shows that minimum wage exposure is associated with higher wage growth. A 1 percentage point increase in $\text{GAP}_j$ is associated with nearly a 1 percentage point increase

[11] Standard errors are clustered at the commuting-zone level (*regiões geográficas imediatas* as defined by the Brazilian statistical agency).

in average wage growth, consistent with full compliance with the minimum wage. The right panel shows a negative and statistically significant effect on employment growth. Over 1999-2010, a 1 percentage point increase in $\text{GAP}_j$ is associated with a 0.15 percentage point lower employment growth rate.

Figure 4: Intensive vs Extensive Margin: Survivors Growth (left) and Exit Probability (right)

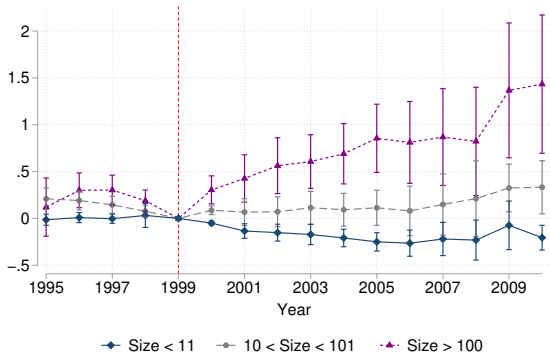



*Notes:* The figure shows, in the left panel, the estimated coefficient $\beta_t$ of regression (RS1) with employment growth as the outcome variable conditional on surviving establishments. The right panel shows the exit probability from a linear probability model adapting the specification in (RS1).

The estimates above combine both establishments that operated during the entire period and establishments that shut down, reflecting both the extensive margin (exiting) and the intensive margin (hiring and layoff decisions). Figure 4 separates these margins. Among surviving establishments, greater exposure is associated with lower employment growth, with a magnitude similar to that in the full sample. At the extensive margin, a 1 percentage point increase in exposure raises the probability of having exited by about 0.06 percentage points, hence, an establishment with the average exposure of 21 percent is about 1.2 percentage points more likely to have exited than an unexposed one. The results therefore indicate that the negative employment response operates through both lower employment growth among survivors and a higher probability of exit.

To explore heterogeneous effects across establishments, we interact $\text{GAP}_j$ with indicators for establishment size and age. Figure 5 shows substantial heterogeneity in employment growth. Among establishments with fewer than 11 workers in 1999, greater exposure is

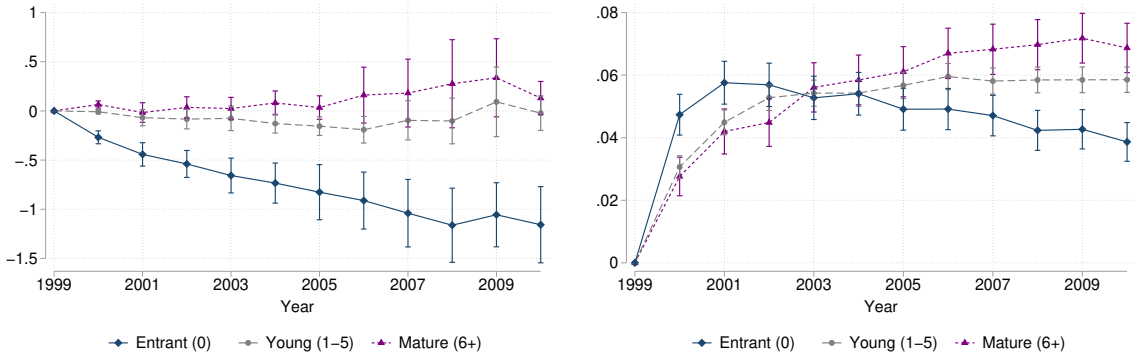
Figure 5: Survivors Employment Growth by Size




*Notes:* The figure shows the estimated coefficient $\beta_t$ of regression (RS1) adapted to interact the GAP variable with dummy variables for different firm sizes. The outcome variable is employment growth conditional on surviving establishments.

associated with lower subsequent employment growth. For establishments with more than 50 workers, the relationship is instead positive. This pattern is consistent with the findings of Dustmann et al. (2022) for the German minimum wage and points to a non-linear response of establishment employment to minimum wage exposure. As we show later, the reallocation toward large employers points to a non-linear response of employment to minimum wage changes, consistent with models of monopsonistic labor markets.

Figure 6: Survivors Growth (left) and Exit Probability (right) by Age




*Notes:* The figure shows results for the regression (RS1) adapted to interact the GAP variable with dummy variables for different firms' age. In the left panel, the figure shows the estimated coefficient for the interacted GAP variable with employment growth as an outcome variable conditional on surviving establishments. The right panel shows the exit probability from a linear probability model.

Finally, Figure 6 highlights heterogeneity by establishment age. Young establishments exposed to larger minimum wage increases experience lower employment growth, whereas the relationship is positive for mature establishments (left panel). Furthermore, the right panel shows that treated younger establishments had a higher likelihood of ceasing operations shortly after a minimum wage increase. However, once these establishments survive the early years, their exit probability becomes lower than that of mature establishments. This suggests the presence of selection effects during entry and early years. Overall, these results suggest that the minimum wage policy may contribute to employment reallocation from young to older establishments, as shown in the right panel of Figure 1.

## 3.4 Regional Approach

The establishment-level approach provides valuable evidence on the heterogeneity of minimum wage effects, but also has important limitations. First, it focuses on incumbent establishments and therefore does not capture post-2000 entry. Second, RAIS covers only the formal sector and cannot capture responses in the informal sector. Finally, it cannot identify local aggregate and general equilibrium effects, such as changes in unemployment and aggregate wage levels. We complement it with census data, which allows us to exploit variation in exposure to minimum wage hikes across municipalities and examine these additional margins.

**Treatment and empirical strategy.** As in the establishment-level analysis, the regional approach exploits cross-municipality variation in pre-policy wage distributions to measure exposure to the minimum wage increase. The municipality-level measure, $\text{GAP}_m$, captures the proportional increase required to bring all formal workers in municipality $m$ up to the 2010 national minimum wage, relative to total formal and informal earnings:

$$\text{GAP}_m = \frac{\sum_{i \in m} \max\{0, \text{MW}_{2010} - w_i^f\}}{\sum_{i \in m} w_i^f + \sum_{i \in m} w_i^i}, \tag{8}$$

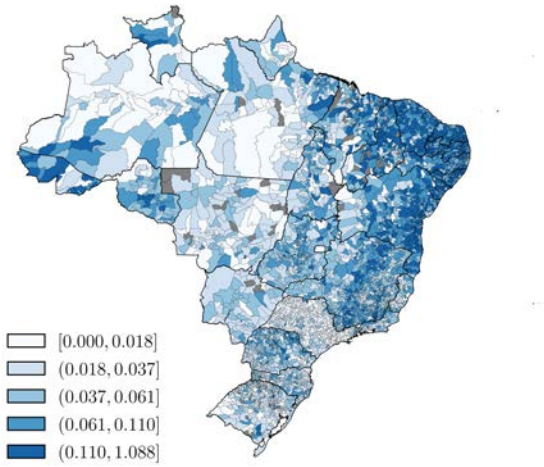
where $\text{MW}_{2010}$ is the 2010 national monthly minimum wage, expressed in 1999 values, and $w_i^f$ and $w_i^i$ denote the monthly earnings of formal and informal workers $i$, respectively, in municipality $m$ in 1999. The numerator is constructed from RAIS, while the denominator combines formal earnings from RAIS with informal earnings from the 2000 census. Specifically,

$$\sum_{i \in m} w_i^f + \sum_{i \in m} w_i^i = (1 + \text{RIF}_m) \sum_{i \in m} w_i^f, \tag{9}$$

where $\text{RIF}_m \equiv \sum_{i \in m} w_i^i / \sum_{i \in m} w_i^f$ is the ratio of informal to formal earnings in municipality $m$. We estimate $\text{RIF}_m$ from the census and obtain total formal earnings from RAIS.

The $\text{GAP}_m$ measure is standard in the literature. In our setting, however, its construction has an important implication: cross-municipality variation in exposure reflects both the formal wage distribution and the size of the informal labor market. Municipalities with more low-wage formal workers have greater exposure, while a larger informal sector reduces the gap relative to total local earnings. As a result, $\text{GAP}_m$ need not vary monotonically with local economic development: poorer municipalities tend to have more low-wage formal workers, increasing exposure, but also larger informal sectors, reducing it.

Figure 7: Exposure to Minimum Wage in Brazilian Municipalities




*Notes:* The figure plots $\text{GAP}_m$, as defined by equation (8), across Brazilian municipalities.

The measure $\text{GAP}_m$ has a population-weighted average of 0.072. This means that bringing formal wages up to the 2010 national minimum wage would require an increase in the formal wage bill equal to 7.2 percent of total formal and informal earnings, on average. There is substantial heterogeneity across municipalities, with $\text{GAP}_m$ ranging from 0 to 1.09. Figure 7 shows the spatial distribution of $\text{GAP}_m$ across the 5,456 Brazilian municipalities. Darker shades indicate greater exposure to the national minimum wage increase. These highly exposed municipalities are primarily concentrated in the Northeast region, one of the poorest regions of the country.

Following Dustmann et al. (2022), we use a difference-in-differences framework to estimate the effects of the 1999–2010 minimum wage increase on municipality-level outcomes, including establishment entry, informal entrepreneurship, and other outcomes. Identification comes from cross-municipality variation in the bite of the minimum wage, captured by $\text{GAP}_m$. We estimate:

$$y_{jmt} = \alpha_m + \alpha_t + \beta \text{GAP}_m \times \text{Post}_t + \text{controls} + \varepsilon_{jmt} \tag{RS2}$$

where $y_{jmt}$ denotes the outcome of establishment or worker $j$ in municipality $m$ at time $t$, and $\alpha_m$ and $\alpha_t$ denote municipality and time fixed effects, respectively. The pre-period is 2000 (or December 1999 for RAIS), and the post-period is 2010. $\text{Post}_t$ equals one in 2010 and zero in the pre-period. We control for time-varying establishment- or individual-level characteristics and include a cubic polynomial in municipality income per capita in 2000 interacted with time fixed effects.[12]

Akin to the establishment-level approach, identification requires that, conditional on pre-period characteristics, outcomes in municipalities with different levels of exposure would have evolved in parallel in the absence of the minimum wage increase. The coefficient $\beta$ measures the differential change in the outcome associated with a 1 percentage point increase in $\text{GAP}_m$ following the minimum wage increase.

[12]Establishment-level controls consist of three-digit industry dummies, while individual-level controls include gender, education indicators, age, and age squared.

**Results.** Table 1 reports the results of specification (RS2) for establishment-level outcomes. The results are consistent with the establishment-level analysis. More exposed municipalities have establishments that are more likely to exit and are older and smaller than those in less exposed municipalities (columns 2-4). The negative size effect is consistent with the lower employment growth among smaller establishments documented in Figure 5. We find no significant effect on the share of new establishments (column 1).

Table 1: Region-level Approach: Firm Results

| | (1) Entrant | (2) Exiter | (3) Age > 5 years | (4) log(size) |
|---|---|---|---|---|
| $GAP_m \times 2010$ | -0.0188 | 0.155*** | 0.325*** | -0.335*** |
| | (0.0290) | (0.0198) | (0.0614) | (0.0918) |
| Observations | 4,707,558 | 4,707,558 | 4,707,558 | 4,707,558 |
| Municipality FE | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes |
| Controls | Yes | Yes | Yes | Yes |

*Notes*: The table shows the results for different regressions using specification (RS2) for firms' variables. Column (1) shows the results with the entrant status as the dependent variable, column (2) with exiter status as the dependent variable, column (3) with age higher than 5 years as the dependent variable, and column (4) the log of the size of the firm as the dependent variable. Standard errors are clustered at the municipality level. *** p<0.01, ** p<0.05, * p<0.1

Table 2 reports the corresponding individual-level estimates. Greater minimum wage exposure is associated with higher earnings in both the formal and informal sectors. A 1 percentage point increase in $GAP_m$ is associated with a 0.9 percent increase in formal earnings (column 5), consistent with nearly full pass-through of the minimum wage increase. Informal earnings also increase, although by less, with a coefficient of 0.503 (column 6). This spillover is consistent with general equilibrium effects in the informal labor market and with the possibility that the minimum wage serves as a reference point even in the absence of direct enforcement (e.g., Meghir et al., 2015). As opposed to the effect on workers, the

coefficient on employer earnings is positive but not statistically significant (column 7).

Table 2: Region-level Approach: Individual Results

| | (1) Informal | (2) Employer | (3) Unemployed | (4) OLF | (5) log(*earn*) Formal | (6) log(*earn*) Informal | (7) log(*earn*) Employer |
|---|---|---|---|---|---|---|---|
| $GAP_m \times 2010$ | 0.159*** | -0.00884*** | 0.0481*** | 0.0268 | 0.892*** | 0.503*** | 0.119 |
| | (0.0236) | (0.00241) | (0.00825) | (0.0174) | (0.0713) | (0.0505) | (0.210) |
| Observations | 7,981,170 | 7,981,170 | 13,030,226 | 13,030,226 | 3,357,422 | 2,003,671 | 175,035 |
| Municipality FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Controls | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

*Notes*: The table shows the results for different regressions using specification (RS2) for individuals' variables. Column (1) shows the results with the informal worker status as the dependent variable, column (2) with employer status as the dependent variable, column (3) with unemployed status as the dependent variable, column (4) with the out of labor force status as the dependent variable, column (5) with log of earnings in the formal sector as the dependent variable, column (6) with log of earnings in the informal sector as the dependent variable, and (7) log of earnings for employers as the dependent variable. Standard errors are clustered at the municipality level. *** p<0.01, ** p<0.05, * p<0.1.

Columns (1) to (4) examine occupational choice and employment outcomes. A 1 percentage point increase in $GAP_m$ is associated with a 0.159 percentage point increase in the probability of informal employment (column 1).[13] This corresponds to a 1.5 percentage point difference between municipalities at the 80th and 20th percentiles of the $GAP_m$ distribution.[14] The effect on the probability of being an employer is small (column 2), while the effects on unemployment and non-participation are also economically small (columns 3 and 4). [15]

[13]Informal workers are defined as paid workers without registered employment relationships and self-employed individuals.

[14]Calculated as $0.159 \times (0.110 - 0.018)$, where the latter values correspond to the 80th and 20th percentiles of the $GAP_m$ distribution shown in Figure 7.

[15]The employment elasticity with respect to the formal wage is approximately 0.05, obtained by dividing the coefficient in column (3) by that in column (5), compared with 0.03 in Dustmann et al. (2022).

# 4 Quantitative Model

In this section, we extend the two-period model of Section 2 to quantify the aggregate effects of the minimum wage. We build an infinite-horizon general equilibrium economy with endogenous entry and exit, heterogeneous markdowns, richer heterogeneity in firm productivity and wages, and imperfect selection into the formal sector. These features allow the model to generate realistic firm-size, wage, and life-cycle dynamics. We later calibrate the model to the Brazilian economy prior to the large increase in the minimum wage.

## 4.1 Households

A representative household has preferences over consumption and workplace varieties. Firm-level employment is aggregated into an employment index $N$ through a Kimball-type aggregator. We assume households do not save and solve the following static problem:

$$\max_{C,\{n_j\}} \left\{ \frac{C^{1-\sigma}}{1-\sigma} - \overline{\nu} \frac{N^{1+\nu}}{1+\nu} \right\} \qquad \text{s.t.} \qquad C = \int w_j n_j dj + T + \Pi,$$
$$\int \Upsilon\left(\frac{n_j}{m_j N}\right) dj = 1 \qquad \text{and} \qquad n_j \leq \overline{n}_j,$$

where $T$ and $\Pi$ denote lump-sum transfers and aggregate profits. The function $\Upsilon$ is increasing and convex, with $\Upsilon(1) = 1$. The variable $m_j$ is a firm-level labor supply shifter capturing differences in workplace attractiveness and amenities. Workplaces with higher $m_j$ are more attractive to the household and receive more labor at any given wage, generating wage dispersion across firms independently of productivity. Finally, the constraint $n_j \leq \overline{n}_j$ captures labor rationing for firms constrained by the minimum wage.

Following Berger et al. (2025), we characterize firm-level labor supply using shadow wages. Let $\xi_j$ denote the multiplier on the rationing constraint and define $\xi_j = w_j(1 - p_j)$. The inverse labor supply curve can then be written as

$$\tilde{w}_j \equiv w_j p_j = \Upsilon'\left(\frac{n_j}{m_j N}\right) \frac{\tilde{W} S}{m_j}, \tag{10}$$

where $\tilde{w}_j$ is a shadow wage that captures the slackness of the rationing constraint and $S$ is the associated supply index. When the constraint is slack, $p_j = 1$ and $\tilde{w}_j = w_j$; when it binds, $p_j \leq 1$ and $\tilde{w}_j \leq w_j$. Aggregate labor supply satisfies

$$\frac{\tilde{W}}{C^\sigma} = \overline{\nu} N^\nu. \tag{11}$$

The shadow wage index $\tilde{W}$ and the supply index $S$, together with the full derivation of the household problem, are defined in Appendix C.1.

## 4.2 Firms

The firm's static problem closely follows the one presented in Section 2. Firms operate in either the formal or informal sector, produce with labor under decreasing returns to scale, $y_j = A_j n_j^\alpha$, and face sector-specific regulations and costs. The quantitative model adds an infinite horizon and richer firm dynamics, including heterogeneous markdowns. Firm-level productivity, $A_j = a_j z_j$, consists of a permanent component, $a_j$, and a transitory component, $z_j$, that evolves endogenously according to the firm's innovation decision. Firms also differ in the labor supply shifter $m_j$. Both $a_j$ and $m_j$ are drawn at entry. Within each period, firms choose employment and innovation and decide whether to continue operating in the following period.

**Static problem.** The production problem of a formal firm is analogous to the one in the tractable model. The main difference is that the inverse labor supply curve is now generated by the Kimball aggregator. The problem of a formal firm unconstrained by the minimum wage is

$$\max_{n_j} \quad A_j n_j^\alpha - (1+\tau) w_j n_j - \kappa_f \qquad \text{s.t.} \quad w_j = \Upsilon'\left(\frac{n_j}{m_j N}\right) \frac{\tilde{W} S}{m_j}. \tag{12}$$

The first-order condition implies

$$w_j(1+\tau) = \underbrace{\left(\frac{\varepsilon(x_j)}{1+\varepsilon(x_j)}\right)}_{md(x_j)} \alpha A_j n_j^{\alpha-1}, \tag{13}$$

where $\varepsilon(x) \equiv \Upsilon'(x)/(\Upsilon''(x)x)$ is the labor supply elasticity, evaluated at the shifter-adjusted employment share $x_j = n_j/(m_j N)$. The term $md(x_j) \equiv \varepsilon(x_j)/(1+\varepsilon(x_j))$ is the firm's markdown.[16] Given aggregates $\tilde{W}$, $S$, and $N$, equations (13) and (10) jointly determine the employment, wage, and markdown of an unconstrained firm.

As in the tractable model, formal firms for which the minimum wage binds can operate in one of two regimes. If the rationing constraint is slack, employment is pinned down by labor supply at the minimum wage:

$$n_j = m_j \, \varphi\left(\frac{m_j \overline{w}}{\tilde{W} S}\right) N < \overline{n}_j, \tag{14}$$

where $\varphi \equiv (\Upsilon')^{-1}$. If the rationing constraint binds, the firm behaves as a wage taker, and employment is $n_j = \overline{n}_j = \left(\frac{\alpha}{\overline{w}} \frac{A_j}{1+\tau}\right)^{\frac{1}{1-\alpha}}$. The relevant regime depends jointly on productivity $A_j$ and the labor supply shifter $m_j$.[17] Appendix C.2 provides the full characterization.

The problem of an informal firm is analogous:

$$\max_{n_j} \quad A_j n_j^{\alpha} - \zeta w_j n_j^{1+\phi} - \kappa_i \qquad \text{s.t.} \quad w_j = \Upsilon'\left(\frac{n_j}{m_j N}\right) \frac{\tilde{W} S}{m_j}. \tag{15}$$

Together with the inverse labor supply curve, the first-order condition determines employment, wages, markdowns, and profits. The full derivation can be found in Appendix C.2.

**Dynamic problem.** The transitory productivity component, $z$, evolves through endogenous innovation as in Atkeson and Burstein (2010). A firm with state $(z, a, m)$ chooses an innovation probability $p \in [0,1]$ at cost $c(p) = a^{\psi_a} z^{\psi_z} \mu(\exp\{\eta p\} - 1)$, where $\mu, \eta > 0$ govern

[16] As discussed later in the text in Section 5.1, our parameterization implies $\varepsilon'(x) < 0$, so larger firms face lower labor supply elasticities and exercise greater market power.

[17] In particular, firms with low productivity and high labor supply shifters are more likely to be constrained by both the minimum wage and the rationing constraint.

the scale and convexity of innovation costs.[18] Conditional on this choice, transitory productivity evolves to $ze^{\Delta}$ with probability $p$ and to $ze^{-\Delta}$ with probability $1-p$, where $\Delta > 0$ is the innovation step in logs. The firm discounts future profits by $\beta \in (0,1)$ and faces sector-specific exogenous exit probabilities $\delta_F$ and $\delta_I$. The dynamic problem of a formal firm that continues operating is[19]

$$\begin{aligned}\tilde{V}_F(z;a,m) = \max_{p\in[0,1]} \; & \pi_F(z;a,m) - a^{\psi_a} z^{\psi_z} \mu \left(\exp\{\eta p\} - 1\right) \\ & + \beta(1-\delta_F)\left[pV_F(ze^{\Delta};a,m) + (1-p)V_F(ze^{-\Delta};a,m)\right]. \end{aligned} \tag{16}$$

where $\pi_F(z;a,m)$ denotes the profits of a formal firm. We allow firms to exit when their value becomes negative. Hence, the value function is $V_F(z;a,m) = \max\{\tilde{V}_F(z;a,m), 0\}$, and the policy $\chi_F^{\text{exit}}(z;a,m)$ equals one when a formal firm exits and zero otherwise. For an interior solution, optimal innovation satisfies

$$p_F(z;a,m) = \frac{1}{\eta}\log\left\{\frac{\beta(1-\delta_F)}{a^{\psi_a} z^{\psi_z}\mu\eta}\left[V_F(ze^{\Delta};a,m) - V_F(ze^{-\Delta};a,m)\right]\right\}. \tag{17}$$

The informal firm's problem is analogous, replacing $F$ with $I$ and $\delta_F$ with $\delta_I$ (see Appendix C.2).

**Entry.** There is an infinite mass of potential entrants. After paying the entry cost $c_e$ in units of the final good, an entrant draws a permanent productivity component $a \sim G_a$ and a labor supply shifter $m \sim G_m$. Entrants do not observe their initial transitory productivity $z$ before choosing a sector. Instead, conditional on $(a,m)$, they observe a noisy signal

$$s = \ln z + \eta_s, \qquad \eta_s \sim \mathcal{N}(0, \sigma_\eta^2), \tag{18}$$

where the prior distribution of initial productivity is $\ln z \sim \mathcal{N}\left(-\frac{\sigma_z^2}{2}, \sigma_z^2\right)$. The signal generates a posterior belief about initial productivity, which entrants use to compare the expected value of operating formally and informally. They then choose the sector before observing

[18] We also assume $\psi_a > 0$ and $\psi_z > 0$, so innovation costs scale with both productivity components.
[19] Recall that both $a$ and $m$ are fixed at entry.

their realization of $z$, after which initial productivity is drawn from the corresponding posterior. Firms cannot change sectors later.

This information structure generates imperfect selection into formality. Entrants with more favorable signals are more likely to choose the formal sector, while signal noise allows some low-productivity firms to enter formally and exit soon after entry. The parameter $\sigma_\eta$ governs the strength of selection at entry.[20] The free-entry condition is

$$c_e = \frac{1}{1+r} \int \mathbb{E}_s \left[ \max \left\{ \mathbb{E}[V_F(z; a, m) \mid s], \mathbb{E}[V_I(z; a, m) \mid s] \right\} \right] dG_a(a)\, dG_m(m). \tag{19}$$

## 4.3 Aggregation and Stationary Equilibrium

The model is solved in a stationary recursive competitive equilibrium. An equilibrium consists of aggregate prices and quantities, firm-level policy functions, the entry decision, and stationary measures of formal and informal firms over their state variables, such that firms and households optimize, the labor aggregator and goods markets clear, the free-entry condition holds, and the stationary measures satisfy their respective laws of motion. Aggregating firm-level outcomes over the stationary distributions determines aggregate employment, output, and the mass of entrants. The full characterization of the equilibrium conditions and stationary measures is provided in Appendix C.3, and the numerical solution algorithm is described in Appendix D.[21]

[20] As $\sigma_\eta \to 0$, the signal becomes perfectly informative, so entrants observe $z$ before choosing a sector. As $\sigma_\eta \to \infty$, the signal becomes uninformative, and $z$ is effectively revealed only after the sector choice. Therefore, $\sigma_\eta$ allows the disciplining of the extent of first-year exit among formal entrants.

[21] In the baseline economy, we normalize $\tilde{WS} = 1$ and use the free-entry condition to determine the implied entry cost $c_e$. In the counterfactuals, $c_e$ is held fixed at its baseline value and $\tilde{WS}$ adjusts to satisfy free entry.

# 5 Benchmark Economy and Calibration

## 5.1 Calibration

This section describes how we parameterize and calibrate the model to the Brazilian economy. We use data from RAIS, the Urban Informal Economy Survey (ECINF), the census, and national accounts. The model is solved at a quarterly frequency, with parameters and moments reported at annual rates. We first specify the remaining functional forms, then set a subset of parameters using external evidence, and estimate the remaining parameters by simulated method of moments (SMM).

### 5.1.1 Functional Forms and Exogenous Parameters

Table 3 summarizes the externally calibrated parameters. We set $\sigma = 1$ (log utility), the inverse Frisch elasticity to $\nu = 2$ (Keane and Rogerson, 2012), and normalize $\overline{\nu} = 1$. We follow Ulyssea (2018) and set the Brazilian payroll tax to $\tau = 37.5$ percent. The annual interest rate is $r = 5$ percent, and the quarterly discount factor $\beta$ is set consistently with this value. The returns-to-scale parameter is set to $\alpha = 0.80$.[22] The innovation step $\Delta = 0.30$ targets the standard deviation of annual employment growth among large formal firms (Atkeson and Burstein, 2010), and the exogenous exit rates, $\delta_F$ and $\delta_I$, are set to match the annual exit rate of large formal firms in RAIS (6.5%) and the average age of informal firms in ECINF (which implies a 10% annual exit rate), respectively.[23] The innovation cost exponent on transitory productivity is set to $\psi_z = (1 + \overline{\varepsilon})/(1 + \overline{\varepsilon}(1 - \alpha))$, which equals the

[22] This value can be interpreted as the reduced-form elasticity with respect to labor after optimizing over capital. For example, standard values of an overall returns-to-scale parameter of 0.85 and a labor share of 2/3 (e.g., Boar and Midrigan, 2025) imply a reduced-form labor elasticity of approximately 0.79 after optimizing over capital. The equilibrium labor share in our model, however, also depends on firms' labor market power. As shown below, the model implies an aggregate labor share of 0.47, slightly below the 0.53 observed in the data.

[23] We define large firms as those with 100 or more employees. In the model, large formal firms do not choose to exit endogenously over the course of a year because their productivity is far above the exit threshold. Hence, $\delta_F$ directly determines their annual exit rate. Informal firms can also exit endogenously and the rate $\delta_I$ captures the exogenous component of their exit.

elasticity of unconstrained profits with respect to $z$ in the CES benchmark.[24] Finally, we set $\phi = 1$, so that the informality cost is quadratic, and estimate the informal fixed cost $\kappa_i$ jointly with the remaining parameters.

**Labor supply elasticity and labor market power.** The labor aggregator determines the labor supply elasticity and the degree of labor market power in the economy. Following Boar and Midrigan (2025) and Klenow and Willis (2016), we parameterize the labor supply elasticity as $\varepsilon(x) = \bar{\varepsilon} x^{-\theta/\bar{\varepsilon}}$. This functional form allows the labor supply elasticity, and hence the firm's markdown, to vary with shifter-adjusted relative employment, at a rate governed by the super-elasticity $\theta/\bar{\varepsilon}$. When $\theta = 0$, the labor supply elasticity is constant at $\bar{\varepsilon}$ and the aggregator reduces to the CES case. We interpret this functional form as a reduced-form representation of micro-founded models of labor market power, such as Berger et al. (2022) and Armangué-Jubert et al. (2025).

There are several estimates of labor supply elasticities - and, consequently, markdowns -which vary across countries and methodologies. Several papers estimate labor supply elasticities directly. Felix (2026) finds that Brazilian workers in the 1990s received about 50 cents per marginal dollar, while Amodio et al. (2026) estimate an inverse labor supply elasticity of 0.82, implying that workers receive about 55 cents per additional dollar of output in a sample of Latin American countries.[25] Other papers infer markdowns using production-function methods in the spirit of Yeh et al. (2022). Amodio et al. (2024) and Eslava et al. (2025) estimate that workers in Latin America receive about 42 and 56 cents per marginal dollar, respectively.[26] Finally, estimates from structural models tend to imply somewhat higher wage-to-MRPL ratios than these micro estimates. For the US, Berger et al. (2022)

[24] In the CES benchmark, this choice prevents innovation incentives from mechanically vanishing as $z$ increases. In the quantitative model, however, labor supply elasticity declines with firm size, so innovation incentives decrease somewhat with $z$.

[25] These estimates use labor demand shocks to identify the responsiveness of wages to employment. Amodio and de Roux (2024), for example, estimate a labor supply elasticity of 2.5 for Colombia, implying a wage-to-MRPL ratio of about 0.71.

[26] For Brazil, Eslava et al. (2025) estimate a wage-to-MRPL ratio of about 0.54. For comparison, Yeh et al. (2022) estimate a ratio of about 0.65 for the United States.

find a payroll-weighted average ratio of 0.78. For Brazil, Lobel (2024) and Bils et al. (2025) estimate ratios of 0.81 and 0.84, respectively, while Amodio et al. (2025) find an average of 0.70 for Peru.

Given the wide range of estimates, we set the labor supply elasticity at the reference firm to $\bar{\varepsilon} = 1.80$, which implies a markdown of 0.64 at $x = 1$. We choose the super-elasticity so that the model reproduces the size gradient in labor supply elasticities estimated for Brazil. Lobel (2024) estimates labor supply elasticities of 5.75 and 4.25 for firms below and above median size, respectively, a ratio of 0.739. With $\theta = 0.19$, the model generates a ratio of 0.760. This value implies an elasticity of the markdown with respect to the employment share of about 0.04 at the reference firm.[27] Although the reference firm has a markdown of 0.64, the average markdown in the model depends on the equilibrium distribution of firm size and labor supply shifters. We show below that the baseline model implies an output-weighted average markdown across all firms of about 0.59 (0.62 when weighted by employment among formal firms, shown in Appendix Table C.1), within the range of estimates in the literature, and an aggregate labor share of 0.47, slightly below the 0.53 observed in the Brazilian national accounts over 1999–2004 (Appendix Figure B.2). Taken together, these results provide reassurance that our calibration is consistent with both the micro and the macro evidence.

**Distributions and shocks.** We assume that the firm-level labor supply shifter is drawn from a log-normal distribution, $\ln m \sim \mathcal{N}(-\sigma_m^2/2, \sigma_m^2)$. The permanent productivity component $\ln a$ follows a Weibull distribution with shape parameter $n_A$ and scale $1/\xi_A$, following Hubmer and Restrepo (2024). When $n_A = 1$, this specification corresponds to a Pareto distribution for $a$ with tail parameter $\xi_A$, while $n_A < 1$ generates a fatter right tail, allowing the model to match the concentration of employment among the largest firms.[28] Finally, the

[27] Amodio et al. (2024) find an elasticity of the markdown with respect to the employment share of 0.068 in a cross-country sample that excludes Brazil and Amodio et al. (2026) find no significant difference between large and small firms in Latin America. For Brazil, Bils et al. (2025) find that markdowns do not differ between large and small employers.

[28] Labor market power makes employment less responsive to productivity than in a competitive labor market, where the elasticity of employment with respect to productivity is $1/(1-\alpha)$, and increasingly so

initial draw of transitory productivity is log-normal, $\ln z \sim \mathcal{N}(-\sigma_z^2/2, \sigma_z^2)$, and the signal noise is normal, $\eta_s \sim \mathcal{N}(0, \sigma_\eta^2)$. The Gaussian specification implies a Gaussian posterior for $\ln z$ given the signal, allowing the posterior moments required for the entry decision to be computed in closed form.

Table 3: Exogenously Calibrated Parameters.

| | Parameter | Value | Target / Source |
|---|---|---|---|
| **Preferences** | | | |
| Relative risk aversion | $\sigma$ | 1.00 | Log utility |
| Inverse Frisch elasticity | $\nu$ | 2.00 | Keane and Rogerson (2012) |
| Labor disutility | $\overline{\nu}$ | 1.00 | Normalization |
| **Technology** | | | |
| Returns to scale | $\alpha$ | 0.80 | Informality viability at $\tau = 0.375$ |
| Interest rate | $r$ | 0.05 | Brazilian data |
| Payroll tax | $\tau$ | 0.375 | Ulyssea (2018) |
| **Labor Market** | | | |
| Supply elasticity | $\overline{\varepsilon}$ | 1.80 | See text; avg. markdown $\approx 0.59$ |
| Super-elasticity | $\theta$ | 0.19 | Amodio et al. (2024); Lobel (2024) |
| **Other** | | | |
| Innovation step | $\Delta$ | 0.30 | SD emp. growth (large firms) |
| Innovation cost curvature in $z$ | $\psi$ | 2.06 | $(1+\overline{\varepsilon})/(1+\overline{\varepsilon}(1-\alpha))$ |
| Formal exit rate | $\delta_F$ | 6.5%/yr | RAIS: large/old firms |
| Informal exit rate | $\delta_I$ | 10%/yr | ECINF: avg. informal age |
| Informal cost curvature | $\phi$ | 1.00 | Normalization |

### 5.1.2 Endogenous Parameters

The remaining 12 parameters, $\Theta = \{\mu, \eta, \psi_a, \kappa_F, \kappa_I, \zeta, \xi_A, n_A, \sigma_z, \sigma_\eta, \sigma_m, \overline{w}\}$, are jointly estimated by simulated method of moments (SMM). We target 13 moments from the Brazilian firm-size distribution, firm dynamics, wages, and informality data, all equally-weighted in our estimating routine. Table 4 reports the parameter values and targeted moments, while Table 5 reports the model fit.

for larger firms as the labor supply elasticity declines with size. This compresses the firm-size distribution relative to the competitive benchmark, motivating a fatter-tailed productivity distribution to match the observed concentration of employment.

The calibration combines moments that discipline four main margins. All parameters are estimated simultaneously and we briefly describe some of the most informative relations between those and the moments to highlight the potential mechanisms behind their identification. First, moments of firm size and employment growth help identify the innovation process. The top 10 percent employment share disciplines the scale of innovation costs, $\mu$, while the dispersion of entrant size and the age profile of firm size provide information about the curvature of innovation costs, $\eta$, and their dependence on permanent productivity, $\psi_a$. The employment growth rate of entering formal firms provides additional information on $\psi_a$. The innovation costs scale with permanent productivity, which allows this moment to help disentangle life-cycle growth generated by innovation from growth generated by selection. The size distribution also contributes to the identification of the shape and scale of the permanent productivity distribution, $(n_A, \xi_A)$.

Second, moments of informality and firm size discipline the costs of operating formally and informally. The formal and informal fixed costs, $\kappa_F$ and $\kappa_I$, affect the extensive margin of informality and the exit of informal firms, while the level of informal labor costs, $\zeta$, affects both the allocation of firms across sectors and their relative size. Third, the entry and wage margins help discipline the sources of heterogeneity that are specific to the quantitative model. The dispersion of initial transitory productivity, $\sigma_z$, affects the composition of firms entering each sector, while the signal noise, $\sigma_\eta$, governs the extent of selection into the formal sector and the resulting churning of young formal firms. The dispersion of labor supply shifters, $\sigma_m$, primarily disciplines wage dispersion across firms. Finally, the minimum wage $\overline{w}$ is chosen to match its position in the wage distribution.

The resulting calibration reproduces the main targeted dimensions of the Brazilian firm distribution and labor market. In particular, the model matches the prevalence of informality, the size distribution of entrants, young-firm churning, wage dispersion, and the position of the minimum wage in the wage distribution. It also generates an average markdown of approximately 0.59 and an employment share of formal firms close to that in the data.

Table 4: Endogenously Calibrated Parameters.

| | Parameter | Value | Targeted Moment |
|---|---|---|---|
| **Innovation** | | | |
| Scale cost | $\mu$ | 0.00040 | Top 10% emp. share |
| Convexity cost | $\eta$ | 12.33 | p90/p10 entrant size |
| $a$-scaling exponent | $\psi_a$ | 1.84 | Old/young size ratio & growth at age 0 |
| **Costs** | | | |
| Fixed cost (formal) | $\kappa_f$ | 0.040 | Share of informal employment |
| Fixed cost (informal) | $\kappa_i$ | 0.069 | Entry rate (formal) |
| Informality cost | $\zeta$ | 1.98 | Formal/informal size ratio |
| Entry cost (implied) | $c_e$ | 3.93 | Free entry |
| **Distributions** | | | |
| Permanent prod. scale | $\xi_A$ | 24.49 | p75/p25 entrant size |
| Weibull shape | $n_A$ | 0.60 | Top 25% emp. share |
| Entrant dispersion | $\sigma_z$ | 0.78 | Share of informal firms |
| Signal noise | $\sigma_\eta$ | 0.94 | Exit rate at age 0 |
| Supply shifter dispersion | $\sigma_m$ | 0.21 | Wage p75−p25 / MW |
| **Policy** | | | |
| Minimum wage | $\bar{w}$ | 0.42 | Avg. wage / MW ratio |

*Notes*: Parameters are jointly estimated via SMM using 13 moments with equal weights. The entry cost is pinned down by the free-entry condition and reported as an implied parameter.

Table 5: Targeted and Non-targeted Moments.

| Moment | Data | Model | Source |
|---|---|---|---|
| **Firm size and concentration** | | | |
| Top 10% employment share | 68.3% | 55.6% | RAIS |
| Top 25% employment share | 82.6% | 75.4% | RAIS |
| Old/young size ratio | 4.0 | 3.81 | RAIS |
| p75/p25 entrant size | 4.0 | 3.39 | RAIS |
| p90/p10 entrant size | 8.0 | 8.30 | RAIS |
| **Entry and exit** | | | |
| Entry rate (formal, annual) | 16.0% | 10.9% | RAIS |
| Exit rate at age 0 | 26.7% | 28.1% | RAIS |
| Employment growth at age 0 | 12.4% | 11.7% | RAIS |
| **Informality** | | | |
| Share of informal firms | 70.0% | 71.4% | RAIS & ECINF |
| Share of informal employment | 35.0% | 34.1% | PNAD |
| Size ratio formal/informal | 1.35 | 1.42 | ECINF |
| **Wages** | | | |
| Avg. wage / MW ratio | 2.50 | 2.38 | RAIS |
| Wage p75−p25 / MW | 1.39 | 1.48 | RAIS |
| **Non-targeted** | | | |
| Median wage / MW | 1.99 | 1.82 | RAIS |
| Wage p90−p10 / MW | 3.11 | 3.22 | RAIS |
| Aggregate markdown | See text | 0.593 | See text |
| Labor share | 0.54 | 0.47 | Penn World Table |
| MW bite (fraction of firms at MW) | ∼15% | 12.4% | |
| Labor supply elasticity, large/small firms | 0.74 | 0.76 | Lobel (2024) |

*Notes*: The top panel reports the 13 targeted moments, which receive equal weights. The bottom panel reports non-targeted moments. Employment growth at age 0 is the Davis–Haltiwanger-Schuh growth rate of surviving formal firms between their first and second years. The labor supply elasticity ratio compares employment-weighted elasticities among formal firms above and below median firm size. The formal/informal size ratio is computed among firms below the 70th percentile of the formal size distribution in both sectors, matching the small-firm coverage of ECINF.

## 5.2 Benchmark Economy and Validation

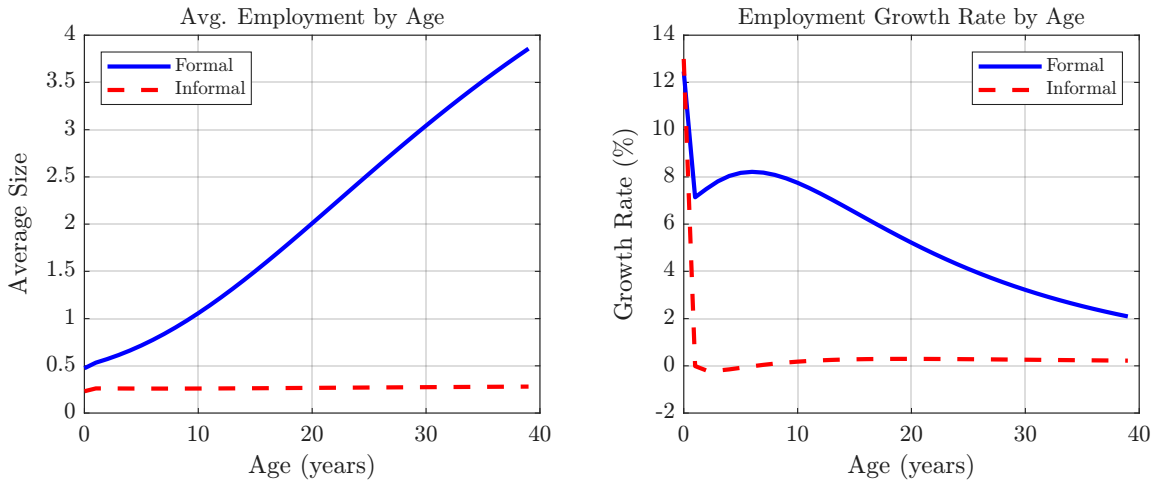
We first examine the cross-sectional and life-cycle properties of the benchmark economy, as well as the model's predictions for moments that are not directly targeted in the calibration.

We start with the model's policy functions. Appendix Figure C.1 shows the innovation probability by permanent productivity type together with the stationary distribution of formal firms. High-$a$ firms face greater returns to innovation and begin innovating at lower levels of transitory productivity, making them the high-growth "gazelles" in the model. Appendix Figure C.2 plots log employment against total productivity, $A = az$. The model reproduces the qualitative implications of Proposition 1. Minimum-wage-constrained firms tend to be at the lower end of the productivity distribution, while unconstrained firms are more productive. The labor supply shifter also generates substantial variation in employment among firms with similar productivity.

Figure 8 presents the resulting life-cycle profiles. Formal firms grow with age, whereas informal firms remain small, and growth rates decline as firms mature. This generates an "up-or-out" pattern through the interaction of the innovation ladder and selection.[29] Appendix Figure C.3 reports exit rates by age and the age composition of the formal sector. Churning is concentrated among young firms: the annual exit rate of entering formal firms is 28.1 percent, close to the first-year exit rate in RAIS, and falls to about 11 percent from age one onward, converging slowly to the exogenous rate $\delta_F \approx 6.5$ percent.

[29] Appendix Figure C.4 disaggregates the growth profile by permanent type. Firm growth is positive at every age for every type, but the highest types are born large and grow more slowly, so age and size are positively correlated but far from collinear.

Figure 8: Average Size and Growth by Age




*Notes:* Left: Average firm size by age for formal and informal firms. Right: Employment growth rates by age.

### 5.2.1 Validation Against the Quasi-Experimental Estimates

We next confront the model with the quasi-experimental estimates from Section 3. The regional difference-in-differences design identifies the effect of minimum wage exposure on firm outcomes from cross-municipality variation in the measure $\text{GAP}_m$. We therefore compare the change implied by the estimated coefficients at the average municipal exposure, $\hat{\beta} \times \overline{\text{GAP}}_m$, with $\overline{\text{GAP}}_m = 0.072$, to the model-implied change 10 years after the 80 percent minimum wage increase along the transition path (we also report the steady-state values for comparison).[30] Table 6 reports the results.

The model approximates the quasi-experimental estimates. The annual exit rate of formal firms rises by 0.9 percentage points in the model, compared with 1.1 percentage points implied by the data, without targeting this response. Average log size, in contrast, rises by 4.8 percent in the model, whereas it falls by 2.4 percent in the data. The model statistic is the net of two large offsetting components: surviving formal firms shrink, an intensive-

[30] In the transition, we assume that the minimum wage increases once and permanently. Given that the empirical increase was phased in over the decade rather than implemented at once, the model path is, if anything, front-loaded.

margin effect of about −16 log points that is locked in on impact and has the same sign as the establishment-level evidence,, while the exit of small formal firms and their sorting into informality raise the average size of those that remain by about +20 log points. The sign of the model response therefore reflects the composition of the formal sector at the entry margin rather than the response of continuing firms.[31]

The age-composition response highlights the importance of the transition path. In the data, greater exposure to the reform is associated with a 2.3 percentage point increase in the share of establishments older than five years. The model produces an increase of the same sign and comparable magnitude along the transition: 10 years after the shock, the share of formal firms older than five years is 1.6 percentage points higher than in the baseline. The mechanism is straightforward. The minimum wage increase reduces entry on impact and raises the exit of young firms, while exit among mature firms changes little. The resulting gap in young cohorts makes the surviving firm population older until entry gradually restores the stationary age distribution. In the new steady state, the share of firms older than five years is 0.7 percentage points lower than in the baseline.

Table 6: Model vs. Quasi-Experimental Estimates

| | **Baseline** | **High MW** | **Model Δ SS** | **Model Δ 10-yr** | **Data-implied Δ** | **DiD $\hat{\beta}$** |
|---|---|---|---|---|---|---|
| Exit rate (annual, formal) | 10.9% | 11.9% | +1.0pp | +0.9pp | +1.1pp | 0.155*** |
| Share of firms age > 5 | 54.8% | 54.1% | −0.7pp | +1.6pp | +2.3pp | 0.325*** |
| Avg. log size (formal) | −0.636 | −0.601 | +3.5% | +4.8% | −2.4% | −0.335*** |

*Notes*: Model Δ SS is the steady-state change from the baseline to the high-MW economy following an 80 percent increase in the minimum wage. Model Δ 10-yr is the corresponding change 10 years after an unanticipated, permanent increase along the transition path. The transition is computed using counterfactual steady-state prices, while the mass of entrants adjusts each quarter to clear the labor aggregator and satisfy free entry. Data-implied Δ is the difference-in-differences coefficient from the municipal firm-level regressions (Table 1) multiplied by average municipal exposure, $\overline{\text{GAP}}_m = 0.072$.

# 6 Counterfactual Analyses

To perform the counterfactual exercises, we make changes in the minimum wage while holding all other parameters fixed and solving for the new stationary equilibrium. We let the

[31] The 10-year and steady-state changes are close for exit rates, as the new exit rate is reached within roughly three years. For log size, the composition component builds as entry cohorts turn over, so the 10-year change (+4.8 percent) exceeds the steady-state change.

equilibrium wage index and the mass of firms adjust so that free entry holds and the labor market clears. Our main counterfactual is one in which we consider an 80 percent increase in the real minimum wage, mirroring the Brazilian experience studied in our empirical exercises. Table 7 reports the effects on the main model aggregates and firm outcomes, comparing the baseline economy with a no-minimum-wage economy and the high-minimum-wage counterfactual.

Table 7: Counterfactual Analysis

| | **No MW** | **Baseline** | **High MW** | **Δ Base→High** |
|---|---|---|---|---|
| Gross Output | 3.951 | 3.949 | 3.919 | −0.74% |
| TFP | 4.518 | 4.516 | 4.484 | −0.70% |
| Labor Index ($N$) | 0.846 | 0.846 | 0.845 | −0.06% |
| Workers (head count) | 0.645 | 0.645 | 0.629 | −2.42% |
| Consumption | 2.344 | 2.343 | 2.330 | −0.56% |
| Share Formal Firms | 29.0% | 28.6% | 24.7% | −13.8% |
| Share Formal Employment | 66.0% | 65.9% | 64.8% | −1.7% |
| Avg Size Formal | 1.228 | 1.246 | 1.465 | +17.6% |
| Avg Size Informal | 0.258 | 0.259 | 0.261 | +0.8% |
| Entry Rate Formal | 10.8% | 10.9% | 11.9% | +9.5% |
| Exit Rate Age 0 | 27.4% | 28.1% | 40.5% | +44.0% |
| Fraction MW Binds | 0% | 12.4% | 42.4% | +243% |
| Welfare $U(C, N)$ | — | 0.6500 | 0.6447 | −0.53% (CEV) |

*Notes*: Comparison of three steady states. High MW corresponds to an 80% increase above baseline. $N$ is the Kimball employment index of the household problem and Workers is the head count $\sum_j n_j$. TFP is $Y/N^{\alpha}$. Welfare is the flow utility $U(C, N) = \ln C - \overline{\nu} N^{1+\nu}/(1+\nu)$. The consumption-equivalent variation (CEV) is the percent change in baseline consumption that equates baseline utility to counterfactual utility.

**Aggregate effects.** The counterfactual shows that there is almost no change in the aggregate labor index, which falls by only 0.06 percent after the increase in the minimum wage. Despite this relatively muted aggregate response, there are substantial heterogeneous effects, especially between formal and informal sectors. The number of employed workers falls by 2.4 percent, with 4.1 percent in the formal sector and a small increase in the informal sector. The share of formal firms declines by 13.8 percent, while the average formal firm becomes 17.6 percent larger.

Part of this response reflects the reallocation mechanism emphasized in the tractable model. By reducing the monopsony power of constrained formal firms, the minimum wage induces some of them to expand. At the same time, selection changes the composition of the formal sector, as less productive firms are more likely to exit or choose informality, raising the average productivity and size of surviving formal firms.

The entry margin reinforces the selection mechanism. The fraction of formal firms constrained by the minimum wage rises from 12.4 to 42.4 percent, first-year exit increases from 28.1 to 40.5 percent, and entrants with less favorable signals increasingly sort into informality. As a result, the formal sector contains fewer firms, but those that remain are larger and more productive. These changes are also reflected in earnings. Table 8 shows that average formal wages rise substantially, while earnings per formal worker increase more modestly. In contrast, both wages and earnings per worker in the informal sector change little.

Table 8: Effects on Earnings by Formality Status

| | **Baseline** | **High MW** | **Δ** |
|---|---|---|---|
| *Formal Sector* | | | |
| Avg Wage | 0.990 | 1.153 | +16.5% |
| Earnings/Worker | 2.848 | 2.951 | +3.6% |
| *Informal Sector* | | | |
| Avg Wage | 0.905 | 0.895 | −1.1% |
| Earnings/Worker | 0.941 | 0.929 | −1.2% |

*Notes*: Comparison of baseline and high-MW steady states. Avg Wage is the unweighted average of firm-level wages. Earnings/Worker is the employment-weighted average wage, i.e., the sector's total wage bill divided by its head count.

**Market power and allocative efficiency.** The minimum wage partially compresses markdowns among formal firms, as constrained firms are pushed closer to their marginal product of labor. The effect, however, is concentrated among a relatively small set of constrained firms, while markdowns among larger firms change little. The aggregate labor share is accordingly essentially unchanged, at 0.47 in both steady states: earnings per formal

worker rise by 3.6 percent while formal head-count employment falls by 4.1 percent, so total labor compensation falls in proportion to output.

At the same time, the policy substantially changes the composition and allocation of formal employment. An Olley and Pakes (1996)-style decomposition shows that average productivity among formal firms rises because low-productivity firms are more likely to exit or sort into informality, but the covariance between productivity and employment shares declines, indicating a weaker allocation of labor toward more productive firms. Thus, the gain from improved selection is partly offset by greater within-formal misallocation, while employment also shifts toward the less productive informal sector. Consistent with these forces, aggregate TFP falls by 0.70 percent. Appendix Table C.1 reports the markdown distribution and productivity decomposition.

Finally, the counterfactual implies a welfare loss of 0.53 percent in consumption-equivalent terms: the representative household would give up 0.53 percent of baseline consumption to avoid moving to the high-minimum-wage steady state. The welfare loss primarily reflects the decline in aggregate consumption of 0.56 percent, while the aggregate labor index changes very little.[32]

## 6.1 Reallocation vs. Life-Cycle Effects

To decompose the total minimum wage effect into reallocation and life-cycle channels, we solve a counterfactual in which the minimum wage is raised to the high level while innovation probabilities $p(a, m, z)$ are held fixed at their baseline values. This shuts down the endogenous response of innovation to the minimum wage, while allowing employment, exit, entry selection, and sector choice to adjust. We label the resulting changes the *reallocation effects*. The residual, the difference between the full counterfactual and the frozen-innovation counterfactual, captures the *life-cycle effects* operating through changes in innovation incentives.

[32]This is a stationary-equilibrium welfare calculation for the representative household. It does not account for transition dynamics, heterogeneity across worker types, or distributional effects across formal and informal workers.

Table 9 reports the decomposition for the main aggregates. The reallocation channel accounts for more than the total decline in output, TFP, and welfare. Output falls by 1.03 percent under frozen innovation, while the life-cycle response offsets more than a quarter of this decline, raising output by 0.29 percent relative to the frozen-innovation counterfactual. The decline in the share of formal firms is also almost entirely a reallocation effect. Average formal firm size rises by 15.5 percent through reallocation and by a further 2.0 percent through the life-cycle response, as the firms that remain formal are positively selected and face stronger innovation incentives. The head count of employed workers, in contrast, falls mostly through the life-cycle channel.

Table 9: Decomposition into Reallocation and Life-Cycle Effects

| | **Full Effect** | **Reallocation** | **Life-Cycle** |
|---|---|---|---|
| Gross Output | −0.74% | −1.03% | +0.29% |
| TFP | −0.70% | −0.99% | +0.29% |
| Labor Index ($N$) | −0.06% | −0.05% | −0.01% |
| Workers (head count) | −2.42% | −0.99% | −1.43% |
| Consumption | −0.56% | −0.64% | +0.07% |
| Share Formal Firms | −13.84% | −14.13% | +0.29% |
| Avg Size Formal | +17.57% | +15.55% | +2.02% |
| Welfare (CEV) | −0.53% | −0.61% | +0.08% |

*Notes*: "Reallocation" is the change under the high-minimum-wage counterfactual with innovation probabilities fixed at their baseline values. "Life-Cycle" is the difference between the full counterfactual and the fixed-innovation counterfactual. CEV is the consumption-equivalent welfare change.

Table 10 shows how these effects vary over the firm life cycle. The reallocation channel raises average formal firm size at nearly every age after entry, with the effect increasing from 13.7 percent at age 1 to 17.1 percent at age 5. The life-cycle channel is small, slightly negative for the youngest cohorts, and grows with age, adding 0.9 percent by age 5. The growth-rate panel highlights the importance of selection among surviving firms. Growth rises sharply for young formal firms, especially at entry, and the effect declines with age. Most of this increase comes from the reallocation channel, reflecting stronger selection into the surviving

cohort. The life-cycle channel further raises growth at later ages through higher innovation among the firms that remain formal. Thus, while minimum-wage-constrained firms may have weaker innovation incentives conditional on productivity, the composition of surviving formal firms shifts toward more productive firms.

Table 10: Decomposition of Formal-Firm Size and Growth Effects by Age

*Average Firm Size (% change)*

| **Age** | **Full** | **Realloc.** | **Life-C.** |
|---|---|---|---|
| 0 | +5.0 | +5.1 | −0.0 |
| 1 | +12.8 | +13.7 | −0.9 |
| 2 | +14.7 | +15.0 | −0.3 |
| 3 | +16.1 | +15.9 | +0.1 |
| 4 | +17.1 | +16.6 | +0.5 |
| 5 | +17.9 | +17.1 | +0.9 |

*Firm Growth Rate (% change)*

| **Age** | **Full** | **Realloc.** | **Life-C.** |
|---|---|---|---|
| 0* | +66.7 | +73.9 | −7.2 |
| 1 | +24.8 | +17.2 | +7.6 |
| 2 | +17.2 | +11.5 | +5.7 |
| 3 | +12.6 | +8.0 | +4.6 |
| 4 | +9.3 | +5.5 | +3.8 |
| 5 | +7.0 | +3.7 | +3.2 |

*Notes:* Entries report percentage changes relative to the baseline. "Reallocation" is the change under the high-minimum-wage counterfactual with innovation probabilities fixed at their baseline values. "Life-Cycle" is the difference between the full counterfactual and the fixed-innovation counterfactual. *The age-0 growth rate is calculated among surviving firms and therefore reflects the strong selection induced by the increase in first-year exit.

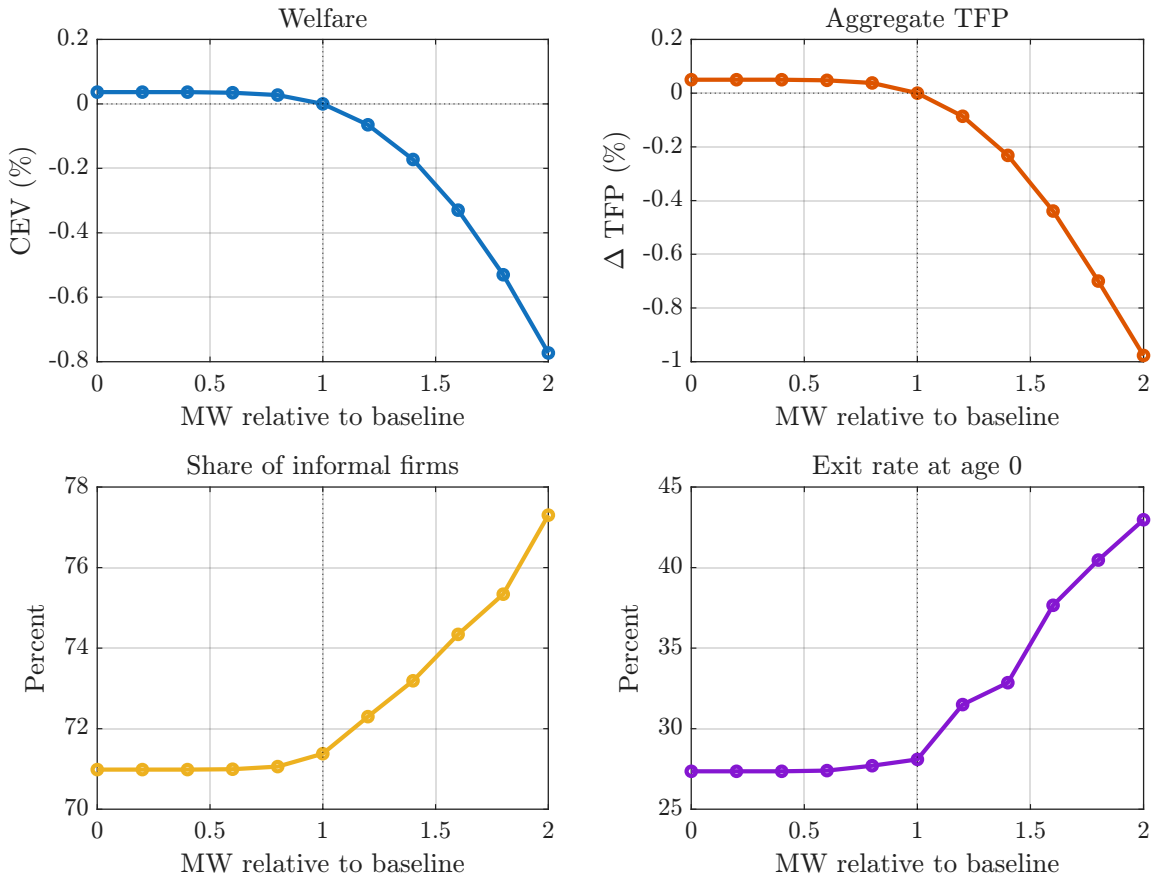
In summary, the 80 percent minimum wage increase leaves the aggregate labor index nearly unchanged, lowers the number of employed workers modestly, and generates substantial changes in firm composition and dynamics. The average formal firm becomes larger, reflecting both reallocation and changes in the composition of firms that remain formal. Entry and exit margins also adjust: first-year exit rises substantially, and surviving young formal firms are more positively selected. At the same time, the share of formal firms declines as some marginal entrants sort into informality. The decomposition shows that most of the aggregate output and welfare losses arise through the reallocation channel, while the endogenous innovation response partly offsets the decline in output. Overall, the main effects of the minimum wage operate less through aggregate employment than through reallocation across firms, selection into formality, and changes in firm growth over the life cycle.

## 6.2 Alternative Minimum Wage Levels

The counterfactual above considers an 80 percent increase in the minimum wage, mirroring the Brazilian experience. We now examine how the stationary equilibrium varies over a broader range of minimum wage levels. This exercise is particularly informative in a monopsonistic labor market, where a moderate minimum wage can in principle raise employment and welfare by reducing firms' wage-setting power. We solve for the stationary equilibrium on a grid of minimum wage levels between zero and twice the baseline level. Figure 9 reports welfare, aggregate TFP, the share of informal firms, and the exit rate of entering formal firms.

Welfare declines monotonically with the minimum wage over the range considered. At sufficiently low levels, the minimum wage does not bind and the allocation is unchanged. Once it begins to bind, further increases raise informality and first-year exit while reducing TFP and welfare. Eliminating the minimum wage yields a small welfare gain of 0.04 percent, whereas doubling the baseline level generates a welfare loss of 0.77 percent in consumption-equivalent terms. Thus, despite monopsony power, we do not find a range in which the minimum wage improves welfare. The reason is that the policy affects not only firms' wage-setting power, but also selection into formality and the allocation of firms across sectors.

Figure 9: Steady-State Effects of Alternative Minimum Wage Levels




*Notes:* Each point is a stationary equilibrium at a minimum wage equal to the indicated multiple of the baseline level, with the entry cost fixed at its baseline value. Welfare is the consumption-equivalent variation relative to the baseline economy; TFP is the percent deviation from the baseline.

# 7 Conclusion

We study the effects of the minimum wage on employment growth and the life cycle of firms. Our focus is the Brazilian economy, where we document a broad reallocation of employment from young to old establishments and identify the rise in the minimum wage as an important driver of this pattern. We use administrative matched employer-employee and census data to characterize and estimate the effects of the large increase in the federal minimum wage between 1999 and 2010 on firms and workers.

We develop a model of monopsonistic firms with endogenous formality and innovation. The model predicts that a higher minimum wage can affect firms not only through employment, but also through selection, formality, and incentives to grow. Consistent with these mechanisms, our empirical analysis finds that greater minimum wage exposure reduces employment growth among young and small establishments while increasing growth among older and larger establishments. At the municipal level, greater exposure is also associated with higher worker earnings and a larger informal employment share.

We then quantify these mechanisms in a general equilibrium model calibrated to Brazil. An 80 percent increase in the minimum wage leaves the aggregate labor index nearly unchanged and lowers head-count employment modestly, while it generates substantial reallocation across firms, reduces the share of formal firms, and changes selection and growth over the firm life cycle. The model also reproduces the magnitude of several untargeted quasi-experimental responses. Across alternative minimum wage levels, welfare declines once the minimum wage becomes binding, as the gains from reducing labor market power are accompanied by distortions in formality, selection, and firm dynamics.

These results highlight that the effects of minimum wages extend beyond employment levels. In economies with substantial informality and heterogeneous firms, minimum wages can reshape which firms operate formally, which firms grow, and how employment and productivity are allocated over the firm life cycle. Our welfare analysis focuses on efficiency and does not capture redistributive effects across workers, which are an important dimension of minimum wage policy. Within this scope, however, the framework provides a rich account of how minimum wages affect business dynamism, selection, reallocation, and productivity over the firm life cycle.

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# Appendix

**"Minimum Wage, Business Dynamism, and the Life Cycle of Firms"**

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## Appendix Contents

**A Simple Model and Proofs of Propositions** **2**

**B Empirical Evidence** **6**

B.1 Informality Trends . . . . . 6

B.2 Additional Figures and Tables . . . . . 8

**C Details of the Quantitative Model** **9**

C.1 Households . . . . . 9

C.2 Firm's Problem . . . . . 12

C.3 Aggregation and Stationary Equilibrium . . . . . 16

C.4 Additional Figures . . . . . 19

**D Computational Algorithm** **22**

D.1 State Space and Discretization . . . . . 22

D.2 Inner Loop: Firm Problem . . . . . 22

D.3 Stationary Distribution . . . . . 23

D.4 Outer Loop: General Equilibrium . . . . . 23

D.5 Simulated Method of Moments . . . . . 24

# A Simple Model and Proofs of Propositions

**Preliminaries.** Before proving the propositions, we record the solutions of the static problems in Section 2, which the proofs reference. The first-order condition of the formal firm's problem (2) yields the labor demand and optimal wage of a formal firm unconstrained by the minimum wage:

$$n_U(z_j) = \left[\frac{\alpha\varepsilon}{1+\varepsilon}\frac{z_j}{1+\tau}\frac{N^{\frac{1}{\varepsilon}}}{W}\right]^{\frac{1}{1/\varepsilon+1-\alpha}}, \quad w_U(z_j) = \left[\left(\frac{\alpha\varepsilon}{1+\varepsilon}\frac{z_j}{1+\tau}\right)^{\frac{1}{\varepsilon}}\left(\frac{W}{N^{\frac{1}{\varepsilon}}}\right)^{1-\alpha}\right]^{\frac{1}{1/\varepsilon+1-\alpha}}. \quad \text{(A.1)}$$

The optimal profit of a formal firm subject to the minimum wage is a piecewise function in the three regions characterized in the main text — unconstrained, constrained on the labor supply, and constrained on the labor demand:

$$\pi_F(z) = \begin{cases} \pi_U(z) = z^{\frac{1/\varepsilon+1}{1/\varepsilon+1-\alpha}}\Pi_U(W,N) - \kappa & \text{if } z \geq \overline{z}, \\ \pi_C^f(z) = z\left(\dfrac{\overline{w}}{W}\right)^{\alpha\varepsilon}N^{\alpha} - (1+\tau)\overline{w}^{1+\varepsilon}\dfrac{N}{W^{\varepsilon}} - \kappa & \text{if } z \in [\underline{z},\overline{z}), \\ \pi_C^c(z) = z^{\frac{1}{1-\alpha}}\Pi_C(\overline{w}) - \kappa & \text{if } z \in (z^f,\underline{z}), \end{cases} \quad \text{(A.2)}$$

where $\Pi_U(W,N)$ and $\Pi_C(\overline{w})$ are functions of aggregates and parameters, with $\Pi_C(\overline{w})$ decreasing in the minimum wage.[1]

**Proposition 1.** *Let $n_j^{MW}$ and $n_j^{No\ MW}$ be the optimal employment hired by firm $j$ in an economy with and without the minimum wage. Suppose a minimum wage, $\overline{w} > 0$, such that $z^* > z^f$ is introduced. If $N$ and $W$ are fixed, then the optimal firm size changes as follows:*

- $n_j^{MW} = n_j^{\text{No MW}}$ if $z \geq \overline{z}$;
- $n_j^{MW} > n_j^{\text{No MW}}$ if $z \in (z^*, \overline{z})$;
- $n_j^{MW} = n_j^{\text{No MW}}$ if $z = z^*$;
- $n_j^{MW} < n_j^{\text{No MW}}$ if $z \in [z^f, z^*)$.

[1] $\Pi_U(W,N) \equiv \left(\frac{\alpha\varepsilon}{1+\varepsilon}\frac{N^{\frac{1}{\varepsilon}}}{W}\frac{1}{1+\tau}\right)^{\frac{\alpha}{1/\varepsilon+1-\alpha}}\frac{1+\varepsilon(1-\alpha)}{1+\varepsilon}$ and $\Pi_C(\overline{w}) = \left(\frac{\alpha}{\overline{w}(1+\tau)}\right)^{\frac{\alpha}{1-\alpha}}(1-\alpha)$.

*Proof.* First, notice that in the absence of a minimum wage, the optimal hiring decision and wage of all firms in the formal sector is given by Equations (A.1) (i.e., $n_j^{\text{No MW}} = n_U(z_j)$). We can now analyze case-by-case.

If $z \geq \overline{z}$, the firm's optimal wage is higher than the minimum wage, $w_U(z) \geq \overline{w}$, and the minimum wage does not change the firm's labor demand. Therefore, if $N$ and $W$ are fixed, we have that $n_j^{MW} = n_j^{\text{No MW}}$ for all $z \geq \overline{z}$.

If $z \in [\underline{z}, \overline{z})$ the minimum wage binds, and the firm respects the labor supply of the households. Since optimal employment with and without the minimum wage is given by the household's labor supply, $w_j < \overline{w}$, and $N$ and $W$ are fixed, we have that

$$n_j^{MW} = \left(\frac{\overline{w}}{W}\right)^{\varepsilon} N > \left(\frac{w_j}{W}\right)^{\varepsilon} N = n_j^{\text{no MW}},$$

and the firms with $z \in [\underline{z}, \overline{z})$ increase employment after the introduction of the minimum wage.

If $z \in [z^f, \underline{z})$, firms might increase or decrease in size after the introduction of the minimum wage. In this region, all firms are constrained by their labor demand, $n_j = \left(\frac{\alpha}{\overline{w}} \frac{z_j}{1+\tau}\right)^{\frac{1}{1-\alpha}}$. Note that $\overline{n}_j$ increases with $z_j$ at a higher rate than the "unconstrained" demand:

$$\frac{\partial \log(\overline{n}_j)}{\partial \log(z_j)} = \frac{1}{1-\alpha} > \frac{1}{1/\varepsilon + 1 - \alpha} = \frac{\partial \log(n_j)}{\partial \log(z_j)}. \tag{A.3}$$

Thus, if $\overline{n}_j$ and $n_j$ (the "unconstrained" labor demand from Equation (A.1)) "cross" for some value $z^* \in (z^f, \underline{z})$, the labor demand for firms $z_j < z^*$ decreases when the minimum wage is implemented, but the labor demand for firms $z_j > z^*$ *increases*. The threshold $z^*$ can be defined by equating $n_j$ and $\overline{n}_j$

$$\left(\frac{\alpha}{\overline{w}} \frac{z^*}{1+\tau}\right)^{\frac{1}{1-\alpha}} = \left[\frac{\alpha\varepsilon}{1+\varepsilon} \frac{z^*}{1+\tau} \frac{N^{\frac{1}{\varepsilon}}}{W}\right]^{\frac{1}{1/\varepsilon+1-\alpha}} \tag{A.4}$$

which gives

$$z^* = \frac{1+\tau}{\alpha} \left[\overline{w}^{1/\varepsilon+1-\alpha} \left(\frac{\varepsilon}{1+\varepsilon} \frac{N^{\frac{1}{\varepsilon}}}{W}\right)^{1-\alpha}\right]^{\varepsilon}. \tag{A.5}$$

Since we assumed that $z^* > z^f$, there are some firms $z \in (z^f, z^*)$ that decrease in size: $n_j^{MW} < n_j^{\text{No MW}}$. Finally, we only need to verify that this threshold, $z^*$, is "low enough" so that there are some firms that are above it, but still constrained. This requires that $z^* < \underline{z}$, or

$$\overline{w}^{1/\varepsilon+1-\alpha}\left(\frac{1+\tau}{\alpha}\right)^{\frac{1}{\varepsilon}}\left(\frac{\varepsilon}{1+\varepsilon}\frac{N^{\frac{1}{\varepsilon}}}{W}\right)^{1-\alpha} < \overline{w}^{1/\varepsilon+1-\alpha}\left(\frac{1+\tau}{\alpha}\right)^{\frac{1}{\varepsilon}}\left(\frac{N^{\frac{1}{\varepsilon}}}{W}\right)^{1-\alpha}. \tag{A.6}$$

This reduces to $(\frac{\varepsilon}{1+\varepsilon})^{1-\alpha} < 1$, which is always satisfied. Therefore, firms with $z \in (z^*, \overline{z})$ increase in size $n_j^{MW} > n_j^{\text{No MW}}$, and firms with $z = z^*$ stay the same size.

□

**Proposition 2.** *Suppose there exists a minimum wage, $\overline{w} > 0$, such that $\underline{z} > z^f$. In addition, assume the productivity growth $\lambda$ is small enough that firms do not skip over the cutoffs ($\lambda z^f < \underline{z}$ and $\lambda \underline{z} < \overline{z}$). Let $p^*(z)$ be interior for all $z \geq z^f$ and fix aggregates $W$ and $N$. Then a marginal increase in $\overline{w}$ has the following effects on the employment growth rate, $g_n(z; \overline{w})$:*

$$\frac{\partial g_n(z;\overline{w})}{\partial \overline{w}} \begin{cases} = 0 & \text{if } z > \overline{z}, \\ = 0 & \text{if } z, \lambda z \in (\underline{z}, \overline{z}), \\ < 0 & \text{if } z, \lambda z \in (z^f, \underline{z}). \end{cases}$$

*Proof.* Let $\mathcal{N}(z;\overline{w}) \equiv \dfrac{n(\lambda z;\overline{w}) - n(z;\overline{w})}{n(z;\overline{w})}$. If $p^*(z;\overline{w})$ is interior, then it only depends on the profit function and parameters:

$$p^*(z;\overline{w}) = \frac{1}{\eta}\log\left\{\frac{\beta}{z^\psi \mu \eta}\left[\pi_F(\lambda z;\overline{w}) - \pi_F(z;\overline{w})\right]\right\}. \tag{A.7}$$

Furthermore, we can write the partial derivative as:

$$\frac{\partial g_n(z;\overline{w})}{\partial \overline{w}} = \frac{\partial p^*(z;\overline{w})}{\partial \overline{w}}\mathcal{N}(z;\overline{w}) + p^*(z;\overline{w})\frac{\partial \mathcal{N}(z;\overline{w})}{\partial \overline{w}}. \tag{A.8}$$

We can now proceed to analyze case-by-case. First, from Equations (A.1) and (A.2), note that neither $\pi(z)$, nor $p^*(z)$ and $n(z)$ depend on the minimum wage for all $z > \overline{z}$. Hence, for

a fixed level of $W$ and $N$:

$$\frac{\partial g_n(z;\overline{w})}{\partial \overline{w}} = 0 \quad \text{if } z > \overline{z}.$$

Second, let $z, \lambda z \in (\underline{z}, \overline{z})$. Using Equation (A.2), we have that

$$\pi_F(\lambda z;\overline{w}) - \pi_F(z;\overline{w}) = z(\lambda - 1)\left(\frac{\overline{w}}{W}\right)^{\varepsilon\alpha} N^{\alpha} \tag{A.9}$$

is a positive function of $\overline{w}$ since $\lambda > 1$. Thus, $\partial p^*(z;\overline{w})/\partial \overline{w} > 0$. Moreover, as $z, \lambda z \in (\underline{z}, \overline{z})$, optimal firm size does not depend on $z$:

$$n = \left(\frac{\overline{w}}{W}\right)^{\varepsilon} N,$$

implying that, for a given minimum wage, $\mathcal{N}(z;\overline{w}) = 0$ and $\partial \mathcal{N}(z;\overline{w})/\partial \overline{w} = 0$. Hence,

$$\frac{\partial g_n(z;\overline{w})}{\partial \overline{w}} = 0 \quad \text{if } z, \lambda z \in (\underline{z}, \overline{z}).$$

Finally, if $z, \lambda z \in (z^f, \underline{z})$, from Equation (A.2):

$$\pi_F(\lambda z;\overline{w}) - \pi_F(z;\overline{w}) = z^{\frac{1}{1-\alpha}}\left(\frac{\alpha}{\overline{w}(1+\tau)}\right)^{\frac{\alpha}{1-\alpha}}(1-\alpha)\left(\lambda^{\frac{1}{1-\alpha}} - 1\right),$$

which is a decreasing function of $\overline{w}$. Thus, $\partial p^*(z;\overline{w})/\partial \overline{w} < 0$. Since all firms in $z, \lambda z \in (z^f, \underline{z})$ are in their constrained labor demand: $n(z) = \left(\frac{\alpha}{\overline{w}}\frac{z}{1+\tau}\right)^{\frac{1}{1-\alpha}}$, we have that:

$$\mathcal{N}(z,\overline{w}) = \frac{n(\lambda z;\overline{w}) - n(z;\overline{w})}{n(z;\overline{w})} = \lambda^{\frac{1}{1-\alpha}} - 1.$$

Since $\partial \mathcal{N}(z;\overline{w})/\partial \overline{w} = 0$ and $\lambda > 1$, we have that the first term of Equation (A.8) is negative and the second term zero, implying:

$$\frac{\partial g_n(z;\overline{w})}{\partial \overline{w}} < 0 \quad \text{if } z, \lambda z \in (z^f, \underline{z}).$$

□

# B Empirical Evidence

## B.1 Informality Trends

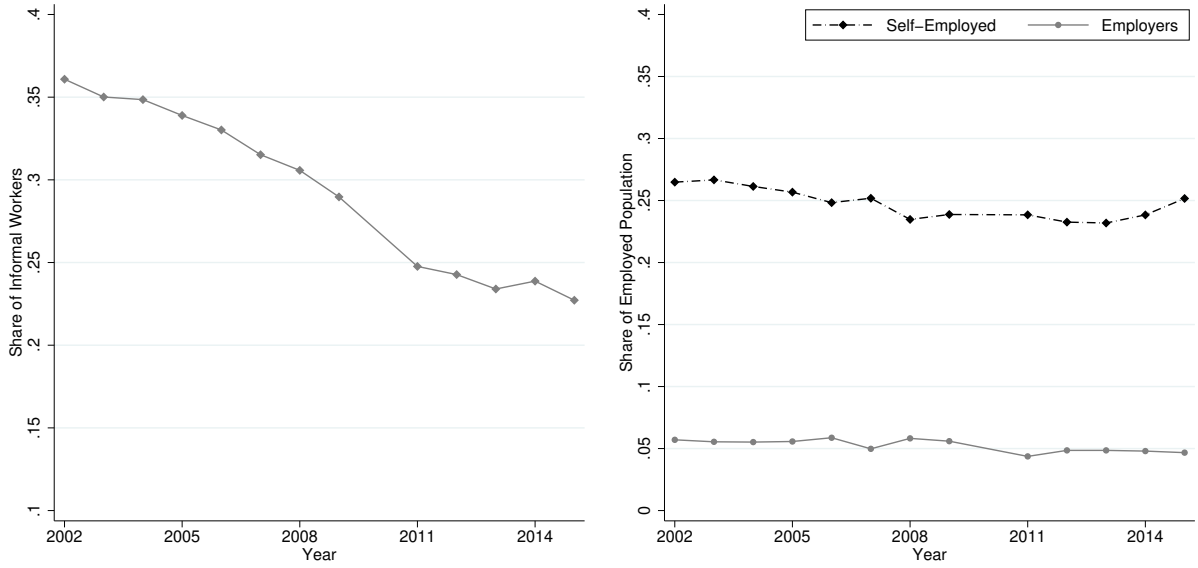
In this subsection, we present an analysis of informality trends in Brazil from 2002 to 2015. To measure the overall trends in informality, we use PNAD (*Pesquisa Nacional por Amostra de Domicílios*), a nationally representative yearly household survey. This survey has traditionally been used to examine long-term shifts in Brazilian demographics, such as age, gender, and education attainment, as well as labor market outcomes, including employment, wages, earnings, industry, and occupations. While PNAD does not allow us to track individual workers or identify specific firms as RAIS does, it does enable us to identify informal workers and entrepreneurs, including self-employed individuals and employers.[2] Additionally, to gather supplementary information on the formal status of entrepreneurs, we augment PNAD with ECINF (*Pesquisa de Economia Informal Urbana*). ECINF is a cross-sectional matched-employer survey conducted by IBGE, focusing on small urban enterprises. It provides nationally representative data on businesses with up to 5 employees, and for our analysis, we use the latest available year, 2003.

In line with the approach taken by Erosa et al. (2023), we distinguish between workers and entrepreneurs. A worker is considered formal if their labor contract is registered with the Brazilian social security system, which is indicated by the signing in the worker's booklet known as *Carteira de Trabalho*. Meanwhile, a firm is classified as formal if it possesses a tax identification number referred to as CNPJ (*Cadastro Nacional de Pessoa Jurídica*). It is worth mentioning that information regarding the formal status of entrepreneurs is only available in the ECINF dataset, specifically for the year 2003. Unfortunately, PNAD does not provide us with information on the formal status of entrepreneurs.

Figure B.1 illustrates a declining trend in the share of informal workers in Brazil. Over the course of a decade, the informality rate among paid workers decreased from over 35 percent to approximately 23 percent. This decline can be attributed to several factors. One significant factor is the demographic change, characterized by an increase in the proportion of younger workers entering the labor market with at least a high school education. Another possible factor is the rise in employment in larger firms, as they tend to have a higher fraction

[2]Note that in 2012, the Brazilian Bureau of Statistics (IBGE) introduced an updated version of PNAD known as *PNAD-Contínua*. This new version, designed as a nationally representative household rotating panel (five interviews at three-month intervals), replaced the original PNAD. The old PNAD survey was discontinued in 2015.

Figure B.1: Informality in Brazil: 2002-2015



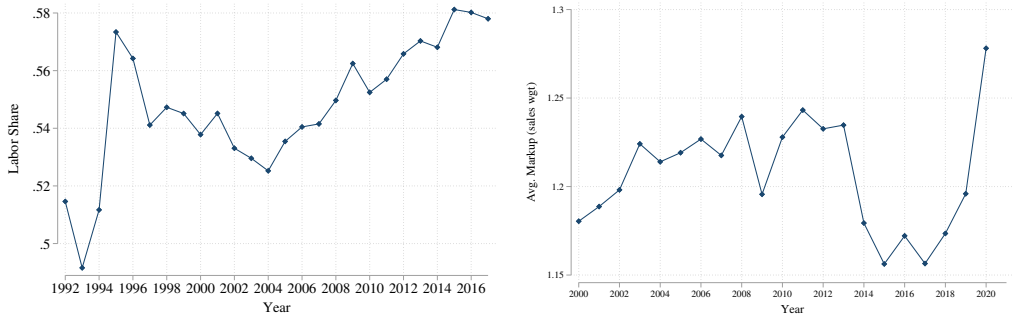

*Notes*: Workers are defined as paid urban employees in private firms. The share of the employed population is over the urban population in private firms. The PNAD is not available in 2010 since it is a census year. Source: PNAD 2002-2015.

of formal workers. Note that during this period, apart from changes in the real minimum wage (which, if anything, would increase informality), there was little change in other labor regulations (Haanwinckel and Soares, 2021).

Measuring the evolution of business informality is challenging due to data limitations. Figure B.1 reveals a slight decline in the share of entrepreneurs in Brazil, from 32 percent to approximately 30 percent. This decline primarily stems from a small decline in the number of self-employed individuals, ranging between 26 percent and 24 percent. It is noteworthy that the majority of self-employed individuals operate in the informal sector, with around 90 percent being unregistered, decreasing to 83 percent in 2012 (Erosa et al., 2023). By comparing entrepreneurs in the ECINF dataset from 2003 with those in the PNAD-*Contínua* dataset, Erosa et al. (2023) argue that the informality rate for firms experienced a slight decline from 30 percent in 2003 to 28 percent. Therefore, the decrease in informality is primarily driven by improvements from the worker side, with a minor contribution from the firm side.

## B.2 Additional Figures and Tables

Figure B.2: Labor Share (left) and Average Markup (right) in Brazil




*Notes:* The left panel shows the evolution of the labor share in Brazil. The right panel shows the evolution of the average markup.

Figure B.3: Entry Rate (left) and Entrants Employment Share (right)

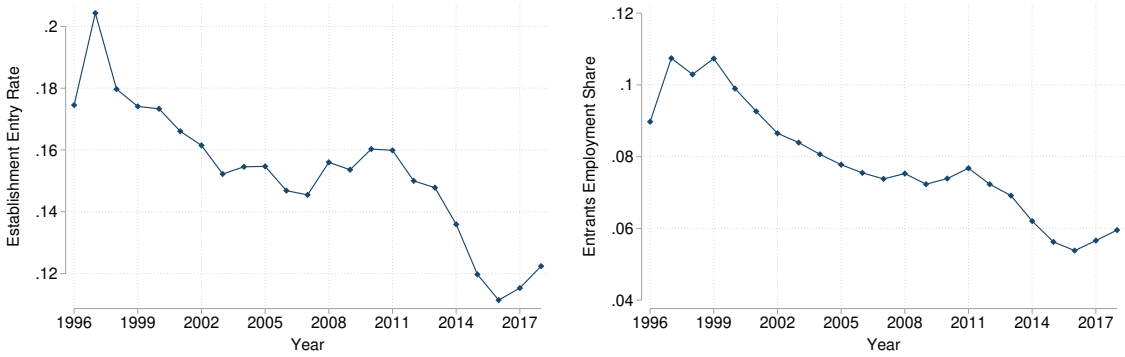
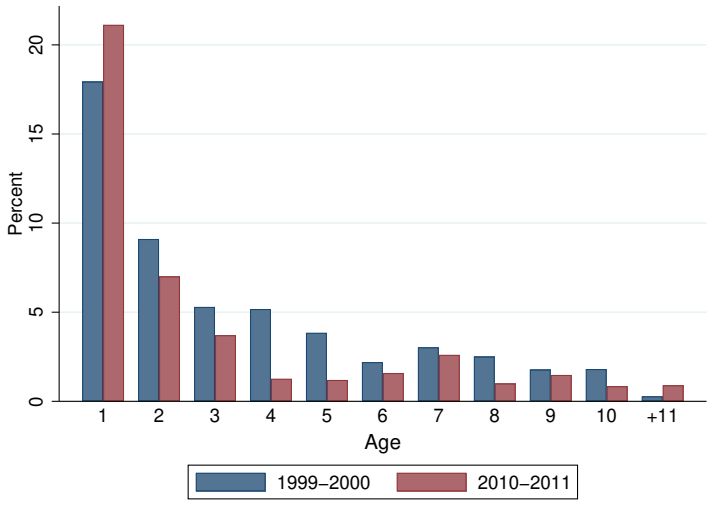



Table B.1: Average $GAP_j$ by Selected Characteristics

| | Avg. GAP | Observations |
|---|---|---|
| All Establishments | 0.21 | 1,809,026 |
| Age $\leq 5$ | 0.24 | 1,070,155 |
| Age $> 5$ | 0.16 | 738,871 |
| Size $\leq 20$ | 0.22 | 1,681,936 |
| Size $> 20$ | 0.08 | 127,090 |

Figure B.4: Establishment Growth Rate by Age: 1999-00 and 2010-11




# C Details of the Quantitative Model

## C.1 Households

The static household problem is given by:

$$\max_{C,\{n_j\}} \left\{ \frac{C^{1-\sigma}}{1-\sigma} - \overline{\nu} \frac{N^{1+\nu}}{1+\nu} \right\} \qquad \text{s.t.} \qquad C = \int w_j n_j dj + T + \Pi,$$
$$\int \Upsilon\left(\frac{n_j}{m_j N}\right) dj = 1 \qquad \text{and} \qquad n_j \leq \overline{n}_j,$$

where $T$ and $\Pi$ denote lump-sum transfers and aggregate profits, which are rebated to the household.

The aggregate labor supply is defined implicitly from the Kimball aggregator $\Upsilon$, which is increasing and convex, with $\Upsilon(1) = 1$. The variable $m_j$ is a firm-level labor supply shifter: workplaces with a higher $m_j$ are more attractive to the household (capturing, e.g., amenities or location), and therefore receive more labor at any given wage. The shifter is drawn at entry from a log-normal distribution, $\ln m_j \sim \mathcal{N}(-\sigma_m^2/2,\, \sigma_m^2)$, so that $\mathbb{E}[m_j] = 1$. The shifter generates wage dispersion across firms that is independent of productivity. Finally, $n_j \leq \overline{n}_j$ is the labor rationing constraint: firms constrained by the minimum wage may not hire all

the labor the household is willing to supply. We follow Berger et al. (2025) and characterize the inverse labor supply function using shadow wages.

It is useful to solve the household's problem in two steps. First, we solve an income maximization problem given an aggregate employment index $\overline{N}$. Second, we solve for the optimal aggregate labor supply. The household's income maximization problem is

$$\begin{aligned} &\max_{n_j} \quad \left\{ \int w_j n_j dj \right\} \\ &\text{s.t.} \quad \int \Upsilon\left(\frac{n_j}{m_j \overline{N}}\right) dj = 1 \qquad \text{and} \qquad n_j \leq \overline{n}_j \end{aligned}$$

and the first-order condition for all $j$ is:

$$w_j = \lambda_h \Upsilon'\left(\frac{n_j}{m_j \overline{N}}\right) \frac{1}{m_j \overline{N}} + \xi_j, \tag{C.1}$$

where $\lambda_h$ is the multiplier on the aggregator of the employment index, and $\xi_j$ is the multiplier on the rationing constraint. Following Berger et al. (2025), we normalize the multiplier on the rationing constraint as $\xi_j = w_j(1-p_j)$. This allows the optimality condition to be written as

$$\tilde{w}_j \equiv w_j p_j = \lambda_h \Upsilon'\left(\frac{n_j}{m_j \overline{N}}\right) \frac{1}{m_j \overline{N}}, \tag{C.2}$$

where $\tilde{w}_j$ is a shadow wage that captures the slackness of the rationing constraint: if the constraint is slack, $n_j < \overline{n}_j$, we have $\xi_j = 0$, $p_j = 1$, and the shadow wage is equal to the actual wage: $\tilde{w}_j = w_j$; if the constraint is binding, then $\xi_j \geq 0$, $p_j \leq 1$, and $\tilde{w}_j \leq w_j$.

The envelope condition on $N$ also implies that:

$$\tilde{W} = \lambda_h \int \Upsilon'\left(\frac{n_j}{m_j \overline{N}}\right) \frac{n_j}{m_j \overline{N}^2} dj = \frac{\lambda_h}{\overline{N}} \underbrace{\int \Upsilon'\left(\frac{n_j}{m_j \overline{N}}\right) \frac{n_j}{m_j \overline{N}} dj}_{\equiv S^{-1}} = \frac{\lambda_h}{\overline{N} S}, \tag{C.3}$$

where $S$ is a supply index. Then, the inverse labor supply function is given by

$$\tilde{w}_j = \Upsilon'\left(\frac{n_j}{m_j\overline{N}}\right)\frac{\tilde{W}S}{m_j}, \tag{C.4}$$

and the labor supply function is

$$\tilde{n}_j = m_j\,\varphi\left(\frac{m_j\tilde{w}_j}{\tilde{W}S}\right)\overline{N}, \tag{C.5}$$

where $\varphi \equiv (\Upsilon')^{-1}$. Note that the wage index is implicitly defined as

$$\tilde{W} = \lambda_h \int \Upsilon'\left(\frac{n_j}{m_j\overline{N}}\right)\frac{n_j}{m_j\overline{N}^2}dj = \int \tilde{w}_j\frac{n_j}{\overline{N}}dj = \int \tilde{w}_j\, m_j\,\varphi\left(\frac{m_j\tilde{w}_j}{\tilde{W}S}\right)dj, \tag{C.6}$$

As a result, the shadow wage aggregates and it is easy to see that

$$\int \tilde{w}_j n_j dj = \lambda_h \int \Upsilon'\left(\frac{n_j}{m_j\overline{N}}\right)\frac{n_j}{m_j\overline{N}}dj = \frac{\lambda_h}{S} = \tilde{W}\overline{N}. \tag{C.7}$$

In the second stage of the household's problem, we take this allocation as given and solve

$$\max_{C,N} \quad \left\{\frac{C^{1-\sigma}}{1-\sigma} - \overline{\nu}\frac{N^{1+\nu}}{1+\nu}\right\} \quad \text{s.t.} \quad C = \tilde{W}N + T + \Pi.$$

The first-order condition of this problem implies the labor supply condition:

$$\frac{\tilde{W}}{C^{\sigma}} = \overline{\nu}N^{\nu}. \tag{C.8}$$

**Relationship to the tractable model.** The tractable model uses a CES labor aggregator with a constant labor supply elasticity $\varepsilon$ across workplaces, resulting in a uniform markdown across firms. In the quantitative model, we replace the CES aggregator with a Kimball-type aggregator $\Upsilon$ that allows the labor supply elasticity to vary with firm size.

Following Klenow and Willis (2016) and Boar and Midrigan (2025), we parameterize the elasticity as

$$\varepsilon(x) = \frac{\Upsilon'(x)}{\Upsilon''(x)\,x} = \overline{\varepsilon}\,x^{-\theta/\overline{\varepsilon}}, \tag{C.9}$$

where $x = n_j/(m_j N)$ is the firm's (shifter-adjusted) employment share, $\overline{\varepsilon}$ governs the average elasticity, and $\theta$ controls how fast the elasticity declines with size.

When $\theta = 0$, $\varepsilon(x) = \bar{\varepsilon}$ for all firms and the model reduces to the CES case. When $\theta > 0$, larger firms (higher $x$) face a lower elasticity and hence a wider markdown $md = \varepsilon/(1+\varepsilon)$. This generates cross-sectional variation in markdowns: smaller firms face higher labor supply elasticities and narrower markdown wedges, while larger firms exercise greater monopsony power. Additionally, in the tractable model productivity is a single state $z_j$, so there is no permanent heterogeneity that would allow some young firms to be large and some old firms to remain small.

Here, we decompose productivity into a permanent component $a_j$, that is drawn at entry, and a transitory component $z_j$, which evolves with innovation. Total factor productivity is thus $A_j = a_j z_j$. This allows the model to generate realistic patterns where, for example, some young firms are large (high $a$, also commonly known as "gazelles") while some old firms remain small (low $a$).

## C.2 Firm's Problem

Firms are heterogeneous in their productivity, in their labor supply shifter $m_j$, and in the sector in which they operate. Upon entry, they can choose whether to operate formally or informally, but cannot change sectors later. In both sectors, firms face a fixed cost of operation and produce output using only labor according to the decreasing returns to scale technology, $y_j = A_j n_j^{\alpha}$, where $\alpha \in (0,1)$. Productivity $A_j = a_j z_j$ is characterized by a permanent component, $a_j$, drawn at entry, and a transitory component, $z_j$, that evolves endogenously according to the firm's innovation decision. Formal firms pay taxes on labor and are subject to a minimum wage. Informal firms do not pay taxes nor are they subject to a minimum wage, but they face a convex and increasing cost of labor as in Ulyssea (2018).

Within each period, we assume firms act according to the following timing: first, they pay the fixed cost of operation and choose how many workers to hire; second, they make an investment decision in order to increase their productivity. Finally, given the expected profits from those choices, the firm decides whether to remain or exit the economy.

**Static problem.** The firm's production problem is analogous to the one presented in the simple model. The main difference is that, to be consistent with the shadow wage characterization, the firm maximizes profits taking as given the labor supply function written in terms of shadow wages (10) and the general aggregator $\Upsilon$. The problem of a formal firm

is:

$$\begin{aligned} \max_{n_j} \quad & A_j n_j^{\alpha} - (1+\tau)\tilde{w}_j n_j - \kappa_f \\ \text{s.t.} \quad & \tilde{w}_j = \Upsilon'\left(\frac{n_j}{m_j \overline{N}}\right)\frac{\tilde{W}S}{m_j}. \end{aligned} \tag{C.10}$$

The first-order condition of the firm problem implies

$$\alpha A_j n_j^{\alpha-1} = (1+\tau)\left[w_j + \frac{\partial w_j}{\partial n_j} n_j\right] = (1+\tau) w_j \left[1 + \underbrace{\frac{\partial w_j}{\partial n_j}\frac{n_j}{w_j}}_{=1/\varepsilon(x_j)}\right], \tag{C.11}$$

where $\varepsilon(x) \equiv \Upsilon'(x)/(\Upsilon''(x)x)$ is the labor supply elasticity, evaluated at the shifter-adjusted employment share $x_j = n_j/(m_j N)$. Thus, wages are given by the marginal product of labor times a markdown:

$$w_j(1+\tau) = \underbrace{\left(\frac{\varepsilon(x_j)}{1+\varepsilon(x_j)}\right)}_{md(x_j)} \alpha A_j n_j^{\alpha-1}, \tag{C.12}$$

where the markdown is defined as $md(x_j) \equiv \varepsilon(x_j)/(1+\varepsilon(x_j))$. Thus, for a given set of aggregates $\tilde{W}$, $S$ and $N$, Equations (13) and (10) implicitly define the optimal labor demand, wages and markdown of a given firm.

As in the tractable model, firms with productivity below a certain level will pay wages equal to the minimum wage. And again following Berger et al. (2025), the solution of a firm constrained by the minimum wage is split between two cases. In the first case, even though the firm is constrained to pay a minimum wage, it can still take advantage of its monopsony power to undercut wages below their competitive level. The firm's labor demand is given by

$$\tilde{n}_j = m_j \, \varphi\left(\frac{m_j \overline{w}}{\tilde{W}S}\right) N < \overline{n}_j. \tag{C.13}$$

In contrast, for firms with a sufficiently small productivity, the rationing constraint binds and the firm behaves as if it operates in a competitive labor market, $n_j = \overline{n}_j = \left(\frac{\alpha}{\overline{w}}\frac{A_j}{1+\tau}\right)^{\frac{1}{1-\alpha}}$,

regardless of the labor supply of households. We can find the productivity threshold such that all firms with productivity below that threshold operate under the rationed labor supply evaluating Equation (C.13) as an equality.

The problem of an informal firm is

$$\begin{aligned} \max_{n_j} \quad & A_j n_j^{\alpha} - \zeta w_j n_j^{1+\phi} - \kappa_i \\ \text{s.t.} \quad & \tilde{w}_j = \Upsilon' \left( \frac{n_j}{m_j \overline{N}} \right) \frac{\tilde{W} S}{m_j}. \end{aligned} \tag{C.14}$$

The first-order condition of the informal firm problem implies

$$\alpha A_j n_j^{\alpha-1} = w_j n_j^{\phi} \zeta \left[ (1+\phi) + \underbrace{\frac{\partial w_j}{\partial n_j} \frac{n_j}{w_j}}_{=1/\varepsilon(x_j)} \right], \tag{C.15}$$

which, together with the inverse labor supply equation, implicitly defines $n_j$, $w_j$, $md_j$ and profits.

**Dynamic problem.** The firm's dynamic problem consists of an investment decision to increase its productivity. The transitory component of the productivity, $z$, evolves depending on the firm's investment in innovation (Atkeson and Burstein, 2010). In each period, after the formalization and production decision, a firm with state $(a, m, z)$ can pay a cost $a^{\psi_a} z^{\psi} c(p)$ to increase its transitory productivity, $z$, by a factor of $e^{\Delta}$ with probability $p \in [0, 1]$. With probability $1 - p$ the firm's productivity instead decreases by a factor of $e^{-\Delta}$, where $\Delta > 0$.

The investment cost is specified in units of the final good and scales up as firms become more productive. The cost scales separately in the permanent and transitory components. The exponent on the transitory component is set to $\psi = (1 + \bar{\varepsilon})/(1 + \bar{\varepsilon}(1 - \alpha))$ which is the elasticity of unconstrained profits with respect to $z$ in the CES benchmark, so that innovation incentives do not mechanically die out as $z$ grows.

The exponent on the permanent component, $\psi_a > 0$, is calibrated and disciplines how much faster high-$a$ firms grow over the life cycle. We assume $c(p) = \mu \times (\exp\{\eta p\} - 1)$, where the parameters $\mu, \eta > 0$ control the scale and convexity of the cost function. The

firm discounts future profits by $\beta \in (0,1)$ and with probabilities $\delta_F$ and $\delta_I$, for formal and informal firms, respectively, the firm permanently exits the economy.

For a formal firm, the dynamic problem can be expressed as solving

$$\begin{aligned}\tilde{V}^F(z|a,m) = \max_{p\in[0,1]} \; & \pi^F(z|a,m) - a^{\psi_a} z^{\psi} \mu(\exp\{\eta p\} - 1) \\ & + \beta(1-\delta_F)\left[pV^F(ze^{\Delta}|a,m) + (1-p)V^F(ze^{-\Delta}|a,m)\right], \end{aligned} \tag{C.16}$$

where $\pi^F(z|a,m)$ is the profit of a firm with state $(a,m,z)$ if it were formal and $V^F(z|a,m)$ is its value function. Lastly, firms can decide to exit if their value becomes negative, hence we define $V^F(z|a,m) = \max\{\tilde{V}^F(z|a,m), 0\}$.

Let $\chi^{F,\text{exit}}(z|a,m)$ be an indicator function that equals 1 when a formal firm with state $(a,m,z)$ decides to exit. Assuming an interior solution, the optimal innovation decision is characterized by the following first-order condition:

$$p^F(z|a,m) = \frac{1}{\eta}\log\left\{\frac{\beta(1-\delta_F)}{a^{\psi_a} z^{\psi}\mu\eta}\left[V^F(ze^{\Delta}|a,m) - V^F(ze^{-\Delta}|a,m)\right]\right\}. \tag{C.17}$$

The problem faced by an informal firm is defined analogously:

$$\begin{aligned}\tilde{V}^I(z|a,m) = \max_{p\in[0,1]} \; & \pi^I(z|a,m) - a^{\psi_a} z^{\psi} \mu(\exp\{\eta p\} - 1) \\ & + \beta(1-\delta_I)\left[pV^I(ze^{\Delta}|a,m) + (1-p)V^I(ze^{-\Delta}|a,m)\right], \end{aligned} \tag{C.18}$$

with $V^I(z|a,m) = \max\{\tilde{V}^I(z|a,m), 0\}$. The optimal innovation decision for informal firms follows the same first-order condition as (C.17), replacing $\delta_F$ with $\delta_I$ and $V^F$ with $V^I$. Let $\chi^{I,\text{exit}}(z|a,m)$ and $p^I(z|a,m)$ denote the exit and innovation policy functions of informal firms.

**Entry.** There is an infinite mass of potential entrants that, upon paying an entry cost $c_e$ (in units of the final good), draw their permanent productivity component from the distribution $G(a)$ and their labor supply shifter from $G_m(m)$. We assume $\ln a$ follows a Weibull distribution with shape parameter $n_A$ and scale $1/\xi_A$, following Hubmer and Restrepo (2024). When $n_A = 1$ it collapses to a Pareto distribution with tail parameter $\xi_A$. When $n_A < 1$, it generates a fatter right tail allowing for more employment concentration in the larger firms.

Entrants do not observe their initial transitory productivity before choosing a sector.

Instead, after observing $(a, m)$, they receive a noisy signal

$$s = \ln z + \eta_s, \qquad \eta_s \sim \mathcal{N}(0, \sigma_\eta^2), \tag{C.19}$$

about their initial draw of $z$, whose prior distribution is log-normal, $\ln z \sim \mathcal{N}(-\sigma_z^2/2, \sigma_z^2)$. Based on the posterior belief implied by the signal, entrants choose the sector with the highest expected value. The realized $z$ is then drawn from the posterior distribution associated with their signal.

This structure has two implications. First, the sector choice reflects *selection on expected productivity*: entrants with favorable signals disproportionately select into the formal sector, while entrants with unfavorable signals sort into informality. Second, as the signal is noisy, some formal entrants still realize low values of $z$ and quickly exit, allowing for potential churning among young formal firms. Aggregating the posterior distributions over signals recovers the prior, so selection changes the composition of entrants across sectors without changing the aggregate distribution of initial productivity. The signal standard deviation, $\sigma_\eta$, governs the strength of selection and is disciplined by the exit rate of entering formal firms.

Denote by $\chi_F^{\text{entry}}(a, m, s) \in \{0, 1\}$ the decision to operate in the formal sector given the signal, and by $q_F(a, m) = \mathbb{E}_s[\chi_F^{\text{entry}}(a, m, s)]$ the probability that an entrant of type $(a, m)$ becomes formal. The free-entry condition can then be written as:

$$c_e = \frac{1}{1+r} \int \mathbb{E}_s\Big[ \max\{\mathbb{E}[V^F(z|a,m) \mid a, m, s],\ \mathbb{E}[V^I(z|a,m) \mid a, m, s]\}\Big]\, dG(a)\, dG_m(m), \tag{C.20}$$

where the inner conditional expectations are taken over $z$ using the posterior implied by the signal $s$, and the outer expectation integrates over the signal distribution. Entrants choose the sector after observing the signal, thus free entry prices in the option value of the signal.

## C.3 Aggregation and Stationary Equilibrium

To complete the characterization of the equilibrium, we need to determine the mass of entrants and the productivity distribution in the economy. We focus on the stationary equilibrium.

Let $\Gamma_F(a, m, z)$ and $\Gamma_I(a, m, z)$ be the stationary measure of operating firms in the formal and informal sectors across the state space, and let $M$ be the mass of entrants. It is convenient to define the entrant density over initial transitory productivity for each sector and type $(a, m)$:

$$h_F(z'|a, m) = \mathbb{E}_s \left[ \chi_F^{\text{entry}}(a, m, s)\, f(z'|s) \right], \qquad h_I(z'|a, m) = f(z') - h_F(z'|a, m), \tag{C.21}$$

where $f(z'|s)$ is the posterior density of $z'$ given the signal and $f(z')$ is the prior density.

The stationary measure must satisfy the following law of motion that has $a$ and $m$ as fixed indices:

$$\begin{aligned} \Gamma_F(a, m, z') = {} & MG(a)G_m(m)\, h_F(z'|a, m) \\ & + (1 - \delta_F)(1 - \chi_F^e(a, m, z'))\, p_F(a, m, ze^{-\Delta})\, \Gamma_F(a, m, ze^{-\Delta}) \\ & + (1 - \delta_F)(1 - \chi_F^e(a, m, z'))(1 - p_F(a, m, ze^{\Delta}))\, \Gamma_F(a, m, ze^{\Delta}). \end{aligned} \tag{C.22}$$

Similarly, the informal distribution follows:

$$\begin{aligned} \Gamma_I(a, m, z') = {} & MG(a)G_m(m)\, h_I(z'|a, m) \\ & + (1 - \delta_I)(1 - \chi_I^e(a, m, z'))\, p_I(a, m, ze^{-\Delta})\, \Gamma_I(a, m, ze^{-\Delta}) \\ & + (1 - \delta_I)(1 - \chi_I^e(a, m, z'))(1 - p_I(a, m, ze^{\Delta}))\, \Gamma_I(a, m, ze^{\Delta}). \end{aligned} \tag{C.23}$$

The first term represents the inflow of entrants, which is given by the mass of entrants and the distribution of firms entering at productivity level $z'$, accounting for the sector chosen after observing the signal. The next two terms represent the inflows of firms that (i) were at productivity $ze^{-\Delta}$ and drew a positive productivity shock, and (ii) were at $ze^{\Delta}$ and drew a negative shock. Both terms consider only firms that survived the exogenous exit shock and endogenously decided to keep operating in the market.

Once we have the measures $\Gamma_F(a, m, z)$ and $\Gamma_I(a, m, z)$, together with the free-entry condition, we can solve for the equilibrium wage index $\tilde{W}$ and supply index $S$ (as well

as each firm's wage $w_j$ and labor demand $n_j$), and the mass of entrants $M$.[3] To ease the notation, we write $x_s(a,m,z) = n_s(a,m,z)/(mN)$ for the shifter-adjusted employment share in sector $s \in \{F,I\}$, denote by $\int \cdot \, d\Gamma_s$ the integration over the state space $(a,m,z)$, and use the convention $\tilde{w}_I = w_I$, as informal firms are never constrained by the minimum wage. We can now define the equilibrium of the model economy.

**Definition 1** (Stationary recursive competitive equilibrium)**.** *A stationary equilibrium consists of aggregate quantities* $\{C,N,Y,M\}$*, prices* $\{\tilde{W},S\}$*, firm-level policy functions* $\{n_s(a,m,z), p_s(a,m,z), \chi_s^{exit}(a,m,z)\}$ *for* $s \in \{F,I\}$*, an entry decision* $\chi_F^{entry}(a,m,s)$*, and stationary measures* $\{\Gamma_F(a,m,z), \Gamma_I(a,m,z)\}$ *such that:*

1. *Given prices* $\{\tilde{W},S\}$ *and aggregate employment* $N$*, the policy functions* $n_s$*,* $p_s$*, and* $\chi_s^{exit}$ *solve the firms' static and dynamic problems in each sector.*

2. *The entry decision* $\chi_F^{entry}(a,m,s)$ *is optimal given the posterior beliefs implied by the signal, and the free-entry condition* (C.20) *holds.*

3. *The household optimizes, so that the aggregate labor supply condition* (11) *holds.*

4. *The wage index and the supply index are consistent with firms' wages and employment:*

$$\tilde{W} = \sum_{s\in\{F,I\}} \int \tilde{w}_s(a,m,z)\, x_s(a,m,z)\, m \, d\Gamma_s,$$
$$S^{-1} = \sum_{s\in\{F,I\}} \int \Upsilon'\left(x_s(a,m,z)\right) x_s(a,m,z) \, d\Gamma_s.$$

5. *The labor aggregator clears:*

$$\sum_{s\in\{F,I\}} \int \Upsilon\left(x_s(a,m,z)\right) d\Gamma_s = 1.$$

6. *The goods market clears,* $Y = C + c_e M$*, where net output* $Y = Y_F + Y_I$ *aggregates*

[3] There could be an equilibrium where the free-entry condition does not hold with equality. Since our calibration strategy ensures a positive mass of entrants, we focus only on the equilibrium with positive entry.

*production net of fixed, innovation, and informality costs:*

$$Y_F = \int \left( y(a,m,z) - \kappa_F - a^{\psi_a} z^{\psi} c(p_F(a,m,z)) \right) d\Gamma_F,$$

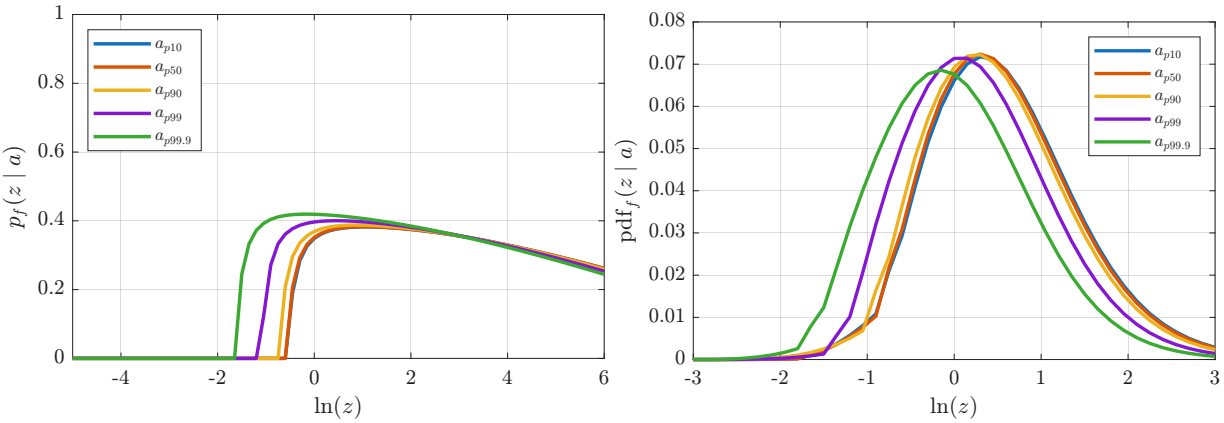
$$Y_I = \int \left( y(a,m,z) - \kappa_I - a^{\psi_a} z^{\psi} c(p_I(a,m,z)) \right) d\Gamma_I - \int w_I(a,m,z)\, n_I(a,m,z) \left( \zeta\, n_I(a,m,z)^{\phi} - 1 \right) d\Gamma_I.$$

7. *The measures* $\{\Gamma_F, \Gamma_I\}$ *are stationary: they satisfy the laws of motion above, given the policy functions, the entry decision, and the mass of entrants* $M$*.*

In the baseline economy, we normalize $\tilde{WS} = 1$ and let the free-entry condition determine the entry cost $c_e$. In the counterfactuals, $c_e$ is held fixed at its baseline value and $\tilde{WS}$ adjusts so that free entry holds. The solution algorithm is described in Appendix D.

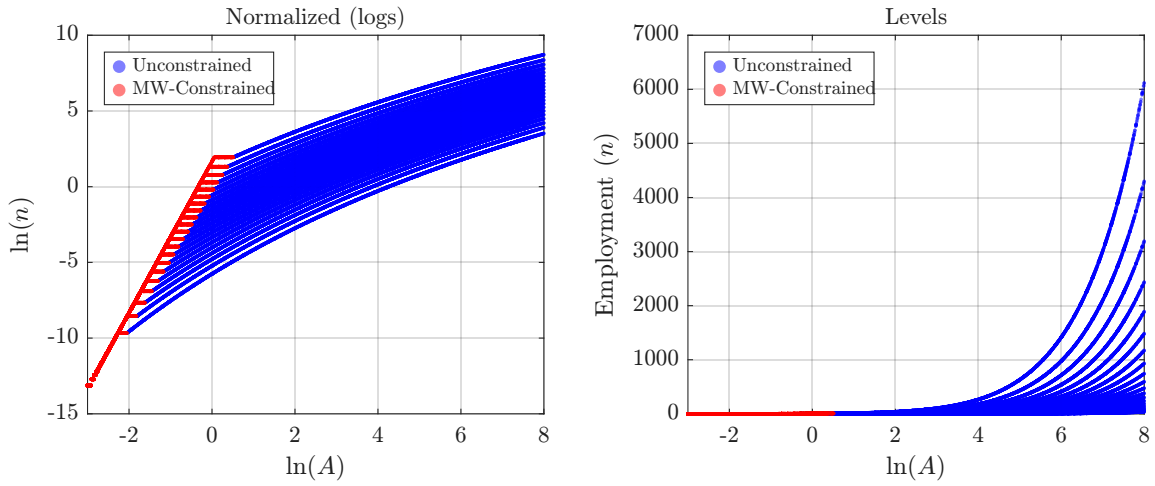
## C.4 Additional Figures

Figure C.1: Innovation Probability and Stationary Distribution



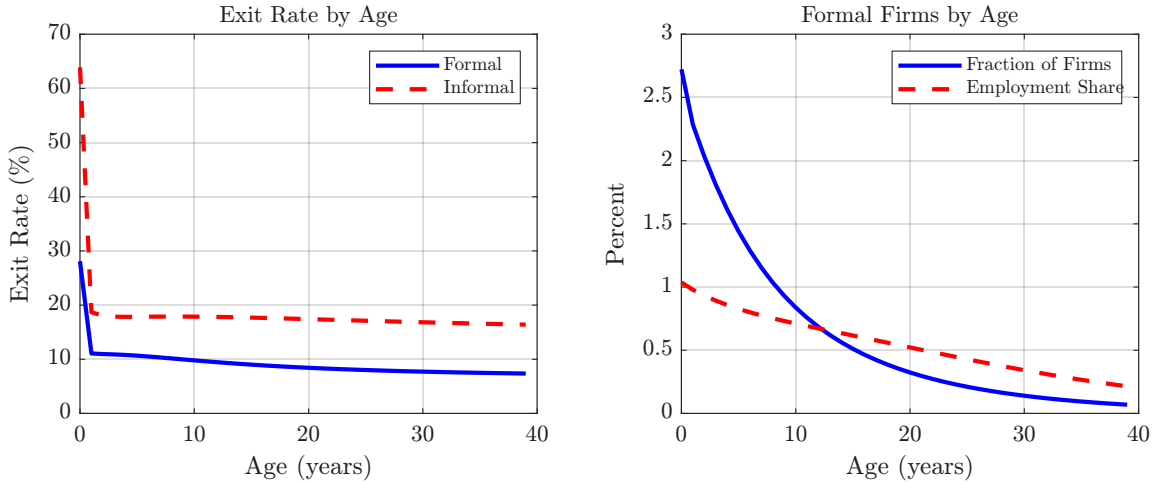

*Notes:* Left: Innovation probability $p(z|a)$ for 5 permanent types. Right: Stationary distribution of formal firms over transitory productivity.

Figure C.2: Firm Size by Productivity



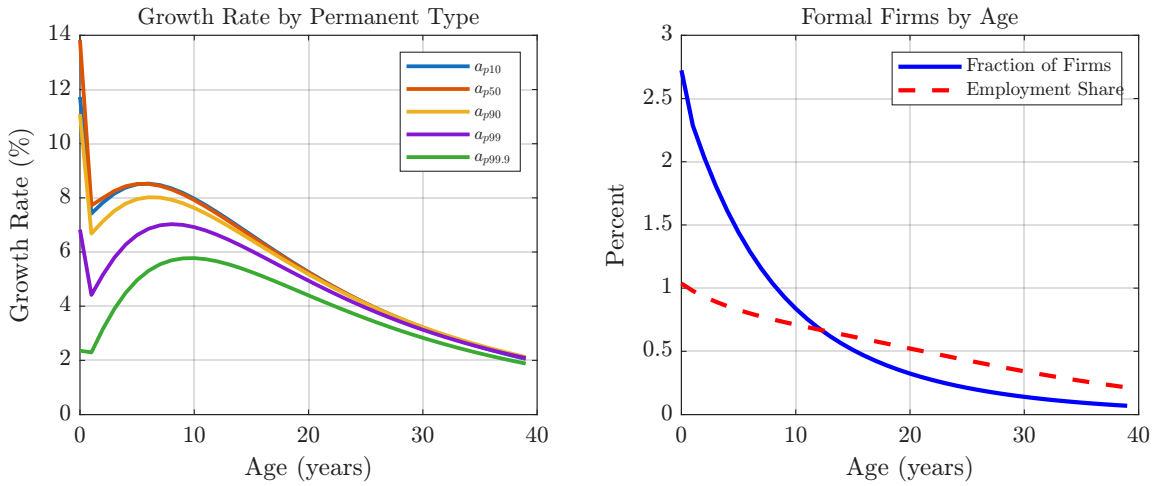

*Notes:* Firm employment vs. log total productivity $A = a \cdot z$, in logs of normalized units (left) and in levels (right). MW-constrained firms in red.

Figure C.3: Exit Rates and Age Composition




*Notes:* Left: Exit rates by age. Right: Employment share by age.

Figure C.4: Growth by Permanent Type and Age Composition




*Notes:* Left: employment growth rates by age for five permanent types $a$. Right: fraction of formal firms and formal employment share by age.

Table C.1: Markdown Distribution and Allocative Efficiency (Formal Sector)

| | **Baseline** | **High MW** |
|---|---|---|
| *Markdown distribution (employment-weighted)* | | |
| p10 | 0.571 | 0.568 |
| p50 | 0.620 | 0.617 |
| p90 | 0.663 | 0.661 |
| Mean | 0.620 | 0.628 |
| Employment share with markdown $\geq 0.95$ | 0.2% | 0.9% |
| *Olley-Pakes decomposition of* $\ln(y/n)$ | | |
| Aggregate (employment-weighted) | 1.712 | 1.753 |
| Unweighted firm mean (selection) | 0.737 | 0.865 |
| OP covariance (allocative efficiency) | 0.975 | 0.888 |
| Informal $\ln(y/n)$ (employment-weighted) | 0.435 | 0.431 |
| Formal employment share | 65.9% | 64.8% |

*Notes*: Markdowns are $(1+\tau)\tilde{w}/\text{MPL}$, the monopsony wedge gross of the payroll tax; quantiles and means are weighted by employment. The Olley-Pakes decomposition writes employment-weighted log labor productivity as the unweighted firm mean plus the covariance between employment shares and productivity.

# D Computational Algorithm

This appendix describes the algorithm used to solve for the stationary equilibrium of the quantitative model in Section 4. The model is solved in Fortran at a quarterly frequency. All rates and moments are annualized when reported.

## D.1 State Space and Discretization

The state space for incumbent firms is $(a, m, z) \in \mathcal{A} \times \mathcal{M} \times \mathcal{Z}$, where $a$ is the permanent productivity component, $m$ the labor supply shifter, and $z$ the transitory productivity component. We discretize the permanent type space $\mathcal{A}$ into 70 grid points, denser near the lower bound, with weights from the Weibull-tailed distribution of $\ln a$ (shape $n_A$, scale $1/\xi_A$). When $n_A = 1$ it becomes a Pareto distribution with tail parameter $\xi_A$. The shifter space $\mathcal{M}$ uses 21 Gauss-Hermite quadrature nodes for $\ln m \sim \mathcal{N}(-\sigma_m^2/2, \sigma_m^2)$. The transitory productivity space $\mathcal{Z}$ is discretized into 101 grid points on a log-linear grid symmetric around $z = 1$, with the per-period step $\Delta/\sqrt{4}$, so that transitions move one grid point up or down, i.e., $z' \in \{ze^{\Delta/2}, ze^{-\Delta/2}\}$ per quarter. The entry signal $s$ is integrated with 100 Gauss-Hermite nodes. For each node we precompute the log-normal posterior weights of $z$ implied by Bayes' rule. The Kimball aggregator $\Upsilon$, which has no closed form for $\theta > 0$, is evaluated from a precomputed high-precision lookup table.

## D.2 Inner Loop: Firm Problem

For given aggregates $(\tilde{W}S, N)$ and the minimum wage $\overline{w}$, we solve each firm's static and dynamic problems. The supply shifter enters only through a rescaling; hence, a firm with state $(a, m, z)$ facing $(\tilde{W}S, N)$ solves the same problem as a firm with state $(a, z)$ facing $(\tilde{W}S/m,\ mN)$.

1. **Static problem.** For each $(a, m, z)$ and sector $s \in \{F, I\}$, solve for optimal employment $n_s(a, m, z)$, wage $w_s(a, m, z)$, and profits $\pi_s(a, m, z)$ using the first-order conditions and the inverse labor supply function (10). For formal firms, determine whether the firm is unconstrained, constrained on the labor supply (Equation 14), or constrained on labor demand, by checking the minimum wage against the unconstrained optimal wage.

2. **Dynamic problem.** Solve the value function by iteration on the $z$ grid (for each $(a, m)$). Given the value function from the previous iteration, compute the optimal innovation probability $p_s(a, m, z)$ from the first-order condition (17), the exit decision $\chi_s^{\text{exit}}(a, m, z) = \mathbb{1}\{\tilde{V}_s(a, m, z) < 0\}$, and update the value function.[1] Iterate until the value function converges.

3. **Entry decision.** For each type $(a, m)$, compute the posterior expected value of entering as formal vs. informal at each signal node and assign the sector with the higher expected value, signal by signal. This yields the formal entry probability $q_F(a, m)$, the entrant productivity densities $h_F$ and $h_I$ (using the posterior weights of the signals at which each sector is chosen), and the implied entry value for the free-entry condition.

## D.3 Stationary Distribution

Given the policy functions, we compute the stationary distribution $\Gamma_s(a, m, z)$ (normalized to a unit mass of entrants) by iterating on the law of motion separately for each type $(a, m)$, which is fixed over a firm's life. Starting from an initial guess, we update the distribution using the transition implied by innovation probabilities, exit decisions, exogenous exit rates, and the inflow of entrants with density $h_s(\cdot|a, m)$. We iterate until the distribution converges.

## D.4 Outer Loop: General Equilibrium

In the baseline we normalize $\tilde{W}S = 1$, so the only aggregate to solve for is employment $N$ (the free-entry condition then determines the implied entry cost $c_e$):

1. **Guess** aggregate employment $N$.

2. **Solve the inner loop**: given $(\tilde{W}S, N)$, solve all firm problems, the entry decision, and the stationary distribution.

3. **Compute the mass of entrants** $M$ from the aggregator constraint,

$$M \sum_{s \in \{F,I\}} \int \Upsilon\Big(\frac{n_s}{mN}\Big)\, d\Gamma_s = 1,$$

[1] At the top of the $z$ grid, the boundary continuation value grows at the rate implied by the innovation-cost scaling. We cap this growth factor just below $1/\tilde{\beta}$, where $\tilde{\beta} = \beta(1 - \delta_s)$, which is necessary for the recursion to satisfy transversality.

and construct aggregate output, consumption, and the supply index $S$.

4. **Update** $N$ from the household optimality condition (11) and iterate to convergence.

The fixed point on $N$ is solved with damping, with an automatic fallback to bisection on the excess-labor condition. In the counterfactuals, the entry cost is held at its baseline value and an outer bisection on $\tilde{W}S$ imposes the free-entry condition. The code is parallelized with OpenMP.

## D.5 Simulated Method of Moments

The endogenous parameters are estimated by minimizing a sum of squared percentage deviations between model and data moments:

$$\mathcal{L}(\Theta) = \sum_{k=1}^{K} \omega_k \left( \frac{m_k^{\text{model}}(\Theta) - m_k^{\text{data}}}{m_k^{\text{data}}} \right)^2, \tag{E.1}$$

where $\Theta$ is the vector of 12 estimated parameters, $m_k$ denotes the $k$-th moment, and $\omega_k$ is the weight assigned to moment $k$. (For convenience, the optimizer formally carries the entry cost as a 13th dimension; it is flat because the baseline solution uses the implied value.) We use $K = 13$ actively targeted moments with equal weights (see Table 5), and the restriction $\psi_a \leq \psi_z$ is imposed inside the objective. The optimization is performed using the Nelder-Mead simplex algorithm with multiple starting points to guard against local minima: we run a multi-start stage with perturbed initial simplices, followed by a final refinement of the best point at a tolerance. Each function evaluation requires solving for the full stationary equilibrium and a full multi-start calibration involves several thousand evaluations.