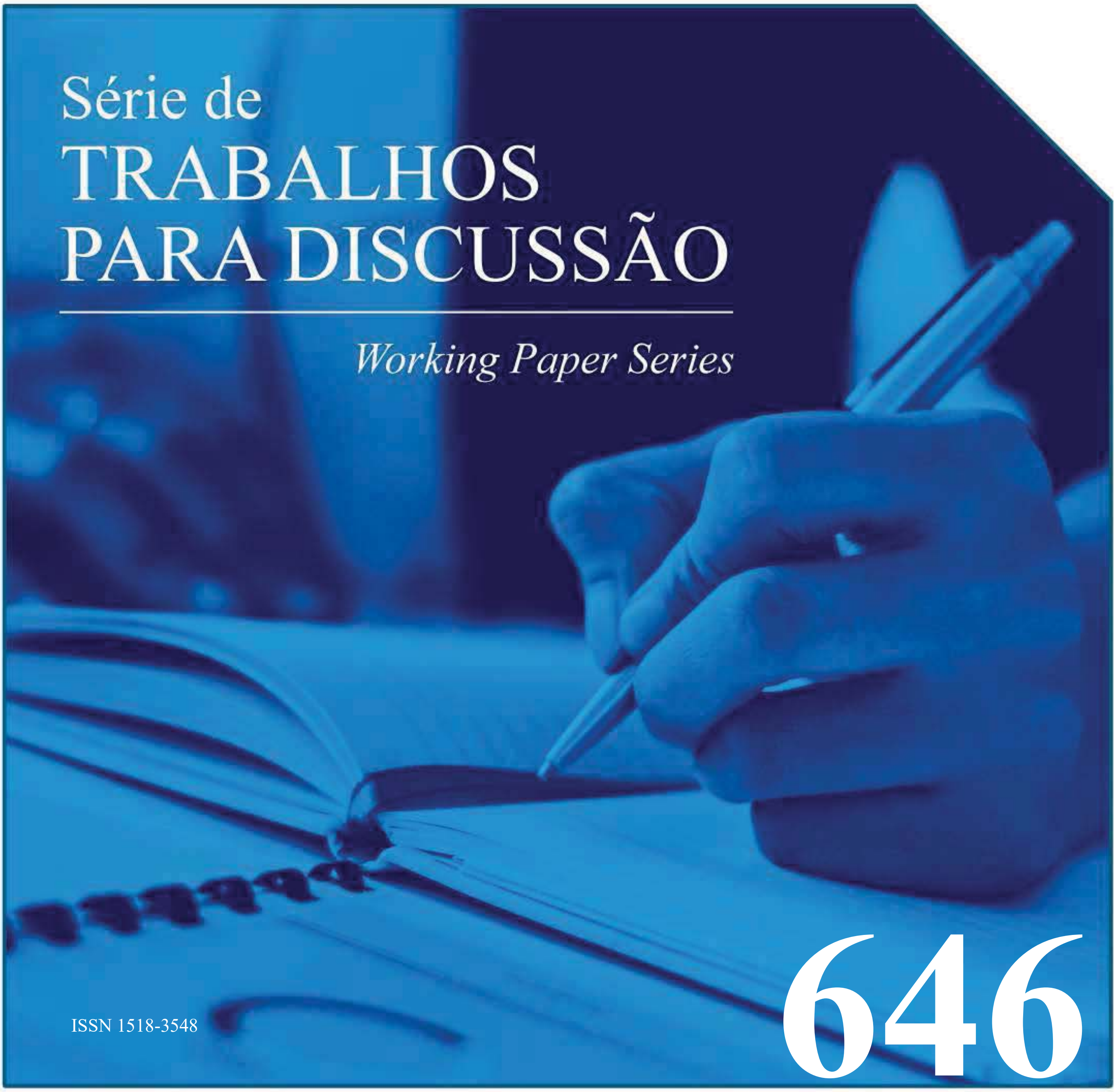

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Labor Market Effects of Unemployment Insurance and UBI in Developing Economies

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Non-technical summary

This paper investigates the impact of introducing a Universal Basic Income (UBI) in developing economies, focusing on Brazil, where informal employment is widespread. The authors analyze a recent reform in Brazil's unemployment insurance (UI) system, which made it harder for many formal workers to qualify for benefits. They find that stricter UI rules increased formal employment, especially in regions with high informality. Building on this evidence, the paper uses a detailed economic model to simulate what would happen if Brazil replaced its current welfare and UI programs with a UBI. The model shows that a UBI of about $80 per household per month could improve overall welfare, particularly for less-educated workers. UBI encourages formal employment because, unlike traditional welfare, it does not penalize workers for earning formal income. However, the reform is expensive and requires higher taxes, raising concerns about financial sustainability. The key takeaway is that UBI can reduce informality and improve incentives to work formally, but its success depends on the ability to finance the program through taxes. The benefits are largest for low-skilled workers, and the increase in formal employment helps offset the higher tax burden. The study highlights the importance of considering informality when designing social policies in developing countries.

Sumário Não Técnico

Este artigo analisa os efeitos da implementação de uma Renda Básica Universal (UBI) em economias em desenvolvimento, com foco no Brasil, onde o emprego informal é predominante. Os autores estudam uma reforma recente no seguro-desemprego brasileiro, que tornou mais difícil para muitos trabalhadores formais acessarem o benefício. Eles mostram que regras mais rígidas para o seguro-desemprego aumentaram o emprego formal, especialmente em regiões com alta informalidade. Com base nessa evidência, o artigo utiliza um modelo econômico detalhado para simular o impacto de substituir os programas atuais de transferência de renda e seguro-desemprego por uma UBI. Os resultados indicam que uma UBI de cerca de $80 por domicílio por mês pode gerar ganhos de bem-estar, principalmente para trabalhadores com menor escolaridade. A UBI incentiva o emprego formal, pois, ao contrário dos programas tradicionais, não penaliza quem recebe renda formal. No entanto, a reforma é cara e exige aumento de impostos, o que levanta preocupações sobre a sustentabilidade financeira. A principal conclusão é que a UBI pode reduzir a informalidade e melhorar os incentivos ao trabalho formal, mas seu sucesso depende da capacidade de financiar o programa via impostos. Os maiores benefícios são para trabalhadores menos qualificados, e o aumento do emprego formal ajuda a compensar o maior ônus tributário. O estudo destaca a importância de considerar a informalidade ao desenhar políticas sociais em países em desenvolvimento.

Labor Market Effects of Unemployment Insurance and UBI in Developing Economies*

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Abstract

This paper studies the labor market impacts of implementing a Universal Basic Income (UBI) in developing economies with large informal sectors. We study an unexpected reform in the unemployment insurance policy in Brazil that tightened the eligibility criteria for most (but not all) formal workers. We provide evidence that unemployment insurance (UI) benefits reduce formal employment, and this effect is amplified by informality. We then study the consequences of replacing the existing transfer and UI policies with a universal basic income using a search-and-matching model where workers and firms jointly sort between formal and informal jobs. We calibrate the general equilibrium model to match key moments concerning unemployment, wage and wealth distributions, as well as the distribution of transfers. Our model captures important trade-offs of UBI in developing countries. While UBI improves incentives to work formally relative to traditional welfare, its implementation raises concerns about financial sustainability due to limited tax revenue. We show that a universal basic income of nearly $80 for each household per month, which replaces the existing transfer programs and UI benefits, can lead to welfare gains, particularly for less skilled individuals. We show that the increase in formal sector activity helps offset the higher tax burden and is a key channel through which outcomes for low-education groups improve with the reform.

Keywords: Means-tested transfers; Welfare programs; Informality; Developing economies; Labor supply; Inequality; Universal basic income; UBI; Unemployment insurance.
JEL Classifications: J65, H53, O17, E24, J46

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1 Introduction

The existence of informality restricts governments in developing countries when designing policies and transfers. Informal jobs often go unobserved by the government, allowing workers to collect transfers or unemployment benefits while working informally. As a result, the cost-effectiveness of these policies can be affected by informality. A Universal Basic Income (UBI) policy could address these issues by providing a guaranteed income through a simple system. Since it is a lump-sum transfer, it offers better incentives to work formally. However, due to its universal nature, the cost of implementing such a policy could potentially be very high. This raises questions about possible taxation counterparts, which are likely of first-order importance in evaluating the consequences of a UBI reform.

Although the idea of universal basic income has been hotly debated, there is only limited evidence about its effects so far.[1] This evidence is not informative about the long-run equilibrium impact on key outcomes such as prices, savings rates, income, and wealth inequality. These effects are likely to be significant, given the prospect of broader eligibility associated with universal transfers. To address this gap, an emerging and growing literature, reviewed below, has relied on general equilibrium models to study the aggregate consequences of UBI. However, all these analyses have focused on advanced economies, and thus little is known about the effects of these policies in developing economies where informality is widespread and tax collection is more difficult. We aim to fill this gap by studying the consequences of UBI using an equilibrium model of the labor market that takes into account how workers and firms jointly sort between formal and informal jobs.

The interaction with informality is a key aspect to bear in mind when thinking about the consequences of UBI in developing economies.[2] On the one hand, social programs — transfer and social insurance programs — require beneficiaries to not be formally employed. This feature imposes an implicit tax on formal earned income, and thus a key concern about these programs is the potential disincentive to work formally. This concern is particularly aggravated when the ready availability of informal jobs exacerbates the disincentives to work in the formal sector that are created by safety net programs. A UBI offers better incentives to formalization than more traditional welfare policies since the transfer amount will not be cut off as formal income rises.[3] Thus, unlike unemployment benefits or income support, UBI does not discourage workers from seeking better-paying jobs.

On the other hand, since transfers would accrue to all individuals, the budgetary concerns of UBI might be aggravated in economies with widespread informality. Tax revenue

[1]See, for instance, Hoynes and Rothstein (2019) for an overview. A true universal basic income has never actually been fully implemented. The majority of basic income pilots and experiments involve elements of targeting, and transfers are made for a given period of time.

[2]Informality can be broadly defined as any deviation from labor regulations, such as avoiding payroll contributions and not conforming to labor law statutes.

[3]A UBI has just an income effect, while traditional safety net programs generate both income and substitution effect.

collection as a share of GDP is only 15 to 20% in lower and middle income countries as opposed to over 30% in upper income countries, and most of the tax revenue is paid by the top earners.[4] This gap is important since it implies that developing countries have less tax revenue to spend on public goods and redistribution. Thus, because of the small tax base, it is argued that a UBI reform would increase marginal tax rates substantially more for those relatively few workers inside the formal sector.[5] To the extent that these individuals are particularly productive, such a tax increase may have disproportionally larger efficiency consequences, and potentially increasing informality even more.

We take these key trade-offs into account to assess whether or not a UBI scheme, as portrayed in popular discussions, is a good idea for a developing economy, using Brazil as a laboratory. The Brazilian economy provides an excellent setting for our work due to its sources of data for both the formal and informal sectors. Nearly two-thirds of businesses and 40 percent of GDP are informal, and labor regulations are both substantive and weakly enforced. Moreover, there is a clear definition of what constitutes informality: we define informal workers as those who do not hold a formal labor contract, which is clearly observable through the worker's booklet (carteira de trabalho).[6]

We begin our analysis by providing evidence on the effects of the unemployment insurance (UI) on formal employment in Brazil. To this end, we study the effects of an unexpected reform in the UI policy that tightened the eligibility criteria for most (but not all) formal workers. More specifically, the reform tightened eligibility for workers with less than two previous UI spells but not for individuals with more than two. We divide Brazilian municipalities in two groups – high exposure and low exposure – according to the share of formal workers affected by the reform. Then, we exploit the geographic variation in this share of affected workers before and after the reform and in the intensity of enforcement of labor regulations in an event study framework. Our goal is to assess if, and to what extent, the presence of stricter enforcement of a costly regulatory framework shapes the labour market responses to changes in transfers. We have two important findings. First, municipalities with a higher share of formal workers affected by the reform saw a higher growth in formal employment relative to municipalities with a lower share, suggesting that, by making it harder for formal workers to collect UI, workers' incentives to remain on the job increased. Second, our estimates indicate this effect increases as the level of labor market enforcement decreases; that is, regions where it is easier to switch to an informal job were disproportionately more affected by the policy change than regions with a higher enforcement. Taken together, these results indicate that social security programs reduce formal employment and informality amplifies this effect, increasing the cost of public policies.

[4]See, for instance, Baunsgaard and Keen (2005) and Besley and Persson (2014).

[5]See, for instance, Hanna and Olken (2019)

[6]It should be noticed, however, that this definition does not capture cases of partial informality, in which formally registered workers receive part of their earnings off the books. In such situations, firms pay lower payroll taxes and workers under report taxable income, meaning that the effective level of informality in the economy is higher than what can be measured using formal contract status alone.

Given this evidence, we develop a stochastic OLG equilibrium model to assess the labor-market consequences of a UBI with the following key ingredients. First, we adopt a search-and-matching framework in the spirit of Diamond-Mortensen-Pissarides (DMP).[7] In this environment, transfers affect vacancy creation and wage bargaining between firms and workers. Firms enter by posting vacancies in either the formal or informal sector and match bilaterally with workers, with match probabilities given by sector-specific matching functions. Firms operating in the informal sector avoid paying taxes but are subject to inspections and may be fined for labor-law violations.

Second, we depart from the standard DMP setting with risk neutrality by combining the search-and-matching framework with incomplete markets as in Krusell et al. (2010), and introduce endogenous job separations as in Bils et al. (2011). Our motivation for doing this is to study the welfare effects of transfers when workers care about consumption smoothing. In addition, by allowing for diminishing marginal utility in consumption and imperfect insurance, wealth affects workers' reservation wages and thus the cross-sectional distributions of wealth play a critical role in determining the aggregate labor response to changes in the transfer system.

Third, working and earning a wage does not only have implications for the cross-sectional distribution of income and wealth, but also for life-cycle profiles through human-capital accumulation on the job. In particular, labor productivity is determined by two components. First, agents are ex-ante heterogeneous concerning their ability, which can be interpreted as pre-market skills such as innate ability or obtained through education. The second component reflects human capital or experience, and accumulates in a learning-by-doing fashion. We build on the work of Ljungqvist and Sargent (1998) and Kehoe et al. (2019) in assuming that worker's productivity changes over time according to laws of motion that depend on her employment status. Employed agents can experience productivity increases during their employment spell, which is influenced by the formality status of the job in line with the evidence in Bobba et al. (2021). On the contrary, idle workers have less opportunities to practice his skills and may even lose previously accumulated knowledge, leading to a depreciation of his human capital.

Fourth, we also depart from the standard DMP model by endogenizing labor-force participation. Each period, individuals choose whether to search for work or stay out of the labor force. Modeling this extensive margin is crucial for evaluating a UBI as a universal transfer raises reservation values and thus affects entry/exit decisions. In addition, fiscal accounting must reflect that UBI is paid to nonparticipants while the tax base adjusts endogenously. Absent this margin, one would understate the fiscal cost of UBI and misattribute changes in employment and informality to job-finding and separation alone.

We use Brazilian microdata to discipline the model and proceed with a quantitative analysis. We target key facts on unemployment, the non-participation margin, and the dis-

[7] See Diamond (1982), Mortensen (1982), and Pissarides (1985).

tributions of wages and wealth. We also model existing transfer and UI programs in detail. In particular, UI benefits are tied to pre-unemployment earnings and are subject to exhaustion consistent with legislation. The model reproduces important non-targeted moments, such as the distribution of transfers and the distribution of income-tax payments. Importantly, we use the calibrated model to simulate the same policy variation studied in the empirical section – a tightening of UI eligibility – and show that it reproduces the observed impact on formal employment, providing external validation of the model, especially regarding the behavioral response of formal employment to UI design.

Next, we study the consequences of replacing the existing UI and means-tested transfer programs with a UBI set as a pre-determined fraction of average total income in the benchmark. The costs of the scheme are financed by adjusting the level of taxation to balance the government budget in equilibrium. We show that a universal basic income of nearly $80 per household per month can lead to aggregate welfare gains, as measured by the consumption-equivalent variation. These welfare gains mainly accrue to less-educated individuals. Although costly, the UBI reform reduces informality, which mitigates the additional burden of higher taxes. The increased activity in formal hiring is a key channel through which outcomes for low-education groups improve under the reform. We also show that welfare gains remain positive when accounting for transition dynamics, though they are smaller than in the new steady state.

This paper contributes to several strands of the literature. First, we contribute to the literature that studies the welfare and aggregate effects of taxes and transfer programs using general-equilibrium models with heterogeneous agents. Lopez-Daneri (2016) studies a revenue-neutral reform of the U.S. income tax and welfare system that involves the adoption of a negative income tax. Wellschmied (2021) studies the savings effects of the asset means-test in US income support programs. Ortigueira and Siassi (2021) study the effects of the U.S. anti-poverty system on savings, labor supply, and marital decisions of non-college-educated workers with children. Guner et al. (2020) study the effects of conditional transfers on households' labor supply with children.[8]

We also contribute to the emerging literature focusing on the impact of UBI using quantitative models in the Bewley-Huggett-Aiyagari tradition. Conesa et al. (2021) and Luduvice (2021) find that it is hard to justify a UBI policy reform on welfare grounds. Guner et al. (2023) find similar conclusions in a model that incorporates heterogeneity in gender and marital status. Daruich and Fernández (2024) and Ferreira et al. (2001) study the impact of UBI on parental skill investments during early childhood and education decisions and find that UBI is not a good idea when the welfare of future generations is taken into account. Ferriere et al. (2023) build on the work in Heathcote et al. (2017b) to study the

[8]Our work also relates to the literature that studies optimal tax progressivity (e.g., Conesa and Krueger 2006; Kindermann and Krueger 2020; Guner et al. 2016; Heathcote et al. 2017b), capital taxation (Golosov et al. 2003; Conesa et al. 2009; Boar and Midrigan 2021) or age-dependent taxation (Erosa and Gervais 2002; da Costa and Santos 2018; Ndiaye 2017; Heathcote et al. 2017a).

optimal negative relation between transfers and income-tax progressivity using a Ramsey approach. They show that most of the welfare gains in the benchmark plan can be attained by a UBI of $26,000 per household. Like us, Rubião and Santos (2021), Jaimovich et al. (2024), and Rauh and Santos (2022) instead put a greater emphasis on the role of labor market frictions.

We add to this literature by evaluating a UBI policy reform as an alternative to the existing transfer and UI programs in a framework that combines formal and informal job creation and incomplete markets. This is important because the existence of informality affects the efficiency-equity trade-off associated with transfers as it depends on the endogenous relationship between formal vacancy creation, incentives to work formally, and precautionary savings.

Our paper also speaks to the scarce empirical literature examining relationship between unemployment insurance and informality. Gerard and Gonzaga (2021) analyze the effects of extending unemployment benefits duration in Brazil and find that longer entitlements increase the length of UB receipt. Complementary analyses of these authors also suggests that significant shares of UB recipients work informally, even when drawing UBs. Van Doornik et al. (2022) show that tighter requirements for UI benefits induce a movement of workers towards firms with higher unemployment risk. Van Doornik et al. (2023) find that eligibility for UI benefits increases formal layoffs, and most of the additional formal layoffs are related to workers transitioning to informal employment.[9] Liepmann and Pignatti (2024) study the relationship between unemployment benefits and informality in Mauritius, where informality is also widespread. They find that efficiency costs tend to exceed the median of efficiency costs identified in studies for high-income countries, and document a large shift towards informal employment among UB recipients.[10]

We contribute to this literature by relying on unique data on enforcement of labour regulation in Brazil. This data allows us to explore the geographic variation in the intensity of enforcement of labor regulations in an event study framework to identify how informality influences the employment responses to changes in UI policy.

The paper is organized as follows. In section 2, we provide reduced form evidence on the effects of the effects of UI policy on formal employment. In section 3, we present the model economy. In section 4 we describe the estimation and calibration of the benchmark economy. Section 5 discusses the properties of the benchmark economy. In section 6, we present the main findings of our quantitative experiments, and section 7 concludes.

[9]For papers on UI eligibility requirements focused on developed countries see, for instance, Birinci and See (2023), De Souza and Luduvice (2023), Michaud (2023) and the papers they cite.

[10]For evidence on the negative effects of means-tested transfers on informality, see De Brauw et al. (2015), Bergolo and Cruces (2021) and Garganta and Gasparini (2015).

2 Empirical Analysis

2.1 Unemployment Insurance and Labor Enforcement

We evaluate a 2015 reform in the Unemployment Insurance program in Brazil. Prior to the reform, in order to be eligible to receive compensation, a formal employee must have worked for at least 6 straight months prior to dismissal. However, in December 2014, a new executive order (*Medida provisória*) was announced to take effect from March 2015 onward. According to the new rule, first-time applicants must have worked for at least eighteen of the twenty-four months prior to the layoff, and second-time applicants at least twelve of the last sixteen months. Importantly, the rule did not change the necessary tenure for individuals with at least 2 prior spells; thus, the reform affected some individuals but not all formal workers. In June 2015, the executive order became law and changed again; the tenure conditions were then reduced to twelve and nine months for first-time and second-time applicants, respectively. Thus, the new set of rules made the conditions to receive UI benefits stricter for workers with less than two prior spells, but not for employees with two or more.

In addition to changes in UI eligibility criteria, we also examine a metric of labor market enforcement. The enforcement of labor laws is the responsibility of the Ministry of Labor, carried out by inspectors on firm premises. These inspectors are allocated to Labor Offices (LOs) throughout the country; however, not all municipalities have LOs. Therefore, for a firm to be inspected, an inspector must drive, by car, from the nearest LO (which can be in another municipality) to the firm (Almeida and Carneiro, 2012). Consequently, the further a municipality is from an LO, the costlier it is to enforce labor regulations in that municipality. Thus, we use driving distance (by car) from a municipality to the nearest Labor Office as a metric of enforcement, as in previous studies (Almeida and Carneiro, 2012; Ponczek and Ulyssea, 2021), measured in hundreds of kilometers. It is worth noting that the focus of inspections is formal firms, and inspectors should enforce labor laws comprehensively, rather than solely verifying if a formal firm is hiring an informal worker.

2.2 Data

Our data comes from three main databases. The first one is *Base de Gestão do Seguro Desemprego* (BGSD), a database with information on every request for an UI benefit. Since BGSD is identified at the individual level, we can observe how many times each employee had received UI benefits prior to December 2014, the month when the reform was announced; if an individual had less than two prior spells, then we consider him an affected person.[11]

[11]It should be noticed that the BGSD may underestimate true need for UI benefits. Van Doornik et al. (2023) documents instances of collusion between firms and workers whereby a formally employed worker is temporarily dismissed in order to collect UI benefits while continuing to work informally for the same employer, returning to formal status once benefits expire.

We then proceed to merge it with our second main database, *Relação Anual de Informações Sociais* (RAIS). This data set contains detailed and identified information on formal labor employment, with data both for workers (like age, race, gender, wages and employment tenure) and firms (like location and age). Focusing on private non-temporary employment only, since public and temporary employees do not receive UI, we are able to construct a panel of affected workers by municipality along time. Throughout the Empirical Analysis section, the terms "formal employment" and "private non-temporary formal employment" will be used interchangeably. It is worth noting that we exclude from the sample municipalities that could be seen as outliers; more specifically, we exclude municipalities with less than 5 formal employees in any month from January 2012 to December 2017. In addition, we also exclude very small and large municipalities as given by the bottom and top 1% of the employment distribution.

The final main dataset contains information from the Ministry of Labor on labor enforcement, gathered by Ponczek and Ulyssea (2021), with the driving distance from each municipality to each LO. With this, we can define the nearest LO to each municipality, as well as the driving distance in hundreds of kilometers.

Our goal is to compare the heterogeneous effects of the change in UI eligibility criteria across municipalities given the level of labor market enforcement. Hence, we need a metric to compare the exposure each municipalities had to the change in UI rules; we define this measure as the share of formal employees affected by the changes in UI criteria in December 2014. That is, our exposure metric is the ratio of affected formal employees to the total number of formal employees in a given municipality. We proceed to split our sample of municipalities in two halves according to this metric of exposure. Municipalities on the top half of exposure are assigned as Treated regions, while the bottom half are assigned as Control, in a process similar to the one adopted by Gerard (2021).

We conduct the analysis at the municipal level using semiannual data from 2012H1 to 2017H2. Table 1 reports summary statistics. There are baseline differences between the treated and control groups. Specifically, the control group comprises larger municipalities, as indicated by the population and formal employment rows. However, as shown in the event-study results below, we do not find evidence of differential pre-trends in formal employment between treated and control municipalities prior to the UI rule change, after controlling for fixed effects and covariates.

2.3 Empirical Specification

Our main empirical specification takes the following Difference in Differences Event Study format:

$$Y_{mts} = Treatment_{ms} \cdot \sum_{p \neq 20142} \beta_p \cdot 1\{t = p\} + \gamma \cdot X_{mts} + \alpha_m + \alpha_t + \alpha_{ps} + \varepsilon_{mts} \quad (1)$$

Table 1: Summary Statistics For Municipalities by Treatment Group

	All	Control	Treated
Population	25673	33368	17981
Formal non-temporary private-sector employees	3623	5840	1406
Affected	1016	1516	516
Exposure (Affected/Formal employees)	0.34	0.25	0.42
Share of White	0.58	0.59	0.54
Share over 40 years old	0.32	0.32	0.31
Share with High School or Less	0.87	0.87	0.87
Distance (100 kms)	0.95	0.86	1.05
Number of municipalities	5371	2685	2686

Notes: This table display average characteristics across municipalities, both for all and split by treatment group. Values are as of December 2014, and shares are expressed as a percentage of formal non-temporary private-sector employees.

In equation 1, m denotes municipalities, t denotes time and s denotes states. Since we want to understand the effect of the reform on labor supply, our dependent variable, Y_{mts} is the log of formal employment. We group time in 12 periods, one for each semester from 2012 to 2017, denoted as $p = \{20121, 20122, ..., 20171, 20172\}$. $Treatment_m$ is a dummy variable that takes the value of 1 if municipality m was treated and 0 otherwise, that is, if the municipality's exposure to the shock (Affected/Employed in December 2014) was above the median. This way, we can estimate the effect of being in the treated group both before and after the tightening in UI rules. In addition, we also include a set of control variables, X_{mts}, which are the shares of white workers, men, workers above 40 years old, and the shares of each of the following educational levels: incomplete elementary, complete elementary, incomplete high school, and complete high school. Note that these shares are calculated with respect to the entire formally employed population. We also add municipality, α_m, and time-fixed effects, α_t, to control for time invariant characteristics in the municipalities and common shocks across municipalities, respectively. On top of that, we also add state-by-period fixed effects α_{ps} to control for time varying characteristics that affect all municipalities within a state, such as a change in state government. Finally, we cluster our error term ε_{mts} at the microrregion level. Microrregions are a subdivision of Brazil, defined by *Instituto Brasileiro de Geografia e Estatística* (IBGE), with a regional identity and similar structure of production, a concept that resembles local economies in (Ponczek and Ulyssea, 2021).

Our main coefficient of interest is β_p. It gives information on the heterogeneous effect of changes in UI rules on regions more exposed ($Treatment_i = 1$) in relation to regions less exposed. A positive β_p from 2015 onwards means that the change in UI has a relative positive effect on employment for regions more exposed. In the context of the model we will show below, stricter rules for UI can be associated with a decrease in the Value of Unemployment, and thus, a greater incentive for workers to remain in a formal employment. Results can be seen in the figure 1 above.

As we can see, prior to the reform announcement (December/2014), there was no effect of being in the treatment group on formal employment. With the tightening of UI rules, employment in treated municipalities became higher than in control municipalities starting in the first half of 2015. Our estimates suggest that the reform led to a gain in formal employment of 9.1% in treated municipalities. This could be due to the decline in incentives for formal employees to go unemployed (to remain unemployed or go informal) after the reform, since for some it would be necessary more time working to get access to the unemployment insurance.

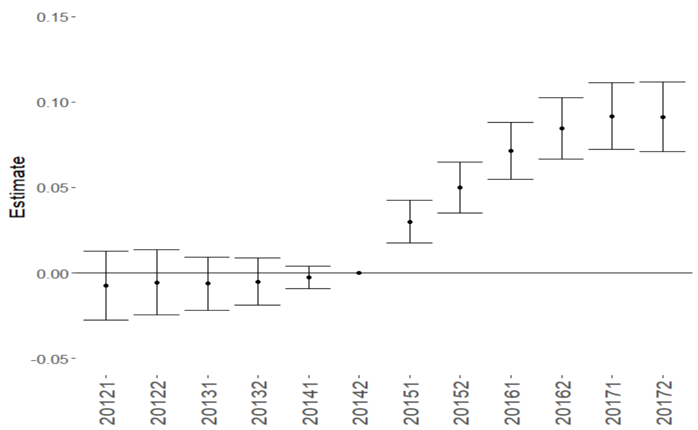


Figure 1: The figure displays the estimated coefficients, $\hat{\beta}_p$, of equation 1 and their 95% confidence interval. The dependent variable is the log of non-temporary formal employment.

We go one step further now to understand the heterogeneous effects for regions with distinct levels of labor enforcement. We run regression 1 above but with restricted samples. We split our sample based on the distance of the municipality to the nearest LO, first we run only for municipalities below the the 25% of the distance distribution, and then we run the regression for municipalities above the 75% of the distance distribution. This way we split municipalities between high enforcement (low distance) and low enforcement (large distance), respectively. Results are displayed in Figure 2 below.

The panel on the left of Figure 2 shows the results for estimating equation 1 only for municipalities below the 25% of the distance distribution, and the one on the right shows for municipalities above the 75% of the distance distribution. Our estimates point to a stronger effect for regions with a higher distance (low enforcement) than for regions with a lower distance (higher enforcement). More specifically, in the second half of 2017, there is an increase in formal employment of 5,7% in treated municipalities relative to the control group, while the increase is nearly three times as high as in municipalities with a high distance.

All in all, these results indicate that tighter conditions for UI collection increase formal employment, with stronger effects in highly informal municipalities. This is consistent with the view that the distortive impact of UI policies is amplified in economies with large informal sectors.

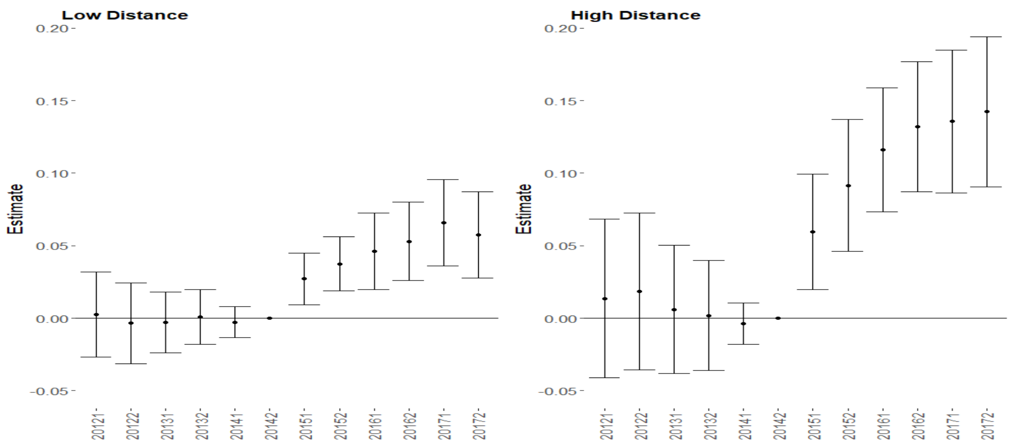


Figure 2: This figure presents the estimated coefficients, $\hat{\beta}_p$, of equation 1 and their 95% confidence interval. The dependent variable is the log of non-temporary formal employment. "Low Distance" corresponds to municipalities in the bottom 25% of the distance distribution, while "High Distance" corresponds to municipalities in the top 25%.

3 Model

3.1 Demography and preferences

Time is discrete and runs eternally. The economy is populated by overlapping generations of individuals who face an exogenous probability, ν, of surviving to the next period. At each period, $1-\nu$ new agents are born, and $1-\nu$ die, so that the population remains constant at the normalized unit level. Individuals' labor productivity is determined by two components. The first one, denoted by e, is realized at birth and retained throughout one's life. It can be interpreted as innate ability and pre-market skills obtained through education. The second one, z, is a stochastic component and its law of motion is explained below.

Agents have preferences over random streams of consumption, c_t, according to

$$\mathbb{E}\left[\sum_{t=0}^{\infty}\beta_e^t\left(\prod_{s=0}^{t}\nu\right)u(c_t,\ell_{u,t},\ell_{o,t})\right], \tag{2}$$

where $\mathbb{E}$ is the expectation operator conditional on information at birth and the intra-period utility takes the following separable functional form:

$$u(c_t,\ell_{u,t},\ell_{o,t})=\frac{c_t^{1-\gamma}}{1-\gamma}+\ell_{u,t}d_u+\ell_{o,t}d_{o,e} \tag{3}$$

The parameter d_u captures the utility from leisure when unemployed, while $\ell_{u,t}$ is an indicator function that takes the value 1 when unemployed and zero otherwise. The valuation of leisure in (3) implies that the marginal rate of substitution between leisure and consumption is decreasing in c, and thus the worker's reservation match quality increases with savings, as in Bils et al. (2011). Similarly, the parameter $d_{o,e}$ captures the utility from leisure when out of the labor force, with $\ell_{o,t}$ equal to 1 when not participating and zero otherwise.

We allow the discount factor β_e to depend on individual's ability as a way to generate an empirically plausible cross-sectional wealth distribution, which has been already explored in Krusell and Smith (1998) and more recently in Krueger et al. (2016), among others.[12]

3.2 Human capital accumulation

In line with Ljungqvist and Sargent (1998) and Kehoe et al. (2019), we think of z as representing the individual's human capital, which is accumulated on the job in a leaning-by-doing fashion. It captures the fact that while working, agents can practice their skills and learn, thereby increasing productivity. While off the job, the worker has less opportunities to practice his skills and may even lose previously accumulated knowledge, potentially leading to a depreciation of his human capital. The dynamics of z are stochastic and are characterized by shocks moving agents up and down the job ladder. In particular, the human capital of an employed worker evolves according to the following sector-specific law of motion:

$$\log z' = (1 - \varphi_s)\bar{z}_s + \varphi_s \log z + \sigma_s \varepsilon' \tag{4}$$

where $s = f$ denotes formal sector and $s = i$ informal sector, φ_s determines the persistence, σ_s the volatility and $\bar{z}_s$ the mean of the process, while ε is a Gaussian disturbance with zero mean and unit variance.

We allow the shock's volatility (σ_s), persistence (φ_s), and mean ($\bar{z}_s$) to differ across sectors. This is in line with the empirical evidence in Bobba et al. (2021) who show that the formality status of the job significantly affects the dynamic of worker's human capital. Notice that neither process results from explicit investment decisions but is a result of the worker's labor market state. In addition, adding idiosyncratic shocks ε to human-capital accumulation allows the model to reproduce the dispersion of wage growth rates observed in the data in a parsimonious way.

A non-employed worker's human capital evolves according to a similar AR(1) process with the same volatility but with a different mean (which we normalize to 0) and persistence φ_u:

$$\log z' = \varphi_u \log z + \sigma_u \epsilon'. \tag{5}$$

[12]See Falk et al. (2018) for experimental evidence on heterogeneity in discount rates.

3.3 Labor market frictions

Workers and firms come together via random search. We assume that a worker's type is observable and that firms can direct their search by posting vacancies for individuals of a given level of education e. In each sector $s = \{f, i\}$, vacant jobs and unemployed workers are brought together in pairs by a matching function M_s, which maps the number of matches in sector s to the total number of job seekers and vacancies in that sector. Let u_e be the measure of job seekers of type e, and $v_{e,s}$ the corresponding measure of vacancies posted by firms for agents in submarket e and sector s. The flow of successful matches within a period in each sector are given by the following matching function:

$$M_s(u_e, v_{e,s}) = \frac{u_e v_{e,s}}{(u_e^\eta + v_{e,s}^\eta)^{\frac{1}{\eta}}} \tag{6}$$

where η determines the interaction between the measure of job searches u_e and vacancies $v_{e,s}$.

We use this matching function, which was proposed by Haan et al. (2000), to ensure that job finding rates are between 0 and 1. Specifically, dividing (6) by u_e, the probability that an unemployed individual of type e matches with a vacancy in submarket e and sector s is then

$$m_s(\theta_{e,s}) = \frac{\theta_{e,s}}{(1 + \theta_{e,s}^\eta)^{\frac{1}{\eta}}}$$

where $\theta_{e,s} = \frac{v_{e,s}}{u_e}$ is the labor market tightness. Note that workers of type e exit unemployment at rate $\sum_s m_s(\theta_{e,s})$.

The job filing rate in the submarket e can similarly be obtained dividing (6) by $v_{e,s}$:

$$q_s(\theta_{e,s}) = \frac{1}{(1 + \theta_{e,s}^\eta)^{\frac{1}{\eta}}}.$$

The assumption that the matching function differs between formal and informal sectors is meant to capture the idea that (i) formal and informal jobs are not necessarily found in similar places and that (ii) firms may rely on different methods to recruit their workers in the two sectors. Namely, it is often argued that jobs in the informal sector are more often found through word-of-mouth communication rather than by applying to ads in the newspapers and then going through a full and potentially lengthy recruitment process. This view fits well with the fact that informal jobs can be found more easily than formal jobs (see e.g. Meghir, Narita and Robin, 2012), and it takes less time to match compared to the formal sector. While we do not model those different recruitment practices explicitly, we allow for the two matching functions to be different to better capture the differences in job finding rates across the two sectors.

3.4 Asset markets

Consumers face idiosyncratic income shocks. Because markets are incomplete, they cannot perfectly smooth consumption. Thus, savings may be precautionary and allow partial insurance against shocks. Agents can accumulate two kinds of tangible assets: physical capital, k, which is used as an input for production, and equity x, which is a claim for the aggregate profit. Let r be the return to capital and div be the dividend paid to the holders of equity. The total amount of equities is normalized to one. As there is no aggregate risk, the equity price remains constant in equilibrium. The equity price p has to satisfy a standard no-arbitrage condition, which implies that the returns on holding capital and equity are equal:

$$p = \frac{div + p}{1 + r - \delta} \tag{7}$$

where δ is the depreciation rate of capital.

Since capital and equity both are riskless and provide the same return and therefore are the same from the consumer's viewpoint, we do not have to keep track of the asset composition of the consumers. In the following, we define total financial resources as:

$$(1 + r - \delta)(k + px) = (1 + r - \delta)a \tag{8}$$

and use a as the state variable for a consumer.

Asset holdings are subject to an exogenous lower bound. More precisely, for our main exercise, we assume that agents are not allowed to contract debt, so that the amount of assets carried over from one period to the next is such that $a' \geq 0$.

3.5 Government

The government levies a revenue tax, τ_f, and a payroll tax, τ_p, on formal firms. It also levies taxes on capital income, consumption, and labor income. Consumption is taxed at a flat rate τ_c, while capital and labor income are taxed according to a non-linear, progressive schedule based on the tax function proposed by Benabou (2003) and more recently used by Heathcote et al. (2017b):

$$T(y_\tau) = \max\{y_\tau - \tau_w y_\tau^{1-\xi}, 0\}, \tag{9}$$

where y_τ denotes taxable income, equal to $ra + w_f$ if the individual is formally employed and equal to ra otherwise, and $T(y_\tau)$ is the tax paid. The parameters τ_w and ξ govern the level and the progressivity of taxation, respectively. For instance, if $\xi = 0$, the tax rate is flat at $1 - \tau_w$, whereas the system is progressive if $\xi > 0$. Note that this tax function is always non-negative, consistent with statutory tax rates in Brazil, which rely exclusively on income-dependent transfers to generate negative net rates.

Government revenue finances a stream of exogenously given government consumption, G. In addition, the government operates two programs in the economy. Formal employed workers are eligible to receive unemployment insurance (UI) benefits upon separation with probability, π_w, which is interpreted as coverage rate of UI among newly separated formal workers. The benefit amount, $b(e, z_f)$, is a function of the worker's average wage in the last formal job, $\bar{w}_f(e, z_f)$, where z_f denotes the worker's productivity upon separation. The UI benefit formula is specified as a piecewise linear function in accordance with Brazilian legislation:

$$b(e, z_f) = \begin{cases} \vartheta_1 \, \bar{w}_f(e, z_f), & \bar{w}_f(e, z_f) \leq w_1, \\ \vartheta_1 w_1 + \vartheta_2 \left[\bar{w}_f(e, z_f) - w_1\right], & w_1 < \bar{w}_f(e, z_f) \leq w_2, \\ \bar{b}, & \bar{w}_f(e, z_f) > w_2, \end{cases} \tag{10}$$

where $0 < \vartheta_2 < \vartheta_1$, and (w_1, w_2) are the bend points of the schedule.

This function implies that for a previous-job wage up to w_1, the benefit equals $\vartheta_1 \bar{w}_f(e, z_f)$, with ϑ_1 representing the replacement rate. For wages between w_1 and w_2, the benefit equals $\vartheta_1 w_1 + \vartheta_2 \left[\bar{w}_f(e, z_f) - w_1\right]$. Finally, for wages above w_2, the benefit is capped at $\bar{b}$, which is the maximum benefit amount.

We use ι_u as an indicator function that takes the value 1 if an unemployed — or informally employed — worker is receiving unemployment insurance and 0 otherwise. To economize on the state space, we assume that the benefit exhaustion is a stochastic event, governed by the following transition matrix:

$$\Pi^u_{\iota_u, \iota'_u} = \begin{pmatrix} 1 & 0 \\ 1 - \pi_u & \pi_u \end{pmatrix} \tag{11}$$

Thus, if an unemployed worker is not currently receiving UI benefits, $\iota_u = 0$, she will not receive them next period either, $\iota'_u = 0$, with probability one. If $\iota_u = 1$, then π_u denotes the probability that benefits are not exhausted in the next period.

The government also runs a welfare system designed to mimic the social programs in the Brazilian economy. The function $Tr(y_v)$ corresponds to the transfer amount received by a household. We assume that the amount of transfers is given by a Ricker function:

$$Tr(y_v) = \begin{cases} \exp(\rho_1) \exp(\rho_2 y_v) y_v^{\rho_3} & \textit{if } y_v > 0 \\ \exp(\rho_1) & \textit{if } y_v = 0. \end{cases} \tag{12}$$

It depends on individual's total verifiable income, consisting of formal wages or unemployment benefits, interest, and dividend income and thus does not take into account informal wages. In particular, y_v is defined as follows:

$$y_v = \begin{cases} ra + w_f, & \text{if formal} \\ ra + b, & \text{if informal with } \iota = 1 \\ ra, & \text{if informal with } \iota = 0 \\ ra + b, & \text{if unemployed with } \iota = 1 \\ ra, & \text{if unemployed with } \iota = 0. \end{cases} \tag{13}$$

The first term, $\exp(\rho_1)$, primarily acts as a scaling factor, governing the level of transfers. The second term, $\exp(\rho_2 y_v)$, is an exponential term capturing rapid changes in transfers as a function of income. This is especially relevant in regions of the income distribution where small changes in income lead to disproportionately large changes in transfers. Finally, the third term, $y_v^{\rho_3}$, captures a more gradual, scalable relationship between income and transfers. This power-law term is important for modeling scenarios where the transfer rate changes at a rate that is more directly proportional to income levels, and can represent more gradual effects, such as the gradual phase-out of certain benefits. The combination of these two terms allows for a more flexible model that can better fit the data.[13]

3.6 Workers' maximization problem

Let $V_f(a, e, z)$ denote the value function of a formally employed worker with individual productivity (e, z), asset holdings a. Similarly, let $V_u(a, e, z, \iota_u)$ denote the value function of an unemployed worker, where ι_u indicates the UI eligibility status as explained above. The recursive problem of a formally employed worker can be written as

$$\begin{aligned} V_f(a, e, z) = \max_{a' \geq 0, c} &: u(c, 0) \\ &+ \beta_e \nu \sum_{\iota'_u} \Pi^w_{\iota'_u} \Big[(1 - \varsigma_{e,f}) \sum_{z\prime} F_f(z, z') \max\{V_f(a', e, z'), V_u(a', e, z', \iota'_u)\} \\ &+ \varsigma_{e,f} \sum_{z\prime} F_f(z, z') V_u(a', e, z', \iota'_u) \Big] \end{aligned} \tag{14}$$

subject to the following budget constraint:

$$(1 + \tau_c)c + a' = a + y_\tau - T(y_\tau) + Tr(y_v). \tag{15}$$

where $y_\tau = ra + w_f(a, e, z)$ denotes taxable income. The continuation value in (14) reflects the worker's survival probability ν, the type- and sector-specific exogenous separation probability $\varsigma_{e,f}$, and the decision of whether to continue the relationship. In addition, note that $\Pi^w_{\iota'_u=1} = \pi_w$ and $\Pi^w_{\iota'_u=0} = 1 - \pi_w$ govern eligibility for UI in the event of separation.

[13] We are not the first to use a Ricker function to model the transfer schedule. See, for instance, Rauh and Santos (2022) and Guner et al. (2024).

Equation (15) represents the household's budget constraint. The wage w_f is determined each period through Nash bargaining between the firm and the worker, as explained below, and therefore depends on the worker's individual state (a, e, z).

Let $V_i(a, e, z, z_f, \iota_u)$ denote the value function of an informally employed worker with asset holdings a, individual productivity (e, z), last formal-job productivity z_f, which is used to compute UI benefits if the worker is eligible, $\iota_u = 1$, and UI eligibility status ι_u. The recursive problem of an unregistered worker is given by

$$\begin{aligned} V_i(a, e, z, z_f, \iota_u) = \max_{a' \geq 0, c} &: u(c, 0, 0) \\ &+ \beta_e \nu \sum_{\iota'_u} \Pi_{\iota_u, \iota'_u} \sum_{z\prime} F_i(z, z') \Big[(1 - \varsigma_{e,i}) \max\{V_i(a', e, z', z_f, \iota'_u), V_u(a', e, z_f, \iota'_u)\} \\ &\qquad\qquad\qquad\qquad\qquad\qquad\qquad + \varsigma_{e,i} V_u(a', e, z_f, \iota'_u) \Big] \end{aligned} \tag{16}$$

subject to the following budget constraint:

$$(1 + \tau_c)c + a' = (1 + r)\, a + w_i(a, e, z, z_f, \iota_u) - T(y_\tau) + \iota_u b(e, z_f) + Tr(y_v). \tag{17}$$

where the taxable income in this case is $y_\tau = ra$. Note that the continuation value in (16) depends on the UI eligibility status next period, which is governed by Π_{ι_u, ι'_u}.

Workers move from unemployment to formal or informal employment according to the endogenous job-finding rates $m_s(\theta_{e,s})$, with $s \in \{f, i\}$. Unemployed workers receiving UI benefits ($\iota_u = 1$) retain the productivity level from their previous formal job, denoted z_f, which – as explained above – is used to compute UI benefits. To economize on the state space, we assume that an unemployed worker does not update z while collecting UI benefits. Given that UI benefits last about five months in the data, we believe this is a reasonable assumption that substantially simplifies the individual's maximization problem. For unemployed workers not receiving UI benefits, productivity evolves according to the transition matrix $F_u(z, z')$.

In addition, unemployed workers not collecting UI may choose to leave the labor force. Because collecting UI benefits requires workers to participate in the labor force, only unemployed individuals without UI can make that transition. We denote the value function of an unemployed worker by $V_u(a, e, \hat{z}, \iota_u)$, and the recursive problem is defined as follows:

$$
\begin{aligned}
V_u(a,e,\hat{z},\iota_u) = \max_{a'\geq 0,\, c} \Big\{ & u(c,1,0) \\
& + \beta_e \nu \sum_{\iota'_u} \Pi^u_{\iota_u,\iota'_u} \sum_{z'} F_u(\hat{z},z') \Big[m_f(\theta_{e,f}) \max\big\{V_f(a',e,z'), V_u(a',e,\hat{z}',\iota'_u)\big\} \\
& \qquad + m_i(\theta_{e,i}) \max\big\{V_i(a',e,z',z_f,\iota'_u), V_u(a',e,\hat{z}',\iota'_u)\big\} \\
& \qquad + \big(1 - m_f(\theta_{e,f}) - m_i(\theta_{e,i})\big)\iota'_u V_u(a',e,\hat{z}',\iota'_u) \\
& + \big(1 - m_f(\theta_{e,f}) - m_i(\theta_{e,i})\big)(1-\iota'_u) \max\big\{V_u(a',e,\hat{z}',\iota'_u), V_o(a',e,z')\big\} \Big] \Big\}
\end{aligned} \tag{18}
$$

subject to

$$
(1+\tau_c)c + a' = (1+r)\,a - T(ra) + \iota_u b(e,z_f) + Tr(y_v). \tag{19}
$$

where $\hat{z} = \iota_u z_f + (1-\iota_u)z$ and $\hat{z}' = \iota'_u z_f + (1-\iota'_u)z'$. Thus, if $\iota_u = 1$ and $\iota'_u = 1$, then $\hat{z} = z_f$ and $\hat{z}' = z_f$, meaning that human capital equals that in the last formal job and is not updated while the worker collects UI benefits, whereas if $\iota_u = 0$, then $\hat{z} = z$ and $\hat{z}' = z'$, meaning that current human capital can differ from z_f and evolves according to $F_u(z,z')$.

Note that the continuation value accounts for the fact that a worker may receive at most one offer per period – either from the formal sector with probability $m_f(\theta_{e,f})$ or from the informal sector with probability $m_i(\theta_{e,i})$. If no offer arrives, which occurs with probability $1 - m_f(\theta_{e,f}) - m_i(\theta_{e,i})$, the worker remains unemployed if $\iota'_u = 1$, while if $\iota'_u = 0$, she may choose not to participate in the labor force.

The recursive problem of an agent outside the labor force is given by:

$$
V_o(a,e,z) = \max_{a'\geq 0,\, c} \Big\{ u(c,0,1) + \beta_e \nu \sum_{z'} F_u(z,z') \max\big\{V_u(a',e,z',0), V_o(a',e,z')\big\} \Big] \Big\} \tag{20}
$$

subject to

$$
(1+\tau_c)c + a' = (1+r)\,a - T(ra) + Tr(y_v). \tag{21}
$$

While outside the labor force, an individual's sources of income are her assets and welfare transfers. In addition, human capital evolves according to $F_u(z,z')$.

3.7 Firms

On the other side of the market, there is a continuum of risk-neutral, infinitely-lived firms. They maximize the expected value of the sum of profit streams and use the real interest rate r to discount the future. Firms use both capital and labor inputs to produce according to a standard Cobb-Douglas production function $f(k,n) = \psi k^{\alpha} n^{1-\alpha}$, where ψ is a scale parameter common to all firms. Production can take place only in a worker-job match and each match consists of one job and one worker. Labor efficiency units, n, are thus given by

ez.

Once a match is formed, the firm must choose the amount of capital employed in the job, which is rented from the households. The value of a formal job filled by a type's e worker with asset level a and productivity shock z is given by

$$J_f(a,e,z) = \max_k \Bigg\{ \psi k^\alpha n^{1-\alpha} - (r+\delta)k - (1+\tau_p) w_f(a,e,z) + \frac{(1-\varsigma_{e,f})\nu}{1+r} \sum_{z'} F_f(z,z') \max\{J_f(a',e,z'),0\} \Bigg\} \quad (22)$$

where $a' = a_f(a,e,z)$, meaning that the firm internalizes the worker's next period asset decision. The continuation value takes into account that a worker-firm pair is dissolved exogenously with the worker's death or with a per-period probability $\varsigma_{e,f}$, which depends on the worker's type. It also captures the possibility that the match no longer yields a positive value to the firm and is thus destroyed.

Given the assumption of frictionless capital market, all formal firms pay the same rental rate r, implying equal marginal products across firms. Thus, the same capital to labor ratio, k/n, is employed at each filled job. In fact, the first order condition implies that

$$\bar{k} = \frac{k}{n} = \left(\frac{\psi\alpha}{r+\delta}\right)^{\frac{1}{1-\alpha}} \quad (23)$$

and plugging (23) into (22), the flow profit can be written as $\pi_f(a,e,z,\iota_w) = \psi^{\frac{1}{1-\alpha}}(1-\alpha)\left(\frac{\alpha}{r+\delta}\right)^{\frac{\alpha}{1-\alpha}} n - w_f(a,e,z)$.

Firms can avoid paying taxes by hiring informally. However, this is not free of cost. Informal firms are subject to inspections and may suffer fines for violating labor laws. A well-documented fact in the literature is that informality declines with firm size.[14] Therefore, the cost of hiring informally, $\chi(k,n)$, is modeled as a convex and increasing function of capital, k, and labor, n. In our one firm-one worker framework, this function implies that the higher the worker's productivity, the greater the cost of informality, thereby decreasing the likelihood that a firm will choose to operate informally. In addition, the dependency on capital entails that the cost of informality distorts the demand for capital, meaning that informal firms will employ smaller levels of capital compared to their formal counterparts. The value of an informal job filled by a type's e worker with asset level a and productivity shock z is given by

[14] See, for instance, De Paula and Scheinkman (2011)

$$J_i(a,e,z,z_f,\iota_u) = \max_k \Bigg\{ \psi k^\alpha n^{1-\alpha} - (r+\delta)k - w_i(a,e,z,z_f,\iota_u) - \chi(k,n)$$
$$+ \frac{(1-\varsigma_{e,i})\nu}{1+r} \sum_{\iota_u'} \Pi^u_{\iota_u,\iota_u'} \sum_{z'} F_i(z,z') \max\left\{J_i(a',e,z',z_f,\iota_u'),0\right\} \Bigg\} \quad (24)$$

where $a' = a_i(a,e,z,z_f,\iota_u)$.

Note that the continuation value considers the possible change in the UI eligibility status next period. It also takes into account the fact that the informal workers' human capital evolves according to F_i.

To create a job in sector $s = \{f, i\}$, a firm first posts a vacancy. The flow cost of posting a vacancy is denoted by $\kappa_{e,s}$. There is free entry of firms, so that the asset value of holding a vacant position is always zero in equilibrium in both sectors, which implies the following job creation condition for the formal sector:

$$\kappa_{e,f} = \frac{q_f(\theta_{e,f})}{1+r} \int \sum_{z'} F_u(z,z') \max\left\{J_f(a',e,z'),0\right\} \frac{\lambda_u(a,e,z,\iota_u)}{u_e} \quad (25)$$

and similarly for the informal sector:

$$\kappa_{e,i} = \frac{q_i(\theta_{e,i})}{1+r} \sum_{\iota_u'} \Pi^u_{\iota_u,\iota_u'} \int \sum_{z'} F_u(z,z') \max\left\{J_i(a',e,z',z_f,\iota_u'),0\right\} \frac{\lambda_u(a,e,z,\iota_u)}{u_e} \quad (26)$$

where $a' = a_u(a,e,z,\iota_u)$.

The right-hand side of equations (25) and (26) corresponds to the present discounted value of future benefits from creating a vacancy in each sector. A firm with a vacancy does not know which worker type it will meet next period. The firm does know, however, the distribution of worker types among the unemployed. The population of unemployed workers at state (a,e,z,ι_u) is given by $\lambda_u(a,e,z,\iota_u)$, so that $\lambda_u(a,e,z,\iota_u)/u_e$ is the conditional density function. Since the matching process is random, a firm in sector s can be matched with any worker of type e in the current period unemployment pool. Equations (25) and (26) pin down the vacancy-unemployment ratio in each submarket e and sector s, $\theta_{e,s}$.

3.8 Wage setting

Wages are determined period by period using Nash bargaining within each worker-firm pair in both sectors. For formal workers, the outside option accounts for the expected value of unemployment given the probability of receiving UI benefits. The Nash bargaining problem is therefore given by:

$$\max_{w_f} \left[V_f(a,e,z) - \sum_{\iota_u} \Pi^w_{\iota_u} V_u(a,e,z,z_f = z, \iota_u) \right]^{\zeta} J_f(a,e,z)^{1-\zeta} \tag{27}$$

where $\zeta \in (0,1)$ is a parameter that represents the bargaining power of the worker.

For informal workers, the outside option depends on whether or not they are collecting UI benefits.

$$\max_{w_i} \left[V_i(a,e,z,z_f,\iota_u) - V_u(u,e,z_f,\iota_u) \right]^{\zeta} J_i(a,e,z,z_f,\iota_u)^{1-\zeta} \tag{28}$$

Note that, in line with Krusell et al. (2010), the Nash solution in (27) and (28) generate wage functions that are increasing in the worker's assets, reflecting that being unemployed is less painful for a worker with greater assets. In turn, as can be seen in equations (25) and (26), this makes the vacancy creation decision to depend on the unemployed asset holdings. To the extent that social insurance affects the individual's savings behavior, it establishes an additional channel through which transfers affect wage, vacancy creation and informality in the model.

Moreover, it should be noticed that marginal taxes and transfers affect wages and profits not only through their influence on net payoffs, but also through the sharing rules. In fact, as has been highlighted by Pissarides (1985), marginal taxes and transfers strengthen the firm's hand in the wage bargain since its share of the surplus from the job increases. Intuitively, a small increment in the negotiated wage benefits the worker less since she attains a smaller part of it. Since informal workers do not pay taxes, this effect is in place only for formal jobs. Thus, since higher marginal taxes reduce the effective bargaining power of the formal worker, it can have a beneficial effect not only on the rate of unemployment but also on formalization. In contrast, unemployment benefits strengthen the formal worker's hand in bargaining since a small increment in the bargained wage would give her an extra benefit in case of separation. These effects are important for one to bear in mind when thinking about the consequences of the UBI reforms considered below.

3.9 Equilibrium

A stationary equilibrium is a list of value functions $(V_f, V_i, V_u, Vo, J_f, J_i)$, decision rules for asset holdings (a_f, a_i, a_u, a_o), wage functions (w_f, w_i), a population distribution across possible individuals' states $\lambda_f(a,e,z)$, $\lambda_i(a,e,z,z_f,\iota_u)$, $\lambda_u(a,e,z,\iota_u)$, and $\lambda_o(a,e,z)$, a value of type-specific labor-market tightness, $\theta_{e,s}$ with $s = \{f, i\}$, and a tax rate τ_c such that:

1. Given the aggregate variables $\theta_{e,s}$, the wage functions (w_f, w_i), and the policy parameters, households solve the maximization problem in (14), (16), (18) and (20).

2. Given the wage schedules (w_f, w_i) and the workers asset-holding decision rule, (a_f, a_i), the values of a filled vacancy (J_f, J_i) satisfy equations (22) and (24).

3. Given the asset values (J_f, J_i), the asset-holding decision $a_u(a, e, z, \iota)$, and the measure of unemployed workers $\lambda_u(a, e, z, \iota_u)$, the number of vacancies posted in each submarket e and sector s is consistent with equations (25) and 26.

4. The wage functions (w_f, w_i) are determined through Nash bargaining between the firms and the workers according to (27) and (28).

5. Equilibrium distributions, λ_f, λ_i, λ_u, and λ_o satisfy the equilibrium stock-flow equations across the different states of the economy implied by the sets of decision rules as well as the idiosyncratic shocks described above.

6. The tax parameter τ_c is set so that the government's aggregate budget constraint

$$T_y + T_p + T_F + \tau_c C \;=\; G + B_{\text{UI}} + B_{\text{Tr}} \tag{29}$$

holds each period, where B_{UI} and B_{Tr} are aggregate UI benefits and transfers, T_y is aggregate income-tax revenue, T_p is payroll-tax revenue, and T_F is taxes on formal firms' revenue.

7. The dividend paid to equity owners every period is the sum of flow profits from formal matches, net of the expenditure on formal vacancies

$$div = \sum_e \int [\pi_f(a, e, z, \iota_w) - \kappa_{e,f} v_{e,f}]\, d\lambda_f(a, e, z, \iota_w)$$

and p can be computed from (7).

8. Aggregate capital satisfies the asset market clearing condition:

$$k = \frac{1}{1+r} A - p.$$

In addition, we assume that that newborn agents start off their lives outside the labor force, and with zero asset holding.

3.10 Welfare measure

The government is a benevolent Ramsey planner that fully commits to fiscal policy. The planner maximizes social welfare by choosing a budget feasible level of transfers subject to allocations being an equilibrium. We consider an Utilitarian social welfare criterion that evaluates the ex-ante expected utility across all agents in the economy as in

$$\mathbb{E} \sum_{t=0}^{\infty} \beta^t \left(\prod_{s=1}^{t} \nu \right) u(c_t, \ell_{u,t}, \ell_{o,t}) \tag{30}$$

where $\mathbb{E}$ denotes the unconditional expectation operator with respect to all possible permanent types and histories. This welfare criterion takes into account the concern of the policy maker for redistribution and insurance against idiosyncratic shocks, as well as the distortions the transfer system imposes on labor supply, job creation, and capital accumulation decisions.

We compute the welfare change, Δ, as the amount of consumption that one would have to remove or add in order to make the utilitarian welfare criterion equal between a benchmark transfer system and some alternative policy. The welfare variation (CEV) is calculated as follows: Let $V^0(\Delta)$ denote the expected utility of an agent born into the benchmark economy. Then, define

$$V^0(\Delta) = \mathbb{E}\left[\sum_{t=0}^{\infty}\beta^t\left(\prod_{s=1}^{t}\nu\right)u_t((1+\Delta)c_t^0, \ell_{u,t}^0, \ell_{d,t}^0)\right]$$

where $u_t((1+\Delta)c_t^0, \ell_{u,t}^0, \ell_{d,t}^0)$ is the flow utility attained by the agent at period t under the benchmark transfer system. Our relevant measure of welfare variation, CEV, is given by

$$\min_{\Delta}\left[V^0(\Delta) - V^1\right]. \tag{31}$$

where we use the flow utility attained under the transfer system we aim at evaluating, $u_t(c_t^1, \ell_{u,t}^1, \ell_{d,t}^1)$, to similarly define V^1.

4 Calibration

A model period is 1 month. We separate the parameters into two groups: the exogenously given and parameters calibrated through the simulated method of moments. As is customary, we associate the parameters with the target that provides the most intuition for its value, but all parameters are determined jointly. The value of the parameters, their sources, and targets are shown in Table 2.

Agents in our model represent household heads and we divide the labor force into three productivity types according to levels of education: basic education or less (at most 8 years of schooling); high school (9-11 years of schooling) and more than high school. The population share of each group is denoted by μ_e and, according to PNADC data, corresponds to $\mu_1 = 0.49$, $\mu_2 = 0.32$ and $\mu_3 = 0.19$, respectively.

Preference parameters: We set risk aversion to 2 and the survival rate ν to $1 - 1/540$, implying that workers remain in the labor market for an average of 42 years. We introduce heterogeneity in discount factors across education groups to match the observed wealth inequality in Brazil. For this purpose, we use data from the World Wealth and Income Database (WID.world), which reports wealth distribution statistics from 1995 to 2019. In our baseline calibration, we use the 2018 data. The dispersion of wealth informs the dispersion of β_e. In particular, we calibrate the distance between β_es to approximate the wealth Gini coefficient. In addition, we target a capital-output ratio of 2.8 to pin down the mean level of β_e.[15] This procedure yields the three discount factors reported in the lower panel of Table 2.

The parameters $d_{o,e}$ capture the utility from leisure when outside the labor force and are calibrated to match the non-participation rate by education using PNADC data. The parameter d_u captures the utility from leisure when unemployed. Since d_u influences the marginal rate of substitution between leisure and consumption, it also directly affects the extent to which the worker's reservation match quality increases with savings. Because micro data on asset holdings in Brazil are not available, we calibrate d_u to approximate the correlation between wages and consumption observed in the data. To this end, we use data from POF, the 2017-2018 Brazilian Consumer Expenditure Survey, which provides detailed information on the consumption and expenditure patterns of the Brazilian population.

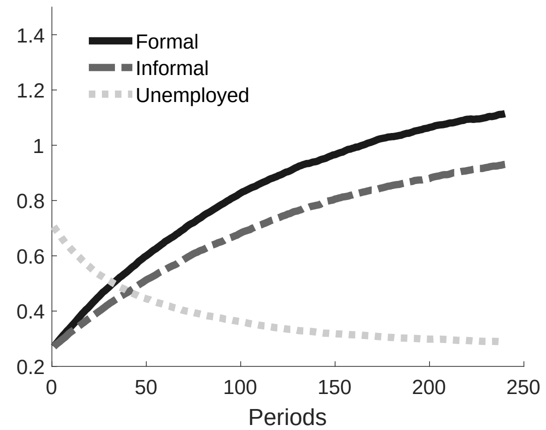
Labor productivity shocks: To calibrate the ex-ante productivity, e, we use data on hourly wages from the Continuous National Household Sample Survey conducted by the Brazilian Institute of Geography and Statistics (PNADC) for 2018. First, we normalize the weighted average of ex-ante productivity to one. Then, we choose the dispersion of e to match the Gini coefficient of hourly wages for workers at the beginning of the life-cycle. In particular, we restrict attention to household heads who are 25 years who have no missing data on wages or hours of work. The values for e are reported in the upper panel of Table 2.

The parameters that characterize the human capital dynamics are $(\bar{z}_s, \varphi_s, \sigma_s)$ with $s = f, i$ for the employed and (φ_u, σ_u) for the unemployed. We do not have direct information about events that may change human capital on the job, such as training or specific knowledge acquisition. Since $(\bar{z}_s, \varphi_s)$ are directly linked to life-cycle wage growth, we use information on age-earnings profiles to identify these parameters. In particular, we choose $(\bar{z}_s, \varphi_s)$ to approximate the simulated mean earnings profile for both sectors with the one computed from a Mincer regression of log hourly wages with standard controls, including education. The parameter φ_u governs the rate at which workers' human capital depreciate over the unemployment spell. Since we do not have a long enough panel dataset to properly estimate the human capital depreciation in Brazil, we rely on the estimates of Bobba et al. (2021) who report an average annual depreciation rate of 10% using Mexican data. This is the moment we target in the calibration of ρ_u. Next, we assume that $\sigma_s = \sigma_u = \sigma$ and use the Gini coefficient of labor income to pin down σ. The values that we obtain are presented in Table 2. To compute $F_s(z, z')$ and $F_u(z, z')$, we apply the algorithm described in Tauchen (1986) to approximate the stochastic processes in (4) and (5) by a first-order Markov chain with 15 points.

[15] This value is taken from Cavalcanti and Santos (2021). Using Heston et al. (2012) Penn World Tables 7.1 and the inventory method, they obtain a value of 2.80 for the capital-output ratio in the Brazilian economy.

Figure 3 shows how human capital evolves over the employment spell in both sectors under the baseline calibration. In the figure, we display the average human capital of a sample of agents who enter the market with mean human capital drawn from $F_u(z, z')$. In both sectors, workers' productivity grows, on average, over time and the profile is steeper in the first few years and then slows down as experience increases. We also show in Figure 3 the average human capital of a sample of individuals who enters unemployment with the average human capital among employed workers.

Figure 3: Life-cycle profile of mean human capital



Notes: One model period on the x-axis is equivalent to one month. The line "Formal" ("Informal") corresponds to the average human capital, $\exp(z)$, of a sample of newborns who enters the market with mean human capital drawn from $F_u(z, z')$ and stay continuously employed in the formal (informal) sector. The line "Unemployed" corresponds to the average human capital of a sample of newborns who enters unemployment with average human capital among employed workers.

Technology: The values of the technological parameters are reported in Table 2. We set the capital share to 0.30, consistent with the estimate in Gomes et al. (2005) once the corrections for self-employed income proposed by Gollin (2002) and Young (1995) are taken into account. The depreciation rate is taken from Cavalcanti and Santos (2021). The scale parameter ψ is chosen so that average income in the benchmark economy is normalized to one. Finally, the cost of hiring informally is given by $\chi_{0,e} k n^{\chi_1}$, where $\chi_{0,e}$ governs the level and χ_1 the degree of convexity. We calibrate these parameters so that the model reproduces the observed share of informality by education, which, as shown in the next section, decreases with e.

Recruiting cost and separation rate: The difference in unemployment rates among types is directly related to the variation in the job separation rates, $(\varsigma_{e,f}, \varsigma_{e,i})$. First, we rely on PNADC data to externally calibrate $\varsigma_{e,f}$. Then, we estimate the implied separation rates for the informal sector, $\varsigma_{e,i}$, such that the unemployment rate for each education group is consistent with the data. According to the PNADC data, the average unemployment rates decline with skill, 8.6%, 6.5%, and 5.1%, respectively. The resulting values of $\varsigma_{e,i}$ are

Table 2: Estimation and calibration of model parameters

Parameter	Description	Values	Source/target
	External calibration		
Parameter	Description	Values	Source/target
γ	Risk aversion	2	Standard
ν	Death probability	$1-\frac{1}{504}$	42 years working life
α, δ	Capital share, depreciation rate	0.3, 0.7%	Gomes et al. (2005)
τ_f, τ_p	Revenue and payroll taxes	4%, 20%	Paes and Bugarin (2006)
ϑ_1, ϑ_2	Repl. rate	0.8, 0.4	UI legislation
$1-\pi_u, \pi_w$	Prob. of UI expiring, eligibility	0.8, 0.17	UI policies
$\varsigma_{1,f}, \varsigma_{2,f}, \varsigma_{3,f}$	Formal separation rate	0.62%, 0.45%, 0.25%	PNADC
ζ	Worker's bargaining power	0.60	Hosio's condition
e_1, e_2, e_3	Permanent productivity	0.65, 1.05, 1.78	Median earnings PNADC
	Internal calibration		
Parameter	Description	Values	Target
$\beta_1, \beta_2, \beta_3$	Discount factor	0.9985, 0.9987, 0.9992	Wealth distribution
$\kappa_{1,f}, \kappa_{2,f}, \kappa_{3,f}$	Recruiting cost, formal	4.03, 5.09, 7.07	Formal job finding prob.
$\kappa_{1,i}, \kappa_{2,i}, \kappa_{3,i}$	Recruiting cost, informal	0.58, 0.95, 1.45	Informal job finding prob.
$\varsigma_{1,i}, \varsigma_{2,i}, \varsigma_{3,i}$	Informal separation rate	1.30%, 0.92%, 0.48%	Unemployment rate by edu
$\bar{z}_f, \bar{z}_i; \varphi_f, \varphi_i$	Mean and persistence of prod.	1.68, 1.37; 0.981,0.987	Mean earnings profiles, (f, i)
σ	Std of innovation	0.004	Residual inequality
τ_c	Consumption tax	17.5%	Gov. budget constraint
τ_w, ξ	Income tax function	0.08, 0.05	Gobetti (2024)
$\bar{b}$	Ceiling for UI benefits	0.52	Share of median wage
d_u	Utility from leisure	0.04	Corr. between w and c
$d_{o,1}, d_{o,2}, d_{o,3}$	Utility from leisure	3.22, 1.35, 0.57	Non-participation rates
$\chi_{0,1}, \chi_{0,2}, \chi_{0,3}, \chi_1$	Cost of informality	0.009, 0.005, 0.004, 1.25	Share of informality by e
η	Matching function curvature	1.90	Matching elasticity
ρ_1, ρ_2, ρ_3	Transfer function	-2.41, -3.62,-0.004	Transfer schedule

Notes: The internally calibrated parameters are estimated using the simulated method of moments (SMM) in which we minimize the sum of the equally weighted squared distance between model and data moments.

reported in Table 2. The values we find for $\varsigma_{e,i}$ are in line with their counterpart in the data, which reflects a much larger separation rate among informal workers.

Next, we calibrate the recruiting cost parameters, $(\kappa_{e,f}, \kappa_{e,i})$, to match the job finding probability in the data. We compute monthly job transition rates from unemployment to employment by level of education using the PNADC data. In particular, given the productivity levels e, the expected individual productivity, and the separation rates, we use the job creation conditions in equations (25) and (26) to solve for $(\kappa_{e,f}, \kappa_{e,i})$. The values we obtain are also reported in Table 2.

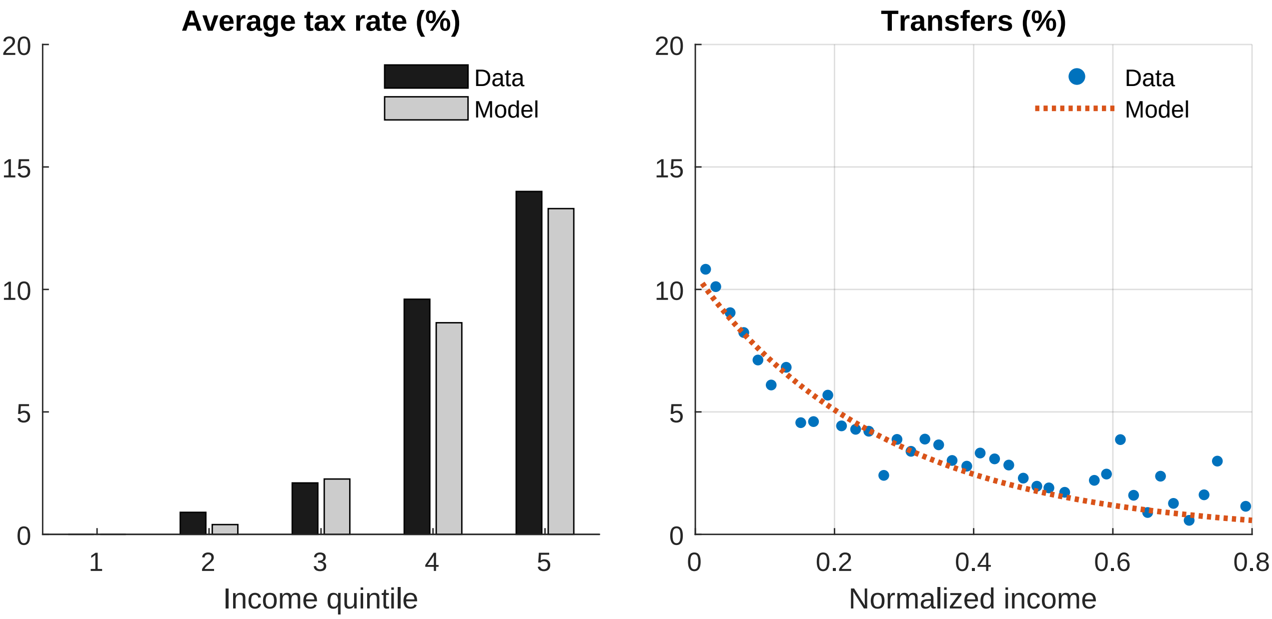
Matching function and worker's bargaining power: Since there are no available data on open vacancies in Brazil, we cannot directly estimate the matching elasticity. We are also not aware of comparable estimates for other developing countries. Thus, in line with most of the literature on developing economies, we target an aggregate matching elasticity with respect to vacancies of 0.2, which is consistent with the estimates reported in Lange and Papageorgiou (2020).[16] This calibration implies a value of η equal to 1.90. We then use the Hosios condition to set the bargaining weight to 0.60, following Shimer (2005) and many others.

[16] See, for example, Albrecht et al. (2009) and Bosch and Esteban-Pretel (2015).

Government parameters: First, we set government consumption, G, to 25% of the economy's output under the baseline calibration. Based on Paes and Bugarin (2006), we set the revenue tax rate at 4%, and the payroll tax rate at 20%. The income tax parameters, (τ_w, ξ), are calibrated to match the actual average tax rate by income as reported in Gobetti (2024). The tax rate on consumption, τ_c, is chosen to raise enough revenue to balance the government budget constraint.

The parameters of the transfer function are calibrated so the the model replicates the effective transfer schedule observed in the data. In particular, we use microdata from the 2014 PNADC household survey, which contains information on household income and transfers received. Details on the dataset and procedure are provided in the appendix. We compute income percentiles using survey weights and construct 2-percentile bins, within which we calculate average pre-transfer income and average transfers. We then calibrate the parameters of the transfer function to match these data points.

Figure 4: Average tax rates and transfers.



Notes: The left panel shows simulated and actual average tax rates by income quintile. The right panel displays normalized average transfers by normalized income. Dots represent binned averages, while the dashed line corresponds to the transfer schedule approximated by equation (12).

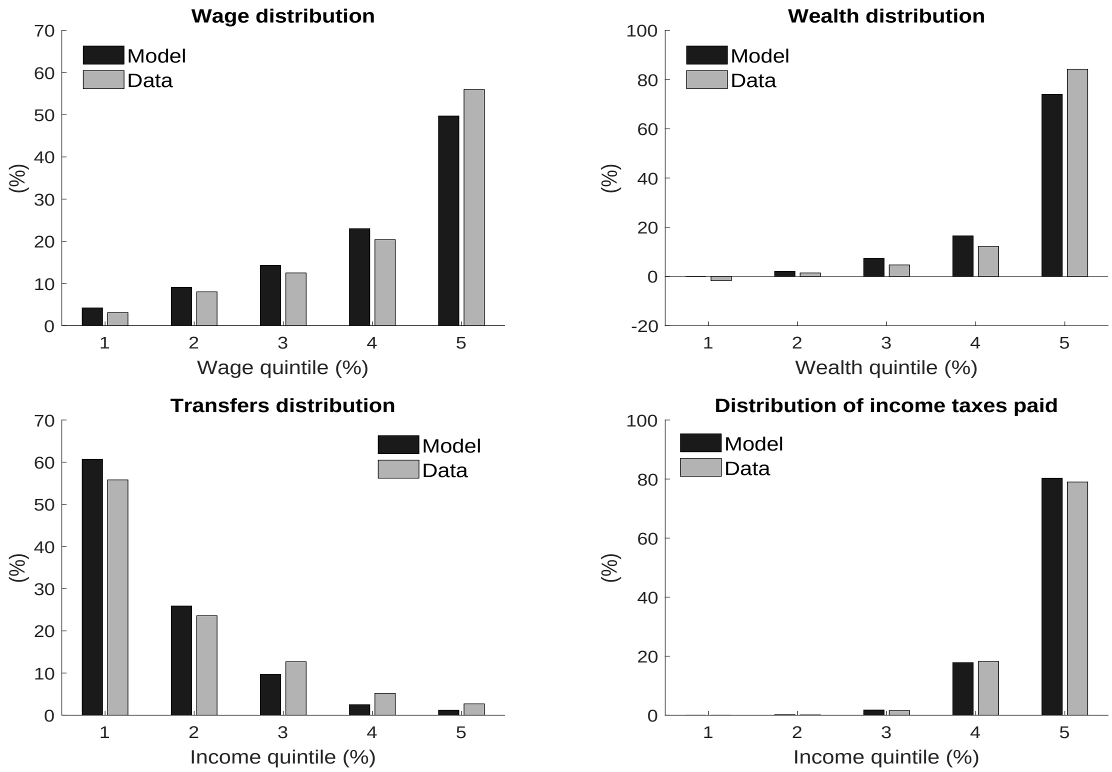
Figure 4 shows the fit of the calibrated tax and transfer functions. The left panel compares simulated and actual average tax rates by income quintile, while the right panel shows simulated and actual transfers by normalized mean income. The calibrated schedules provide a good approximation to the Brazilian data.

The parameters of the UI system are taken from Brazilian legislation. The parameters $(w_1, w_2, \bar{b})$ — the bend points in the UI benefit formula — are normalized by average income, while the parameters $(\vartheta_1, \vartheta_2)$ are set to 0.8 and 0.5, respectively. The probability π_u is set to 0.80 so that UI benefits expire, on average, after five periods in the model. The probability π_w is set to 0.17 to pin down the baseline level of UI coverage consistent with the six-month tenure rule in line with Brazilian policies prior to 2015.

5 Benchmark economy and model validation

In Figure 5, we present the fit of the model (black bars) relative to the data (gray bars) for moments not targeted in our calibration. The top left panel shows the share of total wages accruing to each wage quintile. The model captures this distribution well. The top right panel reports the same distribution for wealth quintiles. Again, the model does a good job reproducing the distribution of wealth, which is visibly more unequal than that of labor income.

Figure 5: Benchmark Model Fit: Non-Targeted Moments



The bottom panels show the distribution of transfers and the distribution of income taxes paid. The model closely matches the data. In the bottom left panel, transfers are primarily received by the bottom income quintile in both the model and the data, although the top quintile receives a smaller share of transfers in the model than in the data. In the bottom right panel, nearly 80% of income taxes are paid by the top quintile, despite the relatively low degree of progressivity in the Brazilian tax schedule. This reflects the fact that informality is heavily concentrated at the lower end of the income distribution.

Next, we study the impact of tightening UI eligibility conditions on formal employment. The goal is to simulate the policy variation analyzed in the empirical section and assess whether the model can reproduce the observed impact on formal employment. To this end, we reduce the probability that formal workers are eligible to receive UI benefits, π_w, by half, which captures the doubling of the average tenure requirement from six to twelve months in the actual reform. To better align with the empirical analysis in Section 2, we consider two scenarios for the level of informality in the economy. The first corresponds to the baseline informality rate, around 33%. The second represents a low-informality economy, where the informality rate is reduced fourfold, to approximately 8.2%.[17]

Figure 3 reports the resulting change in formal employment under both scenarios when π_w is reduced by half. The simulated responses are broadly consistent with the empirical evidence presented in Section 2, providing a form of external validation for the model, particularly with respect to the behavioral response of formal employment to UI design.

Table 3: Effects of decreasing π_w on formal employment

	Baseline Informality		Low Informality	
	Benchmark	$\pi_w = 17\%$	Benchmark	$\pi_w = 8.5\%$
Formal employment	–	$+5.36\%$	–	$+1.10\%$

6 Replacing Existing Programs with a UBI

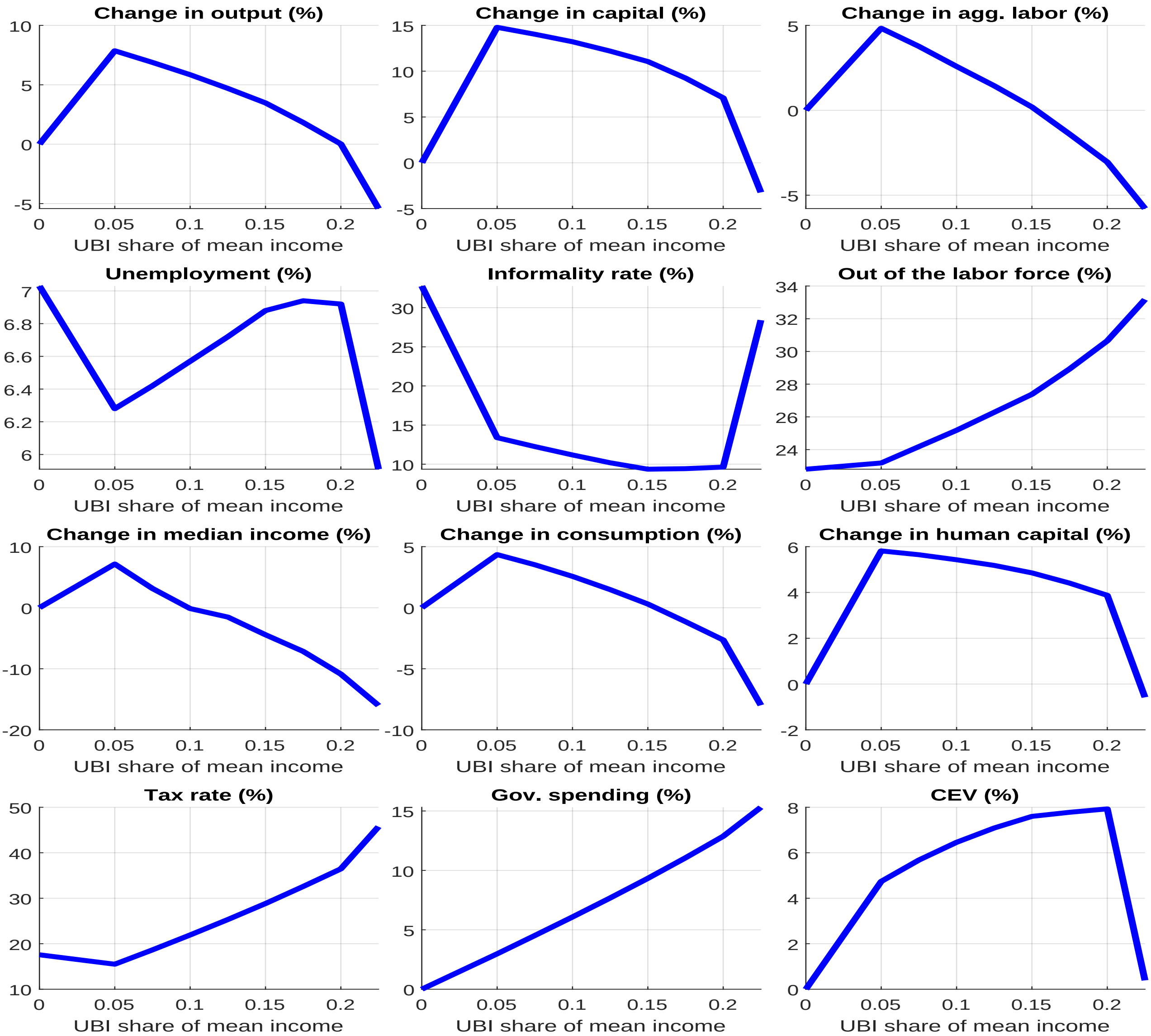
We study a policy experiment that replaces the existing UI and means-tested transfers with a UBI set to a predetermined fraction of average income in the benchmark economy. We report aggregate and distributional effects for UBI levels from 5% to 22.5% of average income, in 2.5 percentage-point increments. The fiscal cost is financed by adjusting the consumption tax rate, τ_c, so that the government budget balances in equilibrium. In each panel of Figure 6, we report percentage deviations from the benchmark for variables whose levels are not directly interpretable, and levels for variables with clear units.

It can be seen that lower levels of UBI increase economic activity. In fact, for a UBI of 5%, aggregate capital and output go up by 15% and 8% in the long-run, respectively, while unemployment rate falls by 0.7 percentage points. In addition, aggregate labor goes up by 5% of the increase. Interestingly, note that the increase in job creation is concentrated in the formal sector as the informality rate falls nearly 19% percentage points. This helps explain the decrease in the consumption tax rate, τ_c, even though the UBI is more expensive than the existing programs (2.98% of output versus 2.1%).

The reason for these positive effects are twofold. On the one hand, note that low levels of UBI entail less social insurance in the counterfactual economy relative to the benchmark, which boosts precautionary savings. Higher asset accumulation, in turn, entails that firms

[17]This counterfactual economy is obtained by increasing the cost of informality, $\chi_{0,e}$, such that the informality rate declines proportionally across all education groups.

Figure 6: The impact of different levels of UBI on the economy



Notes: Each panel shows the effect of introducing different levels of UBI relative to the benchmark economy for the case where both the transfers and UI are eliminated.

have more capital at their disposal, increasing their incentives to create vacancies. This effect is bigger in the formal sector as registered workers are, on average, more productive and thus benefit more from higher capital availability. On the other hand, there is a second effect that acts on the supply side. Since employed and non-employed agents receive the same value, a universal basic income policy – if not set too high – provides no ex-ante disincentive to work formally, as agents do not loose their benefits if they accept an offer from the formal sector.

As the UBI becomes more generous, improvements in activity attenuate and some margins turn non-monotonic. The informality rate continues to decrease, reaching a minimum of 10% at a UBI of 20%, after which it starts to increase again rapidly. Non-participation also accelerates, indicating a stronger income effect on the extensive margin. Given the fall in economic activity, the consumption tax rate moves up fast as the UBI level increases.

We find that welfare gains – as measured by the consumption equivalent variation (CEV) – increase with the level of UBI, reaching a peak at nearly 8% when UBI is 20% of average income, which corresponds to nearly $80 per household per month. Note that at this level of UBI, output is about the same and aggregate labor is nearly 3.5% lower than in the benchmark despite the sizeable increase in the non-participation rate. This is so because of the large increase in the formal employment rate, which goes from nearly 60% at the benchmark to 84% when UBI is 20%, and which is associated with an increase in labor productivity of 4% as measured by the change in average human capital. The increase in formal job creation explains most of the decrease in informality, nearly 60%, with the remainder attributable to movements along the non-participation margin.

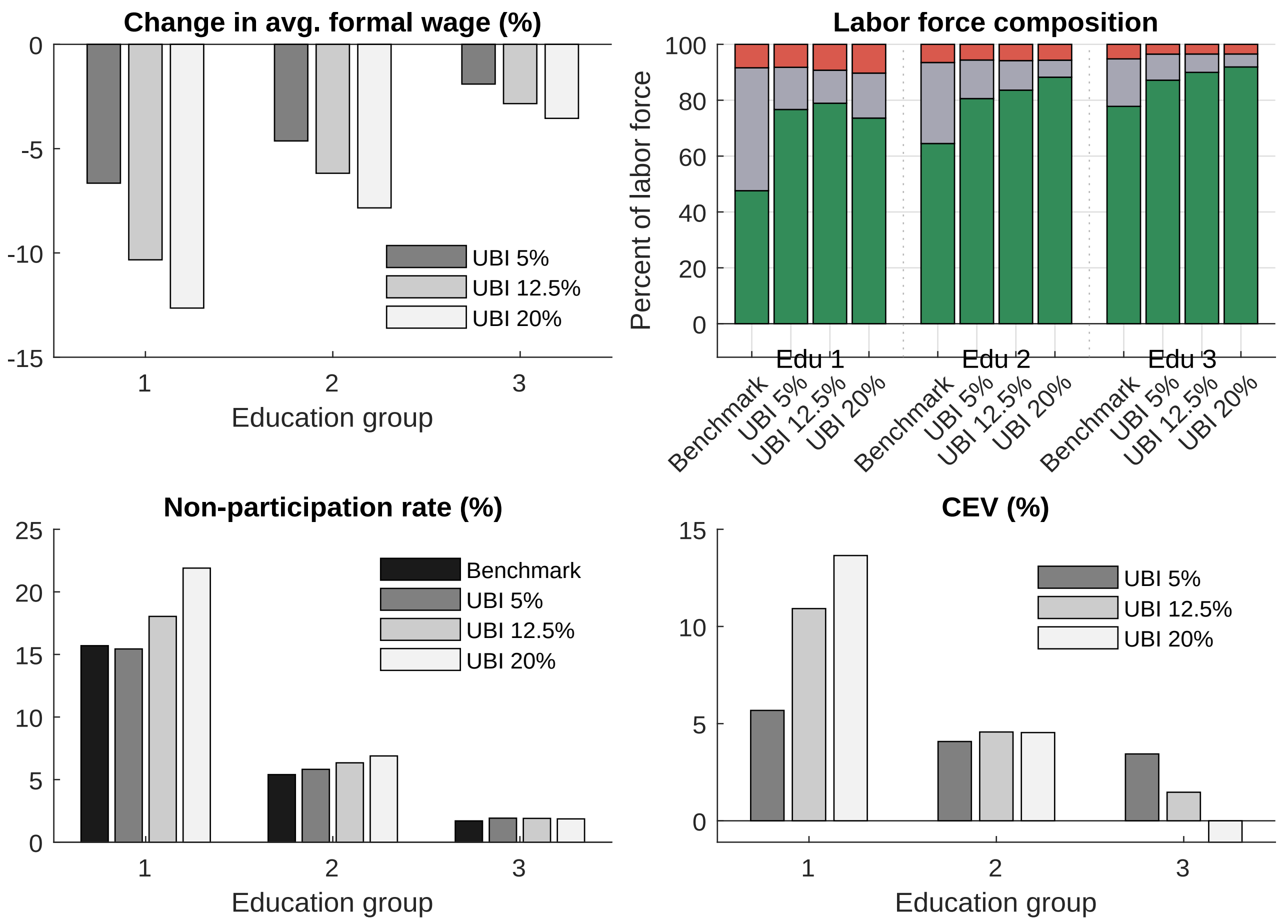
To understand the heterogeneous impact of UBI, Figure 7 shows the effects of our experiment by education at UBI levels of 5%, 12.5%, and 20%. We see that a UBI of 20% generates a negative CEV only for the highly educated group. In fact, those who have not attended college prefer higher levels of UBI, while those with some college or more prefer lower levels. The top panels of Figure 7 show the impacts on formal wages (left) and labor force composition (right). Average wages fall more for low-education groups because their reservation wages are disproportionately more affected by the existing programs. At the same time, the top-right panel shows that the shift from informal to formal jobs is much larger among the least-educated group. As mentioned before, low levels of UBI entail little change along the participation margin, as shown in the bottom-right panel. However, as the level of UBI increases, there is a sizable increase in the non-participation rate, concentrated among the low-education group.

6.1 Decomposition

Table 4 decomposes the long-run effects of replacing UI and means-tested transfers with a UBI financed through τ_c. The two columns under *Held fixed* isolate channels by keeping either labor-market tightness by education and sector, $\theta_{e,s}$, or the interest rate, r, at their benchmark values while implementing a UBI of 20%. The column headed *UBI 20%* reports the full general-equilibrium response when the UBI is set at 20%, which was discussed in the previous section. The difference in outcomes between the scenario in which one variable remains unchanged and the scenario in which all variables are allowed to change provides a measure of that variable's importance.

Holding $\theta_{e,s}$ fixed yields substantially weaker outcomes relative to the full general equilibrium case. Output and capital decline by 3.85% and 2.18%, respectively. Average human capital remains almost unchanged, which helps explain the larger fall in aggregate labor. The decline in the informality rate is much smaller, while the increase in non-participation is comparable to the GE case. Consequently, the required consumption tax rate, τ_c, is nearly 6 percentage points higher. Welfare gains are only about 17% of those in the main experi-

Figure 7: Effects of UBI by Education Levels



Notes: Percent changes are measured relative to the benchmark. In the top-right panel, the bottom (green) bar represents formal employment, the middle (gray) bar represents informal employment, and the top (red) bar represents unemployment.

ment.

Next, we perform a similar exercise to quantify the importance of the interest rate r in shaping the UBI effects. Holding r fixed dampens capital accumulation ($+3.12\%$ versus $+7.09\%$ in GE), which leads to a decline in output of 1.37%. However, it leaves most outcomes close to the full GE case. In particular, the informality and non-participation rates are nearly 0.5 percentage points higher than in the main experiment. In addition, the CEV is nearly 0.7 percentage points higher, implying that endogenous interest rate adjustments have a negative effect on welfare and explain less than 10% of the welfare gains attained in the GE case.

These findings indicate that the endogenous job-creation response is a key mechanism behind the large formalization, the broader tax base, and the improvements in labor productivity and welfare observed in general equilibrium.

Table 4: Decomposition

	Baseline	UBI 20%	Held fixed	
			$\theta_{e,s}$	r
Output (%)	–	+0.02	−3.85	−1.37
Capital (%)	–	+7.09	−2.18	+3.12
Labor (%)	–	−3.04	−4.30	−3.81
Unemployment rate (%)	7.03	6.92	7.13	6.95
Informality rate (%)	32.77	9.63	26.86	10.16
Human capital (%)	–	+3.87	+0.10	+3.78
τ_c (%)	17.57	36.46	42.37	36.62
UBI spending/output (%)	0.00	12.87	13.39	13.05
CEV (%)	–	+7.93	+1.35	+8.60
Median income (%)	–	−10.88	−9.30	−11.87
Consumption (%)	–	−2.64	−7.07	−3.28
Non-participation rate (%)	22.80	30.65	29.18	31.17

Notes: The column headed "$\theta_{e,s}$" reports the effects of introducing a 20% UBI while holding $\theta_{e,s}$ at its benchmark levels. Similarly, the column headed "r" reports the effects when r is held at its benchmark value.

6.2 Alternative Sources of Financing the Reform

Table 5 reports the outcomes of the UBI reform under different financing schemes. The baseline column corresponds to the economy without UBI. We consider two alternative tax instruments to finance the introduction of UBI of 20%: a higher level of income tax, ξ, and a higher revenue tax, τ_F. For the sake of comparison, we also show the case where the government uses a higher consumption tax, τ_c.

When the reform is financed through a higher income tax, the optimal UBI is smaller, at 7.5% of benchmark average income. This scenario generates a larger increase in output and capital accumulation, and a sharper decline in unemployment and informality. However, it also delivers lower welfare gains, 5.4% compared to 7.93% under consumption-tax financing.

Financing the reform through an increase in the revenue tax τ_F yields an optimal UBI of 8.5% of average income. This case shares some similarities with the income tax scenario, producing gains in output, capital, and consumption, though with less favorable effects on welfare and redistribution.

Overall, these experiments highlight that the choice of financing instrument plays a critical role in shaping the aggregate and distributional consequences of the UBI reform. Consumption taxation is less distortive and allows the government to implement a much larger UBI, thereby achieving greater redistribution. In contrast, the efficiency-equity trade-off is much less favorable when the reform is financed through income or revenue taxation, as these instruments are more distortive.

Table 5: Optimal UBI Under Alternative Sources of Financing

	Baseline	τ_c	ξ	τ_F
Optimal UBI (%)	0.00	20.00	7.50	8.50
Output (%)	–	$+0.02$	$+6.11$	$+2.70$
Capital (%)	–	$+7.09$	$+11.00$	$+10.73$
Labor (%)	–	-3.04	$+3.45$	$+2.52$
Unemployment rate (%)	7.03	6.92	6.44	6.62
Informality rate (%)	32.77	9.63	14.02	15.37
Human capital (%)	–	$+3.87$	$+5.26$	$+4.72$
Tax τ_c (%)	17.57	36.46	17.57	15.57
ξ (%)	8.00	8.00	9.23	8.00
τ_F (%)	4.00	4.00	4.00	5.59
UBI spending/output (%)	0.00	12.87	4.55	5.33
CEV (%)	–	$+7.93$	$+5.40$	$+5.86$
Median income (%)	–	-10.88	$+2.72$	-1.14
Consumption (%)	–	-2.64	$+3.09$	$+2.76$
Non-participation rate (%)	22.80	30.65	24.13	24.50

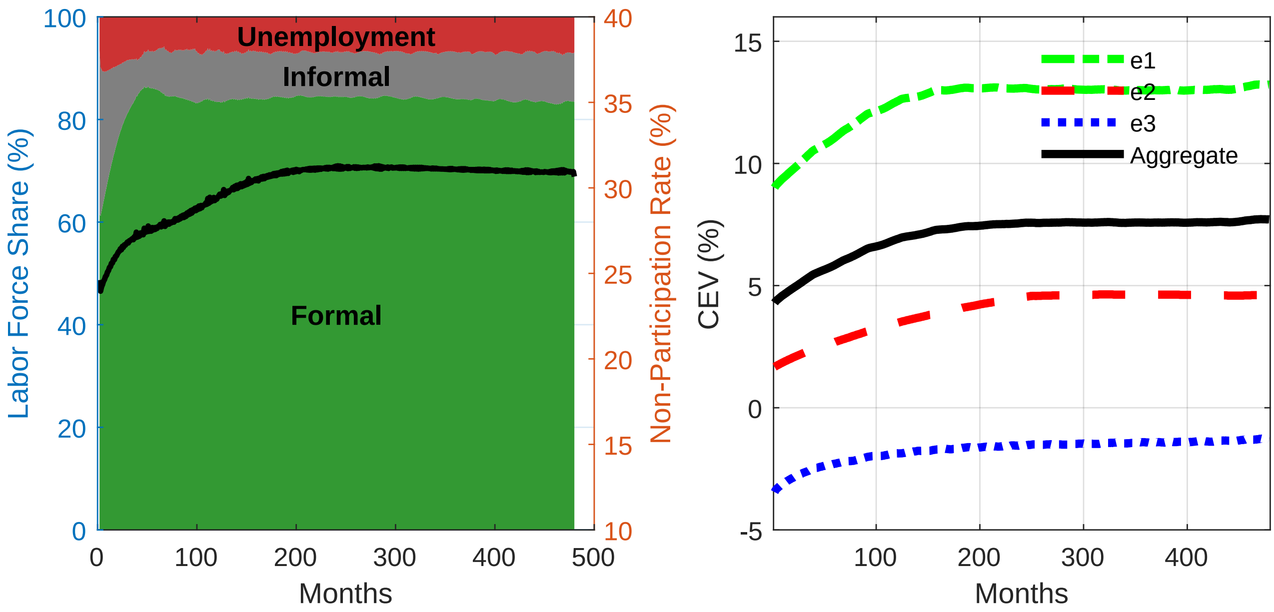
6.3 Transition dynamics

Figure 8 shows the transition dynamics for labor force composition and the non-participation rate (left panel), as well as welfare changes (right panel), when the government implements a UBI of 20% financed through τ_c. The unemployment rate jumps on impact, while informality falls and non-participation increases. This occurs because the universal transfer makes marginal informal jobs relatively unattractive, reducing informal job creation and raising unemployment.

The increase in the formal employment rate is relatively small on impact but accelerates as wages fall, peaking at 85% of the labor force nearly five years after the reform. This increase in formal employment helps explain the decline in informality, which reaches its lowest point around five years after the reform, before rising again and stabilizing at around 9.6% nearly 16 years later. The expansion of formal employment also contributes to reversing the initial rise in unemployment, which falls below the benchmark level about five years after the reform. Non-participation continues to rise until roughly 16 years after the reform, when it stabilizes at around 31%.

The right panel of Figure 8 shows the consumption-equivalent variation, CEV, profiles for each education group and for the aggregate (black line). Low-educated workers gain on impact from the transfer, as the universal benefit outweighs the loss of targeted transfers and unemployment insurance. Middle-educated workers experience smaller gains, while the highly educated group faces greater welfare losses during the transition due to higher tax burdens and weaker returns from formalization, since the benchmark informality rate is much smaller for this group. The aggregate CEV remains positive, but it is nearly 60% lower when accounting for transition dynamics, 3.1%.

Figure 8: Transition Dynamics



Notes: The left panel shows labor force composition over time and the non-participation rate, which is represented by the solid black line and measured on the right y-axis. The right panel displays the CEV – by education and in aggregate – computed relative to the initial steady-state equilibrium.

6.4 Comparing UBI Effects in High- and Low-Informality Economies

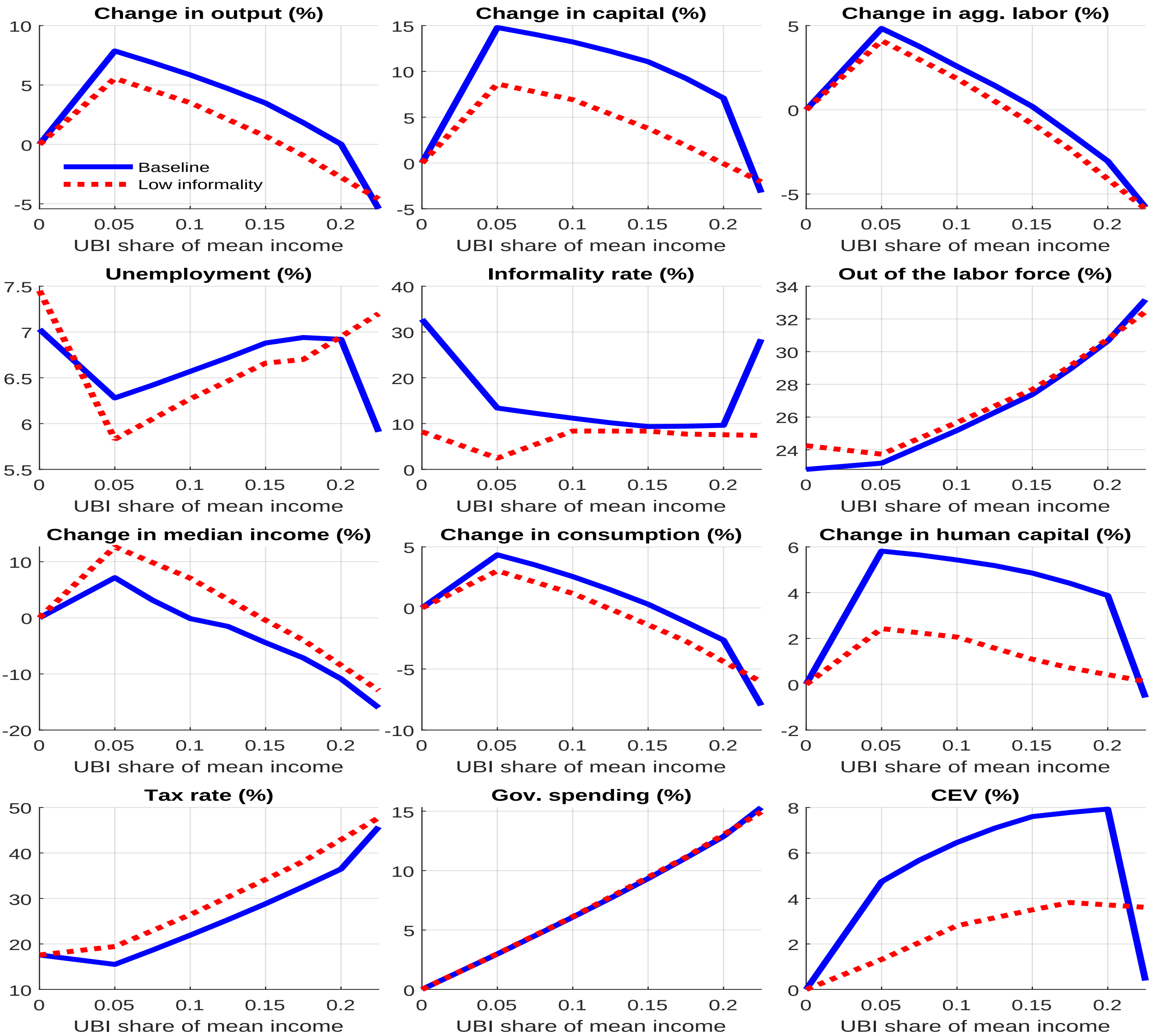
Figure 9 contrasts the effects of the UBI experiment in the benchmark (high-informality) economy (blue) with an economy that starts with low informality (red). As explained before, we generate this low-informality economy by raising the cost of informality such that the informality rate is reduced by a factor of four, to about 8.2%. In both economies, the UBI is financed by adjusting the consumption tax, τ_c.

It can be seen that, throughout, the red line (low informality) shows uniformly smaller responses and weaker reallocation toward formality. At low UBI generosity, the expansion in activity is markedly attenuated when informality is low. As UBI increases, both economies see the gains fade, but capital in the low-informality economy turns negative much earlier than in the benchmark economy.

Unemployment is lower at low and intermediate levels of UBI in the low-informality economy, but increases quickly for UBI levels greater than 20%. Non-participation increases in both economies with UBI generosity. The key difference, though, is at the informality margin. Starting from a low initial rate, the red line shows only modest changes across UBI levels, while the benchmark exhibits large non-monotonic movements: a sharp drop at low UBI followed by a rebound at higher generosity.

Because the formalization channel is muted, the required tax adjustment is larger in the low-informality economy. The tax rate, τ_c, rises monotonically and ends up well above the benchmark schedule at higher UBI levels. Welfare gains are positive in both economies and rise with UBI generosity, but they are substantially smaller when informality is low, roughly half the benchmark gains at 20% UBI. Overall, when the informal sector is small to begin with, UBI delivers smaller gains and is costlier to finance because there is less room for tax-base broadening via formalization.

Figure 9: Comparing UBI Effects in High- and Low-Informality Economies



Notes: Each panel shows the effect of introducing different levels of UBI relative to the benchmark economy. Blue line represents the baseline (high informality) economy; Red line represents the low informality economy.

Conclusions

Exploiting a reform to UI benefits eligibility criteria in Brazil, we document that tighter conditions for UI collection increases formal job creation and this effect is larger in highly informal municipalities, which is consistent with the view that the presence of a large informal sector amplifies the distortionary effect of UI on formal job creation.

Given this evidence, we calibrate a rich heterogeneous agent model that takes into account how workers and firms jointly sort between formal and informal jobs to study the consequences of replacing the existing transfers system and UI policy with a UBI. We show that a universal basic income of nearly $80 for each household per month, can be justified on welfare grounds. A UBI offers better incentives to formalization than more traditional welfare and insurance policies since the transfer amount will not be cut off as formal income rises. Thus, albeit costly, the UBI reform reduces informality, which can attenuate the extra burden of higher taxes.

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A Data on transfers

In this section, we describe the data used to calibrate the transfer function. We use microdata from the 2014 PNADC household survey, specifically the first interview (visit 1) records. The PNADC is a rotating panel in which households are interviewed for up to five consecutive quarters; "visit 1" refers to the household's first wave in the panel. The year 2014 was chosen because (i) it precedes the 2015–2016 recession, when employment and household income fell sharply, and (ii) it predates the 2015 reform of the Unemployment Insurance program, which tightened eligibility rules. We focus on visit 1 because, in 2012, the questionnaire on social program amounts (e.g., *Bolsa Família*, variables V5008–V501011) was collected only in the first interview.

The unit of analysis is the household, as the PNADC collects and reports income and transfer variables at the household rather than the individual level. Eligibility for *Bolsa Família* is determined at the household level, irrespective of marital status. While households with children are more likely to receive benefits, our calibration includes all recipient households, consistent with the program's design. Both income and transfers are normalized by the mean household income. We compute income percentiles using survey weights and construct 2-percentile bins, within which we calculate weighted averages of income and transfers.