Enforcing Labor Regulation - Monitoring and Punishment*

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July 31, 2024

Abstract

This paper examines the effects of stricter enforcement policies on labor informality. I develop a firm dynamics model with occupational choice and capital accumulation featuring informal labor employment, unemployment, and a government facing costs to enforce labor regulation. The model is calibrated using Brazilian data and explores the impact of two policy instruments: higher monitoring and higher penalties. Both instruments reduce informality rates but have different economic outcomes. Higher penalties generate a positive government budget net, increase the TFP, wages, and welfare, and have mixed effects on unemployment. Increasing labor inspections reduces unemployment but decreases TFP and lowers overall welfare. The results highlight that the choice of enforcement instrument significantly affects economic outcomes, underscoring the importance of considering these impacts in policy design.

Keywords: Enforcement of Labor Regulations, Informality, Firm Dynamics.
JEL Classifications: D22, E24, E61, J21, J23, J46, J48, K20, O17

1 Introduction

Informal labor employment is pervasive in developing economies. When costs or frictions prevent policymakers from adjusting formal labor costs, enforcement policies become

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I thank Marcelo Rodrigues dos Santos and Giovanni Gallipoli for their valuable comments and suggestions. I thank Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP) for financial support.

an important tool to increase compliance with labor regulations. Two standard policy instruments to enforce labor regulation are firms monitoring and penalization of the non-compliant ones. In a simple setup, both a higher penalty and a higher probability of being penalized increase the informality costs and they can be treated as substitutes to encourage compliance. However, these policies increase labor costs and could lead firms to reduce labor inputs, exit the market, or prevent the entry of new firms. While the literature is focused on answering whether stricter enforcement of labor regulation decreases informality rate, but at the cost of adverse effects on labor markets, less attention has been given to the implications of the enforcement policy instrument itself.

Yet, the costs and benefits of increasing compliance likely depend on the enforcement instrument used in the policy. First, monitoring policies like firm inspections generate direct costs to the government, and punishment, in the form of a penalty fine, on the contrary, may generate revenues to the government's budget. If the individual's utility is affected by government budget imbalances, substituting monitoring with harsher punishment (or vice versa) may generate different outcomes. Second, economies are composed of heterogeneous agents responding differently to the same policy. Then, different enforcement policies yielding the same aggregate compliance level could be achieved by changing the composition of firms and/or by changing the level of compliance for each type of firm. In this case, the equilibrium distribution depends on the enforcement policy design. Third, the monitoring shock (being inspected) is different from the punishment shock (paying the penalty), and firms' response to variations in enforcement is likely different when changes are due to variations in monitoring compared to changes in the penalty level[1].

This paper investigates the aggregate outcomes of stricter enforcement policies implemented by either increasing monitoring or punishment. Given the discussion above, the goal is to understand in what dimensions and the extent to which the enforcement policy instrument matters. To this end, I develop a firm dynamics model with occupational choice and capital accumulation featuring informal labor employment, unemployment and a government facing costs to enforce the labor regulation. The model's features are consistent with the stylized facts and the recent findings about labor informality and enforcement of labor regulations: (i) Informality is more likely to be found in small firms whereas labor inspections are more likely in large firms. (ii) The firm's compliance with labor regulations increases after being inspected by a labor fiscal. (iii) In the long run,

[1]The third point also implies that heterogeneity among firms should exist since the economy is composed of not inspected and inspected firms. Moreover, it reinforces the argument that the equilibrium distribution varies according to the enforcement policy design since variations in monitoring imply more or less inspected firms paying the same penalty policy and variations in punishment imply more or less inspected firms paying a different penalty.

firms with labor informality infractions are more likely to exit, default on their debts, decrease formal employment and generate lower revenues. Additionally, the firm dynamics model is well-suited to capture the impact of the enforcement policy instrument on individuals' wealth accumulation which in turn affects firms' entry, exit, growth and compliance with labor regulation decisions.

In the model, individuals decide between entrepreneurship or search/keep a job in the labor market. They differ in their wealth, which is also an endogenous choice, and in their entrepreneur productivity, which is subject to exogenous shocks. I follow Fonseca (2022) and introduce an intermediary sector facing frictions in the labor market alike the Search and Matching models. Firms in the intermediary sector directly hire workers from the labor market and sell "transformed labor" as an intermediary good to entrepreneurs. Then, the entrepreneur combines the "transformed labor" with capital, borrowed from a frictional financial market, and its entrepreneur productivity to produce a final good. The entrepreneur can avoid labor taxes by assigning labor in an "informal contract". However, she faces the probability of being inspected by a labor auditor and penalized in case of an informality infraction. The worker's labor income varies according to her labor status. The employed workers earn wages and, specifically, the ones employed in formal labor contracts anticipate severance payments. Unemployed workers engage in home production and have an income corresponding to a fraction of the worker's wage.

The government collects taxes from individuals to finance its consumption and the labor regulation enforcement net costs. It owns a technology (or has the preference) such that the probability of labor inspection increases with the entrepreneur's wealth (proxying firm size) and the number of informal employees. These features align with the correlation between labor inspections and firm size in the data and the intuition that informality infractions should become more visible as the number of informal employees, within the firm, increases. Additionally, in the model, entrepreneurs with a history of labor inspection face informality costs that are higher than formal labor costs. This modeling choice captures the empirical evidence suggesting that compliance with labor regulation increases after a firm is inspected.

The model is calibrated to fit the Brazilian economy. Brazil is an interesting choice since it has a history of high labor informality and enforcement of labor regulations policies is a relevant discussion in the country. For instance, the Brazilian government recently created 900 new labor auditor positions, resulting in a 45% increase in the workforce for this category. The announcement raised the discussion about the impact of the new hirings on the government's budget. In 2017, the Government adjusted the penalty value for "unregistered employee" infraction - a type of infraction related to labor informality - to encourage compliance. However, the discussion among policymakers at that time was

related to the possible harmful effects of a higher penalty on penalized firms. These cases support the argument that the instrument to enforce labor regulation matters, at least, to the policymakers.

I use rich Brazillian data about labor informality, enforcement of labor regulation and firms to calibrate the model. Since labor enforcement data and firms data are respective to firms registered with the tax authority, I focus on formal firms employing informal workers which is defined by Ulyssea (2018) as the intensive margin of informality.

Using the calibrated model, I conduct counterfactual policy exercises to compare economies with higher punishment and economies with more labor inspections. For the former, I increase the value of the penalty fine for informality infraction and, for the latter, I increase the minimum probability of any entrepreneur being inspected.

I show that increasing the costs of informality by either higher punishment or a higher probability of labor inspection decreases the informality rate. Increasing the benchmark penalty fine for a factor of 15 reduces the informality rate by 62%. A similar impact on the informality rate is achieved by increasing the probability of any entrepreneur being inspected by 4.05 percentage points. However, I find that different enforcement policies with similar impacts on the informality rate have different effects on other aggregate outcomes.

I show that the Government Budget Net, TFP and Wage increase with higher punishment policies but decrease with higher monitoring policies relative to the benchmark economy. The unemployment rate decreases as the probability of labor inspection increases. Higher penalty policies, however, have mixed impacts on unemployment. For low increases in the penalty value, the unemployment rate also decreases relative to the benchmark economy. When the penalty policy increases to a value 7 times higher than the benchmark value, the productivity threshold to enter into entrepreneurship increases and the share of entrepreneurs shifts down. At this point and for higher penalties, the unemployment rate is higher than in the benchmark economy.

Regarding aggregate Welfare, it increases with harsher penalties and, on the contrary, decreases with higher monitoring. The effect on wages is the key factor in the different impacts on Welfare between the two enforcement instruments. Even after shutting down the impact of the government budget imbalances on individual consumption, the two instruments still have opposing effects on welfare. The main explanation is that higher punishment increases workers' wages and, then, their consumption while higher monitoring decreases labor earnings and workers' consumption. In all, the counterfactual exercise results suggest that the cost and gains to reduce labor informality rate differ when the stricter enforcement policy is applied with different policy instruments.

Literature: This paper is related to the literature that analyzes the aggregate effects of stricter enforcement of labor regulation (Fugazza and Jacques (2004), Boeri and Garibaldi (2005), Ulyssea (2010) Bosch and Esteban-Pretel (2012), Charlot et al. (2015), Meghir et al. (2015), Ulyssea (2018), Maya and Pereira (2020), Brotherhood et al. (2023), among others). The main contribution of this paper is to investigate whether and in which dimensions the policy instrument used to enforce labor regulation is relevant. From the literature above, only Bosch and Esteban-Pretel (2012) and Brotherhood et al. (2023) disentangle informality costs as the probability of being discovered infringing the labor regulation and the payment of a penalty for such infraction [2]. Bosch and Esteban-Pretel (2012) analysis is based on a search and matching model with the assumption that the match will be dissolved in case the firm is discovered offering an informal labor contract. In their results, the elasticities of the policy instrument (monitoring rate and penalty) have the same direction, but different magnitudes. Brotherhood et al. (2023) develop a firm dynamic model to study the impact of labor regulation enforcement policies on firm dynamics and the evolution of firm productivity. Like in this paper, their model is developed to reproduce the firm response to labor inspections observed in the data. While Bosch and Esteban-Pretel (2012) framework lacks firm dynamics, Brotherhood et al. (2023) study can not assess policy impacts on unemployment. Moreover, these papers and the majority of the studies in the aforementioned literature abstract the feedback of the Government budget imbalances on agents' utility[3].

I also contribute to the literature by developing a more comprehensive framework to study informality. Especially, my model combines the setting of a firm dynamics model with frictions in both financial and labor markets. Since high labor informality, high unemployment and low financial development are striking features in developing economies, my model is a suitable and complete framework to investigate policies impacting labor informality.

The rest of the paper is organized as follows. Section 2 discusses empirical evidence related to labor informality and enforcement of labor regulation. Section 3 outlines the model and Section 4 describes the calibration procedure and model fit. Section 5 presents the results of the counterfactual policy experiments. Section 6 concludes.

[2] Franjo et al. (2021) also develops a firm dynamics model explicitly modeling the monitoring and punishment policy instruments. Their paper, however, is focused on understanding the impact of financial frictions on informality and they do not explore the potential differences from the enforcement instrument.

[3] The search and matching model of Maya and Pereira (2020) allows the income tax to vary to keep the government budget neutral. However, they assume that the policy instrument used to increase informality costs is irrelevant in their setting.

2 Stylized Facts: Informality and Enforcement of labor regulation

This section discusses the stylized facts and empirical findings related to labor informality and enforcement of labor regulation. I use Brazillian microdata to provide empirical evidence on topics relevant to the questions addressed in this paper. Additionally, I present empirical findings from the literature to complement the discussion.

2.1 Data

I mainly use four datasets to conduct the empirical analysis. The first dataset is Labor Inspections data from *Secretaria de Inspeção do Trabalho* (Labor Inspection Office). The data contains the ID identification of all establishments in Brazil inspected by a labor auditor between 2015 and 2022, the date of the labor inspection, the infractions incurred by the establishment, and the value of the penalty fine. I also use *Relação Anual de Informações Sociais* (RAIS) data. RAIS is a matched employer-employee administrative dataset containing employment-related information for the universe of formal employees in Brazil. The third dataset is the firms register data *Cadastro Nacional de Pessoa Jurídica*. This data set contains information on the date of creation, location, industry, legal nature, size classification, and closing date of all Brazilian establishments with legal registration. I use the data set with the firm's information updated in August 2023. These datasets are informative only to establishments registered with the Tax Authority. The empirical evidence extracted from these data is, therefore, relative to the intensive margin of informality. Finally, I use the Brazillian Population Survey Panel (PNAD) data to provide additional information regarding labor informality and entrepreneurs.

2.2 Labor Informality

Labor informality in the private sector is a prominent feature in Developing Economies. According to PNAD, approximately 24% of workers in the private sector declared to be employed in a type of informal labor contract in Brazil between 2015 and 2017. Moreover, informal workers are not restricted to informal firms since we observe firms with legal registration employing workers informally.

A stylized fact about informality is that it is more likely to be found in small and less productive firms (LaPorta and Shleifer (2008)). The recent literature has documented that this is also true for the intensive margin of informality (Ulyssea (2018), Erosa et al. (2023), Brotherhood et al. (2023), Samaniego de la Parra and Fernández Bujanda (2024),

Prado et al. (2024)). Table 1 shows descriptive statistics from the labor inspection data. Columns I and II present, respectively, the share of inspected firms incurring informality infractions and the share of informal workers in inspected firms by firm size. Column III presents the share of informal workers by firm size restricted to firms with informality infractions[4]. As shown in the table, on average, larger firms have a lower probability of employing informal workers and the share of informal workers within the firm decreases with firm size. I also compute the distribution of informality infractions (which proxy the number of informal employees) for the universe of firms with informality infractions. As shown in table 8, 50% of firms employ at most 2 informal workers and 90% employ less than 10 informal employees.

I employ a linear regression model to investigate whether the probability of informality infraction is negatively correlated with the number of formal employees, which proxies firm size, after controlling for firm characteristics (age, sector, and state). Table 2, column II shows the results for the subsample of firms employing at least one formal employee. The coefficients for the group-size variables are negative, statistically significant and decrease, although not linearly, as the size of the firm increases. This indicates that the negative correlation between informality and firm size is not driven by relevant (observable) firms' characteristics [5].

A second stylized fact about labor informality is that informal workers are, on average, less educated and earn lower wages. Ulyssea (2018) suggests, however, that the formal wage premium is due to workers' self-selection into less productive firms. He shows that wages between formal and informal workers within the same firm are not different.

2.3 Enforcement of labor regulation

As discussed in the Introduction, a standard policy to encourage firms to comply with labor regulations is to conduct labor inspections and to impose a penalty for labor infractions. In Brazil, approximately 4% of formal establishments were inspected between 2015 and 2017.

In Brazil, labor inspections are not primarily random. The screening of firms to be

[4]I define informality infraction if the inspected firm has at least one "unregistered employee" infraction. The "unregistered employee" infraction is issued when the labor fiscal finds a worker in the inspected establishment having an employer-employee relationship and the employer has not registered that worker as an employee. In practical terms, if an employee is not registered, the employer is not paying any employee social contributions to the government.

[5]The results considering the full sample (i.e. including firms with zero formal workers group size) are presented in column I. The results indicate that the probability of informality infraction is higher for firms with 1 to 9 formal employees compared to firms with zero formal employees. Firms with zero formal employees include employers and self-employees making this group more diverse. Additionally, the inspection screening of firms with no formal employees may follow a particular procedure. This could make them less comparable to the other size groups.

Table 1: Frequency of Informality Infraction

	Have informality infractions	Share of Informal employees	
	(I)	(II)	(III)
Size (total employees)			
1-4	11.22%	8.06%	71.82%
5-9	11.36%	4.19%	36.86%
10-19	9.91%	2.60%	26.21%
20-49	6.03%	1.11%	18.36%
50-99	3.27%	0.47%	14.46%
100-249	1.47%	0.18%	11.91%
250-499	1.33%	0.20%	14.69%
500-999	1.59%	0.15%	9.40%
more than 999	2.25%	0.14%	6.44%
Sample	Inspected	Inspected	Inspected with inf. Infraction
N	711047	711047	49005

Note: I define informality infraction in column I as an indicator equal to one if the firm has at least one "unregistered employee" infraction in the period. In columns II and III, the variable is the total quantity of informality infractions relative to the total number of employees within the inspected firm. I calculate "total employees" as the sum of the total formal workers previous to the labor inspection with the number of informality infractions. The latter is a proxy for the number of informal employees working at the moment of the inspection. The sample refers to firms inspected between 2015 and 2017 with period frequency at the quarter level.

audited can be a complex process and open to the discretion of the local authority responsible for enforcing the labor regulation. Since labor regulations cover different topics related to working safety conditions, employees' benefits and payments, the likelihood of infringing specific topics in the labor regulation correlates with employers' characteristics. The inspection visit assignments are likely primarily motivated by its industry sector. Other characteristics like age, size and location of the firm are also important factors affecting the inspection screening. A policy target (like labor informality, child labor, labor accidents, etc) can be in place in a specific period and drive labor inspections to be concentrated in certain types of firms (SIT (2023)). The number of establishments per inspector or other limited resources also affects the probability of an establishment being inspected. History of infractions and workers' complaints could also favor the establishment to be inspected.

Table 3 shows the share of Brazillian firms inspected between 2015 and 2017 by firm size. The statistic shown in the table supports the argument that the probability of labor inspection correlates with firm's characteristics. While, on average, 18.5% of firms with more than 9 formal employees received a labor inspection, less than 1.5% of firms with zero formal employees were inspected during this period.

Enforcing labor regulations may generate costs or revenues to the government. The costs of monitoring policies can be very high since they encompass the wages and pensions of the labor fiscals, travel costs, fixed and investment costs with technologies to increase efficiency, training costs, and administrative costs, among others. In Brazil, for instance,

Table 2: Probability of Inspected Firms Having Informality Infraction

	(I)	(II)
1-4 employees	0.0197***	-
	(10.41)	(.)
5-9 employees	0.0151***	-0.00533**
	(7.58)	(-2.70)
10-19 employees	-0.0239***	-0.0450***
	(-13.47)	(-25.42)
20-49 employees	-0.0437***	-0.0658***
	(-26.78)	(-39.87)
50-99 employees	-0.0616***	-0.0847***
	(-37.51)	(-50.40)
100-249 employees	-0.0700***	-0.0939***
	(-46.05)	(-59.13)
250-499 employees	-0.0608***	-0.0857***
	(-36.06)	(-48.65)
500-999 employees	-0.0598***	-0.0853***
	(-33.11)	(-45.15)
more than 999 employees	-0.0433***	-0.0695***
	(-22.39)	(-34.47)
age	-0.000316***	-0.000284***
	(-40.41)	(-35.70)
2nd visit	-0.0362***	-0.0336***
	(-31.25)	(-27.42)
3rd visit	-0.0351***	-0.0335***
	(-26.99)	(-24.95)
4th or higher visit	-0.0404***	-0.0367***
	(-38.51)	(-33.29)
Constant	0.0972***	0.110***
	(12.11)	(13.89)
Sector FE	Yes	Yes
State FE	Yes	Yes
Time FE	Yes	Yes
Observations	457509	397189
R^2	0.06	0.07

Note: The dependent variable is as an indicator equal to one if the firm has at least one "unregistered employee" infraction in the period. The "1st visit" variable is an indicator equal to one for the first inspection observed in the data, which starts in 2015. The regression sample in column I refers to all firms inspected between 2017 and 2018 with period frequency at the quarter level. The regression sample in column II is the same as column I excluding firms with zero formal employees in the quarter previous to the inspection.

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3: Share of firms inspected by labor fiscal

	2015	2016	2017
Formal employees			
0	1.38%	0.96%	1.15%
1-9	3.67%	2.35%	2.87%
10 or more	20.71%	16.48%	18.26%

Note:

the average wage of a labor fiscal is approximately 10 times the average wage of a worker in the private sector. On the contrary, the government raises revenues when the punishment for a labor infraction is a monetary fine. The value of the penalty may vary with the type of infraction and firm characteristics (like size). Additionally, it may depend on labor fiscal evaluation on the degree of harmfulness of the infraction. In Brazil, the punishment for "unregistered employee" - an infraction that captures labor informality - is a lump-sum fine for each informal worker. In 2016, its value corresponded to 40% of the minimum wage. Depending on the enforcement policy, the punishment could generate, instead, a cost to the government. For instance, in Portugal, the new labor regulation states that unregistered employment infractions can be punished with the employer's incarceration.

Labor courts are institutions that are also responsible for enforcing labor regulations. In Brazil, workers can sue firms and request the payment of the not-paid labor obligations and additional monetary compensation. In the case of informal labor contracts, the judge may obligate the employer to pay the employee all the contributions and stipends of the formal labor contracts not paid to the employee for the last five years of the employer-employee relationship.

2.4 Firms Response to Enforcement

There is growing literature investigating the firm response to enforcement of labor regulation. These papers find negative effects of labor inspection on firm dynamics like the decrease in formal employment and revenues and higher firm exit (Brotherhood et al. (2023), Schiavon et al. (2023), Prado et al. (2024), and Samaniego de la Parra and Fernández Bujanda (2024)). Moreover, these results are in line with Almeida and Carneiro (2009) and Almeida and Carneiro (2012) findings at the municipality level. Almeida and Carneiro (2009) provide suggestive evidence that Brazillian cities with more labor inspection visits have lower informality rates, higher unemployment rates and local firms presenting lower employment, output and sales.

To investigate heterogeneous responses to labor inspections, I estimate the effect of labor inspection on firms' exit rate for different groups of size. I restrict the labor inspection data to firms with "unregistered employee" infractions, the treatment group, and firms

with no registered labor infractions, the control group[6]. Although firms in the control group do not have informality infractions, they could be infringing the labor regulations when inspected and these infractions were not registered by the labor fiscal. In Brazil, firms may benefit from not being penalized in their first labor inspection except for serious infractions (e.g. labor informality, child labor, slavery, etc.). The advantage of using these firms as a control group is to reduce the potential bias from the non-random selection of firms to be inspected. Additionally, since these firms were not employing informal workers at the moment of labor inspection, formal employment information from RAIS data is sufficient to calculate the total number of employees.

I group treatment and control firms in size categories where size is measured as the total number of employees previous to labor inspection[7]. For each size group and periods $t \in \{1, 2, 3, 4, 5\}$ after labor inspection, I estimate the following model:

$$Exit_i^{T+t} = \alpha + \beta Treat_i^T + \gamma Cohort + X_i + \epsilon_i \tag{1}$$

where $Treat_i^T$ is a dummy equal to one if the firm has an "unregistered employee" infraction in the year T and equal to zero if the firm was inspected in the year T but has no registered labor infraction. The variable $Cohort$ is the fixed effect for firms inspected in the same year-quarter. The variable X_i is the set of control variables which include the firm's age, sector, and state. The dependent variable $Exit_i^{T+t}$ is a dummy that equals one if the firm i is "out" of the market t years after being inspected. I define a firm as being "out" of the market in period $T + t$ if the firm is closed in period $T + t$ or has an operating "restrictive flag" in period $T + t$. The latter encompasses the case, for instance, when the firm stops paying corporate taxes and the Fiscal Authority blocks the firm from issuing formal invoices. In my sample, once a firm "exits" the market, it can not return to operate in the formal sector.

In the figure 1 below, I plot the coefficients β of equation 1 estimated separated for each size-group and period t. I find that inspected firms with informality infractions have a higher probability of exiting the market after labor inspection. This result is in line with Prado et al. (2024) findings. Additionally, I show that firm response to informality infraction detection is stronger for small firms. Firms employing up to 4 employees with informality infractions are more likely to be "out" of the market by 10.9 percentage points after five years of the labor inspection. However, I do not find statistically significant

[6]The sample is also restricted to firms with only one observed labor inspection in the data. This restriction is imposed to eliminate possible effects of re-inspections

[7]The total number of employees for the treatment group is the total number of formal employees, calculated from RAIS, in the quarter previous to labor inspection plus the number of informality infractions. The latter is a proxy for the total number of informal employees. The firm size for the control group is the total number of formal employees, extracted from RAIS, in the quarter previous to labor inspection.

effects for firms employing 50 to 99 employees. Figure 1 also shows that the effect on exit rate is higher for firms with 20 to 49 employees than firms with 10-19 employees. The non-linear response could be driven by different labor inspection responses in the control group. Recall that firms in the control group could be infringing some labor rules and are also responding to labor inspection. Then, it is possible that I am sub-estimating the effect of labor inspection on firms with informality infractions and the bias is larger for smaller firms.

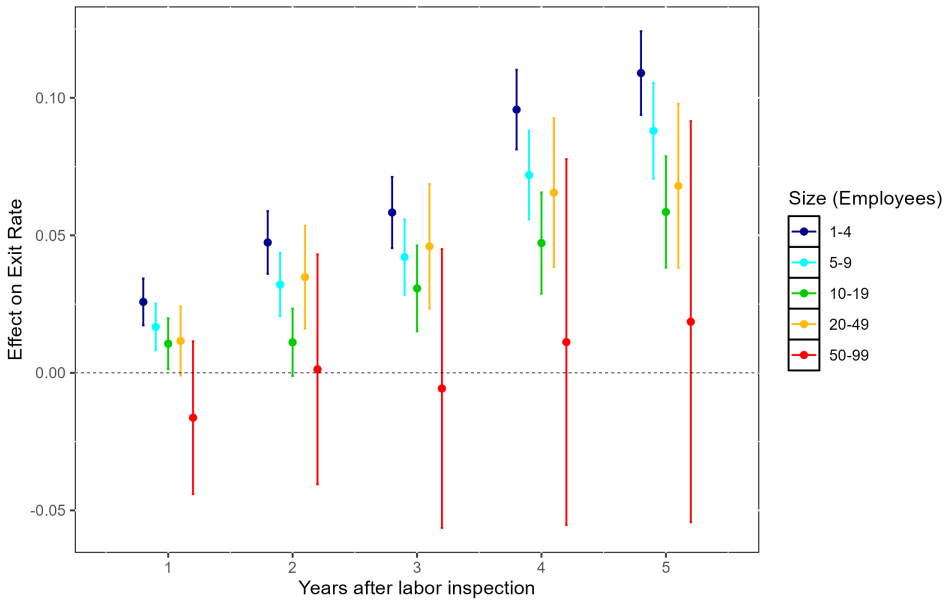


Figure 1: Heterogenous effect of informality infraction detection on exit rate by size and periods after labor inspection
Note: The figure plot the coefficients β and its Confidence Interval from equation 1. Each coefficient was estimated separately for each size-group and period.

Prado et al. (2024), Brotherhood et al. (2023) and Samaniego de la Parra and Fernández Bujanda (2024) findings suggest that inspected firms formalize (at least some) of their informal workers after the inspection. They argue that informality costs are likely higher after the labor inspection which encourages firms to increase compliance with labor regulation[8]. I calculate from labor inspection data that, on average, 87% of firms with informality infractions in the first inspection do not incur an informality infraction in a re-inspection. Accordingly, the coefficients for the order of the labor inspection visit

[8]The probability of a firm being inspected (or the firm's perception of it) is likely higher after the first inspection since it is easier for the labor inspector to infer whether the firm formalized or not the informal workers. Punishment can also increase after the first inspection. The penalty for informality infractions in the case of recidivism, for instance, is doubled in Brazil. In Mexico, firms may be inspected by different government institutions: the Ministry of Labor and Social Welfare (STPS) and Mexico's Social Security Institute (IMSS). Firms first inspected by STPS are not penalized, but penalization is possible if these firms are selected and re-inspected by IMSS.

variable in Table 2 are negative and significant. This suggests that the probability of an inspected firm having an informality infraction decreases after the first inspection.

Higher compliance with labor regulations implies that inspected firms face higher labor costs which implies less investments and lower firm growth. Prado et al. (2024) argues that this is the main mechanism for the observed negative effect on firms' outcomes. The persistent effects of labor inspections for firms with informality infraction on firm exit presented in figure 1 support this argument.

3 Model

In this section, I develop a firm dynamic model featuring entrepreneurship decisions, formal and informal employment, unemployment and a government enforcing labor regulation. The model is motivated by the empirical evidence discussed in the previous section. Particularly, I presented that labor informality, probability of labor inspections and firm response to enforcement shock strongly correlate with firm size. The literature has emphasized that heterogeneity in entrepreneur productivity and financial frictions are important determinants of firm entry, size and survival[9]. Given the relevance of these features, I build my framework on a firm dynamics model with occupational choice, capital accumulation and financial frictions (as in Buera et al. (2020)). I extend it by adding informality in the intensive margin (as in Ulyssea (2018) and Erosa et al. (2023)) and by modeling informality costs as standard policies of enforcement of labor regulation (monitoring and penalty). Additionally, I add unemployment to the model by assuming an intermediary sector facing labor market friction (as in Fonseca (2022)). I assume a small open economy.

3.1 *Environment*

Population, Preferences and Occupational choice: The economy is populated by a unit measure of infinitely-lived individuals. Individuals maximize expected utility and have the following preferences:

$$U = E\left[\sum_{t=0}^{\infty} \beta^t u(c_t)\right]$$

where β is the discount factor and c_t is the individual's consumption.

All individuals are heterogeneous in their "entrepreneurship productivity" z, assets a, and occupation o. Additionally, entrepreneurs differ in their history of labor inspections

[9]See Buera et al. (2015) for the literature review on entrepreneurship, firm dynamics and financial frictions

ι. At the beginning of each period, with probability γ, individuals draw a new productivity z from a fixed Pareto distribution. After the productivity shock, they make an occupational choice between being an entrepreneur or going to the labor market as a worker. All individuals make savings decisions at the end of the period. Additionally, all individuals pay (receive) a lump-sum tax (transfer) b_g that varies with the government net expenses arising from variations in the enforcement policy.

Entrepreneurs: Entrepreneurs combine their "entrepreneur productivity" z with capital k and labor n to produce a homogeneous good according to a production function $zf(k,n)$. Capital is rented at rate r and is limited to a collateral restriction as in Buera et al. (2020) and Midrigan and Xu (2014): $k <= \lambda a$, $\lambda \geq 1$. Entrepreneurs "buy labor input" from an intermediate sector at a competitive price ω. They can assign labor in a formal (n_f) or informal (n_i) labor contract. Formal employment is subject to a labor tax τ_w and severance payment tax τ_{SP}.

Entrepreneurs can be inspected by a labor fiscal and, in case of informality infraction, she is obligated to formalize the informal workers (and pay the corresponding labor taxes) and pay a penalty fine $\varphi_a\omega$ per informal worker. Besides the punishment costs, entrepreneurs also face other informality costs. As presented in section 2, enforcement from labor inspections in Brazil, the benchmark economy, is weak. This suggests other relevant informality costs encouraging firms to employ workers in formal labor contracts[10]. In the model, the informal employee cost is $(1+\tau_{inf})\omega$ (as in Ulyssea (2018)) if she was never inspected. In the previous section, I also discussed and presented suggestive evidence that informality costs are likely to increase after a labor inspection. Then, the cost of each informal employee raises to $(1 + \tau_{inf} + \tau_{rec})\omega$ if she was inspected in the past. I assume that, after the first labor inspection, informality costs rise enough to make informal employment not an optimal decision to the entrepreneur. Since informality costs depend on the history of labor inspection, the entrepreneur receives the flag $\iota = 1$ after the first labor inspection and carries it all future periods up to her exit. The flag ι is reset ($\iota = 0$) with the entrepreneur exit.

Finally, for the entrepreneur to engage in production, she must pay in each period a fixed operational cost χ and a corporate tax τ_π on revenues.[11].

[10]I tested calibrating the model assuming only the penalty fine and the probability of being inspected (monitoring) as informality costs. I assigned the value for the penalty of informality infraction according to its statutory values and targeted the share of inspected firms to calibrate the parameter related to the probability of labor inspection. The calibration result generated an economy with an informality rate in the private sector much higher than the observed in the data.

[11]In this set up we are only considering informality in the intensive margin, which is the focus of this research. Hence, all firms are formal and must pay corporate taxes.

Intermediate sector: The intermediate sector produces an intermediate good according to a production function that employs workers in a one-to-one fashion. The intermediate good is used as labor input in the final good production and can be interpreted as transformed labor. Firms from the intermediate sector and workers are subject to search and matching frictions. Then, as in a standard search and matching framework, vacancies v and unemployed workers u match according to a matching function $\kappa u^{\zeta} v^{1-\zeta}$ and the tightness of the economy is defined by $\theta = \frac{v}{u}$.

Firms do not distinguish whether the posted vacancy is referent to a formal or informal job because the assignment of workers to formal and informal labor contracts happens after the matching. Therefore, workers and firms negotiate wages w given the expected probability of the worker being assigned to a formal job. Wages negotiation is determined by Nash bargaining. Filled vacancies are destroyed at the rate $s = l_f s_f + (1 - l_f) s_i$, where s_f and s_i are, respectively, the exogenous separation rates of workers assigned in formal and informal labor contracts and l_f is the proportion of labor input in formal labor contract.

The flow value of a filled vacancy F and unfilled vacancy V are respectively

$$rF = \omega - w + s(V - F)$$

and

$$rV = -v_{cost} w + q(\theta)(F - V)$$

where $v_{cost} w$ is the cost of an unfilled vacancy, $q(\theta)$ is the probability that an unfilled vacancy gets filled. In equilibrium $V = 0$ because of the free-entry assumption in the intermediate sector. The profits of the intermediate sector are distributed to investors outside the model.

Workers: Workers can be either employed or unemployed. After occupational decisions, unemployed workers search for a job, and with probability α_f they get a job with a formal labor contract and, with probability α_i they get a job with an informal labor contract. While the probability of finding any job depends on the tightness of the economy, the probability of getting a job with a formal or informal contract will also depend on the share of formal labor input used in the production of the final good. Formal and informal workers lose their jobs at the exogenous rate s_f and s_i, respectively. Employed workers receive wages w and unemployed workers earn a flow value of hw from home production. Additionally, the labor income of formal employees includes the severance payment anticipation $s_f \tau_{SP}$. Workers receive risk-free rate returns r from their savings and can not borrow.

Government and Enforcement of Labor regulation: The government is responsible for collecting taxes and enforcing entrepreneurs' compliance with labor regulations. It has a fixed consumption $\bar{G}$. The government consumption is funded with corporate taxes (τ_π), labor taxes (τ_w, τ_{SP}), labor regulations infraction penalties (φ_a) and the lump-sum tax b_g. The latter is charged to all individuals and varies to balance the government budget due to variations in the enforcement policy.

The government enforces labor regulations through labor inspections and punishing labor infractions. Each inspected firm costs $c_{Lfiscal}w$ corresponding to expenses with the labor fiscal payroll. If informal employees are discovered during a labor inspection, the labor fiscal imposes a penalty $\varphi_a\omega$ to the employer for each informal employee.

The government owns a technology or has preferences such that the probability of an entrepreneur being inspected depends on her volume of assets a, informal employees n_i, and history of labor inspections ι. I showed that labor inspections are more likely to happen in larger firms. In the model, I proxy firm size using the entrepreneur's wealth a[12]. The probability of labor inspection should also increase with the number of informal employees since, intuitively, the labor infraction becomes more visible as the number of informal employees increases. I assume random inspections when the entrepreneur has a history of labor inspection. This assumption simplifies the re-inspection probability function and its calibration and, at the same time, does not exclude the impact of the re-inspections on the government's budget[13].

Timeline In figure 2 below, I illustrate the timeline of events of the individuals within a period t. In the timeline, I denote the entrepreneur status by E, unemployed workers by WU, formal workers by WF and informal workers by WI. I also let the status of the state variables a, z and ι explicitly in the timeline.

3.2 *Individual's decisions problems*

The decision problem of an individual with state variables z, a and ι can be written in a recursive formulation. The occupation of an individual at the beginning of a period t is defined by $o \in \{e, wf, wi, wu\}$ where $o = e$ corresponds to entrepreneur and $o = wf$ to

[12]Although the firm's revenue is a more straightforward proxy for firm size than assets a, it would require adding more state variables in the model increasing the computational demand to calibrate the model and to make counterfactual policy exercises.

[13]The model assumes that firms with a history of labor inspection will never employ workers in informal labor contracts. Therefore, the probability of re-inspection does not affect entrepreneurs' decisions. However, we observe re-inspections in the data and re-inspection affects the government budget. Then, I assume random inspections when the entrepreneur has a history of labor inspection.

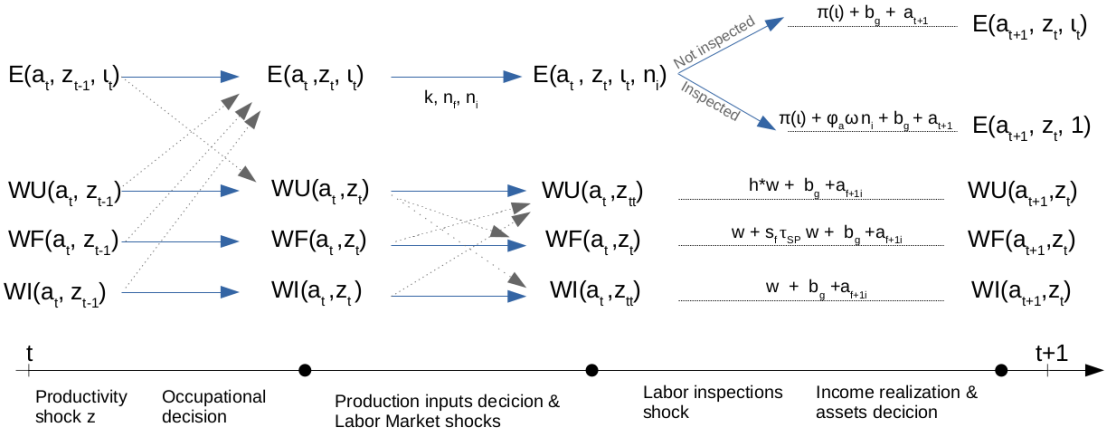


Figure 2: Timeline of the model

the formal worker, $o = wi$ informal worker and $o = wu$ to the unemployed worker. The beginning-of-period value function for individuals is:

$$V(a, z, \iota, o) = \max\{V^E(a, z, \iota, o), V^W(a, z, o)\}$$

where $V^E(a, z, \iota, o)$ denotes the value of being an entrepreneur and $V^W(a, z, o)$ the value of being a worker.

Entrepreneurs: The expected value of being an entrepreneur takes the following form

$$V^E(a, z, \iota, o) = \max_{k, n_f, n_i} \{(1 - p_d(a, n_i, \iota))V^{end}(a, z, \iota, n_i) + p_d(a, n_i, \iota)V^{ed}(a, z, \iota, n_i)\}$$

$$s.t. \quad k \leq \lambda a$$

where $V^{end}(a, z, \iota, n_i)$ and $V^{ed}(a, z, \iota, n_i)$ are the value functions when the entrepreneur is inspected (superscript ed) and is not inspected (superscript end) by the labor fiscal within the period. The decision problems of the individual after entrepreneurship choice will no longer depend on her initial occupation status. However, the labor inspection shock depends on the number of informal employees. Then, in the value functions V^{end} and V^{ed}, I suppress the beginning-of-period-occupation o and add n_i as a state variable.

Denote the profit of an entrepreneur with no history of labor inspection (i.e. $\iota = 0$) by $\pi = (1-\tau_\pi)zf(k, n_i+n_f)+(1-\delta)k-(1+r)k-(1+\tau_w+\tau_{SP})\omega n_f-(1+\tau_{inf})\omega n_i-\chi$. The problem of the not detected and detected entrepreneur with no history of labor inspection are, respectively, given by

$$V^{\mathbf{end}}(a, z, 0, n_i) = \max_{a'} u(c) + \beta\{\gamma V(a', z', 0, e) + (1 - \gamma)V(a', z, 0, e)\}$$

$$s.t. \quad c + a' = \pi + (1 + r)a + b_g$$

$$V^{\mathbf{ed}}(a, z, 0, n_i) = \max_{a'} u(c) + \beta\{\gamma V(a', z', 1, e) + (1 - \gamma)V(a', z, 1, e)\}$$
$$s.t. \quad c + a' = \pi - \varphi_a \omega n_i + (1 + r)a + b_g$$

If the entrepreneur was inspected in a past period (i.e. $\iota = 1$), then her value functions are given by:

$$V^{\mathbf{end}}(a, z, 1, n_i) = V^{\mathbf{ed}}(a, z, 1, n_i) = \max_{a'} u(c) + \beta\{\gamma V(a', z', 1, e) + (1 - \gamma)V(a', z, 1, e)\}$$
$$s.t. \quad c + a' = \pi - (\tau_{rec})\omega n_i + (1 + r)a + b_g$$

Workers: In the search and matching setup, job matches are destroyed and new matches are formed in each period. The type of labor shock will depend on the individual's occupational status at the beginning of the period. The expected value for each beginning-of-period worker status can be written as

$$V^W(a, z, wf) = (1 - s_{wf})V^{Wf}(a, z) + s_{wf}V^{Wu}(a, z)$$

and

$$V^W(a, z, wi) = (1 - s_{wi})V^{Wi}(a, z) + s_{wi}V^{Wu}(a, z)$$

and

$$V^W(a, z, wu) = V^W(a, z, e) = \alpha_f V^{Wf}(a, z) + \alpha_i V^{Wi}(a, z) + (1 - \alpha_f - \alpha_i)V^{Wu}(a, z)$$

where V^{Wf}, V^{Wfi} and V^{Wu} are, respectively, the value of the worker employed in a formal job, of the worker employed in an informal job and of the unemployed worker. Note that, the entrepreneur who decides to exit the market and become a worker, will enter the labor market as an unemployed worker.

The problems of each type of worker are detailed below

$$V^{\mathbf{Wf}}(a, z) = \max_{a'} u(c) + \beta\{\gamma V(a', z', wf) + (1 - \gamma)V(a', z, wf)\}$$
$$s.t. \quad c + a' = w + (1 + r)a + s_{wf}\tau_{SP}w + b_g$$

and

$$V^{\mathbf{Wi}}(a, z) = \max_{a'} u(c) + \beta\{\gamma V(a', z', wi) + (1 - \gamma)V(a', z, wi)\}$$
$$s.t. \quad c + a' = w + (1 + r)a + b_g$$

and

$$V^{\mathbf{Wu}}(a,z) = \max_{a'} u(c) + \beta\{\gamma V(a',z',wu) + (1-\gamma)V(a',z,wu)\}$$

$$s.t. \quad c + a' = hw + (1+r)a + b_g$$

3.3 *Welfare measure*

I measure the welfare change as the amount of consumption one would have to remove or add to make the expected utility across all agents equal between the baseline economy and under some alternative policy. The consumption equivalent variation (CEV) can be calculated as follows:

$$CEV = \left[\frac{U(s)^1}{U(s)^0}\right] - 1$$

where $U(s)^0$ and $U(s)^1$ denote the expected utility to an agent who enters the economy with state s under the baseline and alternative policy economy respectively.

3.4 *Equilibrium*

Define $\Omega = \{a, z, \iota, o\}$ the vector containing the individual state variables (a, z and ι) and the occupational status $o(a, z, \iota)$. Define $O = \{E, W\}$ the set containing the occupational choice between entrepreneurship E and being a worker W. A stationary equilibrium is given by a price vector $\{\omega, w\}$, lump-sum tax b_g, allocations c(Ω), a(Ω), occupational choices $O(a, z, \iota)$, entrepreneurs production input decisions $(k(\Omega), n_f(\Omega), n_i(\Omega))$, labor market tightness θ and a distribution of individuals over Ω, $\mu(\Omega)$, such that:

(i) Decision rules c(Ω), a(Ω), $k(\Omega), n_f(\Omega), n_i(\Omega)$, $O(a, z, \iota)$ solve the agents' problems described in section 3.2.

(ii) Intermediate good ("transformed labor") market clear.

(iii) The equilibrium wage, w, is determined by Nash bargaining.

(iv) The labor informality rate is consistent with the share of labor input assigned in informal labor contracts.

(v) The tax b_g guarantees that the Government's budget is balanced in equilibrium.

(vi) The distribution $\mu(\Omega)$ is the invariant distribution for the economy.

4 Calibration

The model is calibrated to match the Brazilian economy during the period ranging from 2015 to 2017.[14] The period in the model is one year. The majority of the parameters are

[14]When there is no data available for this period, I use the information from the period closer to 2015 or 2017.

estimated directly from microdata (external calibration) or by targeting relevant moments also estimated from microdata (internal calibration). Some parameter values are assigned using external sources. Before I detail the calibration of the parameter values, I present the functional forms of the utility function, production function and labor inspection probability.

4.1 Functional forms

The period utility function is $u(c) = \frac{c^{1-\sigma}-1}{1-\sigma}$ with $\sigma > 0$. The entrepreneurial idea is drawn from an invariant Pareto distribution function $\mu(z) = \eta z^{(\eta+1)}$ with $z \geq 1$. The production function is a standard Cobb-Douglas: $f(k,n) = k^{\alpha_k} n^{\alpha_n}$.

I follow Di Nola et al. (2021) and Franjo et al. (2022) and use a logistic distribution to model the probability of labor inspection. The probability of an entrepreneur with assets a, productivity z and no history of labor inspection (ι=0) is:

$$p_d(a, n_i, 0) = \frac{2}{1 + e^{(-\alpha_p - \beta_a a - \beta_{ni} ni)}} - 1$$

This functional form has two important features that match the model's assumptions. First, the function output will be a value between 0 and 1 for any input. Second, the function output is increasing in the wealth a and informal workers input n_i arguments. The parameter α_p determines the minimum value of p_d.

I assumed that the probability of a re-inspection is random for firms with a past labor inspection. In this case, the functional form is $p_d(a, n_i, 1) = p_{d2}$, with $p_{d2} \in [0, 1]$.

4.2 Externally calibrated parameters

Setup: I assume a small open economy and, therefore, the risk-free rate is given in the model. I assigned a value of 0.02 for the risk-free rate taken from Cavalcanti et al. (2021) model's calibration for a small open economy. The subjective discount factor β takes a value of 0.92 - a standard value in the firm dynamics literature.

Parameters of the utility function and final good production environment: The inverse intertemporal elasticity of substitution parameter σ and the depreciation rate δ take the standard values of 1.5 and 0.6 respectively. Following Cavalcanti et al. (2021), the parameters of the production function exponents are $\alpha_k = 0.27$ and $\alpha_n = 0.31$.

Taxes The revenue and labor taxes are set to their statutory values: $\tau_\pi = 0.3$, $\tau_w = 0.29$ and $\tau_{SP} = 0.08$. Revenue taxes were calculated based on World Bank Do-

ing Business data. The wage taxes τ_w encompasses payroll tax (0.20) and employer's social security contribution (0.09). In the Brazilian economy, all formal employees are obliged to contribute to a severance payment fund[15]. The severance payment tax τ_{SP} is of 8% on the monthly wage. Regarding the penalty for the informality infraction, I estimated the value of $\varphi_a = 0.018$. Before November of 2017, the penalty fine for each "unregistered employee" in Brazil was 402.53 BRL. This value corresponded to approximately 20% of the average monthly wage and 1.8% of the annual average wage.

Search and Matching: I extract from the Brazillian Population Survey Pannel Data (PNAD) the transitions between workers status within one year. I set the scale parameter of the matching function κ to 0.47 which corresponds to the probability of an unemployed worker finding a job in the private sector within one year. The separation rates of formal and informal jobs are set to $s_{wf} = 0.06$ and $s_{wi} = 0.12$. The elasticity parameter of the matching function ζ and the Nash bargaining parameter ϕ take the standard values of 0.5. Using the Brazillian Consumer Expenditure Survey (POF-2008), I calculated that workers in home production have current expanses that are approximately 40% of the private sector employees' current expanses. The parameter h from the flow value of the unemployed worker, therefore, is set to 0.4. Finally, I assume a tightness θ of 1.0 in the benchmark economy.

Enforcement of labor regulation: I assume that the minimal probability of an entrepreneur being first inspected is zero in the benchmark economy. Then, the parameter α_p from the probability of labor inspection function takes the value of zero. Using labor inspection data, I calculate that 12% of first inspected firms are reinspected within a year. The assigned value for the probability of labor inspection for entrepreneurs with a history of labor inspection is $p_{d2} = 0.12$. The model only assumes the labor fiscal wage payments as monitoring costs. I estimate that a labor fiscal, on average, visits 88.7 establishments in a year and earns, approximately, 10 times the average wage of the economy. The cost of each inspected entrepreneur is set to $c_{Lfiscal} = 0.11$ corresponding to the inverse of "labor fiscal productivity" times the "wage premium".

Table 4 summarises the parameters set exogenously.

[15]All formal employees have a severance payment fund (FGTS) where the contributions are saved. In the case of a layoff, the employee can withdraw the total amount deposited in the fund account.

Table 4: Calibration - parameters set exogenously

Parameter	Description	Value	Reference
r	Risk-free interest rate – small open economy	0.02	Cavalcanti et all (2021)
β	Discount factor	0.92	Standard value
σ	Coefficient of relative risk aversion	1.5	Standard value
α_k	Elast. of y with respect to k	0.27	Cavalcanti et all (2021)
α_n	Elast. of y with respect to n	0.31	Cavalcanti et all (2021)
δ	Capital depreciation rate	0.06	Standard value
τ_π	Revenues tax	0.30	statutory values
τ_w	Formal wage tax	0.29	statutory values (INSS + IR)
τ	Severance payment tax	0.08	statutory value
φ_a	Penalty for informal employment	0.018	penalty/wage
α_p	Minimum probability of inspection	0	
p_{d2}	Probability of re-inspection	0.12	% firms re-inspected within 4 quarters
$c_{Lfiscal}$	cost to inspect an entrepreneur	0.11	labor fiscal "productivity" x "wage premium"
κ	Scale parameter of matching function	0.47	Transition (unemp. - emp. private sector)
ζ	Elasticity parameter matching function	0.5	Standard value
ϕ	Nash bargaining parameter	0.5	Standard value
s_{wf}	Separation rate of formal jobs	0.06	Transition (formal private sector – unemp.)
s_{wI}	Separation rate of informal jobs	0.12	Transition (informal private sector – unemp.)
θ	Tightness	1.0	
h	home production flow value (rel. to wage)	0.4	Home production workers expenses (rel. emp. workers)

Note:

4.3 Internally Calibrated Parameters

The remaining 10 parameters (γ, η, χ, λ, β_a, β_{n_i}, τ_{inf}, φ_r, v_{cost}, $\bar{G}$) are jointly calibrated to minimize a loss function that computes the distance between targeted moments and their counterparts in the model.

The parameter of the Pareto distribution η determines the thickness of the productivity tail and targets the share of firms with more than 10 formal employees. The probability of drawing a new productivity, γ, is set to match the entrepreneur's exit rate. The fixed cost of production χ influences the minimum efficient scale for an entrepreneur and targets the share of employers in the benchmark economy. The parameter defining the entrepreneur's borrowing capacity λ is disciplined by the level of financial development in the economy, which can be measured by the ratio of external finance to GDP.

The parameters related to the enforcement of labor regulation are calibrated to match moments calculated using labor inspection data. The coefficient in the probability of inspection function related to the entrepreneurs' assets, β_a, targets the proportion of large establishments (more than 10 formal employees) inspected for the first time in a year. The coefficient related to the number of informal workers β_{n_i} targets the median of informal workers at firms discovered employing informal workers by the labor regulator. The other informality costs τ_{inf} is disciplined by the labor informality rate in the private sector.

The value of an unfilled vacancy v_{cost} is calibrated such that the tightness θ takes

the value 1.0 in the baseline economy. The government fixed consumption $\bar{G}$ is the government consumption in the benchmark economy with the tax $b_g = 0$.

4.4 Calibration results

Table 5 presents the values of the parameters internally calibrated in column 3. Columns 5 and 6 show the model fit. The model does a good job of replicating the targeted moments for the majority of the parameters. However, it understates the median of informal workers in inspected firms. Differently from the data, in the model, the majority of entrepreneurs employ at least one informal worker until being first inspected. As a result, informal workers are more widespread among firms in the estimated economy than in the data.

Table 5: Calibration - parameters set by solving the model

Parameter	Description	Value	Target	Model	Data
γ	New productivity arrival rate	0.22	exit rate(%)	13.99	16
η	Curvature Pareto distribution	3.4	% of firms ($n_f > 1$) w/ more than 10 formal workers	22.57	19.23
χ	Fixed cost of production	1.0	share of employers	8.51	6.5
λ	Collateral borrowing restriction	0.55	credit/GDP – firms	22.80	25
β_{ni}	Parameter - inspection prob. function - informal workers	0.017	median informal workers in infractor firms	1	2
β_a	Parameter - inspection prob. function - assets	0.018	% inspected firms w/ more 10 formal employees	12.37	10.56
τ_{inf}	Other informal costs	0.312	Informality rate in the private sector	24.36	22.88
v_{cost}	Vacancy cost	0.49658	Normalization of tightness		
$\bar{G}$	Fixed Government consumption	0.265463	Balanced budget with $b_g = 0$		

Note:

The model also presents features consistent with the data that are not directly targeted in the calibration. Table 6 shows that the equilibrium unemployment rate in the baseline economy is close to the unemployment rate of the targeted economy. The average number of formal employees within a firm is also close to the data.

Table 6: Not targeted moments

Moment	Model	Data
Unemployment rate (%)	13.41	11.05
Mean formal workers	9.18	8.06*

Note: *Mean formal workers in 2016

Table 7 shows features of the entrepreneur's exit rate produced by the calibrated model that aligns with the empirical findings presented in section 2. The column "not inspected" presents the exit rate of entrepreneurs never inspected by firm size, the column "inspected T" presents the exit rate, by firm size, of the inspected entrepreneurs in the current period of the inspection, and the column "past inspection" presents the exit rate of entrepreneurs with a history of labor inspection by firm size. The first column presents the referent size measured as the total number of employees.

Table 7: Exit rate by firm size and entrepreneurs inspection status

Size ($n_f + n_i$)	Not Inspected	Inspected T	Past Inspection
1-4	18.04	19.26	16.78
5-9	13.74	13.18	13.04
10-19	11.73	11.61	11.60
20-49	11.48	11.48	11.48
50-99	11.48	11.48	11.48
100-499	11.48	11.48	11.48
500-999	11.48	11.48	11.48
more than 999	11.49	11.48	11.48

Note: The table presents the share of individuals (in %) that change from entrepreneurs occupation to worker occupation in the calibrated model for three different groups: never inspected entrepreneurs, entrepreneurs inspected within the period, and entrepreneurs inspected in the past

I highlight the exit rate difference between "inspected T" and "past inspection" groups of entrepreneurs. The exit rate of firms inspected within the period is higher than the rate of the group of firms with a history of labor inspection for smaller firms. Moreover, this difference decreases with firm size. These features are according to the results presented in Figure 1 from section 2. Recall that, in the model, firms with a history of labor inspection only employ formal workers. Taking this into consideration, this group is close to the control group used in the empirical analysis of the exit rate. However, I highlight that we should be cautious with the comparison. Firms with a history of labor inspection include firms "recently inspected", which should present higher exit rates since they are still adjusting to the labor inspection shock. On the other hand, the ones inspected a long time ago should present low exit rates since better firms are the ones that could survive in the market employing only formal workers. Although this caveat, the model's results interpretation is consistent with the data.

In the model, I use the entrepreneur's assets, instead of firm size, as a predictor variable for the probability of inspection. A concern related to this function specification is that the entrepreneur's wealth is not a good proxy for firm size. Figure 3 shows how entrepreneurs' wealth is related to total employment within the firm for entrepreneurs with no history of labor inspection. The green line is the employment policy choice (for formal and informal employees) of the entrepreneur with the productivity level $z = 1.60$. In the benchmark economy, 12% of entrepreneurs have this productivity level. As shown in the figure, the number of employees monotonically increases with the entrepreneurs' wealth. The figure also plots the weighted average of the total employees within a firm where the weight is the share of entrepreneurs in each productivity level z. We observe that, on average, employment within the firm increases with the entrepreneurs' wealth in

the benchmark economy.

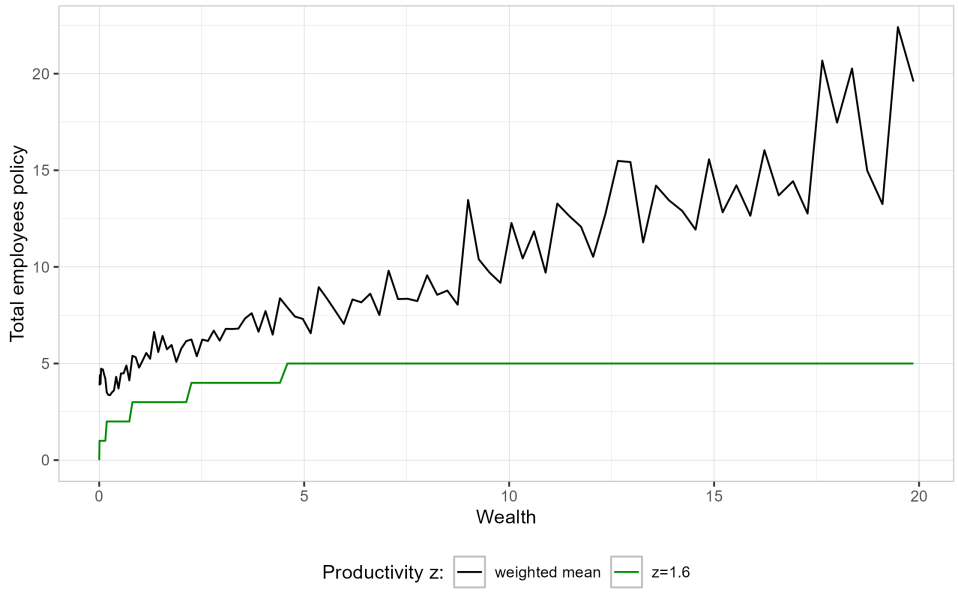


Figure 3: Entrepreneurs wealth x Firm size

5 Counterfactual Exercises

In this section, I use the model to study the aggregate effects of stricter enforcement policies: higher punishment and monitoring. In the counterfactual exercises of higher punishment, I set the value of the penalty fine for informality infractions to $\varphi_a \omega \times n$, where φ_a is the penalty value in the benchmark economy and n ranges from 2 to 16. For the higher monitoring exercises, I change the parameter value α_p, which defines the minimum probability of an entrepreneur being inspected. While in the benchmark economy, the minimum probability of a labor inspection is zero, in the counterfactual exercises, the minimum probability is $0.45\% \times n$, with n ranging from 1 to 10. I keep the other parameter values at the benchmark level in each counterfactual exercise.

Figure 4 shows the equilibrium labor informality rate for each enforcement policy experiment. In the graph, the green dots are the results of the higher monitoring exercises and the first row of the x-axis is the referent counterfactual monitoring policy. Likewise, the blue dots are the equilibrium informality rate of the higher punishment exercises and the second row of the x-axis is the referent counterfactual penalty policy. The black dot refers to the outcome in the benchmark economy. As shown in the graph, the informality rate decreases either in an economy with higher penalty values or more monitoring. The informality rate decreases by, approximately, 62% in the counterfactual economy with a

penalty value of $15 \times \varphi_a$. Similarly, setting the minimum probability of any entrepreneur to be inspected to 4.05% decreases 61% the informality rate compared to the outcome in the benchmark economy.

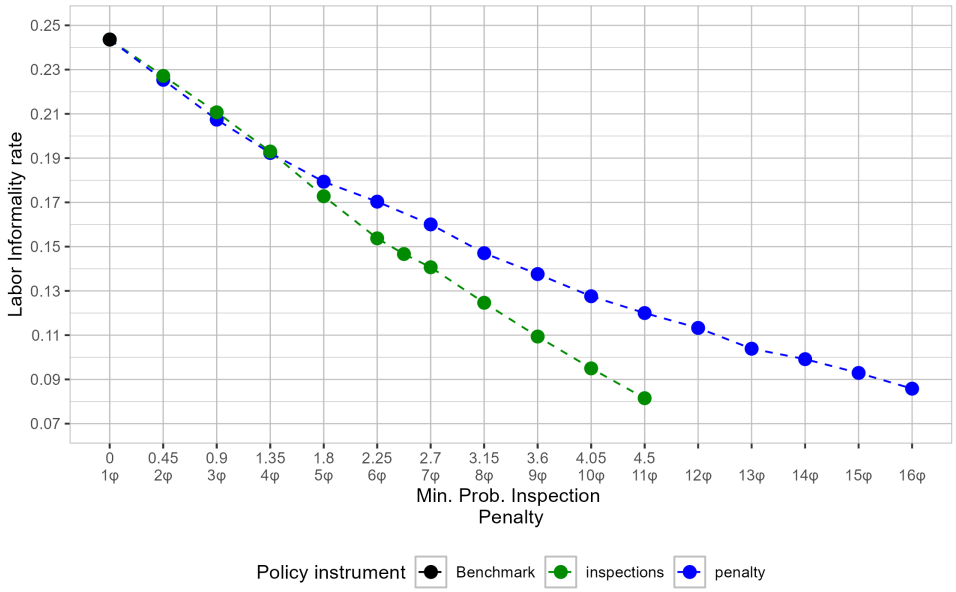


Figure 4: Labor Informality rate outcome

I now compare the impacts of each enforcement instrument on other aggregate outcomes: Government Budget Net, TFP, Unemployment rate, Wages and Welfare. I use the steady-state informality rate of each policy experiment as the reference measure to compare the enforcement instruments. In the next graphs I plot the results with the referent equilibrium informality rate in the x-axis instead of the referent counterfactual enforcement policy. Each panel in Figure 5 shows the counterfactual equilibrium values for each aggregate outcome.

Panel (a) of Figure 5 shows the results for the government budget net. Increasing the penalty generates a positive net in the government budget which means that the individuals in the counterfactual economies with higher punishment receive transfers from the government. On the contrary, economies with higher monitoring generate a deficit in the government budget and individuals must pay taxes to balance the government budget. The counterfactual results also indicate the policy impacts on this outcome are linear in the enforcement degree: a higher penalty level has a higher positive net on the government's budget and a higher monitoring rate yields a higher deficit in the government's budget.

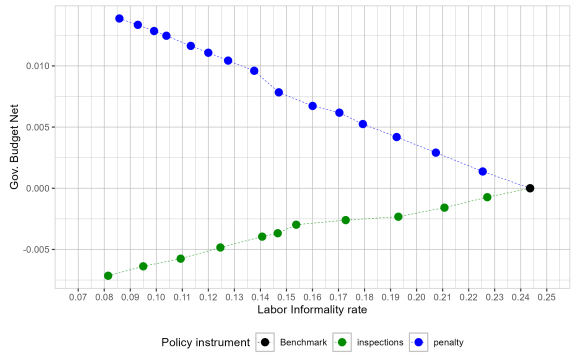
Panel (b) of Figure 5 plots the TFP results. I find that the TFP is positively impacted by higher punishment but decreases with higher monitoring. Appendix A figure 7

presents additional results regarding entrepreneurship. I find that the share of individuals in entrepreneurship decreases with higher monitoring enforcement policies. Increasing the penalty, however, has a non-linear impact on entrepreneurship. Starting from the benchmark policy, the share of entrepreneurs increases with higher penalty policies, but at penalty value $7 \times \varphi_a$, the share of entrepreneurs drops by 1.9% relative to the benchmark level. At this point, the entrepreneurship choice is not optimal anymore for individuals with the productivity level that is in the bottom distribution of entrepreneurs' productivity (in the benchmark economy). From this point, the share of entrepreneurs increases almost linearly with higher penalty values. Panel (b) of figure 7 shows the mean productivity of entrepreneurs in the counterfactual economies. The mean productivity decreases with higher monitoring but increases with higher penalty policies. The results presented in this graph make it evident the entrepreneur's compositional change at the point $7 \times \varphi_a$.

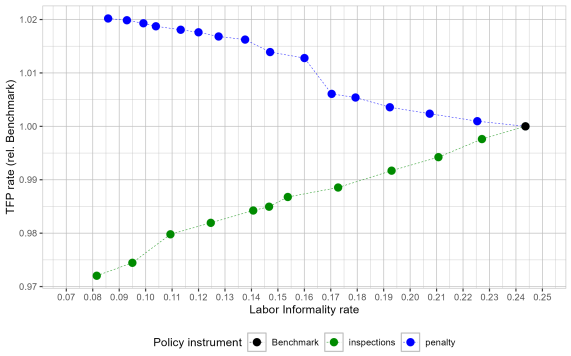
The unemployment rate results are plotted in panel (c) of Figure 5. Stricter enforcement policies applied with higher monitoring decrease unemployment. Higher penalty policies have mixed impacts on unemployment. For low increases in the penalty value, the unemployment rate also decreases relative to the benchmark economy. Since there is a decrease in entrepreneurs in the extensive margin at the penalty policy $7 \times \varphi_a$, the unemployment rate is higher relative to the benchmark for increments in the penalty value higher than $7 \times \varphi_a$. Panel (d) of Figure 5 shows the counterfactual results for the workers' wages. It increases with harsher penalties and, on the contrary, decreases with higher probabilities of labor inspections.

The results above indicate that the economy would be worse with higher monitoring policies since in these economies individuals must pay lump-sum taxes, workers have lower wages and the TFP decreases. Then, as expected, panel (e) shows that welfare decreases with stricter enforcement policies applied with the monitoring instrument. The welfare, on the contrary, is always higher in the counterfactual economies with higher penalty policies.

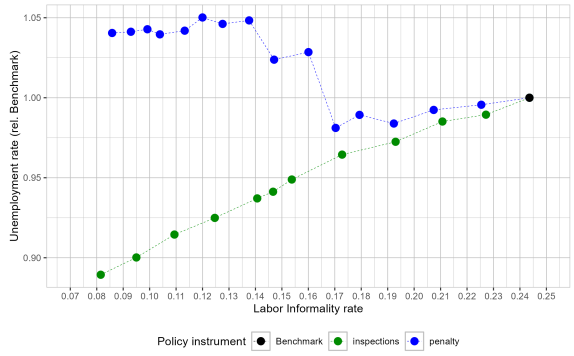
The role of Government Budget imbalances: To investigate the mechanisms underlying the impact of policy changes on aggregate outcomes, I first disentangle the role of government expenses with enforcement in the economy. I repeat the counterfactual exercises, but this time I shut down the effect of the government budget imbalances (due to variation of enforcement costs) on individual utility by setting the lump-sum tax/transfer b_g to zero. I denominate these counterfactual exercises as economies "without the government budget channel". Figure 6 shows the counterfactual results for the punishment policy instrument in light blue and the monitoring policy instrument in light green. The graphs also show the results from the main policy counterfactual exercises to make easier



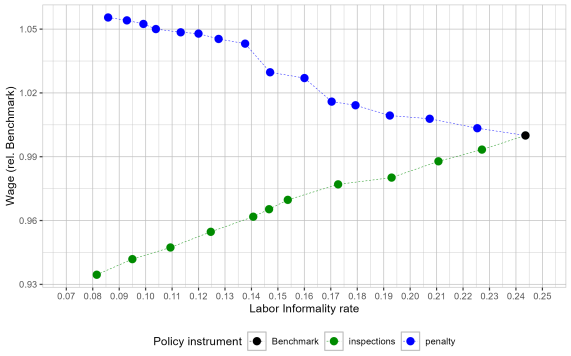
(a) Net Government Budget



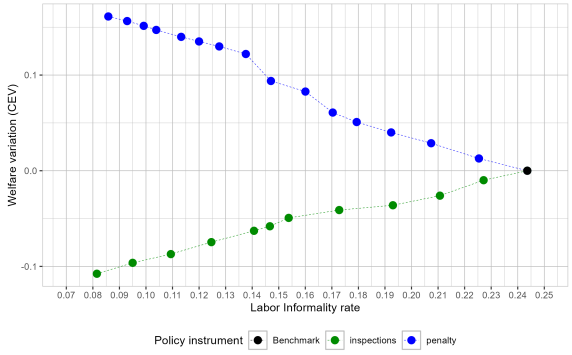
(b) TFP



(c) Unemployment rate outcome



(d) Workers wage



(e) Welfare outcome measure as Consumption Equivalence Variance (CEV)

Figure 5: Counterfactual results

the comparison between the results of economies with and without the government budget channel. As shown in panel 6a in Figure 6, the counterfactual policies in economies without the government budget channel generate, virtually, the same impact on the informality rate of the counterfactual economies with this channel. Since the tax/transfer b_g does not distort individuals' decisions, variations in the government net costs with enforcement mainly impact individuals' consumption and savings.

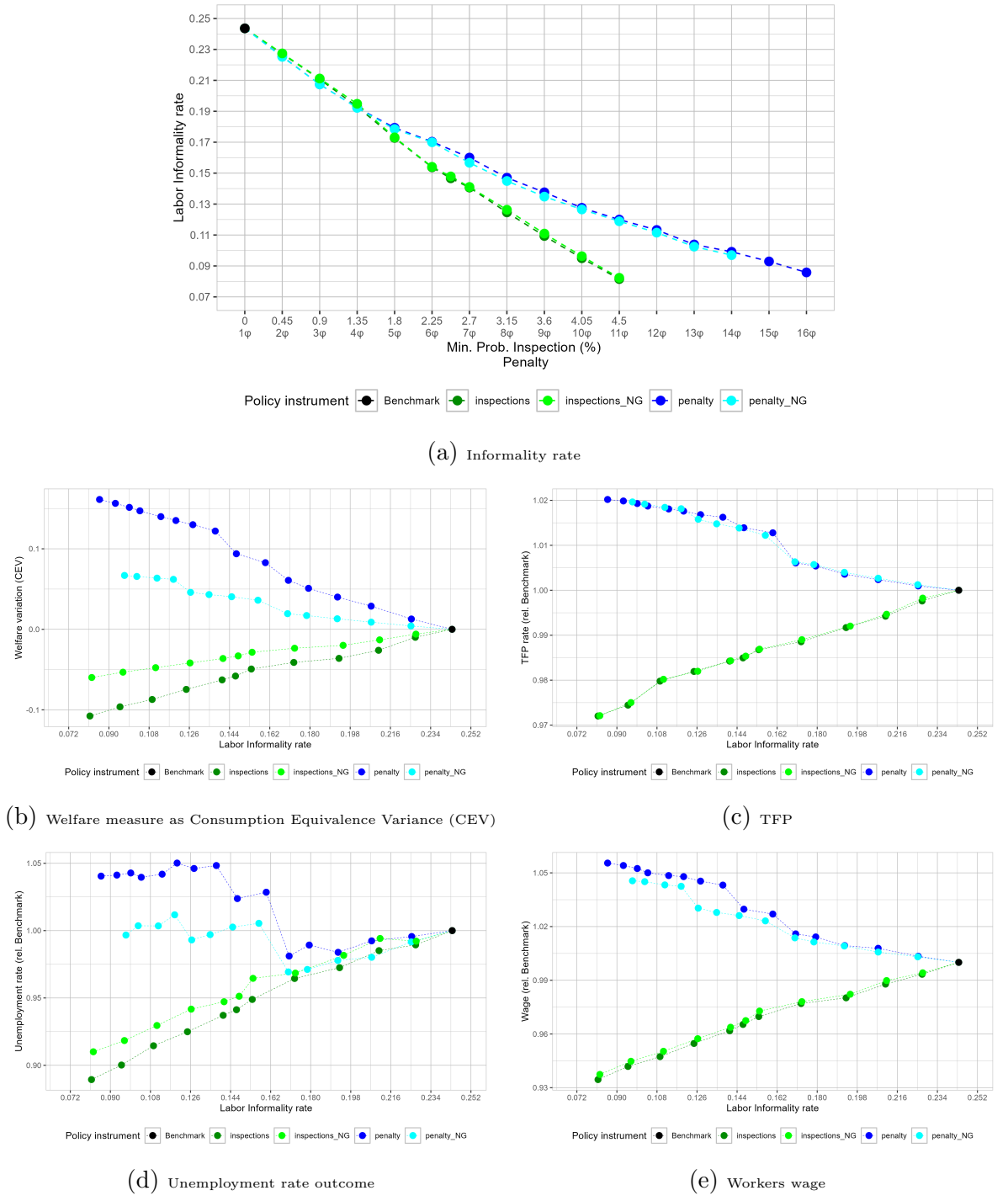
We observe on Panel 6c that the government channel has no relevant impact on TFP. As shown in Panel 6e, both higher penalties and monitoring in the counterfactual economies without the government budget channel impact wages in the same direction but with a lower magnitude relative to the counterfactual economies with the government channel.

Panel 6b from Figure 6 presents the results for the Welfare. Increasing the penalty in the economy without the government channel increases Welfare by less compared to the counterfactual economies with individuals receiving b_g transfers. Similarly, increasing monitoring in an economy without the government channel decreases Welfare, but with a lower magnitude than observed in economies with individuals paying the tax b_g.

In panel 6d we also observe that the government budget channel generates variation in the unemployment rate with lower magnitude compared to the counterfactual economies with the presence of this channel. One explanation for the difference in the intensity of the impacts on the unemployment rate is related to the different equilibrium wages between the two types of economies. A lower (higher) wage increase (decrease) the labor demand and may decrease (increase) the equilibrium unemployment rate. Additionally, Figure 7 panel (d) shows that, on average, the wealth of entrepreneurs is lower (higher) in the counterfactual economies without the budget channel for the higher monitoring (penalty) counterfactual exercises. Then, entrepreneurs in the higher monitoring (penalty) counterfactual economies with the government budget channel have more (less) assets, can rent more (less) capital, and employ more (less) workers compared to economies without the government channel.

Mechanism: Now, I discuss the main mechanisms at play in the counterfactual exercises presented in this section. I start by giving the intuition of the effects of stricter enforcement of labor regulation and, then, I discuss the specific features of each enforcement instrument shock.

Increasing enforcement of labor regulation increases the costs of labor informality which has two opposing effects on entrepreneurship and total demand for labor. Higher informal costs increase formal labor contracts and decrease informal labor contracts and, therefore, decrease the informality rate. On one hand, high informal labor costs decrease



(a) Informality rate

(b) Welfare measure as Consumption Equivalence Variance (CEV)

(c) TFP

(d) Unemployment rate outcome

(e) Workers wage

Figure 6: Counterfactual results with and without the impact of the Government budget variations on individuals' utility.

the demand for informal labor. Additionally, the entrepreneurs who can not afford the higher labor costs exit the market. Unemployment should increase because there is less entry from unemployment to entrepreneurship and more unemployed workers who otherwise would be employed in informal jobs. In this case, wages go down to equilibrate the labor market. On the other hand, more formal jobs increase the share of workers in formal jobs and the labor income since formal workers can anticipate the severance payment. With higher earnings workers can accumulate wealth faster and go to entrepreneurship sooner compared to an economy with more workers on informal labor contracts. A higher share of entrepreneurs increases the demand for labor. Then, wages go up to equilibrate the labor market. I will denominate the former as the first mechanism and the latter as the second mechanism.

Additionally, higher (lower) wages also increase (decrease) workers' labor income and reinforce the positive (negative) enforcement effect on entrepreneurship and labor demand decisions through the wealth accumulation channel. The presence of these opposing forces makes the final impact on entrepreneurship and total employment unclear.

Applying higher penalties as stricter enforcement policy increases the inspected entrepreneurs' expenses at the time of the inspection and less wealth is taken to the next period. Less accumulated wealth can make entrepreneurs to decrease labor demand and/or exit the market reinforcing the first channel of increasing the cost of informality. The results presented in this paper suggested that the second mechanism (higher labor earnings and wealth due to more formal jobs) is stronger for low increases in the penalty level. The first channel is stronger for low-productivity entrepreneurs at the punishment level $7 \times \varphi_a$ since we observe the change in the productivity threshold for entrepreneurship at this point.

Increasing informal labor costs with more monitoring has an amplification effect on compliance. Since entrepreneurs increase compliance after being inspected, the share of formal labor contracts should increase both because entrepreneurs are avoiding the higher probability of being punished and because there are more inspected entrepreneurs complying with labor regulation[16] [17]. More inspected entrepreneurs, more of them are having higher labor costs since the formal labor contract is more costly. The higher labor costs may lead entrepreneurs to accumulate less wealth and/or decrease labor demand and/or exit the market. The negative effects on entrepreneurship in the counterfactual exercises indicate that the first mechanism is stronger for the monitoring enforcement instrument.

[16]It is also possible to generate this amplification effect on compliance with the penalty instrument. For instance, increasing the punishment in the second inspection to a very high level would make full compliance with labor regulation the optimal choice for entrepreneurs after the first inspection.

[17]If the probability of being inspected is endogenous, then it is possible that, in equilibrium, the share of inspected entrepreneurs decreases with higher monitoring.

Interestingly, the decrease in unemployment must be driven by the lower wages. Although the counterfactual economies with higher monitoring have fewer entrepreneurs, the lower labor price pushes up labor demand and increases total employment.

The policy effect on wages is also a key factor for the different impacts on Welfare between the two enforcement instruments. Note that, even after shutting down the effect of the tax/transfer b_g on individual consumption, the two instruments still have opposing effects on welfare. The main explanation is that higher punishment increases workers' wages and, then, their consumption while higher monitoring decreases labor earnings and workers' consumption.

In all, the counterfactual exercise results suggest that the cost and gains to reduce labor informality rate differ when the stricter enforcement policy is applied with different policy instruments.

6 Conclusion

This paper examines the effects of stricter enforcement policies on labor informality. The goal is to understand in what dimensions and the extent to which the enforcement policy instrument matters. I develop a firm dynamics model with occupational choice and capital accumulation, featuring informal labor employment, unemployment, and a government facing costs to enforce labor regulation. The model is calibrated using Brazilian data and explores the impact of two policy instruments: more monitoring and higher penalties.

I find that both instruments reduce informality rates but have different economic outcomes. Higher penalties generate a positive government budget net, increase the TFP, wages, and welfare, and have mixed effects on unemployment. Increasing inspections reduces unemployment but decreases TFP and lowers overall welfare. The results highlight that the choice of enforcement instrument significantly affects economic outcomes, underscoring the importance of considering these impacts in policy design.

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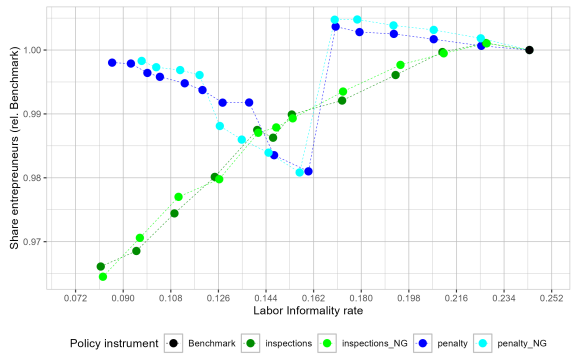
A Online Figures and Tables

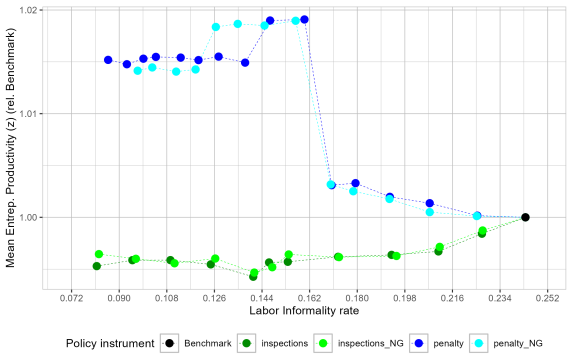
Table 8: Distribution of the Total of Informality Infractions for firms with informality infraction

	Percentile
1%	1
5%	1
10%	1
25%	1
50%	2
75%	4
90%	8
95%	15
99%	80
N	48592

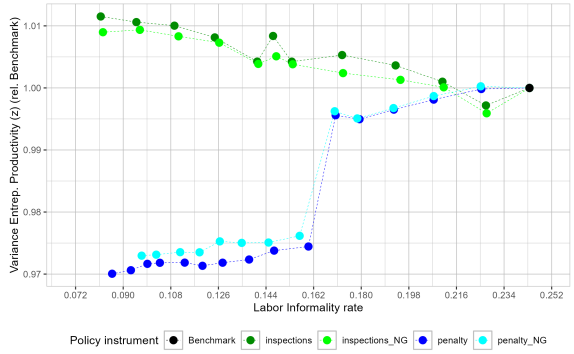
Note: The sample refers to firms inspected between 2015 and 2017 with "unregistered employee" type of infraction. The period frequency of the sample is at the quarter level.



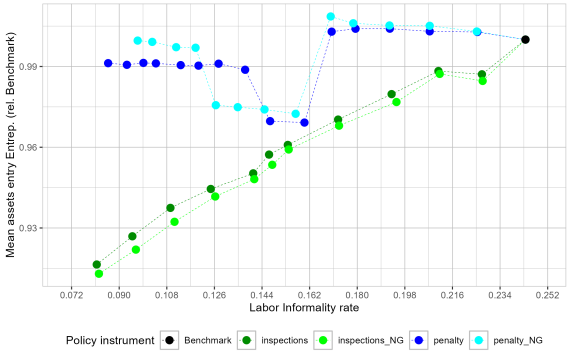
(a) Share of individuals in Entrepreneurship (rel. to the benchmark)



(b) Entrepreneurs' mean productivity (rel. to the benchmark)



(c) Entrepreneurs' variance in productivity (rel. to the benchmark)



(d) Mean wealth of Entrepreneurs (rel. to the benchmark)

Figure 7: Counterfactual results with and without the impact of the Government budget variations on individuals' utility.