Wages and Informality in Developing Countries.*

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Preliminary and Incomplete

Abstract

Informal labour markets are a standard characteristic of labour markets in developing countries. It is often argued indeed that they are the engine of growth because their existence allows firms to operate in an environment where wage and regulatory costs are lower. On the other hand informality means that the amount of insurance offered to workers is lower. Thus the key question is how should one design policy on informality; what is the impact of a tighter regulatory framework on employment in the formal and the informal sector and on the distribution of wages. To answer this question we extend the framework of Burdett and Mortensen (1998) to allow for two sectors of employment. In our model firms are heterogeneous and decide endogenously in which sector to locate. Workers engage in both off the job and on the job search and decide which offers to accept. This introduces direct transitions across sectors which matches the evidence in the data about job mobility. Our paper relates to Van den Berg (2003) and Bontemps, Robin and Van den Berg (2000) and also to other papers which consider two sectors such as Albrecht (2008) and Bosch (2006). Our empirical analysis uses Brazilian data and exploits information on compliance costs, which vary both over time and region. We thus are able to use exogenous variation in the environment to identify parameters of the model. Finally, we use the model to discuss the relative merits of alternative policies towards informality.

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1 Introduction

Informal labour markets are a standard characteristic of labour markets in developing countries. These labour markets are generally seen as operating outside the tax and regulatory framework of the country, not paying taxes or social security contributions of any sort, violating minimum wage laws and not complying with employment protection regulation. It is often argued that as a result they are the engine of growth because their existence allows firms to operate in an environment where wage and regulatory costs are lower. On the other hand, informality implies that the amount of insurance offered to workers is lower. Moreover, informal markets are also subject to regulatory costs: while formal firms pay income taxes and severance, informal firms are subject to being caught and fined by the labour authorities. An interesting policy question is to which degree stricter regulatory codes affect sector of employment and the distribution of wages in the formal and the informal sector.

To answer this question we extend the search framework of Burdett and Mortensen (1998) to allow for two employment sectors - formal and informal; we allow for search frictions in both sectors and transitions between them. This model is particularly suitable for our analysis because on-the-job search allows us to represent workers who move within sector or to a job in another sector. This introduces direct transitions across sectors which corresponds to evidence of direct job mobility between the formal and informal sector. Our paper relates to Van den Berg (2003) and Bontemps, Robin and Van den Berg (2000) because we allow for productivity heterogeneity in the model. Firm heterogeneity is important empirically because it allows for varying composition of formal and informal firms by productivity level, which is also of direct relevance to the analysis of the efficiency aspects of regulatory policies. Moreover, the standard estimated Burdett-Mortensen model, with homogeneous firms, generates an increasing wage density which is counterfactual. Allowing for firm heterogeneity, leads to a richer model with implications that fit the data much better. Our paper also relates to that of Albrecht, Navarro and Vroman (2008) who use the matching framework of Mortensen-Pissarides (1994) to model the informal sector as unregulated self-employment with fixed productivity, while it allowing for heterogeneity in the formal sector. Bosch (2006) uses a similar framework and adds heterogeneous productivity in the informal sector. The author assumes the two markets are subject to same frictions and direct job flows only take place from the informal

to the formal sector, with the assumption that formal workers never accept an offer from the informal sector.

Our paper tries to reconcile conflicting views of informality. The most traditional associates informality with a subsistence sector for a formal segmented market, restricted by the minimum wage and tax laws. Recent literature however presents an alternate view of informality, based on agents' choices rather than based on constraints to operate in the formal sector. To date, a large empirical literature has shown evidence against the segmented market view. They usually find significant job mobility across sectors or workers reporting being better off by taking up an informal job.[1] In what follows, our paper accommodates evidence of transitions between formal and informal sectors, and markets subject to frictions and choices. More specifically, our framework adds to the literature of equilibrium search models with formal and informal sectors by allowing direct transitions across sectors firm heterogeneity in both sectors and endogenous choice of sector by firms. We allow firms to differ in their productivity regardless of the sector in which they operate, implying that any type of firm could act in a sector, with no ex-ante restriction on whether a sector is more productive than the other. Workers can be exogenously laid off or can take up a job opportunity in an alternative firm either in the same sector or in the other. Finally, the policy environment is described by corporate and labour taxes, severance payment , unemployment insurance, a legal minimum wage and an intensity of monitoring of compliance by firms. In addition, to account for worker heterogeneity, we segment the market across observed characteristics such as completed education and gender, as in Van den Berg and Ridder (1998) and Bontemps, Robin and Van den Berg (2000).

The model was designed for analysing economies with substantial informal and formal sectors, found across a wide range of developing economies. We estimate our model using data from Brazil where informality of labour is about 40 percent of the salaried labour force[2]. Our main source is the Brazilian Labour Force Survey, *Pesquisa Mensal de Emprego*, which

[1] For example, Maloney (1999) shows no evidence of segmented markets for Mexico, where transitions between formal and informal sector seem to be equally probable in both directions. Barros, Sedlacek and Varandas (1990), Neri (2002) and Curi and Menezes-Filho (2004) analyse Brazil and also point the significant mobility between sectors. Furthermore, Maloney et al (2007) shows for Colombia that informal workers are more satisfied than formal workes in terms of job flexibility. For Argentina, Pratap and Quintin (2006) findings suggest that informal workers can be as well off as similar formal workers.

[2] Estimate based on recent cross sectional data (PNAD) and the entire salaried workforce.

provides a rotating panel of individuals sampled from the six main metropolitan regions of Brazil. An additional source we use is the administrative data on labour inspections per city and year, which are used in Almeida, Carneiro and Narita (2009). We are thus able to match and identify parameters of the model using exogenous variation by region and year. Finally, the model allows us to discuss the relative merits of alternative policies towards informality.

In the next section, we present the model. In Section 3, we describe the data and the details of estimation of the model. In Section **??**, we present and comment on the main results. In Section 6, we examine the effects of changes in the compliance costs and other policies such as changes in minimum wage, severance and UI. Conclusions are in Section 7.

2 The Equilibrium Search Model

2.1 An Overview

There are two sectors in the economy, the formal and the informal one. The two sectors arise because of the existence of taxes and regulations governing the employment of workers. Imperfect monitoring of compliance with the legal framework creates profitable opportunities for lower productivity firms to ignore the regulations and operate in the informal sector.

In our model the policy environment is described by the corporation tax on profits, income tax, social security contributions, severance pay upon laying off a worker and unemployment insurance, which is implicitly funded by taxes.[3] Firms are monitored with probability π and if caught not complying they pay a fine P per worker. Hence the expected cost of informality is $C = \pi P$ per worker. Firms have a given productivity level p, maximise profits and have to decide whether to comply with the regulations or work in the informal sector, risking a fine.

Workers flow utility depends on the wage they receive from work plus the value of the social security contributions made by the firm on their behalf, which we include in the wage measure: in the formal sector wages are gross wages minus income tax payments. Workers also value severance pay and unemployment insurance as will be evident in the value function.

The economy is subject to search frictions. Subscripts with value 0 denote the unemployed, with value 1 denote the formal sector and with value 2 the informal one. Offers are a Poisson process and arrive randomly from distributions of contract values F_i $(i = 1, 2)$. Arrival rates

[3] We do not model explicitly the link between unemployment insurance and taxes.

are denoted by λ_{ij} where $i = 0, 1, 2$ denotes the sector in which the worker is currently and $j = 1, 2$ the origin of the offer. The worker can receive offers from either sector; indeed we also allow offers from the informal sector to the formal one and some of these offers may be worth accepting. Finally the exogenous lay off rate for each sector is denoted by δ_i $(i = 1, 2)$.

2.2 Workers

Our model assumes identical workers who maximize the expected discounted lifetime income with a discount rate of r. At any instant, unemployed workers receive b, said to be constant across individuals, regardless the sector they arrive from. Let $W_1(w_1)$ and $W_2(w_2)$ denote the values of wage contracts w_1 and w_2 in the formal and the informal sectors. The wage in the formal sector is the after tax but *before* social security deductions and includes an contributions to pensions made by the employer on behalf of the worker; in the informal sector no taxes or contributions are made so the wage is just the gross wage. The workers value functions can be expressed by:

- Value of working in the informal sector:

$$\begin{aligned} rW_2(w) &= w + \delta_2 [U - W_2(w)] \\ &\quad + \lambda_{21} \int \max\{x - W_2(w), 0\} dF_1(x) + \lambda_{22} \int \max\{x - W_2(w), 0\} dF_2(x) \\ &= w + \delta_2 [U - W_2(w)] + \int_{W_2(w)} \left[\lambda_{21}\overline{F}_1(x) + \lambda_{22}\overline{F}_2(x)\right] dx. \end{aligned} \tag{1}$$

  Thus the flow utility in the informal sector is the wage rate (w) plus the value of unemployment net of the value of the lost employment if the person is laid off, which happens at rate δ_1, as well as the value of obtaining a better offer either from the formal or the informal sector.

- Value of working in the formal sector:

$$\begin{aligned} rW_1(w) &= w + \delta_1 [U + UI + sw - W_1(w)] \\ &\quad + \lambda_{11} \int \max\{x - W_1(w), 0\} dF_1(x) + \lambda_{12} \int \max\{x - W_1(w), 0\} dF_2(x) \\ &= w + \delta_1 [U + UI + s \times w - W_1(w)] + \int_{W_1(w)} \left[\lambda_{11}\overline{F}_1(x) + \lambda_{12}\overline{F}_2(x)\right] dx \end{aligned} \tag{2}$$

In addition to the elements of the value that were included in equation 1 for the informal sector, here the flow value includes the severance pay $s \times w$ and unemployment insurance (UI) in the case of a lay off. In our model UI is paid upfront as compensation when the worker is laid off. The only difference with severance pay is that the firm directly pays $s \times w$, whereas UI is funded by general taxation.

- Value of unemployment:

$$\begin{aligned} rU &= b + \lambda_{01} \int \max\{x - U, 0\} \, dF_1(x) + \lambda_{02} \int \max\{x - U, 0\} \, dF_2(x) \\ &= b + \int_U \left[\lambda_{01} \overline{F}_1(x) + \lambda_{02} \overline{F}_2(x) \right] dx. \end{aligned} \tag{3}$$

In other words, the opportunity cost of searching while unemployed is the value of leisure (b) plus the expected gain of searching for a job in the formal and in the informal sectors, where acceptance occurs whenever the value of working exceeds that of unemployment.

We next show that the behaviour of the unemployed can be characterised by a reservation wage policy. This follows from the monotonicity of the value functions in each sector in terms of the wage.

Lemma 1 *Value functions $W_1(w)$ and $W_2(w)$ are left-differentiable with*

$$W_1'(w) = \frac{1 + \delta_1 s}{r + \delta_1 + \lambda_{11} \overline{F}_1(W_1(w)) + \lambda_{12} \overline{F}_2(W_1(w))} > 0, \tag{4}$$

$$W_2'(w) = \frac{1}{r + \delta_2 + \lambda_{21} \overline{F}_1(W_2(w)) + \lambda_{22} \overline{F}_2(W_2(w))} > 0. \tag{5}$$

Since $W_i(w)$ is increasing in w, there exists a reservation wage for offers arriving from the formal sector w_1^R and one for offers from the informal one w_2^R, such that workers are indifferent between accepting a job offer and remain unemployed:

$$U = W_1(w_1^R) = W_2(w_2^R).$$

That is,

$$w_1^R = (1 + \delta_1 s)^{-1} \left[b - \delta_1 UI + (\lambda_{01} - \lambda_{11}) \int_U \overline{F}_1(x) dx + (\lambda_{02} - \lambda_{12}) \int_U \overline{F}_2(x) dx \right], \tag{6}$$

$$w_2^R = b + (\lambda_{02} - \lambda_{22}) \int_U \overline{F}_2(x) dx + (\lambda_{01} - \lambda_{21}) \int_U \overline{F}_1(x) dx, \tag{7}$$

where U satisfies equation (3).

When employed, the optimal strategy is to accept any contract offer which gives the worker a strictly higher value than the current one; because moves involve the possibility of changing sector, it is possible that the workers may take a pay cut in particular to move from the informal to the formal sector.

2.3 Steady-State Worker Flows

In equilibrium the stocks of workers and firms in each sector and in each part of the wage distribution remains stable, which constrains all flows between sectors to balance. We now define these flows and use them to solve for the steady state stocks and for the relationship between the equilibrium wage offer distribution and accepted offers.

The fraction of labour force in each sector is m_i $(i = 1, 2)$ and the unemployment rate is $u = 1 - m_1 - m_2$. Let $G_1(W)$ and $G_2(W)$ be the proportion of the stock of individuals with a contract value lower than or equal to W, respectively. For any $W \geq U$,

$$\begin{aligned} &\left(\delta_1 + \lambda_{11}\overline{F}_1(W)\right) m_1 G_1(W) + \lambda_{12} m_1 \int_U^W \overline{F}_2(x) dG_1(x) \\ &= \lambda_{01} u F_1(W) + \lambda_{21} m_2 \int_U^W \left[F_1(W) - F_1(x)\right] dG_2(x). \end{aligned} \tag{8}$$

On the left hand side of equation 8 are the jobs destroyed in the formal sector which have a contract value lower than W. Job destruction takes place because of layoffs (δ_1) receipt of offers valued more the W from other formal firms and receipt of acceptable offers from the informal sector. On the right hand side is the balancing job creation. Jobs are created when the unemployed accept offers less than W or workers in the informal sector receive and accept offers whose value is lower than W.

Similarly we can also define the flow equation for the informal sector as

$$\begin{aligned} &\left(\delta_2 + \lambda_{22}\overline{F}_2(W)\right) m_2 G_2(W) + \lambda_{21} m_2 \int_U^W \overline{F}_1(x) dG_2(x) \\ &= \lambda_{02} u F_2(W) + \lambda_{12} m_1 \int_U^W \left[F_2(W) - F_2(x)\right] dG_1(x). \end{aligned} \tag{9}$$

An equivalent expression is given by

$$d_i(W)m_iG_i(W) = \lambda_{0i}uF_i(W) - \lambda_{ij}\int_U^W m_iG_i(x)dF_j(x) + \lambda_{ji}\int_U^W m_jG_j(x)dF_i(x), \text{ for } i,j=1,2 \tag{10}$$

where

$$d_i(W) = \delta_i + \lambda_{ii}\overline{F}_i(W) + \lambda_{ij}\overline{F}_j(W) \qquad (i,j=1,2) \tag{11}$$

is the total destruction rate for jobs with value less than W in the respective sector.

In the Appendix we show that the two flow equations imply the following equilibrium relationship between the distribution of offered (F_i) and accepted (G_i) wages in each sector, i.e.

$$\begin{aligned} m_1G_1 &= \frac{\lambda_{01}F_1 - \Phi}{d_1}u, \\ m_2G_2 &= \frac{\lambda_{02}F_2 + \Phi}{d_2}u, \end{aligned} \tag{12}$$

where $\Phi(W)$ is given by

$$\Phi(W) = \frac{\int_U^W e^{\int_U^x B(x^\vartheta)dx^\vartheta}A(x)dx}{e^{\int_U^W B(x)dx}}, \tag{13}$$

and the components A and B are defined as

$$A = \lambda_{01}F_1\tfrac{\lambda_{12}f_2}{d_1} - \lambda_{02}F_2\tfrac{\lambda_{21}f_1}{d_2},$$

$$B = \tfrac{\lambda_{12}f_2}{d_1} + \tfrac{\lambda_{21}f_1}{d_2}.$$

where f_i represent the density functions corresponding to the distributions F_i. We can derive expressions for the proportion of workers in each sector and in unemployment, by setting W equal to its largest value and making use of the fact that $m_1 + m_2 + u = 1$:

$$\begin{aligned} u &= \frac{\delta_1\delta_2}{(\delta_1-\delta_2)\Phi(\overline{W}) + \delta_1\delta_2 + \delta_1\lambda_{02} + \delta_2\lambda_{01}} \\ m_1 &= \frac{\delta_2(\lambda_{01} - \Phi(\overline{W}))}{(\delta_1-\delta_2)\Phi(\overline{W}) + \delta_1\delta_2 + \delta_1\lambda_{02} + \delta_2\lambda_{01}} \\ m_2 &= \frac{\delta_1(\lambda_{02} + \Phi(\overline{W}))}{(\delta_1-\delta_2)\Phi(\overline{W}) + \delta_1\delta_2 + \delta_1\lambda_{02} + \delta_2\lambda_{01}}. \end{aligned} \tag{14}$$

Hence, knowledge of F_1 and F_2 allows us to infer m_1, m_2, u, G_1 and G_2. IN turn F_i represent the optimal strategy of firms, to which we now turn.

2.4 Firms

Firms differ by their labour productivity p. The total measure of potentially active firms is normalized to 1. The distribution function of p is $\Gamma_0(p)$, with $\underline{p} \geq 0$ the infimum and $\overline{p}$ the supremum point. Firms maximise profits by choosing in which sector to operate and the wage they will post, which determines the size of their labour force. Thus, in each sector, the measure of active firms is endogenous, because it depends on the choice of firms to operate in that sector, given their productivity p.

Firms in the formal sector have to pay labour/income taxes on behalf of the worker (τ), corporate taxes on profits (t) and severance payments in proportion to the current wage ($s \times w$) to workers who are laid off. Finally, these firms may be subject to minimum wage laws w_{min}.Informal labour markets are monitored by the government authorities whose role is to enforce tax and labour laws. This implies an expected cost of informality of C in every period.

There are no adjustment costs and no dynamics in the firms' decision. They just maximise profit flows

$$\begin{aligned} \pi_1(p) &= \max_{W \geq U}\{(1-t)\left[p - (1+\tau+\delta_1 s)w_1(W)\right]\ell_1(W)\} \\ \pi_2(p) &= \max_{W \geq U}\{\left[p - w_2(W) - C\right]\ell_2(W)\}, \end{aligned} \tag{15}$$

where we have written the optimisation problem of the firm in terms of choice of contract value W offered to a worker. Thus, $w_i(W)$ denotes the wage to be paid to a worker in sector i corresponding to a contract value W. This implies a workforce of size $\ell_i(W)$, $i = 1, 2$, which are defined as follows. More specifically, functions $w_1(W)$ and $w_2(W)$ are the wages w_1 and w_2 such that $W_1(w_1) = W$ and $W_2(w_1) = W$, i.e., from equations (2) and (1):

$$(1+\delta_1 s)\, w_1(W) = (r+\delta_1)\, W - \delta_1 (U + UI) - \lambda_{11} \int_W^{\mathsf{Z}} \overline{F}_1(x)dx - \lambda_{12} \int_W^{\mathsf{Z}} \overline{F}_2(x)dx, \tag{16}$$

and

$$w_2(W) = (r+\delta_2)\, W - \delta_2 U - \lambda_{21} \int_W^{\mathsf{Z}} \overline{F}_1(x)dx - \lambda_{22} \int_W^{\mathsf{Z}} \overline{F}_2(x)dx. \tag{17}$$

functions $\ell_1(W)$ and $\ell_2(W)$ are the (normalized) sizes of a firm offering a value W in sectors

1 or 2:

$$\ell_1(W) = \frac{m_1 g_1(W)}{n_1 f_1(W)}, \tag{18}$$

$$\ell_2(W) = \frac{m_2 g_2(W)}{n_2 f_2(W)}, \tag{19}$$

where n_1 and n_2 are the (equilibrium) numbers of active firms in the formal and informal sectors. Differentiating the equilibrium flow conditions given in equation (10) yields the following equivalent expressions for firm sizes in terms of the flows in and out of work in each sector, i.e:

$$\ell_1(W) = \frac{1}{n_1}\frac{h_1(W)}{d_1(W)}, \tag{20}$$

$$\ell_2(W) = \frac{1}{n_2}\frac{h_2(W)}{d_2(W)}, \tag{21}$$

where $h_1(W)$ and $h_2(W)$ denote the share of contacts between firms and workers willing to accept a job paid less than W, i.e.

$$h_1(W) = \lambda_{01}u + \lambda_{11}m_1 G_1(W) + \lambda_{21}m_2 G_2(W), \tag{22}$$

$$h_2(W) = \lambda_{02}u + \lambda_{12}m_1 G_1(W) + \lambda_{22}m_2 G_2(W), \tag{23}$$

$\frac{1}{n_1}$ and $\frac{1}{n_2}$ are proportional to the probabilities of drawing any firm in each sector (random matching), and $d_1(W)$ and $d_2(W)$ are the job destruction rates given in equation 11.

$$d_1(W) = \delta_1 + \lambda_{11}\overline{F}_1(W) + \lambda_{12}\overline{F}_2(W), \tag{24}$$

$$d_2(W) = \delta_2 + \lambda_{21}\overline{F}_1(W) + \lambda_{22}\overline{F}_2(W). \tag{25}$$

2.5 Equilibrium productivity distributions

We now need to determine how firms locate in the two sectors. The first observation is that we cannot exclude the possibility that firms are indifferent between the two sectors over some productivity range. Thus when we search for the equilibrium distributions within the informal and the formal sector we define the support of the productivity distribution for informal firms to be $[\underline{p}, \overline{p}_2]$ and for formal firms $[\underline{p}_1, \overline{p}]$, where it is possible that $\overline{p}_2 > \underline{p}_1$, i.e. the maximum productivity at which some firms operate in the informal sector can be higher than the minimum productivity at which some firms decide to operate in the formal one.

We denote the equilibrium measure of productivity in each sector by $\Gamma_i(p)$ $(i = 1, 2)$ and Γ_2. Then, Γ_1 and Γ_2 must have corresponding densities such that

- $\gamma_1(p) = \gamma_2(p) = 0$ if $\pi_1(p) \leq 0$ and $\pi_2(p) \leq 0$;
- $\gamma_1(p) = 0, \gamma_2(p) = \gamma_0(p)$ if $\pi_2(p) > \max\{0, \pi_1(p)\}$;
- $\gamma_1(p) = \gamma_0(p), \gamma_2(p) = 0$ if $\pi_1(p) > \max\{0, \pi_2(p)\}$;
- $\gamma_1(p) > 0, \gamma_2(p) > 0, \gamma_1(p) + \gamma_2(p) = \gamma_0(p)$ if $\pi_1(p) = \pi_2(p) > 0$.

In all likelihood, because of a possible minimum wage in the formal sector, there will be an initial interval of productivity where all activity is accounted for by informal firms ($\underline{p}_2 < \underline{p}_1$), and wage offers are below the minimum wage; for firms with $\underline{p}_1 \leq p \leq \overline{p}_2$ firms operate in both sectors. We also allow for the possibility that there is a range of productivities ($p > \overline{p}_2$) where firms operate only in the formal sector. Given this, the following regimes will be considered.

1. **Inactivity**: $\forall p < \underline{p}_2$, $\Gamma_1(p) = \Gamma_2(p) = 0$.
2. **Informal sector only**: $p \in [\underline{p}_2, \underline{p}_1)$. The lower bound $\underline{p}_2$ verifies

   $$\pi_2(\underline{p}_2) = 0 \Leftrightarrow \underline{p}_2 = w_2^R + C,$$

   and for all $p \in [\underline{p}_2, \underline{p}_1)$,

   $$\begin{aligned} \Gamma_1(p) &= 0, \\ \Gamma_2(p) &= \Gamma_0(p). \end{aligned} \tag{26}$$

3. **Overlapping region**: $p \in [\underline{p}_1, \overline{p}_2]$. For all $p \in [\underline{p}_1, \overline{p}_2]$,

   $$\Gamma_1(p) + \Gamma_2(p) = \Gamma_0(p) - \Gamma_0(\underline{p}_2)$$

   and

   $$\pi_1(p) = \pi_2(p). \tag{27}$$

   Note that a standard value iteration algorithm is not likely to work here. We rather search for $\Gamma_1(p)$ (and $\Gamma_2(p) = \Gamma_0(p) - \Gamma_0(\underline{p}_2) - \Gamma_1(p)$) such that $\pi_1(p) = \pi_2(p)$ on a discrete grid $p = (p_1 = \underline{p}_1 < p_2 < ... < p_N = \overline{p}_2)$.

Formal sector only: $p \in (\overline{p}_2, \overline{p}]$. For all $p \geq \overline{p}_2$,

$$\begin{aligned} \Gamma_1(p) &= \Gamma_0(p) - \Gamma_0(\underline{p}_2), \\ \Gamma_2(p) &= \Gamma_2(\overline{p}_2). \end{aligned} \tag{28}$$

2.6 Computing the Solution to the Model

In this section, we describe the steps for solving the model and finding the equilibrium wage and productivity distributions. The solution is made easier by the fact we have derived the analytical relationship between the offer and observed distribution of wages. The key computational difficulty consists of identifying the overlapping distribution of productivities Γ_1 and Γ_2.

We take as given the policy variables, namely the corporate (t) and labour (τ) taxes, severance pay s, the minimum wages and the expected fine C. The model is solved for a given discount rate r and for a particular set of structural parameters, which are the job destruction and arrival rates $(\delta_1, \delta_2, \lambda_{01}, \lambda_{02}, \lambda_{11}, \lambda_{12}, \lambda_{22}, \lambda_{21})$ and the distribution of productivity $\Gamma_0(p)$, which is specified to be Pareto.

1. **Initialising the overlap region.** As we described earlier it is possible that there is a range of productivities over which formal and informal firms coexist. Over this range we have that $\pi_1(p) = \pi_2(p)$. Thus we need to solve for the thresholds $\underline{p}_1, \overline{p}_2$ of the overlap and for the functions $\Gamma_1(p)$and $\Gamma_2(p)$ within this region, such that $\Gamma_0(p) = \Gamma_1(p) + \Gamma_2(p)$. To find these we minimise $|\pi_1(p) - \pi_2(p)|$ on a discrete grid of $p = (\underline{p}_1 = p_1 < p_2 < ... < p_N = \overline{p}_2)$. We repeat the computational steps below for all pairs of $\underline{p}_1, \overline{p}_2$ on our grid.

2. Given the values for the thresholds (26 and 28) define the measure of firms in the formal and informal sector in the range where there is no overlap in activity. In the overlapping range $[\underline{p}_1, \overline{p}_2]$, we assume initial values for $\Gamma_1(p)$ (on a grid), thus $\Gamma_2(p) = \Gamma_0(p) - \Gamma_1(p)$;

3. **Offer Distribution.** Noting that the contract values offered by the firms ($K_1(p)$ and $K_2(p)$) are increasing in productivity[4] we derive the offered distribution of contracts directly as a function of productivity in each sector using the relationship

$$\begin{aligned} F_1 \circ K_1(p) &= \Gamma_1(p)/n_1, \\ F_2 \circ K_2(p) &= \Gamma_2(p)/n_2. \end{aligned} \tag{29}$$

with $n_1 = \Gamma_1(\overline{p})$ and $n_2 = \Gamma_2(\overline{p}_2)$.We can now compute $\Phi(W)$ as a function of productivity p based on equation 39. Following this we can compute the number of individuals

[4]This is an assumption.

employed in the formal and informal sector as well as the number of unemployed (m_1, m_2 and u respectively) as shown in Section 2.3. The equilibrium wage distributions (G_1 and G_2) in terms of productivity follows from 12.

4. **Profits:** The profits in each sector are given by

$$\begin{aligned}\pi_1(p) &= (1-t)\left[p-(1+\tau+\delta_1 s)w_1(K_1(p))\right]\ell_1(K_1(p)),\\ \pi_2(p) &= \left[p-w_2(K_2(p))-C\right]\ell_2(K_2(p)).\end{aligned}$$

Differentiating each with respect to p and using the envelope theorem we can use the alternative representation

$$\begin{aligned}\pi_1(p)-\pi_1(\underline{p}_1) &= (1-t)\int_{\underline{p}_1}^{p}\ell_1(K_1(x))dx, \qquad (30)\\ \pi_2(p)-\pi_2(\underline{p}_2) &= \int_{\underline{p}_2}^{p}\ell_2(K_2(x))dx.\end{aligned}$$

From (20) to (25), we obtain the firms sizes $\ell_1 \circ K_1(p)$ and $\ell_2 \circ K_2(p)$, which are then used to compute profits at all productivity levels. These can be computed without knowledge of the contract values because we have computed the offered and equilibrium contract distributions as a function of productivity. At the lower bound of productivity for informal firms $\underline{p}_2$ profits there are zero, i.e. $\pi_2(\underline{p}_2)=0$. Assuming there is a binding minimum wage, $w_{\min}$, the minimum profit in the formal sector is given by

$$\pi_1(\underline{p}_1) = (1-t)\left[\underline{p}_1-(1+\tau+\delta_1 s)w_{\min}\,\underline{\ell}_1\right]$$

where the labour force for the lowest productivity firm is given by

$$\underline{\ell}_1 = \ell_1 \circ K_1(\underline{p}_1) = \frac{1}{n_1}\frac{\lambda_{01}u+\lambda_{21}m_2G_2(K_1(\underline{p}_1))}{\delta_1+\lambda_{11}+\lambda_{12}\overline{F}_2(K_1(\underline{p}_1))},$$

Using this we can compute profits at every level of productivity.

5. Using profits at each p , which have been computed in earlier steps, we can solve for individual wages as a function of productivity

$$\begin{aligned}w_1 \circ K_1(p) &= \left[(1+\tau+\delta_1 s)(1-t)\right]^{-1}\left[(1-t)p-\pi_1(p)/\ell_1(K_1(p)\right], \qquad (31)\\ w_2 \circ K_2(p) &= p-C-\pi_2(p)/\ell_2(K_2(p)).\end{aligned}$$

In 31 everything is known on the right hand side at this point, including the labour force size for each level of productivity. From the wages and distributions of offers follow the value of unemployment U, the formal sector values W_1 and the informal sector W_2 as shown in Section 2.2.

6. **Contract Values.** Knowledge of wages will allow us to compute the values of the two sectors (W_1, W_2) from equations 2 and 1. The value of unemployment, is set to the minimum value of work in the informal sector; this determines the value of leisure b. From 31 we have a mapping from wages to productivities. Hence the contract values $K_1(p)$ and $K_2(p)$ follow.

7. **Check for Solution.** Finally check whether $\pi_1(p) = \pi_2(p)$ in the assumed overlapping range. Repeat the computation for the remaining grid points of $\Gamma_1(p)$ (and implied $\Gamma_2(p) = \Gamma_0(p) - \Gamma_1(p)$). Once these are complete restart the process from 1 with a different pair of thresholds $\{\underline{p}_1, \overline{p}_2\}$. A solution is found when we find a pair of thresholds and a pair of firm measures $\Gamma_2(p)$ and $\Gamma_1(p)$ such that in the overlapping area $\pi_1(p)$ is arbitrarily close to $\pi_2(p)$.

3 Estimation

We estimate our model using method of moments; in particular we choose the parameters to match the observed transition rates between sectors.

Consider first the unemployed workers, who we follow over T periods. Workers are not heterogeneous in this model and hence the remaining unemployment duration is exponentially distributed. Thus the implied proportion of those who move out of unemployment and into a job in sector j over the time period of observation T is

$$D_{0j} = \frac{\lambda_{0j}}{\lambda_{01} + \lambda_{02}}(1 - e^{-(\lambda_{01} + \lambda_{02})T}); \qquad j = 1, 2 \tag{32}$$

Now consider workers in the formal sector. Over T periods the proportion making a transition to an alternative job in the same sector, to a job in the informal sector or to

unemployment is, respectively

$$\begin{aligned} D_{11} &= \int \frac{\lambda_{11}\overline{F}_1(x)}{d_1(x)}(1-e^{-d_1(x)T})dG_1(x); \\ D_{12} &= \int \frac{\lambda_{12}\overline{F}_2(x)}{d_1(x)}(1-e^{-d_1(x)T})dG_1(x); \\ D_{10} &= \int \frac{\delta_1}{d_1(x)}(1-e^{-d_1(x)T})dG_1(x). \end{aligned} \tag{33}$$

where $d_1(W) = \delta_1 + \lambda_{11}\overline{F}_1(W) + \lambda_{12}\overline{F}_2(W)$. Similarly the corresponding transition rates for those observed working initially in the informal sector are

$$\begin{aligned} D_{22} &= \int \frac{\lambda_{22}\overline{F}_2(x)}{d_2(x)}(1-e^{-d_2(x)T})dG_2(x); \\ D_{21} &= \int \frac{\lambda_{21}\overline{F}_1(x)}{d_2(x)}(1-e^{-d_2(x)T})dG_2(x); \\ D_{20} &= \int \frac{\delta_2}{d_2(x)}(1-e^{-d_2(x)T})dG_2(x). \end{aligned} \tag{34}$$

with $d_2(W) = \delta_1 + \lambda_{11}\overline{F}_1(W) + \lambda_{12}\overline{F}_2(W)$.

In the above expressions the transition rates for i to j, D_{ij}, and the equilibrium distribution G_i $(i,j=1,2)$ can be estimated directly from the data. Then the estimates $\widehat{G}_i$ are obtained by integration of $\widehat{g}_i$. Note that from wage data, one can estimate wage distributions, say $\widehat{G}_1$ and $\widehat{G}_2$. However, the model is solved with G_1 and G_2 in terms of the contract values. The latter are obtained respectively by $G_1 = \widehat{G}_1 \circ w_1$ and $G_2 = \widehat{G}_2 \circ w_2$ (from Lemma 1). The integrals involving g_1 and g_2 are solved using integration by substitution which allows direct use of $\widehat{g}_1$ and $\widehat{g}_2$, instead of g_1 and g_2 where

$$\begin{aligned} g_1 &= \widehat{g}_1 w_1' = \frac{\widehat{g}_1}{1+\delta_1 s} d_1, \\ g_2 &= \widehat{g}_2 w_2' = \widehat{g}_2 d_2. \end{aligned}$$

We present results using the Epanechnikov kernel and the bandwidth is chosen by rule of thumb. However, the results were not sensitive to the specific choice of kernel.

The offer distributions F_i $(i=1,2)$ have to be obtained as solutions to the equilibrium as explained in section 2.6. These eight transition rates depend on eight parameters, i.e. six arrival rates and two job destruction rates and the model is just identified.

To obtain estimates we thus use a nested algorithm: We start with an initial guess of the parameters. Based on this we compute the equilibrium for each sector, which yields the F_i

for each sector. Given the steady-state offer distributions we solve the moment conditions for the unknown parameters. We repeat this process until convergence.

3.0.1 Estimating Enforcement costs and Unemployment Insurance

In the above process we did not need to know directly unemployment insurance UI, the value of leisure, b or the cost of enforcement. They are all implicitly reflected in the G_i that we actually observe. However, these are all needed to perform counterfactual simulations.

Given the discount rate, r, the labour tax rate τ and the severance pay parameter s, the value of leisure b is identified from the workers value function in the informal sector. The legal minimum wage is not enforced in that sector and hence the minimum observed wage is the reservation wage. Combining this with the value of unemployment we can identify b.[5]

For unemployment insurance we could use data. Alternatively we can back it out from the model, by imposing a government budget constraint. About 8.5% of receipts from labour taxes fund UI. Hence we compute the implied UI using the government budget constraint

$$0.085\tau \int_{\underline{w}_1}^{\overline{w}_1} x dG_1(x) = UI \cdot \delta_1.$$

However, using observed UI and the exploiting possible policy changes could add to the identification of the model. Finally, the implied cost of informality C can be backed out based on

The equality of profits in the overlapping area $\pi_2(\overline{p}_2) = \pi_1(\overline{p}_2)$ identifies the enforcement cost parameter C.

3.0.2 Endogenous arrival rates: Estimating a matching function.

Our approach is to estimate the model for different skill groups and genders separately assuming that there are no spillovers across markets. For each group we estimate a different set of parameters per region and time period. This raises the question of whether we can link the way that the arrival rates and the enforcement costs vary over time and region. In this section we describe a minimum distance procedure that we use to estimate the parameters of an implied matching function and of a function linking the degree of observed monitoring of informal firms to the estimated levels of expected fines (C).

[5] An important issue here is measurement error. At present we have not allowed for wages to be measure with error. If we did, this would affect the estimation of the the distributions G and the value of leisure b.

Consider the possibility of congestion effects in the job offer arrival rates. A simple way to model λ_{ij} is as follows. An unemployed worker has search effort $s_0 = 1$ (normalisation). The search effort of employed workers is s_1 or s_2 depending on the sector in which they work. Assume that the flow of contacts between firms (in general) and workers are given by a matching function $f(\theta)$. We assume that an offer from the formal sector can be sampled with probability $n_1/(n_1 + \alpha n_2)$ while an offer from the informal sector is sampled with probability $\alpha n_2/(n_1 + \alpha n_2)$.[6] Thus, we define the job offer arrival rates to workers in state $i = 0, 1, 2$ from the formal sector and from the informal sector, respectively

$$\lambda_{i1} = \frac{n_1}{(n_1 + \alpha n_2)} s_i f(\theta);$$

$$\lambda_{i2} = \frac{\alpha n_2}{(n_1 + \alpha n_2)} s_i f(\theta).$$

where market tightness is defined as

$$\theta = \frac{n_1 + \alpha n_2}{u + s_1 m_1 + s_2 m_2}$$

and we specify $f(\theta) = \mu\theta^{\eta}$. [7]

We use minimum distance to estimate the search effort parameters s_1 and s_2 and for the remaining matching function parameters α, μ and η. The basic premise of this approach is that the differences across time and regions (local labor markets) can be summarised simply as differences in market tightness.

4 Data

4.1 The labour force survey

Our main source of data consists of a panel of individuals at working age sampled by the labour force survey of Brazil, *Pesquisa Mensal de Emprego* (PME). PME was designed and conducted by the National Statistics Bureau to follow individuals of the six main metropolitan regions of Brazil. Each individual is interviewed during four consecutive months, then for another

[6] Interpretation of α.

[7] This implies an average contact rate for firms $f(\theta)/\theta = \frac{u\lambda_{0j} + m_1\lambda_{1j} + m_2\lambda_{2j}}{n_j}$ which is the same for the informal and for the formal market.

four consecutive months one year after its entry into the sample. The sample period starts on January 2002 and goes until December 2007.[8]

For the purpose of this paper, we select workers aged 23 to 65 who are found to be either unemployed[9] or working as an employee (registered or unregistered). Our definition of formal workers in this paper is thus whether the worker's current job is registered with the Ministry of Labour.[10] In Brazil, there is a federal minimum wage, which should be the minimum paid to all formal employees. The average legal minimum wage over the sample period is of 300 Reais per month.[11] Workers under a formal contract found to earn less than the minimum wage were taken out from sample (8% of formal workers). We believe this is due to reporting error and we similarly discard the 5% lowest wages out of the informal workers sample, thus excluding mostly the zero-wage earners and the part-time jobs. We also trim the very top wages (0.01% highest of the sample).

Table 1 shows, by year, the proportions of workers in each category: unemployed, formal salaried and informal salaried. The cross-sectional sample contains about 66% of formal salaried workers, 20% of informal salaried and 14% of unemployed. Over the period 2002-2007, we observe a large increase in the proportion of formal wage workers. In particular, substantial changes have taken place more recently with the formal workers proportion increasing from 64% in 2004 to 68% in 2007. On the other hand, for the same period, we observe a small decline in the proportion of informal workers and a large drop in the unemployed proportion, respectively, by 1.6 and 2.9 percentage points.

Now, looking at our measure of informality (proportion of informal employees in the population 23 to 65 yrs old), we see that a significant fraction of workforce is informal in the six largest metropolitan regions of Brazil, an average of 24%. As Table 1 shows, informality in our data increased until 2004 following the same trend observed since the 80s in the country. What is more striking is that this trend has been recently inverted with informality declining

[8] Due to methodological changes in the PME data from 2002, we opted to use only the new PME. The first reason is that we solve for the steady-state, which is an assumption hard to defend over a long period of time. The second reason is that the new PME contains retrospective information about duration of the actual employment, which we need to identify job-to-job transitions.

[9] We take out unemployed whose last job was not as an employee. By doing so, we exclude mostly unemployed who once was self-employed or inactive, e.g. individuals whose behaviour deviate from the predictions of our model.

[10] The job is registered if the worker reports having its worker's card "signed" by the firm.

[11] All wages are in Reais of June/2008.

	2002	2003	2004	2005	2006	2007	Total
Unemployed	15.1	15.9	14.9	13.0	13.1	12.0	13.9
Formal salaried	64.7	63.6	63.9	65.7	66.5	68.4	65.6
Informal salaried	20.2	20.5	21.2	21.2	20.4	19.6	20.5
Informality Rate	23.8	24.3	24.9	24.4	23.5	22.2	23.8

Table 1: Working Status, by year.

by 2.7 percentage points in 3 years, from 2004 to 2007.

4.1.1 Transitions

In this paper, we follow individuals up to four months or until their first move which can be job-to-job, unemployment-to-job or job-unemployment, where the job can be in the formal or in the informal sector.[12] At the date of the first interview, we observe the worker's employment status, the duration of spell (time elapsed) and the wage earned. From the subsequent three months, we construct the censoring indicator (**equal to one if the individual or data is missing in all three following months**), the remaining time in the status and the transition indicators. What allows us to identify within sector job transitions (e.g. formal to formal and informal to informal) is the survey question about time of job spell[13]. For example, we consider that a worker has not moved if initially they are a formal worker, declare to be formal in the third month of interview, but answered that the last job duration is more than two months. A description of information we have for transitions is at Table 10 by year and at Table 11 by region.

As Table 10 displays, the average exit rate from unemployment within 4-months is high, which reflects a low duration of unemployment spell (11 months) in the main regions of Brazil. Exit from unemployment to an informal sector job is more frequent and anti-cyclical as we can observe during economic downturns, e.g. during 2003 and 2004. Exit to the formal sector has an increasing trend which accompanies the increase in the proportion of formal workers in the last two years of the sample. Next, the percentage of workers who move job-to-job shows low mobility for initially formal workers and high mobility for informal workers. This is confirmed when we look at average duration of formal and informal jobs, which are respectively 70 and

[12] We do not use the entire sixteen-months window of PME due to attrition problems.

[13] This question is only available in PME after year 2002.

45 months, e.g. much higher among formal employees. The fact that within-sector turnover is higher during recession periods is striking. Maybe this is due to more job separations and fast reallocation. Another interesting fact in this data which confirms evidence found in the empirical literature is that the flow is higher from informal to formal, rather than the contrary. Besides, workers transit more from the informal sector to formal more recently, also contributing to raising formality in past years.

At Table 11, the results by metropolitan region show significant variation on the employment status and on turnover rates across different locations in Brazil. According to local development, we could separate Recife and Salvador as low developed areas from the remaining four regions Sao Paulo, Rio de Janeiro, Belo Horizonte and Porto Alegre as the high developed group. For the low development areas, the two first lines of Table 11 show that unemployment is high, around 18%, while it is about 12% for the high developed areas. Interestingly, we could not associate informality only with level of development. While Recife has about 30% informality rate, Sao Paulo is as informal as Salvador, with respectively 25% and 24%.

Regarding the turnover rates, it is not obvious either to which region characteristics we can associate them. Data shows however that Rio de Janeiro and Salvador distinguish themselves from the other regions as they present much lower turnover rates. Furthermore, Rio de Janeiro has the longest job tenure in the formal (76 months) and in the informal sector (52 months), while Belo Horizonte the shortest duration with 65 in the formal and 42 months in the informal.

To account for workers heterogeneity we estimate the model by sex and education groups. Low education means having 8 or less years of schooling and high education above 8.[14] The composition of workers at the date of the first interview, informality rate and turnover information are provided in Table 4, by group.

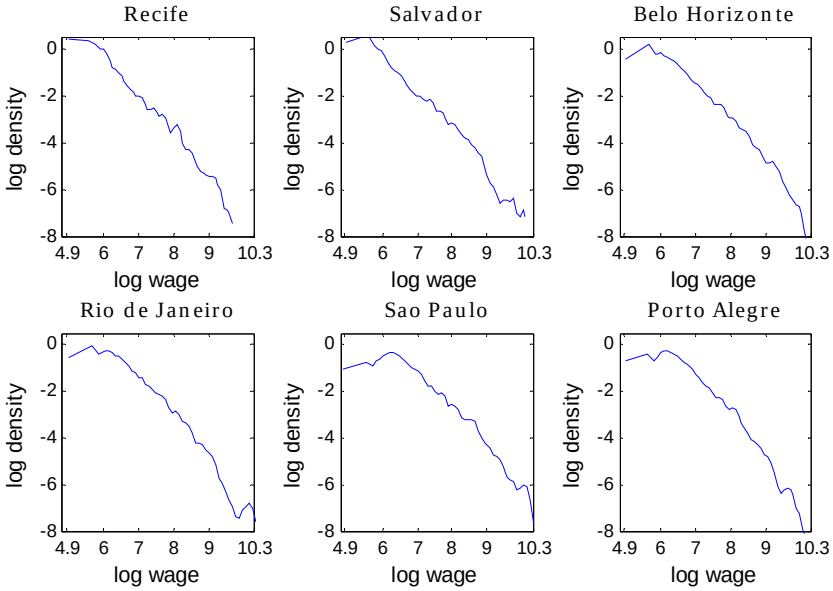
In our estimation, we also separate the economy in segments defined by metropolitan region and year. As we are going to see later, this is particularly convenient for simulation

[14]Note that due to missing education values, the results for all sample in this table will not match that of tables 2 and 3. In our estimations using all sample data, we consider the individuals with missing education.

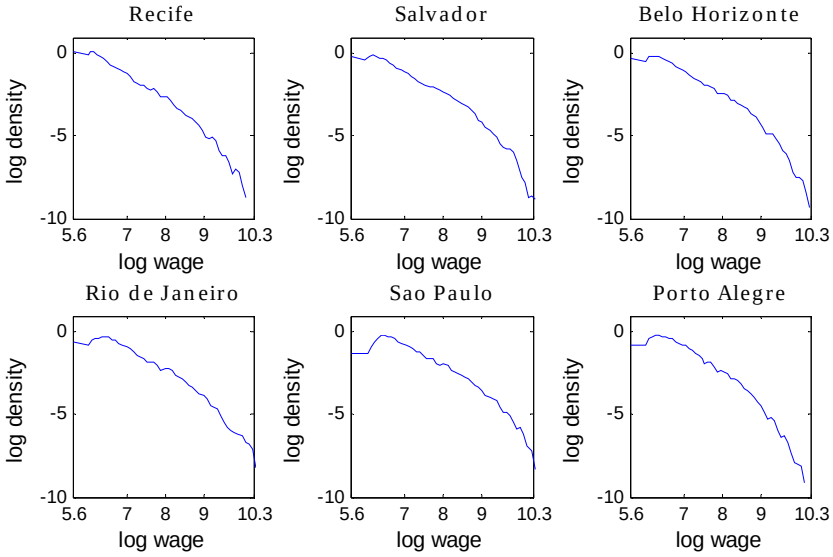
	All sample	Male	Male	Female	Female
		low education	high education	low education	high education
Number of Individuals	431,099	128,978	127,935	56,787	117,399
Unemployed	56,495	14,289	11,749	12,614	17,843
Formal	283,808	82,331	93,506	30,876	77,095
Informal	90,796	32,358	22,680	13,297	22,461
Informality Rate (%)	24.2	28.2	19.5	30.1	22.6
Censored Observations (%)	24.3	24.0	22.5	29.3	24.3
Unemployed	34.5	35.4	29.0	42.3	31.8
Formal	20.8	19.8	20.5	22.9	21.5
Informal	28.9	29.6	27.3	31.8	27.9
Transitions (% of workers by initial status)					
Unemployed-Formal	9.68	11.13	13.66	5.23	8.51
Unemployed-Informal	15.34	24.00	17.06	8.89	11.48
Formal-Formal	2.13	2.22	2.13	2.06	2.08
Formal-Unemployed	1.99	2.15	1.96	1.88	1.91
Formal-Informal	0.33	0.46	0.27	0.30	0.27
Informal-Informal	5.62	7.16	4.65	5.47	4.54
Informal-Unemployed	6.48	7.74	5.74	6.29	5.57
Informal-Formal	1.11	1.39	1.07	0.74	0.96
Mean Duration (in months)					
Unemployed	11.2	10.8	10.7	11.7	11.4
(std.dev)	12.9	13.1	12.0	13.5	12.8
Formal	70.1	71.2	73.7	64.0	67.2
(std.dev)	75.8	77.9	79.1	69.6	71.6
Informal	44.8	45.5	47.9	42.5	42.0
(std.dev)	65.3	69.1	66.8	62.7	59.1

Table 2: Description of data, by sex and education.

because it gives the variation we need to match with policy data varying by region and year. To illustrate, Figures ?? and ?? plot the kernel estimates of the wage densities g_1 and g_2 by region, e.g. the densities of earned wages at the date of the first interview.



Log-density of wages in the Informal sector, by region \bigskip



Log-density of wages in the Formal sector, by region \bigskip

For the first two regions (Recife and Salvador) wages concentrate more at the minimum value observed in our sample. The legal minimum wage is about 5.6 in log terms and that is the minimum in the formal sector. For all the other regions, we observe more of a log-normal shape for both wage distributions.

4.2 Enforcement data

We use administrative data on the enforcement of labour regulations, collected by the Department of Inspections at the Ministry of Labour of Brazil (biannually, from 1996 to 2006). The data was used in Almeida, Carneiro and Narita (2009) and kindly provided by the first two authors. A comprehensive explanation of the enforcement of labour regulation system in Brazil is in Almeida and Carneiro (2009). In short, the Ministry of Labor is in charge of enforcing compliance with labor regulation in Brazil. Given the size of the country, enforcement is first decentralized at the state level and then at a local level, which are the subregions within each state of Brazil. Each metropolitan region is a subregion in itself and there is located the main office of labour inspection in the state. Most of the inspections and fines applied are to ensure firms compliance with the worker's formal registration, severance pay, wage and working time. This accounts for about 62% of all causes for fines applied to firms. Fines can be fixed per worker, or indexed to firm size and profitability. For example, a firm is fined by Reais 403 for each worker that is found unregistered and by Reais 170 per worker due to infractions related to wage such as delay or lack of payment of contractual wage. Depending on its size and profitability, if a firm does not comply with the mandatory contributions towards severance, then it can be fined an amount between Reais 11 and Reais 106 per employee. The fines related to working time (daily, weekly or extra hours) vary from Reais 40 to 4,025 also per worker. In all these mentioned situations, recidivism leads to fine values being doubled. Given that the legal mininum wage is 415 in Reais of 2009, at least for low profit firms, we argue that the fine values are quite significant to deter firms from crime.[15]

In particular, the data contain information on the number of inspections per city. We then construct the number of inspections per metropolitan area present in PME data. To obtain our measure of enforcement, we use the total number of firms by region and year, which is information of all registered firms organized by the National Statistics Bureau. In our paper, the measure of enforcement is thus the number of inspections per firm, which is showed in Table 3, by region and for entire country.

In Brazil, the labour inspection reaches a considerable fraction of firms and decreased

[15] Carneiro and Almeida (2009) also mentions that small businesses are more likely to have to pay the fines. This is because they do not have their own legal department to contest the fine and possibly avoiding paying it. Moreover, if a firm agrees on the fine and pays within 10 days of their notification, there is a 50% discount.

	1996	1998	2000	2002	2004	2006	Total
Recife	0.437	0.198	0.238	0.144	0.136	0.151	0.201
Salvador	0.243	0.108	0.181	0.107	0.076	0.104	0.127
Belo Horizonte	0.174	0.229	0.167	0.118	0.092	0.096	0.139
Rio de Janeiro	0.188	0.135	0.159	0.103	0.092	0.083	0.122
Sao Paulo	0.086	0.070	0.068	0.058	0.048	0.049	0.061
Porto Alegre	0.150	0.085	0.097	0.064	0.046	0.056	0.078
BRAZIL	0.122	0.091	0.095	0.067	0.058	0.066	0.079

Table 3: Number of Inspections per firm

overtime from 12%, in 1996, to 7%, in 2006. The enforcement level, by region, shows similar trend but clearly different levels and size of variation over the years. That variation is what we are going to explore in this paper to simulate the policy impact of labour inspection on our equilibrium level of informality and wage distributions.

5 Results

5.1 Frictional Parameters

The model can be fitted to different markets separately, treating each as a segmented labour market, between which workers do not compete directly. Within this context, aggregating markets is equivalent to broadening the amount of competition but imposing homogeneity across workers, who we might think of as dissimilar in terms of tastes and productivity. In what follows we summarise the results by level of education and by male and female.

Table 4 shows the estimates of the job destruction and the job arrival rates. The unit of time is a month. Subscript 1 refers to the formal sector and 2 to the informal. The arrival rates λ_{ij} denote an offer arriving from sector j to someone currently in sector i. Looking at the pooled results the destruction rates are three times as high in the informal sector than in the formal one. Informal jobs, in the absence of job to job mobility are expected to last nearly five years; so even they are very stable. Unemployed workers receive 50% more offers from the informal sector than the formal one. Interestingly, the arrival rates of jobs from other informal jobs is higher for individuals already in the informal sector than for those who are unemployed; so in terms of sampling informal sector jobs, it pays to be working in the

	δ_1	δ_2	λ_{01}	λ_{02}	λ_{11}	λ_{22}	λ_{12}	λ_{21}
All sample	0.0051	0.0176	0.0281	0.0442	0.0319	0.0717	0.0044	0.0058
Male, low education	0.0055	0.0211	0.0343	0.0739	0.0324	0.0950	0.0048	0.0071
Male, high education	0.0050	0.0152	0.0408	0.0510	0.0291	0.0517	0.0032	0.0057
Female, low education	0.0048	0.0168	0.0141	0.0240	0.0346	0.0703	0.0031	0.0044
Female, high education	0.0049	0.0148	0.0237	0.0320	0.0305	0.0527	0.0032	0.0055

Time unit: month.

Table 4: Friction Parameters

informal sector. This is also true for formal workers. Thus an unemployed worker receiving an offer will improve her search productivity in the sector they received the offer from by taking on the job. Crossing sectors however is much harder on the job with very low arrival rates.

Looking down the table, we see that job destruction rates from the informal sector are basically the same across genders and education. here is some variation for the informal job destruction rates, with the highest rates seen from low education males whose jobs are expected to last less that 5 years (with no job mobility). Low education males also have the highest arrival rates from the informal sector when unemployed, while high education ones the highest arrival rates from the formal one. Low education males also receive about one offer every 11 months to move to an alternative job in the informal sector. Women tend to have lower arrival rates when unemployed, although low education women fare worse than high educated ones in this respect.

In Table 12 we report estimates of the model by region and time. There is quite some variation (standard errors to follow!) and interesting patterns are revealed; for example in many cases we see job destruction rates increasing over time and the arrival rates for the unemployed also increasing. Moreover the arrival rates for jobs in the formal and the informal sector do not always move in the same direction. Overall, periods of lower unemployment are associated with higher job mobility, particularly in the informal sector

5.1.1 Informality Cost the value of leisure and the level of informality

Table 5 presents the implied cost to the firm of remaining informal. This cost arises from random monitoring and imposition of fines. We report the cost in absolute terms and in terms of its relationship to productivity. Based on either of these measures the costs are substantially lower for female workers. This may reflect the type of occupation, such as domestic work, which may be subject to lower levels of monitoring.

In the next two columns we present the estimated flow value of leisure. In all cases this comes close to the minimum wage in the informal sector. Note that because search is more efficient when working it is possible that the lowest wage offered is lower than the flow value of leisure, as it happens for low educated females.

In Table 13 in the appendix we present the results from estimating the model in time region cells. There is substantial variation in the cost of informality both across region and time; whether we can relate this to observable indicators of monitoring will be the subject of a later section. However, overall it seems that the estimated costs of informality has been decreasing according to our model estimates, but the number of inspections have remained quite stable over this time period.

The relative value of leisure varies quite a lot across regions and a bit over time; it has tended to decline with the aggregate unemployment rate. Thus the model attributes at least part of the decline in unemployment to a decline in reservation wages.

In Table 6 we present the implied stocks of workers and firms in each of the states. There are more low education workers in the informal sector, but the difference is more pronounced amongst men. When we estimated the model by region and time (see Table 14 in the appendix) we found that in most areas the number of formal jobs increased, in terms of the number of individuals involved (m_1). This increase is generally accompanied by a decline in informality, except in one case where it has been related to a decline in unemployment. However, when we consider the number of firms in the formal and informal sector, the patterns

	C	$C/min(p)$	b	$b/min(w_2)$
All sample	373.4	0.739	4.858	0.996
Male, low education	325.1	0.712	4.798	0.983
Male, high education	307.6	0.688	4.462	0.904
Female, low education	188.4	0.562	5.151	1.032
Female, high education	187.2	0.568	4.941	0.997

Table 5: Informality Cost and Value of Leisure

	m_1	m_2	u	n_1	n_2
All sample	0.5886	0.2973	0.1141	0.680	0.307
Male, low education	0.5499	0.3531	0.0970	0.610	0.381
Male, high education	0.6391	0.2796	0.0813	0.720	0.265
Female, low education	0.5176	0.2897	0.1927	0.680	0.293
Female, high education	0.5917	0.2818	0.1265	0.720	0.273

Table 6: Steady-State Stocks

are not always in line with the number of workers in the firms. For a number of regions, while the number of workers in the formal sector has increased, the number of firms has declined, implying a growing size of formal firms in these cases. We do not have a direct way of verifying this implication that derives directly as an implication of a the changing equilibrium.

5.2 Formal and informal sector productivity

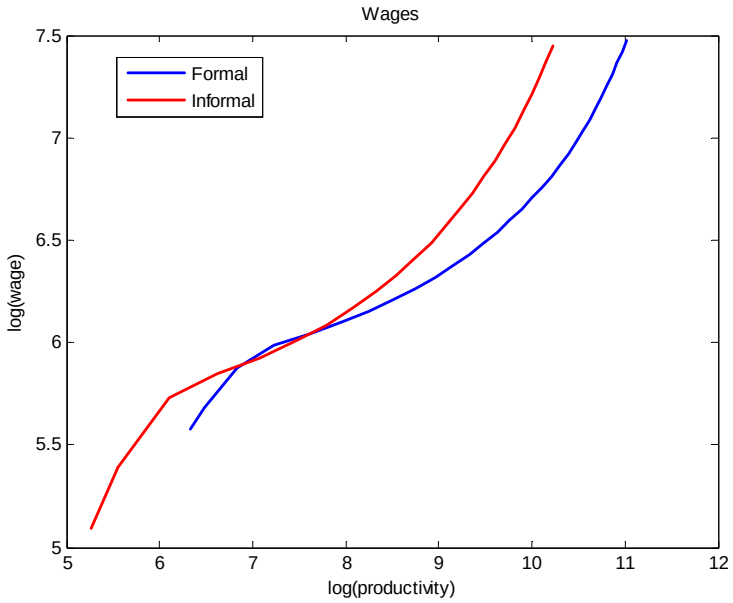
How do firms decide where to locate and is it the case that informal firms have productivities that would make it prohibitively expensive to become formal. Does informality expand substantially the economy in terms of allowing firms that would not operate in the formal sector

under the existing regulatory framework to actually enter the market? We have two ways of answering this crucial policy question: first we look at the range of productivities over which formal and informal firms operate.; second we simulate the implications of closing down the informal sector.

Remember that according to our model it is possible that over a range of productivities a firm may find it equally profitable to locate in the formal or the informal sector. Our model does not resolve how this choice is made; we thus think of it as a mixed strategy with the probabilities of locating in each sector being determined by the overall equilibrium.

As it happens formal firms can be profitable at almost all levels of productivity that informal firms are profitable, suggesting that closing down the informal sector may not be as costly.

In this section we estimate the model for two regions, Salvador - a poor region and San Paulo (a relatively better off city) for low education males . For these groups we present solutions to the model for wages, proportions employed in each sector and implied labour force size by firm (n_1, n_2).

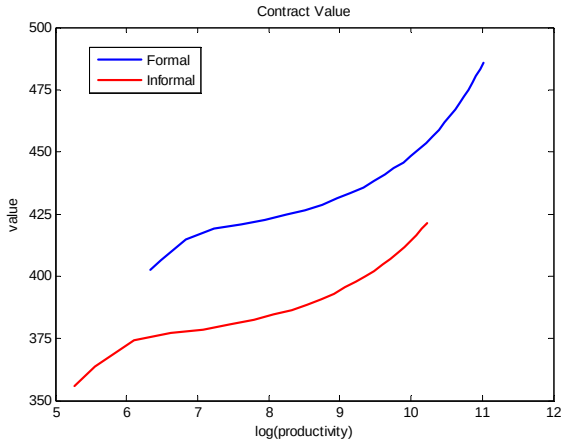


Male Wages by Productivity - Salvador

Graph **??** plots equilibrium log wages in the informal and the formal sector. The informal sector starts at low productivities. The formal sector then begins at a level of productivity at least twice the minimum informal level. The two sectors then operate over a wide range. At higher levels of productivity only formal firms enter. For reasons of scale we have truncated

to the right the range of high productivities for formal firms, but the support is very large, going up to very high levels of productivity.

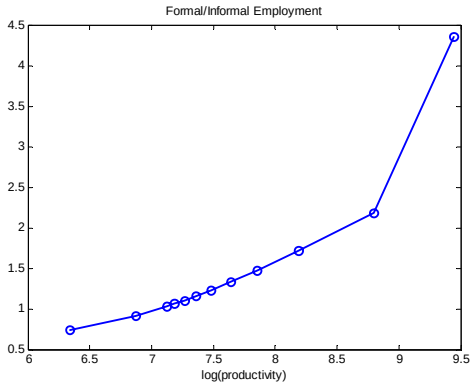
From this graph we can see that the model can produce at the same time compensating wage differentials for working in the informal sector *and* the fact in the data that the average wage in the formal sector is higher than the average wage in the informal sector.: over the region of overlap in this equilibrium the informal sector has to pay more than the formal form with the same productivity. However, the second feature is delivered by the high wages paid by formal firms for levels of productivity beyond the one where informal firms operate.



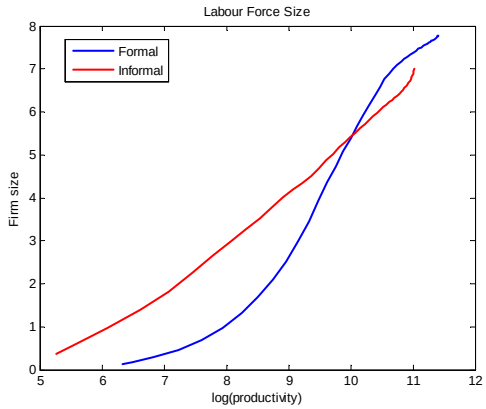
Contract Values for Formal (high) and Informal Firms - Low Education Males in Salvador

The feature of compensating differentials just brings the contract values of the informal firms closer to those of the formal ones, which are higher - close enough to compensate but not equal, because of search costs (see Figure **??**).

To demonstrate the relative importance of employment in the two sectors in the overall region in Figure **??** we plot the ratio $\frac{m_1 g_1(K_1(p))}{m_2 g_2(K_1(p))}$. At very low levels of productivity the informal sector workers outnumber 2:1 the formal ones. However, as productivity increases, they soon become the minority. Finally, figure **??** shows the size of firms in the formal and the informal sector. In the overlap region formal firms are substantially smaller than informal ones, but their size grows faster and they become larger for higher productivities.



Relative total employment in the formal versus the informal sector - Low Education Males in Salvador



Labour force size by firm - Males Salvador

In Tables 7 and 8 we summarise the graphical information in numbers for both Salvador and Sao Paulo. In Sao Paulo the informal firms enter at lower productivity and the overlap with the formal sector begins at twice the productivity than it does in Salvador. Informal wages are higher than formal ones at the higher levels of productivity, but not necessarilly at lower ones. Finally, in Sao Paulo informal firms extend to higher levels of productivity.

productivity	formal wage	informal wage	formal value	informal value	fraction of formal firms
5.27	-	5.09	-	356	0.000
6.34	5.58	5.85	402	381	0.000
7.64	6.07	6.09	422	386	0.551
7.85	6.12	6.09	423	386	0.571
8.18	6.17	6.17	425	388	0.580
8.80	6.28	6.41	430	395	0.588
9.94	6.66	7.12	446	415	0.601
11.01	7.47	-	486	-	1.000

Table 7: Wages, Productivity and Contract Values by Sector Salvador - Males with Low Education

productivity	formal wage	informal wage	formal value	informal value	fraction of formal firms
5.01	-	4.87	-	360	0.000
7.35	5.67	5.77	410	380	0.000
8.79	6.15	6.02	430	390	0.376
9.02	6.21	6.02	430	390	0.453
9.36	6.21	6.17	430	390	0.459
9.99	6.35	6.35	440	390	0.465
11.14	6.66	7.08	450	410	0.519
13.06	8.24	-	530	-	1.000

Table 8: Wages, Productivity and Contract Values by Sector Sao Paulo - Males with Low Education

	Benchmark	No Informal Market
m_1	0.520	0.840
m_2	0.376	-
u	0.104	0.161
n_1	0.550	0.664
n_2	0.450	-
Wages (log)		
Min	4.870	5.656
P10	6.050	5.914
P25	6.286	6.109
Median	6.536	6.273
P75	6.843	7.390
P90	7.184	8.389
Inequality		
w(75)/w(25)	1.745	3.600
w(90)/w(10)	3.108	11.892

Table 9: The impact of closing down the informal sector

6 Policy Simulations

7 Conclusion

Appendix 1. Equilibrium Offer Distribution and Accepted wages

For any $W \geq U$,

$$\left[\delta_1 + \lambda_{11}\overline{F}_1(W)\right] m_1 G_1(W) + \lambda_{12} m_1 \int_U^W \overline{F}_2(x) dG_1(x)$$
$$= \lambda_{01} u F_1(W) + \lambda_{21} m_2 \int_U^W \left[F_1(W) - F_1(x)\right] dG_2(x).$$

Making use of the identity:

$$\int_U^W \overline{F}_2(x) dG_1(x) = \overline{F}_2(W) G_1(W) + \int_U^W G_1(x) dF_2(x)$$

we can rewrite this equation as:

$$d_1(W) m_1 G_1(W) = \lambda_{01} u F_1(W) - \lambda_{12} \int_U^W m_1 G_1(x) dF_2(x) + \lambda_{21} \int_U^W m_2 G_2(x) dF_1(x), \tag{35}$$

where $d_1(W) = \delta_1 + \lambda_{11}\overline{F}_1(W) + \lambda_{12}\overline{F}_2(W)$.

By symmetry we can write the equivalent flow equation for the informal sector as

$$d_2(W) m_2 G_2(W) = \lambda_{02} u F_2(W) + \lambda_{12} \int_U^W m_1 G_1(x) dF_2(x) - \lambda_{21} \int_U^W m_2 G_2(x) dF_1(x), \tag{36}$$

where $d_2(W) = \delta_2 + \lambda_{21}\overline{F}_1(W) + \lambda_{22}\overline{F}_2(W)$.

Summing up both equations leads to the equilibrium flow equation between employment in any sector and unemployment.

$$d_1(W) m_1 G_1(W) + d_2(W) m_2 G_2(W) = \lambda_{01} u F_1(W) + \lambda_{02} u F_2(W). \tag{37}$$

By setting W to its maximal value we obtain this flow equation for the entire population, i.e.

$$\delta_1 m_1 + \delta_2 m_2 = (\lambda_{01} + \lambda_{02}) u.$$

In the next steps we reorganise equations 35 and 36 into a first order differential equation, which will allow us to derive an analytical relationship between the distribution of wage offers and the observed distribution of wages.

Thus, multiplying equation (35) by $\frac{\lambda_{12} f_2(W)}{d_1(W)}$ (with $f_2 = F_2'$) and equation (36) by $-\frac{\lambda_{21} f_1(W)}{d_2(W)}$, and adding the two resulting equations, we obtain the first-order differential equation:

$$\Phi' = A - B\Phi \tag{38}$$

where $\Phi(W)$ is defined by

$$\Phi(W) = \frac{\lambda_{12}}{u} \int_U^W m_1 G_1(x) dF_2(x) - \frac{\lambda_{21}}{u} \int_U^W m_2 G_2(x) dF_1(x).$$

and where

$$A = \lambda_{01} F_1 \tfrac{\lambda_{12} f_2}{d_1} - \lambda_{02} F_2 \tfrac{\lambda_{21} f_1}{d_2},$$

$$B = \tfrac{\lambda_{12} f_2}{d_1} + \tfrac{\lambda_{21} f_1}{d_2}.$$

The solution of this differential equation is given by

$$\Phi(W) = \frac{\int_U^W e^{\int_U^x B(x^0) dx^0} A(x) dx}{e^{\int_U^W B(x) dx}}, \tag{39}$$

with boundary condition $\Phi(U) = 0$. Substituting this solution back into equations 35 and 36 we obtain the equilibrium relationship between the distribution of offered (F) and accepted (G) wages, i.e.

$$\begin{aligned} m_1 G_1 &= \frac{\lambda_{01} F_1 - \Phi}{d_1} u, \\ m_2 G_2 &= \frac{\lambda_{02} F_2 + \Phi}{d_2} u, \end{aligned} \tag{40}$$

Appendix 1. Job offers distributions

We show here how to derive F_1 and F_2 from G_1 and G_2.

Equations (35) and (36) can be equivalently written as

$$\begin{aligned} h_1 \overline{F}_1 &= \lambda_{01} u - \delta_1 m_1 G_1 + \Psi, \\ h_2 \overline{F}_2 &= \lambda_{02} u - \delta_2 m_2 G_2 - \Psi, \end{aligned} \tag{41}$$

with h_1 and h_2 defined as in equations (22) and (23), and where

$$\Psi(W) = \lambda_{21} \int_U^W \overline{F}_1 m_2 dG_2 - \lambda_{12} \int_U^W \overline{F}_2 m_1 dG_1. \tag{42}$$

Notice we can also deduce m_1,m_2 and u by setting W equal to its largest value and making use of the fact that $m_1 + m_2 + u = 1$:

$$\begin{aligned} u &= \frac{\delta_1\delta_2 + (\delta_1 - \delta_2)\Psi(\overline{W}),}{\delta_1\delta_2 + \delta_1\lambda_{02} + \delta_2\lambda_{01}} \\ m_1 &= \frac{\delta_2\lambda_{01} + (\delta_2 + \lambda_{01} + \lambda_{02})\Psi(\overline{W})}{\delta_1\delta_2 + \delta_1\lambda_{02} + \delta_2\lambda_{01}}, \\ m_2 &= \frac{\delta_1\lambda_{02} - (\delta_1 + \lambda_{01} + \lambda_{02})\Psi(\overline{W})}{\delta_1\delta_2 + \delta_1\lambda_{02} + \delta_2\lambda_{01}}. \end{aligned} \tag{43}$$

Then, Ψ solves the differential equation, $\Psi' = A - B\Psi$, with

$$\begin{aligned} A &= (\lambda_{01}u - \delta_1 m_1 G_1)\frac{\lambda_{21}m_2 g_2}{h_1} - (\lambda_{02}u - \delta_2 m_2 G_2)\frac{\lambda_{12}m_1 g_1}{h_2} \\ B &= -\frac{\lambda_{21}m_2 g_2}{h_1} - \frac{\lambda_{12}m_1 g_1}{h_2} \end{aligned}$$

that is

$$\Psi(W) = \frac{\int_U^W e^{\int_U^x B(x^0)dx^0} A(x)dx}{e^{\int_U^W B(x)dx}}.$$

with $\Psi(U) = 0$.

Next, from differentiation of the flow conditions (35) and (36), we obtain

$$\begin{aligned} f_1 &= \frac{d_1}{h_1} m_1 g_1; \\ f_2 &= \frac{d_2}{h_2} m_2 g_2. \end{aligned}$$

Note that from wage data, one can estimate wage distributions, say $\widehat{G}_1$ and $\widehat{G}_2$. In all calculations above we need $G_1 = \widehat{G}_1 \circ w_1$, $G_2 = \widehat{G}_2 \circ w_2$ (Lemma 1) and integrals involving g_1 and g_2. Integration by substitution allows the direct use of $\widehat{g}_1$ and $\widehat{g}_2$, instead of g_1 and g_2 where

$$\begin{aligned} g_1 &= \widehat{g}_1 w_1' = \frac{\widehat{g}_1}{1 + \delta_1 s} d_1, \\ g_2 &= \widehat{g}_2 w_2' = \widehat{g}_2 d_2. \end{aligned}$$

Appendix 2. Productivity distributions

Once the transition rate parameters and F_1 and F_2 have been estimated, then one can use the first-order conditions of profit maximisation to obtain K_1^{-1} and K_2^{-1}:

$$K_1^{-1}(W) = (1+\tau+\delta_1 s)w_1(W) + (1+\tau+\delta_1 s)w_1'(W)\frac{\ell_1(W)}{\ell_1'(W)}, \quad (44)$$

$$K_2^{-1}(W) = w_2(K_2) + C + w_2'(W)\frac{\ell_2(W)}{\ell_2'(W)}. \quad (45)$$

Then, productivity distributions follow from

$$\Gamma_1(K_1^{-1}(W))/n_1 = F_1(W),$$
$$\Gamma_2(K_2^{-1}(W))/n_2 = F_2(W).$$

where the two measures n_1 and n_2 are determined so as to minimise $|\pi_1(p) - \pi_2(p)|$ on the overlapping part of the thus estimated supports of Γ_1 and Γ_2.

7.1 Estimation Outline

Here we provide the steps of estimation using the Brazilian data.

For given values of the discount rate r, labour tax τ, severance s and corporate taxes t, the solution algorithm proceeds as follows:

1. We choose n discretization points (100 points) of wages to obtain the nonparametric wage densities and the parameters for duration analysis (in Section **??**). We obtain the contract value distributions $G_1 = \mathcal{G}_1 \circ w_1$ and $G_2 = \mathcal{G}_2 \circ w_2$ using numerical integration.

2. We assume initial values for w^* such that $W_2(w^*) = \underline{W}_1$ and w^{**} such that $\overline{W}_2 = W_1(w^{**})$, these wage values delimit the area where W_1 and W_2 overlap. We shall see that these are needed in order to have $G_1(W_2)$ and $G_2(W_1)$. The densities $g_1(W_2)$ and $g_2(W_1)$ are first derivatives of $G_1(W_2)$ and $G_2(W_1)$.

3. Job offers distributions: we guess initial values for $u, \Psi(\overline{W})$ and the transition parameters $(\delta_1, \delta_2, \lambda_{01}, \lambda_{02}, \lambda_{11}, \lambda_{22}, \lambda_{12}, \lambda_{21})$. We solve iteratively for $\overline{F}_1, \overline{F}_2, u, \Psi(W)$ and the parameters $(\delta_1, \delta_2, \lambda_{01}, \lambda_{02}, \lambda_{11}, \lambda_{22}, \lambda_{12}, \lambda_{21})$, by maximizing the likelihood functions of workers as explained in section (in Section **??**).and the system in Appendix 1.

4. Contract values: under the assumption that $U = \underline{W}_2$,we iterate on (2) and (1) until finding a fixed point for $W_1(w)$ and $W_2(w)$.

5. Optimal w^* and w^{**}: values of $W_1(w)$ and $W_2(w)$ allows us to obtain new w^* and w^{**}. We thus verify whether those match with initial values assigned in step 2. We search for the best pair (w^*,w^{**}) on a discrete grid of $w = (\underline{w}_2 = w^1 < w^2 < ... < w^N = \overline{w}_2)$ and $w = (\underline{w}_1 = w^1 < w^2 < ... < w^N = \overline{w}_1)$.

6. Productivities: we choose a distribution of productivity types $\Gamma_0(p) \sim Pareto$ where $\underline{p}$ is equal to the minimum productivity in the market. We set $\underline{p} = \underline{p}_2$, such that $\Gamma_0(\underline{p}_2) = 0$.

7. We assume initial values for n_1 and n_2.

8. We thus solve for $\ell_1(W)$,$\ell_2(W)$,$\ell_1'(W)$ and $\ell_2'(W)$ where the last two derivatives are analytically obtained.

9. We now calculate profits, with $\pi_1(W) = (1-t)(1+\tau+\delta_1 s)[w_1'(W)/\ell_1'(W)]\ell_1(W)^2$ and $\pi_2(W) = [w_2'(W)/\ell_2'(W)]\ell_2(W)^2$.

10. Using the firms first-order conditions, as showed by equations (44), we obtain the formal productivities.

11. The condition on the maximal informal profits $\pi_{2\,\max} = \pi_1(p)$ identifies $\overline{p}_2$ and the enforcement cost parameter C.

12. Now, using (45), we obtain the informal productivities.

13. With the productivity supports, we evaluate $\Gamma_0(\overline{p}_2)$ and $\Gamma_1(\overline{p}_2)$.

14. We verify whether initial values of n_1 and n_2 are solution. The optimal n_1 and n_2 are such that the distance $|\pi_1(p) - \pi_2(p)|$ in the overlapping range of productivities and the distance $|n_2 - \Gamma_0(\overline{p}_2) - \Gamma_1(\overline{p}_2)|$ are minimized.

Appendix 4. Data Description by Year and Region

Detailed Data

	All sample	2002	2003	2004	2005	2006	2007
Number of Individuals	441,249	89,081	72,613	68,787	67,715	71,564	71,489
Unemployed	58,004	12,280	10,698	9,548	8,328	8,975	8,175
Formal	290,243	58,412	46,410	44,271	44,688	47,577	48,885
Informal	93,002	18,389	15,505	14,968	14,699	15,012	14,429
Informality Rate (%)	24.3	23.9	25.0	25.3	24.8	24.0	22.8
Censored observations (%)	24.4	28.2	24.9	22.9	19.8	21.7	27.6
Unemployed	34.5	38.3	34.4	33.1	30.5	32.4	37.1
Formal	20.9	24.6	20.8	19.1	16.5	18.3	24.7
Informal	29.0	33.1	30.6	27.5	23.8	26.2	31.9
Transitions (% of workers by initial status)							
Unemployed-Formal	9.75	9.16	9.01	8.41	8.88	11.17	12.63
Unemployed-Informal	15.34	14.56	15.74	15.87	14.36	17.02	14.44
Formal-Formal	2.15	2.04	2.53	2.50	2.05	1.93	1.88
Formal-Unemployed	2.01	2.05	2.19	2.11	1.69	2.08	1.92
Formal-Informal	0.33	0.32	0.35	0.33	0.34	0.35	0.32
Informal-Informal	5.66	5.51	6.33	6.13	5.36	5.89	4.72
Informal-Unemployed	6.55	6.45	7.23	6.87	5.75	7.17	5.77
Informal-Formal	1.12	1.02	1.21	1.00	1.07	1.18	1.27
Mean Duration (in months)							
Unemployed	11.1	12.5	11.2	11.7	11.5	10.4	8.9
(std.dev)	12.9	13.8	12.3	13.2	13.4	12.3	11.2
Formal	70.0	69.8	70.5	70.4	70.2	70.1	69.3
(std.dev)	75.8	75.7	75.6	75.4	75.1	76.2	76.6
Informal	44.8	43.6	44.3	45.0	45.8	45.0	45.2
(std.dev)	65.3	66.1	64.5	65.2	65.6	66.2	64.0

Table 10: Description of data, by year.

	All sample	Recife	Salvador	Belo Horizonte	Rio de Janeiro	Sao Paulo	Porto Al
Number of Individuals	441,249	61,822	56,873	83,278	64,544	107,592	67,
Unemployed	58,004	10,338	10,687	8,959	7,566	13,875	6,
Formal	290,243	36,238	35,156	57,367	43,500	70,009	47,
Informal	93,002	15,246	11,030	16,952	13,478	23,708	12,
Informality Rate (%)	24.3	29.6	23.9	22.8	23.7	25.3	
Censored observations (%)	24.4	33.8	21.6	25.3	17.4	22.6	
Unemployed	34.5	45.8	28.7	39.9	24.2	31.0	
Formal	20.9	28.7	18.7	21.1	15.1	19.7	
Informal	29.0	37.8	23.6	31.7	20.7	26.5	
Transitions (% of workers by initial status)							
Unemployed-Formal	9.75	9.28	5.04	15.75	6.07	8.72	1
Unemployed-Informal	15.34	20.34	6.34	22.36	8.48	17.63	2
Formal-Formal	2.15	2.06	2.15	2.07	2.18	1.72	
Formal-Unemployed	2.01	2.63	1.74	2.33	1.06	2.02	
Formal-Informal	0.33	0.48	0.14	0.50	0.12	0.32	
Informal-Informal	5.66	5.97	5.14	6.93	4.77	5.31	
Informal-Unemployed	6.55	9.94	4.76	8.08	2.58	6.79	
Informal-Formal	1.12	1.16	0.61	1.77	0.67	0.84	
Mean Duration (in months)							
Unemployed	11.1	12.7	13.4	7.1	13.6	10.8	
(std.dev)	12.9	14.7	14.6	9.1	13.3	11.9	
Formal	70.0	71.9	70.8	64.8	76.9	70.4	
(std.dev)	75.8	76.7	78.0	71.9	81.9	73.2	
Informal	44.8	44.1	44.2	41.5	52.3	42.7	
(std.dev)	65.3	64.2	65.1	62.6	72.3	62.0	

Table 11: Description of data, by region.

Friction Parameters

	δ_1	δ_2	λ_{01}	λ_{02}	λ_{11}	λ_{22}	λ_{12}	λ_{21}
All sample	0.0051	0.0176	0.0281	0.0442	0.0319	0.0717	0.0044	0.0058
Recife								
Year 2002	0.0095	0.0278	0.0363	0.0749	0.0289	0.0960	0.0075	0.0060
Year 2004	0.0054	0.0221	0.0210	0.0619	0.0253	0.0458	0.0034	0.0033
Year 2006	0.0070	0.0361	0.0319	0.0673	0.0172	0.0667	0.0051	0.0053
Salvador								
Year 2002	0.0034	0.0091	0.0119	0.0160	0.1270	0.1650	0.0040	0.0093
Year 2004	0.0051	0.0142	0.0138	0.0136	0.0359	0.0909	0.0013	0.0025
Year 2006	0.0042	0.0139	0.0175	0.0220	0.0331	0.0787	0.0033	0.0037
Belo Horizonte								
Year 2002	0.0055	0.0201	0.0355	0.0473	0.0251	0.0869	0.0056	0.0055
Year 2004	0.0060	0.0278	0.0378	0.0800	0.0214	0.1077	0.0077	0.0071
Year 2006	0.0066	0.0214	0.0712	0.0895	0.0288	0.1064	0.0055	0.0113
Rio de Janeiro								
Year 2002	0.0036	0.0114	0.0183	0.0299	0.0405	0.0707	0.0013	0.0039
Year 2004	0.0030	0.0092	0.0160	0.0188	0.0693	0.1296	0.0033	0.0105
Year 2006	0.0023	0.0078	0.0130	0.0200	0.0182	0.0445	0.0016	0.0069
Sao Paulo								
Year 2002	0.0051	0.0173	0.0243	0.0405	0.0129	0.0393	0.0022	0.0041
Year 2004	0.0059	0.0214	0.0244	0.0615	0.0124	0.0724	0.0033	0.0035
Year 2006	0.0051	0.0177	0.0279	0.0484	0.0128	0.0578	0.0024	0.0040
Porto Alegre								
Year 2002	0.0054	0.0183	0.0486	0.0702	0.0163	0.0625	0.0033	0.0100
Year 2004	0.0058	0.0189	0.0506	0.0602	0.0246	0.0830	0.0060	0.0076
Year 2006	0.0065	0.0229	0.0575	0.0753	0.0217	0.0721	0.0028	0.0067

Time unit: month.

Table 12: Estimated Job Destruction and Arrival Rates by Region and Time

Table 13: Table Caption
Informality Cost and Value of Leisure

	C	$C/min(p)$	b	$b/min(w_2)$
All sample	373.4	0.739	4.858	0.996
Recife				
Year 2002	718.2	0.837	4.761	0.964
Year 2004	302.3	0.671	4.712	0.942
Year 2006	318.7	0.660	4.799	0.941
Salvador				
Year 2002	264.4	0.658	5.268	1.070
Year 2004	582.6	0.805	5.161	1.043
Year 2006	263.8	0.621	5.251	1.033
Belo Horizonte				
Year 2002	851.9	0.862	4.814	0.978
Year 2004	628.9	0.816	4.741	0.956
Year 2006	596.0	0.788	4.626	0.911
Rio de Janeiro				
Year 2002	397.7	0.744	5.056	1.028
Year 2004	540.3	0.783	5.319	1.062
Year 2006	169.9	0.498	5.217	1.014
Sao Paulo				
Year 2002	1965.8	0.934	4.479	0.907
Year 2004	1052.9	0.881	4.636	0.936
Year 2006	1146.3	0.877	4.750	0.936
Porto Alegre				
Year 2002	244.6	0.640	4.277	0.869
Year 2004	344.1	0.701	4.667	0.936
Year 2006	680.2	0.809	4.522	0.890

Steady-State Rates

	m_1	m_2	u	n_1	n_2
All sample	0.5886	0.2973	0.1141	0.6800	0.3070
Recife					
Year 2002	0.4829	0.3804	0.1367	0.4700	0.5050
Year 2004	0.4812	0.3847	0.1341	0.6200	0.3680
Year 2006	0.5742	0.2825	0.1432	0.6600	0.3320
Salvador					
Year 2002	0.5605	0.2803	0.1593	0.7600	0.2360
Year 2004	0.5755	0.2084	0.2161	0.6700	0.3120
Year 2006	0.5974	0.2510	0.1517	0.7100	0.2720
Belo Horizonte					
Year 2002	0.6134	0.2784	0.1082	0.6200	0.3560
Year 2004	0.5881	0.3090	0.1028	0.5800	0.4050
Year 2006	0.6601	0.2761	0.0637	0.5500	0.3320
Rio de Janeiro					
Year 2002	0.5827	0.3029	0.1144	0.7000	0.2770
Year 2004	0.6395	0.2417	0.1188	0.7700	0.2290
Year 2006	0.6445	0.2525	0.1030	0.7400	0.2550
Sao Paulo					
Year 2002	0.5785	0.2966	0.1250	0.6100	0.3670
Year 2004	0.5071	0.3664	0.1265	0.4500	0.5400
Year 2006	0.5838	0.3060	0.1102	0.5600	0.4300
Porto Alegre					
Year 2002	0.6505	0.2771	0.0724	0.6400	0.3560
Year 2004	0.6494	0.2701	0.0805	0.6200	0.3280
Year 2006	0.6462	0.2750	0.0788	0.6400	0.3440

Table 14: Steady State Stocks

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