Wages and Informality in Developing Countries.*

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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

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to other papers which consider two sectors such as Albrecht, Navarro and Vroman (2009) and Bosch (2006). Our empirical analysis uses Brazilian labour force surveys. Finally, we use the model to discuss the relative merits of alternative policies towards informality.

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 output, 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 (2009) who use the matching framework of Mortensen-Pissarides (1994) to model the informal sector as unregulated self-employment with fixed productivity, while 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.[1]

The most traditional view of informality associates informality with a subsistence sector in a segmented labor market 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 bytaking up an informal job.[2] In what follows, our paper accommodates evidence of transitions between

[1]Other related papers are for example Gabriel Ulyssea (2010), El-Badaoui, Strobl and Walsh (2010), Boeri and Garibaldi (2005), and Fugazza and Jacques (2003). They use a more simplified structure for dual economies than that of Albrecth et al (2009) and Bosch (2006).

[2]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 (2006) 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

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.[3] Our main source is the Brazilian Labour Force Survey, *Pesquisa Mensal de Emprego*, which provides a rotating panel of individuals sampled from the six main metropolitan regions of Brazil. 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 4, we present and comment on the main results. In Section 5, we examine the effects of changes in the compliance costs and other policies such as changes in severance and unemployment compensation. Conclusions are

(2006) findings suggest that informal workers can be as well off as similar formal workers.

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

in Section 6.

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.[4] Firms are monitored with probability π and if caught not complying they pay a fine. Firms have a given productivity level p, maximize 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. Each employment sector ($j = 1, 2$) begets job offers to searching workers according to a Pois-

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

son process with arrival rate λ_{ij}, where $i = 0,1,2$ denotes the state in which the worker is currently (unemployed, or working in the formal/informal sectors). An offer is an employment contract promising a fixed wage and, implicitly, specific outside options. In particular, a 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 — and can be laid off at sector-specific rates $\lambda_{i0}, i = 1,2$. Lastly, let $F_j, j = 1,2$, defined on $[\underline{W}_j, \overline{W}_j]$, denote the (equilibrium) distribution of contracts' present values that workers sample their offers from. These distributions are endogenous and the rest of the paper will explain how they are determined.

2.2 Workers

We have in mind a pool of low skilled homogeneous workers that will typically engage in jobs requiring low training input. Productivity differences will arise in this model because of firm level heterogeneity. Workers maximize the expected lifetime income discounted at a rate of r. At any instant, unemployed workers receive an income stream b, taken to be constant across individuals, regardless of their history. Let $W_1(w)$ and $W_2(w)$ denote the values of a wage contract w in the formal and the informal sectors, and let U be the value of unemployment.

The wage in the formal sector represents the entire compensation for the worker: thus it is after tax but *before* social security deductions, which are effectively part of their compensation as it entitles them to a pension and to health benefits. Pay also includes 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 as follows.

- Value of working in the informal sector:

$$rW_2(w) = w + \lambda_{20}\left[U - W_2(w)\right] + \lambda_{21}\int_{W_2(w)}^{\overline{W}_1} \overline{F}_1(x)\,dx + \lambda_{22}\int_{W_2(w)}^{\overline{W}_2} \overline{F}_2(x)\,dx, \quad (1)$$

  where overlines on distribution functions denote survival functions: $\overline{F} = 1 - F$. 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 λ_{20}, as well as the "capital gain" of obtaining a better offer either from the formal or the informal sector.[5]

- The value of working in the formal sector is similar, but includes the benefits arising from working in the formal sector

$$rW_1(w) = w + \lambda_{10}\left[U + UI + s\cdot w - W_1(w)\right] + \lambda_{11}\int_{W_1(w)}^{\overline{W}_1} \overline{F}_1(x)\,dx + \lambda_{12}\int_{W_1(w)}^{\overline{W}_2} \overline{F}_2(x)\,dx. \quad (2)$$

  The second term on the right hand side includes the severance pay $s\cdot w$ 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; this simplifies the model and its computation but abstracts from moral hazard of UI because there is no incentive to delay

[5] We make use of the following property: for any CDF F on $[\underline{x},\overline{x}]$, and for all $u \in \mathbb{R}$,

$$\int_{\underline{x}}^{\overline{x}} \max\{x,u\}\,dx = \int_{u}^{\overline{x}} \overline{F}(x)\,dx.$$

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accepting a job.[6] As we show below we determine the level of UI endogenously based on the tax rate used to fund it and on the overall number of unemployed. Both UI and severance pay increase the value of employment in the formal sector. The only difference of UI from severance pay is that the firm directly pays $s \cdot w$, whereas UI is funded by general taxation. This distinction will be of importance when we define the firm's problem. Both will affect the equilibrium distribution of wages. Since there are no shocks to productivity, jobs are only closed down because of exogenous job destruction, which may differ depending on the sector λ_{10} and λ_{20}.

- The value of unemployment consists of the flow of income (or monetised value of leisure) and the expected "capital gain" from obtaining an acceptable job offer, i.e.

$$rU = b + \lambda_{01} \int_U^{\overline{W}_1} \overline{F}_1(x)\, dx + \lambda_{02} \int_U^{\overline{W}_2} \overline{F}_2(x)\, dx.$$

  Note that, in equilibrium, minimum value offers must be greater than the value of unemployment: $\underline{W}_1, \underline{W}_2 \geq U$, for employers to refrain workers from preferring unemployment to work. So the equilibrium unemployment value is such that

$$rU = b + \lambda_{01}(\underline{W}_1 - U + \mu_1) + \lambda_{02}(\underline{W}_2 - U + \mu_2), \tag{3}$$

  where μ_1, μ_2 denote the mean contract value offers in both sectors. THIS HAS CHANGED!

The wage is not sufficient to characterize the relative value of formal and informal jobs, because each sector offers different opportunities and carries different implications upon layoff: these are reflected in the respective value functions $W_1(w)$ and $W_2(w)$ above. Thus

[6] Specifically it avoids making the duration of unemployment a state variable if UI is time limited for example.

workers may transit between sectors accepting lower wages upon the job change, so long as the overall value of the job in the new sector is higher. Within the same sector workers will only move to a new job if the wage is higher.

2.3 Steady-State Worker Flows

In equilibrium the stocks of workers and firms in each sector and in each part of the contract value 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 contract 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 distribution of accepted contract values in the formal and informal sector, respectively: they denote the proportion of the stock of individuals with a contract value lower than or equal to W, respectively. For any $W \in [\underline{W}_1, \overline{W}_1]$,

$$\left[\lambda_{10} + \lambda_{11}\overline{F}_1(W)\right] m_1 G_1(W) + \lambda_{12} m_1 \int_{\underline{W}_1}^{W} \overline{F}_2(x)\, dG_1(x) = \lambda_{01} u F_1(W) + \lambda_{21} m_2 \int_{\underline{W}_2}^{W} [F_1(W) - F_1(x)]\, dG_2(x). \quad (4)$$

On the left hand side of this equation are the jobs destroyed in the formal sector which have a contract value lower than W. Job destruction takes place because of layoffs (λ_{10}), receipt of offers valued more than 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.

Note that G_1 is as usually extended outside its support by making it nil to the left of $\underline{W}_1$ and equal to 1 to the right of $\overline{W}_1$.

Similarly we can also define the flow equation for the informal sector. For $W \in [\underline{W}_2, \overline{W}_2]$,

$$\left[\lambda_{20} + \lambda_{22}\overline{F}_2(W)\right] m_2 G_2(W) + \lambda_{21} m_2 \int_{\underline{W}_2}^{W} \overline{F}_1(x)\, dG_2(x) = \lambda_{02} u F_2(W) + \lambda_{12} m_1 \int_{\underline{W}_1}^{W} [F_2(W) - F_2(x)]\, dG_1(x). \quad (5)$$

In Appendix B we show how to (uniquely) solve equations (4) and (5) for G_1 and G_2 given F_1 and F_2:

Proposition 1. *There is an equilibrium relationship between the distribution of accepted (G) and offered (F) contract values:*

$$m_1 G_1(W) = \frac{\lambda_{01} F_1(W) - \Phi(W)}{d_1(W)} u, \quad (6)$$

$$m_2 G_2(W) = \frac{\lambda_{02} F_2(W) + \Phi(W)}{d_2(W)} u. \quad (7)$$

where $\Phi(W) \equiv \Phi[F_1, F_2](W)$ is an operator on F_1 and F_2 that is derived in Appendix B, and that is nil for all $W \leq \max\{\underline{W}_1, \underline{W}_2\}$, and where, in the denominator,

$$d_1(W) = \lambda_{10} + \lambda_{11}\overline{F}_1(W) + \lambda_{12}\overline{F}_2(W), \quad (8)$$

$$d_2(W) = \lambda_{20} + \lambda_{21}\overline{F}_1(W) + \lambda_{22}\overline{F}_2(W), \quad (9)$$

are the total job destruction rates in sectors 1 and 2.

Straightforwardly, through Proposition 1, we can also derive expressions for the proportion of workers in each sector and in unemployment, by setting W (in equations (6)

and (7) equal to its largest value and making use of the fact that $m_1 + m_2 + u = 1$:

$$\frac{m_1}{u} = \frac{\lambda_{01} - \Phi(\overline{W}_1)}{\lambda_{10} + \lambda_{12}\overline{F}_2(\overline{W}_1)}, \tag{10}$$

$$\frac{m_2}{u} = \frac{\lambda_{02} - \Phi(\overline{W}_2)}{\lambda_{20} + \lambda_{21}\overline{F}_1(\overline{W}_2)}, \tag{11}$$

$$\frac{1}{u} = 1 + \frac{m_1}{u} + \frac{m_2}{u}. \tag{12}$$

ATTENTION: THERE WAS AN ERROR IN THESE CALCULATIONS.

Hence, knowledge of the distribution of wage offers by the formal sector, F_1, and the informal sector F_2, allows us to infer the steady state stocks of employment (m_1 and m_2) and unemployment (u) as well as the equilibrium distribution of accepted wages G_1 and G_2 that are observable. This is not a full characterization of equilibrium; we now need to show how the offer distributions F_1 and F_2 and the decision to post offers in one or the other sector are determined. This depends on firm behaviour to which we now turn.

2.4 Firms

Firms maximize profits by choosing in which sector to operate and the wage they will post, which determines the size of their labour force, given their specific productivity p. In the formal sector there are a number of costs associated with hiring a worker at a wage rate w. These include pay roll taxes (τ), corporate taxes on profits (t) and severance payments ($s \cdot w$) to workers who are laid off. Finally, these firms may be subject to minimum wage laws $w_{\min}$, which imply that wages cannot necessarily adjust pay to offset the effects of severance pay (Lazear, 1990). Informal labour markets are monitored randomly by the government authorities whose role is to enforce tax and labour laws. When caught a firm has to pay a fine depending on its size, $C(\ell_2(W))$. This function will have to be estimated from the data, based on firm behaviour.

There are no adjustment costs and conditional on the wage they pay workers, no dynamics in the firms' decision: they just choose a wage and thus implicitly a contract value W to maximize profit flows

$$\pi_1(p) = \max_{W \geq U} \{(1-t)\,[p-(1+\tau+\lambda_{10}s)w_1(W)]\,\ell_1(W)\}, \tag{13}$$

$$\pi_2(p) = \max_{W \geq U} \{[p-w_2(W)]\,\ell_2(W) - C(\ell_2(W))\}. \tag{14}$$

We denote as $K_1(p)$ and $K_2(p)$ the solutions to the profit maximization problems.

In the above $w_i(W)$ denotes the wage to be paid to a worker in sector i corresponding to a contract value W. More specifically, functions $w_1(W)$ and $w_2(W)$ are the wages such that $W_1(w) = W$ and $W_2(w) = W$, from equations (2) and (1) respectively

$$(1+\lambda_{10}s)w_1(W) = (r+\lambda_{10})W - \lambda_{10}\,(U+UI) - \lambda_{11}\int_W^{\overline{W}_1} \overline{F}_1(x)\,dx - \lambda_{12}\int_W^{\overline{W}_2} \overline{F}_2(x)\,dx, \tag{15}$$

and

$$w_2(W) = (r+\lambda_{20})W - \lambda_{20}U - \lambda_{21}\int_W^{\overline{W}_1} \overline{F}_1(x)\,dx - \lambda_{22}\int_W^{\overline{W}_2} \overline{F}_2(x)\,dx. \tag{16}$$

Functions $\ell_1(W)$ and $\ell_2(W)$ are the labour sizes of a firm offering a value W in sectors 1 or 2. In steady-state, the flow of workers leaving the workforce of any firm should be equal to the inflow of new hires. Hence,

$$\ell_1(W) = \frac{1}{n_1}\frac{h_1(W)}{d_1(W)}, \tag{17}$$

$$\ell_2(W) = \frac{1}{n_2}\frac{h_2(W)}{d_2(W)}, \tag{18}$$

where $h_1(W)$ and $h_2(W)$ denote the share of contacts between firms and workers willing

to accept a job paid W, i.e.

$$h_1(W) = \lambda_{01}u + \lambda_{11}m_1G_1(W) + \lambda_{21}m_2G_2(W), \quad (19)$$

$$h_2(W) = \lambda_{02}u + \lambda_{12}m_1G_1(W) + \lambda_{22}m_2G_2(W), \quad (20)$$

and $d_1(W)$ and $d_2(W)$ are the total job destruction rates given in Proposition 1.

I HAVE REMOVED THE FIRST DEFINITION AS WE NEED TO DEFINE THE SIZE OF A FIRM OFFERING A CONTRACT OUTSIDE OF THE SUPPORT OF THE DISTRIBUTION OF OTHER FIRMS' OFFERS.

2.5 Equilibrium Productivity Distributions

We now need to determine how firms locate in the two sectors. We can expect that informal firms will start operating at a lower productivity level than formal ones, at least in the presence of minimum wages, if expected fines for informality are not too high. However, we cannot exclude the possibility that there is a range of productivities over which firms are indifferent between the two sectors; indeed it turns out that over a substantial range of productivities formal and informal firms coexist and have equal profits. This is a particularly important feature of the model with key implications for the welfare effects of policies towards informality. Of course, the fact that firms of both types coexist over a productivity range does not mean they will have the same size or pay the same rates; quite the contrary and we will discuss this later.

We assume that there exists a number of potential entrants, normalized to one, with a distribution of productivity $\Gamma_0(p)$ on $[\underline{p}, \overline{p}]$. 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 $[\underline{p}_2, \overline{p}_2]$ and for formal firms $[\underline{p}_1, \overline{p}]$, where it is possi-

ble that the upper limit of productivity for informal firms is above the lowest productivity of formal ones, i.e. $\overline{p}_2 > \underline{p}_1$.

We denote the equilibrium measure of productivity in each sector by $\Gamma_i(p)$ $(i = 1,2)$. 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 only ($\underline{p}_2 \leq p \leq \underline{p}_1$), and wage offers are below the minimum wage. For $\underline{p}_1 \leq p \leq \overline{p}_2$, 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, we shall consider equilibria displaying the following regimes.

1. **Inactivity**: For $\underline{p} \leq p < \underline{p}_2$, $\pi_1(p) < 0$, $\pi_2(p) < 0$, and $\Gamma_1(p) = \Gamma_2(p) = 0$.

2. **Informal sector only**: For $\underline{p}_2 \leq p \leq \underline{p}_1$, $\pi_1(p) < \pi_2(p)$, $\Gamma_1(p) = 0$, and $\Gamma_2(p) = \Gamma_0(p) - \Gamma_0(\underline{p}_2)$. It is possible that this interval is just zero, meaning that the first relevant interval is the next one.

3. **Overlapping region**: In this region formal and informal firms of identical productivity coexist and make the same profits: For $\underline{p}_1 \leq p \leq \overline{p}_2$, $\pi_1(p) = \pi_2(p)$, and

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

4. **Formal sector only**: For all $p \geq \overline{p}_2$, $\pi_1(p) > \pi_2(p)$, $\Gamma_2(p) = \Gamma_2(\overline{p}_2)$, and

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

   If there is a range of productivities where only formal firms operate, this will be in the higher range. Implicit in this assertion is that informality profits are increasing slower than formal profits, possibly because rapidly increasing costs of informality.

The nature of this equilibrium has interesting implications because it can explain two seemingly contradictory assertions: first, we would expect compensating differentials to increase wages of the workers taking informal jobs. In the overlapping region the informal firms may have to offer higher wages than equivalent (in productivity) formal firms and this can give rise to compensating differentials. However, there are more formal jobs at higher levels of productivity than at lower ones. This will imply that on average formal workers will be paid more than informal ones. Hence the model can explain what is observed in the data and at the same time imply compensating differentials as we would expect. The computation of the equilibrium is described in Appendix C. THIS ALGORITHM IS WRONG. I CHANGED IT.

3 Data

3.1 The labour force survey

Our main source of data consists of a panel of individuals of 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 four consecutive months one year after their entry into the sample. The sample period starts on January 2002 and goes until December 2007.[7]

For the purpose of this paper, we select workers aged 23 to 65 who are found to be either unemployed[8] or working as an employee (registered or unregistered). Our defini-

[7] Due to methodological changes in the PME data with effect from 2002, we opted to use only PME from year 2002. 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 PME from year 2002 contains retrospective information about duration of the actual employment, which we need to identify job-to-job transitions.

[8] We take out unemployed whose last job was not as an employee. By doing so, we exclude mostly

tion of formal workers in this paper is thus whether the worker's current job is registered with the Ministry of Labour.[9] 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 reals per month.[10] Workers under a formal contract found to earn less than the minimum wage were removed 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 some part-time jobs. We also trim the very top wages (0.01% highest of the sample).

Table 1 shows the proportions of workers unemployed, formal salaried and informal salaried, by year. 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. Over the same period, we observe a relatively large drop in the proportion unemployed.

Now, looking at our measure of informality (proportion of informal employees in the population 23 to 65 years old), we see that a significant fraction of workforce is informal in the six largest metropolitan regions of Brazil, an average of 21% of the active workforce. As Table 1 shows, informality increased in our data until 2004 following the same trend observed since the 80s in the country. Thereafter informality decreased coinciding with an improvement in the business cycle. Our model does not distinguish across periods. However, one could estimate over different subperiods to obtain a structural interpretation of what underlies the changes over time.

unemployed who once was self-employed or inactive, e.g. individuals whose behaviour deviate from the predictions of our model.

[9]The job is registered if the worker reports having a worker's card, which means that the workers is protected by the Employment laws.

[10]All wages are in reals of June of 2008.

TABLE 1
Working Status, by year

	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

Note: Brazilian Labor Force Survey 2002-2007, individuals aged 23-65. The values are percentages of individuals according to their working status at the first interview.

3.1.1 Transitions

We follow individuals for up to four months or until their first move (if that is sooner). This can be job-to-job, unemployment-to-job or job-to-unemployment, where the job can be in the formal or in the informal sector.[11] At the date of the first interview, we observe the worker's employment status, the duration of the 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. We identify job-to-job transitions using the survey question on job duration.[12] For example, we classify a worker as a non-mover in the third month of the interview if she/he does not change status (e.g. remains formal) and declares that the current spell has lasted more than three months, i.e. more than the period that passed since the last interview.

Table 2 presents information on the transitions based on all sample and by region. The average exit rate from unemployment towards the formal sector is about 10% and towards the informal one 15% implying an overall duration of unemployment of 11 months. Exit from unemployment to an informal sector job is more frequent and counter-cyclical judg-

[11] We do not use the entire sixteen-months window of PME due to attrition problems.
[12] This question is only available in PME after year 2002.

ing from the exit rates over the downturn years of 2003 and 2004. Exit to the formal sector is trending up.

Job to job mobility is much higher among informal workers than formal ones, both within the informal sector and from informal to formal. Relatively to all transitions which occur by sector, the transitions from the formal to the informal sector are quite high compared to the transitions from the informal to the formal sector. However in absolute terms the latter are much higher. Thus, overall, the mobility is lower among informal workers. Finally, the transitions towards the formal sector have increased recently, as reflected in the decrease in the rate of informality.

When we break these down by region, Recife and Salvador which are less developed have a higher unemployment rate (18%) than the better off regions of Sao Paulo, Rio de Janeiro, Belo Horizonte and Porto Alegre (12%).[13] However, the level of development does not have an obvious relationship either to the degree of informality or to the turnover rates.

The way the model is set up, workers are homogeneous.[14] We thus focus on low education workers and estimate the model separately by sex. This implicitly assumes that the labour markets are segmented for these groups and they do not compete directly. We define low education to mean those with eight or less years of schooling. We also estimate the model separately for two regions with clearly distinct labour markets, namely Sao Paulo and Salvador. The former is a dynamic and well developed economy, while the latter is characterized by very high levels of unemployment. Separating these regions is important, because both the job destruction rates and the arrival rates are likely to be very different.

[13] Over the period of analysis (2002-2007), the average GDP per capita in 2008 prices for the Recife and Salvador regions were respectively 3.6 and 3.9 thousand dollars, whereas for Sao Paulo, Rio de Janeiro, Belo Horizonte and Porto Alegre the figures were about twice as much or more: 11.2, 9.8, 6.2 and 8.5 thousand dollars, respectively.

[14] Shephard (2009) has achieved this in a one sector model through differences in the value of leisure.

TABLE 2
Description of Data, all sample and by region

	All sample	Recife	Salvador	Belo Horizonte	Rio de Janeiro	Sao Paulo	Porto Alegre
Number of Individuals	441,249	61,822	56,873	83,278	64,544	107,592	67,140
Unemployed	58,004	10,338	10,687	8,959	7,566	13,875	6,579
Formal	290,243	36,238	35,156	57,367	43,500	70,009	47,973
Informal	93,002	15,246	11,030	16,952	13,478	23,708	12,588
Informality Rate (%)	24.3	29.6	23.9	22.8	23.7	25.3	20.8
Censored Observations (%)	24.4	33.8	21.6	25.3	17.4	22.6	26.6
Unemployed	34.5	45.8	28.7	39.9	24.2	31.0	38.3
Formal	20.9	28.7	18.7	21.1	15.1	19.7	23.2
Informal	29.0	37.8	23.6	31.7	20.7	26.5	33.3
Transitions (% of workers by initial status)							
Unemployed-Formal	9.75	9.28	5.04	15.75	6.07	8.72	18.95
Unemployed-Informal	15.34	20.34	6.34	22.36	8.48	17.63	20.33
Formal-Formal	2.15	2.06	2.15	2.07	2.18	1.72	2.93
Formal-Unemployed	2.01	2.63	1.74	2.33	1.06	2.02	2.33
Formal-Informal	0.33	0.48	0.14	0.50	0.12	0.32	0.40
Informal-Informal	5.66	5.97	5.14	6.93	4.77	5.31	5.98
Informal-Unemployed	6.55	9.94	4.76	8.08	2.58	6.79	6.94
Informal-Formal	1.12	1.16	0.61	1.77	0.67	0.84	1.86
Mean Duration (in months)							
Unemployed	11.1	12.7	13.4	7.1	13.6	10.8	8.7
(std.dev)	12.9	14.7	14.6	9.1	13.3	11.9	10.4
Formal	70.0	71.9	70.8	64.8	76.9	70.4	67.7
(std.dev)	75.8	76.7	78.0	71.9	81.9	73.2	75.3
Informal	44.8	44.1	44.2	41.5	52.3	42.7	46.2
(std.dev)	65.3	64.2	65.1	62.6	72.3	62.0	67.8

Note: Brazilian Labor Force Survey 2002-2007, individuals aged 23-65. Transitions are the first move of individuals within four months, starting from the individuals' first interview.

By region and sex, Table 3 displays the composition of workers at the date of the first interview, informality rate and turnover information. Informality is 3-4pp higher among females, regardless of the region. Transitions out of unemployment in Salvador are much lower than in Sao Paulo, but within Salvador these transitions are relatively much higher among males than females. Transitions out of formal jobs are similar for males and females in Sao Paulo, but again the turnover is larger among males than females in Salvador. On the contrary, the exit rate from informal sector jobs to formal ones is 2.6 times larger for males than for females in Sao Paulo and more similar across males and females in Salvador.

In Table 4 we show summary statistics of wages by region and sex and formal versus informal. On average, within each region and sector, males are paid more than females. Formal (informal) workers and those located in Sao Paulo (Salvador) earn more (less). The amount of wage dispersion (measured by the standard deviation of log wages) is larger for males than for females in both regions. The standard deviation of wages in the informal sector is larger than in the formal sector across all groups and more pronouncedly in Sao Paulo.

3.2 Specification and Estimation

3.2.1 Offer Distributions

The offer distributions $F_1(W)$ and $F_2(W)$ are transformations of the observed wage distributions, adjusted for the fact that they are defined here in contract space, and can be estimated nonparametrically. However, we simplify the estimation problem by specifying a parametric distribution. We then check the fit of the resulting distributions. The productivity distributions are directly implied through profit-maximizing restrictions. We now detail this approach to estimation.

TABLE 3
Description of Data, by region and sex

	Sao Paulo		Salvador	
	Males	Females	Males	Females
Number of Individuals	31,006	14,195	13,804	5,637
Unemployed	3,472	3,127	2,265	2,070
Formal	19,369	7,324	8,033	2,366
Informal	8,165	3,744	3,506	1,201
Informality Rate (%)	29.7	33.8	30.4	33.7
Censored Observations (%)	22.7	28.2	21.8	27.1
Unemployed	31.0	40.3	29.1	33.1
Formal	19.3	22.5	18.7	20.9
Informal	27.4	29.4	24.3	29.1
Transitions (% of workers by initial status)				
Unemployed-Formal	8.85	4.28	4.98	1.73
Unemployed-Informal	25.71	11.09	11.20	3.10
Formal-Formal	1.61	1.25	2.59	2.08
Formal-Unemployed	2.03	2.04	2.01	1.28
Formal-Informal	0.39	0.37	0.29	0.11
Informal-Informal	6.49	6.17	5.92	4.47
Informal-Unemployed	8.18	6.02	5.96	4.47
Informal-Formal	1.10	0.42	0.53	0.47
Mean Duration (in months)				
Unemployed	11.0	11.2	12.7	14.5
(std.dev)	12.8	12.7	14.5	15.8
Formal	74.2	64.6	69.5	76.3
(std.dev)	76.7	66.2	79.0	80.2
Informal	43.0	39.0	46.7	45.1
(std.dev)	64.8	61.8	70.0	66.9

Note: Brazilian Labor Force Survey 2002-2007, low education individuals aged 23-65. Transitions are the first move of individuals within four months, starting from the individuals' first interview.

TABLE 4

Description of Wages, by region, sex and whether a formal or an informal worker

	Sao Paulo		Salvador	
	Males	Females	Males	Females
Formal Sector Wages				
Mean	6.67	6.38	6.36	6.15
Std. Dev.	(0.42)	(0.34)	(0.39)	(0.31)
Obs.	18,631	6,688	5,897	1,214
Informal Sector Wages				
Mean	6.35	6.09	5.93	5.76
Std. Dev.	(0.51)	(0.45)	(0.43)	(0.32)
Obs.	7,669	3,397	2,945	926

Note: Brazilian Labor Force Survey 2002-2007, low education individuals aged 23-65. Transitions are the first move of individuals within four months, starting from the individuals' first interview.

Let F_1 and F_2 be two candidate offer distributions, defined on the spaces of contract present values. Let G_1^* and G_2^* denote the observable distributions of wages in both sectors. By construction, $G_1^*(w) = G_1(W_1(w))$, where $W_1(w)$ is the value of wage contract w derived in equation (2). A similar restriction holds for the informal sector. Given F_1 and F_2 we can use Proposition 1 to calculate G_1 and G_2. The estimation algorithm first aims at finding the couple of offer distributions (F_1, F_2) that best matches (G_1^*, G_2^*) with $(G_1 \circ W_1, G_2 \circ W_2)$.

Although we could implement this procedure nonparametrically, we preferred to approximate the offer distributions by non standard beta distributions:

$$\begin{aligned} F_1(x) &= \text{betacdf}\left(\frac{x-\underline{W}_1}{\overline{W}_1-\underline{W}_1};\alpha_1,\beta_1\right) \\ F_2(x) &= \text{betacdf}\left(\frac{x-\underline{W}_{12}}{\overline{W}_2-\underline{W}_2};\alpha_2,\beta_2\right), \end{aligned}$$

where $\text{betacdf}(\cdot;\alpha,\beta)$ is the CDF of a beta distribution with parameters α and β, hoping

that the two-parameter beta distribution would be sufficiently flexible for the purpose of fitting wage distributions. An important reason why a (flexible) parametric specification is useful is that, in order to calculate the function Φ in Proposition 1 and other transition rates (see below) we need to calculate offer densities $f_1 = F_1'$ and $f_2 = F_2'$. Assuming a parametric specification guaranties the smoothness of both the distribution function and its derivative.

In addition to transition rates $\boldsymbol{\lambda} = (\lambda_{ij})_{i,j=0,1,2}$ there are thus 6 parameters to estimate: $\boldsymbol{\theta} = (\underline{W}_1, \overline{W}_1, \underline{W}_2, \overline{W}_2, \alpha_1, \beta_1, \alpha_2, \beta_2)$.

Given $\boldsymbol{\lambda}$ we can estimate $\boldsymbol{\theta}$ as follows. Let $z_k = \cos(k\pi/N), k = 0, ..., N$, be $N+1$ Chebychev nodes on $[-1,1]$. These nodes allow to define grids on $[\underline{W}_1, \overline{W}_1]$ and $[\underline{W}_2, \overline{W}_2]$ as

$$W_{jk} = \frac{\underline{W}_j + \overline{W}_j}{2} + \frac{\underline{W}_j - \overline{W}_j}{2} z_k, \ j = 1,2, \ k = 0, ..., N.$$

For each point on the grids, on can calculate a corresponding wage w_{jk} using equations (15) and (16), and replacing integrals by quadrature approximations. The appropriate quadrature for Chebychev nodes is the Clenshaw-Curtis (CC) quadrature, which weights ω_k can be easily calculated using Fast Fourier Transform (FFT) (see Waldvogel, 2006). For example, we have

$$\begin{aligned}(1+\lambda_{10}s)w_{1k} = (r+\lambda_{10})W_{1k} - \lambda_{10}(\underline{W}_2 + UI) \\ - \lambda_{11}\frac{\underline{W}_1 - \overline{W}_1}{2}\sum_{n=0}^{N}\omega_n \mathbf{1}_{(W_{1n}>W_{1k})}\overline{F}_1(W_{1n}) \\ - \lambda_{12}\frac{\underline{W}_2 - \overline{W}_2}{2}\sum_{n=0}^{N}\omega_n \mathbf{1}_{(W_{2n}>W_{1k})}\overline{F}_2(W_{2n}),\end{aligned}$$

where $\mathbf{1}_{(.)}$ is the indicator function. A similar expression can be obtained to determine

wage nodes for the informal sector, w_{2k}.

Then we search for $\boldsymbol{\theta}$ minimizing

$$Q_1(\boldsymbol{\theta}|\boldsymbol{\lambda}) = \sum_{j=1,2}\sum_{k=0}^{N}\left(\widehat{G}_j^*(w_{jn}) - G_j(W_{jk})\right)^2,$$

where $G_j(W_{jk})$ is calculated using equations (6) and (7), and replacing integrals by CC-quadrature approximations, and $\widehat{G}_j^*$ is an estimate of wage distribution functions,.

Note that, assuming that $U = \underline{W}_2 \leq \underline{W}_1$ and $\overline{W}_2 \leq \overline{W}_1$, we have

$$(1+\lambda_{10}s)\underline{w}_1 = (r+\lambda_{10})\underline{W}_1 - \lambda_{10}(\underline{W}_2 + UI) - \lambda_{11}\mu_1 - \lambda_{12}\int_{\underline{W}_1}^{\overline{W}_2}\overline{F}_2(x)\,dx, \tag{21}$$

$$(1+\lambda_{10}s)\overline{w}_1 = (r+\lambda_{10})\overline{W}_1 - \lambda_{10}(\underline{W}_2 + UI), \tag{22}$$

$$\underline{w}_2 = r\underline{W}_2 - \lambda_{21}(\underline{W}_1 - \underline{W}_2 + \mu_1) - \lambda_{22}\mu_2 \tag{23}$$

$$\overline{w}_2 = (r+\lambda_{20})\overline{W}_2 - \lambda_{20}\underline{W}_2 - \lambda_{21}\int_{\overline{W}_2}^{\overline{W}_1}\overline{F}_1(x)\,dx, \tag{24}$$

where $[\underline{w}_1, \overline{w}_1]$ and $[\underline{w}_2, \overline{w}_2]$ are the observed wage supports in the formal and informal sectors, respectively, and with

$$\mu_1 = \underline{W}_1 + (\overline{W}_1 - \underline{W}_1)\frac{\alpha_1}{\alpha_1+\beta_1},$$
$$\mu_2 = \underline{W}_2 + (\overline{W}_2 - \underline{W}_2)\frac{\alpha_2}{\alpha_2+\beta_2}.$$

Hence, we can simplify the estimation problem slightly by using equations (22) and (23) to substitute observed wage bounds $\underline{w}_2$ and $\overline{w}_1$ for $\underline{W}_2 = U$ and $\overline{W}_1$ (given the α, β and $\underline{W}_1, \overline{W}_2$).

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3.2.2 Transition Rates

In a very similar way as we estimate $\boldsymbol{\theta}$ given $\boldsymbol{\lambda}$, we can estimate $\boldsymbol{\lambda}$ given $\boldsymbol{\theta}$. Natural counterparts to the theoretical transition rates can be calculated from observed flows between states (0: unemployment; 1: working in the formal sector; and 2: working in the informal sector). In Appendix D, we calculate the implied proportions D_{ij} of workers in state $i = 0,1,2$ at the beginning of the survey moving to state $j = 0,1,2$ before the end of the survey, lasting T periods. For example,

$$D_{11} = \int_{\underline{W}_1}^{\overline{W}_1} \frac{\lambda_{11}\overline{F}_1(x)}{d_1(x)}(1 - e^{-d_1(x)T})dG_1(x).$$

Now, in equilibrium,

$$\ell_1(x) = \frac{1}{n_1}\frac{h_1(x)}{d_1(x)} = \frac{m_1}{n_1}\frac{dG_1(x)}{dF_1(x)},$$

allowing to replace the derivative of G_1 by that of F_1 inside the integral. Then CC-quadrature can be used to approximate the integral.

We can thus estimate $\boldsymbol{\lambda}$ given $\boldsymbol{\theta}$ by minimizing the criterion

$$Q_2(\boldsymbol{\lambda}|\boldsymbol{\theta}) = \sum_{i,j=0,1,2} \left(\widehat{D}_{ij} - D_{ij}\right)^2,$$

where $\widehat{D}_{ij}$ is the empirical counterpart of D_{ij}.

We could minimize the two criteria Q_1 and Q_2 jointly but it is numerically faster to use a nested algorithm.

3.2.3 Value of Leisure

As mentioned above we allow unemployment insurance to be determined endogenously: in Brazil about 8.5% of receipts from labour taxes fund UI. Hence we compute the implied

amount using the government budget constraint

$$0.085\tau \int_{\underline{w}_1}^{\overline{w}_1} x d\widehat{G}_1^*(x) = UI \cdot D_{10}.$$

where D_{10} is the average transition probability from a formal sector job to unemployment and where $\widehat{G}_1^*$ is the estimated wage distribution. Remember that UI is paid to workers at the moment of transition into unemployment; hence this calculation is useful for constructing an amount that is consistent with the expected expenditure by Brazil and with the way we model UI.[15]

Having estimated the contract values in both sectors and having set U to be equal to $\underline{W}_2$ we can use the value function for the unemployed (3) to estimate the value of leisure. The legal minimum wage is not enforced in the informal sector and hence the minimum observed wage is the reservation wage. Combining this with the value of unemployment we can identify b.[16]

3.2.4 Productivity Distribution

Up to this point, there has been no need to use the firm profit functions, or indeed the distribution of productivities. To complete estimation we need to estimate the cost function of informality. This will allow us to characterize the choice of firms to locate in either sector and ultimately to carry out counterfactual simulations.

We specify the cost function as $C = C_1 \ell_2(W)^\gamma$, with C_1 and γ being the parameters to be estimated.

Given values for C_1 and γ, and for n_1 and n_2 such that $n_1 + n_2 \leq 1$, we solve for the labour force size in the formal sector ($\ell_1(W) = \frac{1}{n_1}\frac{h_1(W)}{d_1(W)}$) and in the informal sector

[15] By a simplifying assumption.

[16] 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.

($\ell_2(W) = \frac{1}{n_2}\frac{h_2(W)}{d_2(W)}$). From the firm's maximization problem in each sector, we next derive the support of the distribution of formal and informal productivities, i.e. $p_1 = K_1^{-1}(W)$ and $p_2 = K_2^{-1}(W)$ respectively. The first order conditions for the firm's optimisation problem (see (13), (14)) gives

$$p_1 = K_1^{-1}(W) = (1+\tau+\lambda_{10}s)[w_1(W) + w_1'(W)\frac{\ell_1(W)}{\ell_1'(W)}], \tag{25}$$

$$p_2 = K_2^{-1}(W) = w_2(W) + w_2'(W)\frac{\ell_2(W)}{\ell_2'(W)} + C_1\gamma\ell_2(W)^{\gamma-1}, \tag{26}$$

where the expressions for $w_1'(W)$, $i = 1,2$, are given by

$$\begin{aligned} w_1'(W) &= \frac{r+\lambda_{10}+\lambda_{11}\overline{F}_1(W_1(w))+\lambda_{12}\overline{F}_2(W_1(w))}{1+\lambda_{10}s}, \\ w_2'(W) &= r+\lambda_{20}+\lambda_{21}\overline{F}_1(W_2(w))+\lambda_{22}\overline{F}_2(W_2(w)), \end{aligned}$$

and where firm sizes can be differentiated using

$$\begin{aligned} h_1'(W) &= \lambda_{11}m_1G_1'(W) + \lambda_{21}m_2G_2'(W) \\ &= \lambda_{11}n_1\ell_1(W)F_1'(W) + \lambda_{21}n_2\ell_2(W)F_2'(W), \end{aligned}$$

with a similar expression for $h_2'(W)$.

For each point of the contract grids, W_{jk}, one can thus calculate a point p_{jk} on a productivity grid, with $\underline{p}_2 = p_{20}$, $\underline{p}_1 = p_{10}$, $\overline{p}_2 = p_{2N}$ and $\overline{p}_1 = p_{1N}$, allowing to tabulate productivity distributions as

$$\Gamma_j(p_{jk}) = n_j \cdot F_j(W_{jk}),\ j = 1,2, k = 0,...,N.$$

Equilibrium conditions require that $\pi_2(\underline{p}_2) = 0$, and $\pi_1(p) = \pi_2(p) > 0$ for $p \in [\underline{p}_1, \overline{p}_2]$.

We thus estimate C_1 and γ, and n_1 and n_2 such that $n_1 + n_2 \leq 1$, so as to minimize

$$\pi_2(p_{20})^2 + \sum_{k,k'=0}^{N} K(p_{1k} - p_{2k'})[\pi_1(p_{1k}) - \pi_2(p_{2k'})]^2,$$

where K is a kernel matching density.

Lastly, a parametric distribution can be fitted for Γ_0 using the equilibrium restriction

$$\Gamma_0(p) = \begin{cases} \Gamma_0(\underline{p}_2) + \Gamma_2(p), & \forall p \in [\underline{p}_2, \underline{p}_1], \\ \Gamma_0(\underline{p}_2) + \Gamma_1(p) + \Gamma_2(p), & \forall p \in [\underline{p}_1, \overline{p}_2], \\ \Gamma_0(\underline{p}_2) + n_2 + \Gamma_1(p), & \forall p \in [\overline{p}_2, \overline{p}_1]. \end{cases}$$

This forces in particular $\Gamma_0(\underline{p}_2) + n_1 + n_2 = 1$.

3.3 Endogenous Arrival Rates: Estimating a Matching Function

Counterfactual analyses require to predict the effects of a policy on wage distributions and workers stocks, and also on the meeting rates. A simple way to model endogenous arrival rates is as follows. An unemployed worker exerts search effort $s_0 = 1$ (normalisation). The search effort of an employed workers is s_1 or s_2 depending on the sector in which they work. Assume that the flow of contacts between firms and workers are given by a matching function $f(\theta)$, where market tightness is defined below. We assume that the probability of an offer being from the formal sector is $n_1/(n_1 + \alpha n_2)$ while the probability that it is from an informal sector is $\alpha n_2/(n_1 + \alpha n_2)$, where α denotes relative *visibility* of informal vacancies in the market. 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 to be

$$\lambda_{i1} = \frac{n_1}{(n_1 + \alpha n_2)} s_i f(\theta); \tag{27}$$

$$\lambda_{i2} = \frac{\alpha n_2}{(n_1 + \alpha n_2)} s_i f(\theta). \tag{28}$$

where market tightness θ is defined as

$$\theta = \frac{n_1 + \alpha n_2}{u + s_1 m_1 + s_2 m_2}. \tag{29}$$

We specify $f(\theta) = \mu \theta^{\eta}$. Usually η which is the elasticity of the matching function with respect to vacancies is estimated in the range 0.3-0.5 [Pentrogolo and Pissarides (2001)]. Because we normalise $s_0 = 1$, μ is identified.

For each submarket (defined by sex and across two regions Sao Paulo and Salvador), we use minimum distance to impose the restrictions implied by this specification and to estimate the search effort parameters s_1 and s_2 as well as the matching parameters α, μ and η.

The basic premise of this approach is that the differences across local labor markets can be summarised as differences in the matching function, in the search effort exerted by employees, and in the probability of sampling a job from each sector. In Appendix (E), we provide details of the estimation process as well as the estimates for each submarket.

4 Results

We focus our estimation for low education individuals, for whom individual heterogeneity is probaby less important. We present estimates separately for males and females and for

two contrasting regions of Brazil: wealthy and dynamic Sao Paulo and the poorer region of Salvador. By contrasting on these quite different regions we are able to study how the conclusions about informality may differ depending on the state of the labor market.

4.1 The model fit

Table 5 presents evidence on the fit of the model. The model is capable of replicating well the proportions of workers in the formal and informal sectors and the unemployed and particularly well all the transitions between sectors. The distribution of wages is also very well replicated, although the fit is not always perfect.

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ESTIMATION HAS TO BE REDONE ACCORDING TO THE ABOVE DESCRIPTION.

4.2 Frictional Parameters and the Level of Informality

Table 6 shows the job destruction and the job arrival rates.[17] The unit of time is a month. Subscript 0 refers to unemployment, 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.

The estimated job destruction rates are three to five times as high in the informal sector as 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. Low skilled unemployed workers receive twice to three times higher job offers in both regions. Interestingly, the arrival rates of offers from other informal jobs is higher for individuals already working in either sector than for those who are unemployed. It is also easier to locate formal jobs once

[17] We use 500 bootstrap samples to obtain the standard errors, which are in parentheses.

TABLE 5
Model Fit

	Sao Paulo				Salvador			
	Males		Females		Males		Females	
	Actual	Model	Actual	Model	Actual	Model	Actual	Model
m_1	0.625	0.694	0.516	0.504	0.582	0.576	0.420	0.446
m_2	0.263	0.224	0.264	0.248	0.254	0.259	0.213	0.209
u	0.112	0.081	0.220	0.248	0.164	0.166	0.367	0.345
Transitions								
D_{01}	0.088	0.089	0.043	0.043	0.050	0.050	0.017	0.017
D_{02}	0.257	0.257	0.111	0.111	0.112	0.112	0.031	0.031
D_{10}	0.020	0.020	0.020	0.020	0.020	0.020	0.013	0.013
D_{11}	0.016	0.016	0.013	0.013	0.026	0.026	0.021	0.021
D_{12}	0.004	0.004	0.004	0.004	0.003	0.003	0.001	0.001
D_{20}	0.082	0.082	0.075	0.075	0.060	0.060	0.045	0.045
D_{22}	0.065	0.065	0.062	0.062	0.059	0.059	0.045	0.045
D_{21}	0.011	0.011	0.008	0.008	0.005	0.005	0.005	0.005
Formal Wages (log)								
P10	6.28	6.15	5.89	5.96	5.95	5.67	5.72	5.43
P25	6.42	6.50	6.27	6.17	6.09	6.04	5.90	5.79
Median	6.65	6.75	6.41	6.43	6.30	6.29	6.03	6.05
P75	6.93	6.89	6.58	6.65	6.57	6.54	6.25	6.26
P90	7.24	7.07	6.87	6.84	6.89	6.71	6.48	6.39
Informal Wages (log)								
P10	5.87	5.55	5.86	5.56	5.59	5.51	5.41	5.43
P25	6.07	6.09	5.96	5.98	5.70	5.79	5.57	5.56
Median	6.34	6.37	6.16	6.23	5.88	5.95	5.69	5.69
P75	6.67	6.63	6.42	6.41	6.17	6.06	5.81	5.78
P90	7.04	6.98	6.75	6.63	6.51	6.22	6.04	5.96

TABLE 6
Transition Parameters

	λ_{10}	λ_{20}	λ_{01}	λ_{02}	λ_{11}	λ_{22}	λ_{12}	λ_{21}
Sao Paulo								
Males	0.0056	0.0212	0.0271	0.0789	0.0354	0.2924	0.3195	0.0110
	(0.0003)	(0.0011)	(0.0019)	(0.0032)	(0.0035)	(0.0236)	(0.1248)	(0.0021)
Females	0.0076	0.0262	0.0116	0.0301	0.0223	0.1873	0.0839	0.0072
	(0.0008)	(0.0023)	(0.0013)	(0.0021)	(0.0029)	(0.0195)	(0.0534)	(0.0012)
Salvador								
Males	0.0050	0.0170	0.0136	0.0305	0.0370	0.2383	0.2793	0.0036
	(0.0005)	(0.0014)	(0.0015)	(0.0022)	(0.0027)	(0.0291)	(0.0822)	(0.0010)
Females	0.0045	0.0109	0.0044	0.0080	0.0272	0.1889	0.0809	0.0028
	(0.0010)	(0.0018)	(0.0009)	(0.0012)	(0.0039)	(0.0245)	(0.0377)	(0.0014)

Note: The unit of time is a month.

working in the formal sector. However, obtaining formal job offers while working in the informal sector is much harder than when unemployed.

Comparing across regions, Sao Paulo has much higher destruction rates than Salvador in the informal sector, while for both the destruction rates in the formal sector are very small. Effectively formal jobs last a very long time, while in the more dynamic Sao Paulo jobs, and particularly informal ones, seem to be created and destroyed at a much higher rate. Within sector offer rates are similar in both regions; however in Sao Paulo the chance of obtaining an offer from the formal sector, when in an informal job, although low, is substantially higher. However the key differences between the regions seems to be in job destruction rates and in offers received when unemployed.

These differences reflect themselves in the double unemployment rate in Salvador as documented in Table 5, which mirrors the data. In addition the model uncovers a difference in the proportion of implied formal firms. Table 7 shows that while for men these are the same more or less in both regions (with slightly less firms being informal in Salvador), there are twice as many formal firms associated to women in Salvador than

TABLE 7
Proportion of Formal Firms by market

Males		Females	
Sao Paulo	Salvador	Sao Paulo	Salvador
0.30	0.27	0.30	0.62
(0.07)	(0.12)	(0.07)	(0.14)

there are in Sao Paulo. This is a reflection of a number of factors: the lower destruction and arrival rates and the near impossibility of moving from an informal firm to a formal one, which implies a greater incentive to wait for a formal job offer when unemployed.

4.2.1 Informality Cost and the Value of Leisure

Table 8 presents the implied cost to the firm of remaining informal. This cost arises from random monitoring and imposition of fines. We report the cost function[18] parameters and the mean cost per unit of profit. As we would expect in all cases the costs are convex in firm size, which implies that informality will be concentrated among smaller firms that pay less.

In the last column of Table 8 we present the estimated flow value of leisure. For men this is much lower in Sao Paulo than Salvador, another factor underlying the high unemployment rates. For women it is much higher than for men, possibly reflecting the demands of families and home production. The difference across regions is not significant in this case.

4.3 Formal and informal sector productivity and wages

A key feature of the equilibrium we describe is that given productivity, both formal and informal firms can coexist. This can have important policy implications because it implies

[18] $C = C_1 \ell_2 (W)^{\gamma}$.

TABLE 8
Cost of Informality and Value of Leisure

	C_1	γ	$Mean(C/\pi_2)$	b
Males, Sao Paulo	71.5	2.0	0.095	85.6
	(12.8)	(0.47)	(0.073)	(55.1)
Males, Salvador	70.5	1.7	0.244	193.0
	(14.0)	(0.54)	(0.041)	(26.6)
Females, Sao Paulo	53.0	1.7	0.117	291.6
	(14.1)	(0.46)	(0.035)	(34.4)
Females, Salvador	73.0	3.0	0.124	236.4
	(12.7)	(0.71)	(0.077)	(13.5)

that formal firms can be viable in regions of productivity where informal ones operate. Hence policies that reduce informality will not necessarily shut down all jobs in this part of the productivity distribution; on the other hand this should not be taken to imply that such an exercise will be costless, because lower levels of productivity may be able to sustain only smaller and fewer formal firms, given the amount of competition for workers and the overall regulatory costs. We consider these issues by first describing the equilibrium that results from our estimates and subsequently by counterfactual simulations.

Based on the estimates we can back out the implied allocation of workers to the formal and the informal sector for different levels of productivity, as well as the pay structure. The results are presented in Tables 9 and 10 for low education males in Sao Paulo and Salvador, respectively.

For males the lowest point of support of the productivity distribution is similar for both Sao Paulo and Salvador. However, all other percentiles are lower in Salvador, reflecting lower productivity and lower wages. In Sao Paulo there are not formal firms below the 25th percentile of the productivity distribution. In Salvador formal firms start operating at a level of productivity below the 10th percentile. In both markets, informality is to be found (at decreasing rates at all levels of productivity, but the size of formal firms

increases rapidly.

One of the most interesting features of the model is the implied wage structure. First, comparing wages and productivities the implied rents are quite high. Interestigly they are much higher in Salvador than in the more dynamic economy of Sao Paulo. Nevertheless in both cases frictions imply quite substantial rents accruing to firms, which of course can motivate welfare improving policies.

Second, the results justify two seemingly contradictionary statements. Wages are on average higher in the formal sector than in the informal ones, because the formal firms become increasingly large as productivity increases: this is a composition effect. However, given productivity, for the most part formal firms pay less than informal ones: this is a compensating differential for the non-monetary benefits enjoyed when working in the formal sector, such as access to employer provided health insurance[19] and better working environments. This differential disappears and even gets reversed at higher levels of productivity.

The overall picture is similar for women with some small differences: first formal firms in Salvador start operating at a higher part of the distribution of productivity than for the male market; second the wage structure is different and the distribution of productivities do have different shapes. Comparing the wage structures is not straightforward because of the differing productivities of the jobs they tend to work and the resulting changes in composition. However, male wages in the formal sector are more dispersed thane those of females in both regions. Tables 15 and 16 in appendix 6 present the estimates for low education women in Sao Paulo and Salvador, respectively.

To compare like with like Table 11 presents male and female wages for the two regions by sector and overall, at the same productivity level. In all cases, but the informal sector of Salvador, women are paid more conditional on productivity, for lower productivity levels.

[19] Public health is universal in Brazil.

TABLE 9
Sao Paulo, Males - Estimates by productivity

Productivity		cumulative	fraction of	fraction of	wage (log)		value (log)		firm size	
Percentiles	(log)	workforce	formal firms	formal workers	Formal	Informal	Formal	Informal	Formal	Informal
10th	5.542	0.088	0.000	-	-	4.978	-	11.633	-	0.4
25th	5.960	0.099	0.000	-	-	5.545	-	11.641	-	0.8
50th	6.315	0.114	0.272	0.350	5.565	5.874	11.685	11.647	2.7	1.3
75th	6.666	0.220	0.473	0.509	6.146	6.249	11.728	11.671	8.6	7.8
90th	7.047	0.399	0.598	0.674	6.503	6.467	11.796	11.693	26.0	21.5
99th	7.656	0.823	0.859	0.868	6.951	6.777	11.984	11.749	121.3	56.6

TABLE 10
Salvador, Males - Estimates by productivity

Productivity		cumulative	fraction of	fraction of	wage (log)		value (log)		firm size	
Percentiles	(log)	workforce	formal firms	formal workers	Formal	Informal	Formal	Informal	Formal	Informal
10th	5.538	0.174	0.130	0.589	4.429	4.648	11.209	11.159	2.2	0.3
25th	5.676	0.184	0.129	0.555	4.795	5.017	11.219	11.162	2.8	0.4
50th	5.912	0.212	0.174	0.422	5.081	5.514	11.231	11.171	3.7	1.2
75th	6.173	0.282	0.261	0.389	5.508	5.785	11.264	11.184	6.5	4.5
90th	6.572	0.460	0.528	0.458	5.932	6.007	11.330	11.212	16.0	23.6
99th	7.266	0.854	0.999	0.941	6.545	6.380	11.574	11.308	104.6	62.9

TABLE 11
Comparing male and female wages, by productivity

	Sao Paulo				Salvador			
	Formal		Informal		Formal		Informal	
Productivity	Males	Females	Males	Females	Males	Females	Males	Females
6.00	-	-	-	-	5.314	5.434	5.670	5.530
6.25	4.996	5.421	5.545	5.799	5.508	5.686	5.874	5.560
6.50	5.795	5.960	6.092	6.114	5.811	5.885	5.945	5.609
6.75	6.146	6.167	6.249	6.320	6.130	6.123	6.063	5.630
7.00	6.400	6.346	6.467	6.484	6.359	6.259	6.170	5.651
7.25	6.676	6.503	6.553	6.561	6.545	6.324	6.380	5.670
Mean	6.757	6.507	6.510	6.293	6.336	6.065	5.996	5.740

This is only reversed at the higher productivity levels in the formal sector of Sao Paulo. Thus women in most cases seem to work on more competitive labour markets with lower monopsony power for firms. However, on average women are paid less than men because most of them work in lower productivity (and hence lower paid) jobs. In other words the model interprets discrimination as being due to the type of jobs in the female labour market.

5 Policy Analysis

COUNTERFACTUAL ANALYSIS HAS TO BE REDONE AS I BELIEVE THAT THE EQUILIBRIUM COMPUTATION ALGORITHM IS FLOWED.

The model aims at providing a framework for understanding the impact of reducing or eliminating informality. The equilibrium nature of structure is crucial here, because we need to know how the wage structure will change and what will be the overall welfare loss from such policies.

We carry out the following simulations. First we start with small changes to UI and severance pay as well as to the fines imposed for informality. Tables in appendix 7 present

estimates of the effects of these changes on the composition of workforce, firm size and welfare. Here we summarise the implications. Our policy experiments are first to increase UI by 100%: although this sounds a lot, UI in Brazil is quite low particularly because it is time limited: we increase it from one to two minimum wages per month, payable for three months.[20] In our model there is no moral hazard from such policy, because it is payable upfront. Moreover, one cannot quit into unemployment - the only way to claim again is to be layed off due to exogenous job destruction. In reality claiming UI after expiration requires six months legal work. Changing UI will change the equilibrium distribution because it will increase the relative attractivenes of formal jobs, it will increase the cost of formal employment and it will increase corporation taxes, which is the source of funding - all our simulations keep government revenue constant.

As it turns out the increase in UI decreases overall welfare. However the mechanism through which it happens is interesting: it increases the supply of workers to formal firms, which now become a bit larger, although some lower productivity formal firms become informal. The resulting shift increases the profits in the formal sector but decreases informal profits, with the net effect being no change in worker's welfare and an overall drop in firm profits (see Table 17 in the appendix 7). Increasing severance pay by 5 percentage points has a very small negative effect on welfare which can be related mainly to a small decline in formal profits.

We now consider a 10% increase in the costs of informality, with the results in appendix 7 table 17 as above. This increases the proportion of formal firms, without increasing the proportion of formal workers. From the fourth column of table 13, wages in the informal sector change with a 13% decline in the median and an overall shift of the entire distribution to the left. Formal sector wages increase above the median. Firms that

[20]UI benefit ranges from 1 to about 2 minimum wages monthly, depending on the average of the three last wages received from last job, and are payable up to 5 months, depending on the last job spell. The majority of low education workers are entitled to 1 minimum wage per month during about 3 months.

are relocating to the formal sector tend to be the higher productivity informal firms. Thus competition at the higher levels of productivity increases and leads to more rents being captured by the workers. Moreover, with the increase in revenues from fines in the informal sector, the corporation tax decreases. The net effect is an increase in welfare overall and for all concerned (formal and informal workers and firms as well as the unemployed) In particular, the welfare of formal workers increases because their wages go up, due to the increased competition; informal workers and the unemployed are also better off because the value of a formal sector job, that they may move to, has increased. This more than counteracts the decline in informal sector wages.

For females in Sao Paulo, tables 19 and 21 shows that the proportion of formal firms increase by 2pp and, unlike for males, the proportion of workers also raises by 3pp. On the one hand, there is pressure for contract offers to increase in the formal sector, due to more competition. On the other hand, increased supply of workers in that sector forces contract values and wages down. On average, the former impact is offset by the latter, i.e. there is a small decrease in the values offered in the formal sector, following an also slight decrease in wages in that sector. However, overall welfare still goes up, due to an increase in formal sector profits.

The results above were for Sao Paulo. For males in Salvador, tables 23 and 25 show that increasing the cost of informality has a positive but much smaller impact on the overall welfare of workers and no effect on firms profits. This follows from a 2-3% increase in wages in the formal sector, despite a 10% decline of wages for the informal sector at all percentiles. As for females, tables 27 and 29 show that overall welfare increases; the decline in wages in the informal sector by about 4% at the median and more at lower percentiles is counteracted with an increase in informal wages at higher percentiles. This occurs due to relocation of some low productivity informal firms to the formal sector. Moreover, informal firm size goes up by 2 percentage points, which leads to an increase

in profits in the informal sector.

While there are differences in the results implied by different preference and technology parameters across markets (regions and genders), one thing stands out: reducing informality increases welfare overall. This is because the presence of informal firms limits the size of the more productive formal firms and at the same time allows the latter to keep more rents per worker. We now ask the question of what would happen if we could abolish completely the informal sector. [I THINK THIS NEEDS SOME CAREFUL EXPLAINING]

5.1 Abolishing informality.

In Tables 12 and 13 we present the results of abolishing informality for males in Sao Paulo. The Tables for the other markets are in the appendix 7. All simulations are revenue neutral, which is achieved by adjusting the corporation tax. Note that in the absence of an informal sector the corporation tax is non-distortionary because it is imposed on rents and hence can never affect the decision of a firm either to hire or to operate.

We present three different scenarios: one in which the contact rates are kept exogenous and two where they are endogenised as shown in subsection 3.3, each with a different elasticity for the matching function. We first turn to the male market in Sao Paulo. With fixed contact rates unemployment more than doubles. However, once we allow these to adjust unemployment returns to its original 8% level; abolishing informality does not increase unemployment here and may even decrease it depending on the elasticity of the matching function. About 40% of informal firms become formal, while the rest closes down. The average firm size increases from 10.6 (across both sectors) to 19-20 workers. The increased competition in the formal sector leads to wage increases of about 10% in the median and throughout all percentiles. The overall effect is a large increase in workers'

welfare, and a decline in the profits of the average firm. The net effect is a small decline in welfare and a redistribution towards workers. Effectively, the abolition of the informal sector attenuates the monopsony power of formal firms and allows workers to capture a larger fraction of the rents.

The key result that is found across all markets is that abolishing informality redistributes wealth towards workers. However, the extent to which this happens varies with the specific conditions (reflected in the estimated parameters). Part of this redistribution occurs because workers are shifted to the formal sector, without an increase (and indeed sometime a decrease) in unemployment. In in all but one market, for females in Salvador, wages also increase in the formal sector. In terms of productivity formal firms still start operating at the same level; so all low productivity informal firms that did not have formal counterparts just close down and do not switch to the formal sector. However the density of lower productivity formal firms increases as some of the informal firms on the overlapping range switch to become formal.

6 Conclusions

Informality is extremely common in developing countries. While the phenomenon is well recognised its effects are highly disputed and policy makers tend to be hesitant in addressing the issue one way or another. With this paper we wish to contribute to this debate.

On the one hand informal firms are portrayed as regulation busters that offer a much needed competitive fringe. Hence they are considered job creators and an indirect way by which employment protection legislation can be relaxed without governments beeing accused of siding in favour of business and against the workers. Indeed informal firms are low productive; an interpretation is that these jobs, which would not have existed in

TABLE 12

Effects on the composition of workforce, firm size and welfare, of eliminating the informal sector - Sao Paulo, Low Education Males

		No Informal Sector		
	Benchmark	exogenous λ's	$\eta = 0.3$	$\eta = 0.5$
m_1	0.69	0.83	0.94	0.92
m_2	0.23	-	-	-
u	0.08	0.17	0.06	0.08
n_1	0.30	0.58	0.58	0.58
n_2	0.70	-	-	-
Formal firm size (Mean)	26.2	15.9	20.3	19.3
Informal firm size (Mean)	4.1	-	-	-
Welfare (reals($) per month)				
Formal worker [$rE(W_1)$]	743.4	715.3	1062.3	818.54
Informal worker [$rE(W_2)$]	613.8	-	-	-
Unemployed [rU]	562.5	468.0	877.5	643.50
Average worker [$r(uU + m_1E(W_1) + m_2E(W_2))$]	699.6	673.2	1051.6	803.84
Formal firm [$E(\pi_1)$]	1475.2	871.8	872.2	731.23
Informal firm [$E(\pi_2)$]	143.9	-	-	-
Average firm [$N_1E(\pi_1) + N_2E(\pi_2)$]	543.3	507.1	507.3	425.29
Total (Workers + Firms)	1242.9	1180.3	1558.9	1229.1
Government Revenue (formal sector)	565.7	617.4	618.7	618.8
Government Revenue (informal sector)	53.1	-	-	-

Note: In all simulations government revenue is held constant through adjustments in corporate taxes.

TABLE 13

Effects on wages and overall wage inequality - Sao Paulo, Low Education Males

		Increase in			No Informal Sector		
	Benchmark	UI	s	C	exogenous λ's	$\eta = 0.3$	$\eta = 0.5$
Formal Wages (log)							
P10	6.15	6.15	6.15	6.28	6.16	6.55	6.40
P25	6.50	6.50	6.50	6.50	6.45	6.74	6.62
Median	6.75	6.75	6.75	6.75	6.70	6.91	6.86
P75	6.89	6.89	6.89	6.97	6.92	7.07	7.01
P90	7.07	7.07	7.07	7.17	7.13	7.21	7.14
Mean	6.77	6.77	6.77	6.83	6.79	6.98	6.88
Informal Wages (log)							
P10	5.55	5.54	5.55	5.29	-	-	-
P25	6.09	6.09	6.09	6.02	-	-	-
Median	6.37	6.37	6.37	6.24	-	-	-
P75	6.63	6.63	6.63	6.58	-	-	-
P90	6.98	6.97	6.98	6.92	-	-	-
Mean	6.52	6.52	6.52	6.44	-	-	-
Overall Wage Inequality							
p(75)/p(25)	1.73	1.73	1.73	1.75	1.59	1.39	1.48
p(90)/p(10)	2.86	2.86	2.86	3.26	2.63	1.95	2.08

Note: In all simulations government revenue is held constant through adjustments in corporate taxes. Unemployment insurance is increased from 1 to 2 minimum wages payable during about 3 months. Severance pay is increased by 5 percentage points. The cost of informality is raised by 10 percent.

a tightly regulated economy are allowed to exist and hence increase employment. On the other hand workers in the informal sector are often denied access to the benefits of modern societies, such as unemployment insurance and public pensions (except at a minimum level) as well as a proper health and safety framework.

To understand the balance between the pros and cons of informality we set up a model with search frictions and with endogenous decisions by both workers and firms as to where to work and locate jobs respectively. Clearly a competitive framework would necessarily imply that informality is welfare improving, at least with risk neutral agents. Our results show that search frictions are very important and without these elements in the model it would be very hard to understand the role of informality.

Using the simulations from our model we draw two sets of important conclusions. First, marginal increases in regulation, in the presence of an informal sector have little or no perceptible effect on the economy; they also have little effect in the distribution of activity between the formal and informal sector. However, increasing the cost of informality by 10% actually improves welfare of all concerned. [PUT INTUITIVE EXPLANATION HERE]. The resulting increased competition in the formal sector is the main cause. If we go as far as abolishing informality the results are more complex. First, in all cases workers' welfare (including those unemployed) increases substantially. This is both because they obtain formal jobs that are more valuable and because in most cases formal sector wages go up. Average firm profits can either increase or decrease, depending on the specific market. The extent to which they decrease determines whether welfare will increase or not. Unfortunately the model does not predict just one direction of welfare, but in most markets we considered overall welfare went up with the abolition of informality. Thus it seems that informality generates rents and distortions that are usually welfare reducing. This does not imply that labour market regulation will be welfare improving: abolishing informality and reducing regulation may be the way to go for efficient labour markets.

However, search frictions need to be taken into account. Like many complex questions there is no simple answer that will fit all markets. The results do depend on the specific circumstances. Nevertheless, we have shown quite convincingly, that using the informal sector to deregulate the economy is not likely to be the answer.

APPENDIX

A Monotonicity of the Value Functions

Simple differentiation of equations (2) and (1) shows that value functions $W_1(w)$ and $W_2(w)$ are left-differentiable with

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

$$W_2'(w) = \frac{1}{r+\delta_2+\lambda_{21}\overline{F}_1(W_2(w))+\lambda_{22}\overline{F}_2(W_2(w))} > 0. \tag{A.2}$$

B Equilibrium Offer and Accepted Contract Distributions

In this section, we derive G_1 and G_2 from F_1 and F_2.

By equation (4), for any $W \in [\underline{W}_1, \overline{W}_1]$,

$$\left[\lambda_{10}+\lambda_{11}\overline{F}_1(W)\right] m_1 G_1(W) + \lambda_{12} m_1 \int_{\underline{W}_1}^{W} \overline{F}_2(x)\, dG_1(x) = \lambda_{01} u F_1(W) + \lambda_{21} m_2 \int_{\underline{W}_2}^{W} [F_1(W) - F_1(x)]\, dG_2(x).$$

Making use of the identities

$$\int_{\underline{W}_1}^{W} \overline{F}_2(x)\, dG_1(x) = \overline{F}_2(W) G_1(W) + \int_{\underline{W}_1}^{W} G_1(x)\, dF_2(x),$$

$$\int_{\underline{W}_2}^{W} [F_1(W) - F_1(x)]\, dG_2(x) = \int_{\underline{W}_2}^{W} G_2(x) dF_1(x),$$

we can rewrite this equation as

$$d_1(W)\frac{m_1}{u} G_1(W) = \lambda_{01} F_1(W) - \Phi(W), \tag{B.1}$$

where $d_1(W) = \lambda_{10} + \lambda_{11}\overline{F}_1(W) + \lambda_{12}\overline{F}_2(W)$, and

$$\Phi(W) = \lambda_{12}\int_{\underline{W}_1}^{W} \frac{m_1}{u} G_1(x)\, dF_2(x) - \lambda_{21}\int_{\underline{W}_2}^{W} \frac{m_2}{u} G_2(x)\, dF_1(x). \tag{B.2}$$

Turning to the informal sector, equation (5) indicates that for $W \in [\underline{W}_2, \overline{W}_2]$,

$$\left[\lambda_{20} + \lambda_{22}\overline{F}_2(W)\right] m_2 G_2(W) + \lambda_{21} m_2 \int_{\underline{W}_2}^{W} \overline{F}_1(x)\, dG_2(x)$$
$$= \lambda_{02} u F_2(W) + \lambda_{12} m_1 \int_{\underline{W}_1}^{W} \left[F_2(W) - F_2(x)\right] dG_1(x).$$

Using the same integrations by part, we obtain that

$$d_2(W)\frac{m_2}{u} G_2(W) = \lambda_{02} F_2(W) + \Phi(W), \tag{B.3}$$

where $d_2(W) = \lambda_{20} + \lambda_{21}\overline{F}_1(W) + \lambda_{22}\overline{F}_2(W)$.

Next, multiplying equation (B.1) by $\frac{\lambda_{12} f_2(W)}{d_1(W)}$ (with $f_2 = F_2'$) and equation (B.3) by $-\frac{\lambda_{21} f_1(W)}{d_2(W)}$, and adding the two resulting equations, we obtain the first-order differential equation

$$\Phi' = A - B\Phi, \tag{B.4}$$

where

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

with boundary condition $\Phi(U) = 0$ (in fact $\Phi(W) = 0, \forall W \leq \max\{\underline{W}_1, \underline{W}_2\}$**).**

The solution of differential equation (B.4) is given by

$$\Phi(W) = \frac{\int_U^W e^{\int_U^x B(x')dx'} A(x)\, dx}{e^{\int_U^W B(x)\, dx}}. \tag{B.5}$$

Substituting this solution back into equations (B.1) and (B.3) we obtain the equilibrium relationship between the distribution of offered (F) and accepted (G).

C Computing the Equilibrium

In this section we describe the computation of the equilibrium.

1. Define contract value offer distribution F_1 and F_2, with supports bounds $\underline{W}_2 = U < \underline{W}_1 < \overline{W}_2 < \overline{W}_1$. Note that. from equation (3),

$$\underline{W}_2 = U = \frac{b + \lambda_{01}(\underline{W}_1 + \mu_1) + \lambda_{02}\mu_2}{r + \lambda_{01}}.$$

   Define the numbers of firms in each sector n_1, n_2, with $n_1 + n_2 \leq 1$.

2. Use Proposition 1 to derive m_1, m_2, u and G_1, G_2 from F_1, F_2.

3. Profit maximization then implies that optimal decision rules satisfy

$$p = K_1^{-1}(W) = (1 + \tau + \lambda_{10} s)[w_1(W) + w_1'(W)\frac{\ell_1(W)}{\ell_1'(W)}],$$
$$p = K_2^{-1}(W) = w_2(W) + w_2'(W)\frac{\ell_2(W)}{\ell_2'(W)} + C_1\gamma\ell_2(W)^{\gamma-1},$$

   with

$$(1 + \lambda_{10} s)w_1(W) = (r + \lambda_{10})W - \lambda_{10}(U + UI) - \lambda_{11}\int_W^{\overline{W}_1} \overline{F}_1(x)\,dx - \lambda_{12}\int_W^{\overline{W}_2} \overline{F}_2(x)\,dx,$$
$$(1 + \lambda_{10} s)w_1'(W) = r + \lambda_{10} + \lambda_{11}\overline{F}_1(W_1(w)) + \lambda_{12}\overline{F}_2(W_1(w)),$$
$$\ell_1(W) = \frac{1}{n_1}\frac{h_1(W)}{d_1(W)} = \frac{1}{n_1}\frac{\lambda_{01}u + \lambda_{11}m_1 G_1(W) + \lambda_{21}m_2 G_2(W)}{\lambda_{10} + \lambda_{11}\overline{F}_1(W) + \lambda_{12}\overline{F}_2(W)},$$
$$h_1'(W) = \lambda_{11}n_1\ell_1(W)F_1'(W) + \lambda_{21}n_2\ell_2(W)F_2'(W),$$

   with similar expressions for the informal section.

4. Then calculate productivity distributions

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

5. Consistency with the predetermined distribution of productivity Γ_0 requires that

$$\Gamma_0(p) = \begin{cases} \Gamma_0(\underline{p}_2) + \Gamma_2(p), & \forall p \in [\underline{p}_2, \underline{p}_1], \\ \Gamma_0(\underline{p}_2) + \Gamma_1(p) + \Gamma_2(p), & \forall p \in [\underline{p}_1, \overline{p}_2], \\ \Gamma_0(\underline{p}_2) + n_2 + \Gamma_1(p), & \forall p \in [\overline{p}_2, \overline{p}_1]. \end{cases}$$

6. If this consistency restriction is not satisfied, reiterate that sequence with another guess of F_1, F_2 and n_1, n_2.

In practice we discretize functions and approximate integrals as described in the estimation section, and we search for discrete approximations of F_1 and F_2, as well as shares n_1, n_1 so as to minimize a distance between Γ_0 and its prediction. The dimensionality of the optimization problem can be reduced by using simple parametric approximations for F_1, F_2 such as the beta distribution used in the estimation section.

D Estimating the transition parameters

From the labour force survey, we estimate the intensity of transitions from unemployment to job $(D_{0j};\ j = 1,2)$, from a formal sector job to unemployment, to another job in the same sector or to the informal sector $(D_{1j};\ j = 0,1,2)$ and similar ones for a workers initially in the informal sector $(D_{2j}; j = 0,1,2)$. We estimate our transition parameters using method of moments. In particular we choose the parameters to match the observed transition rates between sectors. Consider first the workers who are unemployed at the date of the first interview, that 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

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

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

$$\begin{aligned} D_{11} &= \int_{\underline{W}_1}^{\overline{W}_1} \frac{\lambda_{11}\overline{F}_1(x)}{d_1(x)}(1-e^{-d_1(x)T})dG_1(x), \\ D_{12} &= \int_{\underline{W}_1}^{\overline{W}_1} \frac{\lambda_{12}\overline{F}_2(x)}{d_1(x)}(1-e^{-d_1(x)T})dG_1(x), \\ D_{10} &= \int_{\underline{W}_1}^{\overline{W}_1} \frac{\lambda_{10}}{d_1(x)}(1-e^{-d_1(x)T})dG_1(x). \end{aligned} \tag{D.2}$$

where $d_1(W) = \lambda_{10}+\lambda_{11}\overline{F}_1(W)+\lambda_{12}\overline{F}_2(W)$. Similarly the corresponding transition rates

for those observed working initially in the informal sector are

$$
\begin{aligned}
D_{22} &= \int_U^{\overline{W}_2} \frac{\lambda_{22}\overline{F}_2(x)}{d_2(x)}(1-e^{-d_2(x)T})dG_2(x), \qquad \text{(D.3)}\\
D_{21} &= \int_U^{\overline{W}_2} \frac{\lambda_{21}\overline{F}_1(x)}{d_2(x)}(1-e^{-d_2(x)T})dG_2(x),\\
D_{20} &= \int_U^{\overline{W}_2} \frac{\lambda_{20}}{d_2(x)}(1-e^{-d_2(x)T})dG_2(x).
\end{aligned}
$$

with $d_2(W) = \lambda_{10} + \lambda_{11}\overline{F}_1(W) + \lambda_{12}\overline{F}_2(W)$.

These are the model counterparts for these empirical moments as functions of the arrival rates, the job destruction rates, the offers distributions F_i and as a function of the equilibrium contract values distributions G_i $(i = 1,2)$. Contract offers and equilibrium distributions are related by a complex function as explained in Appendix 2.

E Estimating the matching function

Based on equations (27) and (28) we construct for $i, j = 1,2$ the following conditions which are used to obtain s_1 and s_2

$$s_i = \frac{\lambda_{ij}}{\lambda_{0j}} \qquad \text{(E.1)}$$

For α, we use for $i = 0,1,2$

$$\alpha = \frac{n_1}{n_2}\frac{\lambda_{i2}}{\lambda_{i1}} \qquad \text{(E.2)}$$

From (29), the market tightness θ is a function of s_1, s_2 and α, hence $\theta = \theta(s_1, s_2, \alpha)$. In addition, by setting η equal to a value in the range 0.3-0.5, we can derive expressions to obtain μ. From (27) and (28), for $i = 0,1,2$

$$\mu = \lambda_{i1}\frac{(n_1 + \alpha n_2)}{n_1 s_i \theta^{\eta}} \qquad \text{(E.3)}$$

$$\mu = \lambda_{i2}\frac{(n_1 + \alpha n_2)}{\alpha n_2 s_i \theta^{\eta}} \qquad \text{(E.4)}$$

We use (E.1)-(E.4) to construct our criterion function. Our estimation method consists of minimising

$$\sum_{i=1}^{2}\sum_{j=1}^{2}\left(s_i-\frac{\lambda_{ij}}{\lambda_{0j}}\right)^2+\sum_{i=0}^{2}\left[\left(\alpha-\frac{n_1}{n_2}\frac{\lambda_{i2}}{\lambda_{i1}}\right)^2+\left(\mu-\lambda_{i1}\frac{n_1+\alpha n_2}{n_1 s_i\theta^{\eta}}\right)^2+\left(\mu-\lambda_{i2}\frac{n_1+\alpha n_2}{\alpha n_2 s_i\theta^{\eta}}\right)^2\right]$$

TABLE 14
Matching Function Estimates

				μ		
	s_1	s_2	α	$\eta=0.3$	$\eta=0.5$	θ
Males, Sao Paulo	2.678	2.057	5.497	0.141	0.127	1.726
Males, Salvador	5.934	4.033	9.328	0.101	0.092	1.533
Females, Sao Paulo	2.353	3.424	4.601	0.059	0.054	1.542
Females, Salvador	8.1432	12.186	39.689	0.030	0.026	2.407

F Productivity and wage distributions for women

TABLE 15
Sao Paulo, Females - Estimates by productivity

Productivity		cumulative	fraction of	fraction of	wage (log)		value (log)		firm size	
Percentiles	(log)	workforce	formal firms	formal workers	Formal	Informal	Formal	Informal	Formal	Informal
10th	5.876	0.258	0.000	-	-	4.841	-	11.410	-	0.6
25th	6.110	0.278	0.000	-	-	5.564	-	11.419	-	1.3
50th	6.327	0.292	0.233	0.060	5.483	5.799	11.433	11.425	2.2	2.1
75th	6.590	0.449	0.484	0.447	6.068	6.225	11.488	11.452	9.8	10.1
90th	6.927	0.585	0.691	0.624	6.260	6.405	11.530	11.476	17.4	19.9
99th	7.773	0.925	0.999	0.924	6.779	6.916	11.739	11.592	57.9	39.7

G Simulation Results

TABLE 16
Salvador, Females - Estimates by productivity

Productivity		cumulative	fraction of	fraction of	wage (log)		value (log)		firm size	
Percentiles	(log)	workforce	formal firms	formal workers	Formal	Informal	Formal	Informal	Formal	Informal
10th	5.362	0.350	0.000	-	-	4.970	-	10.920	-	0.6
25th	5.494	0.356	0.634	0.489	4.768	5.112	10.962	10.923	0.8	0.8
50th	5.829	0.409	0.800	0.547	5.285	5.500	11.003	10.939	1.9	4.3
75th	6.363	0.534	0.767	0.661	5.791	5.560	11.103	10.945	6.9	7.0
90th	6.598	0.610	0.638	0.710	5.971	5.609	11.169	10.950	13.1	11.3
99th	7.473	0.858	0.210	0.419	6.447	5.688	11.443	10.964	39.8	26.3

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TABLE 17

Effects on the composition of workforce, firm size and welfare, of changes in taxes, unemployment compensation and in the informality cost - Sao Paulo, Low Education Males

	Benchmark	Increase in UI	Increase in s	Increase in C
m_1	0.69	0.69	0.69	0.69
m_2	0.23	0.23	0.22	0.23
u	0.08	0.08	0.08	0.08
n_1	0.30	0.29	0.30	0.32
n_2	0.70	0.71	0.70	0.68
Formal firm size (Mean)	26.2	27.1	26.2	24.2
Informal firm size (Mean)	4.1	4.0	4.1	4.2
Welfare (reals($) per month)				
Formal worker $[rE(W_1)]$	743.4	743.4	743.4	817.7
Informal worker $[rE(W_2)]$	613.8	613.8	613.8	676.3
Unemployed $[rU]$	562.5	562.5	562.5	618.8
Average worker $[r(uU+m_1E(W_1)+m_2E(W_2))]$	699.6	699.6	699.6	768.7
Formal firm $[E(\pi_1)]$	1475.2	1492.8	1474.2	1728.8
Informal firm $[E(\pi_2)]$	143.9	141.9	143.9	171.6
Average firm $[N_1E(\pi_1)+N_2E(\pi_2)]$	543.3	533.7	543.0	669.9
Total (Workers + Firms)	1242.9	1233.3	1242.6	1438.6
Government Revenue (formal sector)	565.7	565.7	565.7	502.1
Government Revenue (informal sector)	53.1	53.1	53.1	116.0

Note: In all simulations government revenue is held constant through adjustments in corporate taxes. Unemployment insurance is increased from 1 to 2 minimum wages payable during about 3 months. Severance pay is increased by 5 percentage points. The cost of informality is raised by 10 percent.

TABLE 18
Effects on the distribution of productivity - Sao Paulo, Low Education Males

		Increase in			No Informal Sector		
	Benchmark	*UI*	*s*	*C*	exogenous λ's	$\eta = 0.3$	$\eta = 0.5$
Formal Productivity (log)							
Min	6.20	6.20	6.20	6.20	6.20	6.20	6.20
P10	6.29	6.29	6.29	6.29	6.29	6.24	6.24
P25	6.43	6.43	6.43	6.43	6.43	6.29	6.29
Median	6.74	6.74	6.74	6.88	6.88	6.59	6.59
P75	7.08	7.08	7.08	7.17	7.17	6.99	6.99
P90	7.34	7.34	7.34	7.44	7.44	7.17	7.17
Mean	6.97	6.97	6.97	7.02	7.04	6.83	6.83
Informal Productivity (log)							
Min	5.46	5.46	5.46	5.46	-	-	-
P10	5.54	5.54	5.54	5.54	-	-	-
P25	5.82	5.82	5.82	5.82	-	-	-
Median	6.07	6.07	6.07	6.26	-	-	-
P75	6.41	6.41	6.41	6.55	-	-	-
P90	6.70	6.70	6.70	6.85	-	-	-
Mean	6.33	6.33	6.33	6.40	-	-	-

Note: In all simulations government revenue is held constant through adjustments in corporate taxes. Unemployment insurance is increased from 1 to 2 minimum wages payable during about 3 months. Severance pay is increased by 5 percentage points. The cost of informality is raised by 10 percent.

TABLE 19

Effects on the composition of workforce, firm size and welfare, of changes in taxes, unemployment compensation and in the informality cost - Sao Paulo, Low Education Females

	Benchmark	Increase in UI	Increase in s	Increase in C
m_1	0.50	0.50	0.50	0.53
m_2	0.25	0.25	0.25	0.23
u	0.25	0.25	0.25	0.24
n_1	0.30	0.30	0.30	0.32
n_2	0.70	0.70	0.70	0.68
Formal firm size (Mean)	18.6	18.6	18.6	18.2
Informal firm size (Mean)	4.3	4.3	4.3	4.0
Welfare (reals($) per month)				
Formal worker $[rE(W_1)]$	561.1	561.1	561.1	557.4
Informal worker $[rE(W_2)]$	480.2	480.2	480.2	473.1
Unemployed $[rU]$	450.0	450.0	450.0	450.0
Average worker $[r(uU+m_1E(W_1)+m_2E(W_2))]$	513.5	513.5	513.5	512.3
Formal firm $[E(\pi_1)]$	1357.5	1327.3	1355.2	1428.0
Informal firm $[E(\pi_2)]$	112.8	112.8	112.8	106.8
Average firm $[N_1E(\pi_1)+N_2E(\pi_2)]$	486.2	477.1	485.5	529.6
Total (Workers + Firms)	999.7	990.6	999.0	1041.9
Government Revenue (formal sector)	489.1	488.9	489.2	469.0
Government Revenue (informal sector)	23.7	23.7	23.7	44.7

Note: In all simulations government revenue is held constant through adjustments in corporate taxes. Unemployment insurance is increased from 1 to 2 minimum wages payable during about 3 months. Severance pay is increased by 5 percentage points. The cost of informality is raised by 10 percent.

TABLE 20

Effects on the composition of workforce, firm size and welfare, of eliminating the informal sector - Sao Paulo, Low Education Females

		No Informal Sector		
	Benchmark	exogenous λ's	$\eta = 0.3$	$\eta = 0.5$
m_1	0.50	0.61	0.84	0.79
m_2	0.25	-	-	-
u	0.25	0.39	0.16	0.21
n_1	0.30	0.57	0.57	0.57
n_2	0.70	-	-	-
Formal firm size (Mean)	18.6	11.6	17.4	16.0
Informal firm size (Mean)	4.3	-	-	-
Welfare (reals($) per month)				
Formal worker $[rE(W_1)]$	561.1	510.9	718.1	620.0
Informal worker $[rE(W_2)]$	480.2	-	-	-
Unemployed $[rU]$	450.0	414.7	599.0	506.9
Average worker $[r(uU + m_1E(W_1) + m_2E(W_2))]$	513.5	473.0	699.0	596.2
Formal firm $[E(\pi_1)]$	1357.5	772.2	1078.9	979.2
Informal firm $[E(\pi_2)]$	112.8	-	-	-
Average firm $[N_1E(\pi_1) + N_2E(\pi_2)]$	486.2	439.2	613.6	556.9
Total (Workers + Firms)	999.7	912.1	1312.6	1153.1
Government Revenue (formal sector)	489.1	513.4	512.9	512.9
Government Revenue (informal sector)	23.7	-	-	-

Note: In all simulations government revenue is held constant through adjustments in corporate taxes.

TABLE 21

Effects on wages and overall wage inequality - Sao Paulo, Low Education Females

		Increase in			No Informal Sector		
	Benchmark	UI	s	C	exogenous λ's	$\eta = 0.3$	$\eta = 0.5$
Formal Wages (log)							
P10	5.96	5.96	5.96	5.91	6.00	6.19	6.05
P25	6.17	6.17	6.17	6.13	6.12	6.40	6.34
Median	6.43	6.43	6.43	6.41	6.35	6.69	6.52
P75	6.65	6.65	6.65	6.64	6.56	6.87	6.78
P90	6.84	6.84	6.84	6.85	6.76	7.04	6.94
Mean	6.51	6.51	6.51	6.50	6.43	6.75	6.63
Informal Wages (log)							
P10	5.56	5.56	5.56	5.46	-	-	-
P25	5.98	5.98	5.98	5.86	-	-	-
Median	6.23	6.23	6.23	6.08	-	-	-
P75	6.41	6.41	6.41	6.27	-	-	-
P90	6.63	6.63	6.63	6.51	-	-	-
Mean	6.30	6.30	6.30	6.20	-	-	-
Overall Wage Inequality							
p(75)/p(25)	1.61	1.57	1.57	1.71	1.55	1.60	1.56
p(90)/p(10)	2.65	2.65	2.65	2.89	2.12	2.34	2.42

Note: In all simulations government revenue is held constant through adjustments in corporate taxes. Unemployment insurance is increased from 1 to 2 minimum wages payable during about 3 months. Severance pay is increased by 5 percentage points. The cost of informality is raised by 10 percent.

TABLE 22
Effects on the distribution of productivity - Sao Paulo, Low Education Females

		Increase in			No Informal Sector		
	Benchmark	*UI*	*s*	*C*	exogenous λ's	$\eta = 0.3$	$\eta = 0.5$
Formal Productivity (log)							
Min	5.75	5.75	5.75	5.75	5.75	5.75	5.75
P10	6.25	6.25	6.25	6.25	6.25	6.25	6.25
P25	6.39	6.39	6.39	6.39	6.39	6.39	6.39
Median	6.63	6.63	6.63	6.63	6.63	6.63	6.63
P75	6.99	6.99	6.99	6.99	6.99	6.88	6.88
P90	7.31	7.31	7.31	7.31	7.31	7.19	7.19
Mean	7.00	7.00	7.00	7.01	7.03	6.84	6.86
Informal Productivity (log)							
Min	4.06	4.06	4.06	4.06	-	-	-
P10	5.88	5.88	5.88	5.88	-	-	-
P25	6.03	6.03	6.03	6.03	-	-	-
Median	6.18	6.18	6.18	6.18	-	-	-
P75	6.41	6.41	6.41	6.41	-	-	-
P90	6.63	6.63	6.63	6.63	-	-	-
Mean	6.34	6.34	6.34	6.34	-	-	-

Note: In all simulations government revenue is held constant through adjustments in corporate taxes. Unemployment insurance is increased from 1 to 2 minimum wages payable during about 3 months. Severance pay is increased by 5 percentage points. The cost of informality is raised by 10 percent.

TABLE 23

Effects on the composition of workforce, firm size and welfare, of changes in taxes, unemployment compensation and in the informality cost - Salvador, Low Education Males

	Benchmark	Increase in UI	Increase in s	Increase in C
m_1	0.57	0.57	0.57	0.57
m_2	0.26	0.26	0.26	0.26
u	0.17	0.17	0.17	0.17
n_1	0.27	0.26	0.27	0.27
n_2	0.73	0.74	0.73	0.73
Formal firm size (Mean)	21.3	22.1	21.3	21.3
Informal firm size (Mean)	3.99	3.94	3.99	3.99
Welfare (reals($) per month)				
Formal worker $[rE(W_1)]$	491.2	491.2	491.2	497.7
Informal worker $[rE(W_2)]$	374.5	374.5	374.5	365.3
Unemployed $[rU]$	350.0	350.0	350.0	350.0
Average worker $[r(uU + m_1E(W_1) + m_2E(W_2))]$	437.6	437.6	437.6	438.9
Formal firm $[E(\pi_1)]$	941.1	955.9	940.5	941.2
Informal firm $[E(\pi_2)]$	75.6	74.6	75.6	75.6
Average firm $[N_1E(\pi_1) + N_2E(\pi_2)]$	309.3	303.7	309.1	309.3
Total (Workers + Firms)	746.9	741.3	746.7	748.2
Government Revenue (formal sector)	365.1	365.0	365.1	352.2
Government Revenue (informal sector)	46.1	46.1	46.1	62.4

Note: In all simulations government revenue is held constant through adjustments in corporate taxes. Unemployment insurance is increased from 1 to 2 minimum wages payable during about 3 months. Severance pay is increased by 5 percentage points. The cost of informality is raised by 10 percent.

TABLE 24

Effects on the composition of workforce, firm size and welfare, of eliminating the informal sector - Salvador, Low Education Males

		No Informal Sector		
	Benchmark	exogenous λ's	$\eta = 0.3$	$\eta = 0.5$
m_1	0.57	0.73	0.92	0.89
m_2	0.26	-	-	-
u	0.17	0.27	0.08	0.11
n_1	0.27	0.97	0.97	0.97
n_2	0.73	-	-	-
Formal firm size (Mean)	21.3	7.4	10.7	9.9
Informal firm size (Mean)	3.99	-	-	-
Welfare (reals($) per month)				
Formal worker $[rE(W_1)]$	491.2	534.2	574.1	567.0
Informal worker $[rE(W_2)]$	374.5	-	-	-
Unemployed $[rU]$	350.0	364.0	546.0	473.2
Average worker $[r(uU + m_1E(W_1) + m_2E(W_2))]$	437.6	488.1	571.9	556.3
Formal firm $[E(\pi_1)]$	941.1	481.7	307.0	369.3
Informal firm $[E(\pi_2)]$	75.6	-	-	-
Average firm $[N_1E(\pi_1) + N_2E(\pi_2)]$	309.3	468.7	298.7	359.3
Total (Workers + Firms)	746.9	956.8	870.7	915.7
Government Revenue (formal sector)	365.1	411.7	411.3	411.3
Government Revenue (informal sector)	46.1	-	-	-

Note: In all simulations government revenue is held constant through adjustments in corporate taxes.

TABLE 25

Effects on wages and overall wage inequality - Salvador, Low Education Males

		Increase in			No informal sector		
	Benchmark	*UI*	*s*	*C*	exogenous λ's	$\eta = 0.3$	$\eta = 0.5$
Formal Wages (log)							
P10	5.67	5.67	5.67	5.69	5.59	5.90	5.92
P25	6.04	6.04	6.04	6.06	5.98	6.08	6.10
Median	6.29	6.29	6.29	6.31	6.30	6.23	6.33
P75	6.54	6.54	6.54	6.57	6.66	6.37	6.53
P90	6.71	6.71	6.71	6.73	6.94	6.52	6.64
Mean	6.35	6.35	6.35	6.37	6.46	6.27	6.36
Informal Wages (log)							
P10	5.51	5.51	5.51	5.41	-	-	-
P25	5.79	5.78	5.79	5.68	-	-	-
Median	5.95	5.94	5.95	5.84	-	-	-
P75	6.06	6.06	6.06	5.96	-	-	-
P90	6.22	6.22	6.22	6.12	-	-	-
Mean	6.00	6.00	6.00	5.90	-	-	-
Overall Wage Inequality							
p(75)/p(25)	1.95	1.98	1.95	2.05	1.99	1.33	1.54
p(90)/p(10)	3.03	3.02	3.02	3.12	3.88	1.85	2.07

Note: In all simulations government revenue is held constant through adjustments in corporate taxes. Unemployment insurance is increased from 1 to 2 minimum wages payable during about 3 months. Severance pay is increased by 5 percentage points. The cost of informality is raised by 10 percent.

TABLE 26
Effects on the productivity distribution - Salvador, Low Education Males

		Increase in			No Informal Sector		
	Benchmark	*UI*	*s*	*C*	exogenous λ's	$\eta = 0.3$	$\eta = 0.5$
Formal Productivity (log)							
Min	5.29	5.29	5.29	5.29	5.29	5.29	5.29
P10	5.44	5.44	5.44	5.44	5.44	5.37	5.37
P25	5.86	5.86	5.86	5.86	5.86	5.65	5.65
Median	6.22	6.22	6.22	6.22	6.35	6.06	6.06
P75	6.64	6.64	6.64	6.64	6.72	6.35	6.46
P90	6.89	6.89	6.89	6.89	7.17	6.64	6.72
Mean	6.47	6.47	6.47	6.47	6.67	6.20	6.28
Informal Productivity (log)							
Min	3.99	3.99	3.99	3.99	-	-	-
P10	5.54	5.54	5.54	5.54	-	-	-
P25	5.69	5.69	5.69	5.69	-	-	-
Median	5.82	5.82	5.82	5.82	-	-	-
P75	6.04	6.04	6.04	6.04	-	-	-
P90	6.29	6.29	6.29	6.29	-	-	-
Mean	5.99	5.99	5.99	5.99	-	-	-

Note: In all simulations government revenue is held constant through adjustments in corporate taxes. Unemployment insurance is increased from 1 to 2 minimum wages payable during about 3 months. Severance pay is increased by 5 percentage points. The cost of informality is raised by 10 percent.

TABLE 27

Effects on the composition of workforce, firm size and welfare, of changes in taxes, unemployment compensation and in the informality cost - Salvador, Low Education Females

	Benchmark	Increase in UI	Increase in s	Increase in C
m_1	0.45	0.45	0.45	0.45
m_2	0.21	0.21	0.21	0.21
u	0.35	0.35	0.35	0.35
n_1	0.62	0.62	0.62	0.63
n_2	0.38	0.38	0.38	0.37
Formal firm size (Mean)	7.3	7.3	7.3	7.1
Informal firm size (Mean)	5.4	5.4	5.4	5.6
Welfare (reals($) per month)				
Formal worker $[rE(W_1)]$	380.5	378.0	380.5	380.5
Informal worker $[rE(W_2)]$	296.4	296.5	296.4	308.8
Unemployed $[rU]$	275.0	275.0	275.0	275.0
Average worker $[r(uU+m_1E(W_1)+m_2E(W_2))]$	326.5	325.4	326.5	329.1
Formal firm $[E(\pi_1)]$	498.7	494.6	497.9	515.7
Informal firm $[E(\pi_2)]$	1440.0	1435.5	1435.5	1474.3
Average firm $[N_1E(\pi_1)+N_2E(\pi_2)]$	854.6	852.1	854.2	870.4
Total (Workers + Firms)	1181.1	1177.5	1180.7	1199.5
Government Revenue (formal sector)	227.7	228.0	227.7	211.4
Government Revenue (informal sector)	700.0	700.0	700.0	717.0

Note: In all simulations government revenue is held constant through adjustments in corporate taxes. Unemployment insurance is increased from 1 to 2 minimum wages payable during about 3 months. Severance pay is increased by 5 percentage points. The cost of informality is raised by 10 percent.

TABLE 28

Effects on the composition of workforce, firm size and welfare, of eliminating the informal sector - Salvador, Low Education Females

		No Informal Sector		
	Benchmark	exogenous λ's	$\eta = 0.3$	$\eta = 0.5$
m_1	0.45	0.50	0.79	0.69
m_2	0.21	-	-	-
u	0.35	0.50	0.21	0.31
n_1	0.62	0.90	0.90	0.90
n_2	0.38	-	-	-
Formal firm size (Mean)	7.3	5.5	9.2	7.9
Informal firm size (Mean)	5.4	-	-	-
Welfare (reals($) per month)				
Formal worker $[rE(W_1)]$	380.5	319.9	568.3	459.8
Informal worker $[rE(W_2)]$	296.4	-	-	-
Unemployed $[rU]$	275.0	314.6	400.4	314.6
Average worker $[r(uU + m_1E(W_1) + m_2E(W_2))]$	326.5	317.2	532.7	414.6
Formal firm $[E(\pi_1)]$	498.7	2605.0	1380.2	1765.4
Informal firm $[E(\pi_2)]$	1440.0	-	-	-
Average firm $[N_1E(\pi_1) + N_2E(\pi_2)]$	854.6	2340.1	1239.8	1585.9
Total (Workers + Firms)	1181.1	2657.3	1772.5	2000.5
Government Revenue (formal sector)	227.7	927.3	927.6	927.8
Government Revenue (informal sector)	700.0	-	-	-

Note: In all simulations government revenue is held constant through adjustments in corporate taxes.

TABLE 29

Effects on wages and overall wage inequality - Salvador, Low Education Females

		Increase in			No Informal Sector		
	Benchmark	*UI*	*s*	*C*	exogenous λ's	$\eta = 0.3$	$\eta = 0.5$
Formal Wages (log)							
P10	5.43	5.42	5.43	5.43	4.94	5.42	5.27
P25	5.79	5.77	5.79	5.79	5.22	5.72	5.55
Median	6.05	6.03	6.05	6.05	5.47	6.15	5.83
P75	6.26	6.24	6.26	6.26	5.71	6.51	6.14
P90	6.39	6.37	6.39	6.39	6.04	6.73	6.43
Mean	6.07	6.05	6.07	6.07	5.60	6.27	5.98
Informal Wages (log)							
P10	5.43	5.43	5.43	5.33	-	-	-
P25	5.56	5.56	5.56	5.46	-	-	-
Median	5.69	5.69	5.69	5.65	-	-	-
P75	5.78	5.78	5.78	5.91	-	-	-
P90	5.96	5.96	5.96	6.27	-	-	-
Mean	5.75	5.75	5.75	5.86	-	-	-
Overall Wage Inequality							
p(75)/p(25)	1.61	1.61	1.61	1.78	1.64	2.21	1.79
p(90)/p(10)	2.65	2.64	2.65	2.92	3.01	3.70	3.20

Note: In all simulations government revenue is held constant through adjustments in corporate taxes. Unemployment insurance is increased from 1 to 2 minimum wages payable during about 3 months. Severance pay is increased by 5 percentage points. The cost of informality is raised by 10 percent.

TABLE 30
Effects on the productivity distribution - Salvador, Low Education Females

		Increase in			No Informal Sector		
	Benchmark	*UI*	*s*	*C*	exogenous λ's	$\eta = 0.3$	$\eta = 0.5$
Formal Productivity (log)							
Min	5.40	5.40	5.40	5.40	5.40	5.40	5.40
P10	5.45	5.45	5.45	5.45	5.58	5.58	5.58
P25	5.74	5.74	5.74	5.74	5.74	5.74	5.74
Median	6.05	6.05	6.05	6.05	6.18	6.18	6.18
P75	6.38	6.38	6.38	6.38	6.47	6.47	6.47
P90	6.66	6.66	6.66	6.66	6.89	6.77	6.77
Mean	6.41	6.41	6.41	6.41	7.24	6.45	6.56
Informal Productivity (log)							
Min	4.47	4.47	4.47	4.47	-	-	-
P10	5.15	5.15	5.15	5.15	-	-	-
P25	5.36	5.36	5.36	5.36	-	-	-
Median	5.54	5.54	5.54	5.54	-	-	-
P75	5.84	5.84	5.84	5.84	-	-	-
P90	6.49	6.49	6.49	6.49	-	-	-
Mean	6.01	6.01	6.01	6.01	-	-	-

Note: In all simulations government revenue is held constant through adjustments in corporate taxes. Unemployment insurance is increased from 1 to 2 minimum wages payable during about 3 months. Severance pay is increased by 5 percentage points. The cost of informality is raised by 10 percent.

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