



INTERNATIONAL POLICY CENTER  
Gerald R. Ford School of Public Policy  
University of Michigan

IPC Working Paper Series Number 52

**Job Creation and Job Description in the Presence of  
Informal Labor Markets**

**Mariano Bosch**

April 3, 2007

# Job Creation and Job Destruction in the Presence of Informal Labour Markets

Mariano Bosch\*

London School of Economics

04/03/2007

## Abstract

Recessions and policy interventions in labour markets in developing countries are characterized not only by changes in the unemployment rate, but also by changes in the proportion of formal or protected jobs. This reallocation between formal and informal jobs is large and occurs mainly because the job finding rate of formal jobs reacts substantially more than the job finding rate of informal jobs. This paper presents a search and matching model to capture this fact. I assume that there is a distribution of productivities of potential matches and that firms choose to legalize only those matches that are good enough to compensate the costs of formality. In this framework, recessions or stricter regulations in the labour market trigger two effects. As expected, they lower the incentives to post vacancies (meeting effect), but also affect the firms' hiring standards, favouring informal contracts (offer effect). This new channel sheds light on how the actions of policy makers alter the outcomes in an economy with informal jobs. For instance, attempts to protect employment by increasing firing costs will reallocate workers to informal jobs, where job separation is high. They are also likely to increase unemployment.

*JEL classification:* J64, H26, O17

*Keywords:* Informal economy, search models, labour markets, regulations.

## 1 Introduction

The coexistence of formal and informal jobs in developing economies has attracted the attention of researchers and policy makers over the last fifty years. There is vast literature analyzing labour markets in developing economies dating as early as Harris Todaro (1970)

---

\*E-mail: m.bosch@lse.ac.uk. I thank Christopher Pissarides, Rachel Ngai, Alan Manning, Barbara Petrongolo, Alwyn Young, Wouter Den Haan, Francesco Caselli, Evangelia Vourvachaki, Carlos Thomas, William Maloney, Marco Manacorda and all participants in the Money Macro and Labor Seminars at the LSE for helpful comments. All remaining errors are mine.

model<sup>1</sup>. In recent years the flow approach to labour markets has become the conceptual framework for analyzing unemployment dynamics in developed countries. This has spurred a new generation of multisectoral labour market models with formal and informal jobs. The introduction of frictions allows to generate flows of workers between employment statuses. This provides a richer and more complex picture of the interactions between formal employment, informal employment and unemployment. However, so far this effort in understanding these labour markets has lacked evidence on the extend and fluctuations of these flows. This paper constructs a search and matching model with informal jobs guided by recent microeconomic evidence from worker flows in Brazil and Mexico. I examine the implications of macroeconomic shocks and policy interventions on the job finding rates and job separation rates as well as on unemployment and the share of formal employment.

An established fact is that between 40% to 80% of the labour force in developing countries is employed in informal jobs<sup>2</sup>. A less known fact is that the proportion of informal employment varies considerably both during the business cycle and when there is a change in policy. The share of informal employment in Mexico oscillated 4 percentage points every four years during the 1992-2004 period, increasing sharply in recessions. Similarly, informal employment increased in Brazil in 12 percentage points throughout the 1990's as a result of a mix of policy reforms and downturns.

Evidence on the underlying worker flows in Mexico and Brazil provides insights on how these changes are generated.<sup>3</sup> First, the job finding rate of formal jobs is the main margin of adjustment. It is strongly procyclical during cycles and it reacts substantially in the medium run to changes in the incentives to employ formal labour. Conversely, the job finding rate of informal jobs is relatively stable over time and does not present a strong cyclical pattern. Furthermore, the job separation rate is substantially higher in informal jobs (around twice as high). Moreover, job separation in both formal and informal jobs increase in recessions although the latter jumps more in response to negative shocks. Despite this, the job finding rate effect dominates and the proportion of formal employment falls.

This paper provides a framework that is able to capture these stylized facts. The model highlights the substitutability between formal and informal contracts within similar types of jobs. Vacancies posted by firms can be filled formally or informally. This tries to capture the idea that jobs are not intrinsically formal or informal. The motivation for modeling this margin is rooted in the fact that most of the change in the share of formal employment occurs within industries, occupations and population groups. This suggests that reallocation of labour from formal industries/occupations towards informal industries/occupations is not the main driving force behind changes in the proportion of formal jobs.

In this model, the firm's choice of hiring standards plays a primary role in the adjustment of the labour market. Firms post "generic" vacancies and, when the worker arrives, they decide whether to establish a formal or an informal relationship. The outcome depends

---

<sup>1</sup>For early models of the informal sector in developing countries see Lewis (1954), Harris-Todaro (1970) and Fields (1990). Also see Loayza (1996) for and Satchi and Temple (2006) for growth models with informal jobs.

<sup>2</sup>See Hart (1972), de Soto (1989) and Schneider and Enste (2000) for extensive reviews of the causes and consequences of this type of employment. See also Djankov et al. (2002) and Schneider (2003) for detailed cross country estimates of the size of the informal economy for developed and developing countries.

<sup>3</sup>See Bosch and Maloney (2006) and Bosch et al (2006).

on the quality of the match and the trade-offs between formal and informal employment. Formal contracts can fully exploit the idiosyncratic productivity of the match at the cost of abiding with labour regulations. Informal contracts avoid labour regulations but they face a possible penalty if the government detects them. As standard in search and matching models, a positive macroeconomic shock fosters vacancy creation. Hence, the number of meetings between firms and workers increases (*meeting effect*). Moreover, firms extend the use of formal contracts because they can take better advantage of the increase in productivity (*offer effect*). As a result, the job finding rate of formal jobs increases, since the two effects, the general macro effect and the substitution effect, reinforce each other. The effect on the job finding rate of informal jobs is ambiguous, because the two effects go in opposite directions, and therefore, it can be procyclical or countercyclical.

Furthermore, this paper provides a tool to study the effects of policy changes on the allocation of workers in developing countries. I examine the impact of three labour market interventions: hiring costs, firing costs and payroll taxes. I argue that the effect of policies do not only occur through the creation of vacancies and destruction of jobs, but also through the effects on the firm's hiring standards. For instance, protecting formal jobs by raising firing penalties reduces the job separation rate in formal jobs. However, changes in the firm's hiring decisions reallocate jobs from formal into informal employment. The introduction of frictions combined with the empirical evidence gives new insights on the effect of this reallocation. Reallocation from formal jobs into informal jobs implies a shift in production from "protected" jobs, where job separation is low, to "unprotected" jobs, where job separation is high. This has non neutral implications for equilibrium unemployment. The quantitative effects of policies on unemployment will depend on how intense is this reallocation effect. This, in turn, depends on the opportunity costs of employing informal labour. I argue that in developing economies, where the wedge between formal and informal technology is low and enforcement is likely to be deficient, small regulatory changes can have a large reallocation effect.

This paper is related to a growing literature on the existence of informal jobs in a labour market with frictions. First, a series of models focus on the worker's decision to participate in the informal labour market. They usually assume the exogenous existence of both formal and informal firms posting vacancies. Then, heterogeneous workers direct their search towards one of the two type of firms according to their moral costs of operating in the informal sector (Fugaza and Jaques, 2002 and Kolm and Larsen, 2002), to worker's education (Kolm and Larsen, 2004), or to productivity differences (Boeri and Garibaldi, 2006).<sup>4</sup> Other types of models endogenize the firm's choice. Kugler (1999) assumes that firms sort themselves into formal or informal statuses according to their ex-ante productivity levels. Workers are then matched randomly into formal and informal firms. Antunes and Calvalcanti (2004) and Bosch (2004) suggest occupational choice models. Agents are allowed to decide between becoming a formal entrepreneur, an informal entrepreneur or workers in search of a job. Finally, Albrecht et al. (2006) argue that workers' productivity is the major determinant of participation in the informal sector. In a model with heterogeneous workers, they show that the appearance of informal jobs is rooted in the decision of low productivity workers to become informal self-employed.

---

<sup>4</sup>Alternatively, Bouev (2002) suggests that workers may search randomly.

The remainder of the paper is organized as follows. The next section presents the empirical evidence on worker flows for Mexico and Brazil. Section III presents the details of the model. Section IV outlines the main predictions of the variables of the model when the economy is subject to macroeconomic shocks or changes in regulations. Section V presents some extensions of the model that accommodate some particularities of informal employment. Section VI calibrates the model and quantifies the possible effects of policy on the unemployment rate and the share of formality. Finally, section VII concludes.

## 2 Empirical Evidence

There is broad agreement in the literature on the definition of an informal worker. Generally speaking, formal workers are those working in firms licensed with the government and conforming to tax and labour laws, including minimum wage directives, pension and health insurance benefits for employees, workplace standards of safety etc. The informal workers, on the contrary, are those owners of firms that are largely delinked from state institutions and obligations and employees who are not covered by formal labour protections.

The motivation for this model is drawn from the study of gross worker flows in Mexico and Brazil during the last two decades (Bosch and Maloney, 2006 and Bosch et al., 2006). Detailed labour surveys in Mexico and Brazil allow me to compute with precision not only the proportion of informal employment in the economy, but also the gross movements of workers among employment statuses (see Appendix B for details). Workers are classified into formality/informality on the basis of lack of compliance with labour legislation- in particular lack of contributions by the employer to the social security agency as the critical distinguishing characteristic<sup>5</sup>. Empirical papers, including Bosch and Maloney (2006) and Bosch et al. (2006) distinguish between two types of informal workers: informal salaried employees and informal self-employed. I choose to pool together these two types of employment and focus on "informal employment" as a whole based of the lack of protection criteria. Although these two types of employment may have different considerations, they share very similar dynamics in and out of employment. Moreover, they both constitute a very flexible "unregulated" source of labour for formal firms.<sup>6</sup>

In what follows I summarize the main facts emerging from the data. Figures 1 and 2 show the two main indicators of the functioning of Mexican and Brazilian labour markets, the unemployment rate and the share of formal employment. First, unemployment rates are relatively low compared to OECD countries. Despite major macroeconomic shocks in these two countries during the 1980's and 1990's, the unemployment rate never reaches the two digit numbers. Second, informality comprises a substantial part of total employment (between 35%-45%). Informality is mainly countercyclical, increasing especially in periods of deep recessions, such as 1995 in Mexico and 1982-83 in Brazil. Finally, whereas Mexico has not undertaken a major labour reform since the 1970's, Brazil went through a number of reforms during the 1980's and 1990's, the most significant of which was a change in the constitution in 1988. Three changes in regulations affected directly the labour market. There

---

<sup>5</sup>Contributions to social security programs by the employer implicitly impose a series of commitments for the firm, such as paid vacations, minimum wages, severance payments etc.

<sup>6</sup>Excluding self-employed workers from the sample does not qualitatively change the results.

was a significant increase in firing costs, the numbers of maximum working hours per week was reduced from 48 to 44, and union power was enhanced. Although the effect of all these policies is difficult to estimate<sup>7</sup>, it is clear that from the begging of 1990's Brazil experienced a major shift in the allocation of workers between formal and informal jobs. The share of formal employment went from over 65% of total employment to 53% in roughly 10 years. Also, average unemployment increased from 3% to 8%.

Gross worker transitions underlying the evolution of the stocks provide further insights in understanding these labour markets. Figures 3 and 4 show the job finding rate of unemployed workers in Mexico and Brazil for the two types of jobs together with the unemployment rate.<sup>8</sup> Similarly, figures 5 and 6 show the separation rates.

Table 1 summarizes the cyclical properties of the series. The data unveils important patterns. The job finding rate of formal jobs is strongly procyclical. The cross correlation of the job finding rate with respect to unemployment is very high, -0.86 and -0.81 for Mexico and Brazil respectively. Conversely, the job finding rate of informal jobs does not result to have a profound cyclical pattern. It is weakly procyclical in Brazil and slightly countercyclical in Mexico. Overall, the large recessions and recoveries in these two countries during the 1980's and 1990's brought important changes in the job finding rate of formal jobs with only minor fluctuations in the job finding rate of informal jobs.

Moreover, these patterns in the job finding rate do not only correspond to the cyclical behaviour of the labour market. Long run trends also seem to be dominated by adjustments in the job finding rate of formal jobs. After the reform in Brazil, the monthly job finding rate of formal jobs decreased from 0.15 to 0.05, whereas job finding rate of informal jobs remained around 0.22.

Table 1: Correlations and Volatility of HP detrended Worker Flows

$x$	<b>Mexico</b>		<b>Brazil</b>	
	Corr( $u, x$ )	Std( $x$ )/Std( $u$ )	Corr( $u, x$ )	Std( $x$ )/Std( $u$ )
F.emp	(0.53)	1.18	(0.57)	0.76
$JFR_f$	(0.86)	2.29	(0.81)	1.96
$JFR_i$	0.24	1.27	(0.29)	1.22
$JSR_f$	0.75	0.27	0.32	0.14
$JSR_i$	0.92	0.65	0.91	1.17

JFR <sub>$j$</sub> =Job Finding Rate of  $j$  type of jobs,  $j$ =formal, informal

JSR <sub>$j$</sub> =Job Separation Rate of  $j$  type of jobs,  $j$ =formal, informal

$u$ =Unemployment rate. F.emp=Share of Formal employment.

Source: ENEU 1987-2004 (Mexico), PME 1982-2002 (Brazil).

Additionally, the job separation rate is countercyclical in both types of jobs. However, it is substantially higher for informal jobs. On average, around twice as high. Furthermore,

<sup>7</sup>The constitutional reform in Brazil coincided with an the process of trade liberalization of the economy.

<sup>8</sup>The transition probabilities presented in figures 3 to 6 correspond to quarterly transitions for Mexico and monthly transitions quarterly averaged for Brazil. Hence mobility level is not entirely comparable between these two countries. Throughout the paper I refer to them as the job finding and job separation rates although technically correspond to discrete transition probabilities. The continuous transition rates for Mexico and Brazil respectively follow exactly the same cyclical pattern. See Bosch and Maloney (2006) and Bosch et al. (2006).

the volatility of the job separation rate in informal jobs is also higher. This is especially true for Brazil where the job separation rate in formal jobs is reasonable constant over time.<sup>9</sup> However, despite large increases in the job separation rate in informal jobs in recessions, the share of the formal employment decreases in downturns. This highlights that the behaviour of the job finding rate is driving the reallocation of workers between formal and informal jobs<sup>10</sup>.

One alternative explanation for the patterns found in the data are due to changes in the composition of the labour force or in the industry/occupational mix. Manufacturing is mainly formal, between 75% to 80% of workers are formal. Conversely, services employ informal labour extensively (only 40% of jobs are formal). Therefore asymmetric shocks to these industries reallocating labour from manufacturing into services in recessions could be behind the patterns the share of formal employment. I investigate this hypothesis further. Decomposition of the changes in the share of formal employment for different periods shows that between 70% to 95% of the changes occur within industries.

More generally, I use a probit model where I regress the probability of being a formal worker (conditional on employment) on a set of time dummies. This gives the unconditional evolution of the share of formal employment similar to figures 1 and 2. I also run the same regression but including, sex, age, education, industry and occupational dummies in addition to the time dummies. Figures 7 and 8 present the pattern of the time dummies of these two regressions for Mexico and Brazil. The difference between the two series captures the amount of time variation in the share of formal employment that can be explained by observables. These figures suggest that compositional changes are not the explanation to the evolution of the share of formal employment and that changes in the share of formal employment occur within similar type of jobs.

### 3 The Model

This paper introduces into a Mortensen and Pissarides (1994) type of model a within firm decision between two types of contracts; formal and informal. The intuition of the model can be summarized as follows. Entrepreneurs post vacancies in search for workers. The total number of matches between firms and workers,  $m$ , is given by the matching technology

---

<sup>9</sup>The empirical evidence of the Brazilian reform is still inconclusive. Paes de Barros and Corseuil (2001) fail to find any robust findings on how job destruction rates were affected by this reform. This is consistent with the data previously presented. Figures 4 and 6 seem to suggest that the major adjustments were concentrated in the job finding rate of formal jobs and that job separation rate was not substantially altered.

<sup>10</sup>This paper abstracts from direct flows from occupied jobs. I do consider flows from informal jobs into formal jobs in one of the extensions of the model. In practice, direct transitions between formal and informal jobs do occur. Nevertheless, the empirical evidence from direct flows does not contradict, in essence, the modelling approach (see Bosch and Maloney, 2006). That is, the hiring behaviour of firms is the main driving force of changes in the share of formal employment. Flows from informal towards formal jobs are highly procyclical, very much like those from unemployment. Similarly, flows from formal to informal jobs are also largely procyclical but less volatile than the former. Quantitatively, this implies that changes in the share of formal employment are primarily driven by access to formal jobs rather than increasing outflows from formal jobs.

$$m = m(u, v) \quad (1)$$

where  $v$  and  $u$  represent the number of vacancies and unemployed workers respectively. The matching technology is homogeneous of degree one and increasing and concave in both its arguments. The rate at which firms with vacant jobs find workers is given by

$$q(\theta) = m(u, v)/v \quad (2)$$

where  $\theta = \frac{v}{u}$  is generally referred to as the market tightness of the economy. Similarly workers find firms at a rate

$$\theta q(\theta) = m(u, v)/u \quad (3)$$

Workers are ex ante equal, but when the worker and the firm are brought together, some match pairs result to be more productive than others. Once the productivity of the match is realized, the firm has to decide whether to write a formal or an informal contract with the worker or, alternatively, not to consummate the match at all. There is a trade off between formal and informal jobs. If a formal contract is signed, the firm incurs in a hiring cost (i.e. the firm has to train the worker). Then, the job-worker match has access to a better overall technology parameter, but they have to observe a number of labour regulations.<sup>11</sup> Conversely, informal jobs are less productive but avoid all labour regulations imposed by the government. They are, however, subject to monitoring and jobs may be destroyed if the government detects them. Once the match is established both formal and informal jobs are subject to idiosyncratic productivity shocks that may, endogenously, terminate matches.

### 3.1 Payoffs

Let  $V$  be the present discounted value (PDV) to the entrepreneur of the expected profit from posting a vacancy. Similarly,  $J_f^l(z)$  and  $J_i(z)$  represent the PDV for the firm of occupied formal and informal jobs respectively, where  $l$  identifies the new and ongoing formal matches.

$$rV = -pk + q(\theta) \int_{z \min}^{z \max} \max [J_f^n(z) - pc, J_i(z), V] dG(z) - q(\theta)V \quad (4)$$

$$rJ_f^l(z) = pz - w_f^l(z) + \lambda \int_{z \min}^{z \max} \max [J_f^o(s), V - pF] dG(s) - \lambda J_f^l(z) \quad , l = n, o \quad (5)$$

$$rJ_i(z) = \delta pz - w_i(z) + \lambda \int_{z \min}^{z \max} \max [J_i(s), V] dG(s) - \lambda J_i(z) + \phi(V - J_i(z)) - \phi p\sigma \quad (6)$$

---

<sup>11</sup>Initially I just consider hiring and firing cost as the only regulations. Section IV deals with payroll taxes.



The interpretation of equations (4) to (6) is straight forward. Vacant jobs have a current flow cost of  $pk$  and vacancies meet workers at a rate  $q(\theta)$ . Once the worker and the vacancy have met, the productivity of the match is drawn from a known distribution function,  $G(z)$ . Given the realization of the match specific productivity, the firm has three choices. First, it can formalize the relationship, in which case the firm enjoys  $J_f^n(z)$  but has to pay hiring costs,  $cp$ , and it is subject to future firing costs,  $pF$ . Second, the firm can also avoid regulations by hiring the worker informally,  $J_i(z)$ . Third, if the realization of the productivity is too low the firm can decide to keep the vacancy open.

For occupied formal and informal jobs, the first two terms capture the instantaneous profit of the job. That is, the combination of a general productivity parameter  $p$  and the match specific productivity parameter  $z$  minus the wage in each type of job. Note that formal jobs operate with a higher general productivity parameter than informal jobs, being  $\delta < 1$ . This parameter deserves some attention, since it captures one of the trade offs of using informal contracts. The intuition is that similar workers will produce relatively more in formal contracts. Theoretically, one could argue that tenure for formal workers is longer, therefore, there are incentives for the employer to invest in the worker more intensively, in the form of physical capital or on the job training. Empirically, microeconomic work shows that there is a substantial unexplained wage gap between formal and informal workers even after controlling for observables (around 20% to 30%)<sup>12</sup>.

Moreover, the introduction of firing costs in the formal jobs gives rise to two different value functions for occupied jobs. One for the newly created jobs  $J_f^n(z)$ , (when firing costs are not applicable in the bargaining process) and another for ongoing matches for which firing costs are considered when wages are bargained,  $J_f^o$  (see Pissarides 2000).

All types of jobs are subject to idiosyncratic productivity shocks *à la* Mortensen and Pissarides (1994). When a shock arrives at a rate  $\lambda$  wages are renegotiated and the job-worker pair decides whether or not to continue production. In the case of formal jobs, if the job-worker pair decides to terminate the match, the firm has to pay a firing cost,  $pF$ .<sup>13</sup> Informal jobs are also subject to a monitoring activity from the government that destroys the match at a rate  $\phi$ . If informal matches are detected the firm incurs in a penalty of  $p\sigma$ .

I assume that once the nature of the relationship between the worker and the firm has been established (formal or informal) it cannot be modified. Hence, initial formal jobs are always formal, independently of the evolution of the idiosyncratic productivity shock. I relax this assumption in later sections of the paper.

The value functions for the workers, equations (7) to (9), have equally simple interpretation;  $U$  represents the PDV of an unemployed workers. While searching, the unemployed gets a value of  $b$ . They meet jobs at a rate  $\theta q(\theta)$ . Depending on the type of contract offered by the firm, the worker enjoys the match specific PDV of a new formal job  $W_f^n(z)$ , or the PDV of an informal job  $W_i(z)$ . Alternatively, workers can decide to keep searching. Once the workers are employed, they obtain a wage depending on the contract (formal/informal) and

---

<sup>12</sup>See Gonzaga (2003), Almeida and Carneira (2005) for papers referring to the productivity differential between formal and informal jobs in Brazil. Also Marcoullier et al. (1997) for measures of the informal wage gap in Mexico, el Salvador and Peru.

<sup>13</sup>For simplicity I have considered that both types of jobs are subject to the same distribution of shocks.

the productivity of the match, which is subject to changes upon the arrival of shocks.

$$rU = b + \theta q(\theta) \int_{z \min}^{z \max} \max [W_f^n(z), W_i(z), U] dG(z) - \theta q(\theta)U \quad (7)$$

$$rW_f^l(z) = w_f^l(z) + \lambda \int_{z \min}^{z \max} \max [W_f^o(s), U] dG(s) - \lambda W_f^l(z) \quad , l = n, o \quad (8)$$

$$rW_i(z) = w_i(z) + \lambda \int_{z \min}^{z \max} \max [W_i(s), U] dG(s) - \lambda W_i(z) + \phi(U - W_i(z)) \quad (9)$$

### 3.2 Bargain over wages

Following the literature, when workers and firms first meet, or when an idiosyncratic shock arrives, they bargain over the surplus of the job according to a Nash bargain solution. In this particular model three types of bargaining situations may arise. Equation (10) shows the bargaining rule for a new formal match, an ongoing formal match and an informal match respectively.

$$\begin{aligned} J_f^n(z) - pc - V &= \frac{(1 - \eta)}{\eta} (W_f^n(z) - U) \\ J_f^o(z) - V + pF &= \frac{(1 - \eta)}{\eta} (W_f^o(z) - U) \\ J_i(z) - V &= \frac{(1 - \eta)}{\eta} (W_i(z) - U) \end{aligned} \quad (10)$$

where  $\eta$  is the share of the surplus that goes to the worker. When the worker and the firm meet for the first time and they decide to write a formal contract the gain firm is  $J_f^n(z) - pc - V$ . Since the match is not formed, the firm is not obliged to any firing costs to the worker in the case of disagreement. However the firm has to pay the hiring cost,  $pc$ , upon the signing of the contract. When a shock arrives to an ongoing match, the firing cost becomes operational. However, the hiring cost is already sunk. The gain for the firm of continuing the match is  $J_f^o(z) - V + pF$ . Obviously, these considerations do not apply for the informal jobs.

Equation (10) also highlights a well known fact of Nash bargaining. Firms and workers always agree on the type of contract, as well as when to destroy the match. From the hiring point of view, firms are willing to hire a worker formally as long as  $J_f^n(z) - pc > J_i(z)$  and  $J_f^n(z) - pc - V > 0$ , which necessarily implies that  $W_f^n(z) > W_i(z)$  and  $W_f^n(z) > U$ . Similarly the firm-worker match choose an informal contract if  $J_f^o(z) - pc < J_i(z)$  and  $J_i(z) > 0$ .

### 3.3 Equilibrium

This section defines and characterizes the steady-state equilibrium of the model. Four conditions determine the equilibrium of the model. The first equilibrium condition states that the creation of vacancies is driven by free entry. This implies that all profit opportunities from new jobs are exploited and therefore  $V = 0$ .

The second and the third equilibrium conditions relate to the hiring decision of the firm. These are given by

$$J_f^n(R) - pc = J_i(R) \quad (11)$$

$$J_i(W) = 0 \quad (12)$$

I define  $R$  as the level of productivity that makes the firm indifferent between hiring the worker formally or informally, equation (11). Let  $W$  be the level of productivity that makes the firm indifferent between hiring the worker informally or keep searching for workers, equation (12).

The fourth and final equilibrium condition of the model defines the job separation threshold of formal jobs, equation (13). Let  $D$  be the productivity level that makes an ongoing formal job unprofitable. Since firing costs do not apply to informal jobs, the job separation threshold of informal jobs is also given by  $W$ .

$$J_f^o(D) + pF = 0 \quad (13)$$

Figure 10 illustrates the firm's hiring and firing decisions. It plots the PDV for the firm of the different contracts against the level of idiosyncratic productivity of the match  $z$ . The profitability of occupied jobs depends positively on the productivity of idiosyncratic productivity of the match. This makes  $J_f^n(z) - pc$ ,  $J_f^o(z) + pF$  and  $J_i(z)$  upward-sloping. However, the slope of the latter is flatter because of the overall productivity wedge,  $\delta$ , and the existence of monitoring,  $\phi$ . The fixed costs of formal jobs ensure the existence and uniqueness of  $R$ . Similarly,  $W$  and  $D$  are obtained in the intersection of  $J_i(z)$  and  $J_f^o(z) + pF$  with the horizontal axis respectively. Of course, it may be the case that these crossing points are not compatible with the existence of informal jobs. I restrict my analysis to the spectrum of parameters where both formal and informal jobs coexist, that is when  $R > W > 0$ .

I can now rewrite equations (4) to (9) using the different thresholds. For firms

$$pk = q(\theta) \left[ \int_R^{z \max} (J_f^n(z) - pc) dG(z) + \int_W^R J_i(z) dG(z) \right] \quad (14)$$

$$rJ_f^l(z) = pz - w_f^l(z) + \lambda \int_D^{z \max} J_f^o(s) dG(s) - \lambda G(D)pF - \lambda J_f^l(z) \quad (15)$$

$$rJ_i(z) = \delta pz - w_i(z) + \lambda \int_W^{z \max} J_i(s) dG(s) - (\lambda + \phi) J_i(z) - \phi p\sigma \quad (16)$$

and for workers

$$rU = b + \theta q(\theta) \left[ \int_R^{z \max} (W_f^n(z) - U) dG(z) + \int_W^R (W_i(z) - U) dG(z) \right] \quad (17)$$

$$rW_f^k(z) = w_f^k(z) + \lambda \int_D^{z \max} W_f^o(s) dG(s) + \lambda G(D)U - \lambda W_f^k(z) \quad (18)$$

$$rW_i(z) = w_i(z) + \lambda \int_W^{z \max} W_i(s) dG(s) + \lambda G(W)U - (\lambda + \phi) W_i(z) + \phi U \quad (19)$$

Now it is clear what the optimal hiring decision of the firm-worker pair depends on the idiosyncratic productivity of the match. When the worker and the firm meet for the first time, they jointly decide what type of contract to sign. If the idiosyncratic productivity is higher than  $R$  the contract is formal, if it is between  $R$  and  $W$  the contract is informal and if it is less than  $W$  no contract is signed. Once jobs start production, they are subject to productivity shocks. Formal jobs are destroyed if the productivity shock is lower than  $D$ , whereas informal jobs are destroyed if the productivity shock is smaller than  $W$ .

Using (14) to (19) and the bargaining solution, equation (10), I can derive the wage functions for each of the three types of matches, equations (20) to (22). Note that all three wage functions depend positively on the productivity of the match. For new formal jobs, the firing cost enters negatively as the workers have to compensate the firm for future firing costs. For ongoing matches the firing cost enters positively, since the firm has to pay the cost if the worker does not agree to continue the match. All wages depend positively on the market tightness of the economy.

$$w_i(z) = (1 - \eta)b + \eta p (\delta z + \theta k) - \eta \phi p \sigma \quad (20)$$

$$w_f^n(z) = (1 - \eta)b + \eta p (z + \theta k - \lambda F - (r + \lambda) c) \quad (21)$$

$$w_f^o(z) = (1 - \eta)b + \eta p [z + \theta k + rF] \quad (22)$$

With these wage functions and (14) to (19) it is straight forward to obtain the four equilibrium equations of the model. Substitution of the corresponding wage equation into (16) gives

$$J_i(z) = \frac{1}{r + \phi + \lambda} \left[ (1 - \eta) (\delta p z - b - \phi p \sigma) - \eta p \theta k + \lambda \int_W^{z \max} J_i(s) dG(s) \right] \quad (23)$$

Evaluating  $J_i(z)$  at  $W$  and subtracting it from equation (23) .

$$J_i(z) = \frac{(1 - \eta) p \delta (z - W)}{r + \phi + \lambda} \quad (24)$$

Finally substituting equation (24) back into (23) and evaluating at  $W$ , I obtain the threshold that drives the value of an occupied informal job to zero. Note that this threshold determines the lower limit of the hiring decision and the firing of informal workers.

$$W = \frac{b}{\delta p} + \frac{\phi \sigma}{\delta} + \frac{\eta \theta k}{(1 - \eta) \delta} - \frac{\lambda}{r + \phi + \lambda} \int_W^{z \max} (s - W) dG(s) \quad (25)$$

Analogously I obtain the job separation threshold for formal jobs

$$D = \frac{b}{p} + \frac{\eta \theta k}{(1 - \eta)} - \frac{\lambda}{(r + \lambda)} \int_D^{z \max} (s - D) dG(s) - rF \quad (26)$$

Equations (25) and (26) constitute the two equilibrium conditions determining job separations. The job separation rate in formal jobs is given by  $\lambda G(D)$ . Informal workers also

suffer job separations due to the exogenous government monitoring. Therefore the job separation rate is given by  $\lambda G(W) + \phi$ . By comparing equations (25) and (26), the first result of the model is obtained. The job separation rate is always greater for informal workers. This is due to three separate effects. The type of job specific productivity differential, the existence of firing costs and the monitoring of informal jobs. Note that, as in Mortensen and Pissarides (1994), both types of jobs are kept open even if the reservation productivity of the job is below the reservation wage of unemployed workers,  $rU = b + \frac{\eta\theta pk}{(1-\eta)}$ . This occurs because occupied jobs have an option value, captured by the integral term in both equations. This option value represents the potential increase in productivity for the job when a shock arrives. This option value is higher for formal jobs, since, on average, informal jobs are less productive and they have an external source of job destruction.

The third equilibrium equation determines the optimal hiring policy of the firm. Substituting equation (21) into (15) gives the value of new formal jobs

$$J_f^n(z) - pc = \frac{(1-\eta)p(z-D)}{(r+\lambda)} - (1-\eta)p(F+c) \quad (27)$$

equating (27) to (24) I obtain what is the idiosyncratic productivity of the match that makes the firm (and the worker) indifferent between a formal and an informal contract,  $R$ .

$$\begin{aligned} \frac{(1-\eta)p(R-D)}{(r+\lambda)} - (1-\eta)p(F+c) &= \frac{(1-\eta)p\delta(R-W)}{r+\phi+\lambda} \\ R &= \frac{(r+\lambda+\phi)[D+(r+\lambda)(F+c)] - (r+\lambda)\delta W}{(r+\lambda)(1-\delta)+\phi} \end{aligned} \quad (28)$$

Equation (28) states that the expected gain from the marginal formal worker must be equal to the expected gain for the marginal informal worker.

The fourth and final equilibrium equation of the model is the free entry condition. Substituting (??) and (24) into (14) I obtain

$$\begin{aligned} \frac{k}{q(\theta)} &= \int_R^{z^{\max}} \left[ \frac{(1-\eta)(z-D)}{(r+\lambda)} - (1-\eta)(F+c) \right] dG(z) \\ &+ \int_W^R \frac{(1-\eta)\delta(z-W)}{(r+\phi+\lambda)} dG(z) \end{aligned} \quad (29)$$

The left hand side of this equation represents the expected cost of the vacancy, which has to be equal to the expected profit from posting the vacancy. From equation (29), it is straight forward to see the existence and uniqueness of the equilibrium in this model. As market tightness increases, the cost of the vacancy also increases, since vacancies are kept unfilled for longer periods of time. On the other hand, greater market tightness means higher wages and higher job separation rates for formal and informal jobs. This reduces the expected profitability of the vacancy, lowering the right hand side of the equation. Finally as  $\theta$  changes so does  $R$ , however it is easy to show that, in equilibrium,  $R$  does not modify expected profits from the vacancy on virtue of the envelope property it satisfies, that is, the productivity level that makes the firm indifferent between hiring formal and informal workers.

Hence for particular values of  $F$ ,  $c$  and  $k$  there is a unique value of  $\theta$ , that satisfies equation (29). Once  $\theta$  is obtained, the different thresholds can be retrieved from equations (25), (26), and (28).

Figures 11 and 12 show the equilibrium in the  $R$ - $\theta$  space and  $D, W$ - $\theta$  respectively. From the hiring decision (28), there is a positive relation between  $R$  and  $\theta$  (see appendix for proofs). The intuition is straight forward. Lower  $\theta$  leads to lower wage demands. As a result, present and future profits for all types of jobs increase. However, future profits of informal jobs are discounted at a higher rate. This is due to the fact that duration of informal jobs is shorter. Overall, the surplus of formal jobs increases more than the surplus of informal jobs. Therefore,  $R$  decreases.

Similarly, from equation (29), in equilibrium,  $\theta$  is independent of  $R$ , for the reasons stated above. Figure 12 shows the job separation conditions for both types of jobs. These two conditions slope upwards on  $\theta$  since wages are positively related to  $\theta$ .

The steady state values of the stocks close the model.

$$u = \frac{n_f \lambda G(D) + n_i (\lambda G(W) + \phi)}{\theta q(\theta) [1 - G(W)]} \quad (30)$$

$$n_f = \frac{\theta q(\theta) [1 - G(R)] u}{\lambda G(D)} \quad (31)$$

$$n_i = 1 - n_f - u \quad (32)$$

$$\pi = \frac{n_f}{n_i + n_f}$$

where  $u$  is the unemployment rate and  $n_f$  and  $n_i$  the number of formal and informal jobs in the economy. The labour force is normalize to 1. Flows in and out of unemployment determine its steady state value. Flows into unemployment come from occupied formal and informal jobs. Formal jobs are destroyed at a rate  $\lambda G(D)$ , whereas informal jobs are destroyed at at rate  $\lambda G(W) + \phi$ . Flows out of unemployment can be divided in two. The job finding rate of formal jobs is given by

$$JFR_f = \theta q(\theta) [1 - G(R)] \quad (33)$$

and the job finding rate of informal jobs is given by

$$JFR_i = \theta q(\theta) [G(R) - G(W)] \quad (34)$$

Finally,  $\pi$  captures the share of formal employment in the economy.

## 4 Comparative Statics

Next I examine the implications of changes in the key parameters of the model. Two sets of parameters are particularly interesting; productivity shocks and policy interventions.

## 4.1 Macroeconomic shocks: Changes in productivity

Figures 13 and 14 illustrate the implication of an increase in productivity,  $p$ . Note that changes in productivity are equivalent to the inverse changes in unemployment benefits,  $b$ . An increase in the general productivity parameter shifts both job separation conditions downwards. Similarly, the formal/informal hiring condition also shifts downwards, since now firms and workers have more incentives to sign formal contracts. This is because formal jobs are able to take better advantage of the increase in productivity.<sup>14</sup> Finally, the free entry condition is shifted to the right as the expected profit from both types of jobs increases. From the graphs, there is an unambiguous increase in the market tightness, however, the impact on  $R$ ,  $D$  and  $W$  is ambiguous. It is easy to show, however, that all three margins decrease, implying a higher conditional probability of signing formal contracts and lower job separation thresholds in both types of jobs (see appendix for proofs).

**Proposition 1** *An increase in productivity,  $p$ , reduces the job separation rate in both types of jobs.*

This is immediate from figures 13 and 14. In response to a good productivity shock both  $D$  and  $W$  decrease. Hence, the job separation rate in both types of jobs,  $\lambda G(D)$  and  $\lambda G(W) + \phi$ , decrease. However, the model is silent in which of these two probabilities decreases more. This depends on the assumptions about the distribution of shocks,  $G(x)$ .

**Proposition 2** *An increase in productivity,  $p$ , unambiguously increases the job finding rate of formal jobs, but has an ambiguous effect on the job finding rate of informal jobs.*

The job finding rate of formal jobs is given by  $\theta q(\theta)[1 - G(R)]$ . It is useful to distinguish between two separate effects. On the one hand, the probability that a worker meets a firm, which is governed by  $\theta$ , the *meeting effect*. And on the other hand, the conditional probability of signing a formal contract,  $[1 - G(R)]$ , the *offer effect*. A positive productivity shock increases  $\theta$  and reduces  $R$ . Hence, the meeting effect and the offer effect reinforce each other, highly increasing the chance of an unemployed worker of obtaining a formal job. This is consistent with the strong procyclicality of the job finding rate of formal jobs found in Mexico and Brazil.

Similarly, the job finding rate of informal jobs is given by  $\theta q(\theta)[G(R) - G(W)]$ . Again it is useful to separate the two effects. Now the conditional probability of signing an informal contract is given by  $[G(R) - G(W)]$ . A positive productivity shock increases the meeting rate, but lowers  $R$  and  $W$ . In principle, this would tend to lower the conditional probability of signing an informal contract, however the exact effect will depend on the properties of the distribution of shocks  $G(x)$ . Nevertheless, this change in the hiring policy of the firm is a candidate to explain the relative stability of the job finding rate of informal jobs. I take up this issue in the calibration of the model.

---

<sup>14</sup>Note that, all the effects of changes in the overall parameter of productivity of the economy come from the fact that income while unemployed,  $b$ , remains constant. There are other elements that could be subject to changes in productivity such as the hiring costs, or firing costs, which in this model are assumed to be proportional to productivity. In the short run, an increase in productivity could reduce all those fixed costs, strengthening the effects highlighted here.

**Proposition 3** *An increase in productivity,  $p$ , unambiguously decreases unemployment but it has an ambiguous effects on the share of formal employment.*

The unemployment rate is determined by the exit rate from unemployment  $\theta q(\theta)[1 - G(W)]$ , the job separation rate in each type of job and the share of formal employment. Positive productivity shocks generate lower job separation rates in all jobs and increases the rate of exit from unemployment. Therefore, in the face of a positive productivity shock unemployment can only increase if the share of formal employment falls. However, it is easy to show from equation (31) that, if unemployment increases so does the number of formal workers. Hence, it is not possible that a drop in the share of formality as that would imply an increase in the number of informal workers, incompatible with the fact that the labour force is constant. Unemployment must, therefore, fall.

The share of formal employment should follow a procyclical pattern dictated by the hiring decisions of the firm. However, the results are ambiguous, because quantitative changes in job separation rates will depend on the distribution of shocks  $G(x)$ .

## 4.2 Protecting Formal Employment: Changes in firing costs.

Next, I analyze the economy's response to changes in the firing penalties. Figures 15 and 16 show the graphical analysis. An increase in  $F$  shifts the job separation condition of formal jobs downwards. Similarly, the formal/informal hiring condition shifts upwards, capturing the fact that now formal jobs are more expensive. Now, at any given market tightness, the match has to be of higher quality for the firm to be willing to sign a formal contract. Finally, the free entry condition shifts to the left as the expected profits from vacant jobs decrease. Overall,  $R$  increases whereas market tightness and both job separation thresholds decrease, especially for formal jobs. This implies a reduction in the meeting rate and an increase in the conditional probability of signing an informal contract (see appendix for proofs).

**Proposition 4** *An increase in firing costs,  $F$ , unambiguously decreases the job separation rate in both types of jobs.*

This is analogous to the previous case since  $W$  and  $D$  decrease. The direct effect of the decrease in  $F$  lowers the job separation rate in formal jobs since now it is more expensive to fire workers. Indirectly, the decrease in market tightness decreases wage demands in all types of jobs, diminishing the job separation rate in informal jobs and further pushing downwards the job separation rate in formal jobs.

**Proposition 5** *An increase in firing costs,  $F$ , unambiguously decreases the job finding rate of formal jobs, but it has ambiguous effects on the job finding rate of informal jobs.*

The decrease in the meeting rate and the higher standards for formal contracts significantly reduces the job finding rate of formal jobs. However, in this case the conditional probability of signing an informal contract increases unambiguously. This is due to the fact that the gap between  $R$  and  $W$  widens up. Note that the decrease in  $W$  comes from the lower pressure on wages generated by a depressed market tightness. The overall effect on  $\theta q(\theta)[G(R) - G(W)]$  is again ambiguous, but points to the fact that there are two opposing forces determining the job finding rate of informal jobs.



**Proposition 6** *An increase in firing costs,  $F$ , has ambiguous effects on the unemployment rate and the share of formal employment.*

Usually, models studying the impact of firing costs acknowledge two effects (see Bentolila and Bertola, 1990). First, a reduction of the job finding rate and second, a lower job separation rate. Hence, the overall effect on unemployment is ambiguous. In this case, there is an additional effect of substituting formal jobs, where the job separation rate is low, by informal jobs, where the job separation rate is high. This allocation effect is captured by the firm's choice of hiring standards. An increase in  $R$  implies that vacancies that previously were being transformed into formal jobs now become informal jobs when the meeting between a firm and a worker occurs. The strength of this allocation effect depends mainly on two parameters,  $\delta$  and  $\phi$ . The intuition is straight forward from equation (28). If the opportunity cost of employing informal labour is low (big  $\delta$ ), or similarly, when its penalty is small (small  $\phi$ ), small changes in firing costs tend to have stronger reallocation effects. This suggests that developing countries, where the opportunity cost of informality is low, the allocation effects between the formal and informal jobs can be substantial.

## 5 Extensions

I consider three extension to the main framework. First, I have assumed that the initial nature of the job cannot be modified during its life. I relax this assumption here. Second, I consider the impact of payroll taxes in the model.

### 5.1 Informal upgrading and direct flows from informal to Formal jobs

I assume now that the worker-firm pair can decide the best contract at any time. It is easy to argue that only contracts initially established as informal may have the incentives to be transformed into formal contracts. The opposite is never optimal. The intuition is simple. If the worker-firm pair in an informal match receives a positive idiosyncratic shock it may decide to formalize the contract. For that to happen, the boost in idiosyncratic productivity needs to cover the fixed cost associated to the formalization of the contract (the hiring costs and the future firing costs). On the other hand, in order to downgrade a job the firm has to dissolve the previous contract, which implies paying the associated firing costs. It is easy to see that for any  $z$ ,  $J_f(z) + pF > J_i(z)$ , and therefore, there are no profitable opportunities to take advantage of.

There are only minor modifications with respect to the basic version of the model. The flow values for the informal jobs have to take into account the potential upgrading of the job. This modifies the job separation condition for the informal workers. Now the option value of the job incorporates the possibility that the job may become formal. This implies that  $W$  is smaller, but still bigger than  $D$ . Therefore,  $R$  is greater. In other words, informal contracts are more attractive. The new equations are given by

$$\begin{aligned}
rW_i(z) &= w_i(z) + \lambda \int_R^{z^{\max}} W_f^n(z) + \lambda \int_W^R W_i(s) dG(s) \\
&\quad + \lambda G(W)U - (\lambda + \phi)W_i(z) + \phi U \\
rJ_i(z) &= \delta pz - w_i(z) + \lambda \int_R^{z^{\max}} (J_f^n(s) - pc) \\
&\quad + \lambda \int_W^R J_i(s) dG(s) - (\lambda + \phi)J_i(z) - \phi p\sigma \\
W &= \frac{b}{\delta p} + \frac{\phi\sigma}{\delta} + \frac{\eta\theta k}{(1-\eta)\delta} - \frac{\lambda}{r + \phi + \lambda} \int_W^R (s - W) dG(s) \\
&\quad - \frac{1}{\delta} \int_R^{z^{\max}} \left[ \frac{(s - D)}{(r + \lambda)} - (F + c) \right].
\end{aligned} \tag{35}$$

An interesting feature of this extension is that, implicitly, the upgrading of informal jobs generates direct flows from informal to formal jobs. The probability of transition from an informal job into a formal job is given by  $\lambda[1 - G(R)]$ . This makes the direct transitions from informal jobs towards formal jobs procyclical, something consistent with the data. Note, however, that there is no search process involved in these transitions as workers remain in the same firm but with different status. The steady states values vary to account for these transitions from informal jobs into formal jobs and are given by

$$\begin{aligned}
u &= \frac{n_f \lambda G(D) + n_i (\lambda G(W) + \phi)}{\theta q(\theta) [1 - G(W)]} \\
n_f &= \frac{\theta q(\theta) [1 - G(R)] u + \lambda [1 - G(R)] n_i}{\lambda G(D)} \\
n_i &= 1 - n_f - u
\end{aligned} \tag{36}$$

The results on the behaviour of the job finding and job separations rates do not change.

## 5.2 Payroll taxes

I introduce a payroll tax  $t$  to which the employer is subject to. Thus, employers have to pay now  $w_f(z)(1 + t)$  in their formal labour contracts. There are two effects associated with the introduction of the payroll tax. It reduces the surplus of formal matches and it also reduces the share of the surplus allocated to the firm. This generates an asymmetry between formal and informal jobs.

All the effects on the model work through the two job separation conditions. In this case the job separation rate in formal jobs is not unambiguously lower than that of informal jobs. There is a new term in both job separation equations,  $\Omega$ . This term captures the increase of the bargaining power of the workers in formal matches. Changes in the value functions are given by

$$\begin{aligned}
W &= \frac{b}{\delta p} + \frac{\phi\sigma}{\delta} + \frac{\eta}{(1-\eta)\delta} \frac{\theta k}{(1+t)} \\
&\quad - \frac{\lambda}{r+\phi+\lambda} \int_W^{z^{\max}} (s-W) dG(s) + \frac{\Omega}{(1+t)\delta} \\
D &= \frac{b(1+t)}{p} + \frac{\eta\theta k}{(1-\eta)} - \frac{\lambda}{(r+\lambda)} \int_D^{z^{\max}} (z-D) dG(s) - rF + \Omega \\
\Omega &= t\eta\theta q(\theta) \int_W^R \frac{\delta(z-W)}{(r+\lambda)} dG(z)
\end{aligned} \tag{37}$$

## 6 Calibration

This section explores quantitatively the predictions of the model. I present changes in the steady state of macroeconomic shocks and three policy regulations<sup>15</sup>. I take the average values of the Brazilian labour market as benchmark for the calibration. The time span of the exercise is a month. The interest rate,  $r$ , is 0.01. I normalize the overall productivity parameter,  $p$ , to 1. As standard in the literature, I assume a log linear matching function such as

$$\mu q(\theta)^{-\alpha}$$

where  $\mu$  is a scale parameter. I set  $\alpha$  equal to 0.5. To my knowledge, there are no estimates of an aggregate matching function for Brazil or any comparable developing country. This choice of parameter is often used in the literature and it is within the estimates reported by Petrongolo and Pissarides (2001). Similarly, the bargaining power of both types of jobs is set to 0.5.

Almeida and Carneiro (2005) study the impact of enforcement of regulation in firms performance using the Investment climate surveys collected by the World Bank in a set of Brazil manufacturing firms. They report that in their sample of 1641 firms around 0.512% received some kind of labour regulations related fine. I use this estimate and set the monitoring of informal jobs,  $\phi$ , to be equal to 0.005. Regarding the idiosyncratic distribution of shocks, I have assumed a uniform distribution between 0 and 1. This assumption, although arbitrary, is of little importance to the results here presented. I have also explored log normal and exponential type distributions with very similar results.

I set the arrival rate of shocks,  $\lambda$ , equal to 0.05. For a given  $\lambda$ , I set the job separation threshold of informal jobs,  $W$ , consistent with a 3.2% job separation rate in informal jobs. With knowledge of the job separation rate in informal jobs I obtain the value of the optimal hiring decision,  $R$ , that matches the percentage of new formal to informal jobs given by  $(\frac{1-G(R)}{(GR)-G(W)} = 0.42)$ .

---

<sup>15</sup>It is well known that in matching models like this one, the steady state decision rule also characterize the dynamics out of the steady state. The solution for all three decision margins and market tightness,  $R$ ,  $W$ ,  $D$  and  $\theta$  do not involve any sticky variable. Therefore, there are always in their steady state value, jumping to the new steady state following an unanticipated policy change.

There is no evidence on the level of labour market tightness in Brazil. I initially assume that market tightness is equal to  $2/3$ . With this I obtain  $\mu$ , matching an average job finding rate in the formal of formal jobs,  $\mu q(\theta)^\alpha(1 - G(R))$ , of 9.2%. The number of informal and formal workers and the job separation rate in formal jobs are chosen to match an average unemployment rate,  $u$ , of 5.5%. I also introduce payroll taxes in the calibration of the model. The World Bank estimates that the average payroll tax in Brazil is 37.3% of wages. I set  $t = 0.37$ .

Five parameters remain to be calibrated:  $F, \delta, c, b$  and  $k$ . I use the four equilibrium equations of the model to solve for  $F, c, b$  and  $k$ . I choose  $\delta$  to be the free parameter and set it to 0.625. This allows me to explore the impact of changes in  $\delta$ . Table 4 shows the parameter configuration for the exercise.

Table 4: Parameter Configuration

$\lambda = 0.05$	$F = 9.30$
$r = 0.01$	$b = 0.16$
$\phi = 0.005$	$\mu = 1.38$
$\delta = 0.625$	$c = 0.07$
$\eta = 0.5$	$t = 0.37$
$k = 0.46$	$p = 1$

I solve for the remaining parameters of the model and check some values to assess the plausibility of the result. I obtain that  $k$  is 0.46. In the steady state, this implies that the cost of vacancies is 2.98% of output. The choice of  $\delta$  implies that the average wage in informal jobs is 0.81 of that in the formal. Close to the 0.75 found for Brazil. The value for  $b$  is 0.16 which is 40% of the lowest wage in the economy. The level of firing costs, 9.3, represents 15 months of average wages of formal jobs. The World Bank estimates for firing costs in Brazil correspond to 8.5 months of average wages. Finally, the value of  $c$ , 0.07, adds up to 17% of output.

## 6.1 Effects of individual policies

I analyze the quantitative effects of changes in productivity and three different policies: firing costs, hiring costs and payroll taxes. This is shown in table 5.

Table 5: Calibration Results.

	<i>Baseline</i>	$\Delta p = 10\%$	$\Delta F = 0.05$	$\Delta c = 0.05$	$\Delta s = 0.05$
$u$	<b>5.4</b>	4.90	5.90	8.08	6.42
$JFR_f$	<b>9.2</b>	10.42	6.38	2.38	6.35
$JFR_i$	<b>21.9</b>	21.88	24.3	27.47	24.37
$JSR_f$	<b>0.86</b>	0.83	0.77	0.86	0.87
$JSR_i$	<b>3.2</b>	3.18	3.19	3.2	3.3
$\theta$	<b>0.66</b>	0.70	0.64	0.61	0.64
$\pi$	<b>60.93</b>	64.58	52.25	24.44	47.58
$R$	0.89	0.88	0.92	0.97	0.92
$W$	0.64	0.636	0.638	0.639	0.638
$D$	0.172	0.166	0.153	0.171	0.183

Changes in productivity produce all the expected outcomes. A 10% increase in productivity decreases unemployment from 5.4% to 4.90%. Note that the most sensitive variable is the job finding rate of formal jobs which increases from 9.2% to 10.42%, whereas the job finding rate of informal jobs only experiences a negligible decrease of 0.02 percentage points. This is, of course, because of the change in the firms hiring standards. Market tightness, as expected, increases and so does the share of formality in the economy from 60.93% to 64.58%.

The next two columns of table 5 analyze the impact of the fixed cost of formality; firing and hiring costs. In order to allow comparable results, these two parameters are increased by the same amount, 0.05, which corresponds to 17% of the average formal wage. Both policies directly influence the hiring decision of the firm, shifting the threshold at which jobs are made formal. Moreover, they also reduce overall market tightness. As argued before, these two combined effects diminish the job finding rate of formal jobs. The job finding rate of informal jobs increases. Although the effects on the equilibrium unemployment rate are theoretically ambiguous under these two policies unemployment increases. This is partly due to the fact that overall job finding rate ( $JFR_f + JFR_i$ ) decreases and partly to the reallocation of labour from the formal jobs to the informal jobs where job separation is higher. The main difference in the effects of these two policies is related to the behaviour of the job separation rates. An increase in firing costs decrease the job separation threshold in formal jobs through two channels. A direct one, making dismissal more costly, and an indirect one, through diminished wage demands (lower market tightness). Hiring costs only activate the indirect channel. Hence, the job separation rate responds more to changes in firing costs. This implies that, reallocation from formal into informal jobs will be more intense when hiring costs change. Consequently, unemployment rate and the share of formality also vary more.

Finally, payroll taxes affect directly the incentives to hire a formal worker by reducing the net productivity of the match for the firm. Contrary to the previous two policies, it also increases wages demands affecting therefore the job separation condition of formal workers. The job finding rate of formal jobs decreases whereas the job separation rate increases. The job finding rate of informal jobs increases accordingly responding to the new set of incentives. Overall, unemployment increases and formality decreases.

## 6.2 Determinants of the reallocation effect

The essence of the quantitative effects of the model lies on how much firms adjust their hiring standards when a change in policy occurs. I have argued before that this depends on the opportunity cost of using informal labour. In this model, the opportunity cost of informality is embodied in two parameters,  $\delta$  and  $\phi$ . The higher the opportunity cost of informality (lower  $\delta$  and higher  $\phi$ ), the less powerful the shift in employment will be. Tables 6 and 7 present the policy experiments for a recalibrated model, where I decrease  $\delta$  to 0.55 (table 6), and increase  $\phi$  to 0.002 (table 7).

Table 6: Calibration Results ( $\delta = 0.55$ )

	<i>Baseline</i>	$\Delta p = 10\%$	$\Delta F = 0.05$	$\Delta c = 0.05$	$\Delta s = 0.05$
$u$	<b>5.4</b>	5.00	5.66	7.11	6.08
$JFR_f$	<b>9.2</b>	10.09	6.99	4.00	7.24
$JFR_i$	<b>21.9</b>	22.11	23.85	26.32	23.69
$JSR_f$	<b>0.86</b>	0.84	0.76	0.83	0.87
$JSR_i$	<b>3.2</b>	3.18	3.19	3.18	3.19
$\theta$	<b>0.66</b>	0.70	0.64	0.62	0.65
$\pi$	<b>60.93</b>	63.47	55.15	36.72	51.87
$R$	0.893	0.886	0.917	0.952	0.915
$W$	0.64	0.636	0.637	0.636	0.637
$D$	0.172	0.167	0.152	0.166	0.180

Both tables report similar effects. Identical changes in productivity and policy parameters have now a lower impact in the economy. A 10% change in productivity only increases the job finding rate of formal jobs by 0.89 and 0.79 percentage points, respectively, compared to 1.22% before. Similarly, since the substitution of formal workers is less intense, the job finding rate of informal jobs presents a procyclical pattern, indicating that the meeting effect dominates the substitution effect. Moreover, both the unemployment rate and the rate of formality are less affected by changes in policy. Changes in unemployment rate are between 20% and 50% smaller and changes in the share of formality between 30% and 40% smaller.

This exercise also highlights an interesting effect. Developing countries, in which the opportunity cost of informality is likely to be small, are more likely to be subject to strong shifts of labour between informal and formal jobs in the presence of shocks and changes in regulations.

Table 7: Calibration Results ( $\phi = 0.002$ )

	<i>Baseline</i>	$\Delta p = 10\%$	$\Delta F = 0.05$	$\Delta c = 0.05$	$\Delta s = 0.05$
$u$	<b>5.4</b>	5.05	5.72	7.35	6.21
$JFR_f$	<b>9.2</b>	9.99	6.85	3.62	6.94
$JFR_i$	<b>21.9</b>	21.94	23.92	26.54	23.91
$\lambda G(D)$	<b>0.86</b>	0.84	0.76	0.84	0.91
$\lambda G(W) + \phi$	<b>3.2</b>	3.19	3.19	3.19	3.19
$\theta$	<b>0.66</b>	0.69	0.64	0.62	0.64
$\pi$	<b>60.93</b>	63.35	54.48	34.09	50.4
$R$	0.893	0.874	0.910	0.951	0.909
$W$	0.60	0.597	0.598	0.599	0.598
$D$	0.172	0.167	0.152	0.169	0.182

In summary, all policies aimed to increase regulation in formal jobs decrease the market tightness of the economy reducing the meeting rate between vacancies and workers. Additionally, these policies change the incentives to hire and fire formal workers. Overall, the job finding rate of formal jobs is the main variable driving the reallocation between formal and informal jobs. Although the theoretical effects of policies are ambiguous, the simulations show that the net effects tend to increase unemployment and decrease the share of formality.

## 7 Conclusions

Understanding the functioning labour markets with informal jobs seems crucial to study the effects of labour market policies in developing countries. This paper presents a model rooted in the evidence on gross flows of worker in Mexico and Brazil.

The essence of the model is that the divide between formal and informal jobs in developing countries does not only occur across good vs bad jobs or manufacturing vs services. Most of the changes in the proportion of formal jobs and occur within similar types of jobs. This suggests that firms within a given industry not only choose how many vacancies to post, but also what the optimal degree of formality is. I show that productivity and policy shocks produce a large impact on the job finding rate of formal jobs and leave the job finding rate relatively unaffected, as observed in the data. This comes as a result of two separate effects. First, firms increase vacancy creation and second, they are more willing to offer formal contracts.

This model also highlights that this reallocation effect of policy interventions in developing countries has implications to the unemployment rate. Stricter regulations invariably lowers the job finding rate of formal jobs. Policies have different effects on the job separation rate depending on whether they aim to protect jobs (such as firing costs) or they do not (such as payroll taxes and hiring costs). Overall, optimal hiring transfers workers from formal jobs, where job separation is low, into informal jobs, where job separation is high. Theoretically, the overall effects on unemployment and the size of formality are ambiguous. However, this paper shows that in countries where the opportunity cost of employing informal labour is small, this reallocation effect may be very large, generating a fall in the share of formal employment and an increase in the unemployment rate. This seems to be consistent with Brazilian experience during the 90's.

## References

- [1] Albrecht, James W., Navarro, Lucas and Vroman, Susan B., "The Effects of labour Market Policies in an Economy with an Informal Sector" (May 2006). IZA Discussion Paper No. 2141
- [2] Almeida, R. and Carneiro, P. (2005), "Does labour flexibility affect firm performance? Evidence from Brazil", mimeo.
- [3] Antunes, A. R. and Cavalcanti, T. V. (2004), "Accounting for the hidden economy: barriers to legality and legal failures" Bank of Portugal Working Paper WP 20-04.
- [4] Bentolila, S. and Bertola, G., 1990. "Firing Costs and labour Demand: How Bad Is Eurosclerosis?," *Review of Economic Studies*, Blackwell Publishing, vol. 57(3), pages 381-402.
- [5] Boeri T., Garibaldi P. (2006) "Shadow Sorting" CEPR discussion paper.DP5487.
- [6] Bosch, M (2004) "Start up costs, Informality and Policy complementarities". Mimeo LSE
- [7] Bosch, M. and Maloney, W.F. (2006) "Gross Flows of Workers in the Presence of Informal labour Markets: The Mexican Experience 1987-2002 Processes Mimeo World Bank.
- [8] Bosch, M. and Maloney, W. F and Edwin Goni (2006) "Gross Flows of Workers In Brazil" World Bank Chief Economist Office. Washington D.C.
- [9] Bouev, M. (2002) Official Regulations and the Shadow Economy: A labour Market Approach, University of Michigan, Working Paper No. 524, December.
- [10] Djankov, S., La Porta R., Lopez-de-Silanes F., Shleifer A. (2002) "The Regulation of Entry".*Quarterly Journal of Economics*, Vol. 117, No. 1, February, pp.1-37. 57
- [11] De Soto, Hernando (1989) *The Other Path*. Harper and Row, New York.
- [12] Fields G. S. (1990), "labour Market Modelling and the Urban Informal Sector: Theory and Evidence," in OECD, *The Informal Sector Revisited*, Paris.
- [13] Fugazza, M. and Jaques, J. F. (2002) "labour Market Institutions, Taxation and the Underground Economy". *Journal of Public Economics*. Vol. 88, No. 1-2, January, pp. 395-418.
- [14] Fonseca, R., Loper-Garcia, P. and Pissarides, C. (2001). "Entrepreneurship, Start-Up Costs and Employment" *European Economic Review* 45 pp 692-705
- [15] Gonzaga, G. (2003), "Labour turnover and labour legislation in Brazil", *Economia*, Vol. 4, Issue 1, pp. 165-222.



- [16] Harris, John R., and Michael P. Todaro (1970). "Migration, Unemployment and Development: A Two-Sector Analysis," *American Economic Review* 60(1): 126-142.
- [17] Hart, K. (1972). *Employment, income and inequality: A strategy for increasing productive employment in Kenya*. Geneva: International Labour Organization.
- [18] Kenyon, Thomas,(2006) "The Informality Trap: Tax Evasion and Markets for Finance and Technology in Brazil" . Available at SSRN: <http://ssrn.com/abstract=896592>
- [19] Kolm, A.S. and Larsen, B. (2004) "Does tax evasion affect unemployment and educational choice?". Working Paper 4-2004 Department of Economics. Copenhagen Business School.
- [20] Kolm, A.S. and Larsen, B. (2002) "Moral Cost, the Informal Sector and Unemployment" . Working Paper 1-2001. Department of Economics. Copenhagen Business School.
- [21] Kugler, A. (1999) "The impact of Firing Cost on Turnover and Unemployment: Evidence from the Colombian labour Market Reforms", *International Tax and Public Finance*, 6, 389-410.
- [22] Lewis, W. Arthur. (1954). "Economic Development with Unlimited Supplies of labour." *Manchester School of Economic and Social Studies* 22: 139-91.
- [23] Loayza N. (1996) "The Economics of the Informal Sector: A Simple Model and Some Empirical Evidence from Latin America". *Carnegie-Rochester Conference Series on Public Policy*, Vol.45, pp.129-162.
- [24] Marcouiller, D.; V. Ruiz de Castilla, C.Woodruff (1997). *Economic Development and Cultural Change*, Vol. 45, No. 2. (Jan., 1997), pp. 367-392.
- [25] Maloney, W. F. (1999) "Does Informality Imply Segmentation in Urban labour Markets? Evidence from Sectoral Transitions in Mexico," *World Bank Economic Review* 13:275-302.
- [26] Maloney, W. F. (2004) "Informality Revisited," *World Development* 32(7): 1159-1178.
- [27] Mortensen, D. T and C. Pissarides (1994), " Job Creation and Job Destruction in the Theory of Unemployment". *Review of Economic Studies* 61:397-415.
- [28] Paes de Barros, R. and C. Corseuil (2001); "The Impact of Regulations on Brazilian labour Market Performance," IADB, Research Network Working paper #R-427.
- [29] Petrongolo, B and Pissarides, C. (2001). "Looking into the black box: A survey of the matching function" *Journal of Economic Literature* 39: 390-431.
- [30] Pissarides, C.(2000) *Equilibrium Unemployment Theory*. 2nd Edition, Cambridge MA, London UK, MIT press.
- [31] Satchi, M. and Temple, J. (2006). "Growth and Labour Markets in Developing Countries". Discussion Paper No. 06/581. Department of Economics. University of Bristol.

- [32] Schneider, F (2003) "Size and Measurement of the Informal Economy in 110 Countries around the World."
- [33] Schneider, F. and Enste, D. (2000) "Shadow Economies: Size Causes, and Consequences", *Journal of Economic Literature*, 38(10), 77-114.
- [34] Yamada, G. (1996) "Urban Informal Employment and Self-Employment in Developing Countries". *Economic Development and Cultural Change*, Vol. 44, No. 2, 289-314.

## 8 Appendix A: Proofs

### 8.1 Positive relationship between $R$ and $\theta$ in the hiring decision.

Partial derivative of  $R$ , equation (28) with respect to  $\theta$  is given by

$$\frac{\partial R}{\partial \theta} = \frac{1}{[(r + \lambda)(1 - \delta) + \phi]} \left[ (r + \lambda + \phi) \frac{\partial D}{\partial \theta} - (r + \lambda) \frac{\partial \delta W}{\partial \theta} \right] \quad (38)$$

The derivative of job separation thresholds (26) and (25) with respect to  $\theta$  is given by

$$\frac{\partial D}{\partial \theta} = \frac{(r + \lambda)\eta k}{[r + \lambda G(D)](1 - \eta)} > 0 \quad (39)$$

$$\frac{\partial \delta W}{\partial \theta} = \frac{(r + \lambda + \phi)\eta k}{[r + \phi + \lambda G(W)](1 - \eta)} > 0 \quad (40)$$

Since  $W > D$  this implies that

$$(r + \lambda + \phi) \frac{\partial D}{\partial \theta} > (r + \lambda) \frac{\partial \delta W}{\partial \theta} \quad (41)$$

and therefore

$$\frac{\partial R}{\partial \theta} = \frac{1}{[(r + \lambda)(1 - \delta) + \phi]} \left[ (r + \lambda + \phi) \frac{\partial D}{\partial \theta} - (r + \lambda) \frac{\partial \delta W}{\partial \theta} \right] > 0 \quad (42)$$

### 8.2 Effects of an increase in $\frac{b}{p}$ on $\theta$ , $R$ , $W$ and $D$

Total derivative of the free entry condition (14) with respect to  $\frac{b}{p}$  is given by

$$\frac{d\theta}{d\frac{b}{p}} = \frac{-(1 - \eta)\theta q(\theta) \left[ \frac{[1 - G(R)]}{(r + \lambda)} \frac{\partial D}{\partial \frac{b}{p}} + \frac{[G(R) - G(W)]}{(r + \phi + \lambda)} \frac{\partial \delta W}{d\frac{b}{p}} \right]}{k\xi(\theta) + (1 - \eta)\theta q(\theta) \left[ \frac{[1 - G(R)]}{(r + \lambda)} \frac{\partial D}{\partial \theta} + \frac{[G(R) - G(W)]}{(r + \phi + \lambda)} \frac{\partial \delta W}{\partial \theta} \right]} < 0 \quad (43)$$

where

$$\xi(\theta) = -\frac{\partial q(\theta)}{\partial \theta} \frac{\theta}{q(\theta)} > 0 \quad (44)$$

$$\frac{\partial D}{\partial \frac{b}{p}} = \frac{(r + \lambda)}{r + \lambda G(D)} > 0 \quad (45)$$

$$\frac{\partial \delta W}{\partial \frac{b}{p}} = \frac{(r + \lambda + \phi)}{r + \phi + \lambda G(W)} > 0 \quad (46)$$

The total derivative of the job separation condition (26) of formal jobs with respect to  $\frac{b}{p}$  gives

$$\frac{dD}{d\frac{b}{p}} = \frac{(r + \lambda)}{r + \lambda G(D)} \quad (47)$$

$$+ \frac{(r + \lambda)\eta k}{[r + \lambda G(D)](1 - \eta)} \left[ \frac{-(1 - \eta)\theta q(\theta) \left[ \frac{[1 - G(R)]}{(r + \lambda)} \frac{\partial D}{\partial \frac{b}{p}} + \frac{[G(R) - G(W)]}{(r + \phi + \lambda)} \frac{\partial \delta W}{\partial \frac{b}{p}} \right]}{k\xi(\theta) + (1 - \eta)\theta q(\theta) \left[ \frac{[1 - G(R)]}{(r + \lambda)} \frac{\partial D}{\partial \theta} + \frac{[G(R) - G(W)]}{(r + \phi + \lambda)} \frac{\partial \delta W}{\partial \theta} \right]} \right]$$

Since  $(1 - \eta)\frac{\partial D}{\partial \theta} = \eta k \frac{\partial D}{\partial \frac{b}{p}}$  and  $(1 - \eta)\frac{\partial W}{\partial \theta} = \eta k \frac{\partial W}{\partial \frac{b}{p}}$ , equation 47 simplifies to

$$\frac{dD}{d\frac{b}{p}} = \frac{(r + \lambda)}{r + \lambda G(D)} \left[ \frac{k\xi(\theta)}{k\xi(\theta) + (1 - \eta)\theta q(\theta) \left[ \frac{[1 - G(R)]}{(r + \lambda)} \frac{\partial D}{\partial \theta} + \frac{\delta[G(R) - G(W)]}{(r + \phi + \lambda)} \frac{\partial \delta W}{\partial \theta} \right]} \right] > 0 \quad (48)$$

Similarly for the job separation threshold of informal jobs,

$$\frac{d\delta W}{d\frac{b}{p}} = \frac{(r + \lambda + \phi)}{[r + \phi + \lambda G(W)]} \left[ \frac{k\xi(\theta)}{k\xi(\theta) + (1 - \eta)\theta q(\theta) \left[ \frac{[1 - G(R)]}{(r + \lambda)} \frac{\partial D}{\partial \theta} + \frac{\delta[G(R) - G(W)]}{(r + \phi + \lambda)} \frac{\partial W}{\partial \theta} \right]} \right] > 0 \quad (49)$$

Again since  $W > D$

$$(r + \lambda + \phi) \frac{dD}{d\frac{b}{p}} > (r + \lambda) \frac{d\delta W}{d\frac{b}{p}} \quad (50)$$

and therefore

$$\frac{dR}{d\frac{b}{p}} = \frac{1}{[(r + \lambda)(1 - \delta) + \phi]} \left[ (r + \lambda + \phi) \frac{dD}{d\frac{b}{p}} - (r + \lambda) \frac{d\delta W}{d\frac{b}{p}} \right] > 0 \quad (51)$$

hence, a increase in  $\frac{b}{p}$  decreases  $\theta$  and increases all three margins  $R$ ,  $W$  and  $D$ .

### 8.3 Effects of changes in $F$ on $\theta$ , $R$ , $W$ and $D$

Total derivative from the free entry condition (14) with respect to  $F$  gives

$$\frac{d\theta}{dF} = - \frac{(1 - \eta)\theta q(\theta) \left[ \frac{[1 - G(R)]}{(r + \lambda)} \frac{(r + \lambda)\lambda G(D)}{r + \lambda G(D)} \right]}{k\xi(\theta) + (1 - \eta)\theta q(\theta) \left[ \frac{[1 - G(R)]}{(r + \lambda)} \frac{\partial D}{\partial \theta} + \frac{[G(R) - G(W)]}{(r + \phi + \lambda)} \frac{\partial \delta W}{\partial \theta} \right]} < 0 \quad (52)$$

In this case, the total effect of  $F$  on  $R$  depends on  $\left[ \frac{dD}{dF} + (r + \lambda) \right]$  and  $\frac{d\delta W}{dF}$

$$\frac{dR}{dF} = \frac{[(r + \lambda + \phi) \left[ \frac{dD}{dF} + (r + \lambda) \right] - (r + \lambda) \frac{d\delta W}{dF}}{[(r + \lambda)(1 - \delta) + \phi]} \quad (53)$$

The total effect of  $F$  on  $\frac{dD}{dF} + (r + \lambda)$  is given by

$$\frac{dD}{dF} + (r + \lambda) = \frac{(r + \lambda)}{r + \lambda G(D)} \left( \lambda G(D) - \frac{\theta q(\theta) \frac{[1-G(R)]}{(r+\lambda)} \eta k \left[ \frac{(r+\lambda)\lambda G(D)}{r+\lambda G(D)} \right]}{k\xi(\theta) + (1 - \eta)\theta q(\theta) \left[ \frac{[1-G(R)]}{(r+\lambda)} \frac{\partial D}{\partial \theta} + \frac{[G(R)-G(W)]}{(r+\phi+\lambda)} \frac{\partial \delta W}{\partial \theta} \right]} \right) \quad (54)$$

Since  $\lambda G(D)(1 - \eta) \frac{\partial D}{\partial \theta} = \eta k \left[ \frac{(r+\lambda)\lambda G(D)}{r+\lambda G(D)} \right]$ , this expression simplifies to

$$\frac{dD}{dF} + (r + \lambda) = \frac{(r + \lambda)}{r + \lambda G(D)} \left[ \frac{\lambda G(D) k \xi(\theta) + \theta q(\theta) \frac{[1-G(R)]}{(r+\lambda)} \left[ \lambda G(D)(1 - \eta) \frac{[G(R)-G(W)]}{(r+\phi+\lambda)} \frac{\partial \delta W}{\partial \theta} \right]}{k\xi(\theta) + (1 - \eta)\theta q(\theta) \left[ \frac{[1-G(R)]}{(r+\lambda)} \frac{\partial D}{\partial \theta} + \frac{[G(R)-G(W)]}{(r+\phi+\lambda)} \frac{\partial \delta W}{\partial \theta} \right]} \right] > 0 \quad (55)$$

Given that  $\frac{d\delta W}{dF} = \frac{\partial \delta W}{\partial F} + \frac{\partial \delta W}{\partial \theta} \frac{d\theta}{dF} < 0$ , hence

$$\frac{dR}{dF} = \frac{[(r + \lambda + \phi) \left[ \frac{dD}{dF} + (r + \lambda) \right] - (r + \lambda) \frac{d\delta W}{dF}]}{[(r + \lambda)(1 - \delta) + \phi]} > 0 \quad (56)$$

Therefore an increase in  $F$  decreases  $\theta, D$  and  $W$  and increases  $R$ .

## 9 Appendix B: Data, Definitions of Informality and Computation of Transition Probabilities.

### Mexico: Data on flows of workers

The data for Mexico are drawn from the National Urban Employment Survey (ENEU) that conducts quarterly household interviews in the 16 major metropolitan areas. The questionnaire is extensive in its coverage of participation in the labour market, wages, hours worked, etc. that are traditionally found in such employment surveys. The ENEU is structured so as to track a fifth of each sample across a five quarter period. I have concatenated panels from the first quarter of 1987 to the fourth quarter of 2004.

The ENEU has suffered only minor modifications during the covered period but it has substantially changed its geographical coverage. From 1988 to 1992 the survey comprised 16 major urban areas. In 1992 18 more urban areas were introduced and throughout the following years additional cities were included in the sample to reach 44 at the beginning of 1998. The sample is constraint to the original 16 cities although all results are similar with extended the sample.

I broadly follow the ILO definition of informality by dividing employed workers into two types of employment: formal and informal workers. I classify them on the basis of lack of compliance with labour legislation- in particular lack of contributions by the employer to the social security agency, IMSS (or the equivalent for civil servants IMSTS)- as the critical distinguishing characteristic. I also consider informal workers those self-employed and owners of micro firms (less than 6 employees) with no social security contributions, excluding professionals and technicians. Owners of medium or large firms (more than 5 employees) and those professionals and technicians self-employed or with social security contributions are all considered formal.

### **Mexico: Data on small firms.**

The second data source for Mexico is the National Survey of Microenterprises [Encuesta Nacional de Micronegocios (ENAMIN)], which reinterviews a sample of the self-employed individuals covered in previous rounds of the ENEU. These surveys ask detailed questions on the characteristics of firms with up to five employees (15 in manufacturing), including information on capital stock, time in business, and access to credit from formal and informal sources, both for starting the business and at a later time and characteristics on the employees they hire. The employer has to report on the characteristics of each one of his/her employees, as well as, whether any payment towards social security contributions is made for that worker. This way I can obtain what is the percentage of firms that are completely formal, or completely informal or the employ a mixture of both formal and informal contracts.

### **Brazil**

The data for Brazil are drawn from Monthly Employment Survey (Pesquisa Mensal de Emprego, hereafter PME) that conducts monthly household interviews in 6 of the major metropolitan regions (covering 25% of the national labour market). The questionnaire is extensive in its coverage of participation in the labour market, wages, hours worked, etc. that are traditionally found in such employment surveys. The PME is structured so as to track each household during four consecutive months and then drop them from the sample for 8 months, after which they are reintroduced for another 4 months. The rotation procedure is such that each month one fourth of the sample is substituted by households to form a new panel. Thus, after 4 months the whole initial sample has been rotated and after 8 months a third different sample is being surveyed. After 12 months the initial sample is reencountered. Over a period of two years, three different panels of households are surveyed, and the process starts again with three new panels. I have concatenated panels from the January 1983 to December 2002. Regrettably, the PME was drastically modified in 2002 and it is not possible to reconcile the new and old definitions unemployment.

Similar to Mexico the critical factor for my definition of informality is whether the worker is in possession of a work-card or *carteira de trabalho* that entitle the worker to labour rights and benefits. In the case of Brazil the survey does not provide firm size so I consider informal only the self-employed, excluding professionals and technicians. Excluding or including owners from the data does not alter the results in any significant way.

### **Computation of Transition Probabilities.**

I assume a homogenous Markov process  $X(t)$  defined over a discrete state-space  $E = \{1, \dots, K\}$  where  $K$  is the number of possible states (types of jobs) a worker could be found in. I define 4 employment statuses. Inactivity, unemployment, informal employment and formal employment. Since the data are tabulated at discrete points in time we can compute the probability  $p_{ij}(t, t+n) = \Pr(X(t+n) = j, X(t) = i)$ . The interpretation of  $p_{ij}$  is simply, the probability of moving from state  $i$  to state  $j$  in one step ( $n$ ). Discrete time probabilities are straight forward to compute as the maximum likelihood estimator for  $p_{ij}$  is  $p_{ij} = \frac{n_{ij}}{n_i}$  being  $n_{ij}$  the total number of transitions from state  $i$  to state  $j$  and  $n_i$  the total number of observations initially in state  $i$ . I then smooth the series using a moving average filter with a three quarter window.

# Figures

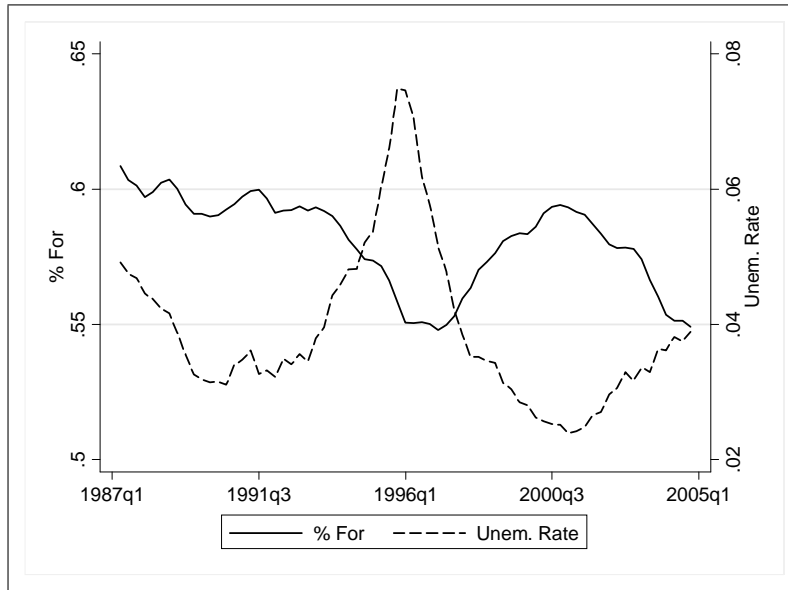


Figure 1: Unemployment Rate and Share of Formal Jobs. Mexico 1987-2004. Constructed with quarterly data from the National Urban Labor Survey (ENEU). % For is the share of formal employment constructed as number of formal workers over total employment. Unemployment rate (Unem. Rate) corresponds to number of unemployed workers over total labor force. The series have been smoothed using a moving average filter with a three quarter window.

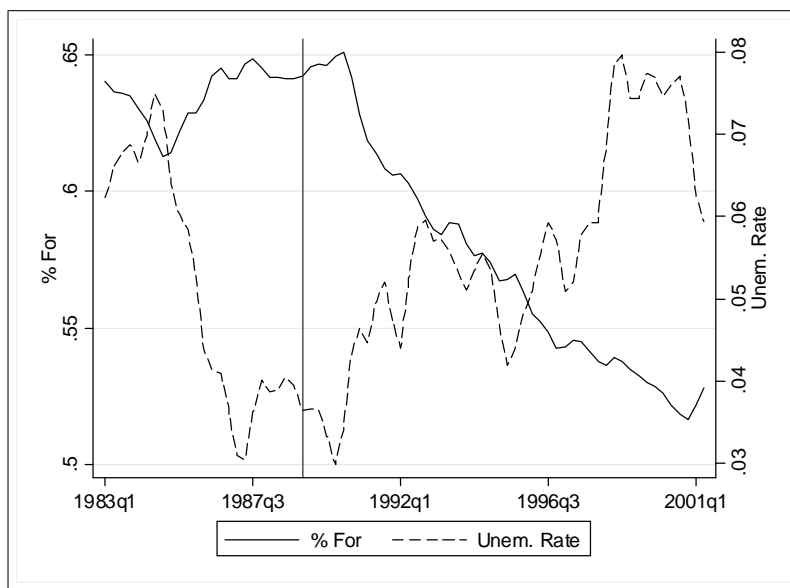


Figure 2: Unemployment Rate and Share of Formal Jobs. Brazil: 1983-2001. Constructed with monthly data, quarterly averaged, from the Monthly Employment Survey (PME). % For is the share of formal employment constructed as number of formal workers over total employment. Unemployment rate (Unem. Rate) corresponds to number of unemployed workers over total labor force. The series have been smoothed using a moving average filter with a three quarter window.



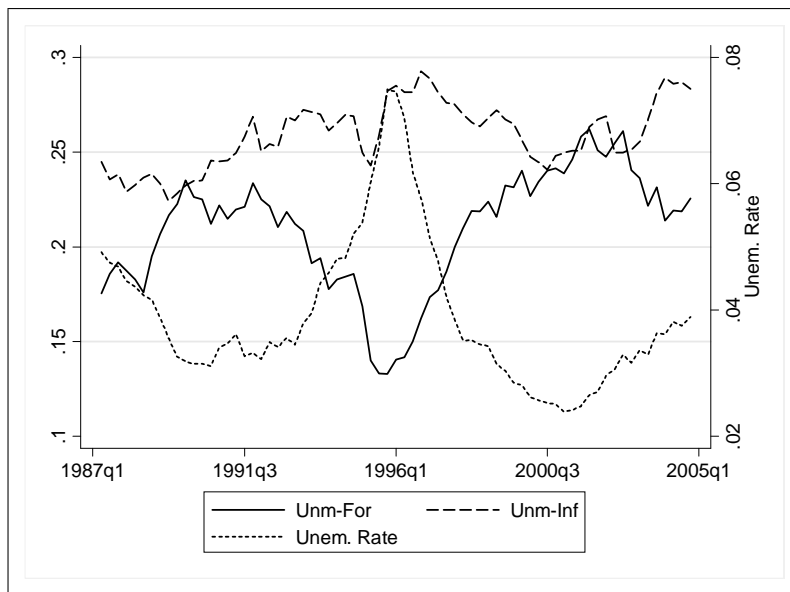


Figure 3: Job Finding Rate and Unemployment rate. Mexico: 1987-2004. Constructed with quarterly data from the National Urban Labor Survey (ENEU). Unm-For and Unm-Inf correspond to the average probability of transiting from unemployment into formal and informal employment respectively. Unemployment rate (Unem. Rate) corresponds to number of unemployed workers over total labor force. The series have been smoothed using a moving average filter with a three quarter window.



Figure 4: Job Finding Probabilities and Unemployment rate. Brazil: 1983-2001. Constructed with monthly data, quarterly averaged, from the Monthly Employment Survey (PME). Unm-For and Unm-Inf correspond to the average probability of transiting from unemployment into formal and informal employment respectively. Unemployment rate (Unem. Rate) corresponds to number of unemployed workers over total labor force. The series have been smoothed using a moving average filter with a three quarter window.

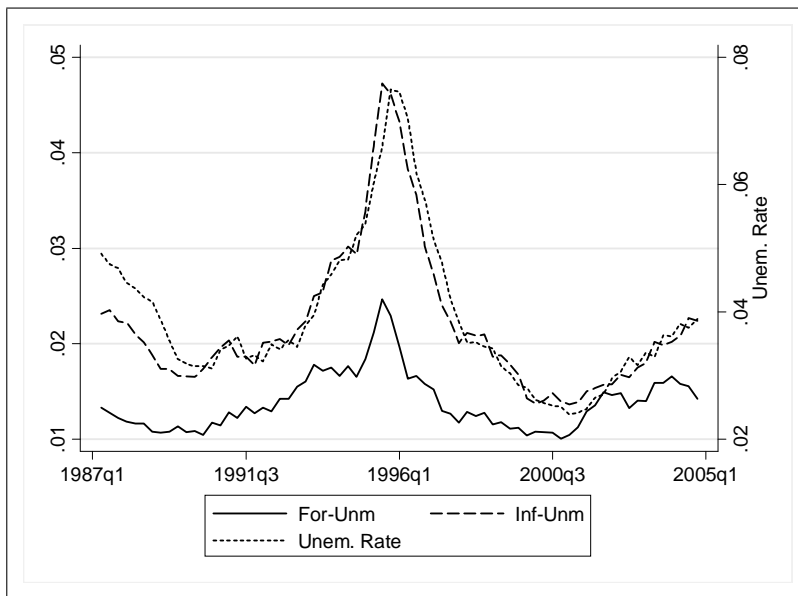


Figure 5: Job separations and Unemployment Rate.Mexico: 1987-2004. Constructed with quarterly data from the National Urban Labor Survey (ENEU). For-Unm and Inf-Unm correspond to the average probability of transiting from formal and informal employment into unemployment. Unemployment rate (Unem. Rate) corresponds to number of unemployed workers over total labor force. The series have been smoothed using a moving average filter with a three quarter window.



Figure 6: Job separations and Unemployment Rate. Brazil: 1983-2001. Constructed with monthly data, quarterly averaged, from the Monthly Employment Survey (PME). For-Unm and Inf-Unm correspond to the average probability of transiting from formal and informal employment into unemployment. Unemployment rate (Unem. Rate) corresponds to number of unemployed workers over total labor force. The series have been smoothed using a moving average filter with a three quarter window.

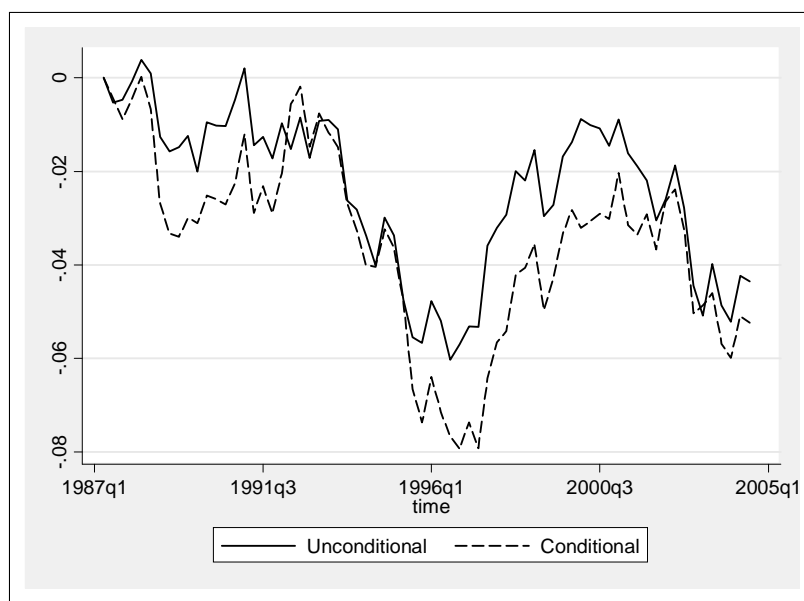


Figure 7: Compositional Contributions of Changes in the Share of Formal Employment. Mexico 1987-2004. The unconditional series corresponds to the value of the time dummies of a probit regression of the probability of being formal on time dummies. In the case of the conditional series gender, age, education, industry and occupational dummies are included in the regression.

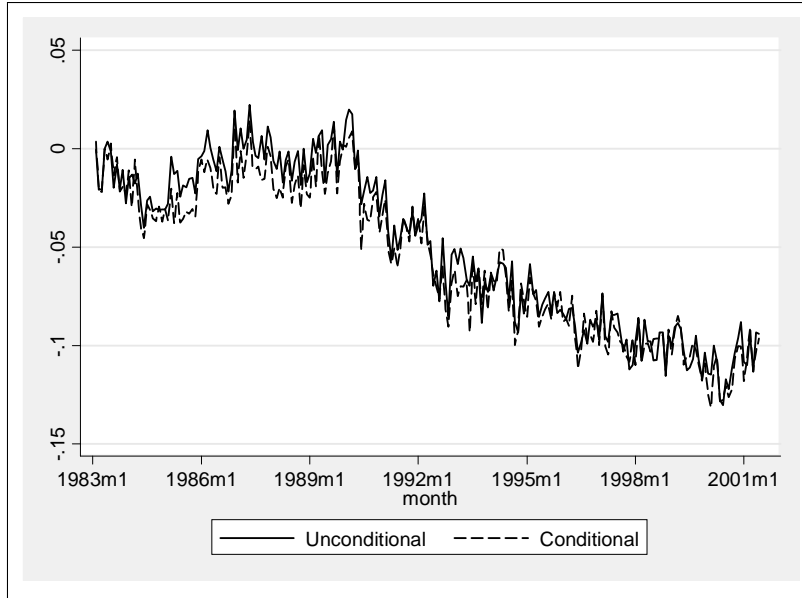


Figure 8: Compositional Contributions of Changes in the Share of Formal Employment. Brazil 1983-2001. The unconditional series corresponds to the value of the time dummies of a probit regression of the probability of being formal on time dummies. In the case of the conditional series gender, age, education, industry and occupational dummies are included in the regression.



Figure 9: Relative Formal Hiring from Unemployment. Large vs Small Firms. Mexico, 1987-2004. Constructed with quarterly data from the National Urban Labor Survey (ENEU). The series show the probability of obtaining a formal contract conditional on leaving unemployment by firm size. The series have been smoothed using a moving average filter with a three quarter window.

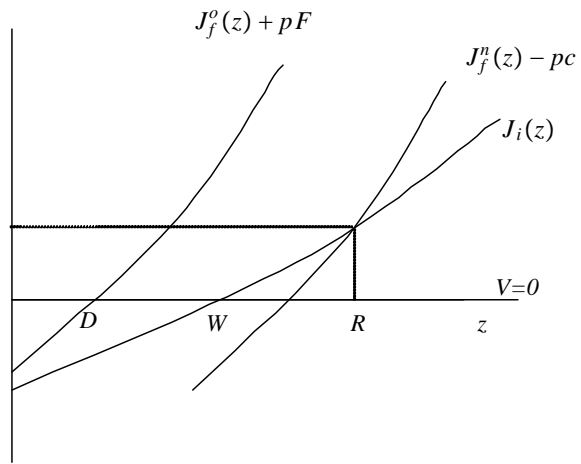


Figure 10: Equilibrium Thresholds.

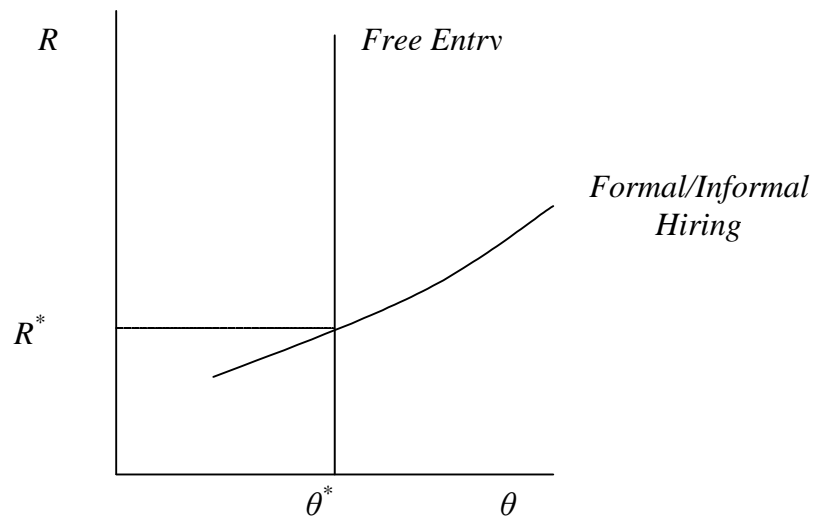


Figure 11: Equilibrium: Free Entry and Hiring

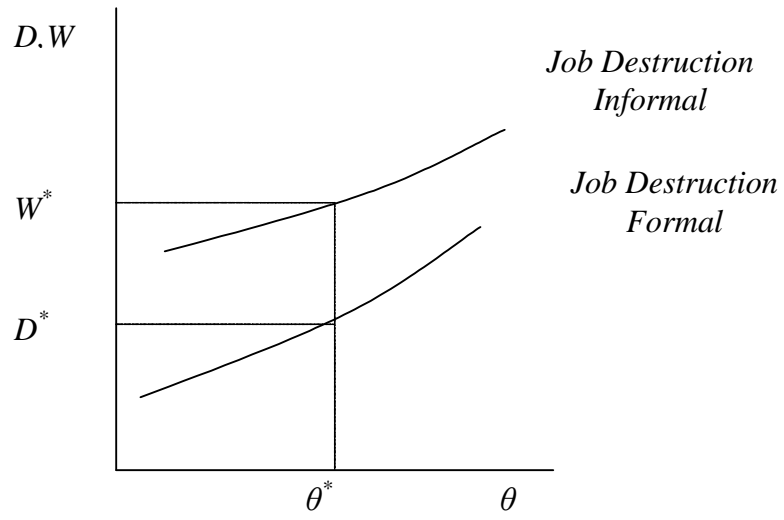


Figure 12: Equilibrium: Job Destruction

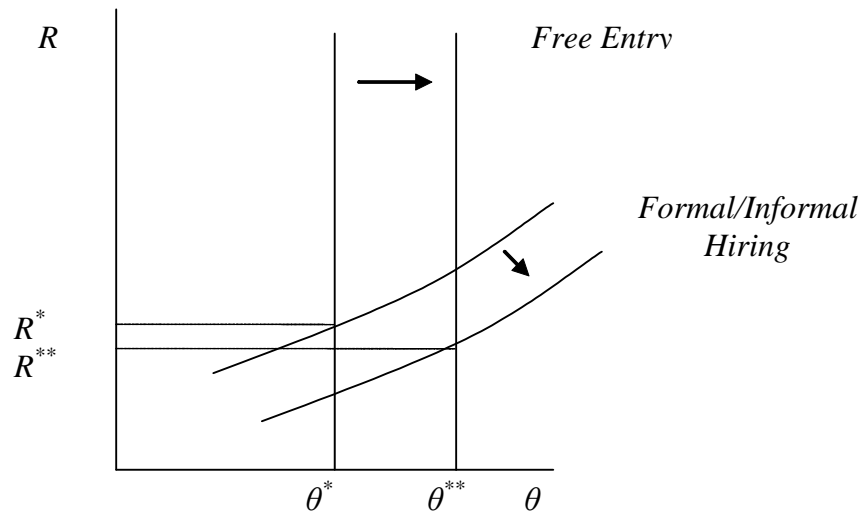


Figure 13: Increase in productivity

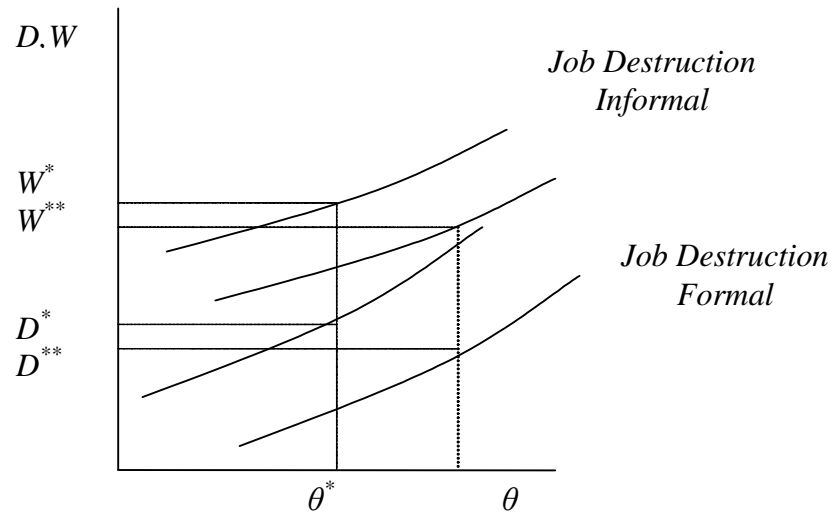


Figure 14: Increase in Productivity

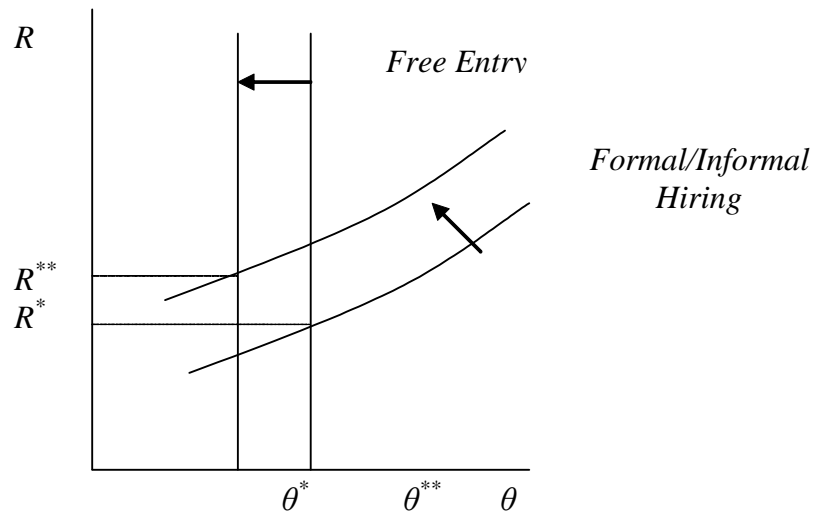


Figure 15: Increase in Firing Costs



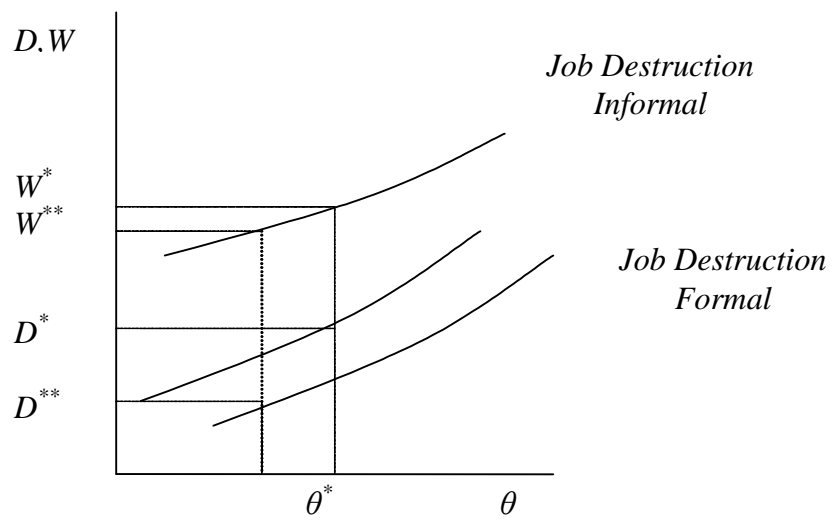


Figure 16: Increase in Firing Costs