GRIPS Discussion Paper 12-20

The Labor Market Effects of Introducing Unemployment Benefits in an Economy with High Informality

By

Mariano Bosch
Julen Esteban-Pretel

February 2013

National Graduate Institute for Policy Studies
7-22-1 Roppongi, Minato-ku,
Tokyo, Japan 106-8677

The Labor Market Effects of Introducing Unemployment Benefits in an Economy with High Informality*

Mariano Bosch†
Inter-American Development Bank

Julen Esteban-Pretel‡
National Graduate Institute for Policy Studies

February 22, 2013

Abstract

Unemployment benefit systems are non-existent in many developing economies. Introducing such programs in these economies poses many challenges, which is partly due to the high level of informality in their labor markets. In this paper we study the consequences on the labor market of implementing an unemployment benefit system in economies with large informal sectors and high flows of workers between formality and informality. We build a search and matching model with endogenous destruction, on-the-job search and inter-sectoral flows, where agents in the economy decide optimally whether or not to formalize jobs. We calibrate the model for Mexico and show that the introduction of an unemployment subsidy system, where workers contribute during formal employment and collect benefits when they lose the job, can deliver an increase in formality in the economy while also producing small increases in unemployment. The exact impact of incorporating such benefits depends on the relative strength of two opposing effects: the generosity of the benefits and the level of the contributions that finance those benefits. We also show important policy complementarities with other interventions in the labor market. In particular, combining the unemployment benefit program with policies that reduce the cost of formality, such as lower firing costs or taxes, can produce decreases in informality and lower impacts on unemployment than when the subsidy program is applied in isolation.

JEL classification: J64, J65, H26, O17

Keywords: Informal economy, search models, labor markets, unemployment benefits, policy interventions, Mexico.

*We thank Veronica Alaimo, James Albrecht, Jesus Fernandez-Villaverde, Hugo Hopenhayn and David Kaplan, and participants at the Experts workshop on unemployment protection systems in high informality countries at the Inter-American Development Bank for comments and suggestions. We respectively acknowledge financial support for this project by the Japanese Ministry of Education through the Grant-in-Aid for Scientific Research, from the Policy Research Center at the National Graduate Institute for Policy Studies, and the Inter American Development Bank Economic and Sector Work RG-1248. All errors are our own.

†Labor Markets and Social Security Unit, Inter-American Development Bank, 1300 New York Ave., NW Washington DC, USA. E-mail: mbosch@iadb.org

‡Corresponding Author: National Graduate Institute for Policy Studies (GRIPS). 7-22-1 Roppongi, Minato-ku, Tokyo 106-8677, Japan. E-mail: julen@grips.ac.jp; Tel: +81-3-6439-6000 Fax: +81-3-6439-6010.

1 Introduction

Most workers in developing countries lack any kind of unemployment insurance. According to the International Labor Organization (2000), 75% of the workers in the world have no access to any kind of income support during unemployment spells. This is due in part to the fact that many countries, especially low income ones, do not have unemployment insurance systems. As countries grow, they begin to develop unemployment benefits mechanisms in their labor markets (see Figure 2).[1] In advanced economies, the presence of unemployment benefits (UB hereafter) generates the traditional problem of moral hazard via reduced job search effort. This has been extensively studied in Pissarides (1983), Acemoglu and Shimer (1999) and Cahuc and Lehmann (2000). The implementation of UB schemes in middle income countries, however, poses several additional challenges because of the existence of large over-developed informal sectors.

Existence of large informal sectors in middle income countries almost by default ensures low coverage of UB for unemployed workers. Informal workers do not pay taxes, or contribute to social security, and their employment conditions are difficult to verify by the authorities. Therefore, a large proportion of workers are likely to not be covered by UB. This is particularly worrying since the data shows that informal workers seem to be more susceptible to losing their jobs. Indeed, a large proportion of worker flows into unemployment originate from informal jobs. According to Bosch and Maloney (2008), 50% of unemployment volatility in Mexico and Brazil is generated by inflows into unemployment from informal jobs. Furthermore, panel data evidence shows that there are quantitatively important worker flows between formal and informal jobs (see Pagés and Stampini (2009) and Bosch and Maloney (2008)). This fluid margin between formal and informal jobs suggests that in these types of countries, the UB are likely to impact not only the unemployment rate but also the employment composition between formal and informal jobs. At the same time, middle income countries impose high costs on the dismissal of formal workers with the double objective of protecting jobs and providing income for unemployed workers. The interaction of current employment protection measures with the introduction of new UB systems can result in expanding costs for formal jobs.

Given the potential impact of establishing a UB system in a labor market with large informality, the objective in this paper is to assess quantitatively the effects of such introduction. In particular we are interested in understanding the main channels through which the implementation of UB in a middle income country with a large informal sector may alter the labor market outcomes of workers, and the actual quantitative impact on unemployment and share of formality. To achieve our goal, we construct a search and matching model where we specifically allow for key salient features of labor markets with informal jobs. We then calibrate and numerically solve the model for Mexico, a country with a large informal sector that lacks UB, but is recently discussing the introduction of one.

The model introduces key mechanisms to understand the impact of a UB system in an economy with substantial informality. There are two types of jobs, formal and informal. Firms open generic vacancies. When matched with ex-ante identical workers, depending on the productivity of the match,

[1] Figure 2 shows, by GDP per capita quintiles, the fraction of countries that have some type of unemployment benefit system. We can see that the higher the income per capita of the country, the more likely the country is to feature unemployment benefits for its workers.

they establish a formal or an informal relationship. For high productivity matches, the firm prefers formalizing the worker for which it has to pay taxes and is liable for firing costs upon dismissal. For low productivity matches, firms find it advantageous to hire workers informally. In this case, no taxes are paid but firms are subject to monitoring and penalties from the government. We also allow for on-the-job search and for matches to be subject to shocks that change their idiosyncratic productivity. These shocks generate endogenous job separations and, together with the worker's search while employed, the model delivers flows between formal and informal jobs. We then introduce a UB system for formal workers on top of the baseline set-up just described. The UB system is such that formal workers pay contributions while employed, and after some time are entitled to collect benefits if they lose their job. Given the inability of the government to fully monitor the informal sector, we allow for workers who are employed informally to collect unemployment benefits if they had lost their previous formal job.

There are two main mechanisms that determine the impact of the UB system on the labor market, and in particular on the unemployment rate and the share of formal employment. First, the UB provides an entitlement contingent on contributing to the UB system while employed. Since only formal workers contribute, a tension arises between the size of the contribution and the generosity of the entitlement. This tension determines how incentives to obtain a formal sector job are changed vis-a-vis trying to gain informal employment. As expected, the higher the generosity of the UB with respect to the contribution rate, the stronger the incentive to get a formal sector job. In our simulations, we find that for realistic parameterizations of the UB system, the availability of such unemployment insurance would foster transitions towards formal sector jobs, both from unemployment and other informal jobs. The second mechanism is set in motion as workers qualify for UB. Due to the government´s inability to monitor the informal sector, workers in this part of the economy can enjoy both unemployment benefits and non-taxed wages. This implies that once employees qualify for the UB, strong incentives exist for those employees to move to the informal sector.

The relative strength of these two mechanisms determines the overall change in unemployment and the share of formal employment due to the introduction of a UB system. For instance, with a replacement rate of 30% for 6 months and a contribution rate from wages of 4%, we find than a UB system in Mexico would decrease the share of formality in 6 percentage points with no change in the unemployment rate. As we increase the generosity of the UB system, both the unemployment rate and the share of formal employment increases. With a replacement rate of 70% and a contribution rate of 4%, the unemployment rate would increase by 1.1 percentage points and the share of formal employment rise by 3 percentage points.

We also study how the introduction of a UB system would interact with other policy reforms. In particular, we analyze the interaction with three additional policies: Lowering dismissal costs, lowering labor taxes, and increasing the monitoring of the informal sector.We find that a combination of any of these three policies with the introduction of UB would increase the share of formal employment, but at the cost of higher unemployment.

This paper is part of a growing literature that studies the effects of labor market policies in the presence of informal jobs in a labor market with frictions. Some examples of this literature include Fugazza and Jacques (2004), Boeri and Garibaldi (2006), Kugler (1999), Antunes and de V. Cavalcanti (2007), Bosch

(2004), Albrecht, Navarro, and Vroman (2009), Zenou (2008), Bosch and Esteban-Pretel (2011) and Margolis, Navarro, and Robalino (2012). While these papers all incorporate informality and study the effects of different policies, they do not asses the quantitative impact of introducing UB in a model with equilibrium unemployment and inter-sectoral flows. Our paper also resonates with an increasing interest in introducing informal working arrangements into the optimal unemployment insurance design literature. Álvarez-Parra and Sánchez (2009) is a prominent example of this recent trend, where the authors design an optimal UB system in the presence of a shadow economy. Their model is parameterized for the Spanish economy and does not include inter-sectoral flows, which recent empirical literature (see Bosch and Maloney (2008)) has emphasized to be important in countries such as Mexico or Brazil. Therefore, our contribution to the literature is to build a model with key features of labor markets with high informality, and provide a quantitative assessment of the impact on the labor market of the introduction of a UB system, as well as a better understanding of the underlying mechanisms driving the changes in unemployment and formality. We show how the trade-offs between contribution and replacement rates reshape the flows between employment status and unemployment, and ultimately the composition of employment.

The rest of the paper is organized as follows: Section 2 explains the model; Section 3 details the parametrization; Section 4 displays and explains the results; and Section 5 summarizes and concludes.

2 The Model

The model is a continuous-time search and matching model of the labor market, in the style of Mortensen and Pissarides (1994), with two sectors, formal and informal, on-the-job search, endogenous job destruction, and a worker/firm contributed unemployment insurance system. In what follows we explain the model in detail.

2.1 Environment

There are three types of agents in the economy: workers, firms and the government. Workers supply labor to firms, which produce output. The government taxes both firms and workers and supplies UB to those workers who were formally employed and qualified to receive such benefit.

Searching workers and vacant firms try to meet in the labor market to form employment relationships. We assume, as is standard in the literature, that such employment relationships are composed of one worker and one firm. Matching occurs randomly and according to a matching function $m = m(s, v)$, where s is the total number of searching workers and v the number of vacancies. We allow on-the-job search, and hence employed workers can move directly to other jobs without transitioning through unemployment. However, we assume that the search intensity of workers holding a job is a fraction $\chi \in [0, 1]$ of those who are unemployed. Hence, $s = u + \chi n$, where u and n are the total number of unemployed and employed workers, respectively. The matching technology is homogeneous of degree one, and increasing and concave in both arguments. A firm having a vacancy matches with an unemployed worker according to a Poisson process with arrival rate $q(\theta) = m(s, v)/v$, where $\theta = \frac{v}{s}$ is the market tightness of the economy. Similarly, the arrival rate of vacancies for workers is $q(\theta) = m(s, v)/s$.

Since the focus of the paper is to study the effect on the labor market of introducing a UB system in an economy with a large informal sector, we need to account for the existence of such a large underground economy. We assume that vacant firms are ex-ante identical and search for workers in a single and uncoordinated labor market. After meeting with a worker, the firm-worker pair decides whether the job will be formal or informal. Hence, informality in our model arises endogenously as the optimal economic outcome of agents' decisions.

Formal and informal jobs differ in several dimensions. On the one hand formal jobs are subject to certain costs which are not incurred by informal jobs. These costs are: (i) a cost c to start production as a formal employment relationship; (ii) a cost F to dissolve an existing employment relationship;[2] (iii) general proportional income taxes, τ_g; and (iv) unemployment benefit contributions, which are assumed to be a fraction τ_b of the wage. On the other hand, informal jobs are subject to government monitoring which dissolves the informal match according to a Poisson process with arrival rate ϕ, and imposes a penalty of σ when discovered.

When a match is formed, either as a formal or informal job, output is produced. Production of the match is the sum of the aggregate productivity in the economy, p, and an idiosyncratic productivity to the match, ε. At the beginning of a match, a value of ε is drawn from a distribution $G : \left[\varepsilon^G_{\min}, \varepsilon^G_{\max}\right] \to [0,1]$. The idiosyncratic productivity to the match changes according to a Poisson process with arrival rate λ_j for $j \in \{f, i\}$. The new levels of ε are i.i.d. and drawn from a distribution $H_f : \left[\varepsilon^{H_f}_{\min}, \varepsilon^{H_f}_{\max}\right] \to [0,1]$ and $H_i : \left[\varepsilon^{H_i}_{\min}, \varepsilon^{H_i}_{\max}\right] \to [0,1]$ for formal and informal matches respectively. This specification allows for shocks to formal and informal jobs to arrive at different rates and from distributions that potentially differ in their variance.

Matches are dissolved endogenously when the idiosyncratic productivity of the match is not high enough to continue production. Additionally, informal matches are destroyed when discovered by the government, as explained before.

The UB system is one in which formal workers pay into the system while employed, and collect from the system when they lose their job. More specifically, a formal employee pays unemployment insurance contributions, and if the match is dissolved, qualifies to receive unemployment benefits, b, according to a Poisson process with arrival rate ψ. Since informal workers are hidden from the government, such workers could potentially collect UB while being employed. Hence, we assume that both unemployed and informal workers are allowed to collect such benefits had they qualified while working at a formal job. Unemployment benefits are terminated according to a Poisson process with arrival rate ρ.

Given the previously explained environment, the labor force of the economy is divided between employed, n, and unemployed workers, u. The employed population is either working in the formal sector, n_f, or in the informal one, n_i. Out of the formal workers, some are on-going employment relationships and some have just started employment.[3] Out of the workers in on-going matches, some have qualified to collect unemployment insurance if they lose the job, $n_f^{o_b}$, and others have not qualified yet, $n_f^{o_z}$. Out of the new formal workers, some were collecting unemployment insurance, $n_f^{n_b}$, and some were not, $n_f^{n_z}$.

[2]Note that the costs c and F only apply to employment relationships, which differ from pure matches in that a match which has just been formed may not become an employment relationship if worker and firm decide that their outside options are more valuable than their value inside the employment relationship.

[3]In this case the firing costs do not apply, since such costs are only paid when dissolving an on-going employment relationship, and not when breaking a match that has just formed and is not yet productive.

Workers in either $n_f^{n_b}$or $n_f^{n_z}$ states are starting new formal jobs, so they have not qualified for collecting UB if they lose their job after starting production. However, since there are workers who were holding formal jobs in which they had already qualified to collect UB, and they can search for new jobs while employed, if they move to a new formal job they are still qualified for UB collection This creates a new state for new formal workers, which we denote by $n_f^{n_q}$. An unemployed worker may still be collecting UB from the government, u^b, or he may have run out of it, u^z. Similarly, informal workers may be collecting such benefits, n_i^b, or may have ceased to do so, n_i^z. Figure 1 shows all the possible states a worker can find himself in the model.

In what follows we develop the problem of the firm and worker and explain the decisions they face.

2.2 Problem of the Firm

Firms posts vacancies in the labor market and try to match with workers and create productive employment relationships. Firms are ex-ante identical, but differ once they form a match with a worker.

Firm's value of a vacancy

The value of an unfilled job for a firm, V, is discounted at rate r, and is composed by the flow cost of having the vacancy posted, k, and the expected return to be obtained from the potential match with a worker. The expected future value of a vacancy can be understood as follows. According to a Poisson process with arrival rate $q(\theta)$ the firm meets a worker. A fraction $\gamma_u = \frac{u^b}{u+\chi n}$ of those workers were unemployed collecting UB. If a firm matches with such worker, it draws an initial value of the idiosyncratic productivity ε and decides whether to hire the worker as a formal employee, which has a set-up cost of c and provides a value of $J_f^{n_b}(\varepsilon)$, as an informal worker, which has a value of $J_i^b(\varepsilon)$ and no set-up cost, or not form an employment relationship at all and remain as a vacant firm, which has a value of V. With probability $\gamma_n = \frac{\chi\left(n_f^{n_q}+n_f^{o_b}\right)}{u+\chi n}$ the firm is matched with a worker who was previously employed in a formal firm and had already qualified for UB collection. The firm then makes a similar decision between hiring the worker formally, which as a value of $J_f^{n_q}(\varepsilon)$ and a set-up cost of c, informally, with value $J_i^b(\varepsilon)$, or stay vacant. Finally, a fraction $(1-\gamma_u-\gamma_n)$ of the searching population is not collecting UB, or, if employed, have not qualified for such benefits. The problem for the vacant firm is then similar, but the values of formal and informal hiring are $J_f^{n_z}(\varepsilon)-c$ and $J_i^z(\varepsilon)$, respectively. If matched with a worker, the firm loses the value of being vacant. The following expression shows the value for a firm to post a vacancy in the labor market:

$$\begin{aligned} rV &= -k + q(\theta)\Bigg\{\gamma_u \int_{\varepsilon_{\min}^G}^{\varepsilon_{\max}^G} \max\left[J_f^{n_b}(\varepsilon') - c, J_i^b(\varepsilon'), V\right] dG(\varepsilon') \\ &\quad +\gamma_n \int_{\varepsilon_{\min}^G}^{\varepsilon_{\max}^G} \max\left[J_f^{n_q}(\varepsilon') - c, J_i^b(\varepsilon'), V\right] dG(\varepsilon') \\ &\quad + (1-\gamma_u-\gamma_n) \int_{\varepsilon_{\min}^G}^{\varepsilon_{\max}^G} \max\left[J_f^{n_z}(\varepsilon') - c, J_i^z(\varepsilon'), V\right] dG(\varepsilon') - V\Bigg\} \end{aligned} \quad (1)$$

We assume that there is free entry of firms into the labor market, which implies that in equilibrium, $V = 0$, since $q(\theta)$ is decreasing in the number of vacancies.

Firm's value of a filled job

Since workers can be in one of 7 states while employed, the value for a firm to hire a worker are also 7 different values. The notation for such values follows that of the states of the worker. We now explain the values of the problem that each firm faces when hiring a worker.

Formal firms hiring workers who have not qualified for UB collection The present discounted value for a firm to hire a formal worker who has not yet qualified for collection of UB in a match with idiosyncratic productivity ε is $rJ_f^s(\varepsilon)$, where $s = n_b$ if the worker was collecting UB, $s = n_z$ if the worker was not employed in a formal firm, but he was not collecting UB, and $s = o_z$ if he was working at a formal firm and had not yet qualified for UB collection. This value is expressed as follows:

$$
\begin{aligned}
rJ_f^s(\varepsilon) \quad = \quad & p + \varepsilon - \left(1 + \tau_g^f + \tau_b^f\right) w_f^s(\varepsilon) + \lambda_f \left[\int_{\varepsilon_{\min}^{H_f}}^{\varepsilon_{\max}^{H_f}} \max\left[J_f^{o_z}(\varepsilon'), J_i^z(\varepsilon') - F, V - F\right] dH_f(\varepsilon') - J_f^s(\varepsilon)\right] \\
& + \varphi \left[\int_{\varepsilon_{\min}^{H_f}}^{\varepsilon_{\max}^{H_f}} \max\left[J_f^{o_b}(\varepsilon'), J_i^b(\varepsilon') - F, V - F\right] dH_f(\varepsilon') - J_f^s(\varepsilon)\right] \qquad (2) \\
& + \eta\left(V - J_f^s(\varepsilon)\right) \text{ for } s \in \{n_b, n_z, o_z\}
\end{aligned}
$$

This value is interpreted as follows: the firm produces output $p + \varepsilon$, and pays wages $w_f^s(\varepsilon)$, which are taxed at rate τ_g^f, and also increased by the amount contributed to the UB system, a fraction τ_b^f of the wage. With arrival rate λ_f the idiosyncratic productivity changes and the match draws a new value from the distribution H_f. The firm loses the value of the current match, $J_f^s(\varepsilon)$, and depending on the new value ε', the firm decides whether to keep hiring the worker in an on-going formal match, which has value $J_f^{o_z}(\varepsilon')$, hire the worker as informal with value $J_i^z(\varepsilon')$, or dissolve the match completely and search for a new worker. The last two options require breaking a formal match, which involves a cost F. With arrival rate φ the worker being hired qualifies to collect UB. This change in status also implies the loss of the current value, and the draw of a new idiosyncratic productivity and similar choices as before for the firm, but where the values of hiring the worker formally and informally are $J_f^{o_b}(\varepsilon')$ and $J_i^b(\varepsilon')$, respectively. Finally, since workers search for new employment opportunities while on-the-job, with arrival rate η the worker finds a new job and leaves the firm, which becomes vacant.

Formal firms hiring workers who have qualified for UB collection When a firm hires a worker who had already qualified to collect UB, it has a present value of $rJ_f^h(\varepsilon)$, where $h = n_q$ if the worker is starting a new formal job, and $h = o_b$ if the match is on-going. The interpretation of this value is very similar to that of a firm hiring a worker who has not yet qualified for collection of UB. The only difference is that, since the worker in this firm has already qualified, he does not get hit by the qualification shock (which occurs at rate φ for non-qualified workers). The expression for $J_f^s(\varepsilon)$ is as follows:

$$\begin{aligned} rJ_f^h(\varepsilon) &= p+\varepsilon-\left(1+\tau_g^f+\tau_b^f\right)w_f^{n_q}(\varepsilon)+\lambda_f\left[\int_{\varepsilon_{\min}^{H_f}}^{\varepsilon_{\max}^{H_f}}\max\left[J_f^{o_b}(\varepsilon'),J_i^b(\varepsilon')-F,V-F\right]dH_f(\varepsilon')-J_f^{o_b}(\varepsilon)\right] \\ &\quad +\eta\left(V-J_f^{o_b}(\varepsilon)\right)\text{ for } h\in\{n_q,o_b\} \end{aligned} \tag{3}$$

Informal firms A firm who is hiring a worker informally has a present value of $rJ_i^j(\varepsilon)$, where $j=b$ if the worker is collecting UB and $j=z$ if he is not collecting such benefits. The value for a firm to hire a worker informally has a similar form to that of hiring the worker formally, but it differs in the following ways: (i) it does not pay taxes, hence the expenditures in wages is simply $w_i^j(\varepsilon)$; (ii) the arrival rate of a new idiosyncratic productivity is λ_i and the new value is drawn from a distribution H_i; (iii) if the worker is collecting UB, he stops collecting according to a Poisson process with arrival rate ρ, and then the match draws a new value of ε and decides how to proceed; and (iv) it gets discovered by the government according to a Poisson process with arrival rate ϕ, in which case it gets fined σ and the match is dissolved. The expression for the value for a firm which hires a worker informally is:

$$\begin{aligned} rJ_i^j(\varepsilon) &= p+\varepsilon-w_i^j(\varepsilon)+\lambda_i\left[\int_{\varepsilon_{\min}^{H_i}}^{\varepsilon_{\max}^{H_i}}\max\left[J_f^{n_j}(\varepsilon')-c,J_i^j(\varepsilon'),V\right]dH_i(\varepsilon')-J_i^j(\varepsilon)\right] \\ &\quad +\mathbb{I}_{j=b}\rho\left[\int_{\varepsilon_{\min}^{H_i}}^{\varepsilon_{\max}^{H_i}}\max\left[J_f^{n_z}(\varepsilon')-c,J_i^z(\varepsilon'),V\right]dH_i(\varepsilon')-J_i^j(\varepsilon)\right] \\ &\quad +\eta\left(V-J_i^j(\varepsilon)\right)+\phi\left(V-J_i^j(\varepsilon)\right)-\phi\sigma\text{ for } j\in\{b,z\} \end{aligned} \tag{4}$$

where $\mathbb{I}_{j=b}$ is an indicator function which equals 1 if the worker at the firm is collecting UB.

2.3 Problem of the Worker

As noted before, there are 9 possible states for a worker in the labor force. These depend on whether he is employed or unemployed, hired formally or informally, collecting UB or not, and if he is employed at a formal firm on whether he has qualified for UB collection. In what follows we explain the value for the worker of being in all these different states and the decisions he faces.

Value of Unemployment

The present value of being unemployed for a worker is denoted by rU^j, where $j=b$ if the worker is collecting UB, and $j=z$ if he is not. Such value can be expressed in the following way:

$$\begin{aligned} rU^j &= z+\mathbb{I}_{j=b}b+\theta q(\theta)\left[\int_{\varepsilon_{\min}^{G}}^{\varepsilon_{\max}^{G}}\max\left[W_f^{n_j}(\varepsilon'),W_i^j(\varepsilon'),U^j\right]dG(\varepsilon')-U^j\right] \\ &\quad +\mathbb{I}_{j=b}\rho\left(U^z-U^b\right)\text{ for } j\in\{b,z\} \end{aligned} \tag{5}$$

The interpretation of the previous equation is simple. An unemployed worker gets flow value of leisure, z, and the UB b if it is still being collected. Then, if matched with a firm, which occurs according to a

Poisson process with arrival rate $\theta q(\theta)$, the worker loses the value of unemployment and after drawing a value of the idiosyncratic productivity ε, the worker decides how to continue. He can start employment as a formal worker, which gives value $W_f^{n_j}(\varepsilon)$, be employed in an informal job with value $W_i^j(\varepsilon)$, or remain unemployed. An unemployed worker collecting UB also faces the possibility of the termination of such benefit. This occurs according to a Poisson process with arrival rate ρ, and where in the previous expression $\mathbb{I}_{j=b}$ is an indicator function which equals 1 if the worker at the firm is collecting benefits.

Value of Employment

Formal employment for a worker who has not qualified for UB collection An employed worker who has not yet qualified to collect UB has a present value of $rW_f^s(\varepsilon)$, where, as in the case of the value of the firm, $s = n_b$ if the worker has just found a job as was previously collecting UB, $s = n_z$ if the worker is in a new match and was not collecting UB in the previous state, and $s = o_z$ if he was working at a formal firm and had not yet qualified for UB collection. The expression for $rW_f^s(\varepsilon)$ is:

$$\begin{aligned} rW_f^s(\varepsilon) &= \left(1-\tau_g^w-\tau_b^w\right)w_f^s(\varepsilon)+\lambda_f\left[\int_{\varepsilon_{\min}^{H_f}}^{\varepsilon_{\max}^{H_f}}\max\left[(W_f^{o_z}(\varepsilon'),W_i^z(\varepsilon'),U^z\right]dH_f(\varepsilon')-W_f^s(\varepsilon)\right] \\ &+\chi\theta q(\theta)\left[\int_{\varepsilon_{\min}^{G}}^{\varepsilon_{\max}^{G}}\max\left[W_f^{n_z}(\varepsilon'),W_i^z(\varepsilon'),U^z\right]dG(\varepsilon')-W_f^s(\varepsilon)\right] \\ &+\varphi\left[\int_{\varepsilon_{\min}^{H_f}}^{\varepsilon_{\max}^{H_f}}\max\left[(W_f^{o_b}(\varepsilon'),W_i^b(\varepsilon'),U^b\right]dH_f(\varepsilon')-W_f^s(\varepsilon)\right] \text{ for } s\in\{n_b,n_z,o_z\} \end{aligned} \tag{6}$$

The previous equation is interpreted as follows: A formal worker who has not yet qualified for UB collects a wage $w_f^s(\varepsilon)$, pays the government a fraction τ_g^w in general taxes, and a fraction τ_b^w in UB contributions. With arrival rate λ_f the match draws a new value of the idiosyncratic productivity, in which case the worker loses the current value, $W_f^s(\varepsilon)$, and decides whether to continue working for the same firm as a formal worker, which gives value $W_f^{o_z}(\varepsilon')$, become an informal worker with value $W_i^z(\varepsilon')$, or go into unemployment. While employed the worker searches for new job opportunities, although at a lower intensity than when unemployed. According to a Poisson process with arrival rate $\chi\theta q(\theta)$, he matches with a new firm. We assume that, if matched with a new firm, the worker leaves the current job and decides on the employment opportunities with the new firm without the possibility of going back to the previous job.[4] Since the worker had not yet qualified for UB collection, the options for the worker and the respective values are to work formally $W_f^{n_z}(\varepsilon')$, work informally $W_i^z(\varepsilon')$, or become unemployed U^z. Finally, with arrival rate φ the worker qualifies to collect UB and after drawing a new value of ε he decides how to proceed, which involves continue working formally with value $W_f^{o_b}(\varepsilon')$, become informal $W_i^b(\varepsilon')$, or move into unemployment.

[4]This assumption is made for simplicity, as it greatly simplifies the problem of the worker and the bargaining with the new firm.

Formal employment for a worker who qualifies for UB collection The value of formal employment for a worker who has already qualified to collect UB is very similar to that of a worker who has not yet qualified, and only differs in that it does not have the term corresponding to the UB qualification. The expression is as follows:

$$\begin{aligned} rW_f^h(\varepsilon) &= \left(1-\tau_g^w-\tau_b^w\right)w_f^h(\varepsilon)+\lambda_f\left[\int_{\varepsilon_{\min}^{H_f}}^{\varepsilon_{\max}^{H_f}}\max\left[(W_f^{o_b}(\varepsilon'),W_i^b(\varepsilon'),U^b\right]dH_f(\varepsilon')-W_f^h(\varepsilon)\right] \\ &+\chi\theta q(\theta)\left[\int_{\varepsilon_{\min}^{G}}^{\varepsilon_{\max}^{G}}\max\left[W_f^{n_q}(\varepsilon'),W_i^b(\varepsilon'),U^b\right]dG(\varepsilon')-W_f^h(\varepsilon)\right] \text{ for } h\in\{n_q,o_b\} \end{aligned} \tag{7}$$

Informal employment Finally, a worker who is employed informally at a firm has a value of $rW_i^j(\varepsilon)$, where $j=b$ if the worker still collects UB, and $j=z$ if he does not. The expression is similar to that of being employed formally, except in that workers at informal jobs do not pay taxes, the arrival rate for a new value of ε is λ_i, there is the possibility of stopping the UB collection (with arrival rate ρ), and the worker can be forced into unemployment without UB collection if caught by the government (with arrival rate ϕ).

$$\begin{aligned} rW_i^j(\varepsilon) &= w_i^j(\varepsilon)+\mathbb{I}_{j=b}b+\lambda_i\left[\int_{\varepsilon_{\min}^{H_i}}^{\varepsilon_{\max}^{H_i}}\max\left[(W_f^{n_j}(\varepsilon'),W_i^j(\varepsilon'),U^j\right]dH_i(\varepsilon')-W_i^j(\varepsilon)\right] \\ &+\chi\left[\theta q(\theta)\int_{\varepsilon_{\min}^{G}}^{\varepsilon_{\max}^{G}}\max\left[W_f^{n_j}(\varepsilon'),W_i^j(\varepsilon'),U^j\right]dG(\varepsilon')-W_i^j(\varepsilon)\right] \\ &+\mathbb{I}_{j=b}\rho\left[\int_{\varepsilon_{\min}^{H_i}}^{\varepsilon_{\max}^{H_i}}\max\left[(W_f^{n_z}(\varepsilon'),W_i^z(\varepsilon'),U^z\right]dH_i(\varepsilon')-W_i^b(\varepsilon)\right] \\ &+\phi\left(U^z-W_i^j(\varepsilon)\right) \text{ for } j\in\{b,z\} \end{aligned} \tag{8}$$

2.4 Surplus

When a firm and a worker form an employment relationship a surplus is created. This surplus is the sum of what firm and worker gain by being in a productive match net of what they lose. Since there are 7 possible employment states for the worker, there are as many surpluses. We can define them as follows for new formal matches

$$S_f^{n_j}(\varepsilon) = \left(J_f^{n_j}(\varepsilon)-c\right)+W_f^{n_j}(\varepsilon)-V-\left(1-\mathbb{I}_{j=b}\right)U^j-\mathbb{I}_{j=b}U^b \text{ for } j\in\{b,z,q\}, \tag{9}$$

for on-going matches

$$S_f^{o_j}(\varepsilon) = J_f^{o_j}(\varepsilon)+W_f^{o_j}(\varepsilon)-(V-F)-U^j \text{ for } j\in\{b,z\}, \tag{10}$$

and for informal matches

$$S_i^j(\varepsilon) \quad = \quad J_i^j(\varepsilon) + W_i^j(\varepsilon) - V - U^j \text{ for } j \in \{b, z\}. \tag{11}$$

Using equations (1) to (8) we can find the expressions for each of the surpluses. These expressions are shown in Appendix B.

2.5 Wages

Wages are chosen as the Nash solution to a bargaining problem, where β_f and β_i are the bargaining powers of the formal and informal workers, respectively. Therefore, wages in new formal matches solve the problem

$$w_f^{n_j}(\varepsilon) = \arg\max \left(J_f^{n_j}(\varepsilon) - c - V\right)^{1-\beta_f} \left(W_f^{n_j}(\varepsilon) - (1 - \mathbb{I}_{j=b}) U^j - \mathbb{I}_{j=b} U^b\right)^{\beta_f} \text{ for } j \in \{b, z, q\},$$

in on-going formal matches wages solve the problem

$$w_f^{o_j}(\varepsilon) = \arg\max \left(J_f^{o_j}(\varepsilon) - (V - F)\right)^{1-\beta_f} \left(W_f^{o_j}(\varepsilon) - U^j\right)^{\beta_f} \text{ for } j \in \{b, z\},$$

and in informal matches solve

$$w_i^{n_j}(\varepsilon) = \arg\max \left(J_i^{n_j}(\varepsilon) - V\right)^{1-\beta_f} \left(W_i^{n_j}(\varepsilon) - U^j\right)^{\beta_f} \text{ for } j \in \{b, z\}.$$

The previous problems deliver the optimal sharing rule for the surplus of the match. Given that this model includes taxes for the formal sector, the division of the surplus between the firm and the worker differs from the standard condition for these types of firms. For new formal matches the sharing rule is

$$W_f^{n_j}(\varepsilon) - (1 - \mathbb{I}_{j=b}) U^j - \mathbb{I}_{j=b} U^b \quad = \quad \hat{\beta}_f S_f^{n_j}(\varepsilon) \text{ and } J_f^{n_j}(\varepsilon) - c = \left(1 - \hat{\beta}_f\right) S_f^{n_j}(\varepsilon) \text{ for } j \in \{b, z, q\} \tag{12}$$

where $\hat{\beta}_f \equiv \frac{\beta_f\left(1-\tau_g^w-\tau_b^w\right)}{(1-\beta_f)\left(1+\tau_g^f+\tau_b^f\right)+\beta_f\left(1-\tau_g^w-\tau_b^w\right)}$.

For on-going formal matches the sharing rule is

$$W_f^{o_j}(\varepsilon) - U^j \quad = \quad \hat{\beta}_f S_f^{o_j}(\varepsilon) \text{ and } J_f^{o_j}(\varepsilon) + F = \left(1 - \hat{\beta}_f\right) S_f^{o_j}(\varepsilon) \text{ for } j \in \{b, z\}. \tag{13}$$

The sharing rule for informal firms is equivalent to the standard text-book sharing rule, since it does not face taxes or firing cost:

$$W_i^j(\varepsilon) - U^j \quad = \quad \beta_i S_i^j(\varepsilon) \text{ and } J_i^j(\varepsilon) = (1 - \beta_i) S_i^j(\varepsilon) \text{ for } j \in \{b, z\} \tag{14}$$

2.6 Thresholds

The value functions in equations(1) to (8) pose firms and workers with problems such as when to convert a new match into a productive relationship, and if they do, if the job should be formal or informal, or when to destroy a match and search for better options. The solution to such problems is of the form of idiosyncratic productivity thresholds that separate the different options.

In the model there are 9 thresholds that determine the formality-informality choice and the match dissolution decision.[5] These thresholds : ε_R^j for $j \in \{b, z, q\}$ and ε_T^j for $j \in \{b, z\}$ are the values of the idiosyncratic productivity that determine the formality-informality decision for new and on-going matches, respectively, where the job will be formal only if the value of ε is above that threshold; $\varepsilon_{D_f}^j$ and $\varepsilon_{D_i}^j$ for $j \in \{b, z\}$ is the value of the productivity that determines the destruction of formal and informal matches, respectively, where matches are dissolved whenever ε falls below that level.

The threshold levels are determined as the levels of the idiosyncratic productivity that make the value for the firm, and also for the worker,[6] the same between hiring the worker formally or informally for ε_R^j and ε_T^j , and give a value of zero for the separation thresholds $\varepsilon_{D_f}^j$ and $\varepsilon_{D_i}^j$. The actual values of the thresholds can be found in Appendix B.

The conditions that determine the thresholds are:

- For formality-informality decision of new matches, ε_R^j for $j \in \{b, z, q\}$:

$$J_f^{n_j}\left(\varepsilon_R^j\right) - c \quad = \quad J_i^j\left(\varepsilon_R^j\right). \tag{15}$$

- For the formality-informality decision of on-going matches, ε_T^j for $j \in \{b, z\}$:

$$J_f^{o_j}\left(\varepsilon_T^j\right) + F \quad = \quad J_i^j\left(\varepsilon_T^j\right). \tag{16}$$

- For the match destruction decision of informal jobs, $\varepsilon_{D_i}^j$ for $j \in \{b, z\}$:

$$J_i^j\left(\varepsilon_{D_i}^j\right) \quad = \quad 0. \tag{17}$$

- For the match destruction of formal jobs, $\varepsilon_{D_f}^j$ for $j \in \{b, z\}$:

$$\varepsilon_{D_f}^j \quad = \quad max\left\{\varepsilon_f^{o_j}, \varepsilon_{D_i}^j\right\}, \tag{18}$$

  where

$$J_f^{o_j}\left(\varepsilon_f^{o_j}\right) + F \quad = \quad 0. \tag{19}$$

The reason for the separation threshold for formal jobs to be the maximum of $\varepsilon_f^{o_j}$ and $\varepsilon_{D_i}^j$ is that formal

[5]Note that we will parametrize the model such that a new match always becomes an employment relationship. That is, there is no productivity value in the distribution G for which the match does not become productive. In equilibrium we will have that for new matches, the firm-worker pair will always find it optimal to start production and only have to decide whether the job is to be formal or informal. This assumtpion is made due to the lack of data on the fraction of matches between firms and workers that do not end in the hiring of the worker, making it difficult to have a target for that fraction that the model can try to reproduce.

[6]It is easy to see from the surplus sharing conditions (9)to (14) that, for instance, whichever ε implies a value of zero for one of the firm's present value functions, also makes the surplus of the match equal to zero, and therefore the value for the worker. Hence, when it is in the interest of a firm to either dissolve a match or turn it informal or formal, it is also optimal for the worker.

jobs have the option of becoming informal if the productivity is low. Hence, when ε falls below ε_T^j it is not worth having the job as formal and it is the value of informality that becomes relevant. However, it is possible that the optimal thresholds are such that $\varepsilon_T^j < \varepsilon_{D_i}^j$, in which case there will be no downgrading of formal jobs into informal, since the productivity value that makes the formal surplus zero is higher than that for informal surplus, $\varepsilon_f^{o_j} > \varepsilon_{D_i}^j$, and firm and worker are better off destroying the formal match than downgrading it to become informal. Therefore, our model delivers the possibility of multiple equilibria.[7] In particular there is the possibility of an equilibrium where there is downgrading of formal jobs into informality, in which case $\varepsilon_{D_f}^j = \varepsilon_{D_i}^j$, and one where there is no downgrading, with $\varepsilon_{D_f}^j = \varepsilon_f^{o_j}$. Note that even if the equilibrium of the model is one in which there is no downgrading of formal jobs, we may still have direct flows from formality to informality, since there is on-the-job search, and a worker can move from a firm that hires him as a formal worker to a different firm that hires him informally. Note also that even if the model equilibrium is such that there is no downgrading for formal jobs, there may still be upgrading of informal jobs to become formal, since the formality-informality decision faced by a filled firm currently hiring a worker informally would be the same one as that faced by a firm hiring a new worker. That is, the relevant threshold for upgrading of informal jobs is ε_R^j, since, as can be seen from equations (1) and (4), the problem posed to an on-going informal firm when the value of ε changes is the same as the one faced by a firm that has just met a worker.

2.7 Flow Equations

Given the way firms and workers make decisions, we can find how the different states for workers evolve in the model using the flow equations shown below.

Total unemployment is

$$u = u^b + u^z,$$

where the evolution of u^b and u^z is

$$\begin{aligned} u^b &= [1-\theta q(\theta)-\rho]\, u^b + \lambda_i H_i\left(\varepsilon_{D_i}^b\right) n_i^b + \lambda_f H_f\left(\varepsilon_{D_f}^b\right)\left(n_f^{n_q} + n_f^{o_b}\right) \\ &\quad + \varphi H_f\left(\varepsilon_{D_f}^z\right)\left(n_f^{n_b} + n_f^{n_z} + n_f^{o_z}\right), \end{aligned} \tag{20}$$

$$\begin{aligned} u^z &= [1-\theta q(\theta)]\, u^z + \rho\left[u^b + H_i\left(\varepsilon_{D_i}^z\right) n_i^b\right] + \left(\lambda_i H_i\left(\varepsilon_{D_i}^z\right) + \phi\right) n_i^z \\ &\quad + \phi n_i^b + \lambda_f H_f\left(\varepsilon_{D_f}^z\right)\left(n_f^{n_b} + n_f^{n_z} + n_f^{o_z}\right). \end{aligned} \tag{21}$$

Formal employment is

$$n_f = n_f^{n_b} + n_f^{n_z} + n_f^{n_q} + n_f^{o_z} + n_f^{o_b},$$

where the evolution of the 5 formal employment states is

[7] For the calibration of the model that delivers the results show in Section 4, the economy has downgrading of formal jobs into informality.

$$n_f^{n_b} = [1-\lambda_f-\varphi-\chi\theta q(\theta)]\, n_f^{n_b} + \theta q(\theta)\left[1-G\left(\varepsilon_R^b\right)\right]\left[u^b+\chi n_i^b\right] + \lambda_i\left[1-H_i\left(\varepsilon_R^b\right)\right] n_i^b, \quad (22)$$

$$\begin{aligned} n_f^{n_z} = {} & [1-\lambda_f-\varphi-\chi\theta q(\theta)\, G(\varepsilon_R^z)]\, n_f^{n_z} + \theta q(\theta)[1-G(\varepsilon_R^z)]\left[u^z+\chi\left(n_f^{n_b}+n_i^z+n_f^{o_z}\right)\right] \\ & +[1-H_i(\varepsilon_R^z)]\left(\lambda_i n_i^z+\rho n_i^b\right), \end{aligned} \quad (23)$$

$$n_f^{n_q} = [1-\lambda_f-\chi\theta q(\theta)\, G(\varepsilon_R^q)]\, n_f^{n_q} + \chi\theta q(\theta)[1-G(\varepsilon_R^q)]\, n_f^{o_b}, \quad (24)$$

$$n_f^{o_b} = \left[1-\lambda_f H_f\left(\varepsilon_T^b\right)-\chi\theta q(\theta)\right] n_f^{o_b} + \left[1-H_f\left(\varepsilon_T^b\right)\right]\left[\lambda_f n_f^{n_q}+\varphi\left(n_f^{n_b}+n_f^{n_z}+n_f^{o_z}\right)\right], \quad (25)$$

$$n_f^{o_z} = [1-\lambda_f H_f(\varepsilon_T^z)-\varphi-\chi\theta q(\theta)]\, n_f^{o_z} + \lambda_f[1-H_f(\varepsilon_T^z)]\left(n_f^{n_z}+n_f^{n_b}\right). \quad (26)$$

Informal employment is

$$n_i = n_i^b + n_i^z,$$

where n_i^b and n_i^z evolve according to the following equations

$$\begin{aligned} n_i^b = {} & \left[1-\lambda_i\left(1-\left[H_i\left(\varepsilon_R^b\right)-H_i\left(\varepsilon_{D_i}^b\right)\right]\right)-\chi\theta q(\theta)\left[1-G\left(\varepsilon_R^b\right)\right]-\phi-\rho\right] n_i^b \\ & +\theta q(\theta)\left(G\left(\varepsilon_R^b\right)u^b+\chi G(\varepsilon_R^q)\left(n_f^{n_q}+n_f^{o_b}\right)\right) \\ & +\left[H_f\left(\varepsilon_T^b\right)-H_f\left(\varepsilon_{D_f}^b\right)\right]\left[\lambda_f\left(n_f^{n_q}+n_f^{o_b}\right)+\varphi\left(n_f^{n_b}+n_f^{n_z}+n_f^{o_z}\right)\right], \end{aligned} \quad (27)$$

$$\begin{aligned} n_i^z = {} & \left[1-\lambda_i\left(1-\left[H_i(\varepsilon_R^z)-H_i\left(\varepsilon_{D_i}^z\right)\right]\right)-\chi\theta q(\theta)[1-G(\varepsilon_R^z)]-\phi\right] n_i^z + \\ & \rho\left[H_i(\varepsilon_R^z)-H_i\left(\varepsilon_{D_i}^z\right)\right] n_i^b + \theta q(\theta)\, G(\varepsilon_R^z)\left[u^z+\chi\left(n_f^{n_b}+n_f^{n_z}+n_f^{o_z}\right)\right] \\ & +\lambda_f\left[H_f(\varepsilon_T^z)-H_f\left(\varepsilon_{D_f}^z\right)\right]\left(n_f^{n_b}+n_f^{n_z}+n_f^{o_z}\right). \end{aligned} \quad (28)$$

We normalize the labor force to unity such that

$$1 = u^b+u^z+n_f^{n_b}+n_f^{n_z}+n_f^{n_q}+n_f^{o_z}+n_f^{o_b}+n_i^b+n_i^z. \quad (29)$$

2.8 Equilibrium

A stationary equilibrium in this economy is: (i) a set of thresholds, $\left\{\varepsilon_R^b, \varepsilon_R^z, \varepsilon_R^q, \varepsilon_T^b, \varepsilon_T^z, \varepsilon_{D_f}^b, \varepsilon_{D_f}^z, \varepsilon_{D_i}^b, \varepsilon_{D_i}^z\right\}$, (ii) the market tightness, θ, and (iii) a set of employment and unemployment rates, $\left\{u^b, u^z, n_f^{n_b}, n_f^{n_z}, n_f^{n_q}, n_f^{o_z}, n_f^{o_b}, n_i^b, n_i^z\right\}$, that satisfy: (I) the optimal decision of firms and workers as stated in the threshold conditions (15) to (19), (II) the vacancy posting condition, equation (1) after imposing that in equilibrium $V = 0$, and (III) the flow equations (20) to (29).

3 Parametrization

The model presented in Section 2 does not have an analytical solution, and therefore we solve it numerically. In order to find the numerical solution to the equilibrium of the economy we need to assign values to the model parameters. A subset of the parameters is set exogenously, either through normalizations or by using values which have become standard in the literature. For the other subset of parameters we use Mexican data from 1987Q1 to 2010Q4 to calculate long-run averages of key variables in the labor market. We then find parameter values that deliver a steady state equilibrium of the model consistent with such empirical evidence. The version of the model used for the calibration of the endogenous parameters is one without unemployment benefits, which is currently the case for Mexico.[8] The values of the model parameters are shown in Table 1. Let us explain in more detail how the model parameters are chosen.

The time period in the model is one month. We set the interest rate to $r = 0.005$, which delivers a yearly interest rate of 6%, which corresponds to the average for the Mexican benchmark rate in recent years. The matching function is assumed to be Cobb-Douglas, $m = \mu u^{\xi} v^{1-\xi}$, with unemployment elasticity $\xi = 0.5$, which is consistent with the estimates from Petrongolo and Pissarides (2001). The scaling parameter, μ, is jointly calibrated with other parameters of the model, as is discussed later. The bargaining power for the worker is set higher for the formal than for the informal sector, with values of $\beta_f = 0.54$ and $\beta_i = 0.46$. This implies an average worker bargaining power of 0.5, as is standard in the literature.

We assume that the bargaining power of workers is higher in the formal sector. We set $\beta_f = 0.54$ and $\beta_i = 0.46$, as to set an average worker bargaining power to around 0.5 which is the standard in the literature.

The risks of operating in the informal sector in the model are captured by the monitoring rate, ϕ, and the penalty for detection, σ. There is very little evidence on the intensity of government monitoring the informal side of the economy, especially for Mexico. Almeida and Carneiro (2009) use the Investment Climate Survey collected by the World Bank in a set of Brazilian manufacturing firms and study the impact of the enforcement of regulations in a firm's performance. They find that around 0.5% of surveyed firms received some kind of labor regulations-related fines within a given quarter. Since there is no similar estimate for the Mexican economy, we use this value for our calibration, and set the separation of informal jobs due to monitoring to $\phi = 0.0017$ in a month. However, note that changing the level of ϕ does not affect the baseline simulation results, as it rescales the value of σ, which is endogenously calibrated so that the model matches the imposed targets in the calibration.

The corporate and pay-roll tax in Mexico totals 32%. We use this number as the value for the general government taxes and set $\tau_g = 0.32$. The Doing Business database at the World Bank provides estimates of the costs of formality in Mexico. The report states that firms have to spend, on average, between 2 to 5 days to register a firm with the social security institute (IMSS in Mexico), which includes the registration and formalization of workers. We take part of this as a proxy for the output forgone by a formal match due to hiring costs, and since the time period is one month, or 30 days, we set $c = 4/30$.

[8] We can reduce the model to one where there is no UB system by assuming that $b = 0$, $\tau_b = 0$,$\varphi = 0$, $\rho = 0$. If we make the previous two assumptions the states for b and z above cease to be different, so there is no distinction between u^b and u^z(they can simply be counted as u), between n_i^b and n_i^z (they can simply be counted as n_i), between $n_f^{n_b}$ and $n_f^{n_z}$ and $n_f^{n_q}$(they can simply be counted as n_f^n) and between $n_f^{o_z}$ and $n_f^{o_b}$(they can simply be counted as n_f^o).

Calibration of the flow value of leisure, z, has attracted significant attention in the U.S. literature.[9] In general terms, the flow value of unemployment captures elements such as the value of leisure, UB and home production. Shimer (2005) chooses to set this parameter at 40% of productivity, whereas Hagedorn and Manovskii (2008) elect a much higher value, close to 95% of productivity. Given that in our model, unemployment benefits, b, are separate for the value of leisure, z, we choose z to be at the lower end of this spectrum so that when we introduce unemployment benefits, the sum of both terms $(b+z)$ lies in the middle of the range of discussed values. We set $z = 0.5$ which in our model corresponds to 50% of average productivity.[10]

he distributions $G, H_f,$and H_i are assumed to be uniform in the intervals $\left[\varepsilon_{\min}^{G}, \varepsilon_{\max}^{G}\right]$, $\left[\varepsilon_{\min}^{H_f}, \varepsilon_{\max}^{H_f}\right]$, and $\left[\varepsilon_{\min}^{H_i}, \varepsilon_{\max}^{H_i}\right]$ respectively. We normalize the maximum of the distributions to 1, that is $\varepsilon_{\max}^{G} = \varepsilon_{\max}^{H_f} = \varepsilon_{\max}^{H_i} = 1$, and calibrate the minimums as we explain below.

The remaining parameters are jointly calibrated so that the steady state version of the model without UB matches certain facts of the long-run empirical evidence for Mexico. In particular, the values of $\varepsilon_{\min}^{G}$, $\varepsilon_{\min}^{H_f}$ and $\varepsilon_{\min}^{H_i}$are calibrated jointly with the values of the endogenous variables θ, ε_R, ε_{D_f}, ε_{D_i}, and ε_T,[11] and the seven remaining exogenous parameters in the model: The cost of posting a vacancy, k, the firing cost, F, the scaling parameter in the matching function, μ, the penalty for informal firms to get caught, σ, the on-the-job search efficiency parameter, χ, and the arrival rates of idiosyncratic productivity shocks λ_f and λ_i. The 15 values for these parameters and endogenous variables are calibrated such that the steady state of the model matches the long-term properties in the data. In particular, they satisfy the equivalent of the equilibrium conditions without UB and 10 moments: (i) the unemployment rate, 4%; (ii) the fraction of formal jobs, 57%; (iii) the job finding rate for formal jobs, 8%; (iv) the flow from formality to informality, 4%; (v) the flow from formality to informality, 5% (vi) the job separation rate of informal jobs, 0.8%; (vii) the job separation rate of formal jobs, 0.5%; (viii) 60% of workers in the formal sector have worked for at least one year;[12] (ix) the elasticity of the job separation rates to productivity changes is three times as large in the informal, than in the formal sector;[13] and (x) market tightness equal to unity, $\theta = 1$. To the best of our knowledge, there are no estimates of the value of the market tightness in Mexico or any comparable economy, mainly due to the lack of data on vacancies. However, as explained

[9]While our model focuses on the steady state of the economy, and the recent discussion about this value is more relevant for models that study cyclical fluctuations, it is still worth to put our calibration in the context of recent papers in this literature.

[10]We perform sensitivity analysis for the value of this parameter. These extra set of results are not shown in the paper, but are available from the authors upon request. We find that varying this parameter within a range of $z \in [0.3, 0.7]$ (depending on the value of the unemployment benefit) does not substantially alter our results concerning the impact of the introduction of the UB system. This is due to two reasons: (i) our analysis focuses on the steady state of the economy, and not on cyclical fluctuations; (ii) all types of workers (formal and informal) obtain the value of leisure, z, while unemployed, which implies that the incentives to be employed in the formal or informal sector are not affected by it.

[11]Note that if we assume that there is no unemployment benefit system in the model, there is no longer a distinction between the states where workers collect or have qualified for UB. Hence the 9 thresholds collapse to only 4: ε_R, ε_{D_f}, ε_{D_i}, and ε_T.

[12]A recent study at the Inter-American Development Bank, Bosch and Kaplan (2012) estimate that this fraction is recently close to 60%. The reason to use this target is that the arrival rate of idiosyncratic productivity shocks in the formal sector, λ_f, affects the destruction rate of formal matches and therefore what fraction of workers entering the unemployment pool have been employed formally for more than a year.

[13]Bosch and Maloney (2008) provide evidence that for Mexico the elasticity of the job separation rates to productivity changes is three times as large in the informal than in the formal sector. We use this target since, as shown in Bosch and Esteban-Pretel (2011) using a model similar to the one in this paper, increasing the value of arrival rate of idiosyncratic shocks, proportionally increases the job separation rate elasticity.

by Shimer (2005), the steady state value of θ is of little importance in the results, since varying it only implies a readjustment of the value of η, leaving everything else unchanged. The calibrated values of $\varepsilon^{G}_{\min}$ $\varepsilon^{H_f}_{\min}$ and $\varepsilon^{H_i}_{\min}$ are 0.49, -1.01 and -0.96 respectively.[14] The values for the remaining four parameters are $\mu = 0.15$, $k = 0.42$, $F = 4.02$, $\sigma = 84.36$, $\chi = 0.2$, $\lambda_f = 0.1$, $\lambda_i = 0.3$.

4 Results

The previous section detailed how the parameter values of the model are selected in order to find the numerical solution of the steady state of the economy. The calibration of the model is targeted to reproduce the main characteristics of the Mexican labor market over the last couple of decades. This requires a version of the model in which the unemployment benefit is not present, as is currently the case for Mexico, where there is no such government subsidies. We now proceed to explain the changes in the steady state equilibrium that would take place following the introduction of a UB system. We look at the shift in incentives of workers and the overall effect on the labor market. We first present the changes due to the introduction of the UB in isolation, and we then discuss the effects on the labor market if the UB system is introduced in combination with other government policies, in particular a reduction in firing costs, decrease in taxes, and the increase in informal monitoring.

In order to understand the effects of the UB system within the model, its worth highlighting the two main mechanisms driving our results. First, there is a trade off between the levels of the benefits and the required contributions. Higher benefits relative to contributions make formal employment and unemployment more attractive states than informality. Formal jobs become more desirable as they grant worker access to UB. Unemployment becomes more attractive, relative to informality, because workers can transit more easily to formal jobs, given that search efficiency is higher while unemployed. The second mechanism is related to the reduced incentives to remain formal as workers qualify for collection of UB. Due to low monitoring, workers can claim unemployment benefits and still work in the informal sector which makes transitions into informality more likely. The interaction of these two mechanism will ultimately determine the overall effects of the introduction of the UB system on the unemployment and the share of formal employment.

4.1 Effects of the Introduction of the Unemployment Benefit System

Table 2 displays the steady state of the economy with and without UB. The first thing to note is that the effect on the labor market of the introduction of UB depends on two factors: (i) the replacement rate (the fraction of the average formal wage that the worker collects as UB, that is $b/\tilde{w}_f$, where $\tilde{w}_f$ is the average formal wage) and (ii) the contribution to the UB system (fraction of the wage paid into the UB system every period that the worker is employed formally, τ_b). These two components have two opposing effects on the incentives of workers and firms.

First, for a given UB contribution, as the replacement rate increases from 30% to 50% to 70% of the average formal wage, unemployment increases and so does formality. For instance, for $\tau_b = 2\%$, formality

[14] Although not shown explicitly, the calibrated lower bound of the initial productivity distribution, $\varepsilon^{G}_{\min}$, is higher than the threshold at which formal and informal jobs are destroyed. This is required to satisfy the assumption that all initial contacts between firms and workers result in match formation.

increases from 53.9%, to 58.8%, to 60.6%, while unemployment rises from 4.2%, to 4.7%, to 5.3%, as the replacement rate grows from 30%, to 50%, to 70%, respectively. The increase in both of these variables is fairly intuitive. On the one hand, since only workers who have been employed in the formal sector and contributed to the UB system are entitled to collect the subsidy, the incentives to become formal increase. This incentive to formalize employment is higher the more generous the UB system, since the opportunity cost of informality, where workers do not contribute to the UB program and therefore cannot qualify for later collection, becomes more important. We can see this from the increasing flow rates from both unemployment and informality into formality. At the same time, increasing the generosity of the system raises the value of unemployment. This is due to the fact that unemployed workers search for new jobs more efficiently than informal ones. In line with this, we observe increases in flows from informality to unemployment as the benefit becomes more generous.

Second, for a given replacement rate, increases in the contributions made to the UB program produce a drop in both unemployment and formality. For instance, fixing the replacement rate at 50% of the average formal wage, as we increase τ_b from 2%, to 8.3%, to 16.7%, we observe a decrease in unemployment from 4.7%, to 3.8% to 2.9%, and a drop in formality from 58.8% to 54.3% to 46.0%. This change in unemployment and formality as τ_g moves responds again to the appropriate incentives of workers. If the replacement rate is kept constant, an increase in the UB contributions reduces the after-tax wages perceived by formal workers and raises the wage paid by firms, thus reducing the value of formal employment and increasing the incentives of workers and firms to be informal, where taxes are not paid but where UB can be collected for some time. At the same time, since the average value of employment drops with the increase in taxes, and given that workers are better off working informally than being unemployed, the increase in UB contributions leads to the informality state to be a more permanent one and informal workers transition less into unemployment. This is apparent also by looking at the increased flow rates into informality both from formality and unemployment. Therefore, raising the UB contributions increases the number of informal workers and lowers both the number of unemployed and formal employees.

Table 2 also shows the required contributions for the UB system to be fully self-financed by workers and firms. We find that 8.3%, 16.7% and 26.6% UB contribution rates are required to self-finance the system with 30%, 50% and 70% replacement rates, respectively. While these rates may seem large for high replacement rates, they provide an idea if the feasibility of such programs of being self-financing is required to be implemented.

In sum, we find that whether the introduction of the UB system produces an increase or a decrease in informality with respect to the situation without such a system depends on the level of the replacement rate and the UB contributions. For low replacement rates, such as 30% of the average formal wage, even if UB contributions are as low as 2% of wages, we find that formality decreases from 57% in the economy with UB to 53.9% after the introduction. However, if the replacement rate is generous enough, for instance 50%, we can have increases in taxes of up to 4% and still observe increases in formality.

4.2 Combining Unemployment Benefit System with Other Policies

The UB system does not work in isolation in affecting workers and firms' incentives, but it interacts with other policy interventions already in place, such as firing costs, general taxes and informal monitoring. In order to study policy complementarity, we perform three experiments where we combine the introduction of the UB program with (i) a decline in firing costs first, (ii) a drop in government taxes, and (iii) an increase in informal sector monitoring by the government. This is especially relevant since changes in the UB system are likely to be implemented in combination with reforms in other labor market institutions to strengthen its effectiveness.

Low Firing Costs and Unemployment Benefits

Table 3 shows the steady state equilibrium of the economy when we lower the firing costs 10%, from $F = 4.02$ in the baseline calibration to $F = 3.61$. We can see from the table that when the UB program is introduced in conjunction with lower firing costs, we can have a situation where informality decreases even if the UB contributions are not at the lowest levels.

To fully understand this result, we can see in the second column of the table what happens when firing costs are lowered even in an economy with no UB program. We see that lowering firing costs produces an increase in unemployment, which is a consequence of easier dismissal of workers. At the same time, we also observe an increase in formality, which is due to the fact that formal employment is now more attractive given that it has higher average productivity and now lower costs.

Implementing a UB system on top of the lower firing costs dampens the negative effect on formality of increased contributions for every replacement rate at the cost of increasing unemployment.

Low Government Taxes and Unemployment Benefits

The results when there is decline in general government taxes from the baseline level of $\tau_g = 32\%$ to a new lower level 10% , $\tau_g = 28.8\%$, can be seen in Table 4. As in the case of lower firing costs, reducing the taxes that are paid by formal matches produces increases in formality, and the UB program can be implemented at a higher gain to formality with respect to the baseline case. The intuition for this result is similar to that of lowering firing costs. The drop in taxes makes formality more attractive, which reduces informality and increases unemployment because the value of search rises.

Higher Monitoring of informal sector and Unemployment Benefits

Finally, we assess the impact of increasing informal jobs monitoring together with the implementation of UB. Table 5 shows the results when we raise the monitoring rate by 10%, from $\phi = 0.0017$ to $\phi = 0.00187$. Higher monitoring of informal activities lowers the value of holding an informal job. This is translated into higher flows from informality to unemployment and also into formality, especially after the introduction of the UB system. In all, the introduction of a UB system together with higher monitoring rates tends to produce a substantial increase in unemployment, and for high levels of the UB replacement rate, also the share of formal employment.

5 Conclusions

Unemployment benefits programs are the exception in many developing countries, especially in Latin America. Several governments are, however, considering implementing such systems to try to protect their unemployed workers and provide the labor market with the incentives to shift away from informality, which is an important problem facing these countries.

The challenges in the implementation of unemployment benefits programs in developing economies are different from those being faced by developed nations. In particular, the existence of large pools of informal employment, whose workers are in general less protected, less productive and do not contribute to the tax system, imply that the reaction of the labor market to the introduction of unemployment benefits may cause changes in workers´ behavior that differ from economies with little or no informality.

In order to understand the effects on the labor market of the introduction of unemployment benefits in an economy with large informality, we build a search and matching model with two sectors, formal and informal, endogenous destruction, on-the-job search and inter-sectoral flows of workers. The decision to be formal or informal is endogenous in the model, which allows us to study how incentives change after the introduction of UB. The UB system is such that formal workers contribute a fraction of their wage to the program while employed and can collect benefits when they lose their jobs. Given the difficulty of monitoring informality in reality, we assume that informal workers can also collect the benefit. However, UB are not collected indefinitely, but are terminated if the worker collects them for too long.

We parametrize the model for the Mexican economy, which is a prime example of a country with high informality and no unemployment benefit system, but which is thinking of introducing one. We find that the labor market's reaction to the existence of unemployment benefits depends on the generosity of the benefits and on the required contributions to finance such a system. Increasing the level of the benefit for a given contribution increases the incentives of workers to be formal in order to qualify for collection, and reduces informality while also increasing unemployment (as the value of being unemployed increases due to the existence of the benefits which cannot be collected if employed formally). On the other hand, as the required contributions increase, leaving the benefits unchanged, the UB program becomes less attractive and so does being formal, which leads to an increase in informality.

We also study the effect of the introduction of the UB program in combination with other policies which can lead to reductions in informality. In particular, we show that there is plenty of scope for policy complementarity. For instance, lowering firing costs, lowering taxes or increasing monitoring of informal activities all reduce the negative effects on formality of the introduction of a UB system. However, they tend to increase the unemployment rate.

References

ACEMOGLU, D., AND R. SHIMER (1999): "Efficient Unemployment Insurance," *Journal of Political Economy*, 107(5), 893–928. 2

ALBRECHT, J., L. NAVARRO, AND S. VROMAN (2009): "The Effects of Labour Market Policies in an Economy with an Informal Sector," *The Economic Journal*, 119(539), 1105–1129. 4

ALMEIDA, R., AND P. CARNEIRO (2009): "Enforcement of labor regulation and firm size," *Journal of Comparative Economics*, 37(1), pp. 28–46. 15

ÁLVAREZ-PARRA, F., AND J. M. SÁNCHEZ (2009): "Unemployment insurance with a hidden labor market," *Journal of Monetary Economics*, 56(7), 954 – 967. 4

ANTUNES, A. R., AND T. V. DE V. CAVALCANTI (2007): "Start up costs, limited enforcement, and the hidden economy," *European Economic Review*, 51(1), 203 – 224. 3

BOERI, T., AND P. GARIBALDI (2006): "Shadow Sorting," CEPR Discussion Papers 5487, C.E.P.R. Discussion Papers. 3

BOSCH, M. (2004): "Start up costs, Informality and Policy complementarities," Mimeo, London School of Economics. 3

BOSCH, M., AND J. ESTEBAN-PRETEL (2011): "Job creation and job destruction in the presence of informal markets," *Journal of Development Economics*, Forthcoming (doi: 10.1016/j.jdeveco.2011.08.004). 4, 16

BOSCH, M., AND D. KAPLAN (2012): "Meassuring the cost of Implementing unemployment Insurance in Mexico: A Naive Estimate," Mimeo, Inter-American Development Bank (IADB), Washington DC. 16

BOSCH, M., AND W. F. MALONEY (2008): "Cyclical Movements in Unemployment and Informality in Developing Countries," *IZA Discussion Paper*, (No. 3514). 2, 4, 16

CAHUC, P., AND E. LEHMANN (2000): "Should unemployment benefits decrease with the unemployment spell?," *Journal of Public Economics*, 77(1), 135–153. 2

FUGAZZA, M., AND J.-F. JACQUES (2004): "Labor market institutions, taxation and the underground economy," *Journal of Public Economics*, 88(1-2), 395 – 418. 3

HAGEDORN, M., AND I. MANOVSKII (2008): "The Cyclical Behavior of Equilibrium Unemployment and Vacancies Revisited," *The American Economic Review*, 98(4), pp. 1692–1706. 16

KUGLER, A. D. (1999): "The Impact of Firing Costs on Turnover and Unemployment: Evidence from the Colombian Labour Market Reform," *International Tax and Public Finance*, 6, pp. 389–410, 10.1023/A:1008711819429. 3

MARGOLIS, D. N., L. NAVARRO, AND D. A. ROBALINO (2012): "Unemployment Insurance, Job Search and Informal Employment," IZA Discussion Papers 6660, Institute for the Study of Labor (IZA). 4

Mortensen, D. T., and C. A. Pissarides (1994): "Job Creation and Job Destruction in the Theory of Unemployment," *The Review of Economic Studies*, 61(3), pp. 397–415. 4

Pagés, C., and M. Stampini (2009): "No education, no good jobs? Evidence on the relationship between education and labor market segmentation," *Journal of Comparative Economics*, 37(3), 387–401. 2

Petrongolo, B., and C. A. Pissarides (2001): "Looking into the Black Box: A Survey of the Matching Function," *Journal of Economic Literature*, 39(2), pp. 390–431. 15

Pissarides, C. A. (1983): "Efficiency Aspects of the Financing of Unemployment Insurance and Other Government Expenditure," *The Review of Economic Studies*, 50(1), 57–69. 2

Shimer, R. (2005): "The Cyclical Behavior of Equilibrium Unemployment and Vacancies," *The American Economic Review*, 95(1), pp. 25–49. 16, 17

Zenou, Y. (2008): "Job search and mobility in developing countries. Theory and policy implications," *Journal of Development Economics*, 86(2), pp. 336–355. 4

Appendix A Data Details

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 labor market, wages, hours worked, etc. that are traditionally found in such employment surveys. The ENEU is structured to track a fifth of each sample across a five quarter period. We have concatenated panels from the first quarter of 1987 to the first quarter of 2004. Starting in the first quarter of 2005 the ENEU was expanded to rural areas to make it nationally representative and renamed as ENOE (National Employment and Occupational Survey)

The ENEU-ENOE 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 the extended sample.

We broadly follow the International Labor Organization (ILO) definition of informality by dividing employed workers into two sectors: formal and informal workers, which we classify on the basis of lack of compliance with labor legislation. In particular we use the lack of contributions by the employer to the social security agency, IMSS (or the equivalent for civil servants IMSTS) as the critical distinguishing characteristic. We 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 big firms (more than 5 employees) and those professionals and technicians self-employed or with social security contributions are all considered formal.

Appendix B Model Equations

Here we write the expressions for the surpluses, wages and thresholds which are not explicitly stated in the main body of the paper.

Surpluses and Wages

Formal match with new worker who was collecting unemployment benefits
The value of the surplus is

$$
\begin{aligned}
(r+\lambda_f+\varphi+\chi\theta q(\theta)) S_f^{n_b}(\varepsilon) =\; & p+\varepsilon-b-z-\left(\tau_g^f+\tau_g^w\right) w_f^{n_b}(\varepsilon)-\left(\tau_b^f+\tau_b^w\right)-(r+\lambda_f+\varphi+\chi\theta q(\theta)) c \\
& -(\lambda_f+\varphi) F+(\lambda_f+\chi\theta q(\theta)+\rho)\left(U^b-U^z\right) \\
& +\lambda_f\left\{\int_{\varepsilon_{D_f}^z}^{\varepsilon_T^z} S_i^z(\varepsilon') dH_f(\varepsilon')+\int_{\varepsilon_T^z}^{\varepsilon_{\max}^{H_f}} S_f^{o_z}(\varepsilon') dH_f(\varepsilon')\right\} \\
& -(1-\chi)\theta q(\theta)\left\{\beta_i \int_{\varepsilon_{\min}^G}^{\varepsilon_R^z} S_i^z(\varepsilon') dG(\varepsilon')+\hat{\beta}_f \int_{\varepsilon_R^z}^{\varepsilon_{\max}^G} S_f^{n_z}(\varepsilon') dG(\varepsilon')\right\} \\
& +\varphi\left[\int_{\varepsilon_{D_f}^b}^{\varepsilon_T^b} S_i^b(\varepsilon') dH_f(\varepsilon')+\int_{\varepsilon_T^b}^{\varepsilon_{\max}^{H_f}} S_f^{o_b}(\varepsilon') dH_f(\varepsilon')\right],
\end{aligned}
$$

and the wage is

$$
\begin{aligned}
w_f^{n_b}(\varepsilon) =\; & \frac{\beta_f}{1+\tau_g^f}\left\{p+\varepsilon-\tau_b^f-(r+\lambda_f+\varphi+\chi\theta q(\theta)) c-(\lambda_f+\varphi) F\right\} \\
& -\frac{1-\beta_f}{1+\tau_g^w}\left\{-\tau_b^w-b-z-(\lambda_f+\chi\theta q(\theta)+\rho)\left(U^b-U^z\right)\right\} \\
& \frac{1-\beta_f}{1+\tau_g^w}(1-\chi)\theta q(\theta)\left\{\beta_i \int_{\varepsilon_{\min}^G}^{\varepsilon_R^z} S_i^z(\varepsilon') dG(\varepsilon')+\hat{\beta}_f \int_{\varepsilon_R^z}^{\varepsilon_{\max}^G} S_f^{n_z}(\varepsilon') dG(\varepsilon')\right\} \\
& +\left[\frac{\beta_f(1-\beta_i)}{1+\tau_g^f}-\frac{(1-\beta_f)\beta_i}{1+\tau_g^w}\right]\left[\lambda_f \int_{\varepsilon_{D_f}^z}^{\varepsilon_T^z} S_i^z(\varepsilon') dH_f(\varepsilon')+\varphi \int_{\varepsilon_{D_f}^b}^{\varepsilon_T^b} S_i^b(\varepsilon') dH_f(\varepsilon')\right].
\end{aligned}
$$

Formal match with new worker who was not collecting unemployment benefits
The surplus is

$$
\begin{aligned}
(r+\lambda_f+\varphi+\chi\theta q(\theta))\, S_f^{n_z}(\varepsilon) \quad = \quad & p+\varepsilon-z-\left(\tau_g^f+\tau_g^w\right) w_f^{n_z}(\varepsilon)-\left(\tau_b^f+\tau_b^w\right)-(r+\lambda_f+\varphi+\chi\theta q(\theta))\, c \\
& -(\lambda_f+\varphi) F+\varphi\left(U^b-U^z\right) \\
& +\lambda_f\left\{\int_{\varepsilon_f^z}^{\varepsilon_T^z} S_i^z(\varepsilon')\, dH_f(\varepsilon')+\int_{\varepsilon_T^z}^{\varepsilon_{\max}^{H_f}} S_f^{o_z}(\varepsilon')\, dH_f(\varepsilon')\right\} \\
& -(1-\chi)\,\theta q(\theta)\left\{\beta_i \int_{\varepsilon_{\min}^G}^{\varepsilon_R^z} S_i^z(\varepsilon')\, dG(\varepsilon')+\hat{\beta}_f \int_{\varepsilon_R^z}^{\varepsilon_{\max}^G} S_f^{n_z}(\varepsilon')\, dG(\varepsilon')\right\} \\
& +\varphi\left[\int_{\varepsilon_{D_f}^b}^{\varepsilon_T^b} S_i^b(\varepsilon')\, dH_f(\varepsilon')+\int_{\varepsilon_T^b}^{\varepsilon_{\max}^{H_f}} S_f^{o_b}(\varepsilon')\, dH_f(\varepsilon')\right]
\end{aligned}
$$

and the wage paid to workers in such matches is

$$
\begin{aligned}
w_f^{n_z}(\varepsilon) \quad = \quad & \frac{\beta_f}{1+\tau_g^f}\left\{p+\varepsilon-\tau_b^f-(r+\lambda_f+\varphi+\chi\theta q(\theta))\, c-(\lambda_f+\varphi) F\right\}-\frac{1-\beta_f}{1+\tau_g^w}\left\{-\tau_b^w-z\right\} \\
& +\frac{1-\beta_f}{1+\tau_g^w}(1-\chi)\,\theta q(\theta)\left\{\beta_i \int_{\varepsilon_{\min}^G}^{\varepsilon_R^z} S_i^z(\varepsilon')\, dG(\varepsilon')+\hat{\beta}_f \int_{\varepsilon_R^z}^{\varepsilon_{\max}^G} S_f^{n_z}(\varepsilon')\, dG(\varepsilon')\right\} \\
& +\left[\frac{\beta_f(1-\beta_i)}{1+\tau_g^f}-\frac{(1-\beta_f)\,\beta_i}{1+\tau_g^w}\right]\left[\lambda_f \int_{\varepsilon_{D_f}^z}^{\varepsilon_T^z} S_i^z(\varepsilon')\, dH_f(\varepsilon')+\varphi \int_{\varepsilon_{D_f}^b}^{\varepsilon_T^b} S_i^b(\varepsilon')\, dH_f(\varepsilon')\right]
\end{aligned}
$$

Formal match with new worker who has qualified for collecting unemployment benefits
The value of the surplus is

$$
\begin{aligned}
(r+\lambda_f+\chi\theta q(\theta))\, S_f^{n_q}(\varepsilon) \quad = \quad & p+\varepsilon-b-z-\left(\tau_g^f+\tau_g^w\right) w_f^{n_q}(\varepsilon)-\left(\tau_b^f+\tau_b^w\right)-(r+\lambda_f+\chi\theta q(\theta))\, c \\
& -\lambda_f F+\rho\left(U^b-U^z\right) \\
& +\lambda_f\left\{\int_{\varepsilon_{D_f}^b}^{\varepsilon_T^b} S_i^b(\varepsilon')\, dH_f(\varepsilon')+\int_{\varepsilon_T^b}^{\varepsilon_{\max}^{H_f}} S_f^{o_b}(\varepsilon')\, dH_f(\varepsilon')\right\} \\
& +\chi\theta q(\theta)\left\{\beta_i \int_{\varepsilon_{\min}^G}^{\varepsilon_R^q} S_i^b(\varepsilon')\, dG(\varepsilon')+\hat{\beta}_f \int_{\varepsilon_R^q}^{\varepsilon_{\max}^{H_f}} S_f^{n_q}(\varepsilon')\, dG(\varepsilon')\right\} \\
& -\theta q(\theta)\left\{\beta_i \int_{\varepsilon_{\min}^G}^{\varepsilon_R^b} S_i^b(\varepsilon')\, dG(\varepsilon')+\hat{\beta}_f \int_{\varepsilon_R^b}^{\varepsilon_{\max}^{H_f}} S_f^{n_b}(\varepsilon')\, dG(\varepsilon')\right\},
\end{aligned}
$$

and the wage is

$$
\begin{aligned}
w_f^{n_q}(\varepsilon) &= \frac{\beta_f}{1+\tau_g^f}\left\{p+\varepsilon-\tau_b^f-\left(r+\lambda_f+\chi\theta q(\theta)\right)c-\lambda_f F\right\}-\frac{1-\beta_f}{1+\tau_g^w}\left\{-\tau_b^w-b-z-\rho\left(U^z-U^b\right)\right\} \\
&-\frac{1-\beta_f}{1+\tau_g^w}\chi\theta q(\theta)\left\{\beta_i\int_{\varepsilon_{\min}^G}^{\varepsilon_R^q}S_i^b(\varepsilon')\,dG(\varepsilon')+\hat{\beta}_f\int_{\varepsilon_R^q}^{\varepsilon_{\max}^{H_f}}S_f^{n_q}(\varepsilon')\,dG(\varepsilon')\right\} \\
&+\frac{1-\beta_f}{1+\tau_g^w}\theta q(\theta)\left\{\beta_i\int_{\varepsilon_{\min}^G}^{\varepsilon_R^b}S_i^b(\varepsilon')\,dG(\varepsilon')+\hat{\beta}_f\int_{\varepsilon_R^b}^{\varepsilon_{\max}^{H_f}}S_f^{n_b}(\varepsilon')\,dG(\varepsilon')\right\} \\
&+\lambda_f\left[\frac{\beta_f(1-\beta_i)}{1+\tau_g^f}-\frac{(1-\beta_f)\beta_i}{1+\tau_g^w}\right]\int_{\varepsilon_{D_f}^b}^{\varepsilon_T^b}S_i^b(\varepsilon')\,dH_f(\varepsilon')
\end{aligned}
$$

Formal match with on-going worker who has qualified for collecting unemployment benefits
The value of the surplus is

$$
\begin{aligned}
\left(r+\lambda_f+\chi\theta q(\theta)\right)S_f^{o_b}(\varepsilon) &= p+\varepsilon-b-z-\left(\tau_g^f+\tau_g^w\right)w_f^{o_b}(\varepsilon)-\left(\tau_b^f+\tau_b^w\right)+\left(r+\chi\theta q(\theta)\right)F+\rho\left(U^b-U^z\right) \\
&+\lambda_f\left\{\int_{\varepsilon_{D_f}^b}^{\varepsilon_T^b}S_i^b(\varepsilon')\,dH_f(\varepsilon')+\int_{\varepsilon_T^b}^{\varepsilon_{\max}^{H_f}}S_f^{o_b}(\varepsilon')\,dH_f(\varepsilon')\right\} \\
&+\chi\theta q(\theta)\left\{\beta_i\int_{\varepsilon_{\min}^G}^{\varepsilon_R^q}S_i^b(\varepsilon')\,dG(\varepsilon')+\hat{\beta}_f\int_{\varepsilon_R^q}^{\varepsilon_{\max}^{H_f}}S_f^{n_q}(\varepsilon')\,dG(\varepsilon')\right\} \\
&-\theta q(\theta)\left\{\beta_i\int_{\varepsilon_{\min}^G}^{\varepsilon_R^b}S_i^b(\varepsilon')\,dG(\varepsilon')+\hat{\beta}_f\int_{\varepsilon_R^b}^{\varepsilon_{\max}^{H_f}}S_f^{n_b}(\varepsilon')\,dG(\varepsilon')\right\},
\end{aligned}
$$

and the wage paid to the worker is

$$
\begin{aligned}
w_f^{o_b}(\varepsilon) &= \frac{\beta_f}{1+\tau_g^f}\left\{p+\varepsilon-\tau_b^f+\left(r+\chi\theta q(\theta)\right)F\right\}-\frac{1-\beta_f}{1+\tau_g^w}\left\{-\tau_b^w-b-z-\rho\left(U^z-U^b\right)\right\} \\
&-\frac{1-\beta_f}{1+\tau_g^w}\chi\theta q(\theta)\left\{\beta_i\int_{\varepsilon_{\min}^G}^{\varepsilon_R^q}S_i^b(\varepsilon')\,dG(\varepsilon')+\hat{\beta}_f\int_{\varepsilon_R^q}^{\varepsilon_{\max}^{H_f}}S_f^{n_q}(\varepsilon')\,dG(\varepsilon')\right\} \\
&+\frac{1-\beta_f}{1+\tau_g^w}\theta q(\theta)\left\{\beta_i\int_{\varepsilon_{\min}^G}^{\varepsilon_R^b}S_i^b(\varepsilon')\,dG(\varepsilon')+\hat{\beta}_f\int_{\varepsilon_R^b}^{\varepsilon_{\max}^{H_f}}S_f^{n_b}(\varepsilon')\,dG(\varepsilon')\right\} \\
&+\lambda_f\left[\frac{\beta_f(1-\beta_i)}{1+\tau_g^f}-\frac{(1-\beta_f)\beta_i}{1+\tau_g^w}\right]\int_{\varepsilon_{D_f}^b}^{\varepsilon_T^b}S_i^b(\varepsilon')\,dH_f(\varepsilon')
\end{aligned}
$$

Formal match with on-going worker who has not qualified for collecting unemployment benefits
The value of the surplus is

$$
\begin{aligned}
\left(r+\lambda_f+\varphi+\chi\theta q\left(\theta\right)\right) S_f^{o_z}\left(\varepsilon\right) &= p+\varepsilon-z-\left(\tau_g^f+\tau_g^w\right) w_f^{o_z}\left(\varepsilon\right)-\left(\tau_b^f+\tau_b^w\right)+\left(r+\chi\theta q\left(\theta\right)\right) F+\varphi\left(U^b-U^z\right) \\
&+\lambda_f\left\{\int_{\varepsilon_{D_f}^z}^{\varepsilon_T^z} S_i^z\left(\varepsilon'\right) dH_f\left(\varepsilon'\right)+\int_{\varepsilon_T^z}^{\varepsilon_{\max}^{H_f}} S_f^{o_z}\left(\varepsilon'\right) dH_f\left(\varepsilon'\right)\right\} \\
&-\left(1-\chi\right)\theta q(\theta)\left\{\beta_i\int_{\varepsilon_{\min}^G}^{\varepsilon_R^z} S_i^z\left(\varepsilon'\right) dG\left(\varepsilon'\right)+\hat{\beta}_f\int_{\varepsilon_R^z}^{\varepsilon_{\max}^G} S_f^{n_z}\left(\varepsilon'\right) dG\left(\varepsilon'\right)\right\} \\
&+\varphi\left[\int_{\varepsilon_{D_f}^b}^{\varepsilon_T^b} S_i^b\left(\varepsilon'\right) dH_f\left(\varepsilon'\right)+\int_{\varepsilon_T^b}^{\varepsilon_{\max}^{H_f}} S_f^{o_b}\left(\varepsilon'\right) dH_f\left(\varepsilon'\right)\right],
\end{aligned}
$$

and the wage that the worker is paid is

$$
\begin{aligned}
w_f^{o_z}\left(\varepsilon\right) &= \frac{\beta_f}{1+\tau_g^f}\left\{p+\varepsilon-\tau_b^f+\left(r+\chi\theta q\left(\theta\right)\right) F\right\}-\frac{1-\beta_f}{1+\tau_g^w}\left\{-\tau_b^w-z-\varphi\left(U^b-U^z\right)\right\} \\
&+\frac{1-\beta_f}{1+\tau_g^w}\left(1-\chi\right)\theta q(\theta)\left\{\beta_i\int_{\varepsilon_{\min}^G}^{\varepsilon_R^z} S_i^z\left(\varepsilon'\right) dG\left(\varepsilon'\right)+\hat{\beta}_f\int_{\varepsilon_R^z}^{\varepsilon_{\max}^G} S_f^{n_z}\left(\varepsilon'\right) dG\left(\varepsilon'\right)\right\} \\
&+\left[\frac{\beta_f\left(1-\beta_i\right)}{1+\tau_g^f}-\frac{\left(1-\beta_f\right)\beta_i}{1+\tau_g^w}\right]\left[\lambda_f\int_{\varepsilon_{D_f}^z}^{\varepsilon_T^z} S_i^z\left(\varepsilon'\right) dH_f\left(\varepsilon'\right)+\varphi\int_{\varepsilon_{D_f}^b}^{\varepsilon_T^b} S_i^b\left(\varepsilon'\right) dH_f\left(\varepsilon'\right)\right].
\end{aligned}
$$

Informal match with worker who collects unemployment benefits
The value of the surplus is

$$
\begin{aligned}
\left(r+\lambda_i+\chi\theta q\left(\theta\right)+\rho+\phi\right) S_i^b\left(\varepsilon\right) &= p+\varepsilon-z-\phi\sigma-\phi\left(U^b-U^z\right) \\
&+\lambda_i\left[\int_{\varepsilon_{D_i}^b}^{\varepsilon_R^b} S_i^b\left(\varepsilon'\right) dH_i\left(\varepsilon'\right)+\int_{\varepsilon_R^b}^{\varepsilon_{\max}^{H_i}} S_f^{n_b}\left(\varepsilon'\right) dH_i\left(\varepsilon'\right)\right] \\
&+\rho\left[\int_{\varepsilon_{D_i}^z}^{\varepsilon_R^z} S_i^z\left(\varepsilon'\right) dH_i\left(\varepsilon'\right)+\int_{\varepsilon_R^z}^{\varepsilon_{\max}^{H_i}} S_f^{n_z}\left(\varepsilon'\right) dH_i\left(\varepsilon'\right)\right] \\
&-\left(1-\chi\right)\theta q\left(\theta\right)\left[\beta_i\int_{\varepsilon_{\min}^G}^{\varepsilon_R^b} S_i^b\left(\varepsilon'\right) dG\left(\varepsilon'\right)+\hat{\beta}_f\int_{\varepsilon_R^b}^{\varepsilon_{\max}^G} S_f^{n_b}\left(\varepsilon'\right) dG\left(\varepsilon'\right)\right],
\end{aligned}
$$

and the wage is

$$
\begin{aligned}
w_i^b\left(\varepsilon\right) &= \beta_i\left\{p+\varepsilon-\phi\sigma\right\}+\left(1-\beta_i\right)\left\{b+z+\phi\left(U^b-U^z\right)\right\} \\
&+\left(1-\beta_i\right)\left(1-\chi\right)\theta q(\theta)\left\{\beta_i\int_{\varepsilon_{\min}^G}^{\varepsilon_R^b} S_i^b dG\left(\varepsilon'\right)+\hat{\beta}_f\int_{\varepsilon_R^b}^{\varepsilon_{\max}^G} S_f^{n_b} dG\left(\varepsilon'\right)\right\} \\
&+\lambda_i\left(\beta_i-\hat{\beta}_f\right)\int_{\varepsilon_R^b}^{\varepsilon_{\max}^{H_i}} S_f^{n_b}\left(\varepsilon'\right) dH_i\left(\varepsilon'\right)+\rho\left(\beta_i-\hat{\beta}_f\right)\int_{\varepsilon_R^z}^{\varepsilon_{\max}^{H_i}} S_f^{n_z}\left(\varepsilon'\right) dH_i\left(\varepsilon'\right).
\end{aligned}
$$

Informal match with worker who does not collect unemployment benefits
The value of the surplus is

$$
\begin{aligned}
\left(r+\lambda_i+\chi\theta q\left(\theta\right)+\phi\right)S_i^z\left(\varepsilon\right) &= p+\varepsilon-z-\phi\sigma \\
&+\lambda_i\left[\int_{\varepsilon_{D_i}^z}^{\varepsilon_R^z} S_i^z\left(\varepsilon'\right)dH_i\left(\varepsilon'\right)+\int_{\varepsilon_R^z}^{\varepsilon_{\max}^{H_i}} S_f^{n_z}\left(\varepsilon'\right)dH_i\left(\varepsilon'\right)\right] \\
&-\left(1-\chi\right)\theta q\left(\theta\right)\left[\beta_i\int_{\varepsilon_{\min}^G}^{\varepsilon_R^z} S_i^z\left(\varepsilon'\right)dG\left(\varepsilon'\right)+\hat{\beta}_f\int_{\varepsilon_R^z}^{\varepsilon_{\max}^G} S_f^{n_z}\left(\varepsilon'\right)dG\left(\varepsilon'\right)\right],
\end{aligned}
$$

and the wage for a worker in such match is

$$
\begin{aligned}
w_i^z\left(\varepsilon\right) &= \beta_i\left\{p+\varepsilon-\phi\sigma\right\}+\left(1-\beta_i\right)z \\
&+\left(1-\beta_i\right)\left(1-\chi\right)\theta q(\theta)\left\{\beta_i\int_{\varepsilon_{\min}^G}^{\varepsilon_R^z} S_i^z\left(\varepsilon'\right)dG\left(\varepsilon'\right)+\hat{\beta}_f\int_{\varepsilon_R^z}^{\varepsilon_{\max}^G} S_f^{n_z}\left(\varepsilon'\right)dG\left(\varepsilon'\right)\right\} \\
&+\lambda_i\left(\beta_i-\hat{\beta}_f\right)\int_{\varepsilon_R^z}^{\varepsilon_{\max}^{H_i}} S_f^{o_z}\left(\varepsilon'\right)dH_i\left(\varepsilon'\right).
\end{aligned}
$$

Thresholds

We now state the expressions for the 7 thresholds of the model, as well as the conditions that determine them

Destruction thresholds

1. We can find $\varepsilon_{D_i}^b$ using the condition $J_i^b\left(\varepsilon_{D_i}^b\right)=0$ or $S_i^b\left(\varepsilon_{D_i}^b\right)=0$. The expression for this threshold is:

$$
\begin{aligned}
0 &= p+\varepsilon_{D_i}^b-z-\phi\sigma-\phi\left(U^b-U^z\right)+\lambda_i\left[\int_{\varepsilon_{D_i}^b}^{\varepsilon_R^b} S_i^b\left(\varepsilon'\right)dH_i\left(\varepsilon'\right)+\int_{\varepsilon_R^b}^{\varepsilon_{\max}^{H_i}} S_f^{n_b}\left(\varepsilon'\right)dH_i\left(\varepsilon'\right)\right] \\
&+\rho\left[\int_{\varepsilon_{D_i}^z}^{\varepsilon_R^z} S_i^z\left(\varepsilon'\right)dH_i\left(\varepsilon'\right)+\int_{\varepsilon_R^z}^{\varepsilon_{\max}^{H_i}} S_f^{n_z}\left(\varepsilon'\right)dH_i\left(\varepsilon'\right)\right] \\
&-\left(1-\chi\right)\theta q\left(\theta\right)\left[\beta_i\int_{\varepsilon_{\min}^G}^{\varepsilon_R^b} S_i^b\left(\varepsilon'\right)dG\left(\varepsilon'\right)+\hat{\beta}_f\int_{\varepsilon_R^b}^{\varepsilon_{\max}^G} S_f^{n_b}\left(\varepsilon'\right)dG\left(\varepsilon'\right)\right]
\end{aligned}
$$

2. We can find $\varepsilon_{D_i}^z$ using the condition $J_i^z\left(\varepsilon_{D_i}^z\right)=0$ or $S_i^z\left(\varepsilon_{D_i}^z\right)=0$, which delivers the expression

$$
\begin{aligned}
0 &= p+\varepsilon_{D_i}^z-z-\phi\sigma+\lambda_i\left[\int_{\varepsilon_{D_i}^z}^{\varepsilon_R^z} S_i^z\left(\varepsilon'\right)dH_i\left(\varepsilon'\right)+\int_{\varepsilon_R^z}^{\varepsilon_{\max}^{H_i}} S_f^{n_z}\left(\varepsilon'\right)dH_i\left(\varepsilon'\right)\right] \\
&-\left(1-\chi\right)\theta q\left(\theta\right)\left[\beta_i\int_{\varepsilon_{\min}^G}^{\varepsilon_R^z} S_i^z\left(\varepsilon'\right)dG\left(\varepsilon'\right)+\hat{\beta}_f\int_{\varepsilon_R^z}^{\varepsilon_{\max}^G} S_f^{n_z}\left(\varepsilon'\right)dG\left(\varepsilon'\right)\right]
\end{aligned}
$$

3. We find $\varepsilon^b_{D_f}$ from the condition

$$\varepsilon^b_{D_f} = max\left\{\varepsilon^{o_b}_f, \varepsilon^b_{D_i}\right\},$$

where $\varepsilon^{o_b}_f$ is obtained using the condition that $J^{o_b}_f\left(\varepsilon^{o_b}_f\right) + F = 0$ or $S^{o_b}_f\left(\varepsilon^{o_b}_f\right) = 0$, and has the form

$$\begin{aligned} 0 = \; & p + \varepsilon^{o_b}_f - b - z - \left(\tau^f_g + \tau^w_g\right) w^{o_b}_f\left(\varepsilon^{o_b}_f\right) - \left(\tau^f_b + \tau^w_b\right) + \left(r + \chi\theta q\left(\theta\right)\right) F + \rho\left(U^b - U^z\right) \\ & + \lambda_f\left\{\int_{\varepsilon^b_{D_f}}^{\varepsilon^b_T} S^b_i\left(\varepsilon'\right) dH_f\left(\varepsilon'\right) + \int_{\varepsilon^b_T}^{\varepsilon^{H_f}_{\max}} S^{o_b}_f\left(\varepsilon'\right) dH_f\left(\varepsilon'\right)\right\} \\ & + \chi\theta q(\theta)\left\{\beta_i \int_{\varepsilon^G_{\min}}^{\varepsilon^q_R} S^b_i\left(\varepsilon'\right) dG\left(\varepsilon'\right) + \hat{\beta}_f \int_{\varepsilon^q_R}^{\varepsilon^{H_f}_{\max}} S^{n_q}_f\left(\varepsilon'\right) dG\left(\varepsilon'\right)\right\} \\ & - \theta q(\theta)\left\{\beta_i \int_{\varepsilon^G_{\min}}^{\varepsilon^b_R} S^b_i\left(\varepsilon'\right) dG\left(\varepsilon'\right) + \hat{\beta}_f \int_{\varepsilon^b_R}^{\varepsilon^{H_f}_{\max}} S^{n_b}_f\left(\varepsilon'\right) dG\left(\varepsilon'\right)\right\} \end{aligned}$$

4. We find $\varepsilon^z_{D_f}$ from the condition

$$\varepsilon^z_{D_f} = max\left\{\varepsilon^{o_z}_f, \varepsilon^z_{D_i}\right\},$$

where $\varepsilon^{o_z}_f$ is obtained using the condition that $J^{o_z}_f\left(\varepsilon^{o_z}_f\right) + F = 0$ or $S^{o_z}_f\left(\varepsilon^{o_z}_f\right) = 0$, and has the form

$$\begin{aligned} 0 = \; & p + \varepsilon^{o_z}_f - z - \left(\tau^f_g + \tau^w_g\right) w^{o_z}_f\left(\varepsilon^{o_z}_f\right) - \left(\tau^f_b + \tau^w_b\right) + \left(r + \chi\theta q\left(\theta\right)\right) F + \varphi\left(U^b - U^z\right) \\ & + \lambda_f\left\{\int_{\varepsilon^z_f}^{\varepsilon^z_T} S^z_i\left(\varepsilon'\right) dH_f\left(\varepsilon'\right) + \int_{\varepsilon^z_T}^{\varepsilon^{H_f}_{\max}} S^{o_z}_f\left(\varepsilon'\right) dH_f\left(\varepsilon'\right)\right\} \\ & - \left(1 - \chi\right)\theta q(\theta)\left\{\beta_i \int_{\varepsilon^G_{\min}}^{\varepsilon^z_R} S^z_i\left(\varepsilon'\right) dG\left(\varepsilon'\right) + \hat{\beta}_f \int_{\varepsilon^z_R}^{\varepsilon^G_{\max}} S^{n_z}_f\left(\varepsilon'\right) dG\left(\varepsilon'\right)\right\} \\ & + \varphi\left[\int_{\varepsilon^b_f}^{\varepsilon^b_T} S^b_i\left(\varepsilon'\right) dH_f\left(\varepsilon'\right) + \int_{\varepsilon^b_T}^{\varepsilon^{H_f}_{\max}} S^{o_b}_f\left(\varepsilon'\right) dH_f\left(\varepsilon'\right)\right] \end{aligned}$$

Formality-informality thresholds

1. We can obtain ε^b_R by using the condition $J^{n_b}_f\left(\varepsilon^b_R\right) - c = J^b_i\left(\varepsilon^b_R\right)$ or $\left(1 - \hat{\beta}_f\right) S^{n_b}_f\left(\varepsilon^b_R\right) = \left(1 - \beta_i\right) S^b_i\left(\varepsilon^b_R\right)$, and has the following form:

$$\left(1 - \hat{\beta}_f\right) \frac{1}{r + \lambda_f + \varphi + \chi\theta q\left(\theta\right)} \frac{1 - \beta_f\left(\tau^f_g + \tau^w_g\right)}{1 + \tau^f_g}\left(\varepsilon^b_R - \varepsilon^{n_b}_f\right) = \left(1 - \beta_i\right) \frac{1}{r + \lambda_i + \chi\theta q\left(\theta\right) + \phi}\left(\varepsilon^b_R - \varepsilon^b_{D_i}\right).$$

where $\varepsilon^{n_b}_f$ is found using the condition $J^{n_b}_f\left(\varepsilon^{n_b}_f\right) + F = 0$ or $S^{n_b}_f\left(\varepsilon^{n_b}_f\right) = 0$, and has the following form:

$$
\begin{aligned}
0 \;=\;& p+\varepsilon_f^{n_b}-b-z-\left(\tau_g^f+\tau_g^w\right)w_f^{n_b}\left(\varepsilon_f^{n_b}\right)-\left(\tau_b^f+\tau_b^w\right)-\left(r+\lambda_f+\varphi+\chi\theta q\left(\theta\right)\right)c \\
&-\left(\lambda_f+\varphi\right)F+\left(\lambda_f+\chi\theta q\left(\theta\right)+\rho\right)\left(U^b-U^z\right) \\
&+\lambda_f\left\{\int_{\varepsilon_f^z}^{\varepsilon_T^z}S_i^z\left(\varepsilon'\right)dH_f\left(\varepsilon'\right)+\int_{\varepsilon_T^z}^{\varepsilon_{\max}^{H_f}}S_f^{o_z}\left(\varepsilon'\right)dH_f\left(\varepsilon'\right)\right\} \\
&-\left(1-\chi\right)\theta q(\theta)\left\{\beta_i\int_{\varepsilon_{\min}^G}^{\varepsilon_R^z}S_i^z\left(\varepsilon'\right)dG\left(\varepsilon'\right)+\hat{\beta}_f\int_{\varepsilon_R^z}^{\varepsilon_{\max}^G}S_f^{n_z}\left(\varepsilon'\right)dG\left(\varepsilon'\right)\right\} \\
&+\varphi\left[\int_{\varepsilon_f^b}^{\varepsilon_T^b}S_i^b\left(\varepsilon'\right)dH_f\left(\varepsilon'\right)+\int_{\varepsilon_T^b}^{\varepsilon_{\max}^{H_f}}S_f^{o_b}\left(\varepsilon'\right)dH_f\left(\varepsilon'\right)\right].
\end{aligned}
$$

2. We can obtain ε_R^z by using the condition $J_f^{n_z}\left(\varepsilon_R^z\right)-c=J_i^z\left(\varepsilon_R^z\right)$ or $\left(1-\hat{\beta}_f\right)S_f^{n_z}\left(\varepsilon_R^z\right)=\left(1-\beta_i\right)S_i^z\left(\varepsilon_R^z\right)$, and has the following form:

$$
\left(1-\hat{\beta}_f\right)\frac{1}{r+\lambda_f+\varphi+\chi\theta q\left(\theta\right)}\frac{1-\beta_f\left(\tau_g^f+\tau_g^w\right)}{1+\tau_g^f}\left(\varepsilon_R^z-\varepsilon_f^{n_z}\right) \;=\; \left(1-\beta_i\right)\frac{1}{r+\lambda_i+\chi\theta q\left(\theta\right)+\phi}\left(\varepsilon_R^z-\varepsilon_{D_i}^z\right),
$$

where $\varepsilon_f^{n_z}$ is derived using the condition $J_f^{n_z}\left(\varepsilon_f^{n_z}\right)+F=0$ or $S_f^{n_z}\left(\varepsilon_f^{n_z}\right)=0$, and has the following form:

$$
\begin{aligned}
0 \;=\;& p+\varepsilon_f^{n_z}-z-\left(\tau_g^f+\tau_g^w\right)w_f^{n_z}\left(\varepsilon_f^{n_z}\right)-\left(\tau_b^f+\tau_b^w\right)-\left(r+\varphi+\lambda_f+\chi\theta q\left(\theta\right)\right)c-\left(\lambda_f+\varphi\right)F+\varphi\left(U^b-U^z\right) \\
&+\lambda_f\left\{\int_{\varepsilon_f^z}^{\varepsilon_T^z}S_i^z\left(\varepsilon'\right)dH_f\left(\varepsilon'\right)+\int_{\varepsilon_T^z}^{\varepsilon_{\max}^{H_f}}S_f^{o_z}\left(\varepsilon'\right)dH_f\left(\varepsilon'\right)\right\} \\
&-\left(1-\chi\right)\theta q(\theta)\left\{\beta_i\int_{\varepsilon_{\min}^G}^{\varepsilon_R^z}S_i^z\left(\varepsilon'\right)dG\left(\varepsilon'\right)+\hat{\beta}_f\int_{\varepsilon_R^z}^{\varepsilon_{\max}^G}S_f^{n_z}\left(\varepsilon'\right)dG\left(\varepsilon'\right)\right\} \\
&+\varphi\left[\int_{\varepsilon_f^b}^{\varepsilon_T^b}S_i^b\left(\varepsilon'\right)dH_f\left(\varepsilon'\right)+\int_{\varepsilon_T^b}^{\varepsilon_{\max}^{H_f}}S_f^{o_b}\left(\varepsilon'\right)dH_f\left(\varepsilon'\right)\right].
\end{aligned}
$$

3. We can find ε_R^q by using the condition $J_f^{n_q}\left(\varepsilon_R^q\right)-c=J_i^b\left(\varepsilon_R^q\right)$ or $\left(1-\hat{\beta}_f\right)S_f^{n_q}\left(\varepsilon_R^q\right)=\left(1-\beta_i\right)S_i^b\left(\varepsilon_R^q\right)$, and has the following form:

$$
\left(1-\hat{\beta}_f\right)\frac{1}{r+\lambda_f+\chi\theta q\left(\theta\right)}\frac{1-\beta_f\left(\tau_g^f+\tau_g^w\right)}{1+\tau_g^f}\left(\varepsilon_R^q-\varepsilon_f^{n_q}\right) \;=\; \left(1-\beta_i\right)\frac{1}{r+\lambda_i+\chi\theta q\left(\theta\right)+\phi}\left(\varepsilon_R^q-\varepsilon_{D_i}^b\right),
$$

where $\varepsilon_f^{n_q}$ is found using the condition $J_f^{n_q}\left(\varepsilon_f^{n_q}\right)+F=0$ or $S_f^{n_q}\left(\varepsilon_f^{n_q}\right)=0$, and has the following form:

$$
\begin{aligned}
0 \quad = \quad & p+\varepsilon_f^{n_q}-b-z-\left(\tau_g^f+\tau_g^w\right) w_f^{n_q}\left(\varepsilon_f^{n_q}\right)-\left(\tau_b^f+\tau_b^w\right)-\left(r+\lambda_f+\chi\theta q\left(\theta\right)\right) c-\lambda_f F+\rho\left(U^b-U^z\right) \\
& +\lambda_f\left\{\int_{\varepsilon_{D_f}^b}^{\varepsilon_T^b} S_i^b\left(\varepsilon'\right) dH_f\left(\varepsilon'\right)+\int_{\varepsilon_T^b}^{\varepsilon_{\max}^{H_f}} S_f^{o_b}\left(\varepsilon'\right) dH_f\left(\varepsilon'\right)\right\} \\
& +\chi\theta q(\theta)\left\{\beta_i \int_{\varepsilon_{\min}^G}^{\varepsilon_R^q} S_i^b\left(\varepsilon'\right) dG\left(\varepsilon'\right)+\hat{\beta}_f \int_{\varepsilon_R^q}^{\varepsilon_{\max}^{H_f}} S_f^{n_q}\left(\varepsilon'\right) dG\left(\varepsilon'\right)\right\} \\
& -\theta q(\theta)\left\{\beta_i \int_{\varepsilon_{\min}^G}^{\varepsilon_R^b} S_i^b\left(\varepsilon'\right) dG\left(\varepsilon'\right)+\hat{\beta}_f \int_{\varepsilon_R^b}^{\varepsilon_{\max}^{H_f}} S_f^{n_b}\left(\varepsilon'\right) dG\left(\varepsilon'\right)\right\}.
\end{aligned}
$$

4. We can derive ε_T^b by using the condition $J_f^{o_b}\left(\varepsilon_T^b\right)+F=J_i^b\left(\varepsilon_T^b\right)$ or $\left(1-\hat{\beta}_f\right) S_f^{o_b}\left(\varepsilon_T^b\right)=\left(1-\beta_i\right) S_i^b\left(\varepsilon_T^b\right)$, and has the following form:

$$
\left(1-\hat{\beta}_f\right) \frac{1}{r+\lambda_f+\chi\theta q\left(\theta\right)} \frac{1-\beta_f\left(\tau_g^f+\tau_g^w\right)}{1+\tau_g^f}\left(\varepsilon_T^b-\varepsilon_f^{o_b}\right) \quad = \quad \left(1-\beta_i\right) \frac{1}{r+\lambda_i+\chi\theta q\left(\theta\right)+\phi}\left(\varepsilon_T^b-\varepsilon_{D_i}^b\right)
$$

5. We can find ε_T^z by using the condition $J_f^{o_z}\left(\varepsilon_T^z\right)+F=J_i^z\left(\varepsilon_T^z\right)$ or $\left(1-\hat{\beta}_f\right) S_f^{o_z}\left(\varepsilon_T^z\right)=\left(1-\beta_i\right) S_i^z\left(\varepsilon_T^z\right)$, and has the following form:

$$
\left(1-\hat{\beta}_f\right) \frac{1}{r+\lambda_f+\varphi+\chi\theta q\left(\theta\right)} \frac{1-\beta_f\left(\tau_g^f+\tau_g^w\right)}{1+\tau_g^f}\left(\varepsilon_T^z-\varepsilon_f^{o_z}\right) \quad = \quad \left(1-\beta_i\right) \frac{1}{r+\lambda_i+\chi\theta q\left(\theta\right)+\phi}\left(\varepsilon_T^z-\varepsilon_{D_i}^z\right)
$$

Figure 1: Labor Force Structure and Possible States for Workers

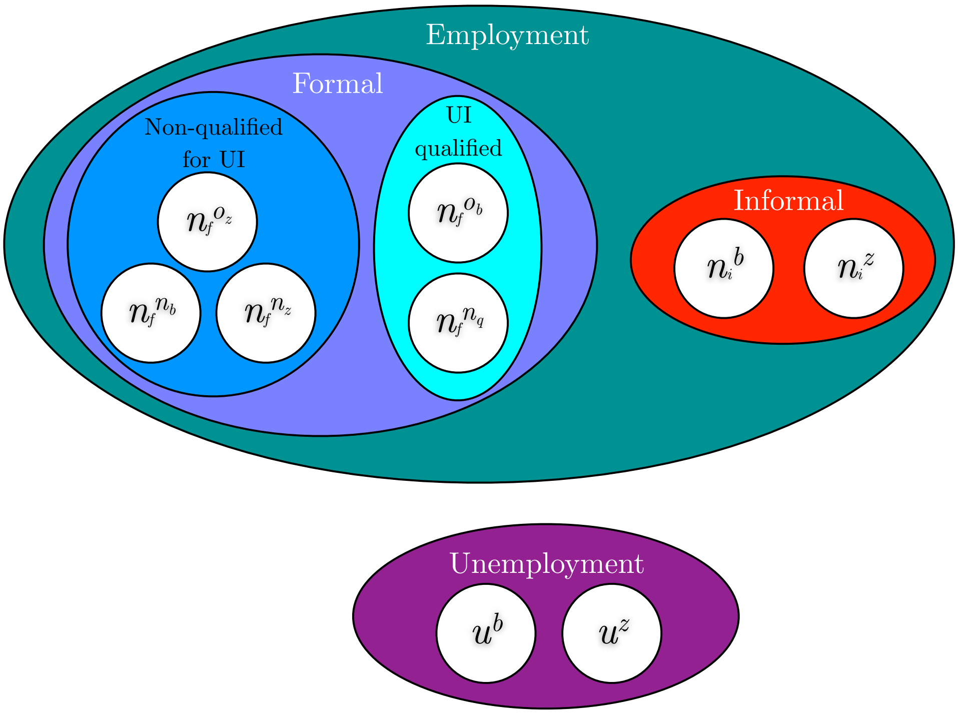
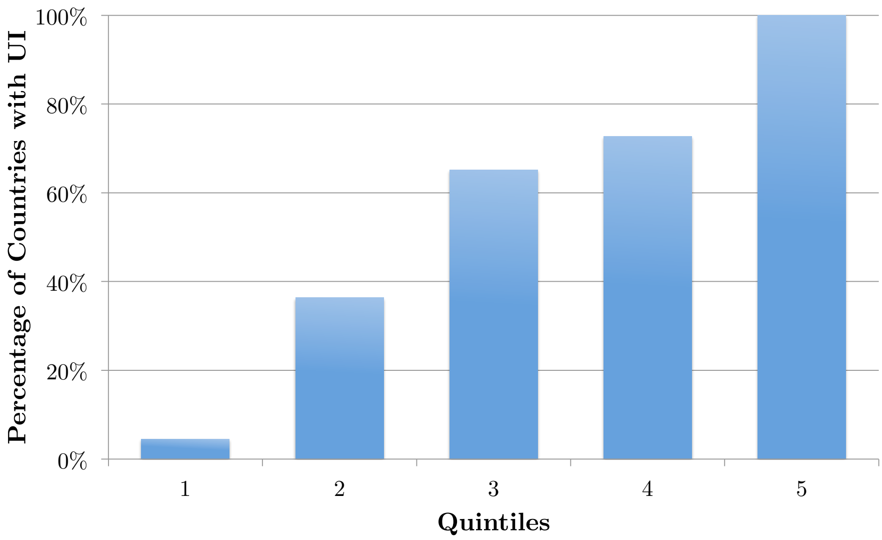


Figure 2: Unemployment Benefits Availability by GDP per Capita Quintiles



Notes: Fraction of countries that have some type of unemployment benefit system ordered by quintiles of GDP per capita. Source International labor Organization.

Table 1: Parameter Values

Exogenous Parameters		
Discount factor	r	0.005
Exponent in the matching function	ξ	0.5
Bargaining power of formal workers	β_f	0.54
Bargaining power of informal workers	β_i	0.46
Maximum of the distribution of G	ε_{max}^{G}	1
Maximum of the distribution of H_f	$\varepsilon_{max}^{H_f}$	1
Maximum of the distribution of H_i	$\varepsilon_{max}^{H_i}$	1
Arrival rate of informal monitoring shocks (being caught while informal)	ϕ	0.0017
Arrival rate of UB termination shocks	ρ	0.2
Arrival rate of UB qualification shocks	φ	0.08
General government tax	τ_g	0.32
SS value of agg productivity	p	1
Flow value of being unemployed (excluding UB)	z	0.5
Cost of opening a formal job	c	4/30
Endogenous Parameters		
Cost of posting a vacancy	k	0.42
Scaling parameter in the matching function	μ	0.15
Arrival rate of new productivity level for formal matches	λ_f	0.1
Arrival rate of new productivity level for informal matches	λ_i	0.3
Search efficiency while on the job	χ	0.2
Minimum of the distribution of G	ε_{min}^{G}	0.49
Minimum of the distribution of H_f	$\varepsilon_{min}^{H_f}$	-1.01
Minimum of the distribution of H_i	$\varepsilon_{min}^{H_i}$	-0.96
Penalty for being caught as informal firm	σ	84.36
Firing cost	F	4.02

Table 2: Steady State Equilibrium for Baseline Calibration

	No UB	With UB										
		Replac. Rate = 0.3			Replacement Rate = 0.5				Replacement Rate = 0.7			
	Baseline	τ_b 2.0%	τ_b 4.0%	τ_b 8.3%	τ_b 2.0%	τ_b 4.0%	τ_b 8.3%	τ_b 16.7%	τ_b 2.0%	τ_b 4.0%	τ_b 8.3%	τ_b 26.5%
Unemployment	4.0%	4.2%	4.0%	3.6%	4.7%	4.4%	3.8%	2.9%	5.3%	5.1%	4.5%	1.8%
Vacancies	0.23	0.24	0.24	0.23	25.8%	25.4%	24.6%	23.2%	28.1%	27.7%	26.8%	23.0%
Employment	96.0%	95.8%	96.0%	96.4%	95.3%	95.6%	96.2%	97.1%	94.7%	94.9%	95.5%	98.2%
Formality	57.3%	53.9%	51.5%	45.1%	58.8%	57.5%	54.3%	46.0%	60.6%	60.0%	58.7%	48.6%
U-F Flow Rate	7.0%	9.0%	8.4%	7.0%	12.2%	11.8%	10.8%	8.5%	13.3%	13.3%	13.1%	9.9%
U-I Flow Rate	8.4%	6.6%	7.2%	8.5%	3.9%	4.2%	5.1%	7.1%	3.3%	3.3%	3.3%	6.0%
F-U Flow Rate	0.5%	0.5%	0.5%	0.5%	0.6%	0.6%	0.5%	0.4%	0.7%	0.6%	0.6%	0.3%
I-U Flow Rate	0.8%	0.9%	0.8%	0.7%	1.1%	1.0%	0.8%	0.5%	1.4%	1.3%	1.1%	0.3%
F-I Flow Rate	4.4%	6.5%	6.8%	7.4%	6.5%	6.7%	7.2%	8.4%	6.6%	6.7%	7.0%	8.7%
I-F Flow Rate	4.9%	6.4%	6.1%	5.2%	8.0%	7.9%	7.4%	6.2%	9.2%	9.1%	9.0%	7.4%
$\tilde{w}_i/\tilde{w}_f$	83.1%	78.3%	78.7%	79.8%	83.4%	83.8%	84.9%	87.5%	94.3%	95.1%	96.8%	104.7%
New u UB qualified		32.9%	32.9%	32.1%	22.0%	22.0%	21.6%	18.9%	13.0%	12.7%	12.0%	3.3%
Workers collecting UB		28.4%	26.2%	21.1%	39.6%	38.0%	34.4%	26.4%	47.5%	46.8%	45.2%	33.2%
UB Rev/UB Exp		25.0%	50.0%	100.0%	13.0%	26.0%	52.5%	100.0%	8.3%	16.6%	33.9%	100.0%

Notes: The description of the variables in the tables are as follows: "Unemployment" is the aggregate unemployment rate; "Vacancies" in the number of vacancies posted by firms; "Employment" is the employment rate; "Formality" is the ratio of formal to informal employment; $\tilde{w}_i/\tilde{w}_f$ is the average wage in the informal sector relative to that in the formal sector; "New u UB qualified" is the fraction of workers entering unemployment who have qualified to collect UB; "Workers collecting UB" is the fraction of workers who collect UB out of the total number of unemployed and informal workers (who is the population of workers who could potentially collect UB); "UB Rev/UB Exp" is the ratio of UB collections relative to the total expenditures for the government in UB payments, and represents the rate of self-financing of the UB program. The replacement rate is the fraction of the average formal wage which is paid by the government as the unemployment benefit, b.

Table 3: Steady State Equilibrium with Lower Firing Costs

	No UB	No UB	With UB										
			Replac. Rate = 0.3			Replacement Rate = 0.5				Replacement Rate = 0.7			
	Baseline	F	τ_b	τ_b	τ_b	τ_b	τ_b	τ_b	τ_b	τ_b	τ_b	τ_b	τ_b
		3.61	2.0%	4.0%	8.3%	2.0%	4.0%	8.3%	16.7%	2.0%	4.0%	8.3%	26.5%
Unemployment	4.0%	4.1%	4.3%	4.1%	3.6%	4.9%	4.6%	4.0%	2.9%	5.5%	5.3%	4.8%	2.0%
Vacancies	23.2%	23.6%	24.7%	24.3%	23.6%	26.6%	26.2%	25.4%	23.8%	29.1%	28.7%	27.9%	24.0%
Employment	96.0%	95.9%	95.7%	95.9%	96.4%	95.1%	95.4%	96.0%	97.1%	94.5%	94.7%	95.2%	98.0%
Formality	57.3%	61.2%	56.4%	54.5%	50.0%	60.2%	59.5%	57.1%	51.4%	60.8%	60.4%	59.5%	54.5%
U-F Flow Rate	7.0%	8.4%	10.2%	9.7%	8.6%	13.1%	13.0%	12.2%	10.4%	13.5%	13.4%	13.3%	11.9%
U-I Flow Rate	8.4%	7.1%	5.5%	6.0%	7.1%	3.2%	3.2%	3.9%	5.5%	3.3%	3.3%	3.3%	4.3%
F-U Flow Rate	0.5%	0.5%	0.5%	0.5%	0.5%	0.6%	0.6%	0.5%	0.4%	0.7%	0.7%	0.6%	0.3%
I-U Flow Rate	0.8%	0.9%	0.9%	0.9%	0.7%	1.2%	1.1%	0.9%	0.5%	1.4%	1.3%	1.2%	0.3%
F-I Flow Rate	4.4%	4.6%	6.8%	7.0%	7.6%	6.8%	7.0%	7.4%	8.3%	7.2%	7.3%	7.5%	8.4%
I-F Flow Rate	4.9%	5.9%	7.1%	6.9%	6.2%	8.5%	8.4%	8.2%	7.4%	9.7%	9.7%	9.6%	8.8%
$\tilde{w}_i/\tilde{w}_f$	83.1%	80.4%	78.3%	78.7%	79.7%	84.6%	85.1%	86.2%	88.8%	95.8%	96.8%	98.9%	108.5%
New u UB qualified			29.9%	30.1%	29.9%	19.3%	19.4%	19.2%	17.6%	10.7%	10.3%	9.5%	1.8%
Workers collecting UB			32.4%	30.5%	26.3%	43.2%	42.3%	39.3%	32.9%	49.4%	48.9%	47.8%	41.9%
UB Rev/UB Exp			24.0%	48.2%	97.1%	12.5%	25.2%	51.2%	98.5%	8.0%	16.2%	33.0%	99.4%

Notes: Low firing costs implies a cut in these costs by half, from $F = 4.02$ in the baseline calibration to $F = 3.61$. All other parameters remain the same. The description of the variables in the tables are as follows: "Unemployment" is the aggregate unemployment rate; "Vacancies" in the number of vacancies posted by firms; "Employment" is the employment rate; "Formality" is the ratio of formal to informal employment; $\tilde{w}_i/\tilde{w}_f$ is the average wage in the informal sector relative to that in the formal sector; "New u UB qualified" is the fraction of workers entering unemployment who have qualified to collect UB; "Workers collecting UB" is the fraction of workers who collect UB out of the total number of unemployed and informal workers (who are the population of workers who could potentially collect UB); "UB Rev/UB Exp" is the ratio of UB collections relative to the total expenditures for the government in UB payments, and represents the rate of self-financing of the UB program. The replacement rate is the fraction of the average formal wage which is paid by the government as the unemployment benefit, b.

Table 4: Steady State Equilibrium with Lower General Taxes

	No UB	No UB	With UB										
			Replac. Rate = 0.3			Replacement Rate = 0.5				Replacement Rate = 0.7			
	Baseline	τ_g	τ_b	τ_b	τ_b	τ_b	τ_b	τ_b	τ_b	τ_b	τ_b	τ_b	τ_b
		28.8%	2.0%	4.0%	8.3%	2.0%	4.0%	8.3%	16.7%	2.0%	4.0%	8.3%	26.5%
Unemployment	4.0%	4.3%	4.5%	4.3%	3.9%	5.1%	4.8%	4.3%	3.2%	5.7%	5.5%	5.0%	2.2%
Vacancies	0.23	0.24	0.25	0.24	0.24	0.26	0.26	0.25	0.24	0.29	0.28	0.27	0.24
Employment	96.0%	95.7%	95.5%	95.7%	96.1%	94.9%	95.2%	95.7%	96.8%	94.3%	94.5%	95.0%	97.8%
Formality	57.3%	66.0%	57.2%	55.2%	50.1%	60.8%	59.5%	56.7%	49.6%	61.4%	60.9%	59.7%	51.3%
U-F Flow Rate	7.0%	8.7%	9.9%	9.3%	8.1%	12.8%	12.4%	11.5%	9.5%	13.4%	13.3%	13.2%	10.9%
U-I Flow Rate	8.4%	6.8%	5.8%	6.3%	7.5%	3.3%	3.7%	4.5%	6.3%	3.3%	3.3%	3.3%	5.1%
F-U Flow Rate	0.5%	0.6%	0.5%	0.5%	0.5%	0.6%	0.6%	0.5%	0.4%	0.7%	0.7%	0.6%	0.3%
I-U Flow Rate	0.8%	1.0%	1.0%	0.9%	0.8%	1.2%	1.1%	0.9%	0.6%	1.5%	1.4%	1.2%	0.4%
F-I Flow Rate	4.4%	3.7%	6.1%	6.4%	6.9%	6.2%	6.4%	6.9%	7.9%	6.5%	6.6%	6.8%	8.2%
I-F Flow Rate	4.9%	6.1%	6.9%	6.6%	5.9%	8.2%	8.1%	7.8%	6.8%	9.3%	9.3%	9.1%	7.9%
$\tilde{w}_i/\tilde{w}_f$	83.1%	81.1%	77.7%	78.1%	79.0%	82.8%	83.2%	84.1%	86.4%	93.0%	93.8%	95.5%	103.2%
New u UB qualified			32.5%	32.8%	32.8%	21.9%	22.0%	21.9%	20.4%	13.3%	13.1%	12.6%	6.2%
Workers collecting UB			31.5%	29.5%	25.0%	42.2%	40.6%	37.1%	29.7%	48.6%	47.9%	46.4%	36.2%
UB Rev/UB Exp			25.5%	51.0%	102.6%	13.1%	26.4%	53.4%	102.2%	8.4%	16.8%	34.3%	101.8%

Notes: Low τ_g implies a cut in the general government tax rate from $\tau_g = 32\%$ in the baseline calibration to $\tau_g = 28.8\%$. All other parameters remain the same. The description of the variables in the tables are as follows: "Unemployment" is the aggregate unemployment rate; "Vacancies" in the number of vacancies posted by firms; "Employment" is the employment rate; "Formality" is the ratio of formal to informal employment; $\tilde{w}_i/\tilde{w}_f$ is the average wage in the informal sector relative to that in the formal sector; "New u UB qualified" is the fraction of workers entering unemployment who have qualified to collect UB; "Workers collecting UB" is the fraction of workers who collect UB out of the total number of unemployed and informal workers (who are the population of workers who could potentially collect UB); "UB Rev/UB Exp" is the ratio of UB collections relative to the total expenditures for the government in UB payments, and represents the rate of self-financing of the UB program. The replacement rate is the fraction of the average formal wage which is paid by the government as the unemployment benefit, b.

Table 5: Steady State Equilibrium with Higher Monitoring

	No UB	No UB	With UB										
			Replac. Rate = 0.3			Replacement Rate = 0.5				Replacement Rate = 0.7			
	Baseline	ϕ	τ_b	τ_b	τ_b	τ_b	τ_b	τ_b	τ_b	τ_b	τ_b	τ_b	τ_b
		0.0018	2.0%	4.0%	8.3%	2.0%	4.0%	8.3%	16.7%	2.0%	4.0%	8.3%	26.5%
Unemployment	4.0%	5.6%	5.9%	5.7%	5.5%	6.2%	6.0%	5.6%	4.9%	6.7%	6.5%	6.1%	3.8%
Vacancies	0.03	0.03	0.04	0.04	0.04	0.06	0.06	0.06	0.05	0.07	0.07	0.07	0.07
Employment	96.0%	94.4%	94.1%	94.3%	94.5%	93.8%	94.0%	94.4%	95.1%	93.3%	93.5%	93.9%	96.2%
Formality	57.3%	66.4%	57.6%	55.6%	50.5%	61.3%	60.1%	57.4%	50.6%	61.6%	61.1%	60.0%	53.0%
U-F Flow Rate	7.0%	8.5%	9.8%	9.3%	8.1%	12.8%	12.4%	11.6%	9.8%	13.2%	13.1%	13.0%	11.8%
U-I Flow Rate	8.4%	6.8%	5.7%	6.1%	7.2%	3.1%	3.4%	4.1%	5.8%	3.3%	3.3%	3.2%	4.0%
F-U Flow Rate	0.5%	0.7%	0.7%	0.7%	0.6%	0.7%	0.7%	0.7%	0.6%	0.8%	0.8%	0.7%	0.5%
I-U Flow Rate	0.8%	1.4%	1.4%	1.3%	1.2%	1.6%	1.5%	1.3%	1.0%	1.8%	1.7%	1.6%	0.8%
F-I Flow Rate	4.4%	3.5%	5.8%	6.1%	6.6%	5.9%	6.1%	6.5%	7.5%	6.2%	6.3%	6.5%	7.6%
I-F Flow Rate	4.9%	6.0%	6.9%	6.6%	5.9%	8.2%	8.1%	7.8%	6.9%	9.4%	9.3%	9.2%	8.1%
$\tilde{w}_i/\tilde{w}_f$	83.1%	83.0%	79.0%	79.3%	80.3%	84.5%	84.9%	85.8%	88.3%	95.3%	96.1%	98.1%	106.6%
New u UB qualified	17.4%	62.8%	34.3%	34.2%	33.4%	23.2%	23.1%	22.6%	19.9%	13.9%	13.5%	12.7%	5.4%
Workers collecting UB			32.0%	30.0%	25.3%	43.0%	41.5%	38.1%	30.8%	49.0%	48.4%	47.2%	38.6%
UB Rev/UB Exp			25.6%	51.2%	102.8%	13.2%	26.4%	53.5%	102.2%	8.3%	16.8%	34.2%	102.0%

Notes: In this experiment we increase by 5% the monitoring rate ϕ compared to the baseline case. The new value of ϕ is 0.0018. All other parameters remain the same. The description of the variables in the tables are as follows: "Unemployment" is the aggregate unemployment rate; "Vacancies" in the number of vacancies posted by firms; "Employment" is the employment rate; "Formality" is the ratio of formal to informal employment; $\tilde{w}_i/\tilde{w}_f$ is the average wage in the informal sector relative to that in the formal sector; "New u UB qualified" is the fraction of workers entering unemployment who have qualified to collect UB; "Workers collecting UB" is the fraction of workers who collect UB out of the total number of unemployed and informal workers (who is the population of workers who could potentially collect UB); "UB Rev/UB Exp" is the ratio of UB collections relative to the total expenditures for the government in UB payments, and represents the rate of self-financing of the UB program. The replacement rate is the fraction of the average formal wage which is paid by the government as the unemployment benefit, b.