Labor Market Policies in a Dual Economy

Julen Esteban-Pretel*and Sagiri Kitao†

June 19, 2013

Abstract

A structural model of unemployment is built to explain the labor mobility between informal and formal sectors and to quantify the effects of labor market policies on employment, precautionary and life-cycle savings and welfare. The model is calibrated to labor market dynamics in Mexico, where almost half of the workforce is in the informal sector. An introduction of unemployment insurance has a negligible impact on unemployment but induces a sectoral reallocation of formal labor into informality. Generous severance payments from employers lowers the wage of formal jobs and reduces flows from unemployment to formality as well as those from formality to unemployment, leaving the formal share almost unchanged. Shifting the tax burden from labor income onto consumption has a significant effect on the share of formal workers of the economy, raising wealth and improving welfare.

Keywords: Unemployment insurance, severance payment, informal sector, dual economy.

J.E.L. classification codes: E6, J2, J6, O17.

*National Graduate Institute for Policy Studies, Email: julen.esteban@gmail.com.

†Hunter College, City University of New York, Email: sagiri.kitao@gmail.com.

1 Introduction

The size of the shadow economy as a fraction of GDP in many countries of the world is very large, especially in developing regions.[1] For the world as a whole, Schneider, et al. (2010) estimate that the average size of the underground economy is 33%. Regions such as Latin America and Sub-Saharan Africa see over 40% of their economic activities take place informally, and in some countries up to 66% of the economy is underground. Even OECD countries count with over 17% of output being produced informality.[2]

The distinction between formality and informality is important since these two parts of the economy differ in many key aspects. The informal sector is characterized by the lack of compliance with government regulations, which leads firms and workers in this sector to evade taxation, but also forces individuals out of government-provided social insurance. At the same time, workers in the underground economy face higher labor mobility [3] and associated earnings volatilities. Non-observance of regulations by the underground sector also implies that policies designed and implemented by the government may not always achieve the desired goal, since in many cases they fail to reach the large hidden fraction of the economy.

Mexico is a prime example of the issues described above, with a history of attempts to curve informality. Schneider, et al. (2010) estimate that around 30% percent of Mexican output is produced informally and we estimate that 43% percent of the working population is employed in the underground sector, using data of the Mexican Statistics and Geography National Institute (INEGI).[4] Workers in the Mexican shadow economy face not only lower wages, but also higher risks of job loss and no protection from exogenous dismissals. The government of Mexico has implemented many labor market policies over the last decade, but the large size of the informal market has remained high. One important debate taking place now is the implementation of an unemployment insurance system, which is mostly non-existent at present, and how it will affect the labor market. Analyzing the effects of such labor market policy reforms faces many challenges, not the least of which is the fact that a large fraction of the workers are employed in the underground economy.

Most of the studies in the vast literature analyzing labor market policies do not distinguish between formal and informal sectors that coexist in the economy. At the same time, those papers that do analyze policies within a multi-sector framework often abstract from key features of micro-founded macroeconomic models such as risk aversion and precautionary savings, which may be critical in quantifying the

[1] Schneider, et al. (2010) estimate the size of the shadow economy for 162 countries in the world from 1999 to 2007. They define the underground economy as including all market-based legal production of goods and services that are deliberately hidden from public authorities to avoid compliance with regulations or the payment taxes or social security contributions.

[2] See Schneider, Buhen and Montenegro (2010) for details on the estimation of these numbers.

[3] See Bosch and Maloney (2008) for an empirical analysis of worker flows in Brazil and Mexico.

[4] The average over 2000-2010. See section 3 for detailed description of the data and the statistics we computed from the INEGI database.

effects of social insurance policies.

The goal and contribution of this paper is two-fold. First, we build a model that captures the main characteristics of modern structural macroeconomic models, but in the context of a dual sector economy. Second, we use the model to simulate alternative labor market and fiscal policies that are receiving a lot of attention and are under discussion in developing countries, such as Mexico, in order to understand their impact on unemployment, job flows and welfare.

The paper builds a structural life-cycle model with one-sided search, extended to a dual sector economy. Individuals are heterogeneous in the stage of life-cycle, human capital, wealth and idiosyncratic labor productivity. They face uncertainty in employment and productivity, as well as the mortality risks. The market is incomplete and risk-averse individuals are allowed to engage in precautionary savings of riskless assets to smooth consumption. We calibrate the parameters of the model to match key labor market features of the Mexican economy. We then use the model to analyze three policies: labor income versus consumption taxes; introduction of unemployment insurance; changes in severance payments.

The analysis of labor market policies is incomplete without taking into account the cost of such policies and how the government finances additional expenditures. In order to understand the role played by different taxes before we simulate labor market policies in the model, we first study the consequences of financing the current state of the economy via labor income versus consumption taxes, two of the major sources of revenues besides oil in Mexico (OECD, 2011). We confirm that consumption taxes are less distortionary than labor income taxes. The change, however, on employment due to higher labor taxes turns out to be surprisingly small. What occurs in our dual sector economy is a significant sectoral reallocation, in which workers move from formal jobs to informal jobs that remain free of taxes. Such a shift involves a decline in productivity and earnings, imposing a sizeable welfare loss on individuals.

We then introduce an unemployment insurance system in our model and quantify the impact on the labor market. We allow formal workers who get laid off to collect benefits up to a maximum period of time. Given the lack of monitoring of economic activities in the informal sectors, we assume that both unemployed and informal workers are able to collect benefits. We find that the introduction of the system produces an increase in unemployment, although the magnitudes of the changes are small because workers qualify for benefits only through layoffs that occur with small probabilities and the benefits will expire eventually. The hazard rates into formality do change as benefits become more generous, and there is in fact a large difference in the hazard to formality before and after the expiration of benefits since workers become pickier when they are collecting benefits. Their reservation wage to accept a formal job rises since they have more to lose by leaving unemployment or informality while they are still collecting benefits.

The third policy that we analyze is the change in severance payments. We find that increasing the severance payment to provide higher protection to formal employ-

ees does reduce the risk of lay-off of such worker, but also depresses the equilibrium wages in the formal sector. These opposing effects leave the unemployment rate and the share of formality almost unchanged. The hazard rates, both into formality and informality, decrease as the level of severance payment is increased, due to the wealth effect through larger transfers and a rise in precautionary savings.

Our paper contributes to two strands of literature. First, it builds on numerous papers that study labor market policies in a structural model, in which individuals make optimal decisions of consumption and labor supply in an incomplete market. We employ a search-island framework of Lucas and Prescott (1974) as adopted by Alvarez and Verazierto (2001) and more recently by Kitao, Ljungqvist and Sargent (2008). These papers, however, focus on a single sector of the economy and the framework is not suitable to study policies in an economy like Mexico, where more than one half of workers reside in the informal sector.

Second, it connects to studies about shadow economies, and in particular with those that analyze labor market policies within a framework with equilibrium unemployment. Some examples in this literature are Kugler (1999), Fugazza and Jaques (2004), Boeri and Garibaldi (2006), Antunes and Cavalcanti (2007), Zenou (2008), Albrecht, et al. (2009), Bosch and Esteban-Pretel (2012) and Margolis, et al. (2012). While these papers all incorporate informality and study the effects of introducing different policies in the labor market, they do so without allowing for asset accumulation, missing some important channels through which government policies affect the behavior of agents. To overcome these shortcomings we incorporate precautionary savings and wealth distribution which emerge as a response of heterogeneous agents to uninsurable shocks, in the tradition of incomplete market models of Bewley (1984), Huggett (1993) and Aiyagari (1994).

The remainder of the paper is organized as follows. Section 2 presents the model; Section 3 describes the data and the calibration of the model parameters; Section 4 displays the results of the different policy experiments; and Section 5 summarizes and presents the main conclusions of the paper.

2 Model

2.1 Environment

In each period there is a continuum of individuals born with stochastic life-spans. Each individual passes through two stages of life-cycle, working-age and retirement phases. A working-age individual faces probability ρ of transitioning to the retirement age. All individuals are subject to mortality risks every period. δ_w and δ_r denote the death probability in each period for working-age and retired individuals, respectively.

There are two sectors of production in the economy; formal and informal sectors. An unemployed individual finds a job offer with probability π_s^U in sector s, which he chooses to accept or reject. An employed individual in sector s faces probability

q_s every period that employment is terminated by an employer and becomes unemployed. With probability π_s^E, individuals employed in sector s will receive a job offer from the other sector, which they decide to accept or reject. Conditional on no exogenous separation, all employed individuals have an option to quit the job and become unemployed or remain employed in the current sector. When a job is terminated exogenously, the worker receives severance payment g_s from the firm in sector s that laid off the worker.

Earnings of an employed individual are determined by three components; human capital h, idiosyncratic labor productivity ε, and sector-specific market wage per efficiency unit w_s. Human capital grows at an average rate of γ_h while employed and depreciates at δ_h while unemployed. The evolution of the human capital is expressed by transition matrices $H^E(h, h')$ and $H^U(h, h')$ for employed and unemployed individuals, respectively, which denote the probability of human capital h' in the next period conditional on the current human capital of h.

An individual in sector s draws a new idiosyncratic labor productivity ε' with probability $\Lambda_s(\varepsilon, \varepsilon')$ conditional on current productivity ε. When an individual is newly matched with a job in sector s, he will draw an idiosyncratic productivity ε from the stationary distribution of the productivity in each sector implied by the Markov transition matrices.

2.2 Preferences

Individuals derive utility $u(c)$ from consumption c and incur disutility B from working. Future utility is discounted at rate β.

2.3 Production

A firm in sector $s \in \{1, 2\}$ creates a job at time t incurring a startup cost μ_s to produce output at time $t+1$ with productivity level $z = z_s^0$. The firm's productivity then follows a Markov process, $Z_s(z, z')$. More precisely, we assume that in each period, firms draw a new productivity with probability p_s^z from a uniform distribution with a support of $[0, \overline{z}_s]$ and calibrate the transition matrices accordingly.

The firm's production function is given as

$$F_s(z, k, n) = zk^{\alpha}n^{1-\alpha}, \qquad \text{with} \alpha \in (0, 1). \tag{1}$$

where z_t is the current job-specific productivity level, k_t is physical capital that depreciates at the rate δ_k and n_t is efficiency units of labor supplied by the worker filling the job.

The matching mechanism is based on the framework of Lucas and Prescott (1974), Alvarez and Veracierto (2001) and Kitao, Ljungqvist and Sargent (2008), extended to our multiple-sector economy. We assume that firms and workers are randomly matched in the centralized labor market. The market wage is competitively determined in each sector and a firm makes a payment to each worker which is

the market wage times the efficiency units of the worker filling the job in the current period. In a new period, all surviving and new firms are randomly matched with old and new workers of each sector.

The timing of events is as follows. At the beginning of each period, firms observe the new productivity level z and decide whether to continue production or terminate jobs. At this point the firm does not know the identity of the worker who will fill a particular job in the current period. Therefore, all firms have the same reservation productivity level $\overline{z}$, below which jobs are terminated. Firms terminating a job will incur a layoff cost g_s, which is paid to the laid off worker as a severance payment. As a result of job destructions initiated by firms, a fraction q_s of existing jobs in sector s are terminated, which for workers is the likelihood that their employment is terminated exogenously. Conditional on no exogenous separations, workers may receive a job offer from the other sector, in which case they will decide whether to accept the offer and move to the other sector, remain in the current sector or quit the job and become unemployed. If a worker receives no job offer from the other sector, the choice is between staying in the current sector and quitting. All remaining jobs in each sector are randomly matched with workers in the centralized labor market, which include all existing and surviving workers and new entrants to the labor market. Firms observe the matched worker's efficiency units and choose the amount of capital to rent in the competitive market to maximize the profit. Workers are paid the market wage w_s per efficiency unit and the wage rate is determined such that newly created jobs break even and make no profit in expectation. The market wage adjusts to ensure that all workers in the centralized labor markets are matched to a job.

2.4 Government

The government imposes tax on consumption at rate τ_c and on labor income in sector s at rate $\tau_{l,s}$.

In the benchmark model, there is no unemployment insurance.

2.5 Individuals' problem

The state vector of an employed individual is given as $x_E = \{a, h, s, \varepsilon\}$, where a denotes assets from the previous period, h the level of human capital, $s \in \{1, 2\}$ the sector in which the individual works and ε idiosyncratic productivity in the current sector. The state vector of an unemployed individual is $x_U = \{a, h\}$. A retiree's state consists of assets only, $x_R = \{a\}$.

We let β_w and β_r denote discount factors inclusive of the survival probabilities, i.e. $\beta_w = \beta(1 - \delta_w)$ and $\beta_r = \beta(1 - \delta_r)$.

Employed

$$\begin{aligned} V(a,h,s,\varepsilon) &= \max_{c,a'} \{u(c) - B_s + \beta_w(1-\rho)\left[q_s EU(a',h')\right. \quad (2)\\ &\quad +(1-q_s)\pi_s^E E\max\{V(a',h',s,\varepsilon'),V(a',h',\tilde{s},\tilde{\varepsilon}'),U(a',h')\}\\ &\quad \left.+(1-q_s)(1-\pi_s^E)E\max\{V(a',h',s,\varepsilon'),U(a',h')\}\right]\\ &\quad +\beta_w\rho R(a')\} \quad (3) \end{aligned}$$

subject to

$$a' + c = (1-\tau_s)\varepsilon h w_s + (1+r)a + g_s \quad (4)$$

Note that the severance payment g_s is positive only if the worker is laid off by a firm.

Unemployed

$$\begin{aligned} U(a,h) &= \max_{c,a'} \{u(c) + \beta_w(1-\rho)\left[\right. \quad (5)\\ &\quad +\pi_1^U\pi_2^U E\max\{V(a',h',s_1,\varepsilon_1),V(a',h',s_2,\varepsilon_2),U(a',h')\}\\ &\quad +\sum_{i=1}^{2}\pi_i^U E\max\{V(a',h',s_i,\varepsilon_i),U(a',h')\}\\ &\quad \left.+(1-\pi_1^U)(1-\pi_2^U)EU(a',h')\right]\\ &\quad +\beta_w\rho R(a')\} \quad (6) \end{aligned}$$

subject to

$$a' + c = (1+r)a \quad (7)$$

Retirees

$$R(a) = \max_{c,a'} \{u(c) + \beta_r R(a')\} \quad (8)$$

subject to

$$a' + c = (1+r)a \quad (9)$$

2.6 Firms' problem

A firm with productivity z matched with a worker with efficiency units n will optimally choose the level of capital k used in production. The value function of an existing firm in sector s with the productivity level of z is

$$\begin{aligned} J_s(n,z) &= \max_k \left\{zk^{\alpha_s}n^{1-\alpha_s} - w_s n - (r+\delta_k)k\right\}\\ &\quad +\frac{1}{1+r}\sum_{z'} Z_s(z,z')\tilde{J}_s(z'). \quad (10)\\ \tilde{J}_s(z) &= \max\{E_n\left[J_s(n,z)\right], -g_s\}, \quad (11) \end{aligned}$$

Associated with the solution to an existing firm's optimization problem is a reservation productivity $\bar{z}_s$ that satisfies

$$E_n \left[J_s(n, \bar{z}_s) \right] = g_s. \tag{12}$$

The break-even condition for starting a new firm is

$$\mu_s = \frac{1}{1+r} E_n \left[J_s(n, z_s^0) \right]. \tag{13}$$

In a stationary equilibrium, firms that shut down the operations are replaced by the entry of new firms, which possess the initial productivity level of z_s^0.

2.7 Stationary equilibrium

Individual states are $x_E = \{a, h, s, \varepsilon\}$, $x_U = \{a, h\}$ and $x_R = \{a\}$ for employed individuals, unemployed and retirees, respectively. Let the state space of three types of individuals be denoted as $\mathbb{X}^E$, $\mathbb{X}^U$ and $\mathbb{X}^D$, and the entire state space of all individuals as $\mathbb{X}$ with $X \in \mathbb{X}$ being the general state vector of an individual including the employment and retirement state $N \in \{E, U, R\}$.

The equilibrium is given by allocation functions of individuals in each state; labor income and consumption tax rates; layoff cost; a set of value functions $\{V(x_E)\}_{x_E \in \mathbb{X}^E}$, $\{U(x_U)\}_{x_U \in \mathbb{X}^U}$ and $\{R(x_R)\}_{x_R \in \mathbb{X}^R}$; and distribution of individuals over the state space given by $m(X)$, such that (1) individuals solve the problem described in section 2.5, (2) firms solve the problem described in section 2.6.

3 Calibration

This section presents the parametrization of the model. As we discuss more in details below, we use different micro databases to calibrate parameters related to the labor market and asset holdings and various macroeconomic and fiscal data to calibrate other parameters. Micro data used in the paper, which runs from 2000 to 2010, is obtained from the Mexican Statistics and Geography National Institute (INEGI). Employment related data, such as unemployment rate, worker flows and wages is obtained from the National Urban Employment Survey (ENEU) and its revised version, the National Employment and Occupational Survey (ENOE). Data on assets is drawn from the National Household Income and Expenditures Survey (ENIGH). Data on inflation and interest rates is taken from the website of the Bank of Mexico.[5]The annual interest rate is set at 4%, the difference between the short-term nominal government funding rate as reported by the Bank of Mexico and the CPI inflation rate.[6] The frequency of the model is quarterly. Calibrated parameters of the model are summarized in Tables 2, 3 and 4.

[5]http://www.banxico.org.mx

[6]More precisely, it is computed as the average real interest rate on one-year government bonds in 2000-2010.

3.1 Demographics

We set the probability of retirement $\rho = 1/45$ on an annual basis, so that individuals remain in the labor force for 45 years on average, close to the average years of employment among individuals in the ENEU/ENOE data. The death probabilities are $\delta_w = 0.0050$ and $\delta_r = 0.061$ on an annual basis for working-age individuals and retirees, respectively, based on the estimates of the death probabilities by age by the National Population Council of Mexico and we use their figures for 2010. The population is constant and the newborns replace those who die and leave the model in each period. We assume that newborns enter the economy with no assets. We abstract from intergenerational linkage through bequest motives and transfers and assume that accidental bequests are confiscated by the government ("thrown into the ocean").

3.2 Labor market dynamics and asset holdings

To obtain employment data we concatenate the quarterly panels of ENEU from the first quarter of 2000 to the fourth quarter of 2004, with those of ENOE from the first quarter of 2005 to the fourth quarter of 2010. Both ENEU and ENOE are quarterly household surveys that track workers for 5 quarters, and are extensive in their information of labor market participation, wages, hours and other relevant information. ENEU covered 48 major metropolitan areas,[7] and was redesigned and renamed ENOE in 2005, extending the interviews to rural areas. We restrict our sample to workers between the ages of 16 and 65.

Formality definition: We broadly follow the International Labor Organization (ILO) definition of informality. We divide employed workers into two categories, formal and informal, and we classify them on the basis 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 defining informal employment. We also consider as informal workers those self-employed and owners of small firms (less than 6 employees) with no social security contributions, excluding professionals and technicians. Owners of larger firms and those professionals and technicians self-employed or with social security contributions are all considered formal.

Worker flows: We follow the matching method used in Shimer (2007) to construct workers flow data. Given the survey structure of ENEU-ENOE, 80 percent of the households interviewed in any given quarter are found in the following survey. This allows us to match individual records over two consecutive quarters, and record workers' transitions between the three sates of employment: formality (F),

[7] 16 cities are dropped for the survey of 2004, reducing the number of surveyed metropolitan areas to 32 from that year and into ENOE.

informality (I) and unemployed (U). We, therefore, obtain 9 types of transitions: FF, FI, FU, IF, II, IU, UF, UI and UU.[8]

Letting Ω_{it} be the sample weight of worker i at quarter t in the sample, and Λ_t^{XY} the number of workers who move from state $X \in \{F, I, U\}$ to state $Y \in \{F, I, U\}$ in quarter t, the gross flow from state X to Y is given by $\Gamma_t^{XY} = \sum_{i \in \Lambda_t^{XY}} \Omega_{it}$. The total number of workers in a particular state $X \in \{F, I, U\}$ is computed as $X_t = \sum_{Y \in \{E,U,I\}} \Gamma_t^{XY}$. The transition probabilities follow easily from the gross flows, and are computed as $p_t^{XY} = \frac{\Gamma_t^{XY}}{X_t}$.

Given the above description of gross worker flows, we calculate the unemployment rate as $u_t = \frac{U_t}{F_t + I_t + U_t}$. Similarly, we compute the share of formal employment among total employment as $\frac{F_t}{F_t + I_t}$.

The ENEU-ENOE surveys contain a question related to the reasons why unemployed workers separated from the previous firm. We use this information to calculate the fraction of separations which are due to quits and lay-offs.

Wage dynamics: Data for nominal wages is obtained using the information on weekly labor earnings and hours worked. Real wages are calculated deflating wages by the CPI index with base of 2001. Given individual data for real hourly wages in two consecutive quarters we estimate the AR(1) process of log wages in the formal and informal sectors. We control for age and education of the individuals, and we introduce year dummies to control for macroeconomic changes in the economy.

The wage premium for working in the formal sector ($\frac{w_F}{w_I}$) is calculated regressing real log wages on a formal sector dummy, and controlling for age and education of the individuals.

Asset holdings: Asset data for Mexico is not readily available and has to be inferred from the expenditure and capital earnings reported in ENIGH. This survey, which is conducted every two years, records expenditures and earnings for households across the country. We use the surveys of 2000, 2002, 2004, 2006, 2008 and 2010, and convert the nominal values into real by using the CPI index.

Given the available data from ENIGH, we calculate the assets of individuals as the sum of residential and financial assets.

- **Residential assets**: The value of housing assets owned by an individual is not available as such. However, ENIGH contains a question about the market rent for a residence such as the one owned by the household. We use information on rent-to-value ratio for Mexico[9] to infer the value of the house.[10]

[8] We classify a worker as employed (formally or informally) only if he/she also reports to have actually worked at least 1 hour per week.

[9] According to real state agency Numbeo.com, the annual rent-to-value ratio in Mexico is 15. http://www.numbeo.com/property-investment/rankings_by_country.jsp

[10] While ENIGH contains information about whether the house is fully own or mortgage payments are still being made, it does not report what fraction of the house is own. However, only about 10%

- **Financial assets**: This category is calculated using reported data on earnings from different types of capital assets. These include, but are not limited to, stocks, bonds, savings accounts, loans and land.[11] Given the lack of available data on the return of the different types of assets, we assume that on average they provide the same return as the 1-year bond from the government.[12] Hence, we sum the value of all the earnings from the different sources and, using the interest rate for each year, we back-up the value of the assets.

Nelder-Mead calibration: We use the moments described above as targets in calibrating the following eleven parameters; parameters B_s that represents the disutility of work in each sector s, parameters π_s^E that denote probability of on-the-job offers from the other sector while working in sector s, parameters π_s^U for the probability of receiving a job offer from sector s while being unemployed, parameters p_s^z for the probability of firms drawing a new productivity shock z in sector s, parameters $\overline{z}_s$ that represent the scale of firms' productivity, and finally subjective discount factor β.

We use the Nelder-Mead Method (1965) to calibrate the eleven parameters using eleven targets as summarized in Table 1.

Table 1: Jointly calibrated parameters and target moments

	Parameter description	Target moments	Target values
1	work distuility B_1	flow rate from F to U	1.9%
2	work distuility B_2	flow rate from I to U	3.5%
3	prob of job offers (emp) π_1^E	flow rate from F to I	9.5%
4	prob of job offers (emp) π_2^E	flow rate from I to F	13.3%
5	prob of job offers (unemp) π_1^U	average unemployment rate	3.7%
6	prob of job offers (unemp) π_2^U	% of jobs that are formal	57%
7	prob of z draw p_1^z	separation due to layoff in F	1.22%
8	prob of z draw p_2^z	separation due to layoff in I	2.32%
9	firm productivity scale $\overline{z}_1$	average earnings (normalization)	1.0
10	firm productivity scale $\overline{z}_2$	wage ratio w_1/w_2	1.235
11	discount factor β	avg asset-earnings ratio (annual)	1.2

of residential units own by individuals have outstanding mortgages. A recent study from the Bank of Mexico reports that the loan-to-value ratio for new mortgages is 65-70 percent from 2009. In order to asses the role of mortgages on the distribution of assets in Mexico we calculate the value of residential assets using two different assumptions: (i) We assign only 35% of the value of the house for those units with outstanding mortgages; (ii) We ignore outstanding mortgages and assign the full value of the house as residential asset. We find that the difference in the asset distribution of the whole economy does not change very much under these two assumptions. This may be due to the fact that, as previously stated, only 10% of of houses have outstanding mortgages. We therefore make the simplifying assumption that individuals own the whole value of the house.

[11]The full list of capital assets can be found in the documentation for the various years of the survey.

[12]We obtain this rate from the Bank of Mexico website: http://www.banxico.org.mx

3.3 Human capital and idiosyncratic productivity

The transition matrix of human capital while employed $H^E(h, h')$ is calibrated to match the average growth rate of wages between ages 20 and 50 at 2.7%, based on the wage growth data. While unemployed, we assume that human capital can depreciate. Based on the estimates of skill depreciations using the U.S. data, we assume an annual depreciation rate of 15% and calibrate the transition matrix $H^U(h, h')$ accordingly. See, Pavoni and Violante (2008) for the survey of various estimates. We assume that the human capital lies in the range of [0, 10] and that newborns enter the economy at the lowest level of human capital.

The transition matrix of idiosyncratic labor productivity $\Lambda_s(\varepsilon, \varepsilon')$ is based on the AR(1) process estimated using the ENEU-ENOE individual panel data. Unemployed individuals who receive a job offer make a draw of idiosyncratic productivity ε from the stationary distribution of the productivity in each sector.

3.4 Firms

Firing cost g_1 in the formal sector corresponds to 16 weeks (4 months) of average earnings in the formal sector, based on the the tenure schedule of the severance payment in Mexico and the average duration of employment in the formal sector.[13] $g_2 = 0$ in the informal sector.

The entry cost is set at 50% of average monthly earnings in each sector. In the Cobb-Douglas function, the capital share is set at 0.4 and annual depreciation rate is 6%.

3.5 Government

The proportional labor income tax in the formal sector $\tau_{l,1}$ is set at 15%, as in the range of estimates of effective labor income taxes in Mexico (Sarabia, 2005).[14] There is no labor income tax in the informal sector, that is, $\tau_{l,2} = 0$. The consumption tax is set at 15%, the value-added tax rate in Mexico.

[13] http://www.doingbusiness.org/data/exploreeconomies/mexico

[14] We compute the tax revenues from the labor income tax in the benchmark economy and assume that they are the expenditures of the government that are exogenous to the model. In experiments, we assume that the same amount of expenditures need to be raised through taxes and compute the tax rate that would satisfy the budget constraint of the government, which also has to raise additional revenues to finance the unemployment insurance program.

Table 2: Functional forms and parameters (1)

Param.	Description	Value/Target
Demographics		
δ_w	Death probability (working age)	0.0050 (annual)
δ_r	Death probability (retirees)	0.0613 (annual)
ρ	Retirement probability	1/45 (annual)
Preferences		
$u(c)$	Consumption utility	$\log(c)$
B_s	Disutility of work in sec. s	Separation rate from sec. s to U
β	Discount factor	Average wealth to earnings at retirement
Human capital		
$H^E(h,h')$	Markov transition (employed)	Growth of wages over life-cycle
$H^U(h,h')$	Markov transition (unemployed)	Estimates of skill depreciation in the U.S.
Job offers		
π_s^E	Prob. of new offer: employed in sec. s	Transition probabilities between sectors
π_s^U	Prob. of new offer in sec. s (unemployed)	Job finding rates in sec. s
Idiosyncratic productivity		
$\Gamma_s(\varepsilon,\varepsilon')$	Markov transition	AR(1) estimates for sec. $s \in \{1,2\}$
r	Interest rate	4%

Table 3: Functional forms and parameters (2): firms and production

Param.	Description	Value/Target
Firms' productivity		
p_1^s	Prob. of drawing new z in sec. s	Lay-offs in sec. s
$\overline{z}_1$	Scale of z in sec. 1	Normalization
$\overline{z}_2$	Scale of z in sec. 2	Relative wage w_1/w_2
μ_s	Cost of opening job in sec. s	50% of monthly earnings in s
Production function		
α	Share of capital	0.4
δ_k	Depreciation of capital	0.06
g_1	Firing cost	4 months of average earnings in formal sector

Table 4: Functional Forms and Parameters (3): Government

Param.	Description	Value/Target
$\tau_{l,1}$	Labor income tax	15%
τ_c	Consumption tax	15%

4 Numerical results

4.1 Benchmark model

Table 5 shows key statistics of the benchmark economy and the outcome of the calibration. Marked with an asterisk are the variables used as target moments in the calibration of parameters as discussed in section 3. The unemployment rate is 3.7%, which matches the average value in Mexico in 2000 to 2010 based on the ENEU data that we used as a calibration target, and the average duration of unemployment is about 3.5 months.

The wage rate in the formal sector is about 23% higher than in the informal sector, as we targeted in the joint calibration of labor market parameters. As shown in the middle part of the table, there is a high degree of mobility across sectors and between employment and unemployment. The mobility, however, is much higher among workers in the informal sector, who will exit the sector with probability 17% every quarter, as opposed to 11% in the formal sector. The layoff probability due to firm-initiated job destruction is 2.32% in the informal sector, about twice as high as in the formal sector. Unemployed individuals are much more likely to receive an offer from the informal sector, with probability 83%, than in the formal sector with probability 46%. Once on the job, formal workers face a higher probability of receiving an offer from the other sector than informal workers. Formal workers, however, are less likely to accept offers and the intersectoral flow rate to the other sector is 9.5% while it is 13.3% in the informal sector.

Table 5: Benchmark economy and labor market variables

Variables		
Unemployment rate*	3.71%	
% of jobs that are formal*	56.92%	
Avg. unemp. duration	3.56 months	
Avg. asset-earnings ratio (annual)*	1.205	
	Formal	Informal
Avg. earnings (annual)	1.0840	0.8880
Wage rate (annual)	0.3772	0.3056
Employment flows		
(1) remain in sector	88.59%	83.26%
(2) flow to other sector*	9.52%	13.25%
(3) flow to unemp.*	1.89%	3.49%
− quit	0.67%	1.17%
− layoff*	1.22%	2.32%
Hazard rate : from unemp. to I or F	30.67%	54.17%
On-the-job offer prob. from the other sector	29.98%	23.09%
Job offer prob. when unemployed	45.68%	82.57%

* indicates a moment used as a calibration target.

4.2 Tax policy

Before presenting the outcome of labor market policy simulations, we first analyze the role of labor income taxes on the labor supply and sectoral allocations.

Table 6 summarizes the simulation results under different labor income tax rates, where in each scenario the consumption tax rate is adjusted so that the government budget remains balanced. More precisely, we had exogenously set the tax rates on labor income and consumption in the benchmark model at 15%, respectively. The amount of revenues raised by these taxes in the benchmark economy is kept as exogenous government expenditures that need to be financed under alternative policies. As the tax revenues go up or down with a change in both the tax rate and tax base, some component of the government budget has to be adjusted to balance the budget. We let the consumption tax play the role to clear the budget.

Table 6: Labor income and consumption taxes

Labor income tax	5.00%	15.00%	25.00%
Consumption tax	19.59%	15.00%	17.65%
Unemp. rate	3.26%	3.71%	4.32%
Formal share	78.52%	56.93%	30.87%
Hazard rates	84.49%	84.84%	84.27%
- U to F	37.54%	30.67%	20.24%
- U to I	46.95%	54.17%	64.03%
Intersectoral flow rates			
- F to I	4.24%	9.52%	16.69%
- I to F	17.75%	13.25%	7.51%
Aggregate savings	+9.68%	–	−7.29%
Aggregate consumption	+6.10%	–	−10.09%
Welfare	+1.05%	–	−3.05%

As we can see in Table 6, unemployment rises as the labor income tax increases. This is as expected given the effect of distortionary taxation on work incentives. The change in unemployment is, however, surprisingly small. The unemployment rate remains in the narrow range of 3.3% and 4.3% when the tax rate shifts from 5% to 25%. Unlike in a one-sector model, changes in labor income taxes only affect net earnings in one sector, the formal one, since informal sector earnings are tax free. As a result, after-tax wages in the formal sector become increasingly less attractive relative to those in the informal sector as taxes rise. This implies that under higher income taxation the increased disincentive to work among employees who pay taxes is partially offset by a rise in the number of workers who more easily accept jobs in the informal sector. This sectoral shift is apparent in the sharp decline in the share of formal employment from about 80% to 30% when the labor income tax rate is adjusted from 5% to 25%. As shown in Table 6, the intersectoral flows from formal to informal sector rises from about 4% to 17%.

When the labor income tax is below the benchmark level of 15%, the tax revenues from labor income decline and the consumption tax has to increase. This occurs despite the rise in the share of formal workers from 57% to 79%. An increase in the labor tax beyond the benchmark level of 15% induces a sharper drop in the share of the formal sector employment, from about 57% to 30%, significantly reducing the labor income tax base, and the consumption tax has to rise above 15%.

Higher levels of the labor income tax produce a drop in the total earnings of the household. As explained above, higher taxes increase unemployment, which in turn reduces the time to accumulate human capital while increasing the risk of skill depreciation while out of work. In addition, the average efficiency of informal workers declines sharply with the drop in the reservation wage, as the informal jobs become relatively more attractive compared to the formal ones that are subject to high labor income taxes. As a result, a higher labor tax reduces the disposable income and drives down both savings and consumption. The latter is also hit by a rise in the consumption taxes. As shown in Table 6, the aggregate consumption declines by about 10% when the labor income tax is raised from 15% to 25%. This leads to a significant welfare loss in the order of 3% in consumption equivalence while households enjoy the welfare gain of 1% in consumption equivalence when the labor income tax is reduced to 5%.[15]

In what follows, we simulate various labor market policies that affect labor participation and sectoral allocation of jobs. To finance expenditures of such policies, alternative financing methods can be considered to balance the government budget. Anton, Hernandez and Levy (2011), for example, suggest the use of consumption taxes to cover the expenditures for social insurance programs. Direct taxation alleviates the problem of the tax evasion and enforcement, a serious issue in an economy with a large informal sector as in Mexico. As seen in the previous results, if a program is financed by income taxation, a relative change in the after-tax earnings can cause a shift of the labor force between informal and formal sectors. A rise in the labor tax, for example, can reduce the tax base, requiring a further rise in the tax rate and exacerbating distortions in the sectoral allocation. This is an unintended and undesirable consequence of a policy both economically and politically. For these reasons, we use consumption tax as the principal way to balance the government budget in the baseline simulations, although we also present some results under the alternative assumption that policy expenditures are financed by labor taxes.

4.3 Unemployment insurance

The benchmark economy has no unemployment insurance that would help individuals smooth consumption and alleviate shocks to incomes associated with exogenous job separations. In this section we introduce unemployment insurance in the bench-

[15]The welfare effect is computed as the level of additional consumption given to every state in the economy with an alternative policy so that a new-born individual will be just as well off as in the benchmark economy.

mark model calibrated to the Mexican economy. We assume that the insurance will pay benefits that replace 50% of previous earnings with a fixed maximum duration. These benefits are provided to unemployed individuals only when they are separated from a job for exogenous reasons. Workers are not entitled to benefits if they quit the job.

An economy with dual markets displays a non-standard feature that is not present in single market models. Namely, the government is unable to comprehend the work undertaken in the informal sector, which is precisely what defines informality. Therefore, we assume that, first, only those individuals who are laid off from a job in the formal sector are entitled to benefits, and second, individuals are able to "hide" and continue to receive benefits even after they accept a job in the informal sector, as long as they have been unemployed for less than the maximum duration of the benefits. We consider the maximum benefit duration of 6, 12, 24 and 36 months. As we discussed in section 4.2, we let the consumption tax adjust so that the government budget is balanced. The introduction of the unemployment insurance requires an additional state variable, which captures the amount of benefits that an unemployed or informal worker is entitled to. The value functions and individual problems under this setting are presented in Appendix A.

As shown in Table 7, more generous unemployment insurance increases the average duration of unemployment. The unemployment rate rises from 3.71% in the benchmark model to 3.84% when 6-month unemployment insurance is introduced, and to 3.96%, 4.12% and 4.43% as the maximum duration increases to 1, 2 and 3 years. The second section of the table shows that the decline in the hazard rates is driven by a large drop in the flows from unemployment to formal employment. There is little change in the outflow into the informal sector since workers are able to keep the benefits while making earnings in the informal sector and there is no work disincentive associated with the insurance benefits.

Table 7: Unemployment insurance: financed by consumption taxes

UI duration	0m	6m	12m	24m	36m
Unemp. rate	3.71%	3.84%	3.96%	4.12%	4.43%
Formal share	56.93%	56.63%	55.88%	54.73%	53.70%
Avg unemp. duration (months)	3.56	3.65	3.75	4.06	4.42
Hazard rates	84.84%	83.19%	81.69%	78.42%	75.32%
- U to F	30.67%	28.25%	25.73%	22.83%	20.81%
- no benefits	–	30.58%	30.64%	30.96%	30.89%
- with benefits	–	18.68%	9.09%	3.70%	2.41%
- U to I	54.17%	54.94%	55.96%	55.59%	54.52%
Job separation rates					
- F to U	1.89%	1.89%	1.88%	1.76%	1.75%
- I to U	3.49%	3.61%	3.69%	3.80%	4.02%
Intersectoral flow rates					
- F to I	9.52%	9.51%	9.51%	9.52%	9.53%
- I to F	13.25%	13.18%	12.89%	12.31%	11.80%
- no benefits	–	13.25%	13.25%	13.27%	13.27%
- with benefits	–	7.49%	3.55%	1.74%	1.15%
UI recipients (% of labor force)	–	1.26%	2.49%	4.86%	6.94%
- Unemployed (% of all UI)	–	59.87%	36.20%	25.34%	22.58%
- Informal workers (% of all UI)	–	40.13%	63.80%	74.66%	77.42%
Aggregate savings	–	0.77%	1.18%	2.17%	2.82%
Aggregate consumption	–	−0.13%	−0.76%	−1.99%	−3.01%
Consumption tax	15.00%	15.71%	16.70%	18.78%	20.49%
Welfare effect	–	−0.01%	−0.22%	−0.74%	−1.17%

We can also see that with the unemployment insurance, the share of formal employment drops from 56.93% in the benchmark economy to 56.63%, 55.88%, 54.73% and 53.70% as the maximum duration of benefits increase. The drop in formality may be partly surprising given some of the debates that have taken place in countries such as Mexico, where the introduction of unemployment insurance is seen as a way to fight informality and provide incentives for workers to move into the formal sector (Anton, Hernandez and Levy, 2011). Our simulations suggest that the benefit of additional insurance with the formal jobs is not large enough to raise the size of the formal sector. Given the small chance of qualifying for benefits through layoffs, a positive effect if any is mostly undone by the fact that benefits can still be collected while employed informally, and many more workers choose to take those types of jobs before the expiration of the benefits. This intuition is re-enforced by looking at the flow rates from unemployment or informality to formality, both conditional on the eligibility to receive unemployment benefits. As shown in Table 7, when 6 month benefits are introduced, the flow rate from unemployment to formality falls from 30.67% in the benchmark to 28.25%, by just about 2.4 percentage points.

However, this seemingly small decline hides the massive heterogeneity between those without benefits, who move to formality with probability 30.58% and those receiving benefits, whose likelihood of moving is less than 19%. The large difference is also observed in the intersectoral flow rates from informality to formality between those with and without benefits.

The number of unemployment insurance recipients, as well as its decomposition by employment status, are reported in Table 7. We observe that a significant fraction of recipients are not unemployed and make earnings in the informal sector. Furthermore, when the benefits are available for as long as 3 years, more than three quarters of the recipients have a job in the informal sector.

Finally, as the maximum duration of the benefits increases, individuals save more in anticipation of a longer period of unemployment with low income. This is financed through a reduction in consumption, as can be seen in Table 7 in the decline in aggregate consumption. In addition, expenditures incurred by the government to finance the unemployment insurance program lead to a rise in consumption tax, from 15% in the benchmark economy to 15.71%, 16.70%, 18.78% and 20.49%, respectively. The sharp increase in consumption taxes also reflects the decline in the aggregate consumption, which constitutes the tax base. Given the drop in consumption, the welfare deteriorates as the unemployment insurance becomes more generous, as shown in the last row of Table 7.

Up until now the results presented assumed that the expenditures associated with the unemployment insurance are financed by raising taxation on consumption. Table 8 presents the results of the simulation when the previously explained unemployment insurance policies are financed via labor income taxes, leaving constant the consumption tax rate at benchmark level of 15%. The qualitative results of this alternative policy are similar to the ones presented above. In particular, when unemployment insurance is introduced, and as duration of benefits increase, we find that unemployment increases, formality drops (both of these due to a sharp decline in the hazard rates into formality) and welfare decreases. However, we find that quantitatively labor income taxes are more distortionary and have a greater impact on the sectoral allocations and welfare than in the case of financing the benefits with consumption taxes. Furthermore, when the duration of benefits increases up to 24 months, the taxes necessary to finance the system start to explode and the formal sector disappears, rendering the system unsustainable. Therefore, our results suggest that it seems preferable to finance the unemployment insurance system with consumption taxes rather than with labor income taxes.

Table 8: Unemployment insurance: financed by labor income taxes

UI maximum duration	0m	6m	12m
Unemp. rate	3.71%	3.77%	3.92%
Formal share	56.93%	56.45%	54.94%
Avg unemp. duration (months)	3.56	3.61	3.72
Hazard rates	84.84%	83.88%	82.21%
- U to F	30.67%	28.10%	24.80%
- U to I	54.17%	55.78%	57.41%
Job separation rates			
- F to U	1.89%	1.88%	1.82%
- I to U	3.49%	3.54%	3.69%
UI recipients (% of labor force)	–	1.26%	2.48%
- Unemployed (% of all UI)	–	59.61%	35.83%
- Informal workers (% of all UI)	–	40.39%	64.17%
Aggregate savings	–	−0.24%	−0.85%
Aggregate consumption	–	−0.31%	−1.27%
Labor income tax	15.00%	16.25%	17.90%
Welfare effect	–	−0.09%	−0.37%

4.4 Severance payment

In order to understand the effects of the severance payment on households' behavior and the responses of firms to the additional costs of layoffs, we simulate the model with alternative levels of severance payments in two steps. First, we allow only households to respond and reoptimize. We shut down the effects through the interaction between households and firms by holding the wage rates, w_s, and the rates of job destruction initiated by firms, q_s, in each sector at the benchmark levels. Table 9 shows the results of these simulations. In the second step, we let firms respond to the changes in the layoff cost and solve for full equilibrium, in which the wage rates and job destruction rates are determined in the labor market. These results are displayed in Table 10.

Table 9: Severance payments: partial eq. with households' problem only

Severance pay	0m	4m	8m	12m	24m
Unemp. rate	3.75%	3.71%	3.84%	3.83%	4.28%
Formal share	55.21%	56.93%	57.06%	57.02%	57.42%
Hazard rates	84.91%	84.84%	83.39%	82.61%	76.03%
- U to F	29.35%	30.67%	30.44%	30.29%	28.88%
- U to I	55.56%	54.17%	52.95%	52.32%	47.15%
Job separation rates					
- F to U	1.80%	1.89%	1.90%	1.82%	1.87%
- I to U	3.64%	3.49%	3.62%	3.63%	3.84%
Aggregate savings	−1.00%	–	1.49%	3.47%	11.02%
Aggregate consumption	−1.84%	–	1.05%	2.31%	5.55%
Consumption tax	15.63%	15.00%	14.94%	14.77%	14.34%
Welfare effect	−0.69%	–	+0.43%	+0.85%	+2.02%

Table 10: Severance payments: full equilibrium

Severance pay	0m	4m	8m	12m	24m
Unemp. rate	3.71%	3.71%	3.72%	3.76%	3.97%
Formal share	56.83%	56.93%	56.99%	57.02%	56.82%
Hazard rates	85.31%	84.84%	84.11%	83.03%	78.48%
- U to F	30.83%	30.67%	30.41%	29.96%	27.69%
- U to I	54.48%	54.17%	53.69%	53.07%	50.79%
Job separation rates					
- F to U	1.93%	1.89%	1.84%	1.80%	1.65%
- I to U	3.48%	3.49%	3.52%	3.56%	3.74%
Formal worker layoff rate (q_1)	1.27%	1.22%	1.17%	1.13%	0.98%
Formal wage w_1 rel. to bnch	1.63%	–	−1.54%	−2.97%	−6.72%
Aggregate savings	−0.03%	–	+0.73%	+1.77%	+5.15%
Aggregate consumption	−0.54%	–	+0.22%	+0.30%	+0.00%
Consumption tax	15.20%	15.00%	15.09%	15.23%	15.81%
Welfare effect	−0.21%	–	−0.01%	−0.12%	−0.67%

First we will examine the partial equilibrium results. As the severance payment increases from 4 months of earnings to 8, 12 and 24 months, risks associated with layoffs decline. This benefit, however, occurs only with jobs in the formal sector. Unemployed individuals find a job offer from the formal sector with the added insurance benefit more attractive relative that of the informal sector. The flow rate from unemployment to employment in the informal sector falls from 55.56% with no severance payment to 47.15% when the laid off workers receive generous benefits of 24 months earnings. The flow rate from unemployment to formality also drops with the increase in the generosity of the severance payment, although the decline is less

sharp, from 30.67% in the benchmark case to 28.88% for the 24 months scenario. Part of the decline in hazard rates into both formal and informal sectors is due to a rise in wealth as laid off workers receive a larger severance transfer payment. In the benchmark model, as discussed in section 4.1, about two-thirds of the transitions from formal employment to unemployment are due to exogenous layoffs. When all of these laid off workers receive transfers from the firms, the wealth effect reduces the incentive to accept job offers. Since the experiments in Table 9 ignore the cost of the additional transfers that firms bear with the increase in firing costs, it is not surprising that individuals are better off as the generosity increases, as shown in the last row of the table.

Once we allow for full equilibrium and endogenous wage determination and job destruction, a large response from firms is observed as shown in Table 10. In this case, higher severance payment affects the behaviour of the labor market agents in several ways. First, higher protection for formal workers imply lower lay-off rates, which drop from 1.22% in the benchmark economy to 0.98% when severance payment are equivalent to 24 months of wages. Second, higher firing costs increase the costs of employing formal workers and the equilibrium wage rate falls by more than 1.5% as the severance payment rises from 4 to 8 months of earnings, and by about 3% and 7% as it increases to 12 and 24 months. Third, as already explained in the partial equilibrium analysis, the more generous severance payment produces an increase the wealth of the households (even after the drop in formal wages), which renders workers choosier about the jobs they take, reducing the hazard rate both into formality and informality, as severance payment increases. Note, however, that the flow rate from unemployment to formality falls more sharply with the level of the severance payments in Table 10 than in Table 9, reflecting the impact of a decline in the wage rates.

In general, the overall effect of layoff costs on unemployment depends on the relative strength of the lower separation rate and the lower job finding rate. Ljungqvist (2002) and Kitao, Ljungqvist and Sargent (2008) show that a higher layoff cost tends to decrease unemployment in a model with a frictional labor market, but their results are derived in a single labor market. In the case of a dual economy, the drop in the layoff rate is not enough to compensate for the decline in the hazard rates into both sectors due to the increase wealth, and the increase in the separation rate from the informal sector. We find that the net effect is a small increase in the unemployment rate, from 3.71% in the benchmark economy to 3.72%, 3.76% and 3.97% when the severance payment is 8, 12 and 36 months of earnings. The welfare effects are also very small, in the order of much less than 1% in consumption equivalence even with a severance payment of 36 months earnings.

5 Conclusion

The paper builds a structural life-cycle model of unemployment with a dual economy and simulates different policies on taxation, unemployment insurance and severance payments. Given that any government policy based on official work record in the formal sector fails to reach half of the workforce that reside in the informal sector, policies are shown to bring about consequences that would not emerge in standard single-sector models. Unemployment insurance, intended to help smooth consumption and possibly induce more workers to choose formality, is found to do the opposite. The unemployment rate rises with the generosity of benefits and the labor share of the formal sector declines. The unintended outcome is driven by the inability of the government to comprehend economic activities in the informal sector, giving unemployed individuals incentives to accept informal jobs and continue to receive benefits. Such effects are exacerbated if the benefits are financed by labor income taxes on formal workers rather than by consumption taxes. Severance payments do not create such a moral hazard problem in accepting formal job offers. However, the layoff costs imposed on firms in the formal sector lead to a lower wage, making jobs in the formal sector less attractive than those in the informal sector. This effect offsets the lower layoff probability in the formal sector and the net effect is a marginal increase in the unemployment rate and deterioration of welfare.

Our experiments also suggest that policies that would remove distortions in the formal sector are most effective in encouraging workers to undertake a job in formality. Given the higher productivity and wages in the formal sector, such shifts increase the output of the economy, raise disposable income of households and enhance welfare. Consumption tax appears to be a better choice than labor taxes when additional revenues must be raised to cover expenditures.

Recently economists as well as policy makers are debating a comprehensive reform of the social insurance system, including the social security and health insurance programs, as discussed by, for example, Anton, Hernandez and Levy (2011). An obvious challenge, as identified in our study, is how to comprehend the workers in the informal sector and provide necessary social insurance to the population without generating unintended disincentives. Our framework as appropriately extended will serve as a basis for quantitative analysis of such policies and we leave these topics for our future research.

References

[1] Aiyagari, S. Rao (1994): "Uninsured Idiosyncratic Risk and Aggregate Saving," Quarterly Journal of Economics, 109(3), pp. 659-684.

[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), pp. 1105-1129.

[3] Anton, A., F. Hernandez and S. Levy (2011): "The End of Informality in Mexico? Fiscal Reform for Universal Social Insurance, working paper.

[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), pp. 203-224.

[5] Bewley, Truman F. (1986): "Stationary Monetary Equilibrium with a Continuum of Independently Fluctuating Consumers," Hildenbrand, W. and A. Mas-Colell, Ed., in *Contributions to Mathematical Economics in Honor of Gerald Debreu*, North-Holland, Amsterdam, pp. 79-102.

[6] Bosch, M., and J. Esteban-Pretel (2012): "Job creation and job destruction in the presence of informal markets," Journal of Development Economics, 98 (2), pp. 270–286.

[7] Bosch, M., and W. F. Maloney (2008): "Cyclical Movements in Unemployment and Informality in Developing Countries," IZA Discussion Paper, No. 3514.

[8] Boeri, T., and P. Garibaldi (2006): "Shadow Sorting," CEPR Discussion Papers 5487, C.E.P.R. Discussion Papers.

[9] Fugazza, M., and J.-F. Jacques (2004): "Labor market institutions, taxation and the underground economy," Journal of Public Economics, 88(1-2), pp. 395 – 418.

[10] Huggett, M. (1993): "The Risk-free Rate in Heterogeneous-agent Incomplete-insurance Economies," Journal of Economic Dynamics and Control, 17(5-6), pp. 953-969.

[11] Kitao, S, L. Ljungqvist and T. Sargent (2008): A Life Cycle Model of Trans-Atlantic Employment Experiences. mimeo, New York University

[12] 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.

[13] Ljungqvist, L. (2002): How Do Layoff-Costs Affect Employment? Economic Journal, 112 (482), pp. 829-853.

[14] 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).

[15] OECD.(2011). OECD Economic Surveys Mexico 2011. http://www.oecd.org/eco/surveys/economicsurveyofmexico2011.htm

[16] Pavoni, N. and G. L. Violante (2007): Optimal Welfare-to-Work Programs. Review of Economic Studies, 74 (1), pp. 283-318.

[17] Sarabia, A. A. (2005): Average Effective Tax Rates in Mexico. *Economia Mexicana*, XIV (2), pp. 185-215.

[18] Schneider, F. and Enste, D. (2000): "Shadow economies: Size, causes and consequences," Journal of Economic Literature, 38, pp. 77-114.

[19] Schneider, F. Buhen, A. Montenegro, C. (2010): "New estimates for the shadow economies all over the world," International Economic Journal, 24, pp. 443-461.

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

A Individuals' problem with unemployment insurance

Employed

$$\begin{aligned} V(a,h,s,\varepsilon,b) &= \max_{c,a'}\{u(c) - B + \beta_w(1-\rho)\left[q_s EU(a',h',b')\right. \qquad (14)\\ &\quad +(1-q_s)\pi_s^E E\max\{V(a',h',s,\varepsilon',b'),V(a',h',\tilde{s},\tilde{\varepsilon}',b'),U(a',h',b')\}\\ &\quad \left.+(1-q_s)(1-\pi_s^E)E\max\{V(a',h',s,\varepsilon',b'),U(a',h',b')\}\right]\\ &\quad +\beta_w\rho R(a')\} \qquad (15)\end{aligned}$$

subject to

$$a' + c = (1-\tau_s)\varepsilon h w_s + (1+r)a + g_s + b \qquad (16)$$

Unemployed

$$\begin{aligned} U(a,h,b) &= \max_{c,a'}\{u(c) + \beta_w(1-\rho)\left[\right. \qquad (17)\\ &\quad +\pi_1^U\pi_2^U E\max\{V(a',h',s_1,\varepsilon_1,0),V(a',h',s_2,\varepsilon_2,b'),U(a',h',b')\}\\ &\quad +\sum_{i=1}^{2}\pi_i^U E\max\{V(a',h',s_i,\varepsilon_i,b'),U(a',h',b')\}\\ &\quad \left.+(1-\pi_1^U)(1-\pi_2^U)EU(a',h',b')\right]\\ &\quad +\beta_w\rho R(a')\} \qquad (18)\end{aligned}$$

subject to

$$a' + c = (1+r)a + b \qquad (19)$$