Labor Market Policies in a Dual Economy*

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Abstract

A structural model of unemployment is built to account for 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 only a small impact on unemployment but induces a sectoral reallocation of formal labor into informality. Generous severance payments from employers lower the wage of formal jobs and reduce flows from unemployment to formality. Shifting the tax burden from labor income onto consumption significantly raises the share of formal workers of the economy, enhancing productivity and welfare.

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

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

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1 Introduction

The size of the shadow economy is large, especially in developing regions. Averaged across countries in the world, Schneider, et al. (2010) estimate that more than one-third of GDP is produced in the underground economy.[1] In regions such as Latin America and Sub-Saharan Africa, over 40% of the economic activities take place informally, and in some countries two-thirds of the economy is underground.

Distinguishing between formality and informality is important in analyzing policies of such an economy. An informal sector, by definition, is characterized by the lack of compliance with government regulations. Individuals avoid paying taxes on income earned informally but they are also disconnected from social insurance. Policies may not always achieve the desired goal, since in many cases they fail to reach the large hidden fraction of the economy, despite the fact that workers in the informal sector tend to face higher labor mobility and associated earnings volatilities, hence in need of more insurance.[2]

Mexico is a prime example of such issues, with a history of attempts to curve informality. Using the data of the Mexican Statistics and Geography National Institute (INEGI), we estimate that 43% percent of the working population is employed in the underground sector.[3] Workers in the Mexican shadow economy face not only lower wages, but also higher risks of job loss and little protection from exogenous dismissals. One important debate currently taking place is the implementation of an unemployment insurance system, which is mostly non-existent at present, and how it will affect the labor market outcomes.

Most of the studies in the 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 study policies within a multi-sector framework often abstract from key features of micro-founded macroeconomic models such as risk aversion and precautionary savings, which are important in quantifying the economic and welfare 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, which have been developed mostly in a single-sector economy, and extend it to the context of a dual sector economy. Second, we use the model to simulate labor market and fiscal policies that are intensely debated in developing countries, such as Mexico, in order to understand the economic impact through changes in employment, job flows, welfare, etc.

[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 of taxes or social security contributions.

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

[3] The average over 2000-2010. See section 4 for detailed description of the data and the statistics we computed from the INEGI database. Schneider, et al. (2010) estimate that around 30% percent of Mexican output is produced informally.

The paper builds a structural life-cycle model with labor market frictions and one-sided search in a dual sector economy. Individuals are heterogeneous in the stage of life-cycle, human capital, wealth, idiosyncratic labor productivity and the sector where they work. They face uncertainty in employment and productivity, as well as the mortality risks. The market is incomplete and risk-averse individuals engage in precautionary savings of riskless assets to smooth consumption. Parameters of the model are calibrated to match key labor market features of the Mexican economy. We use various micro data in Mexico, including the National Urban Employment Survey (ENEU) and the National Employment and Occupational Survey (ENOE) for the wage and employment data and the National Household Income and Expenditure Survey (ENIGH) for the asset profile. The calibrated model is used to analyze two labor market policies, unemployment insurance and layoff cost.

The analysis of labor market policies is incomplete without accounting for the fiscal cost of such policies. Therefore before simulating labor market policies, we study consequences of using labor income taxes versus consumption taxes to finance public expenditures, which are the two major sources of revenues besides oil in Mexico (OECD, 2011). Consumption taxes are less distortionary than labor income taxes. The impact, however, on employment due to higher labor taxes turns out to be surprisingly small. In our dual sector economy, workers move from formal jobs to informal jobs that remain free of taxes. Such a sectoral reallocation in response to a rise in distortionary taxation involves a decline in productivity and earnings, imposing a sizeable welfare loss on individuals.

We then introduce an unemployment insurance system in our model. Laid-off workers in the formal sector can collect benefits for up to a given maximum duration of unemployment. Given the lack of monitoring of employment in the informal sector, we assume that unemployed individuals who accept a job in the informal sector can continue to collect benefits until they reach the maximum duration. We find that the introduction of the system produces an increase in unemployment, although the magnitude of the change is small because workers qualify for benefits only through exogenous layoffs and benefits expire eventually. Hazard rates, however, into formality decline as benefits become more generous. There is in fact a large difference in the hazard rates to formality before and after the expiration of benefits since workers are more selective while they are still entitled to benefits and their reservation wage to accept a formal job is higher.

The next labor market policy that we analyze is severance payment. We find that providing more protection to formal employees through higher severance payment reduces the likelihood of lay-offs in the formal sector, but the policy also depresses the equilibrium formal wages. These opposing effects leave the unemployment rate and the share of formality almost unchanged. Hazard rates, both into formality and informality, decrease as the level of severance payment increases, due to the wealth effect through larger transfers and a rise in savings.

The remainder of the paper is organized as follows. Section 2 discusses related literature and key model features that are adopted in our model. Section 3 presents

the model. Section 4 describes the data and the calibration of the model parameters and section 5 displays the results of the different policy experiments. Section 6 summarizes and presents the main conclusions of the paper.

2 Literature

Our paper builds on two strands of literature. First, it contributes to a long tradition in macroeconomics that uses a large-scale and discrete-time model of heterogenous agents, who make optimal consumption and labor supply decisions in an incomplete market as they go through stages of life-cycle. The paper is an addition to the group of incomplete market models pioneered by Bewley (1984), Imrohoroglu (1989), Huggett (1993) and Aiyagari (1994). The model is also a version of life-cycle models developed by Auerbach and Kotlikoff (1987), where individuals enter the economy with no asset and start accumulating wealth for precautionary and retirement reasons. Using a life-cycle rather than an infinitely-lived agent model helps us approximate the earnings-wealth ratio that is consistent with the data with a reasonable value of an intertemporal preference parameter. We introduce stochastic aging probabilities, a modeling device developed by Blanchard (1985) and used by Gertler (1999) and Cagetti and De Nardi (2006) in a life-cycle framework, which allows us to reduce the size of individual state space in our model with a large number of individual states.

The literature has been extended to incorporate labor market frictions and to study various policies and issues of unemployment. A search-island model of Lucas and Prescott (1974) captures search frictions that lead to short-run unemployment. The framework is adopted by Alvarez and Verazierto (2001) and more recently by Kitao, Ljungqvist and Sargent (2008) to study the effects of severance payments and issues of European unemployment, respectively. As in Kitao, et al (2008), we assume that workers who find the island will be randomly matched with a firm and receive a job offer at the equilibrium wage per efficiency unit, which clears the market in the island. As in Mortensen and Pissarides (1999), each firm creates one job, while being subject to idiosyncratic productivity shocks. A certain fraction of jobs are destroyed each period, which workers perceive as an exogenous probability of job losses.

The framework allows us to study the labor market dynamics in two sectors (islands) and analyze the effect of labor market policies, such as unemployment insurance and layoff costs, that affect only one sector of a multi-sector economy directly, while accounting for the job mobility across different sectors and differentiated wage rates that emerge in the two sectors.

The model differs from those that employ a matching mechanism such as Mortensen and Pissarides (1994), Hagedorn and Manovskii (2008) and Krusell, Mukoyama and Sahin (2010), in which wages are determined by Nash bargaining between a worker and a matched firm. We have chosen to use the island model where the wage is determined competitively partly because it would significantly reduce the computa-

tional burden in our model with a large state space since one would otherwise have to carry and iterate on the distribution of matched pairs as an equilibrium object, which depends on the combination of all the state variables of individuals and firms.[4] Instead, we are able to include states of individuals that are rich enough to capture the dynamics of exogenous and endogenous worker mobility among unemployment and employment in the two sectors, as well as the heterogeneity in wages within and across sectors. All papers mentioned above focus on a single sector of the economy and one of our major contributions is to extend it to a dual-sector economy in a tractable way.

Secondly, our paper also connects to studies about shadow economies, in particular with those analyzing labor market policies using a framework of equilibrium unemployment. Examples in this literature include 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 labor market policies, they do so without allowing for asset accumulation or risk aversion of individuals, missing some important channels through which government policies affect the behavior of agents. Our model overcomes the shortcomings as we incorporate precautionary savings and wealth distribution which emerge as a response of risk-averse agents to uninsurable shocks, in the tradition of above-mentioned incomplete market models.

3 Model

3.1 Environment

In each period there is a continuum of individuals born with uncertain 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 and 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. 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

[4]The challenge in our model would be to keep track of the distribution over the asset space, which consists of many grids in the computation. As we discuss in Section 3, this is in addition to the states of human capital, idiosyncratic labor productivity and employment status for each individual. Resulting wages, however, may not necessarily carry features that are in line with empirical findings where individuals with more assets, controlling for everything else, will always achieve a higher wage through bargaining, as the value of their outside option is higher.

offer from the other sector, which they decide to accept or reject. Conditional on no separation that is exogenous to workers, 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 by the employer, the worker receives a 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.

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

3.2 Production

A firm in sector $s \in \{1, 2\}$ creates a job incurring a startup cost μ_s to produce output next period 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 is the current job-specific productivity level, k is physical capital that depreciates at the rate δ_k and n is efficiency units of labor ϵh 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, et al. (2008), extended to our multi-sector economy. 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, each firm observes its new productivity level z and decides whether to continue production or terminate the job. At this point the firm does not know the identity of the worker

who will fill a job if the firm decides to continue production. Therefore, all firms have the same reservation productivity level $\overline{z}$, below which jobs are terminated. Firms terminating a job in sector s 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 separation that is exogenous to workers, they 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. Once matches are formed, 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 generate no profit in expectation. The market wage adjusts to ensure that all workers in the centralized labor market are matched to a job.

3.3 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 and we will introduce it in Section 5.

3.4 Individuals' problem

The state vector of an employed individual is given as $x_E = \{a, h, s, \varepsilon\}$, where a denotes assets carried 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. $\beta_w = \beta(1 - \delta_w)$ for working-age individuals and $\beta_r = \beta(1 - \delta_r)$ for retirees.

Employed

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

subject to

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

If a worker in sector s receives a job offer from the other sector $\tilde{s} \neq s$, he will also draw an idiosyncratic productivity $\tilde{\varepsilon}'$, which determines the wage in sector $\tilde{s}$ if he accepts the offer.

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

Unemployed

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

subject to

$$a' + c = (1 + r)a \tag{7}$$

If an unemployed individual receives an offer from both sectors s_1 and s_2, he will compare the values of employment in each sector based on the draws of idiosyncratic productivity ε_1 and ε_2 in two sectors, as well as the value of remaining unemployed.

Retirees

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

subject to

$$a' + c = (1 + r)a \tag{9}$$

3.5 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

$$\begin{aligned} J_s(n,z) \;=\; & \max_k \left\{ z k^\alpha n^{1-\alpha} - w_s n - (r + \delta_k)k \right\} \\ & +\frac{1}{1+r} \sum_{z'} Z_s(z,z') \tilde{J}_s(z')., \qquad (10) \\ & \qquad (11) \end{aligned}$$

where

$$\tilde{J}_s(z) = \max\left\{ E_n\left[J_s(n,z) \right], -g_s \right\}, \tag{12}$$

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

$$E_n \left[J_s(n, \bar{z}_s) \right] = g_s. \tag{13}$$

The break-even condition for starting a new firm is

$$\mu_s = \frac{1}{1+r} E_n \left[J_s(n, z_s^0) \right]. \tag{14}$$

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.

3.6 Stationary equilibrium

Individual states are $x_E = \{a, h, s, \varepsilon\}$, $x_U = \{a, h\}$ and $x_R = \{a\}$ for the employed, unemployed and retirees, respectively. Let the state space of three types of individuals be denoted as $\mathbb{X}^E$, $\mathbb{X}^U$ and $\mathbb{X}^R$, 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 3.4 and optimally choose consumption, wealth and labor supply, (2) firms solve the problem described in section 3.5 and optimally make the entry and exit decisions and choose the level of capital used in production, and (3) the market wage w_s clears the labor market in sector s.

4 Calibration

This section presents the parametrization of the model. The frequency of the model is quarterly. As we discuss in more detail 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, including 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). Inflation and interest rates are taken from the Bank of Mexico.[5] The annual interest rate is set at 4%, the short-term nominal government funding rate as reported by the Bank

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

of Mexico adjusted by the CPI inflation rate during the same period.[6] Calibrated parameters of the model are summarized in Tables 2, 3 and 4.

4.1 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 and 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 reported by the National Population Council of Mexico in 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").

4.2 Labor market dynamics and asset holdings

To obtain employment statistics 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 provide detailed information on labor market participation, wages, work hours and other relevant variables. ENEU covered 48 major metropolitan areas,[7] and was redesigned and renamed ENOE in 2005, extending the interviews to rural areas. For the purpose of obtaining labor market data, we restrict our sample to workers between the ages of 16 and 65.

Formality definition: We broadly follow the International Labor Organization (ILO)'s definition of informality. We divide employed workers into two categories, formal and informal, and 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 distinguishing characteristic defining informal employment. We also consider as informal workers self-employed individuals 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 with social security contributions are all considered formal workers.

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

[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.

Worker flows: We follow the matching method used in Shimer (2007) to construct workers flow data. Given the survey structure of ENEU and ENOE that track workers for 5 quarters, 80 percent of the households interviewed in any given quarter are interviewed again in the following survey. This allows us to match individual records over two consecutive quarters, and record workers' transitions among the three sates of employment: employed in formality (F), informality (I) and unemployed (U), and obtain 9 types of transitions across three employment states.[8] We classify a worker as employed, formally or informally, if he/she also reports to have worked at least 1 hour per week.

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 probability from state X to Y is derived as $p_t^{XY} = \frac{\Gamma_t^{XY}}{X_t}$.

The unemployment rate is calculated as $u_t = \frac{U_t}{F_t + I_t + U_t}$ and the share of formal employment among total employment is given as $\frac{F_t}{F_t + I_t}$.

The ENEU and ENOE surveys contain a question related to the reasons why unemployed workers separated from the previous employer. 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 variables on weekly labor earnings and hours worked in the ENEU and ENOE surveys. Real wages are calculated deflating wages by the Mexican CPI index. 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 use year dummies to control for macroeconomic changes.

The wage premium for the formal sector, defined as $\frac{w_F}{w_I}$, 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 we rely on the expenditures and capital earnings data reported in ENIGH to infer the asset profile. This survey, which is conducted every two years, records expenditures and earnings for households across the country. We use the surveys from 2000 to 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. The value of housing assets owned by an individual is not available as such. However, ENIGH contains a question about the market rent equivalence for a residence owned by the household. We use

[8] Remaining in formal (FF), moving from formal to informal (FI), from formal to unemployment (FU), IF, II, IU, UF, UI and UU.

information on rent-to-value ratio for Mexico[9] to infer the value of the house.[10] As to the financial assets, we compute the values using reported data on capital income from different types of 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 all different types of assets, we assume that on average they provide the same return as the 1-year bond issued by the government.[12] Hence, we sum the value of all the capital income from the different sources and use the interest rate for each year to infer the value of the assets owned by individuals.

Nelder-Mead calibration: We use the moments described above as targets in calibrating the following eleven parameters; parameters B_s that represent 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 method of Nelder and Mead (1965) to calibrate the eleven parameters using eleven targets as summarized in Table 1.

[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 owned or mortgage payments are still being made, it does not report what fraction of the house is the equity. However, only about 10% of residential units owned by individuals have outstanding mortgages. A recent study of the Bank of Mexico reports that the loan-to-value ratio for new mortgages is 65-70 percent in 2009. In order to assess the impact of mortgages on the distribution of assets in Mexico we tried calculating the value of residential assets using two different assumptions: (i) assign only 35% of the of the house value for those units with outstanding mortgages; (ii) ignore outstanding mortgages and assign the full value of the house as residential assets. We find that the difference in the asset distribution does not change very much across these two assumptions. This may be due to the fact that only 10% of houses have outstanding mortgages. We therefore assume that individuals own the whole value of the house and count it as their residential assets.

[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

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

4.3 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 ENEU and ENOE individual data. While unemployed, we assume that human capital depreciates at a constant rate. Due to the lack of estimates using Mexican data, we use the estimates of the skill depreciations using U.S. data, and set an annual depreciation rate of 15%. The transition matrix $H^U(h, h')$ is calibrated accordingly. See, Pavoni and Violante (2008) for the survey of 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 $\Lambda_s(\varepsilon, \varepsilon')$ in sector s is based on the AR(1) wage process estimated using the ENEU and ENOE individual panel data. Unemployed individuals who receive a job offer make a draw of initial idiosyncratic productivity ε from the stationary distribution of the productivity in each sector.

4.4 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 schedule of the severance payment in Mexico by the tenure and the average duration of employment in the formal sector.[13] There is no severance payment in the informal sector, that is, $g_2 = 0$.

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

[13]See http://www.doingbusiness.org/data/exploreeconomies/mexico for more information on mandatory severance payments in Mexico.

4.5 Government

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

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%

[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 in equilibrium that would satisfy the budget constraint of the government.

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 in sec. 1	4 months of average earnings in formal sector
g_2	Firing cost in sec. 2	0

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

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

5 Numerical results

5.1 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 4. The unemployment rate is 3.7%, which matches the average value in Mexico from 2000 to 2010 based on the ENEU and ENOE data 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 16.7% every quarter, as opposed to 11.4% in the formal sector. Out of the 16.7%, 13.3% move to the formal sector and 3.5% unemployment. From the formal sector, 9.5% move to the informal sector and 1.9% to unemployment. Probabilities of quit and layoff are both higher in the informal sector, but the difference is larger in the layoff probability due to firm-initiated job destruction, which stands at 2.3% in the informal sector, about twice as high as in the formal sector.

As explained in section 4.2, probabilities of receiving a job offer are not what we observe in the data and calibrated jointly with other parameters while using various

realized flow rates as target moments. Unemployed individuals are much more likely to receive an offer from the informal sector, with probability 83% in each quarter period, than from the formal sector with probability 46%. Once on a 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 they receive and the intersectoral flow rate from formal to informal is 9.5% while it is 13.3% in the other way.

Except when employed individuals are laid off by firms, all the transitions of workers across sectors and between employment and unemployment are the results of individuals' optimal employment decisions. Formal jobs are associated with a higher wage and greater protection since employers must pay the severance payment to a worker that they lay off. At the same time, however, workers are subject to the labor income tax on earnings only in the formal sector. Unemployed individuals who decide whether to accept a job in the formal sector versus informal sector also take into account the difference in the expected duration of a job in each sector, as well as the likelihood of transitioning to another sector later when a new job offer arrives while working on the job. Although employment in the informal sector is subject to a higher probability of exogenous termination, they will receive an offer for a formal job about once in every four quarters, with probability 23.1% every period.

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.

5.2 Tax policy

The analysis of labor market policies is incomplete without taking into account fiscal and redistributional cost of such policies. In later sections, we discuss the effect of expanding employment protections through unemployment insurance and layoff costs. Benefits of the policies must be traded off against distortions created by taxation. In Mexico, consumption and labor income are the two major sources of the government's revenues beside oil (OECD, 2011).

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

Table 6 summarizes the simulation results under alternative labor income tax rates. In each scenario the consumption tax rate is adjusted so that the government budget remains balanced. More precisely, in the benchmark model, 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 fixed as exogenous government expenditures that need to be financed under alternative tax 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 shown 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 magnitude, however, of the change in unemployment is 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 the formal one, since the government is unable to capture the earnings in the informal sector and the labor income of informal workers 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. With high labor income taxation, the impact of the greater disincentive to work among formal employees is partially offset by a rise in the number of workers in the informal sector. This sectoral shift is apparent in the sharp decline in the share of formal employment from 79% to 31% when the labor income tax rate rises from 5% to 25%. As shown in Table 6, the intersectoral flow rate from formal to informal sector increases 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. An increase in the labor tax induces a sharper drop in the share of the formal sector employment and reduces the labor income tax base, and the consumption tax has to rise to cover the given government expenditures.

Higher levels of the labor income tax produce a drop in the total earnings of the individual. As explained above, higher taxes increase unemployment, which in turn reduces the time to accumulate human capital, and makes workers face the risk of skill depreciation while out of work. In addition, the average efficiency units of informal workers decline 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 average savings and consumption. The latter is also hit by a rise in 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%.

To quantify the welfare effects of alternative tax policies, we compute the change in welfare as the percentage adjustment of consumption given to the individual at every state in the economy under an alternative policy so that a new-born individual will be just as well off as in the benchmark economy. The rise in labor taxes from 15% to 25% would lead to a significant welfare loss in the order of 3% in consumption equivalence, while individuals enjoy the welfare gain of 1% in consumption equivalence when the labor income tax is reduced to 5%.

In what follows, we simulate various labor market policies that affect labor participation and sectoral allocation of employment. 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 labor 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 exacerbate 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 income taxes.

5.3 Unemployment insurance

In the benchmark economy there is 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 benchmark model. We assume that the insurance will pay benefits, which replace 50% of previous earnings with a given maximum duration. These benefits are provided to unemployed individuals only when they are separated from a job for reasons that are exogenous to workers. 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. 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 and do not switch to a job in the formal sector. We consider the maximum benefit duration of 6, 12, 24 and 36 months as alternative scenarios. As we discussed in section 5.2, 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. Note that the benefits are tied to the earnings prior to the job separation and do not necessarily reflect the wage that the unemployed individual would receive once finding and accepting a job offer. The value functions and individual problems in the economy with unemployment insurance are presented in Appendix A.

As shown in Table 7, more generous unemployment insurance with a longer maximum period of benefits 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 also highlight the finding 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 increases. The drop in formality may be 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 and that the opposite change could happen. Given the relatively small chance of qualifying for benefits through layoffs, a positive effect on the number of formal jobs if any is mostly offset by the fact that benefits can still be collected while employed informally, and many more workers choose to take a job in the informal sector before the expiration of benefits.

The incentive effects of the unemployment insurance is clearly identified by studying at the flow rates from unemployment or informality to formality, 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 to formality 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 employed 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 contributes to the decline in the aggregate consumption, which constitutes the tax base. Given the drop in consumption, 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 previously explained unemployment insurance policies are financed by labor income taxes, leaving constant the consumption tax rate at the benchmark level of 15%. Qualitative results of unemployment insurance 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 and formality drops, both of which are driven by a sharp decline in the hazard rates into formality, and welfare deteriorates. 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 is downsized, rendering the system unsustainable. Therefore, our results suggest that it may be 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%

5.4 Severance payment

In the benchmark model, firms in the formal sector are required to make a severance payment equivalent to four-months average earnings upon dismissal of a worker. More generous severance payment provides workers with protection against income fluctuations associated with exogenous layoffs initiated by employers. Workers receive such protection also through unemployment insurance, but the two policies differ in two key aspects. For the severance payment, benefits are paid by employers and in a one-time lump-sum fashion upon dismissal, but the unemployment insurance is provided by the government, financed through taxes and benefits are paid conditional on the worker remaining unemployed, or working but not in the formal sector. Both policies provide benefits only for dismissed workers in the formal sector.

In order to understand the effects of the severance payment on individuals' 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 individuals to respond and reoptimize. We shut down the effects through the interaction between individuals and firms by holding the wage rates, w_s, and the rates of job destruction initiated by firms, q_s, in each sector fixed at the benchmark levels. Table 9 shows the results of these simulations. The partial equilibrium analysis helps us identify the effects associated with a different level of severance payment on workers' labor supply decisions. 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 market. These results are displayed in

Table 10.

Table 9: Severance payments: partial eq. with individuals' 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 reported in Table 9. As the severance payment increases from 0 to 4 months of earnings as in the benchmark, and 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 to that of the informal sector. The flow rate from unemployment to employment in the informal sector falls from 55.6% with no severance payment to 47.2% when

the severance payment is raised to 24 months of earnings. The flow rate from unemployment to formality shows a little change, in the range between 28.9% and 30.7%. The decline in total hazard rates is partly due to a rise in wealth since laid off workers receive a larger severance transfer payment. In the benchmark model, as discussed in section 5.1, 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.

Welfare of individuals increases with the rise in the severance payments, as shown in the last row of the table. 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.

Once we allow for full equilibrium, letting the market determine the wages and firms terminate jobs, a large response from firms is observed as shown in Table 10. In this case, higher severance payment affects the behavior of the labor market agents in several additional ways. First, higher protection for formal workers imply a lower lay-off rate, which drops from 1.22% in the benchmark economy to 0.98% when severance payment are equivalent to 24 months of wages. Second, higher firing cost 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 individuals (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, et al (2008) show that a higher layoff cost tends to decrease unemployment in a model with a frictional labor market. Their results, however, are derived in a single labor market. In the case of our dual economy calibrated to the Mexican economy, we find that 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. The net effect is a small increase, not a decrease, 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.

6 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. The model is calibrated to the Mexican economy, where the majority of workers reside in the informal sector. Given that any government policy based on official work record in the formal sector fails to reach half of the workforce, 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 individuals 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 in economies with a large informal sector 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.

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A Individuals' problem with unemployment insurance

Employed

$$\begin{aligned} V(a,h,s,\varepsilon,b) &= \max_{c,a'}\{u(c) - B + \beta_w(1-\rho)\left[q_s EU(a',h',b')\right. \quad (15)\\ &\quad +(1-q_s)\pi_s^E E\max\{V(a',h',s,\varepsilon',b'),V(a',h',\tilde{s},\tilde{\varepsilon}',b'),U(a',h',b')\}\\ &\quad \left.+(1-q_s)(1-\pi_s^E)E\max\{V(a',h',s,\varepsilon',b'),U(a',h',b')\}\right]\\ &\quad +\beta_w\rho R(a')\} \quad (16)\end{aligned}$$

subject to

$$a' + c = (1-\tau_s)\varepsilon h w_s + (1+r)a + g_s + b \quad (17)$$

Unemployed

$$\begin{aligned} U(a,h,b) &= \max_{c,a'}\{u(c) + \beta_w(1-\rho)\left[\right. \quad (18)\\ &\quad +\pi_1^U\pi_2^U E\max\{V(a',h',s_1,\varepsilon_1,0),V(a',h',s_2,\varepsilon_2,b'),U(a',h',b')\}\\ &\quad +\sum_{i=1}^{2}\pi_i^U E\max\{V(a',h',s_i,\varepsilon_i,b'),U(a',h',b')\}\\ &\quad \left.+(1-\pi_1^U)(1-\pi_2^U)EU(a',h',b')\right]\\ &\quad +\beta_w\rho R(a')\} \quad (19)\end{aligned}$$

subject to

$$a' + c = (1+r)a + b \quad (20)$$