Taxes, Transfers and the Distribution of Employment in Mexico

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Abstract

The informal sector accounts for a substantial fraction of employed population in Mexico and other Latin American countries. In this paper we study the interaction between the tax and transfers system and the size and composition of informal sector. To do that we build a search model that can be calibrated to the Mexican data. Our model features two employment statuses: employed and unemployed; and two sectors: formal and informal. We estimate our model to data from *Encuesta Nacional de Ocupación y empleo (ENOE)* by simulated GMM. Then we perform three different policy analyses: changes in the distribution of the transfers between formal and informal sector workers, changes in the size of the transfer system, and changes in the progressivity of taxes and transfers (pending).

Our model is able to capture key features of Mexican labor markets, such as the distribution of the labor force across sectors and the distribution of accepted wage offers. Dividing transfers equally between formal and informal sector workers increases the size of the informal sector by 5 percentage points, it also increases average wages in the formal sector by 6% whereas wages in the informal sector fall by 4%. When we double the size of transfers, the size of informal sector falls by 5 percentage points. However, it has a big effect on the distribution of accepted wage offers: average wages increase by 10% in the formal sector and they raise by 16% in the informal sector.

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1   Introduction

The informal sector accounts for roughly 50% of the employed population in Mexico, a feature that is shared by many Latin American countries. This may be a barrier to development for a wealth of reasons. Workers employed in the informal sector do not participate in the tax and transfer system that allows the funding of education, health, retirement benefits and infrastructure, to mention a few. A sizable informal sector has been found to be related to lower productivity, either through using less efficient technologies or through a limited size necessary to be undetectable (see Cavalcanti & Antunes (2007), Leal (2009) and Moscoso & Erasmo (2010)). There are also papers that relate the size of the informal sector to less education (xxxx). As a consequence of these, Mexico's income per capita may be smaller than it could be with a smaller informal sector. Naturally the size of the informal sector worries policy makers all over the world.

In this paper we investigate the effects of tax and transfer policies on the size of the informal sector and the consequences to the aggregate variables of the Mexican economy. In particular, the distribution of the labor force, the distribution of accepted wage offers and productivity. This is in contrast with studies that deal with policies aimed to reduce the size of the informal sector through direct enforcement (see De Paula & Sheinkman (2010), Dabla-Norris et. al (2008) and Kuhen (2010)) and more in line with the idea that the informal sector is the product of choice and institutions such as a tax and transfer system (as in Perry, Maloney et al. (2002)) We want to provide a careful quantitative assessment of important policy reforms (see Schneider (2007) for a broad discussion on policies aimed to reduce the size of the shadow economy.)

To study this issue we build a search model in the spirit of McCall (1970.) The model features four different labor market states: employment-unemployment in the formal sector and employment-unemployment in the informal sector. Therefore a worker may be employed in the formal sector, unemployed in the formal sector, employed in the informal sector and unemployed in the informal sector. With this model we are able to study policies that may change the value of unemployment in the formal sector and therefore the value of being employed in the formal sector. The main idea of the paper may still seem counterintuitive to many policy makers as if a country suffers from the malaise of informality, an increase in the generosity of the transfers system, when it is conditional on belonging to the formal sector, may help to reduce the size of the informal sector in a significant way. This is a quantitative exercise, as policies may change the value of employment and unemployment in opposite directions. Only with a model we can quantify the equilibrium results. We start by focusing on the effects of such policies on the decisions of workers, taking as given the distribution of wage offers in the formal and informal sector. This is particularly convenient to isolate the effect of the tax and transfers system on choice. It is also useful to understand how taxes and transfers influence the distribution of accepted wage offers. If we identified an

employment with a wage, and wages with a measure of productivity, the distributions of accepted wage offers become an important element to our analysis because they measure how workers are allocated into different productivities (note: these results are pending on a general equilibrium of our model). Our model is then extended to a general equilibrium setup. We do that by using two different frameworks. In the context of search frictions, as in Mortensen & Pissarides (1994,) we introduce matching technologies for the formal and informal sectors, and include formal and informal firms that post formal and informal vacancies. This allows us to study the potential role of stochastic rationing into determining the distribution of employment. Then we study the same problem in the context of competitive search to understand the general equilibrium implications without matching frictions. To our knowledge this is one of the first quantitative papers that deals with multi-sector search models.

We estimate our model by simulated GMM[1] to key moments of Mexican labor markets using micro-data from "National Employment and Occupational Survey" (*Encuesta Nacional de Ocupación y Empleo (ENOE)* in Spanish.) We use the calibrated model to simulate three different type of policies: changes in the distribution of transfers between the formal and informal workers, changes in the size of the transfers, and changes in the structure of the tax and transfers system.[2] Next we give a preview of our results. A toy version of our model fits consistently important features of the Mexican data, such as the distribution of employment, unemployment and wages. Selection into formal or informal employment have a big impact on the observed distribution of wages. The mean of the ex-ante distribution of wage offers in the formal sector relative to the informal sector is 1.76, whereas this same statistic is 1.52 using the distributions of accepted wage offers. Therefore, the informality wage gap is bigger than the one we observe in the data and workers' choices reduce this gap.

We find that when we change the distribution of the transfers from our benchmark calibration, where informal workers receive 20% of the transfers, to informal workers receiving 50% of the transfers, the informal sector raises by 5 percentage points[3]. The average wage using the distribution of accepted wage offers in the formal sector increases by 6% whereas the same statistic for informal workers falls by 4%. This may flag substantial productivity changes across sectors and for the Mexican economy overall.

We also find that doubling the size of transfers increase the size of the informal sector by 5 percentage points, going in the opposite direction of splitting transfers in half between formal and

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[1]As future work we are planning to estimate our model as a nested likelihood problem in the spirit of Keane & Moffit (1998) to check how sensitive our results are to the estimation technique

[2]For example, if we look to OECD countries, taxes and transfers are progressive. This may change the value of the different options that a worker face in quantitatively important ways.

[3]Note that this is not directly comparable to the other experiment as the value of the transfers is changing within and across experiments

informal unemployed workers. This is conditional on our benchmark calibration assuming that formal workers 80% of the transfers. Doubling the size of the transfer system also has substantial effects on the distribution of accepted wage offers. Average wage in the formal sector raises its average wage by 10% and if also raises average wages in the informal sector by 16%.

From a policy perspective, policies aimed to be more "fair" to informal workers increase the size of the informal sector without improving inequality (as measured by the Gini coefficient on wages.) However, policies that increase the generosity of the transfer system, while restricting the transfers to formal workers, may substantially reduce the size of the informal sector and improve inequality. Our paper is closely related to Albrecht et al. (2009) in that we use a search model to study the impact of taxes and transfers on the size of the informal sector. However our paper differs in several important dimensions. We start by focusing on the workers' decision problem in a choice theoretic framework rather than Pissarides' equilibrium unemployment model, although we later extend our model in that direction; the choice structure of our model also differs in several elements that will be discussed in the following sections. This bottom-up approach also has the advantage of allowing us to understand what is the role of each of the elements that we introduce in our model. Workers are ex-ante homogeneous in our model, but they receive independent realizations drawn from an exogenous wage distribution that makes them ex-post heterogenous. They assume that workers are ex-ante heterogeneous in their ability-productivity so they self select into informality. Finally, we focus on the transfer side of the tax and transfer system. There is a tax levied on formal sector workers[4] that is used to finance transfers like unemployment benefits, severance payments[4], social security and health insurance among other welfare benefits. Our transfers are given conditional on previously being a formal sector worker whereas in Albrecht et al. (2009) the unemployment state is not conditional on the sector workers belong to. We show that this distinction is very important to understand the effects of the tax and transfers system on informality.

The paper is structured as follows. Section 2 presents evidence on the characteristics of Mexican labor market from ENOE and the size and composition of its tax and transfer system compared to other OECD countries. Section 3 lays down the model. Section 4 explains the calibration procedure to fit relevant statistics taken from ENOE. Section 5 present simulation results and Section 6 concludes and discusses extensions for future research.

2   Data

In this section we briefly present some facts for Mexico. It is worth pointing out that these features are shared to some degree by many developing economies, particularly in Latin America.

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[4]The severance payment is levied on the firm in the real world. As we will abstract from firms, this can be consider as a reduced form when firms pass on the severance tax on formal sector workers' wages

We focus on Mexico because it has a large informal sector and a rich data set which is relevant to the purpose of this paper. Additionally, Mexico has recently been in the spotlight of the policy debate surrounding informal sector literature.

We use data from the *"National Employment and Occupational Survey"* (ENOE in Spanish.) ENOE is a household survey that aims to measure unemployment and working conditions for a representative sample of the Mexican economy. The ENOE includes some questions that can be used to classify the labor force into formal and informal employment. Following the Mexican Law, we set as informal to all those workers that do not have Social Security provided as part of their job benefits. All employers in Mexico are required by law to enroll their employees into the Social Security system. If an employee provides information revealing that no Social Security is provided in the current job, then we classify such an employee as informal. If an employee is not enrolled in the Social Security System, that employee will not pay taxes and will lack of the transfers provided by the government. As for the self-employed workers, they are not required to enroll in the Social Security system. We think of them as informal too because the incidence of tax evasion is big in this group. Table 1 presents the main characteristics of the labor force according to this classification. These numbers will be later use as moments to match in the estimation of our model. Note the distribution of the labor force between formal and informal sector is derived as the stationary distribution implied by the transition matrix between sectors that we show in Table 2. We use this numbers to be consistent with the definition of steady state in our model

TABLE 1. Labor Force Statistics

Sector	Employment	Unemployment	Mean Wage	Std. Wage
Formal	.419	.024	31.69	31.63
Informal	.539	.025	21.06	24.24

Note first that more than 50% of employed workers is in the informal sector. Also note that the informal sector is characterized by a lower mean wage with also a lower standard deviation. With our model we will be able to tell how much of these differences are due to the selection into different sector's employment.

TABLE 2. Labor Market Transition Matrix

rows: t col: $t+1$	Formal	Informal	Unemployed
Formal	.84	.13	.30
Informal	.10	.85	.05
Unemployed	.23	.48	.29

3 Model

To study the effect of the tax and transfer policies laid out in the introduction, we build a model that is simple enough to understand the main forces that we think are behind the distribution of employment and unemployment of the Mexican economy. Then we extend the model to general equilibrium to be able to provide an adequate framework to understand how productivity and the distribution of wages changes when we change policies. This may also allow us to provide welfare measures of the policy changes.

3.1 A Toy Structural Model of the Mexican Economy

The economy is populated with a continuum of risk-neutral workers that discount consumption streams at a rate β. Workers are ex-ante identical but they face draws from two different distributions of wage offers. G_F is the distribution of wage offers in the formal sector and G_I is the distribution of wage offers in the informal sector. Draws from both distributions are assumed to be independent for simplicity.

The individual state variables are employment status (employed or unemployed,) employment sector (formal or informal) and current wage (w_F or w_I.) Employed workers face an exogenous sector specific separation probability, λ_i where $i \in \{F, I\}$. We abstract from on the job search because ENOE is quarterly and average duration of unemployment is less than a quarter in Mexico. Thus, observed transitions from formal to informal employment and vice-versa may include a short period of unemployment which can not be measured. We opt for the simpler specification of the model, although we acknowledge that there may in fact be direct transitions between employments without going through unemployment

Workers employed in the formal sector face a tax system $T(w_F)$ whereas those employed in the informal sector do not pay taxes. Unemployed workers that come from the formal sector receive some fraction (θ) of the tax proceeds as a transfer: $\Omega_F(w_F)$. This transfer can be understood as unemployment benefits, severance payments averaged over the periods that the worker is unemployed and the cash present discounted value of health insurance and retirement benefits. Unemployed workers from the informal sector get the remaining fraction ($(1-\theta)$) of taxes as a transfer $\Omega_I(w_I)$. This may include welfare programs that are universal or specially targeted to them, such as *Seguro Popular*. Every period unemployed workers get a draw from both formal and informal sector wage distributions with independent probabilities ϕ_i where $i \in \{F, I\}$. They must choose whether they remain unemployed or accept any of the offers at hand.

Next we present the Bellman equations that characterizes the decision structure of our model and lay out the concept of equilibrium that we use. For that we need to characterize the steady state equilibrium level of employment and unemployment in the formal and informal sectors and the

steady state distributions of accepted wage offers in the formal and informal sector.

3.1.1 Value functions

The decision problem of an individual is characterized by four Bellman equations: the value of being employed in the formal sector with a wage w_F, $W_F(w_F)$; the value of being employed in the informal sector with a wage w_I, $W_I(w_I)$; the value of being unemployed from a formal sector employment with wage w_F, $U_F(w_F)$; and the value of being unemployed from an informal sector employment with wage w_I, $U_I(w_I)$[5]

1. Value of being employed in the formal sector: note that we do not allow for on the job search so far:

$$W_F(w_F) = w_F - T(w_F) + \beta \left[\lambda_F U_F(w_F) + (1 - \lambda_F) W_F(w_F) \right] \tag{1}$$

2. Value of being employed in the informal sector

$$W_I(w_I) = w_I + \beta \left[\lambda_I U_I(w_I) + (1 - \lambda_I) W_I(w_I) \right] \tag{2}$$

3. Value of being unemployed in the formal sector

$$
\begin{aligned}
U_F(w_F) = \Omega_F(w_F) + \beta \left[\phi_F \phi_I E \max \left\{ W_F(w_F'), W_I(w_I'), U_F(w_F) \right\} \right. \\
+ \phi_F(1 - \phi_I) E \max \left\{ W_F(w_F'), U_F(w_F) \right\} \\
\left. + \phi_I(1 - \phi_F) E \max \left\{ W_I(w_I'), U_F(w_F) \right\} + (1 - \phi_F)(1 - \phi_I) U_F(w_F) \right]
\end{aligned}
\tag{3}
$$

4. Value of being unemployed in the informal sector

$$
\begin{aligned}
U_I(w_I) = \Omega_I(w_I) + \beta \left[\phi_F \phi_I E \max \left\{ W_F(w_F'), W_I(w_I'), U_I(w_I) \right\} \right. \\
+ \phi_F(1 - \phi_I) E \max \left\{ W_F(w_F'), U_I(w_I) \right\} \\
\left. + \phi_I(1 - \phi_F) E \max \left\{ W_I(w_I'), U_I(w_I) \right\} + (1 - \phi_F)(1 - \phi_I) U_I(w_I) \right]
\end{aligned}
\tag{4}
$$

Despite off we do not allow the arrival of offers when the worker is employed. Unemployed workers may get simultaneous offers from the formal an the informal sector. This allows workers to transition from formal to informal employment and vice versa although the have to go through at least one period of unemployment.

The value functions in equilibrium define reservation wages. These will be used to define transitions between employment and unemployment in both formal and informal sectors. Note that we will have four different reservation wages: the reservation wage of an unemployed worker previously in

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[5]The values of unemployment depend on wages only through transfers. If transfers are independent from wages then the values of unemployment are scalars.

the formal sector employment that evaluates an offer from the formal sector: w_{FF}^R; the reservation wage of an unemployed worker previously in the informal sector that evaluates an offer in the formal sector: w_{IF}^R; the reservation wage of an unemployed worker previously in the formal sector that evaluates an offer from the informal sector: w_{FI}^R; and the reservation wage of an unemployed worker previously in the informal sector that evaluates an offer in the informal sector: w_{II}^R.

To define these reservation wages we use the system of value functions (1)-(4). We assume that the following sufficient conditions for the existence of reservation wages hold. For any two pair of wages $(w_F^{(1)}, w_I^{(1)}) \geq (w_F^{(2)}, w_I^{(2)})$: (1) $W_F(w_F^{(1)}) \geq W_F(w_F^{(2)})$ for $i \in \{F, I\}$, (2) $U_i(w_i^{(1)}) \geq U_i(w_i^{(2)})$ for $i \in \{F, I\}$ and $W_i(w_i^{(1)}) - W_i(w_i^{(2)}) \geq U_i(w_i^{(1)}) - U_i(w_i^{(2)})$ for $i \in \{F, I\}$. This will guarantee that there are unique reservation wages and that wages above these values will induce the worker to choose employment over unemployment.

$$W_F\left(w_{FF}^R\right) = U_F\left(w_{FF}^R\right) \tag{5}$$
$$W_I\left(w_{II}^R\right) = U_I\left(w_{II}^R\right) \tag{6}$$
$$W_F\left(w_{IF}^R\right) = U_I\left(w_{IF}^R\right) \tag{7}$$
$$W_I\left(w_{FI}^R\right) = U_F\left(w_{FI}^R\right) \tag{8}$$

3.1.2 Steady State Employment, Unemployment and Wage Distributions

With the reservation wages we are able to define the steady state levels of employment and unemployment and then stationary wage distributions in the formal and informal sectors. Let e_t^F be the employment in the formal sector at date t. Similarly we can define e_t^I, u_t^F and u_t^I. The evolution of these variables is driven by reservation wages, the exogenous distribution of wage offers, the exogenous probabilities of separation and the exogenous probabilities of drawing a wage offer.

The evolution of these aggregate variables is defined by the following set of difference equations:

$$
\begin{aligned}
e_{F,t+1} &= (1-\lambda_F)e_{F,t} + \phi_F(1-\phi_I)\left[\left(1-G_F(w_{FF}^R)\right)u_{F,t} + \left(1-G_F(w_{IF}^R)\right)u_{I,t}\right] \\
&+ \phi_F\phi_I\left[\left(1-G_F(w_{FF}^R)\right)\left(1-G_I(w_{FI}^R)\right)prob\left(w_F > w_I\right)u_{F,t} + \left(1-G_F(w_{FF}^R)\right)G_I(w_{FI}^R)u_{F,t}\right. \\
&+ \left.\left(1-G_F(w_{IF}^R)\right)\left(1-G_I(w_{II}^R)\right)prob\left(w_F > w_I\right)u_{I,t} + \left(1-G_F(w_{IF}^R)\right)G_I(w_{II}^R)u_{I,t}\right] \\
e_{I,t+1} &= (1-\lambda_I)e_{I,t} + \phi_I(1-\phi_F)\left[\left(1-G_I(w_{FI}^R)\right)u_{F,t} + \left(1-G_I(w_{II}^R)\right)u_{I,t}\right] \\
&+ \phi_F\phi_I\left[\left(1-G_F(w_{FF}^R)\right)\left(1-G_I(w_{FI}^R)\right)prob\left(w_I > w_F\right)u_{F,t} + \left(1-G_F(w_{FF}^R)\right)G_I(w_{FI}^R)u_{F,t}\right. \\
&+ \left.\left(1-G_F(w_{IF}^R)\right)\left(1-G_I(w_{II}^R)\right)prob\left(w_I > w_F\right)u_{I,t} + \left(1-G_F(w_{IF}^R)\right)G_I(w_{II}^R)u_{I,t}\right] \\
u_{F,t+1} &= \left[(1-\phi_F)(1-\phi_I) + \phi_F(1-\phi_I)G_F(w_{FF}^R) + \phi_I(1-\phi_F)G_I(w_{FI}^R)\right. \\
&+ \left.\phi_F\phi_I G_F(w_{FF}^R)G_I(w_{FI}^R)\right]u_{F,t} + \lambda_F e_{F,t} \\
1 &= e_{F,t+1} + e_{I,t+1} + u_{F,t+1} + u_{I,t+1}
\end{aligned}
$$

Consider the first equation that define employment in the formal sector next period. The first component is the mass of workers whom did not loose their formal employment. The second component are those workers that accept and offer from the formal sector. Finally we have the unemployed workers in the formal and informal sector that get acceptable offers from both sectors but the formal sector offer dominates the informal sector offer. The second equation follows a similar logic. The third and forth equations describe the evolution of unemployment in the formal and informal sector. Consider the third equation. The formal unemployment rate tomorrow is the sum of those formal workers that do not get an offer, plus those that get offers but reject them. Finally there is an inflow of workers that loose their employment in the formal sector. These system of equations define a steady state for the employment and unemployment distribution. Next we need to define the equilibrium distribution of accepted wage offers. These can be computed from the primitive distribution of wage offers and rational individual behavior. Define $\Gamma_{F,t}$ and $\Gamma_{I,t}$ as the equilibrium distribution of accepted wage offers on each sector:

$$
\begin{aligned}
\Gamma_{F,t+1}(w_F) &= (1-\lambda_F)\Gamma_{F,t}(w_F) + \phi_F(1-\phi_I)g_F(w_F)\left[I\left(w_F \geq w_{FF}^R\right)u_{F,t} + I\left(w_F \geq w_{IF}^R\right)u_{I,t}\right] \\
&+ \phi_F\phi_I g_F(w_F)\left[I\left(w_F \geq w_{FF}^R\right)\left(1-G_I(w_{FI}^R)\right)prob\left(w_F > w_I\right)u_{F,t}\right. \\
&+ I\left(w_F \geq w_{FF}^R\right)G_I(w_{FI}^R)u_{F,t} + I\left(w_F \geq w_{IF}^R\right)\left(1-G_I(w_{II}^R)\right)prob\left(w_F > w_I\right)u_{I,t} \\
&+ \left.I\left(w_F \geq w_{IF}^R\right)G_I(w_{II}^R)u_{I,t}\right]
\end{aligned}
$$

$$
\begin{aligned}
\Gamma_{I,t+1}(w_I) \;=\; & (1-\lambda_I)\Gamma_{I,t}(w_I) + \phi_I(1-\phi_F)g_I(w_I)\left[I\left(w_I \geq w_{FI}^R\right)u_{F,t} + I\left(w_I \geq w_{II}^R\right)u_{I,t}\right] \\
& + \; \phi_F\phi_I g_I(w_I)\left[I\left(w_I \geq w_{FI}^R\right)\left(1-G_F(w_{FF}^R)\right)prob\left(w_I > w_F\right)u_{F,t} \right. \\
& + \; I\left(w_I \geq w_{FI}^R\right)G_F(w_{FF}^R)u_{F,t} + I\left(w_I \geq w_{II}^R\right)\left(1-G_F(w_{IF}^R)\right)prob\left(w_I > w_F\right)u_{I,t} \\
& + \; \left. I\left(w_I \geq w_{II}^R\right)G_F(w_{IF}^R)u_{I,t}\right]
\end{aligned}
$$

Each of the equations define a steady state measure of accepted wage offers: Γ_F and Γ_I. The measures are normalized to one.

The steady state equilibrium transfer system can be defined as:

$$
\theta u_F + (1-\theta)u_I = \int_0^\infty T(w_F)d\Gamma_F(w_F)
$$

which tells us that total resources collected by the government equal total transfers to the unemployed from the formal and informal sector.

3.2 Extension to General Equilibrium

3.2.1 Equilibrium with Matching Frictions

Decision problem of firms:
We start by modeling the behavior of firms in the simplest way possible to be able to compare our results with the decision model.

There is a continuum of firms with mass 1. Every firm may decide to post a vacancy in the formal or in the informal sector. Firms can change their decision every period. Firms discount future values at the rate β (the same rate as workers do.) Vacancies fill at a random rate that is sector dependent $q_i(\theta)$, where $i \in \{F, I\}$. This rate comes from matching technology as it is standard in the literature of search with matching frictions. The parameter θ is the labor market tightness. We assume it is not sector specific because there is a unique labor market but two different sectors. When a vacancy is filled a quality of the match is drawn from a distribution that depends on the sector ($G_i(x_i.)$ The following two Bellman equations describe the problem of posting a vacancy:

1. Value of creating a vacancy in the formal sector:

$$
V_F = -c_F + \beta\left(q_F(\theta)E\max\left\{J_F(x_F'), V_F, V_I\right\} + (1-q_F(\theta))\max\left\{V_F, V_I\right\}\right)
$$

2. Value of creating a vacancy in the informal sector:

$$V_I = -c_I + \beta \left(q_I(\theta) E \max \left\{ J_I(x_I'), V_F, V_I \right\} + (1 - q_I(\theta)) \max \left\{ V_F, V_I \right\} \right)$$

where $J_i(x_i)$ is the value of a filled vacancy We assume that the cost of creating a vacancy is not the same in the formal sector and informal sector. We believe the assumption is reasonable as formal and informal vacancies may use different advertisement mechanism to reach workers. In equilibrium, the value of vacancies is zero. Otherwise, firms would be creating vacancies in either sector until any possible gain in value disappears. This gives us two job creation conditions

$$c_F = \beta q_F(\theta) E \max \left\{ J_F(x_F'), 0 \right\}$$

and

$$c_I = \beta q_I(\theta) E \max \left\{ J_I(x_I'), 0 \right\}$$

When a vacancy is filled, worker and firm sign a contract (either legal or implicit) that pays the worker a wage $w_i(x_i)$ for producing x_i units of consumption. If the vacancy filled is formal, the firm is labeled as formal and has to pay social contributions for the worker (τ_{sc}) The formal firm has to pay a severance payment when the match is destroyed ($S(x_F)$.) We assume matches are destroyed at an exogenous rate λ_i As formal employed workers usually have to fill an income tax form, we assume that income taxes are paid only by the employed workers[6]. A filled vacancy has a value $J_i(x_i)$ that depends on the productivity realization. The value of a formal employment can be written as:

$$J_F(x_F) = \frac{x_F - (1 + \tau_{sc}) w_F(x_F) - \beta \lambda_F S(w_F(x_F))}{1 - \beta(1 - \lambda_F)}$$

similarly the value of an informal firm can be written as:

$$J_I(x_I) = \frac{x_I - w_I(x_I)}{1 - \beta(1 - \lambda_I)}$$

Decision problem of workers:

Workers face the same set of decisions than in the toy version of this model. However, there are two main differences: wages are not exogenous anymore but depend on the bargaining process with the formal and informal firms, and job finding probabilities are endogenous. Also the tax and transfers system has two different components first a tax that is used to fund social contributions. This tax is levied on firms, but firms levy it on workers through the wage equation, and it is a constant fraction of wages. The second component is a tax schedule that is levied on formal

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[6]We abstract from business taxes

workers to fund general government spending. We assume that informal workers do not pay any tax.

The decision of workers can be summarized by a set of four Bellman equations:

1. Value of being employed in the formal sector: note that we do not allow for on the job search so far:

$$W_F(x_F) = w_F(x_F) - T((1 - \tau_{sc})w_F(x_F)) + \beta \left[\lambda_F U_F(x_F) + (1 - \lambda_F) W_F(x_F) \right] \tag{9}$$

2. Value of being employed in the informal sector

$$W_I(x_I) = w_I(x_I) + \beta \left[\lambda_I U_I(x_I) + (1 - \lambda_I) W_I(x_I) \right] \tag{10}$$

3. Value of being unemployed in the formal sector

$$
\begin{aligned}
U_F(x_F) = {} & \Omega_F^{sc}(w_F(x_F)) + S(w_F(x_F)) + \Omega_F^g(w_F(x_F)) \\
& + \beta \left[q_F(\theta) q_I(\theta) E \max \left\{ W_F(x_F'), W_I(x_I'), U_F(x_F) \right\} \right. \\
& + q_F(\theta)(1 - q_I(\theta)) E \max \left\{ W_F(x_F'), U_F(x_F) \right\} \\
& \left. + q_I(\theta)(1 - q_F(\theta)) E \max \left\{ W_I(x_I'), U_F(x_F) \right\} + (1 - q_F(\theta))(1 - q_I(\theta)) U_F(x_F) \right]
\end{aligned}
\tag{11}
$$

4. Value of being unemployed in the informal sector

$$
\begin{aligned}
U_I(x_I) = {} & \Omega_I^{sc}(w_I(x_I)) + \Omega_I^g(w_I(x_I)) + \beta \left[q_F(\theta) q_I(\theta) E \max \left\{ W_F(x_F'), W_I(x_I'), U_I(x_I) \right\} \right. \\
& + q_F(\theta)(1 - q_I(\theta)) E \max \left\{ W_F(x_F'), U_I(x_I) \right\} \\
& \left. + q_I(\theta)(1 - q_I(\theta)) E \max \left\{ W_I(x_I'), U_I(x_I) \right\} + (1 - q_F(\theta))(1 - q_I(\theta)) U_I(x_I) \right]
\end{aligned}
\tag{12}
$$

where $\Omega_i^{sc}(w_i(x_i))$ are the transfers component that is financed through social contributions and $\Omega_i^g(w_i(x_i))$ are the transfers component financed through general taxation.

Definition of equilibrium:

To define an equilibrium in this model we need to characterize three elements: the bargaining process between workers and firms, the evolution of employment and unemployment and the equilibrium distribution of productivities in the formal and informal sector.

Lets begin with the bargaining process. We assume that workers and firms negotiate wages in a Nash bargaining process, as it is standard in the literature. There are two negotiation processes, one for the formal sector workers and firms and another one for the informal sector. The wage

schedules can be found implicitly as a solution to the following system of equations

$$
\begin{aligned}
W_F(x_F) - U_F(x_F) &= \alpha_F \left(W_F(x_F) + J_F(x_F) - V_F - U_F(x_F) \right) \\
W_I(x_I) - U_I(x_I) &= \alpha_I \left(W_I(x_I) + J_I(x_I) - V_I - U_I(x_I) \right)
\end{aligned}
$$

where α_F and α_I are the bargaining powers of workers in the formal and informal sectors. The evolution of employment, unemployment and productivities is similar to the system spelled out in the previous section but we have to change ϕ_i for $q_i(\theta)$ and wages are now a function of the latent productivities. We do not repeat all the algebra to save space.

We assume that the budget of the government balances. Now it has two components: the first one are the social contribution taxes that it are devoted to provide social services.

$$
\tau_{sc} \int w_F(x_F) d\Gamma(x_F) = \int \left(\Omega_F^{sc}(w_F(x_F)) + S(w_F(x_F)) \right) d\Gamma(x_F) + \int \Omega_I^{sc}(w_I(x_I)) d\Gamma(x_I)
$$

where $\Gamma(x_i)$ are the steady state equilibrium distributions of latent productivities in the formal and in formal sectors. The budget balance for general government spending is given by

$$
\int T((1 - \tau_{sc})w_F(x_F)) d\Gamma(x_F) = \int \Omega_F^g(w_F(x_F)) d\Gamma(x_F) + \int \Omega_I^g(w_I(x_I)) d\Gamma(x_I)
$$

A steady state equilibrium in this economy is a list: $W_i(x_i)$, $U_i(x_i)$, $J_i(x_i)$, V_i, $w_i(x_i)$, $\Gamma_i(x_i)$, $q_i(\theta)$, θ, τ_{sc}, $T((1 - \tau_{sc})w_F(x_F))$, $\Omega_i^{sc}(x_i)$ and $\Omega_i^g(x_i)$ such that:

1. Taking $w_i(x_i)$, $q_i(\theta)$, τ_{sc}, $T((1 - \tau_{sc})w_F(x_F))$, $\Omega_i^{sc}(x_i)$ and $\Omega_i^g(x_i)$ as given, $W_i(x_i)$, $U_i(x_i)$ solve the system of Bellman equations for workers' decisions

2. Taking $w_i(x_i)$, $q_i(\theta)$, $(w_F(x_F))$ and τ_{sc} as given $J_i(x_i)$ and V_i solve the system of Bellman equations for firms' decisions

3. Nash bargaining: $w_i(x_i)$ are solutions to the Nash bargaining problem in the formal and informal sectors

4. $\Gamma_i(x_i)$ are consistent with optimal behavior of workers and firms, wages set through Nash bargaining, job finding rates and the latent distribution of productivities

5. Budgets of the Government balance

3.2.2 Competitive Search Equilibrium

[WORK IN PROGRESS]

4 Calibration

To calibrate the model we use simulated GMM. As a first step we set $\theta = 1$ which means that informal-unemployed do not get any transfer. We assume that the tax schedule levied on the formal workers is proportional $T(w_F) = \tau w_F$ and we set $\tau = .15$, which roughly represents the average tax on income that is levied on formal workers. Formal-unemployed workers get a lump-sum transfer that equals collected taxes.

$$\Omega_F = \tau \int_0^\infty w_F d\Gamma_F(w_F)$$

We assume that wage offers of formal and informal sectors are drawn from i.i.d. log-normal distributions with potentially different mean and variance

$$\log(w_i) \to N(\mu_i, \sigma_i^2) \text{ where } i \in \{F, I\}$$

This gives us eight parameters to calibrate that we collect in the vector

$$\varphi = (\lambda_F, \lambda_I, \phi_F, \phi_I, \mu_F, \mu_I, \sigma_F, \sigma_I)$$

We chose the vector of parameters that minimized the mean squared percent deviation from a set of statistics from ENOE. The statistics we choose are the fraction of employees in the formal sector $(\hat{e}_F)$, the fraction of employees in the informal sector $(\hat{e}_I)$, total unemployment $(\hat{u})$, unemployment in the informal sector $(\hat{u}_I)$, mean wage in the formal sector relative to the informal sector $(\frac{\bar{w}_F}{\bar{w}_I})$, mean wage in the informal sector $(\bar{w}_I$, we normalize this number to 1,) coefficient of variation of wages in the formal sector (cv_F) and coefficient of variation of wages in the informal sector $(cv_I.)$ The following table shows the vector of parameters that minimized the mean squared deviation of the simulated moments to their ENOE equivalents It is worth commenting that the probability of

TABLE 3. Calibrated Parameters

λ_F	λ_I	ϕ_F	ϕ_I	μ_F	μ_I	σ_F	σ_I
.030	.043	.425	1.000	.002	-.498	.881	.780

loosing a job in the formal sector is smaller than the probability of loosing a job in the informal sector. This is probably due to severance payments and other employment regulations that affect formal employment only. It is also more than twice as likely to get an offer in the informal sector than in the formal sector. This parameters should be interpreted carefully until we have a general equilibrium version of the model, where job finding and job destruction probabilities will be endogenously determined. These estimated parameters induce the following moments that we

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compare to those in the data in the next table.

TABLE 4. Calibration Performance

	e_F	e_I	u	u_I	$\frac{\bar{w}_F}{\bar{w}_I}$	$\bar{w}_I$	cv_F	cv_I
Data	.419	.539	.041	.024	1.600	1.000	1.000	.868
Model	.418	.538	.043	.026	1.528	1.033	1.016	.793

The model provides a very good match of employment and unemployment. It matches employment in the formal and informal sector up to two decimal points. The model also matches the distribution of unemployment and total unemployment, even though total unemployment is over estimated by .002 percentage points but formal unemployment is matches accurately. The model is also very accurate capturing the first order and second order moments of the observed distribution of wages. The distributions of accepted wages imply a Gini coefficient of .45 for the formal sector employees and .35 for the informal sector employees. Overall, the Gini coefficient is .42. The OECD reports a Gini coefficient around .45 in the last decade. This is remarkable as the model is very parsimonious[7]

As can be seen in Table 3, our model also implies that accounting for the selection into formal and informal sectors reduces the formal wage premium by 13%. This means that this wage premium is bigger than what we observe in the data. However, the relative variability of the ex-ante distribution of wages is smaller than the variability for the accepted wage offer distributions.

TABLE 5. Distribution of Wage Offers

Distribution	$\frac{\mu_F}{\mu_I}$	$\frac{cv_F}{cv_I}$
Ex-Ante	1.768	1.142
Ex-Post	1.528	1.280

Figure 1 plots the distribution of accepted wage offers in the formal (panel (a)) and the informal sector (panel (b)) against the ex-ante distribution of wage offers. We observe a substantial difference between ex-ante and ex-post distributions. Selection into formal and informal employment tilts the distribution of accepted wage offers to the right of the ex-ante distribution of wage offers. It can also be noted that the distribution of accepted wage offers has two kinks. Consider panel (a), the first kink is a mass point of zero and it is the reservation wage of informal unemployed workers (w_{IF}^R.) that consider to accept a formal employment offer. Changes in this value will change the bottom tail of the distribution of accepted wage offers. The second kink is the reservation wage of formal unemployed workers (w_{FF}^R) Changes in this value may have big effects

[7]In particular, given that we are abstracting from an intensive margin in the choice of hours and a more detailed modeling of transfers, to mention a few.

on the mass of wages that concentrate around the average. The same comments apply to panel (b). The first kink would be the reservation wage for an informal unemployed worker (w_{II}^R) and the second kink for those formal unemployed workers (w_{FI}^R)

FIGURE 1. Ex-Ante vs. Accepted Wage Distributions
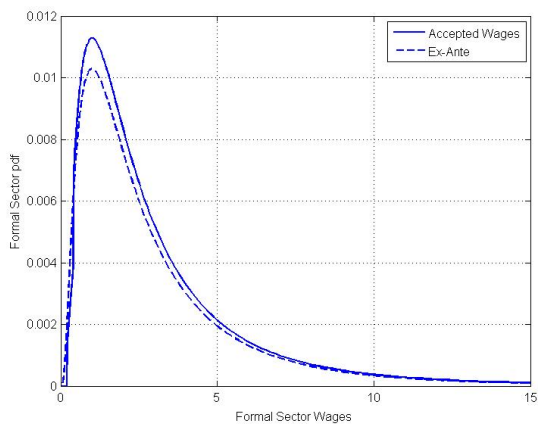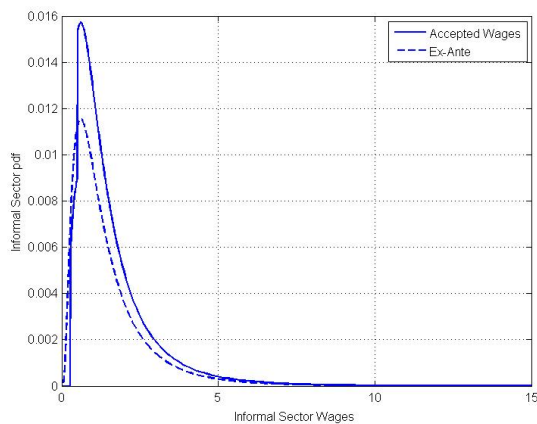
(a) Formal Sector   (b) Informal Sector

5 Policy Simulation

In this section we analyze two types of policy reforms: changing the generosity of the transfers system and changes in the distribution of the transfers between formal and informal workers.

5.1 Changes in Distribution of Transfers

We will keep taxes constant at the benchmark level of 15% but change the distribution of the transfers between formal and informal workers. Starting from the benchmark assumption in which formal workers get all the transfers when they become unemployed, we increase the share that informal workers get from the transfers system.

Dividing transfers equally between formal and informal workers increases the share of the informal sector by 5 percentage points, as we can see in Table 6. This number is similar to what we find when we double the size of transfers. It is also interesting to note that even though total unemployment does not change, its distribution between formal an informal sector changes. For our benchmark calibration informal unemployed workers represent 60% of total unemployed. When we divide transfers equally between formal and informal unemployed workers, this share raises by 9%. If we look at how does inequality change when we change the distribution of transfers we see that in the formal sector inequality goes down while in the informal sector inequality goes up, leaving total inequality roughly constant. Therefore, extending benefits to the informal sector increases its size substantially without changing inequality. On the other hand, restricting transfers to formal workers would increase the size of formal sector by almost 3 percentage points[8]

TABLE 6. Changes in Distribution

θ	1	.8	.6	.5	.4	.2
e_F	.438	.417	.391	.367	.367	.355
e_I	.517	.540	.567	.582	.590	.602
u_F	.020	.017	.014	.013	.012	.011
u_I	.024	.025	.027	.028	.029	.030
$\bar{w}_F$	1.572	1.577	1.621	1.652	1.673	1.715
$\bar{w}_I$	1.037	1.011	.985	.970	.962	.955
$Gini_F$	.441	.437	.425	.419	.415	.407
$Gini_I$	.357	.350	.349	.353	.356	.361
$Gini$	.418	.416	.413	.414	.414	.415

Changing the distribution of transfers from 20% to informal workers to 50% also have a big

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[8]This is a big number as if we consider an economically active population of 65 million, 3 percentage points are roughly 3 million.

impact on the distribution of accepted wage offers in the formal sector. Average wage increases by 6%, this number raises to 9% when informal workers get 80% of the transfers. The increase in average wage goes through the increase in the reservation wage of informal unemployed workers, the bottom tail of the distribution, as we can see in panel (a) of Figure 2. Similarly average wages fall in the informal sector because the value of informal unemployment raises more than the value of informal employment. Being unemployed from the informal sector becomes an attractive alternative. Average wages fall for the informal employed workers by 4% (by 6% when 80% of transfers are given to informal unemployed workers)

FIGURE 2. Changes in Distribution of Transfers and Distribution of Wages

(a) Formal Sector

(b) Informal Sector
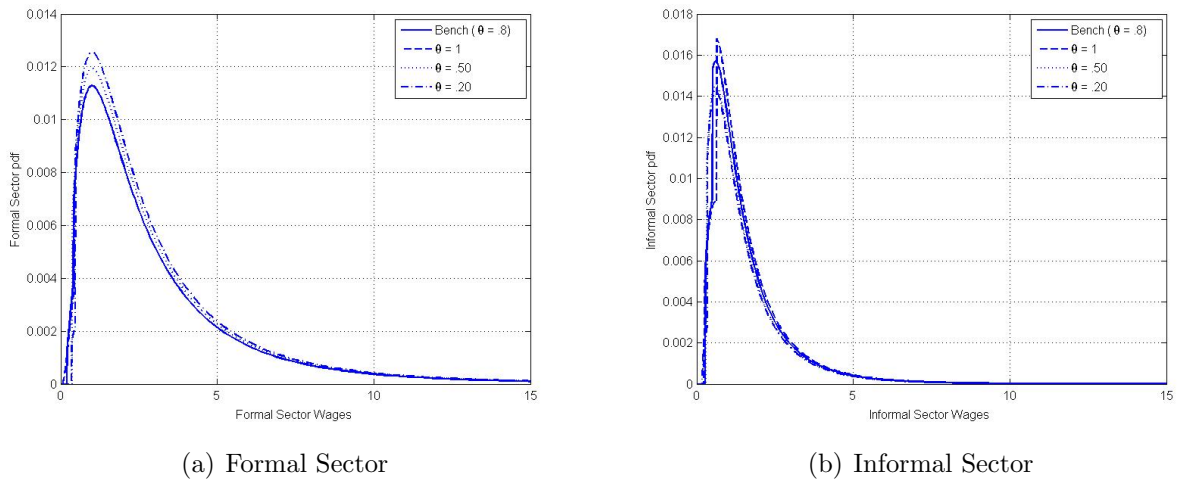
We support this interpretation in Table 7, checking how do the reservation wages change when we increase the share of transfers that the informal workers get.

TABLE 7. Changes in Reservation Wages

τ	1	.8	.6	.5	.4	.2
w_{FF}^R	.439	.420	.392	.3839	.367	.351
w_{IF}^R	.066	.201	.328	.3839	.420	.480
w_{FI}^R	.644	.514	.383	.3210	.274	.201
w_{II}^R	.245	.280	.313	.3210	.328	.343

The reservation wages that affect both distributions move in opposite directions. As the share of transfers that formal workers perceive falls while keeping the same tax rate, w_{FF}^R falls. However, the reservation wage of informal unemployed workers to accept an offer in the formal sector raises. Quantitatively, the overall effect induces a raise in the average wage of the formal sector.

5.2 Changes in the Size of the Transfers

We will keep the distribution of transfers constant to its benchmark level and change the size of transfers from a tax rate of 5% to a tax rate of 55%. Note that as the budget balances this is equivalent to a change in transfers' size.

Increasing the size of transfers first reduces the size of informal employment because the value of the transfers that a worker gets when unemployed in the formal sector out-weights the cost in terms of higher taxes. As the size of transfers rise this drop reverses and informal employment raises again, as can be observed in Table 8. The effects of doubling the size of transfers are quantitatively important: informal employment drops by 5 percentage points.

TABLE 8. Changes in Size

τ	5%	15%	25%	35%	45%	55%
e_F	.386	.417	.446	.464	.467	.450
e_I	.573	.540	.507	.484	.475	.486
u_F	.013	.017	.022	.027	.033	.039
u_I	.026	.025	.024	.023	.023	.024
$\bar{w}_F$	1.544	1.577	1.648	1.747	1.882	2.018
$\bar{w}_I$	.935	1.010	1.099	1.183	1.260	1.309
$Gini_F$	.443	.437	.428	.420	.413	.417
$Gini_I$	.366	.350	.343	.340	.342	.345
$Gini$	.430	.416	.405	.398	.396	.403

Note also that total unemployment raises and tilts towards the formal sector because the incentives to remain unemployed increase with the raise in the size of the transfers' program. Doubling the size of transfers increases unemployment by .8%. The effect on the distribution of accepted wage offers is big. Doubling the size of transfers increases average wages in the formal sector by 10% and it increases average wages by 16% in the informal sector. The effects on wage inequality are small.

Table 9 spells out how the distribution of employment, unemployment and accepted wage offers changes. In the formal sector, the reservation wage of formal workers raises because the value of being unemployed increases. The value of formal employment increases too, but the increase in the value of unemployment dominates. The increase in the value of formal employment over the value of informal unemployment makes the reservation wage of informal workers to accept a formal employment offer drop. This is what creates the U-shape on the size of the informal sector.

Figure 3 illustrates how changes in the reservation wages map into changes in the distributions of accepted wage offers.

TABLE 9. Changes in Reservation Wages

τ	5%	15%	25%	35%	45%	55%
w_{FF}^R	.300	.420	.575	.754	.990	1.301
w_{IF}^R	.234	.201	.154	.096	.029	.000
w_{FI}^R	.335	.514	.705	.864	1.013	1.109
w_{II}^R	.256	.280	.300	.321	.335	.343

FIGURE 3. Changes in Size of Transfers and Distribution of Wages

(a) Formal Sector

(b) Informal Sector
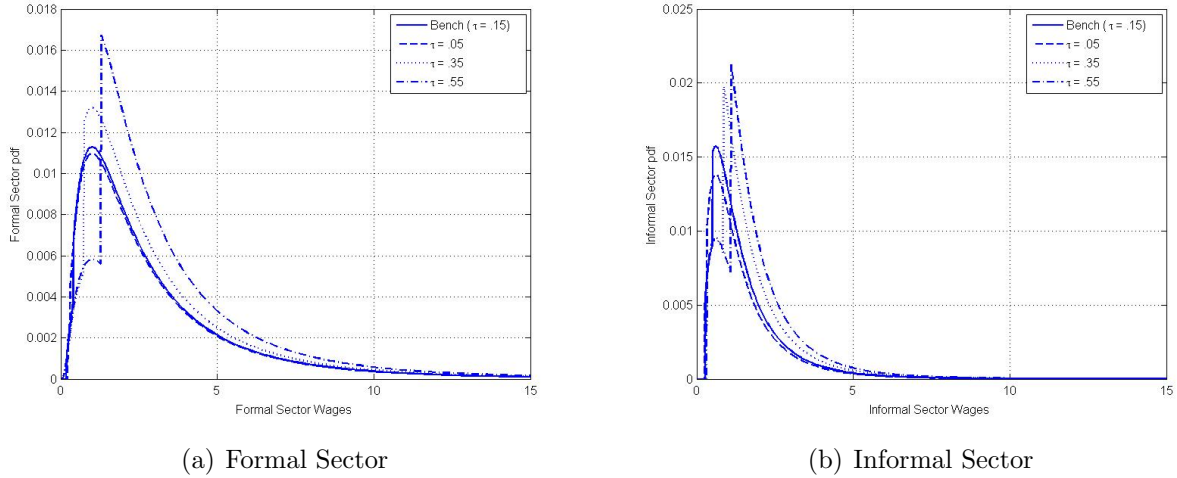
5.3 Interaction between Size and Distribution

In this section we show how the combination of size of transfers and its distribution between formal and informal workers shape employment, unemployment, wages, inequality and the weight of the informal sector in measured GDP in our model.

Figure 4 shows the composition of the size of the formal and informal sector in the steady state. The figure clearly shows that the effects of policy on the size of the informal sector depends on the combination of size and distribution of transfers. If the formal sector receives all transfers we get the biggest reduction on the size of the informal sector. The minimum size of the informal sector is achieved when formal workers get all transfers and the size of the transfers system is considerably increased from 15% of wages in the formal sector to 45%. However, the size of the informal sector can only be reduced when a bigger share is given to it when the size of the transfers is reduced.

Figure 5 shows the composition of employment in both formal and informal sectors. It tracks the composition of the sectors shown in Figure 4. The logic on how changes in size and distribution affect employment and unemployment was explained in previous sections.

Figure 6 shows the composition of unemployment. When size increases total unemployment raises, but also unemployment on each of the sectors. When all transfers are given to the formal

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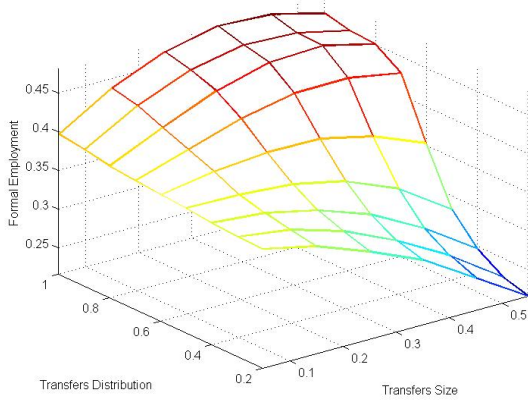FIGURE 4. Changes in Policies and Sectoral Composition
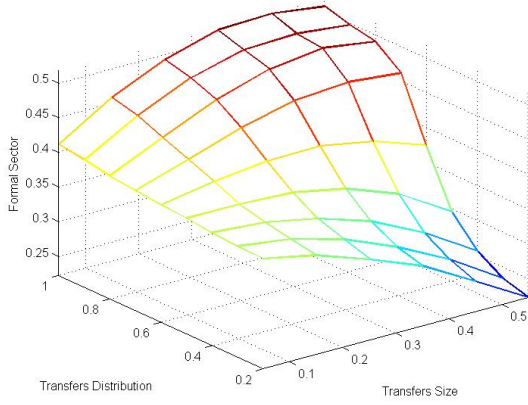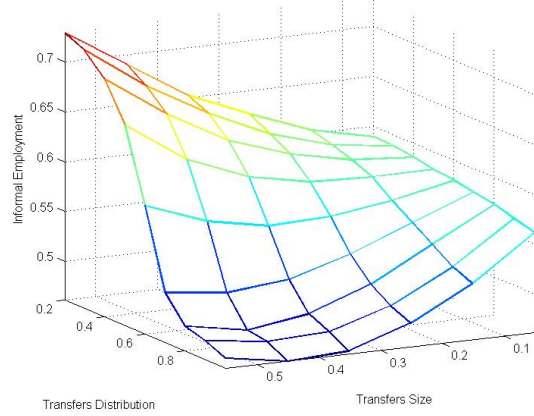

(a) Formal Sector
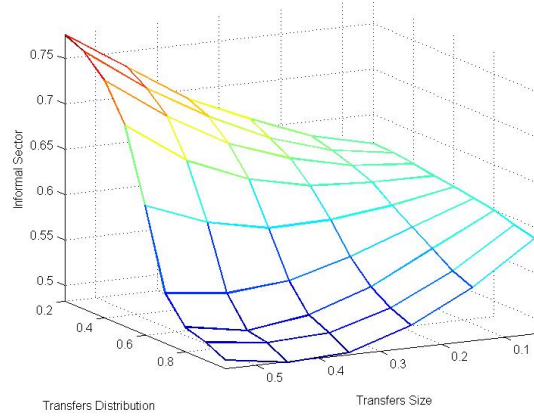
(b) Informal Sector

FIGURE 5. Changes in Policies and Employment Composition


(a) Formal Sector

(b) Informal Sector

sector, increasing the size of the transfers system increases formal unemployment but reduces informal unemployment because it is attractive to accept an offer in the formal sector and then randomly become a formal unemployed worker.

Figure 7 shows how the combination of policies change the composition of GDP, in hour model

$$GDP = \int_0^\infty w_F d\Gamma_F(w_F) + \int_0^\infty w_I d\Gamma_I(w_I)$$

FIGURE 6. Changes in Policies and Unemployment Composition

(a) Formal Sector

(b) Informal Sector
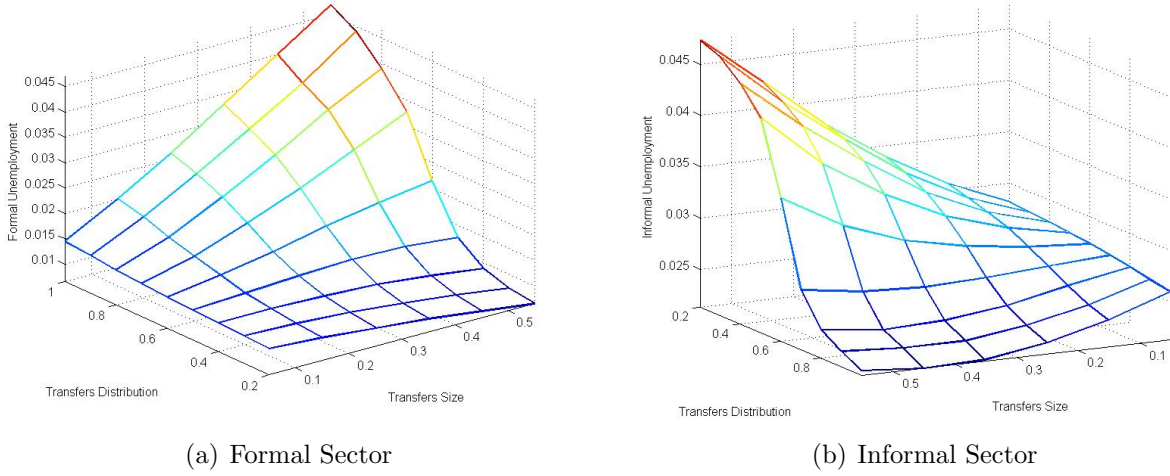
so GDP is affected by changes in the total measure of formal and informal employees[9] and changes in the shape of the distribution.

In the Appendix we show similar figures for average wages and inequality.

FIGURE 7. Changes in Policies and Composition of GDP

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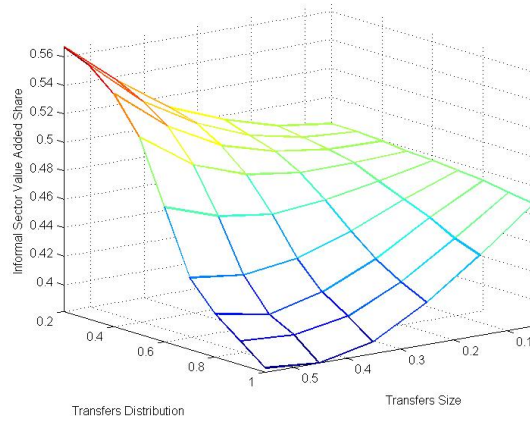
[9]As $\int_0^\infty d\Gamma_i(w_i) = e_i$ where $i \in \{F, I\}$

6 Conclusion

We have built a search model that features four different labor market states to capture the choice of workers to be employed in the formal or informal sectors. We do this to study key features of Mexican labor markets to evaluate some important policy reforms. Even though the policies analyzed are very stylized they capture three main features of taxes and transfers: the split of the budget between formal and informal workers, the size of the system and its progressivity. As a consequence of their choice and current tax and transfers system, unemployment also depend on the sector.

We calibrate the model to Mexican data because of its relative quality, but our model may apply to other countries. A very simple specification of the model is able to match accurately key statistics of the Mexican economy. With the calibrated version of the model we perform several simulation exercises to quantify the effects of tax and transfers policies aimed to increase the value of formality. This policies are now in the center of a vivid policy debate.

We find that giving a bigger share of transfers to informal workers increase the size of the informal sector by a substantial amount and it does not make the distribution of wage offers more equal. There are also a potentially important reallocation of the labor force across sectors and productivities. Based on our findings, programs like universal health care or universal unemployment insurance may not be a good idea after all.

On the other hand, increasing the size of the transfers program reduces the size of the informal. Therefore increasing social protection to formal workers only may be the way to go to fight informality with taxes and transfers.

The next step of our research is to embed our model into a general equilibrium setup to evaluate the consequences of the proposed policy reforms. Natural extensions would be to include an intensive margin for labor choice, asset accumulation with credit constraints. These features seem relevant for economies such as Mexico and will be included in the future versions of this paper.

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8 Appendix

FIGURE 8. Changes in Policies and Inequality

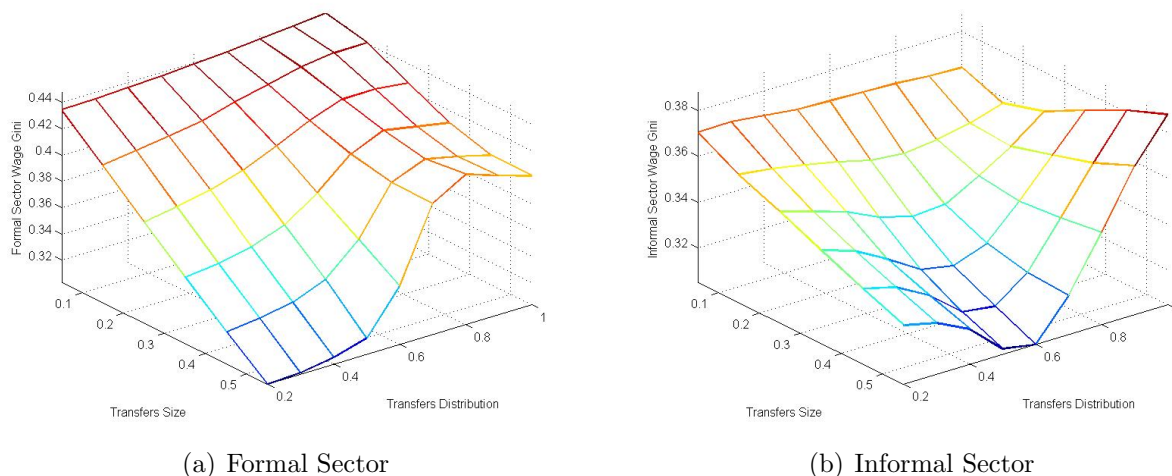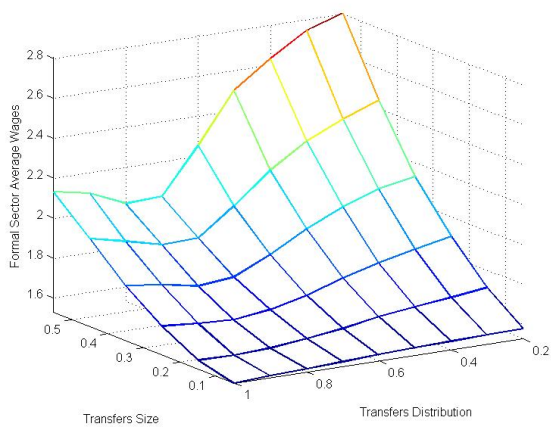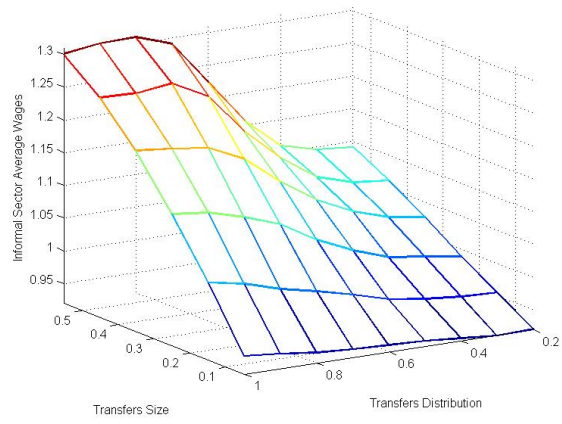(a) Formal Sector   (b) Informal Sector

FIGURE 9. Changes in Policies and Wages

(a) Formal Sector

(b) Informal Sector