Cross-subsidies, and the elasticity of informality to social expenditures: the case of Mexico's Seguro Popular *

Jorge Alonso-Ortiz
ITAM

Julio Leal
Banco de México

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Abstract

How is the size of the informal sector affected when the distribution of social expenditures across formal and informal workers changes? How is it affected when the tax rate and the generosity of these transfers changes? We use a search frictions model with an informal sector, (ex-post) heterogeneous workers, and conditional taxes and transfers to address these questions. In our model, formal jobs are "better" than informal jobs, but harder to get. Taxes are proportional to the wage, while transfers are lump sum, implying a cross-subsidy from high-income to low-income workers. We calibrate the model to Mexico and perform counterfactuals. We find that the size of the informal sector is quite inelastic to changes in taxes and transfers. This is due to frictions, and due to the fact that the marginal worker weighs two opposing forces: changes in taxes (negative) vs. changes in transfers (positive). These two forces act simultaneously leaving reservation wages roughly unchanged. Our results are consistent with the empirical evidence on the recent introduction of Seguro Popular.

Keywords: informality, social expenditures, cross-subsidies, Seguro Popular.
JEL codes: E26, J46, O17.

1 Introduction

The informal sector accounts for a large share of employment in many low-income and middle-income countries. Neither firms that operate in the informal sector, nor their workers, pay taxes or social contributions.[1] As a consequence, informal workers are not enrolled in social security. A common policy reaction of many governments has been to introduce transfer programs directed to informal workers to alleviate their lack of protection. Several authors have argued that the introduction of these type of social programs provides an incentive for informality and discourages formality as higher taxes are needed to

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[1]Despite popular beliefs, the informal sector is included in national accounts statistics. The informal sector is measured using employment and micro-business surveys (See UN-SNA 1993). Of course, this measurement is subject to standard errors.

finance the programs.[2] Thus, two natural questions arise: 1) how is the size of the informal sector affected when the distribution of transfers across formal and informal workers changes? and 2) how is the size of the informal sector affected when the generosity of transfers (i.e. the tax rate) received by both formal and informal workers changes?

To our knowledge, there is no clear reference in the literature that addresses these questions within the context of a model. A *basic model of informality* often used (see Section 3), consists on a simple extension to the framework used by Summers (1989), where a labor supply and demand curves model in a perfectly competitive setup, was used to illustrate the idea that "without close links between taxes and benefits (...) large distortions can result." Similarly, this *basic model of informality* assumes a demand curve for formal labor, a demand curve for informal labor, a constant supply of labor, and perfectly competitive markets with free mobility across formal and informal jobs.[3] In parallel to Summer's model, providing valuable transfers to informal workers represents an incentive for informality because (by definition) such transfers are not tied to taxes; similarly, changes in taxation on formal workers can affect the size of the informal sector if benefits provided by formal jobs are not fully valued.[4] One key assumption in this framework is that workers *voluntarily* choose to be formal or informal, and, as a result, workers (whom are assumed to be homogeneous) remain indifferent between the two kinds of jobs.

In contrast, a traditional view sustains that jobs in the formal sector are "better" than informal jobs because the former offer more protection and benefits (thus, implicitly assuming that formal benefits are highly valued). In the most traditional version of this view, above market equilibrium wages forces workers to stay informal and *involuntarily* queue for formal sector jobs.[5] Thus, providing transfers to informal workers would hardly affect the incentives to be informal (because there are none).

The most recent literature on informality and labor markets tends to focus on models that are somewhere in between the two views above, recognizing some role for choice and some role for chance, in accordance with the most recent empirical evidence.[6] In addition, the recent literature has also recognized the importance of worker's heterogeneity to address several questions. Models with search and matching *frictions*, and heterogeneous workers, have been used to study the effects of labor market policies (such as unemployment insurance, severance payments, and the like) on informality.[7] The innovation in this paper is to focus on how the distribution of both taxes and transfers across formal and informal workers

[2]For the case of the health care program "Seguro Popular" recently introduced in Mexico, the seminal work is Levy (2008), and recent contributions include Duval Hernández and Smith Ramírez (2011), Azuara and Marinescu (2013), and Bosch and Campos-Vázquez (2010).

[3]Recent work explicitly using this model include Maloney (2004), Levy (2008), and Almeida and Carneiro (2012). This model has also been used to study the extent in which payroll taxes linked to social security benefits affect the size of the informal sector in developing countries. For example, for the case of Chile see Edwards and Edwards (2002), and for Colombia see Kugler et al. (2008).

[4]See section 3.

[5]This is the view of the dual labor markets. The seminal paper is Lewis (1954), and recent contributions include Fields (1990), Chandra and Khan (1993), and Loayza (1994). See Fields (2004) for more references. As pointed out by Albrecht et al. (2009), the recent work by Satchi and Temple (2009), preserves the spirit of dualism in the labor markets. The authors use a search and matching model but informal workers search (queue) for formal sector jobs, while formal workers are not allowed to search for informal jobs.

[6]See for example, Maloney (2004) and Perry et al. (2007)

[7]See for example, Albrecht et al. (2009), Bosch and Esteban-Pretel (2012), Fugazza and Jacques (2004),Meghir et al. (2012); Esteban-Pretel and Kitao (2013); Zenou (2008)

affect informality.

In this paper, we address the questions posed above by using a model that has three main characteristics: 1) search frictions with formal and informal sectors; 2) taxes and transfers that depend on the formality status of individuals; and 3) (ex-post) heterogeneous workers.

We believe that including the first characteristic is a natural step that follows from the discussion above. Individuals searching for a job will get an offer only with some probability. Furthermore, an offer from the formal sector will arrive with less probability than an offer from the informal sector. Similarly, jobs can be lost with some probability every period, and the probability of loosing a formal job is lower than the probability of loosing an informal job. Thus, our model captures well the popular idea that formal jobs are less risky than informal jobs, but harder to get. We emphasize that in our model being informal is a choice (given frictions) which allow us to have two-way flows: from the informal sector to the formal sector (with a period of unemployment in between), and viceversa. Our calibrated version of the model will be consistent with the view that, in general, formal jobs are better than informal jobs,[8] but search frictions prevent all workers from having the chance to obtain a formal job offer, and thus, many end-up optimally accepting informal jobs because these arrive more frequently.

The second characteristic (conditional taxes and transfers) is included to capture a feature of reality of the tax and transfer system: formal workers pay taxes and receive transfers, while informal workers receive transfers but do not pay taxes. Thus, the tax revenue from the taxes paid only by the formal workers is distributed as social expenditures and split between two groups: formal and informal workers.

Finally, the third characteristic (heterogeneous workers) is included to allow for the possibility of a cross-subsidy through the tax and transfer system from high-income workers to low-income workers. Specifically, if taxes are proportional to the wage rate, and transfers are set by dividing the tax revenue equally across the population, then individuals with low-wages will receive a high transfer relative to the taxes they pay, and the opposite will occur for high-wage earners (they will pay high taxes and receive a small transfer).

In the model, we assume that transfers are divided equally among the members of each group (formal or informal), and that these do not depend on wages. As we will see, the design of this tax and transfer system leads to results that might seam counter-intuitive at first sight. For example, when a sufficiently large fraction of the tax revenue is given to formal workers, it might be the case that a tax hike increases formality. The reason for this is that if the marginal worker (i.e. the one that is indifferent between being unemployed and working) is a low-wage earner, then, for this worker, transfers in the formal sector will increase more than taxes, which will lead to an increase in the value of a formal job, and as a result to an increase of formality in equilibrium.

We calibrate this model to Mexico, a typical developing country with a sizable informal sector by matching several moments of the economy. We match employment and unemployment; the fraction of

[8]The view that formal jobs are "better" than informal jobs is at odds with the also widespread view that the valuation of the benefits provided by formal jobs is low. We recall in section 3 that "partial-valuation" of benefits is a necessary condition to obtain a positive elasticity of informality to payroll taxes in the *basic model of informality*. If benefits are fully valued, the elasticity of the informal sector to tax changes is zero in that model. The reason for this is that the basic model assumes free mobility. We do not rely on the assumption of free mobility in our model, thus, it is not necessary to assume that benefits are not fully valued to obtain a non-zero elasticity.

employment and unemployment in the formal sector; the first and second moments of the distribution of wages in both sectors; the total social expenditures over GDP ratio, and the fraction of social expenditures directed to formal workers. Using this calibrated model we perform three counter-factual exercises: 1) We change the distribution of transfers, holding taxes constant; 2) We change taxes, holding the distribution of transfers constant; and 3) We change both, taxes and the distribution of transfers, simultaneously, to replicate the facts associated with the recent introduction of Seguro Popular (SP). Specifically, we simulate an increase in the generosity of the transfer system along with a redistribution towards informal workers consistent with the data from the SP program. We think of this last exercise as a way to validate the quantitative performance of our model.

Our results are fourfold. First, we find that the distribution of social expenditures across the two groups (formal and informal) is an important determinant of informality and that it influences its size in both directions: more transfers to informal workers increase informality, but also, more transfers to formal workers increase formality. The reason for this is that the distribution of transfers affect the relative value of formal and informal jobs. The mechanics in the model that produce these changes are as follow. When transfers directed to formal individuals increase, formal jobs become more valuable. Since unemployment reflects the discounted future value of working, the value of formal unemployment also increases, but the value of formal jobs increases more than the value of formal unemployment. This occurs because the value of unemployment takes into account not only the possibility of getting a formal job in the future, but also the possibility of ending up in an informal job with lower transfers (see Fig. 5.1). This pushes-down the reservation wage for a formal job, and more formal offers are accepted. On the other hand, the value of informal jobs and the value of informal unemployment both decrease (because transfers are lower), but the value of a job decreases more than the value of unemployment for similar reasons. This, in turn, pushes-up the reservation wage, and less informal jobs are accepted.

Second, we find that the informal sector is quite inelastic to small changes in the distribution of social expenditures. Increasing the fraction of transfers to formal workers by 1% (holding taxes constant) decreases the size of the informal sector only by 0.24%. The main reason for this is the presence of frictions which act as a deterrent for mobility across sectors.

Third, regarding the second question of this paper, we find that the informal sector decreases when taxes increase, which is in clear contrast to the common belief that more taxes automatically imply more informality. The magnitude of the effect is very small, nonetheless. The reason for this relies on the opposite forces affecting the marginal worker's choices. On the one hand side, taxes increase, which lowers the value of formal jobs; but, on the other hand, transfers increase, which increases its value. These two effects tend to offset each other for the current distribution of transfers across the formal and informal sectors. Of course, the elasticity is greatly influenced by the way transfers are distributed. In fact, when all transfers are given to informal workers, the elasticity has the opposite sign, and the range of variation in informality for comparable tax changes is much greater.

Finally, and consistent with the three previous results, our model predicts a small increase on informality in response to the introduction of SP, which is in line with the evidence found using micro-

econometric techniques.[9] We believe that this last result is a way to validate the quantitative performance of our model. If we had found that our model gives implausible numbers for the SP counter-factual exercise, we would have reasons to be worry about how suitable the model is to address the questions posed in this paper.

Our paper is related to the literature on the effects of social programs on informality (e.g. Levy (2008), Bosch and Campos-Vázquez (2010), Duval Hernández and Smith Ramírez (2011), and Azuara and Marinescu (2013)). It improves on the existing *basic model of informality* by emphasizing the importance of frictions and worker's heterogeneity, both of which affect the incentives faced by the marginal worker. The basic model gives support to many popular ideas regarding informality such as that increasing taxes automatically reduces the formal sector, or that there exists partial-valuation of formal benefits. These popular beliefs lose support in a more realistic model such as the one used here.

Despite our application to Mexico, we believe that our results are relevant for other countries with similar characteristics to Mexico, such as Brazil, Perú, Colombia, and many other Latin American and developing countries in general. For example, in Almeida and Carneiro (2012) the authors empirically analyze a change in policy in Brazil that increased the benefits of formal jobs, showing that this led to a decrease in informality. Our theoretical analysis is consistent with this type of response of informality.

The rest of the paper is organized as follow. In section 2 we present relevant facts on Mexico's labor markets, social expenditures, and those regarding the introduction of Seguro Popular. In section 3, we present the basic model of informality to build intuition on our later results. In sections 4 and 5, we present our baseline model that includes search frictions and ex-post worker's heterogeneity, and discuss its equilibrium properties. In section 6 we calibrate the model to the Mexican data and in section 7 we present the results. Section 9 concludes.

2 Relevant Facts

In this section we present relevant facts on Mexican labor markets and social expenditures. We would like to address three main issues. The first one is that there are important flows between formality and informality, and viceversa. This means that unemployed individuals that used to have an informal job often choose to go into the formal sector; similarly, unemployed individuals that previously had a formal job, often choose an informal job. The second issue concerns social policy in Mexico. Social programs are directed to special groups in the population and we distinguish between formal and informal workers; however, transfers are distributed equally among the members of a group. Taxes on the other hand, are proportional to the income of the individuals. The third issue is regarding the recent introduction of Seguro Popular, a social program directed to informal workers: this signified a change in the size and the distribution of transfers across formal and informal groups.

[9] See footnote 2

2.1 Data on workers' flows

To obtain workers' flows we use a household survey that specializes on labor market issues: Encuesta Nacional de Ocupación y Empleo (ENOE). We use data from the first quarter of 2012 to the third quarter of 2013, and obtain simple averages. We chose this period because we wanted to focus on a period after the Seguro Popular program was fully introduced (see below). We define a formal worker as one that is enrolled in the traditional Mexican Social Security system (IMSS) and an informal worker as one that does not have access to IMSS. Under Mexican law, employers are legally obliged to enroll their employees in IMSS, but self-employed workers are not obliged to enroll themselves. Furthermore, we believe that the decision to become self-employed, although influenced by social programs, it greatly depends on other factors, such as, the managerial ability of individuals. For these reasons, we will focus on employees only, and abstract from self-employed workers. Given the presence of alternative social programs for those not covered by IMSS, the formality status of employees is directly linked to the type of social programs they have access to.

We are interested in four labor market states: formal employment, informal employment, unemployment of individuals that used to have a formal job, and unemployment of individuals that use to have an informal job. Henceforth, we will refer to those unemployed individuals that were formal in the previous job as "formal unemployed." We will use the term "informal unemployed" in an analogous way. Table 1 presents the time average of quarter to quarter transition probabilities across these four states for the 2012-2013 period.[10]

There are several facts worth mentioning in Table 1. First, there is high persistence in the employment states; second, the probability of directly switching from a formal job to an informal one or vice versa is around 10% for both kind of workers. Third, notice, however, that the probability of becoming unemployed for an informal worker is almost twice as high as the probability of becoming unemployed for a formal worker (0.045 vs. 0.023). This reflects the fact that the informal sector is more "dynamic" and jobs can be destroyed more easily than in the formal sector. Fourth, formal unemployed and informal unemployed display radically different transition probabilities. For an informal unemployed the probability of going back to an informal job is six times bigger than the corresponding probability of getting a formal job (0.665 vs. 0.130). In contrast, for a formal unemployed, the probability of moving to a formal job is higher than the probability of moving to an informal job. Another interesting feature is the fact that the probability of remaining unemployed when formal, is higher than the corresponding probability when the individual is an informal unemployed (0.273 vs. 0.205).

This evidence suggests that there is something fundamentally different between the two kinds of unemployment. If the differences were minimal, a model that abstracted from such distinction would suffice. In this paper we offer a very simple explanation behind these differences: on the one hand, formal jobs are harder to get, because they arrive at a low probability; on the other hand, transfers while unemployed are contingent on the unemployed individual's previous work. Since the transfers

[10] To construct this transition matrix, it was necessary to track down the previous employment of all unemployed individuals in t. We do this to be able to record the formality status of the previous job, and taking advantage of the rotating panels in ENOE.

Table 1: Labor Market Transition Matrix

	$e_{F,t+1}$	$e_{I,t+1}$	$u_{F,t+1}$	$u_{I,t+1}$
$e_{F,t}$	0.865	0.112	0.023	0.000
$e_{I,t}$	0.100	0.855	0.000	0.045
$u_{F,t}$	0.456	0.271	0.273	0.000
$u_{I,t}$	0.130	0.665	0.000	0.205

Notes: The Table shows the Transition Matrix between two consecutive quarters. We define four states: formal employment (e_F), informal employment (e_I), formal unemployment (u_F), and informal unemployment (u_I). The starting states are shown in the rows, while the ending states are in the columns. The content of a cell (x,y) indicates the fraction of individuals that started in state x, and ended next quarter in state y.

Table 2: Labor Market Stocks

	Data implied by transition matrix (2012-2013)	Raw data average (2012-2013)
e_F	0.451	0.452
e_I	0.507	0.480
u_F/u	0.33 (0.014)	.320
u_I/u	0.66 (0.028)	.680
u	0.042	0.067

Notes: The Table shows the value of labor market aggregates implied by the transition matrix in Table 1, compared to actual data on the same variables.

that accrue to formal unemployed individuals are bigger than the transfers that accrue to informal ones, formal individuals stay longer in unemployment, and are willing to wait until a formal offer arrives. As a result, formal unemployed individuals accept more formal sector offers than informal unemployed people.

We obtain the steady state stocks of the four states above implied by this transition matrix, and compare them to the simple time averages in the raw data in Table 2.[11] We note that in the data, the unemployment rate is higher than in the implied stocks. The reason for this is that we are abstracting from self-employment, and thus the denominator used to calculate unemployment in the data is small. Next, we argue that transfers differ according to formality status.

2.2 Social Expenditures

Mexico has two competing transfer systems: social security and social protection programs. Social security transfers are those provided by IMSS, and, therefore, received only by formal workers. These transfers (mostly in kind) consist of health care services, retirement pensions, disability insurance, housing loans, work risk insurance, day care services, sports and cultural facilities, and life insurance, among others.

Informal workers, on the other hand, are beneficiaries of an alternative transfer system made up of several unlinked social programs that include cash and in kind transfers. Among the most important programs of this type is Seguro Popular, which was introduced in 2004 and provides free health care for

[11] To obtain the steady state stocks we rise this matrix to the 1000 power.

individuals without access to social security. In section 6 we provide a quantitative assessment of the introduction of Seguro Popular on the size of the informal sector. Another example of a sizable social program is Progresa-Oportunidades, which was introduced in the nineties, and provides cash transfers for poor families.

One important feature of social programs of this kind is that they provide transfers (either, in kind or in cash) that can be thought of as increasing the amount of goods consumed by the individuals. To the extent in which these transfers provide perfect substitutes of goods and services that consumers value, this assumption is correct.

To obtain the size of transfers, there are easily available data at the aggregate level on the Social Expenditure database of the OECD (SOCX.) This database reports that total social expenditure was 7.7% of GDP in 2011 and 7.4% in 2012 (which gives an average in of 7.5% during these two years). This includes cash and in kind benefits from both transfer systems above.[12]

However, the SOCX database does not consider the distribution of transfers between formal and informal workers. To our knowledge there is no database that includes the distribution of all social programs across formality status. One available assessment can be found in the influential book of Levy (2008), who estimated that an informal worker gets 5670 MXP out of 24519 MXP, that is, 23% of total social transfers. However, the data used for this figure, corresponds to a period before Seguro Popular was fully introduced, and therefore it is likely to underestimate the current split of social transfers. There is also data from the ministry of health regarding expenditures on health services, including IMSS and Seguro Popular, across "covered" (by social security) and "uncovered" workers. According to this data, in 2011, 45% of all government health spending was done on informal workers.

To assess the fraction of social expenditures in programs directed to formal workers we use the detailed database of SOCX, where the title and transfer amount of each program is recorded. We classify each program according to the government institution that provides it. Those provided by the Secretaría de Desarrollo Social (Social Development Ministry) are classified as programs directed towards informal workers, while those that are provided by IMSS, ISSSTE or PEMEX are classified as programs directed towards formal workers. Regarding health spending, we use data from Secretaría de Salud (Health Ministry) to obtain the fraction spent in programs directed to informal workers. Using this methodology we conclude that 62% of of social spending is distributed to programs directed to formal workers, and the rest to informal workers.

2.3 Social programs and cross subsidies

The concept of "partial-valuation" of benefits is grounded on the idea that government supplied goods and services are of less quality than the same goods and services provided by the market. There is for sure efficiency losses associated with government production. However, we argue that even if this is the case, the way in which social policy is generally organized, many workers may end-up receiving larger

[12]The OECD Social Expenditure Database classify expenditures according to the purpose of the social program that originates it. There are nine main areas: old-age, survivors, incapacity-related benefits, health, family, active labor market policies, unemployment, housing, and other social policy areas. Education is not included.

benefits than the taxes they pay. The reason is the existence of a cross subsidy from high-income to low-income workers that is possible due to the nature of the tax and transfer systems.

Take for example the case of IMSS in Mexico. IMSS is an institute that provides health care (among other goods and services) to affiliated workers and their families, and its operation is financed through a payroll tax. Thus, low-wage earners pay less taxes than high-wage earners. However, every affiliated individual has the right to receive the same health care services, with no exception. The amount in which health care services in IMSS are provided to individuals is not based on how much contributions (taxes) the worker paid; instead, services are daily provided for everyone that is affiliated as demand indicates. Every year there is a budget allocated to the operation of IMSS health care services.

Based on these facts, we believe that a reasonable good way to model social policy is using transfers that are rebated to workers on a per-capita basis. Of course we do recognize that some social programs are directed towards special groups in the population, this is precisely the reason why we use a model where some transfers are received by informal workers and other transfers are received by formal workers. But given that, we still have to take a stand on the way transfers are distributed within these special groups. We distribute transfers within groups on a per-capita basis, independently of the individual's wage, to reflect the idea that the goods and services received through the transfer system are the same for each member of a group. Under this arrangement, notice that –since taxes do depend on wages– it is possible to have individuals within groups that receive a transfer that is larger, equal, or smaller than the taxes paid.

2.4 The case of Seguro Popular

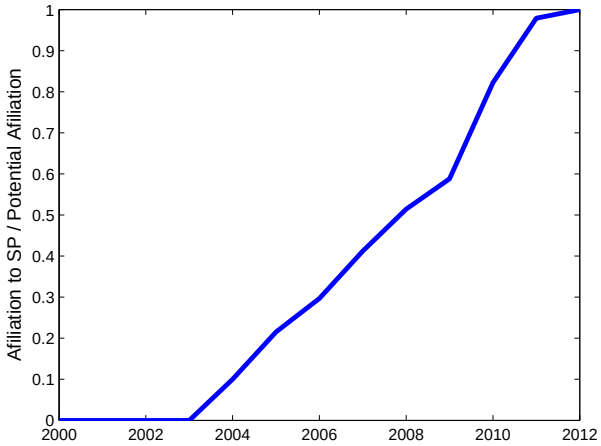
Seguro Popular is a program designed to provide health services to the population not covered by the traditional social security system. The program was gradually introduced in Mexico starting in 2004 and reaching its potential in 2012. This has signified an important increase in the transfers devoted to informal workers. Figure 2.1 shows the evolution of affiliation to the system. In particular, the figure shows the cumulative number of persons registered each year as a fraction of the total number of persons registered in 2012 (the potential). As it is clear from the figure, at the beginning of 2009 more than 50% of potential affiliation had already taken place, and by the end of 2010 82% were enrolled.

As a result of the introduction of Seguro Popular, government health spending increased from 2.6% of GDP to 3.1% in the period. But more importantly, the composition of expenditures across the formal and informal sectors changed (See Figure 2.2). Government spending on health programs devoted to informal workers increased from 32% of total spending in 2004 to 45% in 2011.

Is there any evidence in the aggregate data that this change in the size and distribution of taxes and transfers has induced changes in informality? To answer this question we look at time series data of the size of informality and the cyclical component of GDP.[13] We include the cyclical component of GDP to emphasize the counter-cyclical nature of informality. The series are presented in Figure 2.3. Notice that informality increases in 2009 and stays high until 2012, when it starts going down again. The increase

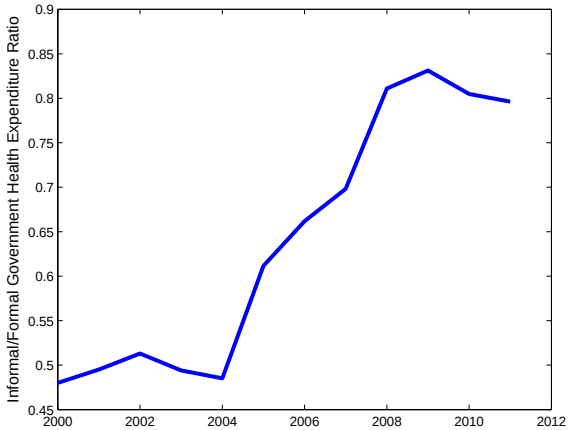
[13]The definition of informality here is the same one used in section 2.1: formal workers are those enrolled in IMSS. We use an HP-filter to de-trend the series.

Figure 2.1: Affiliation to Seguro Popular



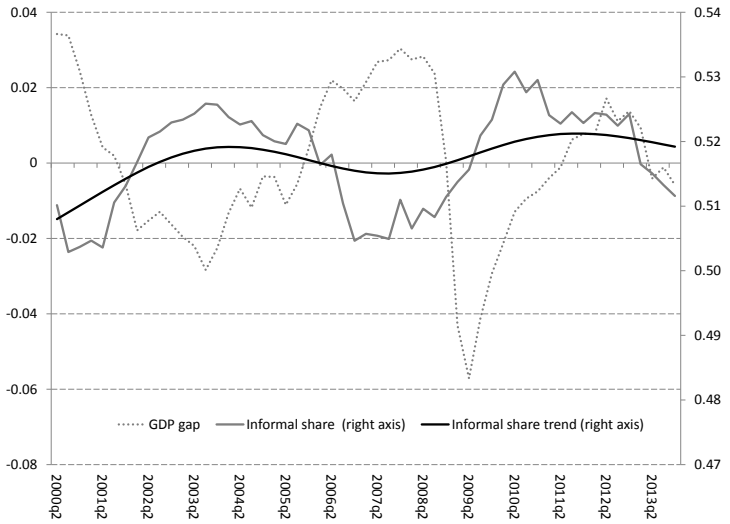
Source: Sistema de Protección Social en Salud. Informe de Resultados 2012. Notes: The Figure shows the evolution of affiliation to the Seguro Popular program. Relative Affiliation is presented as a fraction of Potential Affiliation. Potential Affiliation is defined as the number of people enrolled in the program in 2012.

Figure 2.2: Informal/Formal Government Health Expenditure Ratio



Source: Ministry of Health . Notes: The Figure shows the evolution of the ratio of public helth expenditures on informal workers relative to that on formal workers.

Figure 2.3: Evolution of informality among employees



Source: Own calculation using ENE, ENOE and National Accounts. Notes: The Figure shows the evolution of informality and the GDP gap between 2000 and 2013. Informality is clearly counter-cyclical. There is no clear change on the evolution of informality between 2004 and 2012 when Seguro Popular was introduced.

in informality that starts in 2009 can be attributed, in great part, to the severe contraction experienced by the Mexican economy in that year. So we believe that the evidence of changes in informality due to the design of social programs is not strong. In section 7 we perform a counter-factual exercise using the model described in Section 4 and show that our model predicts a small increase on informality due to the introduction of Seguro Popular. This is consistent with the evidence found elsewhere.[14]

[14]See footnote 2

3 A *basic model of informality* with homogeneous workers

In this section we would like to review the standard results of two-sector models with homogeneous workers and no labor market frictions (i.e. no unemployment). This will be useful to later compare these results against the ones from our framework with heterogeneous workers and frictions. These models typically assume an exogenously given supply of labor, and a demand curve for each type of worker, formal and informal (e.g. Maloney (2004); Fields (1990, 2004); and Levy, 2008). One can think of two representative firms, one formal and one informal that lead to these demands through profit maximization. No endogenous entry by firms is allowed.

On the worker's side, it is assumed that there is a continuum of identical workers with mass 1, and each worker can freely choose to work either as a formal or as an informal worker. If formal, the worker receives the wage w_F, if informal, the worker obtains wage w_I. We will consider the inclusion of taxes and transfers in a second stage. Market clearing works in the following way: labor demand equals labor supply for each type of worker, and, in addition, the sum of formal workers plus informal workers has to be equal to 1 (the total mass of workers).

Due to free mobility, in this economy wages must equalize:

$$w_F = w_I,$$

and given the absence of taxes or transfers, this also implies that the marginal cost of a formal worker is equal to the marginal cost of an informal worker. Figure 3.1 depicts the equilibrium for this simple economy. As shown by Fig. 3.1, firms demand labor until the marginal benefit of an extra worker is equal to its marginal costs. The total amount of formal labor demanded is given by the intersection of curve D_F and marginal cost w_F. This is measured in the x-axis from left to right by the distance OF. Similarly, the quantity demanded of informal labor is given by the intersection of D_I and w_I, and is measured in the x-axis from right to left by the distance PF. Notice that the sum of formal workers and informal workers is equal to the distance OP which measures the total amount of labor available in the economy. Thus, in these models, the size of the informal sector is "positive" even in the absence of taxes and transfers. For later reference, we will refer to this equilibrium as the "undistorted" equilibrium.

Now consider an economy with taxes. In particular assume that the formal workers have to pay a fixed rate $\tau > 0$ of their income. In this case, due to free mobility, it is the case that:

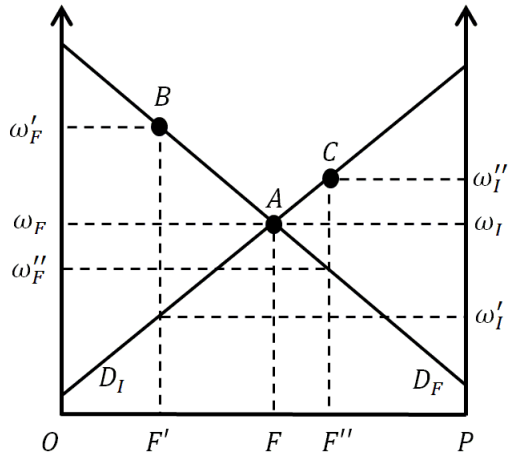
$$(1-\tau)w_F = w_I. \tag{3.1}$$

What must be equalized is net earnings in order to eliminate arbitrage opportunities. However, from the perspective of the firms, marginal costs are still given by:

$$\begin{aligned} w_F &: MC\ formal\ worker \\ w_I &: MC\ informal\ worker \end{aligned} \tag{3.2}$$

Thus, a labor tax introduces a wedge between the marginal cost of formal labor and the marginal cost

Figure 3.1: Equilibrium in a two-sector model with homogeneous workers



Source: Author's elaboration. Notes: The graph summarizes the equilibrium in the "basic model of informality" with free mobility. Point A shows the equilibrium without taxes and transfers. In this case, the size of the formal sector is given by OF, while the size of the informal sector by PF. Point B is the equilibrium when a tax on formal workers is present, in this case the formal sector shrinks. Finally, point C shows the equilibrium when the transfers to formal workers T are bigger than the taxes they pay $T > \tau w_F$. In this case, the formal sector increases.

of informal labor, in particular: $w_F > w_I$. This wedge affects the equilibrium by increasing the share of informal labor as depicted in Figure 3.1 by the variables with an apostrophe. As shown by Fig. 3.1, the intersection of D_F and w'_F is at point B, which implies a smaller formal sector measured by OF' and a larger informal sector PF'.

Finally, consider an economy with taxes and transfers. Assume that $\tau > 0$ as before, and that additionally, formal workers get a lump-sum transfer$T > 0$. Again, due to free mobility, net earnings equalize to eliminate arbitrage opportunities, and it must be that:

$$\begin{aligned} (1-\tau)w_F + T &= w_I \\ \iff w_F - \tau w_F + T &= w_I \end{aligned} \tag{3.3}$$

Now, to understand the implications of the interaction of these two policies on the marginal costs faced by firms, lets consider the next three general cases:

a)$T = \tau w_F$,

b)$T < \tau w_F$, and

c)$T > \tau w_F$.

Case (a) corresponds to a situation when the workers get back all what they paid in taxes. In this case, marginal costs of formal and informal workers equalize: $w_F - \tau w_F + T = w_I \Leftrightarrow w_F = w_I$. The first equality follows from the free mobility condition, while the second one follows from the equation (a) above. Therefore, when the formal workers are given back their taxes, the equilibrium is the same as in the undistorted case.

Case (b) $T < \tau w_F$ corresponds to the situation when the workers do not get back the total proceeds of their taxes. In this case, a wedge between the marginal cost of formal workers and that of informal workers is present, in particular: $w_F > w_I$. The equilibrium for this case is similar to the case when we only had a tax and no transfer and the informal sector increases. In fact, $T = 0$, can be seen as an extreme case of (b).

The opposite happens in case (c), $T > \tau w_F$, where the workers get more than what they paid in taxes. A wedge between the marginal cost of a formal worker and an informal one is introduced again, but in this case $w_F < w_I$ and, as a consequence, *the formal sector increases.* This situation is depicted in Figure 3.1 with the variables labeled with two apostrophes. The marginal cost of a formal worker is now intersected with D_F at point C in the graph. This implies that the formal sector is given by the distance OF''.

Given our assumption of homogeneous workers, cases (b) and (c), correspond to situations where the budget of the government is not balanced. However, when there are heterogeneous workers, cross-subsidies between high-income and low-income workers, allow for the possibility to have all three cases above simultaneously, and, at the same time, to have a balanced budget in equilibrium. In our model below, we will have workers that receive more than what they paid in taxes, workers that receive less than what they paid in taxes, and workers that receive the same than what they paid. We will argue that the marginal workers, that is, those workers that are indifferent between being formal or informal, receive more transfers than what they pay in taxes (case c above, $T > \tau w_F$). Consequently, a more generous system (that increases taxes along with transfers, keeping a balanced budget) will increase transfers proportionally more than taxes for these marginal workers, which will result in an increase of the formal sector.

4 Model with frictions and (ex-post) heterogeneous workers

To study the effects of the structure of taxes and transfers in Mexico, we build a search model that features a formal sector, an informal sector, and unemployment. 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 face random draws from two different, and independent 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. The individual state variables are employment status (formal, informal), unemployment status (formal or informal) and current wage (w_F or w_I).[15] We refer to unemployed individuals that previously had a formal job as "formal unemployed," and we use the term "informal unemployed" in an analogous way. Employed workers face an exogenous sector specific separation probability, λ_i where $i \in \{F, I\}$. As we abstract from on the job search, observed transitions in any direction between formal and informal employment include a period of unemployment.

The structure of taxes and transfers in the model is as follow. Workers employed in the formal sector pay a proportional tax on wages τw_F whereas those employed in the informal sector do not pay taxes.

[15] We abstract from sub-index t, since we will be focusing on the steady state.

Tax revenue is the sum of all taxes paid by formal workers. A fraction θ of the tax proceeds is transferred to formal workers and the remaining fraction $(1-\theta)$ is transferred to informal workers. These transfers are on a per capita basis: a formal worker receives T_F, while an informal worker receives T_I. We think of these per-cápita transfers as the value of all cash and in-kind benefits accrued to workers. These might include health services, retirement benefits, unemployment insurance, and other social security and social protection benefits.

Every period, unemployed workers get a draw from both formal and informal sector wage distributions with independent probabilities q_i where $i \in \{F,I\}$. They must choose whether they remain unemployed or accept any of the offers at hand. Note that we assume that the transfers while unemployed are the same as the transfers while employed. Since $T_F > T_I$ (see section 6), this implies that formal unemployed individuals get a higher transfer than informal unemployed ones. For the informal sector, we think of these transfers as the health care services of Seguro Popular, and other social protection programs that do not stop if an individual looses his or her job. Regarding formal unemployed, individuals can enjoy IMSS health care services for two months after they lose their job, although, during strong recessions, this period has been extended to 4 months. Since in our data, only 27% of formal unemployed individuals remain as such next quarter, we believe this benefit is meaningful. Additionally, formal unemployed individuals have access to severance pay, and to part of their retirement funds. To keep the model as simple as possible, we do not intend to capture all these details of Mexican labor laws. Instead, we believe that all these regulations imply that, in general, the formal unemployed individuals are in a much better financial position than the informal unemployed ones, which is well captured by our model. Moreover, having $T_F > T_I$ while unemployed helps to obtain calibrated values of frictions that are consistent with the popular view that formal jobs are less risky, but harder to get (see section 6).

Next, we write down Bellman Equations that characterize the decision of workers and lay out an equilibrium definition. For that we need to characterize the steady state equilibrium levels of employment in the formal and informal sectors, unemployment, and the steady state distributions of accepted wage offers in both sectors.

4.1 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, $V_F(w_F)$; the value of being employed in the informal sector with a wage w_I, $V_I(w_I)$, and the values of being formal or informal unemployed U_F, and U_I.

The value of being employed in the formal sector is given by:

$$V_F(w_F) = T_F + (1-\tau)w_F + \beta\left[\lambda_F U_F + (1-\lambda_F)V_F(w_F)\right] \tag{4.1}$$

This function says that the value of being a formal worker is given by today's income plus the value of the future discounted by β. Current income has two sources: the transfers T_F, and the wage net of taxes $(1-\tau)w_F$. The value of the future must take into account the possibility of losing the job which occurs with probability λ_F, or keeping it with probability $1-\lambda_F$.

The value of being employed in the informal sector is analogous to the previous one:

$$V_I(w_I) = T_I + w_I + \beta[\lambda_I U_I + (1-\lambda_I)V_I(w_I)] \tag{4.2}$$

In this case, the transfers are different (T_I) and no taxes are paid. Also, if the informal worker loses the job, the value of unemployment is different if a formal worker loses it ($U_I \neq U_F$).

Thus, the value of being unemployed after having a formal job is:

$$\begin{aligned} U_F = T_F + \beta[q_F q_I E \max\left\{V_F(w'_F), V_I(w'_I), U_F\right\} + q_F(1-q_I)E\max\{V_F(w'_F), U_F\}... \\ + q_I(1-q_F)E\max\{V_I(w'_I), U_F\} + (1-q_F)(1-q_I)U_F] \end{aligned} \tag{4.3}$$

Note the value of the future of the formal unemployed, must take into account the possibility of ending up with an informal job next period.

Finally, the value of being unemployed after having an informal job is given by:

$$\begin{aligned} U_I = T_I + \beta[q_F q_I E \max\left\{V_F(w'_F), V_I(w'_I), U_I\right\} + q_F(1-q_I)E\max\{V_F(w'_F), U_I\}... \\ + q_I(1-q_F)E\max\{V_I(w'_I), U_I\} + (1-q_F)(1-q_I)U_I] \end{aligned} \tag{4.4}$$

Note that the transfers differ whether the previous job was formal or informal (i.e. $T_F \neq T_I$). Note also that informal unemployed must also take into account the possibility of switching sector.

The value functions define reservation wages in equilibrium. These will be critical in determining equilibrium flows among both types of employment and both types of unemployment. Note that we will have four different reservation wages: a reservation wage of an formal unemployed worker facing an offer from the formal sector (w^R_{FF}); a reservation wage of an formal unemployed worker facing an offer from the informal sector (w^R_{FI}); a reservation wage of an informal unemployed worker facing an offer from the formal sector (w^R_{IF},); and a reservation wage of an informal unemployed worker facing an offer from the informal sector (w^R_{II}). To define these reservation wages we use 4.1 - 4.4, above.

$$V_F\left(w^R_{FF}\right) = U_F \tag{4.5}$$

$$V_I\left(w^R_{II}\right) = U_I \tag{4.6}$$

$$V_F\left(w^R_{IF}\right) = U_I \tag{4.7}$$

$$V_I\left(w^R_{FI}\right) = U_F \tag{4.8}$$

4.2 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 the stationary wage distributions in the formal and informal sectors. Let e^F_t be the employment in the formal sector at date t. Similarly, we can define e^I_t, u^F_t, and u^I_t. The evolution of these variables is driven by reservation wages, distributions of wage offers, and separation and wage drawing probabilities.

The evolution of these aggregate variables is defined in the appendix. We define the evolution of formal employment here for illustrative purposes:

$$\begin{aligned} e_{F,t+1} &= (1-\lambda_F)e_{F,t} + q_F(1-q_I)\left[Prob\left(V_F > U_F\right)u_{F,t} + Prob\left(V_F > U_I\right)u_{I,t}\right] \\ &+ q_F q_I[Prob\left(V_F > U_F\right)Prob\left(V_I > U_F\right)Prob\left(V_F > V_I\right)u_{F,t} \\ &+ Prob\left(V_F > U_I\right)Prob\left(V_I > U_I\right)Prob\left(V_F > V_I\right)u_{I,t} \\ &+ Prob(V_F > U_F)Prob(V_I < U_F)u_{F,t} + Prob\left(V_F > U_I\right)Prob\left(V_I < U_I\right)u_{I,t}] \end{aligned}$$

The first component is the mass of workers whom did not loose their formal employment. The second component are those workers that receive an offer from the formal sector, do not receive an offer from the informal sector, and accept the offer. Finally, we have unemployed workers that get offers from both sectors, but the formal sector offer dominates. The full system of equations can be found in the appendix. This system defines a steady state for employment and unemployment distributions. Key to define the steady state equilibrium employment and unemployment levels by sector are the probabilities that compare different offers. In the calibration we will assume log-normality of the distributions from where workers draw offers, which will facilitate the computation of these probabilities. More details can be found in the appendix.

The equilibrium distribution of accepted wage offers can be computed from the primitive distribution of wage offers and individual behavior. We let $\Gamma_{F,t}$ and $\Gamma_{I,t}$ be the equilibrium distributions of accepted wage offers on each sector. We have derived analytic expressions for these objects in the appendix. It must be emphasized that these objects heavily depend on the exogenous distributions of wages from where agents make draws. We refer the readers to section 8 where we discuss general equilibrium effects.

4.3 The tax and transfers system

The transfer system is defined in the steady state equilibrium. First, total resources collected by the government are given by:

$$\Omega = \tau \int w_F d\Gamma_F(w_F).$$

$\theta\Omega$ is transferred to formal workers and the rest to informal workers. In turn, per-cápita transfers are defined as:

$$T_F = \theta\Omega/(e_F + u_F) = \theta\Omega/(\int d\Gamma_F(w_F) + u_F),$$

$$T_I = (1-\theta)\Omega/(e_I + u_I) = (1-\theta)\Omega/(\int d\Gamma_i(w_i) + u_I).$$

5 Equilibrium characterization

The goal in this section is to describe characteristics of the equilibrium that are important for our main results. We are particularly interested in the way workers react to changes in taxes and transfers. For di-

dactic purposes we will start with an analysis of what happens when the distribution of transfers changes; then, we will consider the effects of an increase in taxes.

The purpose of this section is to build intuition for our main exercises presented in section 7. In the new appendix, we present a wider explanation of the conditions under which taxes and transfers affect reservation wages, and provide analytic solutions of reservation wages in the context of a simple model of informality.

5.1 A shift of transfers towards formal individuals, increases the formal sector.

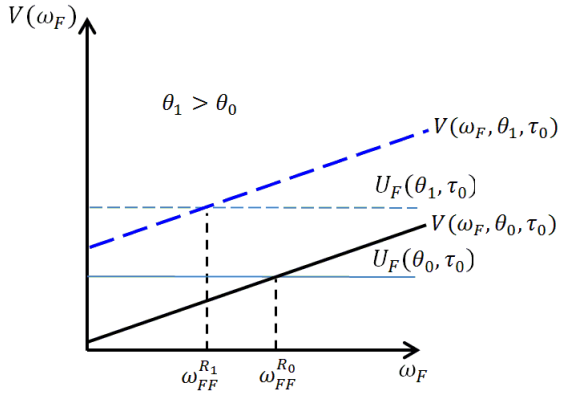
Consider the effects on the decisions of marginal workers when faced with changes in the distribution of transfers, θ. Consider an increase in θ from θ_0 to θ_1, and focus on a formal unemployed individual. The problem faced by this individual can be summarized in Figure 5.1. When $\theta = \theta_0$, the reservation wage equals $w_{FF}^{R_0}$, in contrast, when theta increases to θ_1, the reservation wage falls to $w_{FF}^{R_1}$. The reason behind this drop in the reservation wage is that, as transfers increase, the value of both, formal jobs and formal unemployment increase, but the former increases more than the latter. The value of formal jobs increases because these now receive more transfers (and taxes remain constant); similarly, the value of formal unemployment increases because it takes into account the discounted future value of formal jobs. However, the value of formal unemployment is additionally affected by a negative force because it has to weigh the possibility of ending-up with an informal job in the future (see equation 4.3). Since informal jobs now receive less transfers, these are less valuable, and this tends to reduce the value of formal unemployment.

Figure 5.2 shows what happens to the reservation wage of an informal unemployed individual when θ increases. In this case, the reservation wage increases, because the value of an informal job is reduced more than proportionally with respect to the value of informal unemployment. The reason for this is similar than before, the value of informal unemployment has to take into account the possibility of switching to a formal job next period. So, the drop in U_I is not as large as the drop in V_I.

5.2 Higher taxes do not necessarily imply higher informality

Now, lets analyze the mechanics of the model when taxes increase. To gain intuition, consider first the case when $\theta = 0$, that is, when no transfers are given to formal individuals. Focus on a formal unemployed worker. The decision problem of this worker is summarized in Figure 5.3. Originally, taxes are at τ_0, thus, the value function is depicted by the solid line as an increasing function of the wage. As Fig. 5.3 shows, the worker accepts the offer if $w_F > w_{FF}^{R_0}$ (because $V_F > U_F$) and rejects otherwise. The effect of an increase in taxes from τ_0 to τ_1 is shown in Fig. 5.3 by the dashed line. Since $(1-\tau)$ multiplies the wage in equation 4.1, the effect of an increase in taxes is to reduce the value of being formal for every possible wage. Notice that the reduction in the value function is larger for high wage earners than for low wage earners, which is a consequence of the proportionality of the tax. In sum, this implies that the reservation wage increases to $w_{FF}^{R_1}$, and, as a result, less workers decide to become

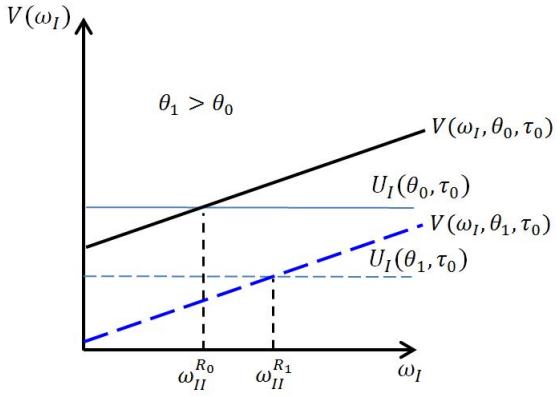
Figure 5.1: Effects of an increase in θ on the w_{FF} reservation wage.



Value of a formal job increases more than the value of formal unemployment

Notes: The Figure considers a formal unemployed individual and shows the effect on the reservation wage of a change in the distribution of transfers that increases the transfers to formal workers while reduces those for informal ones. The value of a formal job increases more than the value of unemployment, which reduces the reservation wage.

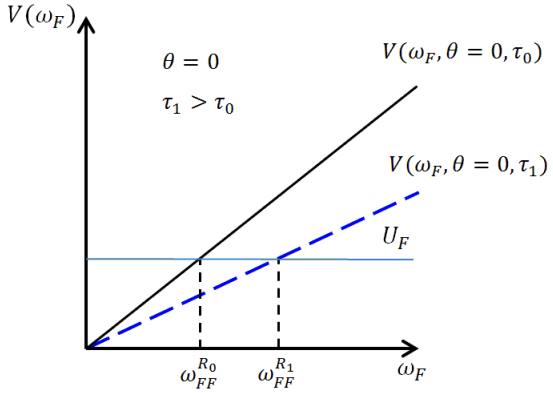
Figure 5.2: Effects of an increase in θ on the w_{II} reservation wage.



Value of an informal job decreases more than the value of informal unemployment

Notes: The Figure considers an informal unemployed individual and shows the effect on the reservation wage of a change in the distribution of transfers that increases the transfers to formal workers while reduces those for informal ones. The value of an informal job decreases more than the value of unemployment, which increases the reservation wage.

Figure 5.3: Effects of a tax increase with no transfers rebated.



Value of formality decreases for all workers

Notes: The Figure considers a formal unemployed individual and shows the effect on the reservation wage of an increase in taxes, when no transfers are rebated. The value of a formal job decreases more than the value of unemployment, which increases the reservation wage, leading to less formal employment.

formal.[16] In this case, higher taxes bring a decrease in formality, in accordance to popular beliefs.

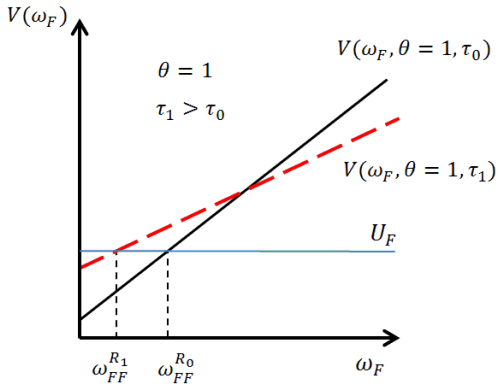
Now consider what happens when transfers to formal workers are positive ($\theta > 0$), for didactic purposes focus on the case when $\theta = 1$. In this case, an increase in taxes will come associated with an increase in transfers to formal workers. However, due to the fact that transfers are given on a per-cápita basis and taxes are proportional to the wage, transfers will increase more than taxes for workers with a low wage, and will increase less than taxes for workers with a high wage. In other words, high-wage earners will subsidize low-wage earners through the tax and transfer system. The effect of increasing taxes in this context is depicted in Figure 5.4. The dashed line lies below the solid line for high wages, while it lies above the solid line for low wages; since the original reservation wage is low, this implies that the formal sector becomes more attractive for the marginal worker. Consequently, the reservation wage goes down, and more unemployed workers decide to go into the formal sector. [17]

In summary, this analysis suggests that the formal sector can be increased if more transfers are given to formal workers, even if the extra resources are obtained through higher taxes. This result holds as long as the value of $\theta \in \{0, 1\}$ remains sufficiently high. We believe this is an important result because it contrasts with the common idea that higher taxes imply, automatically, more informality.

[16] To be precise, the value of formal unemployment would also shift in response to the tax change, but the shift will be small. The reason for this is that the value of formal unemployment takes into account the possibility of ending-up accepting an informal job offer. In this particular example, the value of informal jobs after the tax change is higher because they are getting all the extra revenue from the increase in taxes ($1 - \theta = 1$).

[17] Notice that the value of formal unemployment will also change, but this change will be small due to similar reasons as in the previous footnote. See also the appendix.

Figure 5.4: Effects of a tax increase with a cross-subsidy.



Notes: The Figure shows that an increase in formal employment is possible as a result of a tax hike, if a cross-subsidy is present. It considers a formal unemployed individual and shows the effect on the reservation wage of an increase in taxes when all revenue is rebated to formal individuals as per-capita transfers. The value of a formal job decreases for rich workers, but it increases for poor workers which are the marginal ones. This decreases the reservation wage, and leads to more formal employment.

6 Calibration

In this section we present our calibration strategy. The goal is to assess the value of the parameters in the model by connecting the model with the data. Typically, there is a group of parameters that can be calibrated independently from the rest, while another group must be calibrated jointly. All parameters but θ are jointly calibrated. We set $\theta = 0.62$, based on the discussion of Section 2 regarding the distribution of transfers.

Next, we describe the parameters that we need to jointly calibrate. These include the job-firing probabilities, the job-finding probabilities, means, and standard deviations of wage distributions both in formal and informal sectors, and the tax rate. Regarding the distribution of wages, we assume that wage offers of formal and informal sectors are drawn from i.i.d. log-normal distributions[18] with potentially different mean and variance:

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

This gives us nine parameters to jointly calibrate that we collect in the vector:

$$\varphi = (\lambda_F, \lambda_I, q_F, q_I, \mu_F, \mu_I, \sigma_F, \sigma_I, \tau)$$

Next, to perform the calibration of these parameters, we proceed in three stages. First, we solve for the equilibrium numerically, this means that we write down a computer code that receives an arbitrary

[18] A large number of studies, such as McCurdy (1980) and Abowd and Card (1986), show that the hypothesis of log-normality for the distribution of wages can not be rejected.

Table 3: Summary of targeted moments

Moment	Notation	Data	Model
Formal	e_F	0.451	0.4536
Informal	e_I	0.507	0.5035
Unemployed	u	0.042	0.0429
Unemployed from I	u_I	0.028	0.0276
Mean wage F	$\bar{\omega}_F$	36.85	36.3888
Mean wage I	$\bar{\omega}_I$	22.50	24.0146
Standard deviation F	$\hat{\sigma}_F$	42.38	42.675
Standard deviation I	$\hat{\sigma}_I$	27.80	26.2906
Ratio of Social Expenditures to GDP	$\frac{\Omega}{y}$	0.075	0.0746
Social expenditures on formal workers	θ	0.62	0.62

Notes: This table shows the targeted moments to be replicated by the model. Column "Data" shows the actual moment in the data, while column "Model" shows the moment delivered by the model under our baseline calibration. See notes of Table 4 and the text for the details of our calibration procedure.

Table 4: Calibrated Parameters

λ_F	λ_I	q_F	q_I	μ_F	μ_I	σ_F	σ_I	Ω
0.0238	0.0395	0.3157	0.9092	2.946	2.2681	0.9919	1.0227	4.505

Notes: This Table shows the value of parameters for our baseline calibration. We calibrate the model by solving for the equilibrium numerically and iterating over different sets of parameters. For each iteration we compute the targeted moments in Table 3 until we find a set of parameters that replicates well such moments. See more details in the text.

set of parameters as inputs, and produces equilibrium outcomes. To summarize these outcomes we set-up a list of relevant moments that describe the economy. The statistics we choose in this list 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 $\bar{w}_F$, mean wage in the informal sector $\bar{w}_I$, the standard deviation of wages in the formal sector $\hat{\sigma}_F$, the standard deviation of wages in the informal sector $\hat{\sigma}_I$, and the ratio of transfers to GDP $\frac{\Omega}{y}$.[19] A summary of the moments considered is presented in Table 3.

We continue with the calibration procedure by iterating over different sets of parameters so that the model replicates the selected key moments of Table 3. More precisely, we start with a guess of the parameters values, and use a computer program to look for the values that minimize the mean squared percent deviation between the model and the data on the selected moments. Table 4 shows the vector of parameters that resulted from this procedure.

The role played by frictions in our results is an important one as we make clear in the next section. The picture depicted by the calibrated values of frictions is quite intuitive. For example, the firing probability in the formal sector is much smaller than in the informal sector; while it results easier to get an offer from the informal sector than from the formal one. This is consistent with the popular idea that formal jobs are less risky, but harder to get. Note also that the tax rate consistent with a revenue of 7.5% of GDP is $\tau = 0.2729$, which lies within a reasonable range. The moments induced by these parameters

[19] In our model GDP is $y = \int w_F d\Gamma_F + \int w_I d\Gamma_I$

are compared against those in the data in Table 3. Our model and calibration procedure provide a good match of employment and unemployment levels and the first two moments of the observed distribution of wages are also replicated quite well.

One interesting point regarding the calibrated values of the job-firing probabilities, is that the assumption of two different unemployment states is important. This is because we also ask in the calibration to match the stocks of each type of unemployment. Since the stock of formal unemployment is substantially lower than the stock of informal unemployment, a lower firing probability in the formal sector is needed. Furthermore, the per-capita transfer received by the formal unemployed (T_F) is higher than the per-capita transfer received by the informal unemployed (T_I), which tends to increase duration. A higher duration would tend to increase formal unemployment, which is offset with a low firing probability in the formal sector.

7 Results

Given our baseline calibration, we can use our model to obtain equilibrium outcomes (through our computer code) for different sets of parameters that represent counter-factual scenarios that we have an interest in. We can also use our model to emulate the changes in taxes and transfers observed when the introduction of Seguro Popular took place, and compare the equilibrium outcomes of our model with those in the data.

Regarding the counter-factual exercises, we would like to organize the discussion analyzing two general policy changes: 1) changes in the size of transfers (i.e. higher taxes), given a constant distribution; and 2) changes in the distribution of transfers given size. Of course, we would also like to analyze policy changes that involve a combination of the above two cases.

7.1 Changes in the distribution of transfers

Consider first changes in the distribution of transfers, this is presented in Table 5. The benchmark values for the size of the informal sector, the formal sector, general unemployment, and formal unemployment are shown in the column in bold ($\theta = .62$). Notice also, that in this table the size of transfers is kept constant, which corresponds to a value of τ in our benchmark of 0.2729. When the fraction of resources devoted to formal workers increases to $\theta = 1$, the size of the informal sector decreases to 0.4288; and there is a corresponding increase in the size of the formal sector, this corresponds to the case when all the tax revenue is given to formal workers. In contrast, when the tax revenue is given only to informal workers ($\theta = 0$), informality goes up to 0.7108. This shows that the way transfers are distributed across formal and informal workers is a relevant force that determines the size of the informal sector. (see Figures 5.1 and 5.2).

Also of interest is the response of unemployment to the increase in θ. As the value of transfers to formal workers increases, formal unemployment increases. This is explained by two effects, first, the increase in formality increases the number of people that can potentially be formal unemployed; second, since transfers also increase for the formal unemployed this also increases the value of formal unem-

Table 5: Effects of changes in the distribution of transfers, given size.

Panel a

	θ				
	0	.25	.50	**.62**	1
e_I	0.7108	0.6096	0.5345	**0.5035**	0.4288
e_F	0.2435	0.3466	0.4226	**0.4536**	0.527
$u = u_F + u_I$	0.0458	0.0437	0.0429	**0.0429**	0.0442
u_F	0.0077	0.0112	0.014	**0.0152**	0.0191

Panel b

w^R_{FF}	13.9765	8.2773	4.948	**3.6408**	0
w^R_{II}	4.9846	5.4061	6.0197	**6.3654**	7.8812
w^R_{IF}	14.3051	8.3086	4.7519	**3.3263**	0
w^R_{FI}	4.6826	5.3862	6.2247	**6.6819**	8.5962
$\bar{\omega}_F$	50.5172	42.0108	37.797	**36.3888**	33.8177
$\bar{\omega}_I$	21.4012	22.3066	23.416	**24.0146**	26.4573
σ_F	50.8386	45.4272	43.2986	**42.675**	41.5513
σ_I	24.7335	25.3316	25.9631	**26.2906**	27.5599

Notes: Panel a shows the effect of changes in the distribution of transfers between formal and informal workers, on selected labor market outcomes. θ represents the fraction of resources allocated to transfers for formal workers. The size of the informal sector depends negatively on the value of θ. Panel b shows the effects of changes in θ on equilibrium reservation wages and on the distribution of wages.

ployment. Notice however, that general unemployment is almost unchanged, which is consistent with an offsetting reduction of informal unemployment. To see why, notice that when θ increases, there is less informality and less transfers are given to informal unemployed. General unemployment is barely affected because the changes in θ do not affect the distribution of transfers across employment/unemployment status in an important way.

It is also interesting to look at the way reservation wages respond to changes in θ in order to fully understand the mechanics of the model. Notice that, as θ increases, the reservation wage of a formal unemployed individual with an offer from the formal sector (and no offer from the informal sector), w^R_{FF}, is reduced. This means that more formal jobs are accepted. Similarly, the reservation wage of an informal unemployed with a formal offer in hand is reduced, in fact, when $\theta = 1$, practically any formal job offer is accepted ($w^R_{IF} = 0$). The reduction on the reservation wage occurs despite the fact that the value of formal unemployment is higher when θ increases. Nonetheless, the value of a formal job increases more than the value of formal unemployment, which reduces the reservation wage (see Figure 5.1).

In contrast, the reservation wage of an informal offer increases when θ goes up. This reflects the fact that informal jobs become less attractive as less transfers are given to these individuals (see Figure 5.2). Consequently, less informal jobs are accepted, and the size of the informal sector is reduced. Furthermore, a larger amount of formal jobs with low wages are accepted and thus the mean wage in the formal sector is reduced. The opposite happens with the mean wage of informal jobs.

Table 6: Effects of changes in size and distribution of transfers on the size of the informal sector

		θ				
		0	.25	.50	**.62**	1
τ/τ_0	*.8*	0.6657	0.5934	0.5333	**0.5074**	0.4371
	.9	0.6869	0.6015	0.534	**0.5054**	0.4324
	1	0.7108	0.6096	0.5345	**0.5035**	0.4288
	1.1	0.7391	0.6176	0.5349	**0.5020**	0.4253
	1.2	0.7808	0.6256	0.5354	**0.5009**	0.4219

Notes: The Table presents the effect of changes in the tax rate on the size of the informal sector, for different distribution shares of transfers. The effect on informality of a tax hike is ambiguous and depends on the share of transfers on formal workers.

7.2 Changes in the generosity of transfers (the tax rate)

Consider now changes in the size of transfers, given the current distribution. What is the effect on the size of the informal sector of increasing taxes in 20%? Table 6 shows this in the column in bold. The benchmark value of τ is (0.2729), and we present the effects of increasing and reducing this parameter in 10 and 20%. This implies that the value of τ ranges between 22% to 33%.

In response to a 20% increase in τ, informality would barely change, in fact it decreases by less than half of a percentage point (from 0.5035 to 0.5009). This sign of this change is opposite to the popular idea that more taxes induce higher informality. However, we would like to stress that in the present model, the effect of tax increases depends heavily on the parameter θ. If all tax revenue is given back to formal workers ($\theta = 1$), a tax hike actually decreases informality as discussed before (see Figure 5.4). This can be confirmed in the last column of Table 6: when the tax rate increases, informality goes down from 0.4288 to 0.4219. In contrast, when all tax revenue is transferred to informal workers (i.e. $\theta = 0$), the result of an increase in taxes is what most people would expect: a severe increase of informality (see Figure 5.3).

Above all, the most important result derived from table 6 is that informality is pretty inelastic to changes in τ for an important range of values of θ. To put this into perspective, notice that Tab. 6 considers changes in the tax rate in a range of 10 percentage points (from 22% to 33%), and only when $\theta = 0$, the range of variation of informality in response to changes in τ is more than 10 percentage points. However, for values above $\theta = .25$, the range of variation of informality in the table is less than 3 percentage points. In sum, the results in this table imply that the elasticity of informality to realistic changes in taxes and transfers is small. This is confirmed next, when we study the effects of the introduction of Seguro Popular.

7.3 Importance of frictions and wage dispersion

In this section we study the importance of frictions for the size of the elasticity. We also study the sensitivity to the wage dispersion below. Our baseline, is an elasticity of -0.24 when θ increases in 1 percentage point –ceteris paribus. A natural argument to make is that when transfers for formal workers increase, people would like to move out of informal jobs and into the now more attractive formal jobs.

Table 7: The importance of frictions

		Bench.	Factor t			
			1.00	1.01	1.05	1.10
λ_I	e_I	0.5035	0.5011	0.4993	0.4923	0.4840
	Elasticity	-	-0.24	-0.42	-1.12	-1.95
q_F	e_I	0.5035	0.5011	0.4995	0.4933	0.4858
	Elasticity	-	-0.24	-0.40	-1.01	-1.77

Notes: The Table shows the elasticity of informality to changes in the distribution of transfers with simultaneous changes in frictions of different magnitudes. Frictions (either λ_I or q_F) are multiplied times a factor t (first row) along with the change in θ of one percentage point.

Since in our model, the job separation probability is fixed, this represents a barrier for such kind of movement. Similarly, another possible argument is that when formal jobs become more attractive, people will search for those jobs more intensively, and the job-finding probability will increase. This, of course, can not happen in our framework because such probabilities are fixed.

Thus, we would like to allow for more job separations from informality, or a higher job-finding probability of formal jobs, at the same time we increase θ. To achieve such goal, we perform additional counter-factual exercises assuming that frictions change along with the θ parameter. We present the elasticity of informality under these conditions in Table 7. We multiply each friction times a factor $t > 1$, along with the change in θ. We consider an increase of θ of one percentage point, from 0.62 to 0.63.

The Table shows that if we allow for more transitions, either by increasing job separations out of the informal sector, or by increasing the job finding rate in the formal sector, the elasticity of informality to changes in transfers increases substantially. In particular, a job separation probability 10% higher, along with an increase in θ of 1 percentage point creates a reduction in the informal sector of almost 2 percentage points. This is an elasticity 8 times higher than in the baseline case. A similar patter emerges when we allow the job-finding rate in the formal sector to vary.

This might be interpreted as undermining our claim that the elasticity of informality is low. Nonetheless, in the next section, we use the evidence related to the recently introduced "Seguro Popular" to argument in favor of our baseline specification. We see the results in this section as a way to highlight the importance of frictions on determining the extent of the elasticity.

Next we explore the importance of wage dispersion for our main results. In particular, it can be argued that the strength of the cross-subsidy channel crucially depends on the extent of wage dispersion, for a given mean. Intuitively, if all formal workers receive the same wage, then, no cross subsidy is possible.[20]

To investigate the importance of this channel, we perform the following quantitative exercise. We proceed in two stages, first we multiply the formal sector dispersion parameter times a factor $f \geq 0$, and then, we compute the change in informality when we increase the tax rate in 1 percentage point. We report the elasticity, as the change in the informal sector size in response to a 1 percentage point increase in the tax rate in Table 8. We note that the value of this elasticity in the benchmark ($f = 1$) is positive

[20]We are grateful to an anonymous referee for pointing this out.

Table 8: The importance of wage dispersion

	Bench ($f=1$)	$f=0$	$f=2$
Elasticity	0.19	-0.98	1.27

Notes: The Table shows the elasticity of informality to a changes in the tax rate of one percentage point, for different values of the wage dispersion. The parameter f (first row) indicates whether dispersion is eliminated or doubled relative to the baseline calibration value.

Table 9: Data on distribution and generosity of transfers associated to the introduction of SP

Data	2004	2011
Health Spending / GDP (Generosity)	2.59	3.05
Share of health spending directed to formal workers (Distribution)	0.6756	0.5567

Notes: The Table shows relevant data on health expenditures, before and after the introduction of Seguro Popular, a social protection program directed to provide health care services for informal workers. The introduction of this program signified a change in the distribution and the generosity of transfers.

and equal to 0.19. The results of this exercise are quite intuitive. If we eliminate wage dispersion in the formal sector ($f=0$), there are no opportunities for cross subsidies, therefore, the value of a formal job can only go down when taxes increase (provided that a fraction of the tax revenue is given to informal workers). Thus, we see that the elasticity is close to -1 in this case, compared to a positive elasticity of 0.19 in the benchmark. Finally, note that when we double the wage dispersion in the formal sector ($f=2$), the economic force associated with the cross-subsidy channel is stronger and the elasticity is positive and much higher than in the benchmark.

Table 8 highlights the importance of the wage dispersion for the size of the elasticity. We emphasize that our benchmark calibration reproduces the wage dispersion found in the data, along with other relevant moments. Thus, the size of the elasticity is disciplined by matching such moments.

7.4 Effects of Seguro Popular

In this section we analyze the effect of changes in taxes and transfers associated with the introduction of Seguro Popular (SP). We interpret the calibrated parameters above as representing the situation after the introduction of the program. We simulate a reduction in generosity equivalent to 0.5% of GDP and an increase in the transfers directed to formal workers, both consistent with the data from OECD SOCX and Secretaría de Salud (see Table 9 and Section 2). Given that Table 9 refers to health spending only, we also use the data in the detailed SOCX database to perform an assessment of the value of θ before the SP was introduced. We conclude that before SP was introduced, the generosity of transfers amounted to 7% of GDP and the value of θ consistent with the distribution of transfers at the time was 0.66.

With this at hand, we perform a counter-factual exercise using our model: we change the generosity of transfers and the distribution to reflect a 7% of GDP revenue to GDP ratio, and a fraction of transfers to formal workers of 0.66. The results are presented in Table 10. Our model predicts that the impact of Seguro Popular was to increase the share of informality in 0.8 percentage points. This result is consistent with previous literature that has reported a small effect of the introduction of this program on informality

Table 10: Impact of the introduction of Seguro Popular in informality and unemployment

	Before SP	After SP	Difference
Generosity ($\frac{\Omega}{y}$)	0.070	0.0750	-0.005
Distribution (θ)	0.660	0.620	0.04
e_I	0.4956	0.5035	-0.0079
u	0.0432	0.0429	0.0003

Notes: The Table shows the effect of the introduction of Seguro Popular (see Table 9) on informality and unemployment.

(see footnote 2). Our model also predicts almost no change in the unemployment rate due to this change in policy.

In general the small change found as a result of the introduction of SP is the result of the presence of frictions that reduce mobility across sectors. Also important for this result is the small size of the transfers relative to the value of work and unemployment. Thus, a lesson from this exercise is that in order to obtain big changes in informality, transfers changes should be of considerable size. Put it differently, under the current distribution, it is hard to obtain sizable changes in informality for realistic changes in taxes and transfers.

8 Discussion

One important limitation of our model is the lack of general equilibrium effects. In this section we discuss how the results could change if these type of effects were considered. For explanatory purposes lets focus on the tax changes in Table 6. One key variable for the decision of the firm is the relative wage of formal workers vs. that of informal workers. We saw in Table 6 that a tax increase makes the formal sector more attractive for the marginal worker, because transfers are bigger than taxes for this worker. Since all the action in our model is coming from the workers, in a richer model, this would signify an increase in the supply of formal workers and a decrease in the supply of informal workers. An increase in the supply of formal workers would tend to push formal wages down relative to the informal wages, in order to keep demand in line with supply. This effect would reduce the value of formal sector jobs, and increase the value of informal jobs. Thus, general equilibrium introduces a feedback effect that go in the opposite direction of our current results.

How much would formal sector wages go down after an increase in taxes? Would it be enough to end up reducing the size of the formal sector? The answer to this is related to how substitutable are formal and informal workers from the point of view of the firms. In models where there is an occupational choice with formal and informal entrepreneurs, the answers to these questions are related to how the marginal entrepreneurs are affected with changes in relative wages. Now consider a change in the distribution of transfers in favor of formal workers (see Table 5). In this case, the supply of formal workers will also increase, and this will push wages down, which will reduce the value of formal jobs. The extent of this "feedback" effect remains a quantitative questions that we leave for future research.

9 Conclusion

In this paper we have used a search frictions model to study the elasticity of informality to changes in social policy transfers. In our model formal jobs are "better" than informal jobs because they are tied to larger transfers, and are less risky. On the other hand formal jobs are harder to get. Thus, workers optimally decide to accept informal jobs because these arrive more frequently.

In contrast to the basic model of informality, we do not rely on the assumption of partial valuation of benefits to obtain a non-zero elasticity of informality to taxes and transfers. Instead we use a model where workers are heterogeneous in the wages they accept, and thus, the tax and transfer system allows for a cross subsidy from high-wage earners to low-wage earners. In this model, workers that receive a transfer that is larger than the taxes paid coexist with workers that receive transfers that are equal or smaller than the taxes paid. The sign and magnitude of the elasticity of informality to changes in taxes and transfers greatly depends on which of the two situations above is the one prevailing for the marginal worker.

We calibrate the model for Mexico, and perform counter-factuals. Given that 62% of social expenditure is given to formal workers, we find that the elasticity of informality to tax changes, given distribution is small. The reason is that the marginal worker faces two opposing forces: higher taxes that reduce the value of a formal job, vs. higher transfers that increase the value of a formal job.

We use our model to study the effects on informality of the recently introduced Seguro Popular, and we find that the effects are quite small in line with the empirical literature using micro-data. Our model also offers an alternative way to rationalize the empirical evidence found in Almeida and Carneiro (2012), where an increase in taxes (due to an increase in enforcement) is associated with more formalization.

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Appendix

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 the 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, distributions of wage offers, and separation and wage drawing probabilities.

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

$$\begin{aligned}
e_{F,t+1} &= (1-\lambda_F)e_{F,t} + q_F(1-q_I)\left[Prob\left(V_F > U_F\right)u_{F,t} + Prob\left(V_F > U_I\right)u_{I,t}\right] \\
&+ q_F q_I[Prob\left(V_F > U_F\right)Prob\left(V_I > U_F\right)Prob\left(V_F > V_I\right)u_{F,t} \\
&+ Prob\left(V_F > U_I\right)Prob\left(V_I > U_I\right)Prob\left(V_F > V_I\right)u_{I,t} \\
&+ Prob(V_F > U_F)Prob(V_I < U_F)u_{F,t} + Prob\left(V_F > U_I\right)Prob\left(V_I < U_I\right)u_{I,t}] \\
e_{I,t+1} &= (1-\lambda_I)e_{I,t} + q_I(1-q_F)\left[Prob\left(V_I > U_F\right)u_{F,t} + Prob\left(V_I > U_I\right)u_{I,t}\right] \\
&+ q_F q_I[Prob\left(V_F > U_F\right))Prob\left(V_I > U_F\right))Prob\left(V_I > V_F\right)u_{F,t} \\
&+ Prob\left(V_F > U_I\right))Prob\left(V_I > U_I\right))Prob\left(V_I > V_F\right)u_{I,t} \\
&+ Prob(V_F < U_F)Prob(V_I > U_F)u_{F,t} + Prob(V_F < U_I)Prob(V_I > U_I)u_{I,t}] \\
u_{F,t+1} &= [(1-q_F)(1-q_I) + q_F(1-q_I)Prob\left(V_F \leq U_F\right) + q_I(1-q_F)Prob\left(V_I \leq U_F\right) \\
&+ q_F q_I Prob\left(V_F \leq U_F\right)Prob\left(V_I \leq U_F\right)]u_{F,t} + \lambda_F e_{F,t}. \\
1 &= e_{F,t+1} + e_{I,t+1} + u_{F,t+1} + u_{I,t+1}
\end{aligned}$$

Consider the first equation that defines 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 receive an offer from the formal sector, do not receive an offer fro the informal sector, and accept the offer. Finally, we have unemployed workers that get offers from both sectors, but the formal sector offer dominates. The second equation follows a similar logic for the informal workers. The third equation describes the evolution of unemployment. The unemployment rate tomorrow is the sum of those workers that do not get offers, plus those that get offers but reject them, plus an inflow of workers that lost their employment in period t. This system of equations define a steady state for employment and unemployment distributions. Key to define steady state employment and unemployment by sector in equilibrium are the probabilities that compare different offers. In the calibration we will assume log-normality of distributions from where workers draw offers, which will facilitate the computation of these probabilities. As wage draws from formal and informal sector belong to different log-normal distribu-

tions there is not an analytic solution to $Prob(V_F > V_I)$. We log-linearize each value function around its respective mean wage.

$$V_F(w_F)|_{\mu_F} \longrightarrow N\left(\frac{(1-\tau)e^{\mu_F}+\beta\lambda_F U_F}{1-\beta(1-\lambda_F)}, \left[\frac{(1-\tau)e^{\mu_F}}{1-\beta(1-\lambda_F)}\right]^2 \sigma_F^2\right)$$

$$V_I(w_I)|_{\mu_I} \longrightarrow N\left(\frac{e^{\mu_I}+\beta\lambda_I U_I}{1-\beta(1-\lambda_I)}, \left[\frac{e^{\mu_I}}{1-\beta(1-\lambda_I)}\right]^2 \sigma_I^2\right)$$

$$V_F(w_F)|_{\mu_F} - V_I(w_I)|_{\mu_I} \longrightarrow N\left(\frac{(1-\tau)e^{\mu_F}+\beta\lambda_F U_F}{1-\beta(1-\lambda_F)} - \frac{e^{\mu_I}+\beta\lambda_I U_I}{1-\beta(1-\lambda_I)}, \left[\frac{(1-\tau)e^{\mu_F}}{1-\beta(1-\lambda_F)}\right]^2 \sigma_F^2 + \left[\frac{e^{\mu_I}}{1-\beta(1-\lambda_I)}\right]^2 \sigma_I^2\right)$$

We need to define the equilibrium distribution of accepted wage offers. These can be computed from the primitive distribution of wage offers and individual behavior. Let $\Gamma_{F,t}$ and $\Gamma_{I,t}$ be the equilibrium distributions of accepted wage offers on each sector:

$$\begin{aligned}
\Gamma_{F,t+1}(w_F) &= (1-\lambda_F)\Gamma_{F,t}(w_F) + q_F q_I g_F(w_F)\left[I(w_F > w_{FF}^R)Pr(V_I > U_F)\right. \\
&\quad Pr(V_F(w_F) > V_I)u_{F,t} + I(w_F > w_{IF}^R)Pr(V_I > U_I)Pr(V_F(w_F) > V_I)u_{I,t} \\
&+ \left. I(w_F > w_{FF}^R)Pr(V_I < U_F)u_{F,t} + I(w_F > w_{IF}^R)Pr(V_F(w_F) > V_I)u_{I,t}\right] \\
&+ q_F(1-q_I)g_F(w_F)\left[I(w_F > w_F^R)u_t\right]
\end{aligned}$$

$$\begin{aligned}
\Gamma_{I,t+1}(w_I) &= (1-\lambda_I)\Gamma_{I,t}(w_I) + q_F q_I g_I(w_I)\left[I(w_I > w_{FI}^R)Pr(V_I > U_F)\right. \\
&\quad Pr(V_I(w_I) > V_F)u_{F,t} + I(w_I > w_{II}^R)Pr(V_F > U_I)Pr(V_I(w_I) > V_F)u_{I,t} \\
&+ \left. I(w_I > w_{FI}^R)Pr(V_F < U_F)u_{F,t} + I(w_I > w_{II}^R)Pr(V_F < U_I)u_{I,t}\right] \\
&+ q_I(1-q_F)g_I(w_I)\left[I(w_I > w_{FI}^R)u_{F,t} + I(w_I > w_{II}^R)u_{I,t}\right]
\end{aligned}$$

Where $I(w > w^R)$ is an indicator function equal to 1 if $w > w^R$, and zero otherwise. Each of the equations above, can be used to find a steady state measure of accepted wage offers: Γ_F and Γ_I, respectively. Since we normalized the measure of workers in the economy to one, this implies that $\int d\Gamma_i(w_i) = e_i$ where $i \in \{F, I\}$.

Effect of taxes and transfers on the reservation wage.

The goal in this appendix is to analytically study the effect of taxes and transfers on the reservation wage. We start with a simple model. Individuals can be either employed or unemployed. While unemployed

individuals search for jobs, and receive wage offers form a distribution $F(w)$. If an individual accepts a wage w, it remains in that job forever. The value of working is defined as follows:

$$V(w) = w + \beta V(w) \tag{9.1}$$

Assume that no transfers are given while unemployed. The value of being unemployed is given by:

$$U = \beta \mathrm{E}\left\{O(w')\right\}, \tag{9.2}$$

where $O(w') = max\{V(w'), U\}$, and w' is next period's wage.

Solving for $V(w)$ in equation 9.1, we get $V(w) = \frac{w}{1-\beta}$. Next, we obtain an expression for the reservation wage. The reservation wage equalizes the value of employment and unemployment, thus:

$$\begin{aligned} V(w^R) &= U \\ \frac{w^R}{1-\beta} &= U \\ \frac{w^R}{1-\beta} &= \beta \mathrm{E}\left\{O(w')\right\} \end{aligned} \tag{9.3}$$

Since the above expression is in terms of $\mathrm{E}O(w')$ we look for an expression of this function in terms of the reservation wage. We have:

$$\begin{aligned} \mathrm{E}O(w') &= \mathrm{E}max\left\{\frac{w'}{1-\beta}, \frac{w^R}{1-\beta}\right\} \\ \mathrm{E}O(w') &= \left(\frac{1}{1-\beta}\right)\mathrm{E}max\left\{w', w^R\right\} \\ \mathrm{E}O(w') &= \left(\frac{1}{1-\beta}\right)\int_0^\infty max\left\{w', w^R\right\} f(w')dw' \end{aligned}$$

using this last expression in equation 9.3, we obtain:

$$w^R = \beta \int_0^\infty max\left\{w', w^R\right\} f(w')dw'$$

which is in terms of the reservation wage and parameters. Subtracting βw^R from both sides, we obtain:

$$w^R = \frac{\beta}{1-\beta}\int_{w^R}^\infty (w' - w^R)dF(w')$$

finally, integration by parts renders:

$$w^R = \frac{\beta}{1-\beta}\int_{w^R}^{\infty}[1-F(w')]dw$$

which is an equation that gives the reservation wage in terms of only parameters. In this simple example, the only two determinants of the reservation wage are the density function, and the discount rate.[21]

Consider now the case where taxes and transfers are present. Let τ be a proportional tax on wages, T be the transfer while employed, and b the transfer while unemployed. Write down the value functions:

$$V(w) = T + (1-\tau)w + \beta V(w) \tag{9.4}$$

$$U = b + \beta \mathrm{E}\left\{O(w')\right\} \tag{9.5}$$

following the same steps as before, we can reach an expression for the reservation wage in terms of fundamental, and policy parameters:

$$w^R = \left(\tfrac{1-\beta}{1-\tau}\right)(b-T) + \beta\int_0^{\infty} max\left\{w', w^R\right\} f(w')dw'$$

subtracting βw^R from both sides we arrive to:

$$w^R = \left(\tfrac{b-T}{1-\tau}\right) + \tfrac{\beta}{1-\beta}\int_{w^R}^{\infty}[1-F(w')]dw \tag{9.6}$$

which shows that, in principle, policy parameters can affect the reservation wage. If the transfers while unemployed (b) go up, the reservation wage increases, leading to more unemployment; in contrast, if the transfers while employed (T) increase, the value of working goes up, and the reservation wage decreases, generating more employment.[22]

Note that the tax rate does not affect the reservation wage in the absence of transfers. If both transfers are zero ($b = T = 0$), then, the first term of the right hand side of the equation above, disappears. The reason for this is that both value functions, $V(w)$ and U, are affected proportionally in response to the tax change. Keep in mind that taxes can also affect the value of unemployment because this depends on the value of future employment.[23]

Note also that when transfers are positive, the effect of taxes on the reservation wage is ambiguous,

[21] Note that if the individual cares less about the future, the reservation wage goes down, meaning that they would accept more offers and lower wages. Similarly, if the cdf is shifted to the right, such that, the probability for every possible wage offer above the reservation wage increases, then the reservation wage goes up.

[22] When transfers increase, the value of unemployment also increases, because unemployment takes into account the value of future employment.

[23] In particular, note that both value functions are multiplied by the same constant: $1-\tau$. Note that while the value of working changes slope $V(w) = (1-\tau)w/(1-\beta)$, its value decreases exactly the same as the value of unemployment when the former is evaluated at the reservation wage.

and depends crucially on the sign of $(b-T)$. Suppose we are in the case where $T=0$ and $b>0$. Then, an increase in the tax rate produces an increase in the reservation wage. Thus, higher taxes induce a drop in employment, as usual economic intuition suggests. In a graph such as the ones presented in section 5, the value of working shifts down more than the value of not working. This is because the value of unemployment now includes a constant term (b) that is not affected by the tax, while the value of employment depends proportionally on the tax rate.

In contrast, when $b=0$ and $T>0$, an increase in the tax rate leads to a decrease in the reservation wage, which leads to more employment! In this case the opposite occurs: the value of employment shifts down by less than the value of unemployment, because the value of employment now includes a constant term that is not affected by the tax, while the value of unemployment doesn't have a constant term. As a result, U falls *proportionally* more than $V(w)$.

When the transfers are the same across the employment and unemployment states ($b=T$), we are back in the case where taxes do not matter. This happens because the constant parts of both value functions that do not depend on taxes are equivalent, and the values of both states are affected by taxes proportionally. The key insight from this analysis is that, in order for policy to affect the reservation wage, it needs to affect the *relative* value of the employment and unemployment states. When this relative value is held constant, either by multiplying the functions times the same factor $(1-\tau)$, or by adding them the same constant ($b=T$), the reservation wage is unaltered.

At a very basic level, this is why policy changes can affect the reservation wage in an economy with an informal sector. The fact that unemployed individuals take into account the possibility of ending up in an informal job next period, prevents the value of employment and unemployment to shift by the same proportion when a policy change is considered.

This can be better understood with the following example. Consider a slightly modified model, where we include a third state: employment, unemployment, and confinement. Furthermore, assume that you can only go to confinement if you are unemployed. This occurs with probability q. To be in confinement, means that you receive a low transfer ε, and stay there forever. This model shares one important feature with the richer model of informality in section 4, which is that, if you are unemployed, you have to take into account the possibility of ending up in a bad situation. The model is summarized with the following four equations:

$$\begin{aligned} V(w) &= T+(1-\tau)w+\beta V(w) && (9.7)\\ U &= b+\beta\left(qEO(w')+(1-q)C\right) && (9.8)\\ C &= \varepsilon+\beta C \\ O(w') &= \max\left\{V(w'),U\right\} \end{aligned}$$

How is the expression for the reservation wage affected in this case? Again, following the standard procedure, it can be shown that:

$$w^R = \left(\frac{1}{1-\beta q}\right)\left(\frac{1}{1-\tau}\right)[(1-\beta)b+\beta(1-q)\varepsilon-(1-\beta q)T]+\left(\frac{\beta q}{1-\beta q}\right)\int_{w^R}^{\infty}[1-F(w')]dw. \quad (9.9)$$

As these equations suggest, the reservation wage is now affected by policies. The reason is that, the introduction of confinement produces an asymmetry between the employment and unemployment states. *Ceteris paribus*, an increase in transfers while unemployed, increases the reservation wage, producing less employment; similarly, an increase in the transfers under confinement increases the reservation wage, also leading to less employment; in contrast, an increase in transfers while employed, decreases the reservation wage, which leads to more employment.

The effect of tax changes, again, is ambiguous, and depends crucially on the sign of

$$[(1-\beta)b+\beta(1-q)\varepsilon-(1-\beta q)T].$$

In this case, even if $T=b$, taxes affect the reservation wage. To see this, note that when transfers are equalized then: $[(1-\beta)b+\beta(1-q)\varepsilon-(1-\beta q)T]=\beta(1-q)(\varepsilon-T)$. If the transfer under confinement is bigger than the transfer while employed/unemployed ($\varepsilon > T$), an increase in the tax rate leads to less employment; however, the opposite occurs when $T>\varepsilon$. In this last case, the value of unemployment shifts down proportionally more than the value of employment, because the later includes the constant term T.

Note, additionally, that even if $T=b=0$, changes in taxes affect the reservation wage if $\varepsilon > 0$. The bottom line is, again, that the introduction of a third state allows for the policy parameters to affect the relative value of employment to unemployment, and in turn, the reservation wage. This is exactly what the introduction of informality creates in the richer model of section 4. In that model, we have chosen to use $T=b$, so the reservation wage changes are due exclusively to the asymmetry introduced by informality.

Consider now a model with informality, although, simpler than the model in section 4. In this model, individuals transit to formal and informal jobs through unemployment. With probability q an unemployed person receives a formal offer, and with probability $1-q$, an informal one. Individuals receive transfers, T_F for formal workers, T_I for informal workers, and b for unemployed. Note that, the transfer while unemployed does not depends on the sector of the previous job.

The value function of formality is:

$$V_F(w_F) = T_F + (1-\tau)w_F + \beta\left[\lambda U + (1-\lambda)V_F(w_F)\right], \quad (9.10)$$

where λ is the job separation rate which is independent of the sector. The value of unemployment is given by:

$$U = b+\beta[qE\max\left\{V_F(w'_F),U\right\}+(1-q)E\max\{V_I(w'_I),U\}] \quad (9.11)$$

The value of working informally is:

$$V_I(w_I) = T_I + w_I + \beta\left[\lambda U + (1-\lambda)V_I(w_I)\right]. \tag{9.12}$$

A direct analogy can be made between the pair of equations (9.7, 9.8), and the pair (9.10, 9.11). In particular, note that the possibility to end up next period with an informal job modifies the value of unemployment in equation 9.11 in a similar way than the introduction of confinement in equation 9.8 does. As long as the individual takes into account the possibility of ending up in a "third" state, taxes and transfers will be able to affect the *relative* value of employment and unemployment, and therefore, the reservation wage.

After some algebra, it can be shown that the reservation formal wage is given by:

$$\begin{aligned} w_F^R &= \left(\frac{1-\tilde{\beta}}{(1-\tau)(1-\tilde{\beta}-\beta q\beta\lambda)}\right)\left[(1-\beta)b+(1-\beta)\beta(1-q)EO(w_I')-(1-\beta q)T_F\right]\ldots \\ &\quad \ldots\left(\frac{1-\beta}{1-\tilde{\beta}-\beta q\beta\lambda}\right)E\max\left\{w_F', w_F^R\right\}. \end{aligned} \tag{9.13}$$

Note the close resemblance between equation **??** and equation 9.13. As before, the effect of taxes on the reservation wage crucially depends on the term inside the square brackets. In section 5, we focus on the case where $b = T$, thus the term in the brackets becomes:

$$\left[(1-\beta)b+(1-\beta)\beta(1-q)EO(w_I')-(1-\beta q)T_F\right] = \beta(1-q)\left[(1-\beta)EO(w_I')-T_F\right],$$

which implies that the effect of the tax rate depends on the sign of $[(1-\beta)EO(w_I')-T_F]$.

One important question is under which conditions an increase in taxes can lead to more formal employment. This would require that $(1-\beta)EO(w_I') < T_F$ in order to induce a decrease in the reservation wage in response to a tax hike. However, a decrease in the reservation wage can also be achieved if transfers increase. The exercise considered in section 5.2 is one where taxes and transfers are tied in equilibrium, and an increase in taxes, also leads to an increase in transfers. Due to the presence of the cross-subsidy, transfers increase more than taxes for the marginal workers, leading to a decrease in the reservation wage.

Finally, the exercise considered in 5.1, where we change the distribution of transfers between formal and informal workers, can also be studied in the context of this model. Note that the reservation wage in equation 9.13 depends negatively on the level of formal transfers (T_F), and positively on the value of informality through $EO(w_I')$. Note also that the exercise includes an increase in formal transfers with a simultaneous decrease in informal transfers. These two forces lead to a decrease in the reservation wage in equation 9.13.