Cross-subsidies, and the elasticity of informality to social expenditures

Alonso-Ortiz, Jorge and Leal Ordonez, Julio

Instituto Tecnologico Autonomo de Mexico, Banco de Mexico

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Cross-subsidies, and the elasticity of informality to social expenditures *

Jorge Alonso
ITAM

Julio Leal
Banco de México

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Abstract

In the quest to alleviate the lack of protection of an important group in the population, social programs directed to informal workers are being introduced in developing countries. How is the size of the informal sector affected when the distribution across formal and informal workers and/or the generosity of social transfers change? The nature of many tax and transfer systems imply a cross subsidy from high-income to low-income workers. Thus, depending on the wage of the worker, the transfers tied to formal jobs could be bigger, equal, or smaller than the taxes paid. The effects of changes in taxes and transfers greatly depend on which of the three situations above is the one prevailing for the marginal worker. In this paper, we use a search frictions model with an informal sector, heterogeneous workers, and conditional taxes and transfers to address this question. In the model formal sector jobs are tied to larger benefits, and are less risky, but harder to get. We calibrate the model to the Mexican economy and perform a number of counter-factuals. We find that the size of the informal sector is quite inelastic to marginal changes in the generosity of transfers due to the presence of two opposing forces on the marginal worker: more taxes vs. more transfers. In comparison, the informal sector is more elastic to changes in the distribution of transfers because only one force is present in this case. Our results are consistent with the novel empirical evidence found in Almeida and Carneiro (2012) for Brazil, and with the evidence found in Azuara and Marinescu (2013) on the effects of Seguro Popular in Mexico.

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

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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.

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 finance the programs[2]. Thus, a natural question that arises is how is the size of the informal sector affected when the distribution across formal and informal workers and/or the generosity of transfers change?

To our knowledge, there is no clear reference in the literature that addresses this question within the context of a model. A *basic model of informality* often used, 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[3]. This model has 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[4]. Within the context of this model, and similarly to Summers' model, changes in taxation can affect the size of the informal sector only if social security benefits are not fully valued. Two key implicit assumptions needed to achieve this result are that workers are homogenous, and that are free to move across formal and informal jobs; thus, they voluntarily choose to be formal or informal. In this context, wages adjust to reflect the valuation of benefits made by workers.

In parallel, 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 benefits are highly valued). Under this view, above market equilibrium wages forces workers to stay informal and involuntarily queue for formal sector jobs[5]. So we have, at least, two opposite views in the literature regarding how workers value the benefits tied to formal jobs. Notice that these two views also differ in terms of their assumptions about how labor markets operate. While the first one assumes perfectly integrated markets and free mobility of workers across sectors, the second one assumes segmented labor markets.

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. This is also what the most recent empirical evidence suggests[6]. Models with search and matching frictions, have been used to study the effects of labor market policies such as unemployment insurance, severance payments, and the like, on informality [7]. However, these models have not yet been used to study the way in which policies that link taxes and benefits/transfers affect labor market outcomes.

One important recent piece of empirical evidence is the one found in Almeida and Carneiro (2012).

[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 Bosc and Campos-Vázquez (2010).

[3]Recent work explicitly using this model include Maloney (2004), Levy (2008), and Almeida and Carneiro (2012)

[4]For the case of Chile see Edwards and Edwards (2002), and for Colombia see Kugler et al. (2008)

[5]This is the view known as the dual labor markets view. 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)

The authors study a database for Brazil that includes changes in tax and regulation enforcement levels over time and across different locations. The authors argue that enforcement was rarely done along the extensive margin (i.e., registration), and that most enforcement activities consisted on audits to firms that were already operating in the formal sector. Thus, increased enforcement had a direct impact on better compliance of formal firms with tax and regulation laws. They find that "in response to a rise in labor inspections we observe an increase in formal employment, a decrease in informal employment, (...) a (...) decline in wages at the top of the formal wage distribution, and an increase in informal wages." These findings are inconsistent with the first view referred above: if benefits are not fully valued, then an increase in labor inspections should translate into an increase in the tax burden on the formal sector, which would discourage formality. The authors argue that minimum wages bind in Brazil, and that workers in the bottom of the wage distribution can enjoy the benefits without reducing their wages, which makes formal jobs more attractive. In this paper we offer an alternative way to rationalize the results of Almeida and Carneiro. We argue that the reason behind these results relies on the nature of the tax and transfer system, in particular, it relies on the existence of a cross subsidy from high-income to low-income workers that makes the benefits received by the marginal worker bigger than the taxes he/she pays.

In this paper, we argue that in order to obtain a positive elasticity of informality to payroll taxes, the notion of "partial-valuation" of benefits is "needed" only in the context of perfectly competitive markets. However, for many workers, the benefits tied to formal jobs are bigger than the taxes these workers pay. We take the point of view that formal jobs are better than informal jobs, but that 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. Under this view, it is possible to have some workers that value social security more than the taxes they pay, and some workers that value it equally or less than the taxes they pay. We do not rely on the assumption of partial valuation of benefits, instead, we use a search frictions model with an informal sector, heterogeneous workers, and conditional taxes and transfers. Formal workers pay taxes and receive a transfer, while informal workers receive transfers but do not pay taxes. Thus, the tax revenue from the taxes paid by the formal workers is distributed between two groups: formal and informal workers. Within each group we assume that transfers are divided equally among the members of the group, and that these do not depend on wages.

There are three key characteristics in our model that make it different to the basic one. First, it includes frictions: 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. Thus we can have two-way flows (with a period of unemployment in between): from the informal sector to the formal sector, and viceversa.

Second, workers are heterogeneous in the wages they accept. This is important because, keeping the government budget balanced, the presence of workers' heterogeneity will allow for a cross-subsidy

from high-wage earners to low-wage earners through the tax and transfer system. 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 tax they pay, and the opposite will occur for high-wage earners (they will pay high taxes and receive a small transfer). 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 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 an increase of formality in equilibrium.

Third, we distinguish between two kinds of unemployed individuals: those who previously had a formal job, and those who previously had an informal job. We refer to these as formal unemployed, and informal unemployed, respectively. We present evidence that the transition probabilities of the two kinds of unemployed individuals differ dramatically. In particular, informal unemployed are more likely to get an informal job, while formal unemployed are more likely to obtain a formal job. We believe this is related to the fact that transfers while unemployed differ between formal and informal individuals. In particular, the formal unemployed enjoy of a larger transfer than informal unemployed, this increases the value of formal unemployment relative to the value of informal unemployment. This way, it is optimal for formal unemployed individuals to wait longer for a formal sector offer which arrives less frequently than informal sector offers.

In sum, we offer a model that is useful to study the effects on informality of changes in taxes and transfers, and that it is also consistent with the view that formal sector jobs are less risky than informal sector jobs, but harder to get. Additionally, our model is also consistent with the popular idea that an unemployed individual that previously had a formal job is in a much better position than an unemployed person that previously had an informal job, this occurs in our model because transfers are bigger for the later group.

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 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 several counter-factual exercises. We use the case of the recently introduced SP program to validate the results of our model. 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. Our model predicts a small increase on informality in response to the introduction of SP, in line with the evidence found in the micro-literature[8].

One of the key features in our model is its emphasis on the marginal worker (i.e. the one that is indifferent between being unemployed and working) within the context of heterogeneous workers. To gain some intuition on why this is important, in section 3 we present a frictionless model with homogenous workers that we refer to as the "basic model of informality". In models with homogenous

[8]See footnote 2

workers the marginal worker and the average worker are the same, whilst in models with heterogeneity, the marginal worker and the average worker differ. In both models, what is important for the elasticity of informality to taxes and transfers is the behavior of the marginal worker. The basic model gives support to many popular ideas regarding informality such as that increasing taxes is "bad" for the formal sector. In section 3 we will see that in the context of the *basic model of informality* this result only holds if we also require that transfers are not fully valued by workers. This assumption is needed specially in the presence of a balanced budget. Since workers are homogenous in the basic model, the balanced budget not only means that aggregate tax payments are equal to aggregate transfers; it also means that the taxes paid by each worker must be equal to transfers received by each worker. Thus, if partial valuation is not introduced, then the equilibrium would be the same as in the undistorted case, and the elasticity of informality would be zero.

However, if one is willing to give up the budget balance constraint, the basic intuition for some of our results in the richer model with heterogeneous workers is also present in this basic model of informality. Our model with heterogeneous workers opens up the possibility to have in equilibrium workers that pay more taxes than the transfers they receive, or workers that pay less taxes than the transfers they get, while still complying with a balanced budget constraint.

In our counter-factual exercises we simulate a range of changes in the distribution and the generosity of transfers. We find that if the fraction of transfers to formal workers increased to 1 (from a level of 0.62), without changing the overall generosity, the informal sector would decrease 8 percentage points (from the current level of 50% to a level of 42%). There would be an offsetting increase in formal employment and a corresponding increase in formal unemployment, but overall unemployment would remain barely constant; additionally, mean wages would decrease in the formal sector and increase in the informal sector. 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 transfers also increase while unemployed, the value of formal unemployment also increases, but the value of a formal job increases more than the value of formal unemployment because the value of the future while employed increases more than while unemployed (see Fig. 5.3). This pushes-down the reservation wage for a formal job, more formal offers are accepted, and the mean wage in the formal sector decreases. On the other hand, the value of informal jobs and the value of informal unemployment both decrease, but the value of a job decreases more than the value of unemployment, which pushes-up the reservation wage. As a result, the mean wage in the informal sector increases.

We also find that when taxes increase, the informal sector decreases, given the current distribution of transfers. This also happens for other distributional settings where more transfers are given to formal workers. The reason, as mentioned before, is that under such circumstances, transfers will increase more than taxes for the marginal worker, which will make the formal sector more attractive.

A general result from our simulations is that the informal sector is somewhat inelastic for marginal tax changes around the current level of transfers' generosity and distribution. 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 side, transfers also increase which increases the value of a formal job. Of course this elasticity is greatly influenced by the way transfers are distributed across the formal and informal sectors. In fact, when all transfers are given to informal workers, the

range of variation in informality for comparable tax changes is much greater. On the other hand, informality seams more elastic to changes in the distribution of transfers, given size. The reason for this is that there are no counteracting forces as in the case of tax changes.

Our model is consistent qualitatively with the empirical evidence found in Almeida and Carneiro (2012) for Brazil. In addition, we perform a quantitative exercise to asses the effects of the introduction of Seguro Popular, a health care program directed to informal workers. We find that our results are in line with previous empirical evidence on the effect of this program on 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.

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 1uarter 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.

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

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. [9]

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 viceversa 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 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[10]. 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.

[9] 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.

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

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

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 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.[11]

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.

[11]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.

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 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.

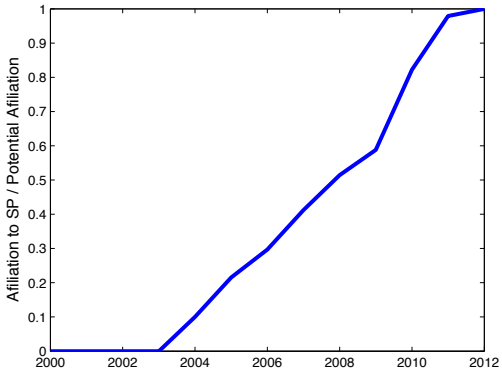
Take for example the case of IMSS in Mexico. IMSS is an institute that provides health care (among other goods and services) to affiliated workers and their families, and its operation is financed through a payroll tax. Thus, low-wage earners pay less taxes than high-wage earners. However, every affiliated 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

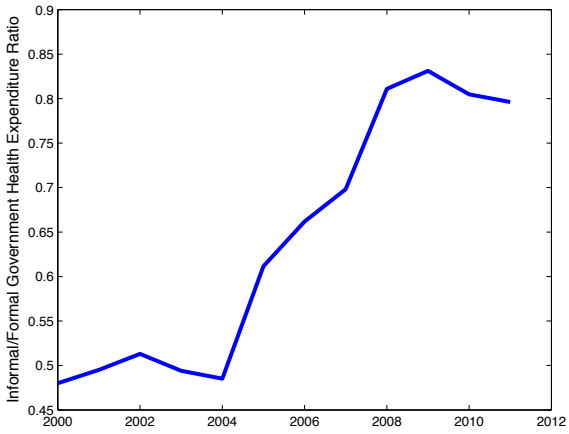
Seguro Popular is a program designed to provide health services to the population not covered by the traditional social security system. The program was gradually introduced in Mexico starting in 2004 and reaching its potential in 2012. This has signified an important increase in the transfers devoted to informal workers. Figure 2.1 shows the evolution of affiliation to the system. In particular, the

Figure 2.1: Affiliation to Seguro Popular



Source: Sistema de Protección Social en Salud. Informe de Resultados 2012.

Figure 2.2: Informal/Formal Government Health Expenditure Ratio



Data source: Ministry of Health .

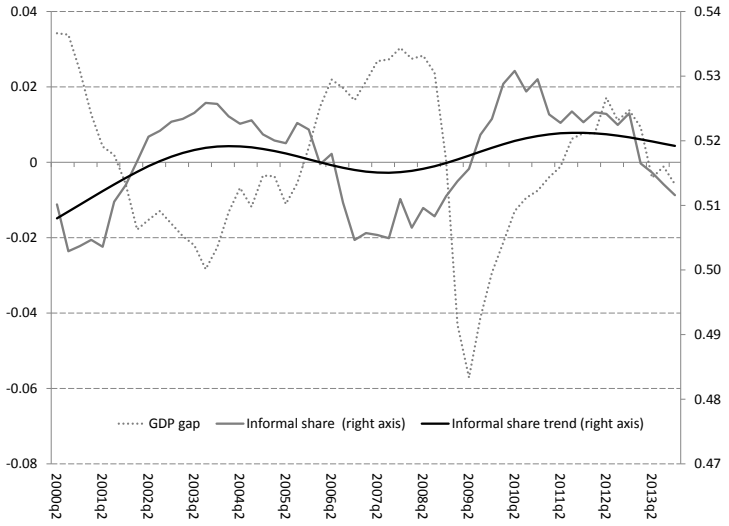
figure shows the cumulative number of persons registered each year as a fraction of the total number of persons registered in 2012 (the potential). As it is clear from the figure, at the beginning of 2009 more than 50% of potential affiliation had already taken place, and by the end of 2010 82% were 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.[12] We include the cyclical component of GDP to emphasize the counter-cyclical nature of informality. The series are presented in Figure

[12]We use an HP-filter to de-trend the series.

Figure 2.3: Evolution of informality among employees



Source: Own calculation using ENE, ENOE and National Accounts.

2.3. Notice that informality increases in 2009 and stays high until 2012, when it starts going down again. The increase 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[13].

[13]See footnote 2

3 A *basic model of informality* with homogenous workers

In this section we would like to review the standard results of two-sector models with homogenous 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.

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 of informal labor, in particular: $w_F > w_I$. This wedge affects the equilibrium by increasing the share

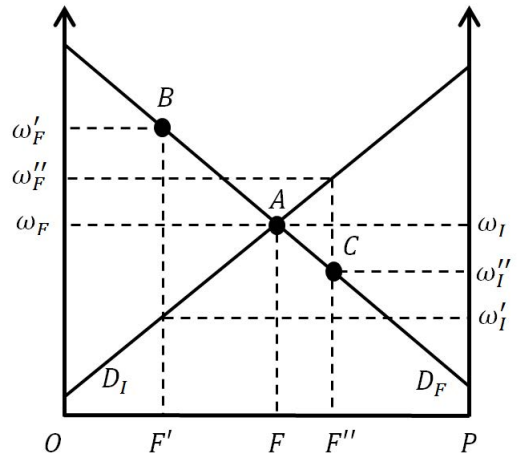


Figure 3.1: Equilibrium in a two-sector model with homogenous workers

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 homogenous 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 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).[14] 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. 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

[14] We abstract from subindex t, since we will be focusing on the steady state.

unemployed or accept any of the offers at hand. 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.

- Value of being employed in the formal sector:

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

- Value of being employed in the informal sector:

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

- Value of being unemployed after having a formal job:

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

- Value of being unemployed after having an informal job:

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

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_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 distributions 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:

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

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

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 $i \in \{F, I\}$.

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:

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

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

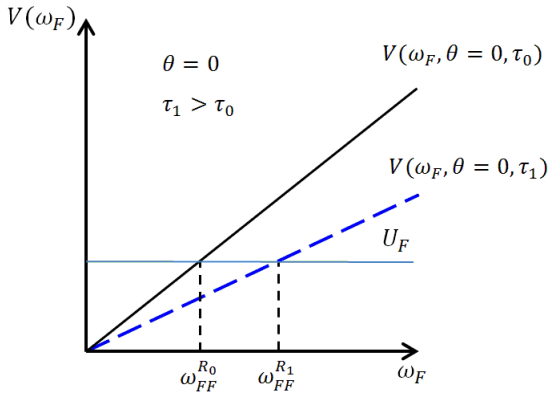


Figure 5.1: Effects of a tax increase with no transfers on the value of a formal job.

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

5.1 Higher taxes do not necessarily imply higher informality

The goal in this section is to 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 an formal unemployed worker with a formal offer w_F in hand, and no offer from the informal sector. The decision problem of this worker is summarized in Figure 5.1. 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. 5.1 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. 5.1 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 formal. 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 5.2. The dashed line lies below the solid line for

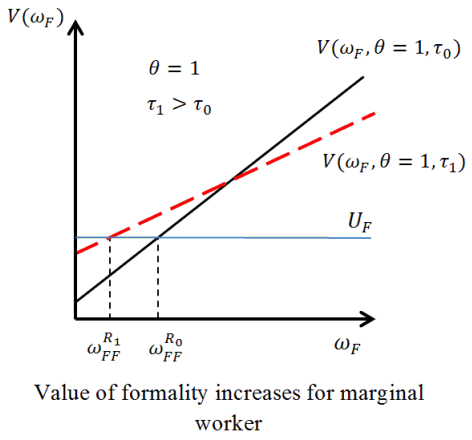


Figure 5.2: Effects of a tax increase with all transfers to formal workers.

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.

In summary, 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 also in the case when the worker gets two offers, and 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.

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

Consider now 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 with a formal job offer in hand and no offer from the informal sector. The problem faced by this individual can be summarized in Figure 5.3. 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 the value of a formal job increases more than proportionally as transfers increase. This is due to the fact that the value of formal unemployment also increases, and this is included in the value of a formal job.

I contrast, Figure 5.4 shows what happens to the reservation wage of an informal unemployed when θ increases. In this case, the reservation wage increases, because the value of an informal job is reduced by more than the value of informal unemployment.

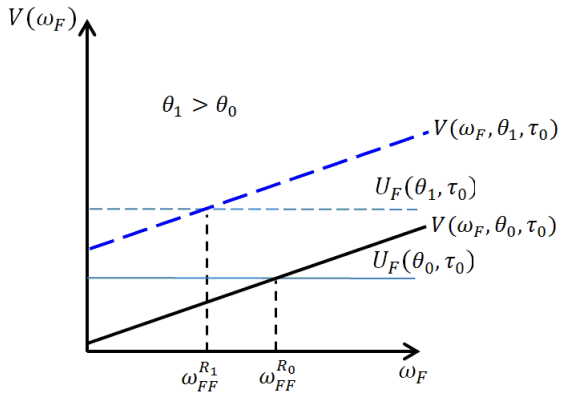


Figure 5.3: Effects of an increase in θ on formal unemployed individuals.

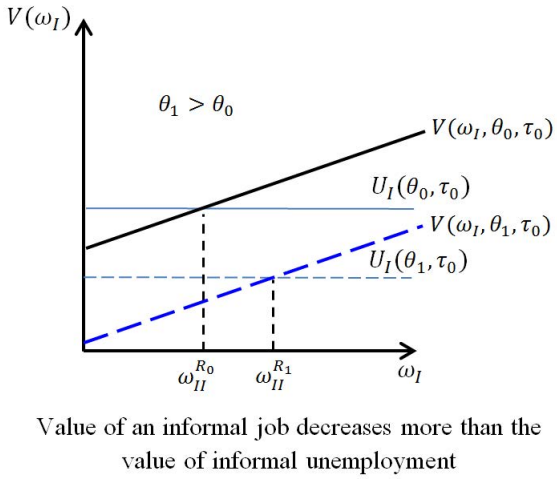


Figure 5.4: Effects of an increase in θ on informal unemployed individuals.

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

6 Calibration

We calibrate the model by choosing parameters and simulating the model to replicate a set of key moments introduced in Section 2 and described below. We repeat this simulation iterating over the set of chosen parameters until we are close to the key targeted moments. All parameters but θ are found through simulations. We set $\theta = 0.53 = 1 - 0.47$, based on the discussion of Section 2 and Appendix B regarding the distribution of transfers. For the rest of the parameters, we chose their values by minimizing the mean squared percent deviation from the moments selected. The statistics we choose are the fraction of employees in the formal sector $\hat{e}_F$, the fraction of employees in the informal sector $\hat{e}_I$, total unemployment $\hat{u}$, unemployment in the informal sector $\hat{u}_I$, mean wage in the formal sector $\bar{w}_F$, 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 $\frac{\Omega}{y}$[15]. A summary of the moments considered is presented in Table 3.

The parameters we need to calibrate are job firing probabilities, job finding probabilities, means, and standard deviations of wage distributions both in formal and informal sectors. We assume that wage offers of formal and informal sectors are drawn from i.i.d. log-normal distributions[16] with potentially different mean and variance:

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

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

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

The following table shows the vector of parameters that minimized the mean squared deviation of the simulated moments to their ENOE equivalents.

The firing probability in the formal sector is smaller than in the informal sector. This is an important feature in our model and it is related with the assumption of two different unemployment

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

[16] 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 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

states. When we consider two different unemployment states, 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 is higher than the per-capita transfer received by the informal unemployed which tends to increase duration. A higher duration would tend to increase formal unemployment, this is offset with a low firing probability in the formal sector.

This feature is consistent with the common idea that being unemployed after having a formal sector job leaves the worker in a much better position than being unemployed after having an informal job. The source of this idea is that the formal sector in Mexico is subject to high severance payments. We do not model explicitly severance payments, but we believe that the current specification is rich enough to capture the mechanics behind this common idea.

Similarly, job finding probabilities are smaller in the formal sector than in the informal sector, which is also consistent with the idea that the informal sector is more dynamic as is not subject to labor market regulations. Finally, the tax consistent with a revenue of 7.5% of GDP is $\tau = 0.2729$, which lies within a reasonable range. We compare moments induced by these parameters against those in the data in Table 3.

The model provides a good match of employment and unemployment and it captures very well the first two moments of the observed distribution of wages.

7 Results

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 few 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

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

are distributed across formal and informal workers is a relevant force that determines the size of the informal sector. Notice that, 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 unemployment.

Notice however, that general unemployment is almost unchanged, which is consistent with an offsetting reduction of informal unemployment. To see why informal unemployment is reduced, notice that when θ increases, there is more 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 5.3).

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 5.4). 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

7.2 Changes in the size of transfers (the tax rate level)

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 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! (see Figures 5.1, and 5.2). 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.

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 in perspective, notice that Tab. 6 considers changes in taxes in a range of 10 percentage points, and only when $\theta = 0$, the range of variation of informality in response to changes in τ is 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 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 7) and Section 2. Given that Table 7 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

Table 7: 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

Table 8: 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

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

In general the small changes found as a result of the introduction of SP are the result of 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, changes in transfers 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. In contrast, when we fix the generosity of the system, and change the distribution of transfers, we find a bigger elasticity of informality. The reason is that in this case, the forces acting over the marginal worker go only in one direction.

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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