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CROSS-SUBSIDIES, AND THE ELASTICITY OF INFORMALITY TO SOCIAL EXPENDITURES: THE CASE OF MEXICO'S SEGURO POPULAR

BY JORGE ALONSO-ORTIZ

Centro de Investigación Económica, ITAM

AND

JULIO LEAL*

Banco de México

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 changes along with the generosity of these transfers? In our search model, taxes are levied on formal-sector workers as a proportion of their wage. Transfers, in contrast, are lump-sum and are received by both formal and informal workers. This implies that high-wage formal workers subsidize low-wage formal workers as well as informal 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 the presence of search frictions and to the cross-subsidy in our model: for low-wage formal jobs, a tax increase is roughly offset by an increase in benefits, leaving the unemployed approximately indifferent. Our results are consistent with the empirical evidence on the recent introduction of the "Seguro Popular" healthcare program.

JEL Codes: E26, J46, O17

Keywords: informality, social expenditures, cross-subsidies, Seguro Popular

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,

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*Correspondence to: Julio Leal, Research Economist, Banco de México, Avenida 5 de Mayo 2, Colonia Centro, Código postal 06059, Delegación Cuauhtémoc, Ciudad de México, México (jleal@banxico.org.mx).

[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, 1993). Of course, this measurement is subject to standard errors.

informal workers are not enrolled in social security. A common policy reaction of many governments has been to introduce transfer programs directed at informal workers to alleviate their lack of protection. Several authors have argued that the introduction of these types of social programs provides an incentive for informality and discourages formality, as higher taxes are needed to 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? (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 of 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 (see Section 3). One key assumption in this framework is that workers *voluntarily* choose to be formal or informal, and, as a result, workers (who are assumed to be homogeneous) remain indifferent between the two kinds of jobs.

In contrast, a traditional view maintains 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 force workers to stay informal and *involuntarily* to queue for formal-sector jobs.[4] 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 above two views, recognizing some role for choice and some role for chance, in accordance with the most recent empirical evidence (see, e.g., Maloney, 2004; Perry *et al*., 2007). In addition, the

[2]For the case of the "Seguro Popular" healthcare program, which has recently been 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 includes Maloney (2004), Levy (2008), and Almeida and Carneiro (2012). This model has also been used to study the extent to 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]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.

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 (see, e.g., Fugazza and Jacques, 2004; Zenou, 2008; Albrecht *et al*., 2009; Bosch and Esteban-Pretel, 2012; Meghir *et al*., 2012; Esteban-Pretel and Kitao, 2013). The innovation in this paper is to focus on how the distribution of both taxes and transfers across formal and informal workers affects 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 above discussion. Individuals searching for a job will get an offer with only 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 losing a formal job is lower than the probability of losing 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 allows us to have two-way flows: from the informal sector to the formal sector (with a period of unemployment in between), and vice versa. Our calibrated version of the model will be consistent with the view that, in general, formal jobs are better than informal jobs,[5] 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).

[5]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.

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 who 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 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 at formal workers. Using this calibrated model, we perform three counterfactual 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" (or "SP"). Specifically, we simulate an increase in the generosity of the transfer system along with a redistribution toward 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 affects the relative value of formal and informal jobs. The mechanics in the model that produce these changes are as follows. When transfers directed at 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 Figure 5). 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 fewer 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 percent (holding taxes constant) decreases the size of the informal sector only by 0.24 percent. 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 opposing forces affecting the marginal worker's choices. On the one hand, taxes increase, which lowers the value of formal jobs; but, on the other, transfers increase, which increases their 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 in which 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 in informality in response to the introduction of SP, which is in line with the evidence found using micro-econometric techniques (see footnote 2). 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 counterfactual exercise, we would have reasons to be worried 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; 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 follows. In Section 2 we present relevant facts on Mexico's labor markets and 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, which 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 is that

there are important flows between formality and informality, and vice versa. This means that unemployed individuals who used to have an informal job often choose to go into the formal sector; similarly, unemployed individuals who previously had a formal job often choose an informal job. The second issue concerns social policy in Mexico. Social programs are directed at 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 at 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 in 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 who is enrolled in the traditional Mexican Social Security system (IMSS) and an informal worker as one who 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, 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 to which they have access.

We are interested in four labor market states: formal employment, informal employment, unemployment of individuals who used to have a formal job, and unemployment of individuals who used to have an informal job. Henceforth, we will refer to those unemployed individuals who 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 2012–13 period.[6]

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 percent for both kinds of workers. Third, note, 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, the formal unemployed and informal

[6]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 to take advantage of the rotating panels in ENOE.

TABLE 1
The 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 who started in state x, and ended next quarter in state y.

unemployed display radically different transition probabilities. For an informal unemployed person, 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 person, 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 person (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 a 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 with a low probability; and on the other, 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.[7] 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 healthcare services, retirement pensions, disability insurance, housing

[7]To obtain the steady state stocks, we rise this matrix to the power of 1,000.

TABLE 2
Labor Market Stocks

	Data Implied	Raw Data
	By Transition Matrix (2012–13)	Average (2012–13)
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.

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 healthcare 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 1990s, 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 to which these transfers provide perfect substitutes for 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 percent of GDP in 2011 and 7.4 percent in 2012 (which gives an average of 7.5 percent during these two years). This includes cash and in-kind benefits from both transfer systems detailed above.[8]

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 5,670 MXP out of 24,519 MXP, that is, 23 percent of total social transfers. However, the data used for this figure correspond to a period before Seguro Popular was fully introduced, and therefore they are 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 SP, across "covered" (by social security) and "uncovered" workers. According

[8]The OECD Social Expenditure Database classifies expenditures according to the purpose of the social program in which they originate. 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 this data, in 2011, 45 percent of all government health spending was directed at informal workers.

To assess the fraction of social expenditures in programs directed at formal workers, we use the detailed SOCX database, in which 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 (the 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 (the Health Ministry) to obtain the fraction spent in programs directed at informal workers. Using this methodology, we conclude that 62 percent of social spending is distributed to programs directed at formal workers, and the rest to informal workers.

2.3. *Social Programs and Cross-Subsidies*

The concept of "partial valuation" of benefits is grounded in the idea that government-supplied goods and services are of a lower quality than the same goods and services provided by the market. There are certainly efficiency losses associated with government production. However, we argue that even if this is the case, given 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, which is made 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 healthcare (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 lower taxes than high-wage earners. However, every affiliated individual has the right to receive the same healthcare services, with no exceptions. The amounts in which healthcare services in IMSS are provided to individuals are not based on the amount of contributions (taxes) the worker has paid; instead, services are provided on a daily basis for everyone who is affiliated, subject to demand. Every year, there is a budget allocated to the operation of IMSS healthcare services.

Based on these facts, we believe that a reasonably good way to model social policy is to use 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 in which some transfers are received by informal workers and other transfers are received by formal workers. However, given that, we still have to take a stand on the way in which transfers are distributed within these special groups. We distribute transfers within groups on a per capita basis, independent 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, note that—since taxes do depend on wages—it is possible to have individuals within groups who receive a transfer that is larger than, equal to, or smaller than the taxes paid.

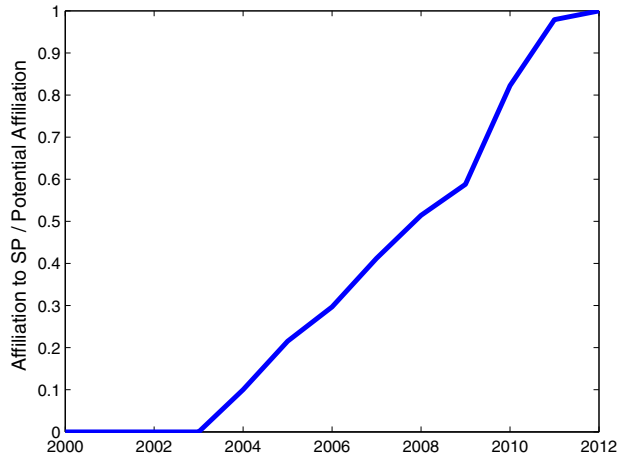

Figure 1. Affiliation to Seguro Popular [Colour figure can be viewed at wileyonlinelibrary.com]

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.

2.4. *The Case of Seguro Popular*

Seguro Popular is a program designed to provide health services to those members of 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 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 is clear from the figure, at the beginning of 2009 more than 50 percent of potential affiliation had already taken place, and by the end of 2010, 82 percent were enrolled.

As a result of the introduction of Seguro Popular, government health spending has increased from 2.6 percent of GDP to 3.1 percent in the period. But, more importantly, the composition of expenditures across the formal and informal sectors has changed (see Figure 2). Government spending on health programs devoted to informal workers has increased from 32 percent of total spending in 2004 to 45 percent 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.[9] We include the cyclical component of GDP to emphasize the countercyclical nature of informality. The series are presented in Figure 3. Note that informality increases in 2009 and stays high until 2012, when it starts

[9]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.

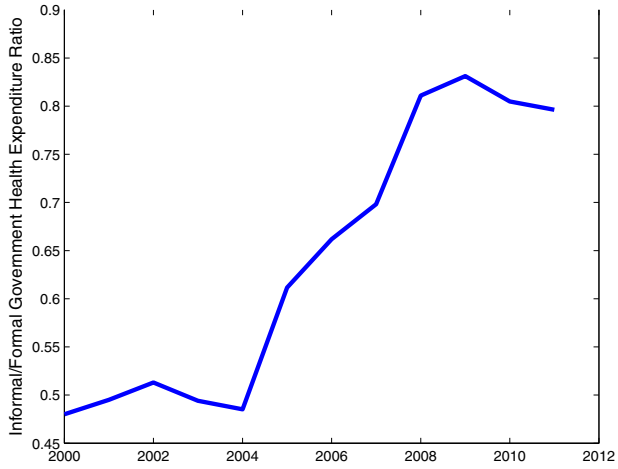

Figure 2. The Informal/Formal Government Health Expenditure Ratio [Colour figure can be viewed at wileyonlinelibrary.com]

Source: Ministry of Health.

Notes: The figure shows the evolution of the ratio of public health expenditures on informal workers relative to that on formal workers.

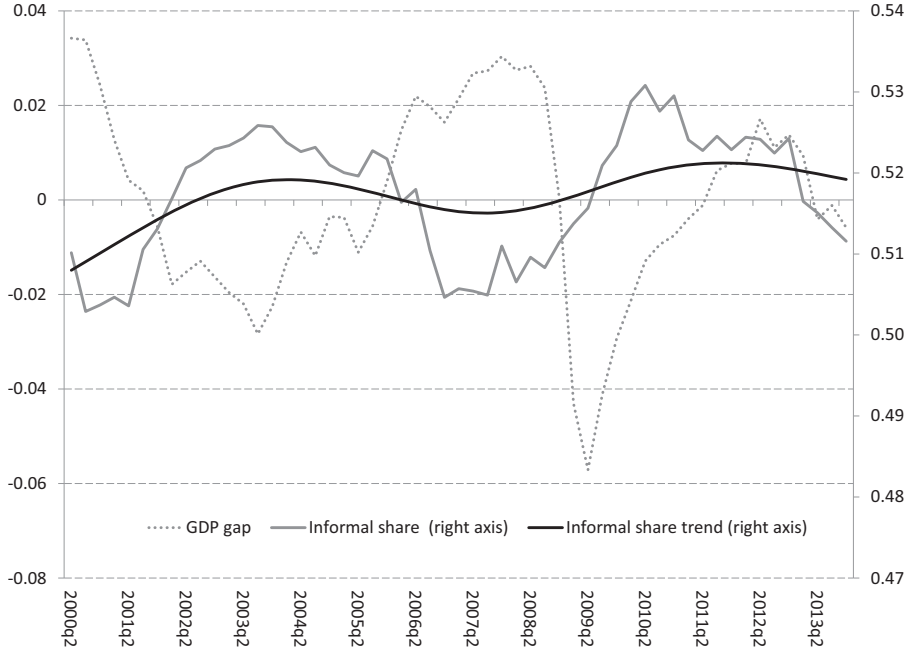

Figure 3. The Evolution of Informality among Employees

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 countercyclical. There is no clear change in the evolution of informality between 2004 and 2012 when Seguro Popular was introduced.

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 for changes in informality due to the design of social programs is not strong. In Section 7, we perform a counterfactual 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 (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 later to compare these results against those 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. Fields, 1990, 2004; Maloney, 2004; Levy, 2008). One can think of two representative firms, one formal and one informal, which 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 the 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 4 depicts the equilibrium for this simple economy. As shown in Figure 4, 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 on 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 on the x-axis from right to left by the distance PF. Note 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

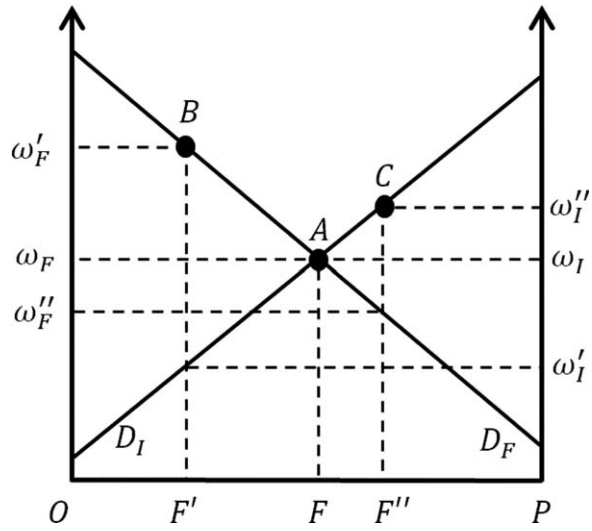

Figure 4. Equilibrium in a Two-Sector Model with Homogeneous Workers

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 is given 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.

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

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

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

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 of informal labor, as depicted in Figure 4 by the variables with a prime. As shown in Figure 4, 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 the case 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, let us 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 in which the workers get back all that they paid in taxes. In this case, marginal costs of formal and informal workers equalize: $w_F - \tau w_F + T = w_I \iff w_F = w_I$. The first equality follows from the free mobility condition, while the second one follows from the equation in (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 in which the workers do not get back the total proceeds of their taxes. In this case, a wedge is present between the marginal cost of formal workers and that of informal workers; 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 example of case (b).

The opposite happens in case (c), $T > \tau w_F$, where the workers get more than 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 4 by the variables labeled with two primes. The marginal cost of a formal worker now intersects with D_F at point C on 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 in which the government's budget is not balanced. However, when there are heterogeneous workers, cross-subsidies between high-income and low-income workers allow for the possibility of having all three cases above simultaneously, while also having a balanced budget, in equilibrium. In our model below, we will have workers who receive more than they paid in taxes, workers who receive less than they paid in taxes, and workers who receive the same as they paid. We will argue that the marginal workers, that is, those workers who are indifferent between being formal or informal, receive more in transfers than 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 who 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, informal), and current wage (w_F or w_I).[10] We refer to unemployed individuals who 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 $i \in \{F, I\}$. Note that, since we do not allow for on-the-job search in the model, 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. The 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 capita transfers as the value of all cash and in-kind benefits accruing 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 the 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 on 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 healthcare services of Seguro Popular, and other social protection programs that do not stop if an individual loses his or her job. Regarding formal unemployed, individuals can enjoy IMSS healthcare services for two months after they lose their job, although, during severe recessions, this period has been extended to four months. Since, in our data, only 27 percent of formal unemployed individuals remain as such in the next quarter, we believe that 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 the 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 captured well 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 decisions 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.

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

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

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

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 of 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 his or her job, the value of unemployment is different than if a formal worker loses his or her job ($U_I \neq U_F$).

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

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

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

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

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

Note that the transfers differ depending on whether the previous job was formal or informal (i.e. $T_F \neq T_I$). Note also that the 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 Equations (4.1)–(4.4), which yields the following:

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

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

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

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

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 (in the Online Supporting Information). We define the evolution of formal employment here for illustrative purposes:

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

The first component is the mass of workers who did not lose their formal employment. The second component consists of those workers who 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 who get offers from both sectors, but the formal-sector offer dominates. The full system of equations can be found in the Appendix (in the Online Supporting Information). This system defines a steady state for the employment and unemployment distributions. Key to defining the steady state equilibrium employment and unemployment levels by sector are the probabilities at which the different offers can be compared. 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 in each sector. We

have derived analytic expressions for these objects in the Appendix (in the Online Supporting Information). 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, the total resources collected by the government are given by

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

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

$$T_F=\theta\Omega/(e_F+u_F)=\theta\Omega\Big/\left(\int \mathrm{d}\Gamma_F(w_F)+u_F\right),$$

$$T_I=(1-\theta)\Omega/(e_I+u_I)=(1-\theta)\Omega\Big/\left(\int \mathrm{d}\Gamma_i(w_i)+u_I\right).$$

5. Equilibrium Characterization

The goal in this section is to describe the characteristics of the equilibrium that are important for our main results. We are particularly interested in the way in which workers react to changes in taxes and transfers. For didactic 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 Alonso-Ortiz and Leal (2016), 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. 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

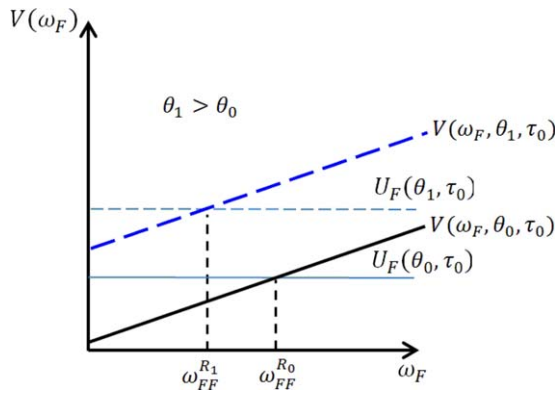

Figure 5. The Effects of an Increase in θ on the w_{FF} Reservation Wage [Colour figure can be viewed at wileyonlinelibrary.com]

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 reducing those for informal ones. The value of a formal job increases more than the value of unemployment, which reduces the reservation wage.

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 in the way of transfers, these are less valuable, and this tends to reduce the value of formal unemployment.

Figure 6 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 to

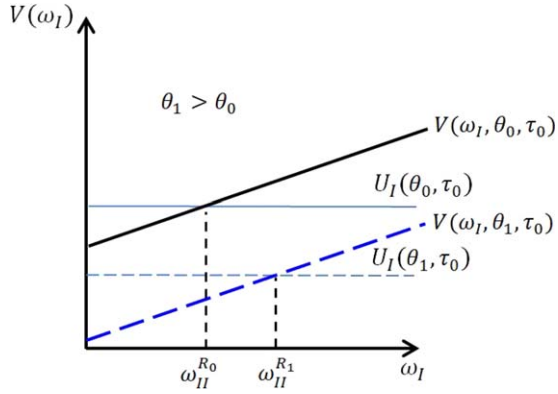

Figure 6. The Effects of an Increase in θ on the w_{II} Reservation Wage [Colour figure can be viewed at wileyonlinelibrary.com]

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 reducing those for informal ones. The value of an informal job decreases more than the value of unemployment, which increases the reservation wage.

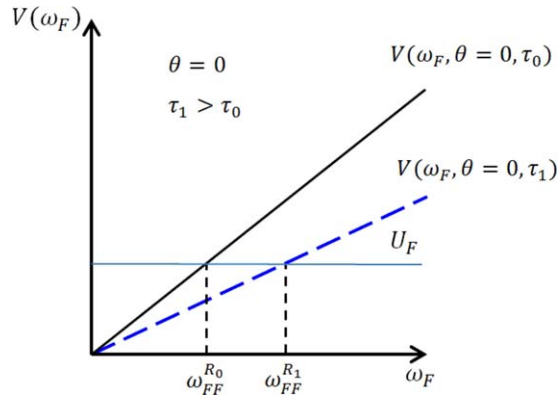

Figure 7. The Effects of a Tax Increase with No Transfers Rebated [Colour figure can be viewed at wileyonlinelibrary.com]

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.

before: the value of informal unemployment has to take into account the possibility of switching to a formal job in the 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, let us 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 7. Originally, taxes are at τ_0; thus, the value function is depicted by the solid line as an increasing function of the wage. As Figure 7 shows, the worker accepts the offer if $w_F > w_{FF}^{R_0}$ (because $V_F > U_F$) and rejects it otherwise. The effect of an increase in taxes from τ_0 to τ_1 is shown in Figure 7 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. Note 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, fewer workers decide to become formal.[11] In this case, higher taxes bring about a decrease in formality, in accordance with popular beliefs.

Now consider what happens when transfers to formal workers are positive ($\theta > 0$); for didactic purposes, we focus on the case when $\theta = 1$. In this case, an increase in taxes will become associated with an increase in transfers to formal

[11]To be precise, the value of formal unemployment would also shift in response to the tax change, but the shift would 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 $(1-\theta=1)$.

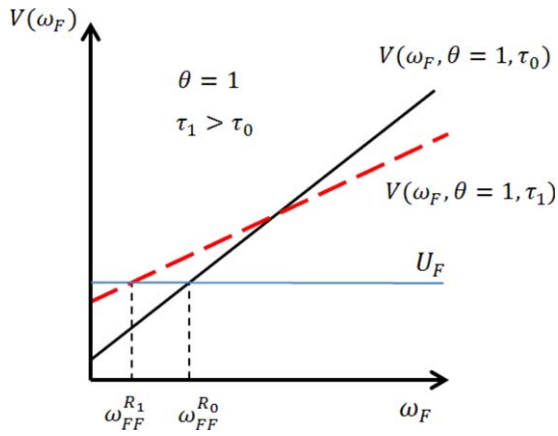

Figure 8. The Effects of a Tax Increase with a Cross-Subsidy [Colour figure can be viewed at wileyonlinelibrary.com]

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, who are the marginal ones. This decreases the reservation wage, and leads to more formal employment.

workers. However, due to the fact that transfers are given on a per capita basis and taxes are proportional to wages, 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 8. 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.[12]

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 that this is an important result because it contrasts with the common idea that higher taxes automatically imply a greater degree of informality.

6. Calibration

In this section, we present our calibration strategy. The goal of the calibration is to assess the value of the parameters in the model by connecting the model with the data. This goal is usually achieved by looking for the set of parameters that will make the model deliver equilibrium outcomes that resemble the data.

[12]Note 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 Alonso-Ortiz and Leal (2016).

To perform this task in a practical way, 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 set of parameters as inputs, and produces equilibrium outcomes associated with that specific set of parameters. Second, we summarize these equilibrium outcomes by setting up a list of relevant moments that describe the economy (see below). We intentionally choose moments in this list that are also observable in the data, in such a way that each moment has a value in the data, and a value in the model that we can compute using our code. Third, we iterate over different sets of parameters and look for the set that brings the value of the moments in the model as close as possible to the value of the moments in the data.

We typically start by identifying the group of parameters that can be calibrated independently from the rest. In order to be able to independently calibrate a parameter, it must be the case that a moment in the list referred to above is completely determined by the value of such a parameter. This is the case of the parameter θ which, in the model, fully determines the fraction of expenditures that are transferred to formal workers. In fact, in this case, the parameter and the moment are synonyms. Thus, we set $\theta=0.62$, based on the discussion in Section 2 regarding the distribution of transfers.

In contrast, if a parameter needs to be jointly calibrated, this means that no moment in the list uniquely depends on the value of one parameter. Indeed, the usual case is to have a situation in which a single moment is influenced by many parameters, simultaneously. Next, we describe the parameters that we need to jointly calibrate. These include the job-firing probabilities, the job-finding probabilities, the means and standard deviations of wage distributions in both the formal and the informal sectors, and the tax rate. Regarding the distribution of wages, we assume that wage offers of the formal and informal sectors are drawn from i.i.d. log-normal distributions[13] with potentially differing means and variances:

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

This gives us nine parameters to jointly calibrate, which we collect in the vector φ:

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

Next, to perform the calibration of these parameters, we proceed in the three stages referred to above. First, we solve for the equilibrium numerically; this means that we write down a computer code that receives an arbitrary value of the vector φ as input and produces equilibrium outcomes. To summarize these outcomes we set up a list of relevant moments that describe the economy. The statistics that we choose in this list are as follows: 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, $\hat{u}_I$; the mean wage in the

[13]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 cannot 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. The "Data" column shows the actual moment in the data, while the "Model" column shows the moment delivered by the model under our baseline calibration. For details of our calibration procedure, see the notes to Table 4 and the text.

formal sector, $\bar{w}_F$; the 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, Ω/y.[14] A summary of the moments considered is presented in Table 3.

We continue with the calibration procedure by iterating over different values of the vector φ, so that the model replicates the selected key moments of Table 3. More precisely, we start with a guess of the parameter values, and use a computer program to look for the values that minimize the mean squared percent deviation between the value in the model and the value in the data on the selected moments. Table 4 shows the vector of parameters that results 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 turns out to be 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 percent of GDP is $\tau=0.2729$, which lies within a reasonable range. The moments induced by these parameters 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

[14]In our model, GDP is $y=\int w_F \mathrm{d}\Gamma_F+\int w_I \mathrm{d}\Gamma_I$.

TABLE 4
The 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 such moments well. See more details in the text.

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 counterfactual scenarios in which we have an interest. 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 counterfactual exercises, we would like to organize the discussion by 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; these are 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 type (θ=0.62). Note 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 in which transfers are distributed across formal and informal workers is a relevant force that determines the size of the informal sector (see Figures 5 and 6).

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 who can potentially be formal unemployed; second, since transfers also increase for the formal unemployed, this also increases the value of formal

TABLE 5
The 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.

unemployment. Note, however, that general unemployment is almost unchanged, which is consistent with an offsetting reduction of informal unemployment. To see why, note that when θ increases, there is less informality and less in the way of transfers is 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 in which reservation wages respond to changes in θ in order to fully understand the mechanics of the model. Note 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 $\theta = 1$, virtually any formal job offer is accepted ($w^R_{IF}=0$). The reduction in 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).

In contrast, the reservation wage of an informal offer increases when θ increases. This reflects the fact that informal jobs become less attractive as less in the way of transfers is given to these individuals (see Figure 6). Consequently, fewer 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

TABLE 6
THE EFFECTS OF CHANGES IN SIZE AND DISTRIBUTION OF TRANSFERS ON THE SIZE OF THE INFORMAL SECTOR

		θ				
		0	0.25	0.50	**0.62**	1
τ/τ_0	*0.8*	0.6657	0.5934	0.5333	**0.5074**	0.4371
	0.9	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.

thus the mean wage in the formal sector is reduced. The opposite happens with the mean wage of informal jobs.

7.2. *Changes in the Tax Rate (the Generosity of Transfers)*

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

In response to a 20 percent 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). The 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 previously (see Figure 8). This can be confirmed in the last column of Table 6: when the tax rate increases, informality decreases, 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 strong increase in informality (see Figure 7).

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, note that Table 6 considers changes in the tax rate over a range of 10 percentage points (from 22 percent to 33 percent), and it is only when $\theta = 0$ that 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.

TABLE 7
The Importance of Frictions

			Factor t			
		Bench	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 1 percentage point.

7.3. *The 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 by 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. Since in our model, the job separation probability is fixed, this represents a barrier for movement of that kind. 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, cannot 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 as we increase θ. To achieve such a goal, we perform additional counterfactual 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 by a factor $t > 1$, along with the change in θ. We consider an increase in θ of 1 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 percent 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 that is eight times higher than in the baseline case. A similar pattern 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 of highlighting the importance of frictions in 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

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 change in the tax rate of 1 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.

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.[15]

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 by a factor $f \geq 0$, and then we compute the change in informality when we increase the tax rate by 1 percentage point. We report the elasticity as the change in the size of the informal sector 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 case ($f = 1$) is positive 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 decrease 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 case. 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 case.

Table 8 highlights the importance of 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. *The Effects of Seguro Popular*

In this section, we analyze the effect of changes in taxes and transfers associated with the introduction of Seguro Popular. We interpret the above calibrated parameters as representing the situation after the introduction of the program.

TABLE 9
DATA ON DISTRIBUTION AND GENEROSITY OF TRANSFERS ASSOCIATED WITH THE INTRODUCTION OF SP

Data	2004	2011
Health spending/GDP (generosity)	2.59	3.05
Share of health spending directed at formal workers (distribution)	0.6756	0.5567

Notes: The table shows relevant data on health expenditures, before and after the introduction of Seguro Popular. The introduction of this program signified a change in the distribution and the generosity of transfers.

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

TABLE 10
The Impact of the Introduction of Seguro Popular on Informality and Unemployment

	Before SP	After SP	Difference
Generosity (Ω/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.

We simulate a reduction in generosity equivalent to 0.5 percent of GDP and an increase in the transfers directed to formal workers, consistent with the data from both the OECD's SOCX database and the 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 SP was introduced. We conclude that before SP was introduced, the generosity of transfers amounted to 7 percent of GDP and the value of θ consistent with the distribution of transfers at the time was 0.66.

With this on hand, we perform a counterfactual exercise using our model: we change the generosity of transfers and the distribution to reflect a 7 percent 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 has been to increase the share of informality by 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 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, transfer changes should be of considerable size. To put this differently, under the current distribution, it is hard to obtain sizable changes in informality in response to 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 types of effects were considered. For explanatory purposes, let us focus on the tax changes in Table 6. One key variable for the decision of the firm is the relative wage of formal workers versus 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 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 goes in the opposite direction to our current results.

By how much would formal-sector wages decrease 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 formal and informal workers are from the point of view of the firms. In models where there is an occupational choice, with both formal and informal entrepreneurs, the answers to these questions are related to how the marginal entrepreneurs are affected by 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 question 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 in which 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 who receive a transfer that is larger than the taxes paid coexist with workers who 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 above two situations is the one that prevails for the marginal worker.

We calibrate the model for Mexico, and perform counterfactuals. Given that 62 percent 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, versus 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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Supporting Information

Appendix: Steady State Employment, Unemployment and Wage Distributions