

MODELING INFORMALITY FORMALLY: HOUSEHOLDS AND FIRMS

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Informality is widespread in most developing countries. In Latin America, 50% of salaried employees work informally. Three stylized facts characterize informality: (1) small firms tend to operate informally while large firms tend to operate formally; (2) unskilled workers tend to be informal while skilled ones have formal jobs; (3) ceteris paribus, secondary workers (a worker other than the household head) are less likely to operate formally than primary workers. We develop a model that accounts for all these facts. In our model, both heterogeneous firms and workers have preferences over the sector they operate and choose optimally whether to function formally or informally. There are two labor markets, one formal and the other informal, and both firms and workers act unconstrained in them. By contrast, a prominent feature of the preexisting literature is that workers' decisions play no role in determining the equilibrium of the economy. In our model, policies that reduce the supply of workers in the informal labor market at given wages will increase the level of formality in the economy. This has noteworthy implications for the design of social programs in developing countries. We also show that an increase in the participation of secondary workers would tend to raise the level of informality in the economy. (JEL J24, J33)

I. INTRODUCTION

Recent estimates indicate that around 10% of gross domestic product (GDP) in the United States is produced by individuals or firms that evade taxes (Schneider and Enste 2000). In Latin America, approximately 50% of all salaried employees work informally. An important question is, therefore: What are the determinants of informality? Unfortunately, three decades of research have not yet yielded a consensus opinion on this point.

*We thank David Levine, two anonymous referees, seminar participants at London School of Economics, University of Edinburgh, Universidad Di Tella, Universidad de San Andrés, Washington University in St. Louis, Universidad Nacional de San Luis, Pontificia Universidad Católica de Chile, Fundación de Investigaciones Económicas Latinoamericanas, LACEA Annual Meetings 2006, EALE Annual Meeting 2007, SOLE Annual Meeting 2008, and ISNIE 2009 for useful comments and Leopoldo Tornarolli from CEDLAS for providing us with the data used in this paper. We are also grateful for the excellent research assistance of Paulo Somaini.

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The traditional explanation, initiated with the work of Lewis (1954), assumes the existence of segmented labor markets in which some workers do not have access to jobs in the regulated, formal sector. These workers are forced to accept lower-paying informal-sector jobs that usually involve inferior working conditions. While this view has become prevalent in the development literature, direct empirical tests of the premise that informal workers would expect higher wages in the formal sector yield mixed results. For instance, Magnac (1991), Maloney (2004), and Pratap and Quintin (2004) do not find compelling evidence of segmentation between the formal and the informal sectors using data from Colombia, Mexico, and Argentina, respectively. It is, nonetheless, certainly plausible that the presence of unions might segment the labor market (Layard et al. 1991). However, even if we believe that unionization has been an important factor in determining labor-market segmentation in the past, the pronounced decline of unionization throughout Latin America over the last

ABBREVIATIONS

GDP: Gross Domestic Product
VAT: Value Added Taxes

two decades seems to be a less satisfactory explanation of the phenomenon at the present time, especially since informality increased in most countries in Latin America during the same period (Gasparini and Tornarolli 2006).

Another approach emphasizes the role of labor-market regulation and taxation as the main cause of informality. A pioneering study by De Soto (1989) describes how informal workers develop their own laws and institutions to make up for the shortcomings of the official legal system. It is certainly true that the size of the shadow economy is affected by the burden of taxes and social security contributions, as well as by the many other regulations governing the official economy. The problem with adopting this explanation of informality unreservedly, however, is that it overlooks the fact that workers have nonpecuniary preferences for the sector they work for, and these preferences play a role in determining the equilibrium level of formality of an economy. In particular, workers in the informal sector are not eligible for socially mandated benefits.

Three stylized facts characterize informality: (1) small firms tend to operate informally while large firms tend to operate formally; (2) unskilled workers tend to be informal while skilled ones have formal jobs; (3) *ceteris paribus*, secondary workers (a worker other than the household head) are less likely to operate formally than primary workers. In this paper, we present a model of an economy in which the sizes and wages of the formal and informal sectors are endogenously determined that accounts for these three facts. Our model entails a continuum of types on both sides of the labor market (i.e., firms and workers). Firms choose whether to operate formally or informally and workers choose in what sector they work. In equilibrium, managerial talent determines *size dualism* at the firm level, and human capital is the factor that determines whether workers are employed in the formal or informal sector. In our model, both heterogeneous firms and workers have preferences over the sectors they operate and choose optimally whether to function formally or informally. By contrast, a prominent feature of the preexisting literature is the idea that workers' decisions play no role in determining the equilibrium of the economy. Thus, our model is the first one in which policies that affect workers' preferences (as well, of course, as firm preferences) over the formal or the informal sector such as pension plans, public

health issues, and unemployment and any social benefits will affect the sizes and wages of the formal and the informal sectors. This has profound consequences for the design of policies, especially social programs.

Our main findings are as follows: First, secondary workers, *ceteris paribus*, are less likely to operate formally than primary workers are. This is because, whatever the net benefits of operating formally may be for a worker having a given human capital endowment, they will be lower if another member of the household is already in the formal sector. This is observed in the data. Thus, an increase in the participation of secondary workers would tend to raise the level of informality in the economy.¹ We believe that this effect could partially explain the increases in informality in Latin America seen over the last two decades.²

Second, we show that all the regulations—fixed costs—that increase the cost of operating formally, both for firms and for workers, influence the equilibrium as they would be expected to do.³ One important instance is that of social programs. Any program that affects the supply to the (formal) informal sector will affect the equilibrium in our model. For example, social programs that target the poor by conditioning eligibility on the labor-market status of each individual will increase (reduce) the supply of workers to the informal (formal) sector, increasing the size of the informal sector in the economy. There is ample empirical evidence supporting this effect. The expansion of the social safety network since the 1990s in Latin America could then also partially explain the increases in informality seen over the last two decades.

1. Female labor force participation has increased substantially in Latin America in the last five decades. It increased from approximately 20% in 1960 to 35% in 2000 and to almost 40% in 2008 (World Development Indicators).

2. For example, in a previous version of this paper we simulated the rates of formality for Argentina, which is the Latin American country where informality increased the most during the last two decades. We assumed that only the demographic composition of the labor force changed over time (and that the formality rates of all these groups are unaffected by these shifts in the labor force composition) and find that approximately 20% of the rise in informality between the early 1970s and the 1990s could be directly accounted by the reduction of the share of the labor force represented by primary workers during that period (Galiani and Weinschelbaum 2007).

3. The same is true for payroll taxes—or any taxation that affects labor demand in the formal sector of the economy—and enforcement.

Third, as in the previous literature that followed the lead of Rauch (1991), size dualism is present in the equilibrium of the economy we model: small firms operate informally whereas large firms operate formally. Finally, workers with low human capital work in the informal sector whereas those with high human capital work in the formal sector. Thus, distributions of both human capital and managerial talent affect the equilibrium of the economy. A poor economy with low levels of human capital and limited managerial capabilities is likely to exhibit high levels of informality. This is also observed in the data.

The rest of the paper is organized as follows. Section II reviews the previous literature on informality. Section III presents evidence on the nature of informality in Latin America, which serves as a basis for the analysis offered in this paper. Section IV portrays the setup of our model, while Section V reports on a set of comparative static exercises. Section VI studies the effect of incorporating secondary workers into the labor market. Finally, Section VII presents our conclusions.

II. LITERATURE REVIEW

Dualistic models of labor markets have pervaded the literature since the seminal work of Lewis (1954). Firms and workers are assumed to comply with regulations in the formal sector but not in the informal sector. Wages in the formal sector are set exogenously and above the competitive equilibrium level. The labor market is then segmented, with only some workers obtaining jobs in the formal sector. The classic model presented in this literature is the one developed by Harris and Todaro (1970).

An excellent formalization of this type of model is provided by Rauch (1991), who develops a model in which the prevailing real wage in the formal sector is exogenous. Firms can refrain from paying the exogenously determined real wage provided they operate on a scale smaller than a given detection threshold. The product market is assumed to be competitive. Workers are homogenous but firms differ in terms of managerial talent, which in turn determines firm size as discussed by Lucas (1978). Thus, in equilibrium, there is a break in the size distribution of firms. Informal wages are lower than formal wages. However, unemployment does not arise as in the study by Harris and Todaro (1970) because, in this model, workers' utilities are not

equalized in equilibrium. Some workers obtain jobs in the formal sector while the others are underemployed (in the sense that they could be earning more in a competitive equilibrium) in the informal sector.⁴ Note, however, that the emphasis in this paper is on *size dualism*—that is, the existence of a difference in size between the smallest formal-sector firm and the largest informal-sector firm. By contrast, the earlier theoretical literature focused on *labor-market dualism*, which is defined as the existence of a difference between the formal-sector wage and the informal-sector wage for economically identical employees.

Fortin et al. (1997) extends Rauch's model by introducing corporate profit and payroll taxes and by assuming that the marginal cost of tax and regulation evasion increases with the size of the firm. They derive three forms of dualism that are consistent with labor-market segmentation: scale, wage, and evasion. In equilibrium, small firms in the informal sector benefit by paying lower wages and taxes than firms in the formal sector do, but incur the risk of being penalized for noncompliance with such labor regulations.

Thus, in this type of model, homogenous workers are paid less in the informal sector only because of the presence of labor-market regulations that affect the profit function of firms operating in competitive product markets.

A significant departure from dualism is found in the work of Amaral and Quintin (2006), who explicitly model the labor market as a competitive market. They assume that both workers and entrepreneurs are heterogeneous. As in the previous models, firms differ in managerial talent. Firms in the formal sector pay taxes on profits but have access to the credit market, while those in the informal sector do not pay taxes and have no access to credit. Therefore, in equilibrium, large firms are formal and small firms

4. Rauch's model is consistent with many of the hypotheses advanced to account for the formal-sector wage floor. If the legal minimum wage set by the government is the binding factor, then, clearly, given the limited administrative resources of third-world governments, the number of workers protected by the law can be maximized by focusing enforcement efforts on large firms. If it is union bargaining power that sets the wage floor, big firms will once again be the focus since, as is well known, unions concentrate their organizing efforts on large companies. Even if one believes that the efficiency wage hypothesis is the relevant factor, and if the efficiency wage entails minimizing the cost of monitoring workers (as described by Shapiro and Stiglitz 1984), then it is reasonable to think that small firms will be able to monitor almost costlessly and therefore do not need to pay the efficiency wage.

are informal. Workers only derive utility from the wages they receive at work; they have no intrinsic preferences for the sector they work for (i.e., they do not have nonpecuniary preferences). Thus, there is a differentiated demand for formal and informal employment but labor supply is the same in both sectors. In other words, there is only one labor market in this economy. Therefore, and contrary to the previous literature, similar workers earn the same amount in the formal and informal sectors. Within this framework, Quintin (2008) models the impact of limited contract enforcement on the size of the informal economy.

Other interesting and related papers are Straub (2005) and de Paula and Scheinkman (2009, 2010). Straub (2005) develops a model where formal firms pay an entry fee to become formal. Formal firms have access to a public good, while informal firms do not. The public good is identified with access to a better credit market (lower interest rates). In this case as well, in equilibrium, large firms are formal and small firms are informal. The labor market is not modeled. For their part, de Paula and Scheinkman (2009) assume that firms pay taxes on sales when they operate in the formal sector but, on the other hand, pay lower interest rates on capital. Hence, in equilibrium, there is also a break in the size distribution of firms. As in the previous models, firm size is determined by managerial talent. Workers are homogenous but, in this model, they are paid the same in both sectors. Informality is defined as tax avoidance; they test the model with Brazilian data. de Paula and Scheinkman (2010) analyze the role of value added taxes (VAT) in transmitting informality. Through this channel, they find that the level of informality of a firm is correlated to the informality of the firms from which it buys inputs or sells its output. They confirm this result also using Brazilian data.

A major feature of the previous literature is that workers' decisions are seen as playing no role in determining the equilibrium. On the one hand, it is only the firms that choose optimally whether to operate formally or informally while homogenous workers are constrained to obtain the best jobs available. On the other hand, both firms and workers act unconstrained, but the latter do not derive nonpecuniary utility from the sector they work for. Firms have differentiated demands for formal and informal employment but workers are indeed indifferent about which sector they work for. Thus, there is only one

labor market in the economy. By contrast, in our model, workers do have nonpecuniary preferences for the sector they work for. Firms choose whether to operate formally or informally, and workers choose in which sector to work. Therefore, there are two labor markets in the economy in which both firms and workers act unconstrained. At equilibrium, managerial talent determines *size dualism* at the firm level, and human capital is the factor that divides workers into those who work in the formal sector and those who work in the informal sector. In our model, any characteristic of the economy that changes workers' (firms) preferences over the formal or the informal sector affects the size and wages of the formal and the informal sectors.

III. INFORMALITY IN LATIN AMERICA

Formality is usually defined on the basis of the right to exercise socially mandated benefits such as health insurance and pensions. We follow the trend exhibited in the literature and define formality on the basis of whether or not an employee pays social security taxes (see, among others, Gasparini and Tornarolli 2006).

In the literature, workers are usually categorized into three groups: formal employees, informal employees, and independent workers. Independent workers are distinguished from employees for two reasons. First, independent workers typically differ in their motivations and skills. They tend to be individuals who display entrepreneurial skills and who attach a high value to the nonpecuniary benefits of independent work (see, among others, Blanchflower and Oswald 1998). Second, the surveys most commonly used as a source of data on the labor force in Latin America collect information on employees' social security contributions but not on contributions by business owners or the self-employed. Consequently, it is not possible to establish whether or not self-employed persons are operating formally or informally.⁵ We have therefore abstracted from the decision to work as an independent worker and focus our analysis on firms' and salaried workers' decisions as to whether or not to operate within the formal sector of the economy.

5. Even if most self-employees operate informally, which it is unlikely to be the case—as illustrated, for example, by the case of independent professionals—the share of self-employees in the labor force in LAC is smaller than the share of salaried workers that operate informally (Gasparini and Tornarolli 2006).

TABLE 1
Formality Rates among Salaried Workers (%)

Country	Mean	Males	Females	Household Heads	Spouses	Other Household Members
Argentina	57.5	60.2	53.9	65.2	59.2	43.7
Bolivia	27.7	26.9	29.3	33.5	33.4	15.0
Brazil	67.7	68.5	66.7	70.9	68.3	61.7
Chile	87.3	90.1	83.0	92.2	84.3	82.4
Ecuador	30.3	26.7	37.9	34.2	44.0	20.8
El Salvador	54.6	47.2	69.1	52.6	67.7	51.9
Guatemala	41.7	41.3	42.5	44.3	43.8	38.1
Mexico	42.0	40.6	44.7	43.1	47.5	38.5
Paraguay	27.6	26.8	28.8	33.7	36.9	17.8
Peru	31.0	32.7	28.3	39.8	35.3	23.3
Uruguay	75.4	78.2	72.3	81.5	76.1	65.5
Venezuela	60.4	57.6	64.7	67.5	66.9	50.5
Average	50.3	49.7	51.8	54.9	55.3	42.4

Notes: Statistics from the latest survey available for each country. All surveys are for the years 2002, 2003, or 2004. A worker is defined as formal if he/she pays social security taxes. The same definition is applied to all countries. For Argentina, we excluded the individuals that work in the social program *Jefes y Jefas de Familia*. Sampling weights are used to compute all the statistics by country in this table. Average statistics are unweighted averages of country rates.

Source: Prepared by the authors based on data from the Socio-Economic Database for Latin American and the Caribbean (CEDLAS).

In Table 1 we present evidence on formality rates among salaried workers in Latin America. The data are taken from household surveys for 12 countries (those listed in Table 1) in which the existence or absence of social security contributions is registered for each employee in the sample. All the surveys used here are for the years 2002–2004. On average, approximately half of all salaried workers hold informal jobs. Formality rates also appear to display a large variance among countries—ranging from 87% in Chile to 27.6% in Paraguay—and tend to increase with development. The richest countries in this sample—that is, Argentina, Brazil, Chile, and Uruguay—all have formality rates above 50%, while all the poorest countries except El Salvador (Bolivia, Ecuador, Guatemala, and Paraguay) exhibit formality rates among salaried workers well below that level.

On average, no appreciable differences are observed in the degree of formalization neither between males and females nor between heads of household and spouses. At first glance, this might seem counterintuitive, but it is actually the natural result of sample selection. Females who participate in the labor market are, on average, more educated than males.⁶ In Table 2 we restrict the sample to households where both

members (i.e., the head of the household and the spouse) are salaried employees and present formality rates for household heads and spouses where each of these groups is divided into three educational categories: low-, medium-, and high-education level. Our findings indicate that the likelihood of a salaried worker being formally employed increases with the individual's level of education. Conditioning on the level of education, heads of household are more likely to be formally employed than their spouses are, but among highly educated individuals, there are no differences at all.⁷

We further investigate the results in Table 2. When the head of the household and the spouse participate in the labor market, the decision could be for both to work in the formal sector (FF), for one to work in the formal and the other in the informal sector (FI), or for both to be employed in the informal sector (II). We estimate a multinomial logit model for these three potential outcomes focusing on the effect of human capital on the likelihood of observing any of them. In the econometric model we include a full set of educational dummies for

6. However, this is not true at the margin. Thus, the recent increase of female labor supply observed through Latin America is capable of causing an increase in the mean levels of informality. This is specially so if secondary

workers, *ceteris paribus*, have lower incentives to operate formally than primary workers.

7. Similar results hold even when we do not impose this sample restriction in the analysis (Galiani and Weinschelbaum 2007).

TABLE 2

Formality Rates among Households in Which Both Members Are Salaried Workers, by Household Status and Educational Level (%)

	Household Heads			Spouses		
	Low Education	Medium Education	High Education	Low Education	Medium Education	High Education
Argentina	61.2	77.0	84.0	28.8	64.5	82.3
Bolivia	8.6	28.3	78.6	5.7	28.2	75.9
Brazil	71.2	88.0	92.9	53.8	82.6	92.2
Chile	89.9	96.5	97.0	72.9	87.4	93.3
Ecuador	21.8	62.3	79.6	16.0	51.8	78.1
El Salvador	50.8	81.6	92.8	54.7	85.2	90.0
Guatemala	44.5	73.5	79.2	31.3	80.6	85.0
Mexico	40.2	62.8	74.1	35.8	63.2	71.7
Paraguay	30.9	69.1	66.9	16.6	50.5	64.4
Peru	7.9	47.9	67.2	3.7	25.1	63.6
Uruguay	80.8	92.5	95.3	63.6	88.0	96.4
Venezuela	67.4	80.2	91.6	56.9	85.4	89.8
Average	47.9	71.6	83.3	36.6	66.0	81.9

Notes: See Table 1. The low-education category includes all individuals that have not completed high school; the medium-education classification includes individuals who have exactly completed high school while the high-education category includes all individuals with more than high school (i.e., incomplete or complete tertiary/college education).

Source: See Table 1.

each individual.⁸ We also include as regressors the age and the age squared of both the head of the household and the spouse, country-fixed effects, and a dummy variable indicating whether the household resides in an urban area. We summarize the results in Figure 1. As can be seen, the probability that the head of the household and his/her spouse work both formally increases monotonically in the education of the couple while the probability that both of them are informal decreases monotonically in their education. Interestingly enough, the likelihood that one works formally while the other operates informally first increases with the education of the couple and then decreases.

Finally, in Table 3 we present formality rates by firm size. Overall, small firms tend to operate informally while large firms are substantially more likely to operate formally. Thus, in summary, informality is highly concentrated in small firms, and the likelihood that a worker is employed in the informal sector of the economy decreases as his/her level of education

8. For each individual, the omitted education category is no schooling while the schooling dummies included in the model are: incomplete primary, complete primary, high-school dropout, high school, incomplete higher education, and complete higher education (i.e., tertiary or college degree). The model is estimated using the sample in Table 2. Regression results are available upon request.

rises. This relation between education and formality is more pronounced among spouses than among households' heads. In other words, an unskilled or semiskilled spouse is more likely to be employed informally than an unskilled head of household is. In the next two sections we develop a model that accounts for all these facts.

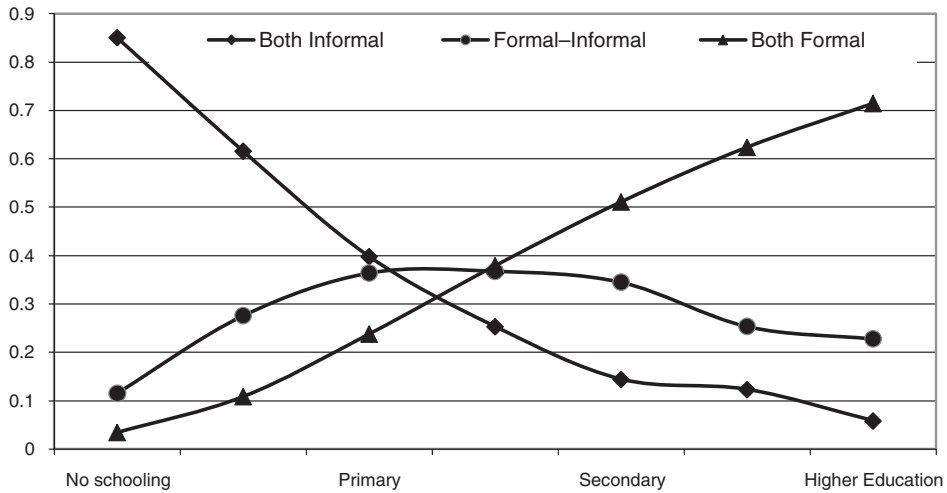
IV. SETUP OF THE MODEL

We model an economy with three types of economic agents: a continuum of firms, a continuum of workers, and the government. Firms are heterogeneous in their managerial talent. They maximize profits by choosing whether to operate formally or informally and by hiring labor. Workers are heterogeneous in their endowment of human capital. They maximize utility by choosing whether to work in the formal or informal sector. The government, whose behavior is not modeled, collects payroll taxes, provides formal workers and their families with non-pecuniary benefits, regulates formal activities, and conducts activities designed to detect and penalize informal operations in the economy.

A. Firms

Firms are assumed to produce a homogenous good that is traded in a perfectly competitive

FIGURE 1
 Predicted Probabilities from Multinomial Logit Model, by Education Level



Notes: This figure is constructed using the estimated coefficients of the multinomial logit model. In order to represent the results graphically, we settled the age of both household members in 46 and the Mexico fixed-effect and the urban dummy in one. Furthermore, for the purpose of the figure, we also assume that both members of the household have the same educational level.

TABLE 3
 Formality Rates among Salaried Workers, by Firm Size (%)

Country	Mean	Small Firms	Rest of Firms	Large Firms
Argentina	57.5	26.5	65.3	87.7
Bolivia	27.7	6.3	35.5	57.4
Brazil	67.7	35.4	83.1	—
Chile	87.3	70.1	88.3	94.6
Ecuador	30.3	5.9	23.8	44.5
El Salvador	54.6	7.0	35.3	83.6
Guatemala	41.7	6.6	47.6	76.2
Mexico	42.0	12.1	57.4	—
Paraguay	27.6	8.2	39.1	62.4
Peru	31.0	4.4	21.8	55.2
Uruguay	75.4	39.0	74.9	96.2
Venezuela	60.4	21.7	75.8	—
Average	50.3	20.3	54.0	

Notes: See Table 1. Firm size is defined as follows (depending on the distinctions made in the available data): Small firm: fewer than four or fewer than five workers; rest of firms: more than four or more than five workers. Large firms: more than 40 or more than 50 workers.

Source: See Table 1.

market using managerial talent (m) and homogeneous units of labor (l).⁹ Using an approach

9. For the sake of simplicity, we normalize the price of the good to 1.

similar to that used in the previous literature, we assume that there is a continuum of firms indexed by their innate managerial talent and distributed with density function $g(m)$ with support in R_+ .

Each firm in the economy chooses whether to operate formally or informally and decides how many units of labor it will hire to produce its output. If a firm operates in the formal sector of the economy, its profit function is given by:

$$\Pi_f(m) = f(m, l) - w_f l(1 + t) - \tau$$

where $f(m, l)$ is the production function, w_f is the prevailing wage per unit of labor paid to workers in the formal sector (i.e., firms are wage takers), t is the payroll tax levied on firms, and τ is a fixed cost incurred by firms that operate formally.

There are a large number of studies in the literature documenting various formal-sector entry costs. The best-known example is the discussion in De Soto's *The Other Path* of the cost of starting a business in Lima, Peru. De Soto finds the complexity and stifling nature of Peruvian laws and regulations to be a powerful disincentive for formality and hence a stimulus for the expansion of the informal sector (see also Stone et al. 1996).

If, on the other hand, a firm operates informally, then its expected profit function is given by:

$$\Pi_i(m) = (f(m, l) - w_i l)(1 - q)$$

where w_i is the prevalent wage per unit of labor paid to workers in the informal sector and q is the probability that a firm is caught operating informally, in which case it will be closed and will lose its current profits.

In the following discussion, we assume that the production function is Cobb-Douglas with constant returns to scale, thereby presenting diminishing returns to labor:

$$f(m, l) = m^\beta l^{1-\beta}$$

Firms choose l in order to maximize profits. Under the assumptions made, the derived labor demand for a firm with managerial talent m is:

$$l^f = m((1 - \beta)/w_f(1 + t))^{1/\beta}$$

if it operates formally and:

$$l^i = m((1 - \beta)/w_i)^{1/\beta}$$

if it operates informally. Note that both demand functions are linear in managerial talent. Thus, the size of a firm (assuming that it does not switch sectors), measured by l , is linearly increasing in m .

Very small firms (i.e., those with managerial talent m close to 0) operate informally because of the fixed cost τ that they would have to incur in order to operate formally. As in the study by Rauch (1991), we now show that in our model there is *size dualism*: small firms operate informally while large firms operate formally. When there are firms operating formally and the profit functions satisfy the following condition, there is a unique cutoff point in firm size:

$$(1) \quad d\Pi_f(m)/dm > (d\Pi_i(m)/dm) \forall m.$$

Condition (1) is equivalent to:

$$(2) \quad (1/w_f(1 + t))^{(1-\beta)/\beta} > (1 - q)(1/w_i)^{(1-\beta)/\beta}.$$

Hence, in equilibrium, it is necessary that inequality (2) be satisfied in order to have firms operating formally. Therefore, we established that, in equilibrium, whenever there are both formal and informal firms, there is a unique cutoff point (\bar{m}) that satisfies:

$$\Pi_f(\bar{m}) = \Pi_i(\bar{m}).$$

Thus, firms with managerial talent $m \leq \bar{m}$ choose to operate informally while firms with managerial talent $m > \bar{m}$ choose to operate formally.

The demand for formal labor is then:

$$l_d^f(w_f, w_i) = \int_{\bar{m}}^{\infty} m((1 - \beta)/w_f(1 + t))^{1/\beta} g(m) dm.$$

while the demand for informal labor is:

$$l_d^i(w_f, w_i) = \int_0^{\bar{m}} m((1 - \beta)/w_i)^{1/\beta} g(m) dm$$

Therefore, the total demand for labor is given by:

$$L_d(w_f, w_i) = \int_0^{\bar{m}} m((1 - \beta)/w_i)^{1/\beta} g(m) dm + \int_{\bar{m}}^{\infty} m((1 - \beta)/w_f(1 + t))^{1/\beta} g(m) dm.$$

In looking at how a change in wages will affect total labor demand, it is useful to break the impact down into direct and indirect effects. The direct effect is the derivative of total labor demand with respect to wages, holding the cut-off point constant. The indirect effect is the derivative of total labor demand with respect to wages that operates through changes in the cutoff point, holding constant the integrand functions.

B. Workers

Workers are endowed with l units of homogeneous labor to sell in the market. There is a continuum of workers indexed by their endowment of labor and distributed with density function $h(l)$ with support in \mathbb{R}_+ . Thus, wages are set for units of substitutable labor. Each worker has to choose whether to sell his/her labor to a firm that operates formally or to a firm that operates informally.¹⁰ Workers cannot split their units of labor between different firms. In the first case, the worker receives w_f per unit of labor plus mandated social benefits. In the second case, the worker receives only w_i per unit of labor.

10. Olsen (1993), cited in Gruber (2000), provides supportive evidence of the presence of worker's self-selection in the United States. He finds that workers with greater than expected health needs (wives whose husbands do not have health insurance, and who have less healthy children) self-select into firms that provide health benefits.

The utility of a worker who chooses to work in the formal sector is^{11,12}:

$$U_f(w_f l, HI) = w_f l + HI - \gamma$$

where HI are the nonpecuniary benefits that, for simplicity's sake, we equate with a government-provided health insurance package which, anticipating the analysis in the next section, we assume covers all members of the worker's family.^{13,14}

Workers also incur a fixed cost γ for working in the formal sector. This includes the direct costs, which are related to (see, among others, De Soto 1989)¹⁵ but also, and perhaps more importantly, indirect costs such as the unemployment insurance and other subsidies, like cash transfers, that a worker would have to disregard when he/she accepts a formal job.

When an informal firm is detected, its workers do not receive their payment. The expected utility of a worker who chooses to work in the informal sector is:

$$U_i(w_i l, HI) = w_i l(1 - q).$$

11. We do not tax workers' formal income because we already taxed firms on their payrolls. As usual, the equilibrium of the economy is unaltered if we instead tax workers' labor earnings or if both firms and workers are both taxed. It only matters the total tax on labor earnings.

12. We assume that the utility function is linear in order to abstract from risk-pooling behavior when, as in Section VI, we allow for situations in which more than one member per family works. Naturally, this is a theoretical abstraction and we are by no means attempting to suggest that risk aversion is not a consideration when households choose the portfolio of sectors where their members work.

13. Although, for the sake of simplicity, we equate mandated social benefits with a health insurance package (that provides better health coverage than public hospitals), there are other mandated benefits associated with the formal jobs that affect workers' payoffs similarly. Examples are pensions and family allowances. Formal workers normally receive pensions from retirement age on, and, after they die, it is common for their surviving spouses, if they are not receiving a pension themselves, to start to receive a pension until their own death. Thus, a formal job provides the entire family with an old-age pension. Family allowances redistribute money among formal workers as a function of family size. Only one worker per family is typically entitled to this type of cash transfer even if both spouses work in the formal sector.

14. There is a large literature in the United States that shows that health insurance is an important determinant of job mobility (Gruber and Madrian 2004). Madrian (1994), for example, estimates that health insurance reduces mobility across jobs for as much as 25%. See also Gruber (2000).

15. An important direct cost associated to work in the formal sector could be transportation costs. These costs could be particularly high in large urban areas where unskilled workers tend to reside further away from where formal firms tend to agglomerate.

When there are workers in both the formal and informal sectors and the utility functions satisfy the following condition, then there is a unique cutoff point that determines that workers with low levels of human capital will be in the informal sector and that those with high levels of human capital will be employed in the formal sector:

$$(3) \quad dU_f(l)/dl > dU_i(l)/dl \forall l.$$

Condition (3) holds if and only if^{16,17}:

$$(4) \quad w_f/w_i > (1 - q).$$

The cutoff point is the level of l that makes workers indifferent as to whether they work in the formal or informal sector. We denote this level of l by \bar{l} , which is determined by:

$$U_f(w_f \bar{l}, HI) = U_i(w_i \bar{l}, HI)$$

or

$$w_f \bar{l} + HI - \gamma = w_i \bar{l}(1 - q)$$

and solving for \bar{l} we obtain:

$$\bar{l} = ((\gamma - HI)/(w_f - w_i(1 - q))).$$

Note that workers with $l > \bar{l}$ prefer to work in the formal sector,¹⁸ thus workers with $l \leq \bar{l}$ operate informally while workers with $l < \bar{l}$ operate formally.

The supply of formal labor is:

$$L_s^f(w_f, w_i) = \int_{\bar{l}}^{\infty} lh(l)dl$$

while the supply of informal labor is:

$$L_s^i(w_f, w_i) = \int_0^{\bar{l}} lh(l)dl.$$

Accordingly, the total supply of labor is:

$$L_s(w_f, w_i) = \int_0^{\bar{l}} lh(l)dl + \int_{\bar{l}}^{\infty} lh(l)dl = L_s$$

16. Note that the formal-sector wage premium is not signed. This result also holds if we instead assume that when an informal firm is detected, workers receive their payment with a positive probability but without certainty.

17. Juarez (2008) presents evidence, exploiting exogenous variability in access to free health care and prescription drugs in Mexico City, that informal female workers are paid approximately 20% more than similar formal female workers in order to compensate for the lack of fringe benefits in informal jobs.

18. Note that if condition (4) holds and $HI \geq \gamma$, all workers would prefer to work in the formal sector. Additionally, as is plausible, if the worker's utility is such that it assigns positive utility to mandate social benefits only after a minimum level of income is achieved (w_l), then condition (4) guarantees a cutoff point regardless of the sign of $HI - \gamma$.

Because labor is inelastically supplied, wages determine the amount of labor that is supplied to the formal or informal sector, but not the total quantity supplied.

C. Equilibrium

We restrict our analysis to equilibria where there are firms and workers operating in both the formal and informal sectors. An equilibrium is a $(w_f; w_i; l_s^f; l_s^i; l_d^f; l_d^i)$ vector such that there is market clearing in both the formal and informal labor markets:

$$(5) \quad l_s^f(w_f, w_i) = l_d^f(w_f, w_i)$$

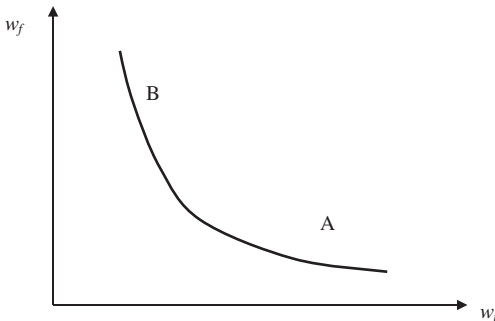
$$(6) \quad l_s^i(w_f, w_i) = l_d^i(w_f, w_i)$$

and where wages satisfy inequalities (2) and (4).

A very interesting characteristic of this equilibrium is that it does not sign the formal-sector wage premium: w_f can be higher, equal, or lower than w_i (see inequality (4)). This result contrasts with the previous literature, where a positive formal-sector wage premium is identified with the presence of *labor-market dualism* in the economy, while the absence of a wage premium is taken to be indicative of the prevalence of a competitive environment in the labor market.

To represent an equilibrium for this economy graphically, we first derive the locus of wages where *total* labor demand is equal to *total* labor supply. That is, the wage pairs (w_f, w_i) are such that $L_d(w_f, w_i) = L_s$. From this condition, we derive an implicit function $H(w_f, w_i) = 0$ that we will denote $w_f^H(w_i)$, which yields a downward-sloping curve, as we assume that the derivative of total labor demand with respect to both wages is negative (Figure 2). Any equilibrium in this economy must lie somewhere on

FIGURE 2
Locus of Possible Equilibria



this curve.¹⁹ While total labor demand and supply are equal along this curve, their composition is not. Each point maps to a different $(l_s^f, l_s^i, l_d^f, l_d^i)$ vector. For example, for a high informal wage (and hence a low-formal wage) such as point A, firms would demand relatively more formal workers than informal ones. However, at that relative wage, a large proportion of workers would prefer to be informal rather than formal. Thus, a point such as A would not be an equilibrium of that economy. The opposite situation would arise at a point such as B.

In the same figure, we can also draw the functions $w_f(w_i)$ showing the wage pairs that would align labor demand and supply within each sector of the economy. Differentiating Equation (5) with respect to both wages, we obtain:

$$(7) \quad -\frac{\frac{\partial l_s^f(w_f, w_i)}{\partial w_i} - \frac{\partial l_d^f(w_f, w_i)}{\partial w_i}}{\frac{\partial l_s^f(w_f, w_i)}{\partial w_f} - \frac{\partial l_d^f(w_f, w_i)}{\partial w_f}} = \frac{dw_f}{dw_i}$$

which can easily be seen to be positive. Differentiating (6) with respect to both wages gives us:

$$(8) \quad -\frac{\frac{\partial l_s^i(w_f, w_i)}{\partial w_i} - \frac{\partial l_d^i(w_f, w_i)}{\partial w_i}}{\frac{\partial l_s^i(w_f, w_i)}{\partial w_f} - \frac{\partial l_d^i(w_f, w_i)}{\partial w_f}} = \frac{dw_f}{dw_i}$$

which is also positive.

Given that total labor supply is inelastic, we know that:

$$\partial l_s^f(w_f, w_i) / \partial w_i = -\partial l_s^i(w_f, w_i) / \partial w_i$$

and

$$\partial l_s^f(w_f, w_i) / \partial w_f = -\partial l_s^i(w_f, w_i) / \partial w_f.$$

And as we assumed that total labor demand is negatively sloped with respect to both formal and informal wages, it holds that:

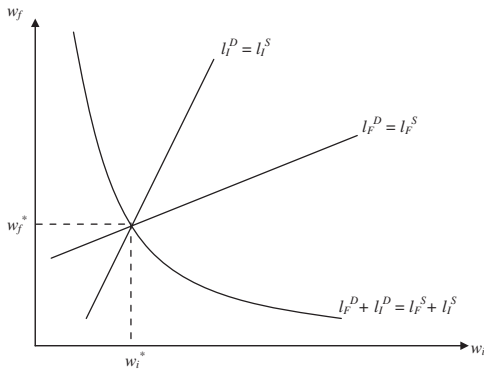
$$\partial l_d^f(w_f, w_i) / \partial w_i < -\partial l_d^i(w_f, w_i) / \partial w_i$$

and

$$-\partial l_d^f(w_f, w_i) / \partial w_f > \partial l_d^i(w_f, w_i) / \partial w_f.$$

19. This always holds if the direct effects predominate over the indirect effects. If there is a case where the indirect effect is positive and predominates over the direct effect, $w_f^H(w_i)$ is not necessarily a function (i.e., for a given informal wage there could be different formal wages that satisfy $w_f^H(w_i)$). If this were the case, there could be multiple equilibria in the economy that might generate interesting economic effects; a discussion of such effects extends beyond the scope of this paper, however.

FIGURE 3
Equilibrium Wages



Therefore, it follows that (8) > (7). Figure 3 presents these three curves together and graphically illustrates an equilibrium in this economy.²⁰

V. COMPARATIVE STATICS

We now explore how the equilibrium we described in the previous section changes in response to changes in the parameters.²¹ We will then look at how the equilibrium of the economy changes when we allow for the incorporation of secondary workers.

A. Changes in Human Capital

We will first look at how different changes in the distribution of worker’s human capital affect the equilibrium of the economy. In this exercise, we hold total human capital constant. The distribution of human capital can change in three qualitatively different ways. First, the new distribution can maintain the total amount of l both above and below the original cutoff point that divides workers between the informal and formal sectors as a function of their human capital. Second, the new distribution can shift l toward workers above the original cutoff point. Third, the new distribution can shift l toward workers below the original cutoff point.

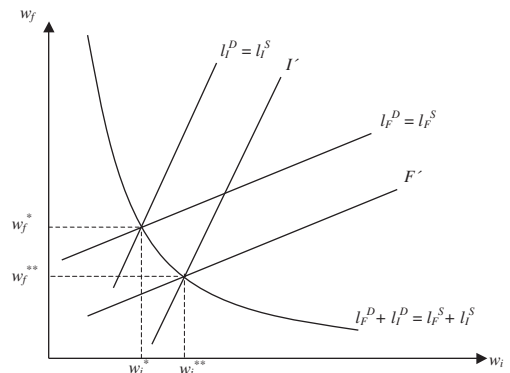
20. All the equilibrium points we analyze in this paper are in the area defined by inequalities (1) and (4). We have not graphed these two relationships in order to keep the figure simple.

21. The reader can read a more complete analysis of these comparative static results in the previous version of this paper (Galiani and Weinschelbaum 2007).

In the first case, the equilibrium of the economy remains unaltered. At prevailing wage levels, workers’ choices would remain unchanged and the aggregate formal and informal labor supply and demand would remain balanced.

If, on the other hand, l is redistributed toward workers in the formal sector, then the curve of equilibrium points in that sector shown in Figure 3 shifts downward, whereas the curve for the informal sector shifts to the right. As the total supply of labor represented by workers above the original cutoff point increases, at prevailing wage levels, there is excess supply in the formal sector. This means that, for a given informal wage, equilibrium in the formal sector is only achieved if formal wages go down. The same reasoning applies to the informal sector. Finally, because neither the total amount of human capital nor the distribution of managerial talent change, the function $w_f^H(w_i)$ representing the wage levels that align the total supply of labor with the total demand for labor remains the same. We illustrate these changes in Figure 4. Thus, in the new equilibrium, the informal wage increases while the formal wage decreases. Managerial decisions also change. At the new wage levels, the managerial talent cutoff point is also lower than in the previous equilibrium. Therefore, more firms choose to operate formally. Moreover, the firms that originally were operating formally increase their total labor demand while those that remain in the informal sector reduce their total labor demand. Thus, a change in the distribution of human capital such as this increases the size of the formal sector. The opposite happens if l is redistributed toward workers in the informal sector.

FIGURE 4
Comparative Statics



We now study what happens when we redistribute managerial talent among firms but we hold total managerial talent constant. *Mutatis mutandis*, the argument is similar to the one provided above for the changes in worker's human capital. Given that labor demand is linear in managerial talent (when firms do not switch from one sector to the other), a redistribution of managerial talent among firms belonging to the same sector does not change either total or sectorial labor demand. A redistribution of managerial talent from one sector to the other instead changes both total labor demand and its composition between sectors. When m is redistributed toward firms in the formal sector, in the new equilibrium, there are more workers and labor in the formal sector. The opposite happens when m is redistributed toward firms in the informal sector.

B. Changes in Taxes and Enforcement

As expected, an increase of the payroll tax rate t induces firms to reduce their demand for formal labor. In the new equilibrium the share of informal labor would increase. Naturally, the opposite happens if payroll taxes are reduced.

An increase in the probability that a firm is detected operating informally (q) lowers the cutoff point of formality as a function of managerial talent, which implies that more firms would choose to operate formally, while fewer firms would choose to operate informally. The workers' cutoff point for formality as a function of human capital also decreases, inducing more workers also to shift into the formal sector. Thus, in the new equilibrium, the size of the formal sector increases. Again, the opposite occurs when q is reduced.

C. Changes in the Cost of Operating Formally

Finally, we study what happens to informality when the cost of operating formally changes. If the cost to firms of operating formally (τ) declines, at prevailing wage levels, the utility of operating in the formal sector increases, whereas the utility of operating in the informal sector remains constant. Thus, the formality cutoff point for firms therefore declines, more firms operate formally, increasing the relative wage of the formal sector and attracting labor to it. Thus, in the new equilibrium, the size of the formal sector increases. The opposite happens if the cost to firms of operating formally (τ) increases.

If the workers' fixed cost of operating formally (γ) is lower (or the nonpecuniary benefits of working in the formal sector HI are higher), at prevailing wage levels, the utility of working in the formal sector increases while the utility of working in the informal sector remains constant. Hence, there is a reduction in the formality cutoff point for workers. Thus, in the new equilibrium, the size of the formal sector increases. The opposite happens if the workers' fixed cost of operating formally (γ) increases.

This last result is quite relevant to our main argument in this paper. Note that it also includes all the policies that affect workers' preferences for one or the other sector. For example, a reduction in the quality of health insurance packages or a deterioration of the pension system would induce workers to increase their preferences over the informal sector. Thus, these "negative" changes in policies will increase the size of the informal sector in the economy, and certainly, they likely played a role in the recent increase of informality in Latin America, especially since the debt crisis of the early 1980s.

As we discussed it earlier, an increase in the workers' costs to operate formally might be the result of indirect costs such as the unemployment insurance and other subsidies, like cash transfers, that a worker would have to disregard when he/she accepts a formal job. In Latin America, there is ample evidence that social programs aiming to alleviate poverty induce workers to move to informality. For example, Gasparini et al. (2007) present evidence showing that a social program in Argentina that provides cash transfers to unemployed household heads induces its beneficiaries to increase substantially the likelihood of working in the informal sector. Using matching techniques, they estimate that beneficiaries of this program are 5 percentage points more likely to operate informally than a similar control group.²² Camacho et al. (2009), using panel data, investigate the effect of the expansion of a noncontributory health insurance program for the poor in Colombia on the likelihood that a worker operates informally. They find that this program increases the probability of working in the informal sector by 4 percentage points.

22. Using instead a difference-in-differences estimator, Jauregui (2009) estimates an even larger effect for the beneficiaries of this program on their likelihood of working informally.

VI. INCORPORATING SECONDARY WORKERS INTO THE LABOR MARKET

We will now turn our attention to what happens to the equilibrium when it is subjected to a major shock, which we produce by allowing households to have a second worker in the labor market. The question of differential incentives between first and secondary workers has been previously explored in labor economics. Gruber and Madrian (2004) provide a review of the differentiated effects of health insurance on labor supply and job mobility in the United States. They show that access to health insurance is an important factor in the labor supply decision of secondary workers. However, all this work focuses only on the household decisions, ignoring the equilibrium effects of those decisions. In our model, instead, heterogeneous firms and heterogeneous workers interact in determining the equilibrium of the economy. Therefore, we study the effects of the presence of secondary workers in the sizes and wages of the formal and the informal sector instead of only consider the household decisions taking equilibrium variables as given. Thus, our paper is the first study in which workers' decision plays a role in shaping the equilibrium size of the formal and informal sectors and hence, where the differential incentives between primary and secondary workers affect the equilibrium of the labor market. Moreover, the difference of incentives between first and secondary workers has not been studied before in the informality literature. Let us consider first the household decision involved in this scenario. Throughout this section, we assume that both workers in the same household have the same level of human capital.²³ When two members of a household participate in the labor market, the decision could be for both to work in the formal sector, for one to work in the formal and the other in the informal sector, or for both to be employed in the informal sector. We will compute the expected utility for each of these possibilities and then analyze the corresponding household choices.

The utility of a household that has two workers in the formal sector is:

$$U_{ff}(w_f l, HI) = 2w_f l + HI - 2\gamma.$$

23. Although in the data, the actual simple correlation of years of education for couples for 23 countries in Latin America is approximately 0.7, this assumption is only made for expositional purpose. All our results are robust to the relaxation of this assumption.

A salient feature of the problem is that, whatever the net benefit of working in the formal sector may be for a worker possessing a level of human capital l , it will be lower for a second worker because she/he already enjoys some portion of the nonpecuniary benefits generated by the first worker. For this reason, *ceteris paribus*, second workers are more likely to operate informally than primary workers. The expected utility of a household that has one worker in the formal sector and the other in the informal sector is:

$$U_{fi}(w_f l, HI) = qw_f + (1 - q)(w_f + w_i)l + HI - \gamma.$$

Finally, the expected utility of a household that has two workers in the informal markets is²⁴:

$$U_{ii}(w_i l, HI) = (1 - q)^2 2lw_i + 2(1 - q)qw_i l.$$

Analyzing the derivatives of the utility functions for each case with respect to human capital, we find that:

$$dU_{ff}/dl > dU_{fi}/dl > dU_{ii}/dl$$

$$\text{whenever } w_f/w_i > (1 - q)$$

which is the same condition we used before in order to establish that, in equilibrium, there was a cutoff point dividing workers between the formal and informal sector.

In this case, there are two worker cutoff points. Both workers in households endowed with low levels of human capital choose to work in the informal sector up to the first cutoff point, while both workers in households endowed with high levels of human capital and above the second cutoff point choose to work in the formal sector. Workers in households with human capital levels between the two cutoff points choose to diversify sectors, with one worker operating formally and the other informally.²⁵

The first cutoff point is determined by:

$$U_{fi}(w_f \bar{l}, HI) = U_{ii}(w_f \bar{l}, HI)$$

and, solving for our functional forms, we obtain:

$$\bar{l} = ((\gamma - HI)/(w_f - (1 - q)w_i)).$$

24. To simplify the explanation, we assume that the probabilities of detection are independent for workers from the same household. However, since we assume risk neutrality, removing this assumption would not change the results.

25. Note that when members of a household differ in their human capital, if they decide that only one operates formally, it will always be the one with higher human capital.

This cutoff point (\bar{l}) that makes a household indifferent between having both workers in the informal sector and one worker in each sector is equal to (\bar{l}) , the cutoff point that makes a household with only one worker in the labor market indifferent between working in the formal and the informal sector. This is because the decision to operate formally or informally is not influenced by the presence of an informal worker in the household.

The second cutoff point is obtained by equalizing the utility function when both workers operate formally with the utility function when one worker operates formally and the other operates informally:

$$U_{ff}(w_f \bar{l}, HI) = U_{fi}(w_f \bar{l}, HI)$$

and, solving for our functional forms, we obtain:

$$\bar{l} = (\gamma / (w_f - (1 - q)w_i)).$$

It is easy to verify that $\bar{l} = \bar{l} < \bar{l}$, as is illustrated in Figure 5. This means that the presence of a formal worker in the household reduces the likelihood that other members of the household will choose to operate formally. This result can only be generated in a model where workers choose optimally the sector they work for.

These cutoff points demarcate three regions in the support of the distribution of human capital. In Region 1, both households with one worker and households with two individuals working would choose to operate informally. In Region 2, households with only one worker would choose to operate formally while households with two workers would choose to diversify between sectors. Finally, in Region 3, both one-worker and two-worker households would choose to operate formally.

We will now consider how the equilibrium of the economy changes when households have a secondary worker. In particular, we will analyze how the equilibrium changes when some of the workers in the distribution are secondary workers.

When some workers with human capital in Region 1 or 3 are secondary workers, there is

no change in the equilibrium. This is because in these regions both primary and secondary workers choose the same sector (informal in Region 1 and formal in Region 3). However, when workers with human capital in Region 2 are secondary workers, they choose to work in the informal sector, whereas they would choose to work formally if they were the only worker in the household. Thus, when some of the workers in Region 2 are secondary workers, at the equilibrium wages of the economy with only one worker per household there is an excess supply of labor in the informal labor market and an excess demand in the formal. Thus, informal wages decrease. Therefore, some formal firms move to the informal sector and some informal workers move to the formal sector. Thus, in the new equilibrium, the informal sector expands. The effects of the existence of these secondary workers are the same as those produced by a redistribution of human capital toward informal-sector workers (Section V(A)).²⁶

A. Empirical Evidence

We now investigate empirically the hypothesis that spouses, *ceteris paribus*, are more likely to work informally if the head of household works formally. Relying on our theoretical framework, in this section, we derive a consistent likelihood estimator for this interesting parameter.

Consider first the estimation of a probit model of the decision of secondary workers as a response to the head of household's sector decision (i.e., a dummy variable that equals 1 if the head of the household has a formal salaried job). Inconsistent estimates are obtained since including the primary worker's endogenous response in the secondary worker's latent model renders the estimation inconsistent. This is clearly shown by the following recursive bivariate probit model (Greene 2003):

$$(9) \quad y_1 = 1[\beta_1 x_1 + \varepsilon_1 > 0]$$

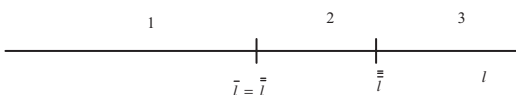
$$(10) \quad y_2 = 1[\beta_2 x_2 + \alpha y_1 + \varepsilon_2 > 0]$$

where Equations (9) and (10) are, respectively, the primary and secondary workers' participation equations. Following the literature, we assume that $(\varepsilon_1, \varepsilon_2)$ is distributed as bivariate normal with mean zero, unit variance, and $cov(\varepsilon_1, \varepsilon_2) = \rho$, and is also independent of

26. The comparative static results, presented in Section V, are robust to the existence of secondary workers.

FIGURE 5

Household Cutoff Point Distribution



(x_1, x_2) . The parameter vector β_1 can be consistently estimated by means of a simple probit model for Equation (9). However, if $\rho \neq 0$, then ε_2 and y_1 are correlated, and a probit model for Equation (10) is inconsistent for both β_2 and α . Thus, when the unobservables that determine both choices are correlated, a probit model for Equation (10) will produce inconsistent estimates of the parameters of the model, including the parameter of interest, α . Consider, for example, the case where $\rho > 0$ (which is our case as estimated in Table 4 below), maybe because the place of residence plays a role in determining the choice that workers make, implying that a probit model for Equation (10) might even produce positive estimates of α , even when the true parameter values were negative. In spite of this, the joint distribution of (y_1, y_2) given (x_1, x_2) is easily obtained and estimated by the method of maximum likelihood.²⁷

In Table 4, we present the results of estimating this recursive bivariate probit model. We employ the dataset used in Table 2 in Section III. Thus, the sample includes only those households in which both the head and spouse are salaried employees. This sample selection provided us with 32,011 household observations.

We present three alternative specifications. In Model 1, for the spouse equation, the dummy variable that equals 1 if the head of the household has a formal salaried job, D_F , is interacted with the three levels of education defined in Table 2. The model also includes as control variables the logarithm of wages, which measures the logarithm of labor earnings of workers in their occupation, and that, in our setup, helps controlling for the individual's unobservable endowment of labor l , education dummies, age and age squared, a dummy variable indicating whether residence is urban or rural, and country-fixed effects. The spouse equation also includes the education dummies of the head of the household (HH) to control for sample selection. The coefficients of interest—that is, those associated to D_F in the spouse equation—are all negative but only those interacted with low- and medium-education levels are statistically significant at conventional levels of significance.

27. Note that, as is always the case in estimating a probit model, a necessary condition to identify α is that y_1 is not a perfect predictor of y_2 . Moreover, to identify the parameters of the model, it is also necessary for the set of variables in x_1 to contain at least one variable excluded in x_2 (Green 2003).

Thus, the evidence suggests that spouses, *ceteris paribus*, are more likely to work informally if the head of household works formally. The marginal effects range between 6% and 13%. These estimates are commensurate with the average differences presented in Table 2. The coefficient of correlation for the error terms in Equations (9) and (10) is quite high (0.521). This indicates that the bias of estimating the probit model for Equation (10) could be quite severe and could even reverse the sign of the true parameter α . Indeed, this is what happens when we estimate the probit model for Equation (10) alone. All other coefficients have the expected sign.

The results are robust across specifications. In Model 2, we add dummies for the total income per capita quartile of the household in the spouse equation (we are unable to calculate this variable for 44 observations, which leave us with 31,967 observations). Finally, in Model 3 we add household size variables as control variables in the spouse equation. All the coefficients of interest remain unaltered across specifications.

VII. CONCLUSIONS AND POLICY LESSONS

In this paper, we present a model of an economy in which the sizes and wages of the formal and informal sectors are endogenously determined. This model entails a continuum of types on both sides of the labor market (i.e., firms and workers). Firms choose whether to operate formally or informally and workers choose in what sector they work. In the equilibrium, managerial talent determines *size dualism* at the firm level, and human capital is the factor that determines whether workers are employed in the formal or informal sector. Thus, in our model, both heterogeneous firms and workers have preferences over the sectors they operate and choose optimally whether to function formally or informally. We emphasize the role of household choice in shaping the outcomes of the economy we study. Using our model, we show that an increase in the participation of secondary workers, *ceteris paribus*, would tend to raise the level of informality in the economy. Furthermore, we believe that the setup of our model is rich enough to be used in further work to study a broad set of general equilibrium effects by introducing dynamics and institutional arrangements not addressed in this paper.

TABLE 4
Recursive Bivariate Probit Models

	1			2			3		
	Coefficient	Standard Errors	Marginal Effect	Coefficient	Standard Errors	Marginal Effect	Coefficient	Standard Errors	Marginal Effect
Spouse Equation									
$D_F \times$ low education	-0.158**	0.064	-0.058	-0.166***	0.039	-0.062	-0.160***	0.027	-0.060
$D_F \times$ medium education	-0.344***	0.066	-0.131	-0.340***	0.053	-0.130	-0.327***	0.051	-0.125
$D_F \times$ high education	-0.141	0.122	-0.052	-0.141	0.092	-0.053	-0.124	0.090	-0.046
Log of wages	0.902***	0.101		0.787***	0.106		0.812***	0.087	
Medium education	0.497***	0.072		0.466***	0.068		0.457***	0.067	
High education	0.318*	0.186		0.343*	0.180		0.332*	0.178	
Age	0.027**	0.013		0.036**	0.014		0.045***	0.011	
Age squared	-0.0003**	0.0001		-0.0005***	0.0002		-0.0006***	0.0001	
Education HH dummies		Yes			Yes			Yes	
Income quartile dummies		No			Yes			Yes	
Number of dependent children <18		No			No			Yes	
Head of Household Equation									
Log of wages HH	0.616***	0.056		0.616***	0.057		0.616***	0.057	
Medium education HH	0.284***	0.035		0.284***	0.035		0.284***	0.036	
High education HH	0.245**	0.105		0.244**	0.105		0.245**	0.106	
HH age	0.059***	0.017		0.058***	0.017		0.058***	0.016	
HH age squared	-0.0008***	0.0002		-0.0008***	0.0002		-0.0008***	0.0002	
Correlation error terms	0.521***	0.083		0.512***	0.069		0.505***	0.062	
Urban/rural dummy		Yes			Yes			Yes	
Country-fixed effects		Yes			Yes			Yes	

Note: Standard errors clustered by country are reported.

*Significant at 10%; **significant at 5%; *** significant at 1%.

A salient feature of the previous literature on informality is that worker decisions play no role in determining the equilibrium of the economy. It is only the firm that chooses optimally whether to operate formally or informally, and either homogenous workers are constrained to obtain the best jobs (as in the dualistic models) or heterogeneous workers are indifferent about which sector they participate in. This is clearly insufficient, as it ignores the role that household choices play in determining the levels of formality in an economy. Naturally, as our model shows, we do not claim that informality is only the result of household's choices. However, ignoring the role of them could be misleading and may well induce to disregard important (unintended) consequences of policies and interventions.

At the policy front, the main lesson from our paper is that governments should not consider only labor demand but also labor supply when tackling informality. Policies that reduce the supply of workers in the informal labor market at given wages will increase the level of formality in the economy. This is a very important lesson to take into account when designing welfare policies in developing countries. Conditioning welfare transfers on the labor-market status of the potential beneficiaries will increase the level of informality of the economy.

Governments seem to want to increase the size of the formal sector for different reasons: to increase tax collection, to improve the productivity of the economy and to provide workers with the nonpecuniary benefits normally linked to formal jobs. Specific policy recommendations would differ depending on where the emphasis is placed. Both our model and the data show that unskilled workers tend to operate informally, so if the provision of health and other benefits are exclusively attached to formal jobs, these workers will not be covered by them. Thus, policies that attempt to achieve universal coverage are likely to be considered to reach the poor. Of course, these policies will reduce the incentives to operate formally, increasing the size of the informal sector.

Finally, when formal jobs provide nonpecuniary benefits, there is the question of whether to narrow access to them just to the worker or to extend them to his/her family. If we consider the incentives that this decision creates, it might appear that our analysis suggest that these benefits should be specified

by the worker in order to enhance the incentives of secondary workers to operate formally. However, at least two considerations are in order here. First, not extending the nonpecuniary benefits of formal jobs to the family of the worker would reduce the incentives of primary workers to operate formally, and hence, the overall effect over formality of specifying benefits by worker instead of households is ambiguous. Therefore, even if we restrict the analysis to the effect of incentives, the answer to this question is case specific. Second, while covering the population with these benefits is considered important, the answer to this question is beyond the scope of our paper, but it is also case specific. Nevertheless, if that is the case, we probably need to think about informality in terms of households and not individuals.

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