



# A competitive model of the informal sector<sup>☆</sup>

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## Abstract

In developing nations, formal workers tend to be more experienced, more educated, and earn more than informal workers. These facts are often interpreted as evidence that low-skill workers face barriers to entry into the formal sector. Yet, there is little empirical evidence that such barriers are important. This paper describes a model where, in equilibrium, the characteristics of formal and informal workers differ systematically, even though labor markets are perfectly competitive. The informal sector emphasizes low-skill work, as in the data, because informal managers have access to less outside financing, and choose to substitute low-skill labor for physical capital.

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## 1. Introduction

In developing economies, workers employed in the untaxed, unregulated, sector tend to be younger, have less education, and earn less than their counterparts in the formal sector.<sup>1</sup>

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<sup>1</sup>See e.g. Thomas (1992) or Maloney (1999).

This is often interpreted as evidence that labor markets are segmented in these nations: barriers to entry, it is conjectured, prevent certain groups of workers from competing for higher paying formal jobs. 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, at best. For instance, Magnac (1991), Maloney (1999), and Pratap and Quintin (2004) find no compelling evidence of segmentation between the formal and the informal sectors with data from Colombia, Mexico, and Argentina, respectively. Heckman and Hotz (1986) present some evidence that earnings functions differ across sectors in Panama but, in the same paper, argue that the parametric tests upon which most segmentation studies are founded are flawed and uninformative.

Given the lack of strong evidence of segmentation, a natural question to ask is whether (and how) the documented differences in worker characteristics and earnings between sectors can arise in an economy where labor markets are competitive. We answer this question in the context of a dynamic version of the span-of-control model of Lucas (1978), with two types of labor.<sup>2</sup> Agents can transform inputs of physical capital, unskilled labor, and skilled labor into a single consumption good according to a strictly concave technology. Our main technological assumption is that unskilled labor is a better substitute for physical capital than skilled labor. The hypothesis that capital and skill are complements is supported by most micro-economic studies with data from industrialized countries (see Hamermesh, 1993, for a review). The few comparable studies for other nations suggest that capital skill complementarity is also the norm in the developing world (see e.g. Zhou, 2001).

In the model, managers can self-finance part of their capital with savings and can borrow funds from an intermediary. At the end of the period, managers can choose to default on the payment they owe the intermediary. In the informal sector, default carries no direct cost. On the other hand, default is costly for formal managers. As a result, their access to outside financing is better. But unlike informal managers, they are subject to taxation. We show that the most talented managers self-select into the formal sector, and that formal managers operate with more physical capital than informal managers. In turn, we show that this implies a greater emphasis on skilled labor in the formal sector as long as the enforcement gap between sectors is wide enough.

While the intuition behind our result is simple, the fact that formal managers operate with more physical capital than informal managers in equilibrium requires a proof. Indeed, at equal talent, managers with more assets will tend to self-select into the informal sector because their need for outside financing is smaller. For instance, managers wealthy enough to operate without outside funds will always opt for the informal sector. We argue that for a large class of enforcement technologies, formal managers' better access to outside financing dominates the potential effect of heterogeneous saving decisions.

That models with endogenous borrowing constraints in the spirit of Kehoe and Levine (1993) have implications for the organization of production that match documented features of developing nations is well known (see, for instance, Banerjee and Newman, 1993). We argue that endogenous borrowing constraints have implications for labor

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<sup>2</sup>Our model also builds on the seminal work of Rauch (1991). Unlike Rauch however, we assume that labor markets are competitive, that there are two types of labor, and we do not impose a size threshold on informal producers.

markets in developing nations that are also borne out by the evidence. The literature on the importance of contractual imperfections for economic development is motivated by the abundant evidence that property rights are not effectively enforced in developing economies (see e.g. Djankov et al., 2002). In contrast, the importance of formal barriers to entry into the formal sector, the premise behind the prevalent view of informal economic activities (see Section 2), is subject to much debate. We show that these elusive barriers are not necessary to account for key characteristics of labor markets in developing economies.<sup>3</sup>

Like all reasonable models of informal sector activities, our model predicts that employers who operate formally should be larger than their counterparts in the informal sector. But it is also consistent with the fact that informal employers tend to rely on self-financed funds much more than formal employers, and that they operate at a markedly lower physical capital to labor ratio (we review the relevant empirical evidence below). Furthermore, it can rationalize systematic differences in the average characteristics of formally and informally employed workers without relying on barriers to entry into the formal sector. Since strong evidence that these barriers are empirically important has yet to be produced, this suggests to us that the policy implications of dualistic models should be treated with caution. In models where labor markets are segmented, policies that increase the absorption of workers by the formal sector can raise national income and welfare because the value of the marginal product of formal workers is higher than that of informal workers (see Ray, 1998, Chapter 10, for a discussion). For instance, directly subsidizing formal employment can restore efficiency in labor markets. In competitive models such as ours, a subsidy of this nature is purely distortionary. In our model, workers in the formal sector earn more, on average, because they tend to be more productive. As a means of alleviating poverty, policies that aim solely at reducing the size of the formal sector are, at best, a poor substitute for investments in education, or investments in the quality of formal institutions (such as property rights enforcement).

## 2. The facts

Empirical studies of informal activities rely on various possible classifications of employment relationships. Some studies consider a worker informally employed if they work for an employer that does not comply with government regulations such as labor laws or the tax code. For instance, Fortin et al. (1997) describe data from Cameroon where workers are classified as formally employed if their employer is officially registered. Other studies (see e.g. Maloney, 1999; Pratap and Quintin, 2004) assign individuals to the formal sector if they receive the benefits mandated by labor laws. Most studies, however, simply define the informal sector as employers whose employment size falls below a certain threshold (see Thomas, 1992, Chapter 4, for a review).

Despite these methodological differences, several facts emerge from existing empirical investigations. First, the informal sector is large in developing nations, often accounting for over one-third of all employment. Second, the distribution of worker characteristics and earnings varies systematically across sectors. Formally employed workers tend to be

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<sup>3</sup>Loayza (1996) and Sarte (2000) also model informal economic activities without resorting to labor market segmentation. In these models, informal firms avoid taxation but must bear an exogenous “cost of informality.” We model that cost explicitly. Furthermore, neither paper considers the distribution of worker characteristics across the two sectors.

Table 1

Average characteristics of employees, Buenos Aires and its suburbs, 1993–1995

|   | Formal sector | Informal sector | <i>T</i> -statistic |
|---|---------------|-----------------|---------------------|
| Observations  | 10,010        | 5682            |                     |
| Average age in years                                    | 37.32         | 33.45           | 17.44               |
| Average tenure in years                                 | 7.88          | 3.42            | 35.14               |
| Percent of workers with tertiary education              | 19.92         | 11.00           | 15.49               |
| Percent of workers in plants with 15 employees or fewer | 30.34         | 79.29           | 69.20               |
| Average gross hourly earnings                           | 4.43          | 3.32            | 16.90               |

*Source:* Argentina's Permanent Household Survey. Earnings are in 1995 pesos using Argentina's CPI as deflator, and corrected for Christmas bonuses (*aguinaldo*). Workers are formally employed if they receive both pension and unemployment insurance benefits. See Pratap and Quintin (2004) for details.

older, have more education, and earn more than informal workers. Third, employers that comply with regulations tend to be much larger than informal employers.

Table 1 illustrates these facts with data for Buenos Aires and its suburbs drawn from Argentina's permanent household survey between 1993 and 1995. The survey is based on biannual interviews of a rotating panel of households.<sup>4</sup> It records each household member's basic demographic and employment data, including the revenues and benefits they derive from each of their occupations, as well as the industry classification and employment size of the establishment in which they work. We restrict our attention to employees who report that they work fewer than 80 h a week, and classify workers as informally employed if they fail to receive social security coverage in the form of pension contributions and unemployment insurance, two benefits mandated by Argentina's labor laws. The resulting sample contains 15,692 observations. According to this definition, one-third of the wage earners in our sample are informally employed, a large fraction typical of developing economies (see e.g. Schneider and Enste, 2000, for more estimates of the size of the unregulated economy in developing nations). The characteristics of informal workers in Argentina are also typical of developing nations. Informal employees are significantly younger, less experienced, and less educated than formal employees. In addition, establishments with 15 employees or fewer account for a significantly higher fraction of employment in the informal sector than in the formal sector. As one would expect given those differences, average hourly wages are higher in the formal sector.

These distinguishing features of labor markets in developing nations motivate standard models of informal economic activities (see Thomas, 1992, Chapter 4, or Ray, 1998, Chapter 10, for surveys of the theoretical literature). The prevalent approach builds on the dual economy notion introduced by Lewis (1954), and treats labor markets as segmented along formal/informal lines. It is founded on the premise that "the wage level and working conditions in the [formal] sector are not available, in general, to the job seekers in the market unless they manage to cross the barrier of entry somehow" (Mazumdar, 1976). Rauch (1991) formalizes this view in a general equilibrium model where firms can choose to pay workers below the minimum wage provided they operate on a scale below a certain

<sup>4</sup>These data are discussed in detail by Pratap and Quintin (2004).

detection threshold. In equilibrium, some workers find high paying jobs in large firms, while the surplus labor is constrained to accept inferior wages in smaller firms. In fact, models with segmented labor markets predict that identical workers should earn more in the formal sector than in the informal sector. What makes the prevalence of these models surprising is that there is no compelling evidence that this central prediction is borne out by the data.

While it is a common view in the development literature that differences in individual and job characteristics alone cannot account for earnings differences between sectors, the evidence on this question is mixed, at best. Most estimates of earnings functions for developing nations suggest that significant differences exist across sectors (see, for instance, Banerjee, 1983; Heckman and Hotz, 1986; Pradhan and Van Soest, 1995; Rosenzweig, 1988 for a survey), but these studies rely on strong parametric assumptions that may yield misleading results. As Heckman and Hotz (1986) point out (see also Maloney, 1999), results are sensitive to the wage equation one chooses to specify, and OLS estimates are biased and inconsistent because individuals may select sectors on the basis of observed and unobserved characteristics that also affect earnings. Pratap and Quintin (2004) circumvent the need to specify a wage function by using semiparametric techniques. They find no support for the hypothesis that observably similar workers earn more in the formal sector than in the informal sector using the data behind Table 1. Magnac (1991) estimates a structural model of labor market decisions with Colombian data and directly tests for the presence of barriers to entry into the formal sector. He finds that the hypothesis that labor markets are competitive cannot be rejected. In summary, the existing empirical literature provides no compelling evidence that labor market are segmented in developing nations.

But if labor markets are integrated, why does the distribution of employee characteristics differ systematically across sectors? We believe that a key reason for these differences is the fact that production is markedly more capital-intensive in the formal sector than in the informal sector. This is evident for instance in a 1983 survey of 10,000 households in Lima discussed by Thomas (1992, pp. 64–78). Almost half of the surveyed workers employed by informal (small) firms<sup>5</sup> operated with under US\$500 of capital per head, while 90% of a comparable sample of formally employed workers operated with over US\$6000 of capital per head. These differences in capital intensity likely reflect the fact that the access of informal firms to outside sources of funds is generally limited. In her comprehensive review of empirical studies of informal sources of financing in developing countries, Mansell Carstens (1995, p. 65) concludes that “financial intermediation in the strict sense is extremely limited” in the informal sector. In his survey, Thomas (1992, pp. 64–78) writes “... it is striking how small a role is played by bank credit [in the informal sector] in comparison with the entrepreneur’s own savings or informal credits, which usually takes the form of loans from family and friends.” In the 1983 Lima study we mentioned above, bank loans account for under 2% of overall credit in informal firms, while own savings account for about 80% of overall credit.<sup>6</sup> Not surprisingly then, the informal sector tends to emphasize activities such as trade where capital requirements are limited (see e.g. Thomas, 1992, p. 74).

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<sup>5</sup>In the 1983 Lima study, firms are classified as informal if they employ nine workers or fewer in the manufacturing sector, four workers or fewer in other sectors.

<sup>6</sup>More generally, there is ample evidence that small firms use little external finance in developing nations (see e.g. Beck et al., 2004).

The model we present in the next section generates differences in access to finance across sectors by assuming that contracts are easier to enforce in the formal sector. Agents who can manage large quantities of productive resources efficiently choose to operate formally because their need for finance is greater. Like standard models therefore, our model predicts that large employers are more likely to operate formally. Standard models (Rauch, 1991; Fortin et al., 1997) generate this scale dualism by positing that firms above a certain size threshold must behave formally, or that the cost of avoiding detection rises with size. In our model, employers whose optimal scale of operation is high choose to behave formally to gain access to formal sources of finance. Provided the contract enforcement gap between sectors is wide enough, the model also predicts that formal employers operate at a higher capital to employment ratio. In turn, this implies that the formal sector emphasizes skilled labor under the assumption that capital and skilled labor are complementary. That is, even though labor markets are perfectly competitive (identical workers earn the same amount in the two sectors), the distribution of employee characteristics differs systematically across sectors in our model, like in the data. In short, competitive models can replicate the features of labor markets in developing nations that are invoked to motivate models with segmented labor markets. Furthermore, the implications of our finance-based model for the capital intensity of production across sectors are also consistent with the available evidence.

### 3. The economy

Time is discrete. Every period, a cohort of measure 1 of two-period-lived agents is born. In the first period of their lives, agents split their time between unskilled work and education. Denote by  $e \in [0, 1]$  the fraction of time they devote to education, so that  $(1 - e)$  is the quantity of unskilled labor services they supply. In the second period of their lives, agents can supply one of two types of labor services: unskilled and skilled. All agents can choose to supply one unit of unskilled labor services. Alternatively, they can supply  $he^p$  units of skilled labor services, where  $h > 0$  while  $p \in [0, 1]$  is an agent-specific parameter. Instead of supplying labor services in the second period of their lives, agents can choose to become managers. A manager of ability  $z \in [0, 1]$  operates a technology that transforms inputs of unskilled labor,  $l_u$ , skilled labor,  $l_s$ , and physical capital,  $k$ , into the unique consumption good according to net schedule  $zF(k, l_u, l_s) \equiv z[\min(k, l_s)]^\alpha l_u^\theta$ , where  $0 < \alpha + \theta < 1$  to allow for managerial profits.<sup>7</sup> Physical capital depreciates entirely from one period to the next.

The managerial and education types  $(p, z)$  of agents are drawn from a joint distribution  $\mu$  with finite support. We assume, for simplicity, that agents know their management and education types at the beginning of the first period of their lives, and that both characteristics are public information. We also assume that  $\mu\{(p, z) \in [0, 1]^2 : p > 0\} > 0$  and that  $\mu\{(p, z) \in [0, 1]^2 : z > 0\} > 0$  so that an equilibrium with positive output exists.

Managers can operate in one of two sectors: formal or informal.<sup>8</sup> In the formal sector, profits are taxed at a uniform rate  $\tau > 0$ . Informal managers, on the other hand,

<sup>7</sup>Assuming that the elasticity of substitution between skilled labor and physical capital is 0 simplifies the analysis, but one only needs to assume that this elasticity is lower than the elasticity of substitution between unskilled labor and physical capital.

<sup>8</sup>One interpretation for this choice is the decision by managers whether or not to legally declare their establishment.



do not pay taxes. The proceeds from taxation are dissipated. In both sectors, managers can self-finance part of their physical capital with savings from the first period of their life. They can also borrow some capital from a financial intermediary with access to perfect capital markets where a one-period risk-free security earns net return  $r > 0$ .<sup>9</sup>

Managers who borrow funds from the intermediary can choose to default on their debt. When they do so, managers bear a cost proportional to their income. This cost measures the extent to which contracts can be enforced,<sup>10</sup> and we assume that contracts are more difficult to enforce in the informal sector than in the formal sector. In fact, for simplicity and without loss of generality, we will set default costs to 0 in the informal sector, while default costs are fraction  $\eta > 0$  of a manager’s income in the formal sector. This implies, in particular, that informal managers must self-finance all production.

As for preferences, we assume that all agents order lifetime consumption streams,  $\{c_1, c_2\}$ , according to  $U(c_1, c_2) = \log c_1 + \beta \log c_2$  where  $\beta > 0$ . The discount rate  $\beta$  measures the willingness of agents to transfer wealth from the first period to the second period. For simplicity, we will assume that  $\beta(1 + r) \leq 1$ . Under that assumption, informal managers are always borrowing-constrained, which simplifies the statement of their problem and the proofs we provide in the appendix. This assumption can be relaxed without altering our basic results.

#### 4. Optimal policies

We focus our attention on equilibria in which wage rates are constant over time. Henceforth, we dispense with time subscripts to curb notation. Denote by  $w_u$  and  $w_s$  the unskilled and skilled wage rates, respectively. Because we assume that workers can move freely between the formal and informal sectors, these prices must be the same in the two sectors. We begin by calculating the income before taxes for managers given the quantity  $k$  of physical capital with which they are able to operate and their managerial ability  $z$ :

$$\Pi(k, z) = \max_{l_u, l_s \geq 0} zF(k, l_u, l_s) - l_s w_s - l_u w_u - k(1 + r). \tag{1}$$

In an environment with perfect enforcement ( $\eta = 1$ ), formal managers would employ the uniquely defined optimal quantity  $k^*(z) = \arg \max_{k \geq 0} \Pi(k, z)$  of physical capital. But managers have the option to default and debt contracts must be self-enforcing. In other words, the net income of formal managers with ability  $z$  and savings  $a$  is

$$\begin{aligned} V(a, z; \eta, \tau) &= \max_{s \leq a, d \geq 0} (1 - \tau)\Pi(s + d, z) \\ \text{s.t. } (1 - \tau)\Pi(s + d, z) + a(1 + r) &\geq (1 - \eta)(1 - \tau)[\Pi(s + d, z) + (s + d)(1 + r)] \\ &\quad + (a - s)(1 + r), \end{aligned} \tag{2}$$

<sup>9</sup>One can think of our economy as a small, open economy, or interpret  $r$  as the net return to a storage technology endowed to the intermediary.

<sup>10</sup>We adopt this particular formulation of the enforcement technology for concreteness. We show in the technical appendix that our results hold for a broad class of enforcement technologies. The technical appendix is available at <http://faculty.smu.edu/pamaral/>, under Research.

where  $s$  is the amount managers use as collateral for their loan, and  $d$  the net loan received by the manager from the intermediary.<sup>11</sup> The inequality constraint says that contracts must be incentive compatible: the intermediary will only lend the manager a net amount  $d \geq 0$  such that defaulting is sub-optimal. The left-hand side of the constraint is the manager's end-of-period income if he honors his debt, while the right-hand side is the income associated with defaulting (by doing so, the manager saves the principal plus the interest due to the intermediary). Denote by  $s(a, z; \eta, \tau)$ ,  $d(a, z; \eta, \tau)$ ,  $l_u(a, z; \eta, \tau)$ , and  $l_s(a, z; \eta, \tau)$  the solutions to the manager's problem.<sup>12</sup> The following lemma characterizes these policy functions and the corresponding value function. All proofs are in the technical appendix.

**Lemma 1.** *For all  $z \in [0, 1]$ , there exists  $a^*(z; \eta, \tau) \leq k^*(z)$  such that:*

- (i)  $V(\cdot, z; \eta, \tau)$ , is strictly concave, strictly increasing, and twice continuously differentiable on  $[0, a^*(z; \eta, \tau))$ , and constant past  $a^*(z; \eta, \tau)$ ;
- (ii)  $s(a, z; \eta, \tau) = a$ , on  $[0, a^*(z; \eta, \tau))$ ;
- (iii)  $d(\cdot, z; \eta, \tau)$  is strictly increasing and concave on  $[0, a^*(z; \eta, \tau))$ ;
- (iv)  $s(\cdot, z; \eta, \tau) + d(\cdot, z; \eta, \tau) = k^*(z)$  on  $[a^*(z; \eta, \tau), +\infty)$ .

The lemma says that the amount that formal managers can borrow rises with their own savings. In rough terms (see the proof in the appendix for details), this is because raising  $s$  weakens the incentive compatibility constraint by raising the opportunity cost of default. We will now argue that the amount formal managers can borrow also rises with their managerial ability.

**Lemma 2.** *For all  $a \geq 0$ ,  $d(a, \cdot; \eta, \tau)$  is increasing.*

This result is due to the fact that the opportunity cost of default rises with the manager's ability, which should be obvious upon inspection of the incentive compatibility constraint. Therefore, the ability of managers to borrow depends jointly on the savings with which they enter the second period (their assets) and their managerial ability. Managers choose to enter the formal sector when their access to outside financing is sufficient to offset the fact that they become subject to income taxation, i.e. when  $V(a, z; 0, 0) < V(a, z; \tau, \eta)$ . Intuitively, managers with less assets, all else equal, should be more likely to operate in the formal sector.

Lemma 1 is illustrated in Fig. 1 which depicts the net profits of managers of a given type  $z$  as a function of their assets. The net income  $V(\cdot, z; \eta, \tau)$  a formal manager of ability  $z > 0$  can generate given his assets is strictly positive at  $a = 0$  because  $d(0, z; \eta, \tau) > 0$  as long as  $\eta > 0$ .<sup>13</sup> His net income then rises at a decreasing rate until  $a = a^*(z; \eta, \tau)$ . The profits of informal managers with the same ability start at 0 since they cannot borrow, but rise to a level higher than  $V(a^*(z; \eta, \tau), z; \eta, \tau)$  since  $\tau > 0$ . Therefore, the two profit functions must cross. (The figure depicts the case where they cross only once, which must hold true, for

<sup>11</sup>The gross loan received by the manager is  $s + d$ , which corresponds to a tax deduction of  $\tau(s + d)(1 + r)$  for depreciation and interest payments. This formulation of the incentive compatibility constraint assumes without loss of generality that the part  $a - s$  of savings not explicitly used as collateral by the agent is not subject to the default cost.

<sup>12</sup>When the manager is unconstrained, there may be several optimal collateral and net loan sizes. In that case, assume for concreteness that agents select the largest optimal net loan.

<sup>13</sup>Formally, this is because  $\lim_{k \rightarrow 0} II(k, z)/k = +\infty$ .



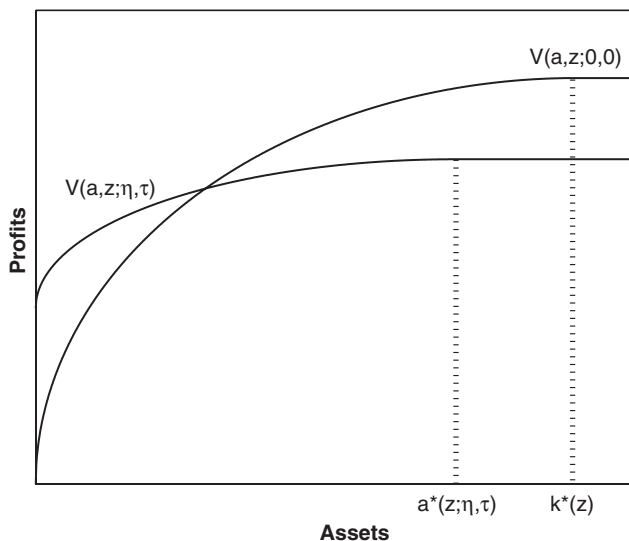


Fig. 1. Net profits in the two sectors.

instance, when  $\eta$  is near 1.) All else equal therefore, wealthier agents are more likely to opt for the informal sector than for the formal sector, as illustrated in the figure.

To obtain the result we seek, namely that the formal sector emphasizes skilled labor, we need to argue that formal managers operate with more physical capital than informal managers. This appears intuitively obvious because more talented managers have a greater need for outside financing (their optimal scale of operation is higher) and a better access to it (their opportunity cost of default is higher, as shown in Lemma 2) and are therefore more likely to opt for the formal sector. But agents with more assets, all else equal, are more likely to choose the informal sector since their need for outside financing is smaller. For instance, agents wealthy enough to self-finance their optimal scale of operation will always opt for the informal sector. We will characterize the net result of these potentially conflicting considerations by considering the problem solved by agents in the first period of their life. Young agents of type  $(p, z)$  solve

$$W(p, z) = \max_{a, e \geq 0} \log c_1 + \beta \log c_2,$$

where

$$c_1 = (1 - e)w_u - a,$$

$$c_2 = a(1 + r) + \max(w_u, he^p w_s, V(a, z; \eta, \tau), V(a, z; 0, 0)). \tag{3}$$

We will now show that managers of higher talent are indeed more likely to become formal managers, and that they use more capital than less productive managers.

**Lemma 3.** *Given  $p \in [0, 1]$  there exist values  $\underline{z}(p; \eta, \tau) \leq \bar{z}(p; \eta, \tau)$  such that in the second period of their lives agents of type  $(p, z)$  become:*

- (i) workers when  $z < \underline{z}(p; \eta, \tau)$ ;
- (ii) managers in the informal sector when  $\underline{z}(p; \eta, \tau) < z < \bar{z}(p; \eta, \tau)$ ;

(iii) *managers in the formal sector when  $z > \bar{z}(p; \eta, \tau)$ .*

*Furthermore, formal managers operate with more capital than informal managers.*

Agents whose managerial ability is at one of the thresholds are indifferent between two occupations, and we use the fact that there are many agents of each type to convexify the excess demand for each type of labor. The basic intuition for the last, key statement of the lemma is as follows. Consider a given informal manager and a given formal manager. If the formal manager has more assets than the informal manager, they operate with more capital, trivially. Assume then that the informal manager saves more than the formal manager. Then their marginal utility of consumption in the first period must be higher, which means (as a necessary condition for optimal saving behavior, see proof for details) that returns to savings are higher in the second period. In turn, because the production function is strictly concave in physical capital, we show that this implies that informal managers operate with less capital than formal managers.

While each agent’s ability thresholds depend on their education type, we now argue that for any pair of wage rates formal managers are uniformly more talented than informal managers. This is because once an agent decides to become a manager, their education type no longer affects their choices.

**Lemma 4.** *Suppose there exist both formal and informal managers. Let  $\underline{z}_F$  denote the lowest managerial talent among formal sector managers, and let  $\bar{z}_I$  denote the highest managerial talent among informal sector managers, then  $\underline{z}_F \geq \bar{z}_I$ .*

In the appendix, we complete our characterization of policy functions by describing the impact of education types on education choices. Quite intuitively, all else equal, agents with high education types devote more time to education, save less, and are less likely to become managers in the second period than agents with low education types. We now turn to establishing our main result.

### 5. Properties of steady state equilibria

A steady state equilibrium is a pair  $(w_s, w_u)$  of wage rates and a list of policies for each agent such that (1) policies are optimal for all agents, and (2) labor markets for both types of labor clear. To make this definition more precise, for each  $(p, z) \in [0, 1]^2$  denote by  $\phi^{p,z}$  the probability distribution such that for all  $e \in [0, 1]$ ,  $l_u \geq 0$ , and  $l_s \geq 0$ ,  $\phi^{p,z}(e, l_u, l_s)$  is the fraction of agents of type  $(p, z)$  who choose to devote time  $e$  to education in the first period of their lives and choose to hire quantities  $l_u$  and  $l_s$  of unskilled and skilled labor in the second period. Optimality requires that for all  $e \in [0, 1]$ ,  $l_u \geq 0$ , and  $l_s \geq 0$ ,  $\phi^{p,z}(e, l_u, l_s) > 0$  implies that  $(e, l_u, l_s)$  is an optimal policy for agent type  $(p, z)$  given wage rates. Since workers are indifferent between sectors, labor market clearing only requires that overall demand equal overall supply for each skill level, i.e.

$$\int_{[0,1] \times \mathbb{R}^2 \times [0,1]^2} l_u d\phi^{p,z}(e, l_u, l_s) d\mu(p, z) = \int_{[0,1] \times \mathbb{R}^2 \times [0,1]^2} (1 - e) d\phi^{p,z}(e, l_u, l_s) d\mu(p, z) + \int_{[0,1]^2} \phi^{p,z}(0, 0, 0) d\mu(p, z), \tag{4}$$

$$\int_{[0,1] \times \mathbb{R}^2 \times [0,1]^2} l_s d\phi^{p,z}(e, l_u, l_s) d\mu(p, z) = h \int_{[0,1] \times \mathbb{R}^2 \times [0,1]^2} e^p d\phi^{p,z}(e, l_u, l_s) d\mu(p, z). \quad (5)$$

The right-hand sides of Eqs. (4) and (5) are the aggregate supply of unskilled and skilled labor, respectively. Indeed, the supply of unskilled labor is the sum of time devoted to work by young agents and the mass of old agents who devoted no time to education in the first period and chose not to become managers (i.e. chose to set  $l_u = l_s = 0$ ). The supply of skilled labor, on the other hand, is the sum of all returns to education.

The set of optimal policies may not be single-valued for all types, but one easily shows that it is finite. Since  $\mu$  has finite support by assumption, all integrals in (4) and (5) are finite sums. This simplifies the proof that a steady state equilibrium exists, which we provide in the appendix.

**Proposition 5.** *A steady state equilibrium exists.*

While steady states always exist, we have yet to show that the model can deliver an informal sector commensurate with existing estimates for developing countries. The next remark records the fact that the size of the informal sector can be made as large as desired in this model by raising the tax rate sufficiently or making the default cost low enough.

**Remark 6.** *For any  $\rho \in [0, 1]$ , there is a pair  $(\tau, \eta) \in [0, 1]^2$  of tax and default cost parameters such that a steady state exists in which the informal share of employment exceeds  $\rho$ .*

An interesting question is whether a sense exists in which the informal share of employment decreases monotonically with  $\eta$  and rises monotonically with  $\tau$ .<sup>14</sup> One interpretation of Remark 6 is that one can find a sequence of tax and default cost parameters that generates a rising sequence of informal employment shares. Furthermore, it is easy to show that the sequence of tax and default cost parameters can be selected so that the tax rate is non-decreasing while the default cost is non-increasing. A stronger monotonicity result requires assumptions that guarantee that steady state equilibria are unique, assumptions which we do not need to obtain the results we are seeking.

The following proposition will enable us to conclude that steady state equilibrium differences between the formal and informal sectors are consistent with the evidence discussed in Section 2.

**Proposition 7.** *In steady state, formal managers (i) are more productive in total factor terms and (ii) employ more capital, more skilled workers, and more unskilled workers than informal managers.*

*In addition, if  $\eta/(1 - \eta) > \alpha\beta(1 + r)/(1 - \theta + \alpha\beta)$ , then formal managers (iii) operate at a higher skilled labor to unskilled labor ratio and (iv) operate at a higher capital to employment ratio than informal managers.*

The last two items of the proposition say that as long as the enforcement gap between sectors is wide enough, the ratio of physical capital to employment and the ratio of skilled labor to unskilled labor are higher in formal establishments than in *all* informal establishments. As a result, formal workers will tend to be older, more educated, and earn more than informal workers, as in the data. The enforcement threshold rises with

<sup>14</sup>Johnson et al. (1997, 1998) find that higher tax burdens and a weaker rule of law tend to be associated with large informal sectors.

$\alpha/(1 - \theta)$ , which measures the importance of capital in production, and with  $\beta$  which measures the willingness of agents to self-finance production. Notice that this condition yields the stark result that all formal establishments operate at a higher skilled labor to unskilled labor ratio than informal establishments. Weaker conditions would suffice to imply that this is true only on average. Also notice that while the specific enforcement gap threshold depends on the form of the enforcement technology one chooses to specify, such a threshold must exist for any enforcement technology since unconstrained managers always operate at the highest possible capital to unskilled labor ratio. As it stands, Proposition 7 shows that labor market segmentation is not necessary to explain the distinguishing features of labor markets in developing nations.

## 6. Conclusion

This paper presents a theory of informal economic activities consistent with the main features of labor markets in economies with large informal sectors. We model the costs associated with producing in the informal sector as resulting from a limited access to formal means of contract enforcement. Managers choose to enter the formal sector when their return to outside financing exceeds the additional tax cost they must bear. As a result, the most productive managers self-select into the formal sector, and operate with more capital. Provided the enforcement gap between sectors is wide enough, they also operate at a higher physical capital to employment ratio than informal managers, which is consistent with the available evidence. This, in turn, implies that the formal sector emphasizes skilled labor, under the assumption that unskilled labor is a better substitute for physical capital than skilled labor.

The model, therefore, successfully replicates key features of labor markets and the organization of production in developing nations without resorting to any assumption of formal barriers to movement between sectors. Combined with the lack of direct evidence that such barriers are important in practice, our results suggest that the leading, dualistic view of labor markets in developing countries should be questioned.

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