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Why Don't Poor Countries Adopt Better Technologies? *

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Abstract:
In this paper we develop a simple heterogeneous-agent model with incomplete markets to explain the prevalence of a large low-productivity, informal sector in developing countries. In our model, the provision of public infrastructure creates a productivity premium for formalization, which increases with infrastructure quality. Our model breaks the symmetry of equilibria and offers endogenous differentiation of rich and poor countries' behavior. While the model supports multiple stable equilibria in 'rich' countries with varying degrees of formalization, including full formalization, it indicates an absence of equilibrium with full formalization in 'poorer' countries. If legislative intolerance alone suffices to jolt a rich country into the equilibrium with complete formalization, accompanying policies may be required in poor countries to first provide the conditions for existence of such equilibrium.

Keywords:
Technology adoption, informal sector, industrialization, inequality, infrastructure

JEL classification: O12, O14, H54

1 Introduction

There seems to be a general agreement that countries that are late-comers to industrialization have the option to adopt better technologies available in advanced industrialized countries in order to jump-start their development process (e.g. Bell and Pavitt, 1993 or Romer, 1993). Our view is that a higher degree of inequality in many poor countries, by creating an environment conducive to the tolerance of informal, low-productivity activities, may explain why these countries are not adopting the highly productive technologies readily available abroad.

In fact, in many developing countries, dualism in the organization of production activities is very pervasive with informal, low-productivity methods of production coexisting with higher-productivity, formal methods. While 17% of the work force in OECD countries derives its income from informally organized production activities, in developing countries, this figure is estimated to be around 60% (Moe and Ihrig, 2000). From a development point-of-view, an important question is why such a significant proportion of the economy-wide resources remains trapped in a low-productivity sector. In this research, we seek an answer to this question, and address the issue of policy responses towards informal organization of production.

We build a heterogeneous-agent model in which the existence of strategic complementarities generates multiple equilibrium formal sector sizes. Our model has four main assumptions: (i) the provision of public infrastructure creates a productivity premium from formalization. Unlike what is typically assumed, formalizing production does not just mean taking an old technology and making it legal, it implies switching from low- to high-productivity technologies to take advantage of the availability of public infrastructures. In our model, agents understand that absent public infrastructures, there is no gain from such technology switch. High-productivity technologies rely on mass production which requires marketing, itself in need of infrastructures for shipping and handling. (ii) The productivity premium from formalization increases with the quality of public infrastructures; (iii) infrastructure quality depends on the level of public funds collected from the formal sector; and (iv) markets are incomplete, implying that agents cannot buy or sell assets in response to exogenous changes in their environment.

It is well known that high-quality, modern infrastructures and related public services are key ingredients of a well-functioning market economy. In such an economy, the adoption of high-productivity technologies may require the building up of physical and institutional infrastructures (railroads, highways, airports, law and order, etc), which makes the quality of these infrastructures a key determinant of the aggregate output level. To see this, one only has to envision what would happen to shipping and handling operations in a country like Canada if traffic in airports, highways, and railroads were to be severely reduced during a long winter season because of poor funding for the provision of snow-plowing

equipments and other accessories. Production activities would be paralyzed, with adverse consequences on output and welfare.

To the extent that the adoption of high-productivity technologies and the availability of public infrastructures go hand-in-hand, and assuming that the building up of these infrastructures is financed by taxes collected from formal sector activities, another important question is whether we should expect a jump in the size of this sector following a permanent reduction in the tax burden.

In our model, the tax revenue collected from the formal sector feeds back into production in the form of productive infrastructures which are essential for the well-functioning of this sector. Agents differ in their endowment of a productive asset, which can be combined with public infrastructures and services to produce output. Two technologies are available for this purpose: a high-productivity technology, intensive in the use of public infrastructures and an informal or cottage-industry, low-productivity technology for which public infrastructures are a productive, but not essential input. The provision of public infrastructures is financed by a lump sum tax reflecting registration fees and fixed costs imposed by the government. This lump sum tax is the mechanism behind agents' interdependent behavior with respect to the issue of whether or not to go formal. As such, it creates a climate for the potential emergence of coordination failures: since the formal sector size determines the level of financing of public infrastructures and services, it acts as a network externality. Hence agents must form expectations over the formal sector size in order to evaluate the gains from formalization. As a result, a multiplicity of equilibria is likely, some of these equilibria Pareto-dominating others. We find that while in 'richer' countries complete formalization is a fulfilled expectations equilibrium, in 'poorer' countries, this equilibrium does not exist. Hence, in the former, multiple equilibria provide a role for legislation banning informal activities to coordinate expectations towards the equilibrium with complete formalization, while in the latter, we show that policies may need to be substantially more sophisticated.

In probing the counters of informalization in a poorer country, we emphasize inequality and tax burden as important themes to consider. As some countries display a higher degree of (wealth) inequality than others, and poverty is far from being uniform in a poorer country, a high degree of inequality, combined with missing asset markets, is found to be associated with the non-existence of an equilibrium with complete formalization. Regarding the issue of the tax burden faced by formal sector agents, we find that changes in the level of the tax have ambiguous effects on the equilibrium formal sector size, as a result of endogenous productivity premium from formalization.

Our paper provides a new stone in the history versus expectations debate opened in Krugman (1991) and reasserted in Adserà and Ray (1998) and Ray (2000).[1] In the presence of multiple equilibria, what determines the choice of one equilibrium rather than another? Fundamentals, or initial conditions,

[1] See also Azariadis (1996) for a survey of the research on poverty traps.

according to the classical tradition. Expectations about other agents' behavior, according to many recent studies in the tradition of the Rosenstein-Rodan's (1943) theory of self-fulfilling prophecies.

History is commonly used to select equilibria. Much of the growth literature bases equilibrium selection on the starting point: initial conditions on the state of the economy and its institutions together with optimal dynamics determine where the economy will end up. Parente and Prescott (1994), for instance, explain why poor countries remain so by the existence of socially suboptimal institutional arrangements. So do Saint-Paul and Verdier (1993). Murphy, Shleifer and Vishny (1989) hold the diametrically opposite view: all that really matters in determining equilibrium in their research is individuals' projections of what others do, and the coordination of such projections. Murphy, Shleifer and Vishny build a theory of industrialization based on the coordination of expectations towards a Pareto dominating equilibrium in an economy with demand spillovers between industrial sectors: the process of coordination is referred to as the "big push." As Matsuyama (1996) pointed out, however, Murphy, Shleifer and Vishny's model leaves open the issue of why coordination is made towards the bad equilibrium in poor countries and towards the good one in rich countries. This criticism holds for most studies reverting to multiple equilibria to explain differences in the behaviors of rich and poor countries. Typically, the model does not offer endogenous explanations of why the poor and the rich end up in different equilibria. Our model does. It provides symmetry-breaking and answers one of Matsuyama's important criticisms of this literature. In the same philosophy, Parente and Prescott (1999) revisit their explanation of the differences between rich and poor countries in a new model where 'barriers to riches' as they call them arise endogenously.

Surely — and Krugman (1991) pointed that out —, history *and* expectations must have some weight in the prevalence of a given equilibrium. In Adserà and Ray (1998), and Dessy and Pallage (2001), a multiple equilibrium world is depicted in which the weight of history favors inertia as the coordination mechanism. Pessimistic beliefs find their source in the history behind the game. In the present paper, history, summarized by the asset distribution and the state of markets, affects equilibrium selection: while agents form expectations on others' behavior, their asset holding may limit their ability to follow the herd. Viewed from that perspective, our research offers a theory of why countries may be trapped in a bad development equilibrium. If history is not corrected by policy, the good equilibrium may not exist for the poor. In the absence of well-functioning asset markets, a credible correcting policy is redistribution. If we extent the notion of productive assets to human capital, then subsidized education becomes a relevant policy option. An impediment to the adoption of such correcting policies comes from the fact that they are not necessarily Pareto improving.

Our paper is also related to the existing works on informal markets. Rauch (1991), for instance, studies the decision to go formal within a two-sector static model, in which minimum wage legislations

are binding only for large firms. Fortin et al. (1997) build a model in which the formal-informal dualism of production organization emerges endogenously in a developing economy, as a result of flexibility in the informal sector wage. These authors use a computable general equilibrium model of Cameroon to simulate the effects on informal sector size of various tax-regulation policies. They find a positive relation between the tax burden and the size of the informal sector. A similar result is found in Ihrig and Moe (2000) who analyze the effects of taxes on the size of the informal labor market. They calibrate a growth model with informal employment to the United States economy, thus seeking quantitative answers to the question of informalization. In particular, Ihrig and Moe measure the social cost of having informal workers. Unlike in our model, taxes in both Fortin et al. (1997) and Ihrig and Moe (2000) do not feed back into production, which makes the productivity premium for formalization, when it exists, independent of tax revenues collected from the formal sector. In Fortin et al., this productivity premium results from an exogenously given penalty assigned to agents caught informalizing, whereas in Moe and Ihrig, this productivity premium comes from exogenous differences in production methods between formal and informal sectors. In the present paper, the productivity premium is endogenized. The advantages of our approach are two-fold. First, it provides an explanation of why low-productivity methods prevail in the informal sector: higher-productivity methods go hand-in-hand with the availability of high-quality public infrastructures, the provision of which require a financial contribution from formal beneficiaries. Second, unlike in the existing literature, the effects of a reduction in the tax burden faced by formal sector agents in a poorer country is shown to be ambiguous.

The rest of the paper is structured as follows. Section 2 presents the basic model. The equilibrium analysis is carried out in section 3. Section 4 characterizes the structures of fulfilled expectations equilibria in light of the history versus expectations debate. Section 5 provides the final discussions.

2 The model

The model captures the relation between public infrastructure quality, technological change and the formalization of production activities. We consider a two-period economy with a single consumption good. The economy is populated by a continuum of two-period lived agents of mass 1. We will think of these agents as consumers-entrepreneurs, each indexed by θ, the agent's endowment of productive capital. We denote by $\Psi(\theta)$ the measure of agents with endowment smaller than θ. $\Psi(.)$ is strictly increasing and differentiable over the support $[\underline{\theta}, \bar{\theta}]$, where $0 \leq \underline{\theta} < \bar{\theta} < \infty$. Endowments are an innate characteristic of their holder. One can think of them either as human capital (entrepreneurial ability) or physical capital. We will discuss policy options for these two possible interpretations of the model. Agents maximize the present value of their identical, life-time utility through the choice of first-period and second-period consumptions, respectively, c_1 and c_2. This life-time utility is given by:

$$U = u(c_1) + \beta u(c_2), \qquad 0 < \beta < 1$$

where β is a time-discounting factor, and u denotes the periodic utility function, which is strictly increasing, strictly concave, and satisfies Inada conditions.

In the initial period, only a cottage-industry, low-productivity technology is available for producing the unique consumption good. It is assumed without loss of generality that an agent θ who uses this technology in the absence of public infrastructures can produce θ units of the unique consumption good. An important feature of this model is that all agents can allocate an exogenously determined fraction of their first-period production/income to contribute to the financing of a productive infrastructure of quality X, which is necessary for the adoption of a high-productivity technology. This is the sense in which production is formalized: formalization in our model is a process of acquiring the right to use a productive, publicly-financed infrastructure. The right to use the infrastructure is given to those who contribute to its financing. Once the infrastructure is built, in the beginning of the second period, those who did not contribute can nevertheless use it, but they cannot adopt the high-productivity technology. This corresponds to a scenario where the high-productivity technology is freely distributed only to those who paid the formalization fee. It is assumed that this formalization fee is exogenously determined, and set at ϕ. Assuming a balanced budget, and letting α denote the number of agents who elect to formalize, the quality of the infrastructure built is given by:

$$X = \alpha\phi. \tag{1}$$

In the second period, those agents who did acquire the right to use the infrastructure will operate the high-productivity technology, described by

$$y_H = f(X, \theta),$$

while those who did not contribute will operate the informal, cottage-industry technology, described by

$$y_L = g\left(X, \theta\right).$$

The functions f and g have the following properties:

A.1 For all $X > 0$, and for all $\theta \in [\underline{\theta}, \bar{\theta}]$, $f_\theta > 0$; and $f(0, \theta) = 0$.

Assumption $A.1$ implies that the formal technology is more productive the higher the asset endowment of agents. This is consistent with the evidence that skilled individuals are more productive in skilled tasks than unskilled individuals. Assumption $A.1$ also implies that infrastructure is essential for operating the high-productivity technology.

A.2 For all $\theta \in [\underline{\theta}, \bar{\theta}]$, $g_\theta > 0$; $g(X, \theta) > \theta \ \ \forall X > 0$; while $g\left(0, \theta\right) = \theta$.

Assumption $A.2$ implies, in particular, that the availability of public infrastructure improves the productivity of the cottage-industry technology. Infrastructure, however, is not necessary for this technology to be operated.

A.3 For all $X > 0$, and for all $\theta \in [\underline{\theta}, \bar{\theta}]$, $f(X, \theta) - g(X, \theta) > 0$; and $f_X - g_X > 0$.

Assumption $A.3$ states that the availability of the public infrastructure generates a productivity premium for formalization, since formalization involves the adoption of a more productive technology (i.e., $f(X, \theta) - g(X, \theta) > 0$). This productivity premium is increasing in the quality, X, of the infrastructure built (i.e., $f_X - g_X > 0$). It is important to note that the assumption that productivity is higher in the formal sector than in the informal sector (i.e., $f(X, \theta) > g(X, \theta)$) is not a feature restricted to our model. When mirrored into the real world, it reflects the fact that highly productive technologies are usually intensive in the use of public infrastructures and services (roads, airports, railways, etc).

Given $\phi > 0$, agents choose whether or not to go formal by anticipating the effect this decision will have on their first- and second-period consumptions. We denote by x each agent's organizational choice: $x = 1$ means formalization in the second period, while $x = 0$ means the status quo. The first- and second-period budget constraints for agent θ are:

$$\begin{aligned} c_1 &\leq \theta - x\phi \\ c_2 &\leq x f\left(X, \theta\right) + (1 - x) g(X, \theta). \end{aligned}$$

This implies that the value of ϕ will be restricted in the semi-closed interval $[0, \underline{\theta})$.

Let $V(x;\alpha,\phi,\theta)$ denote the present-value of utility of an agent θ, who takes a binary action $x \in \{0,1\}$ when $X = \alpha\phi$ is the quality of the public infrastructure. Given the properties of the function $u(c)$, it can be shown that all budget constraints will be saturated, implying that:

$$V(x;\alpha,\phi,\theta) = u\left(\theta - x\phi\right) + \beta u\left[xf(X(\alpha,\phi),\theta) + (1-x)\,g(X(\alpha,\phi),\theta)\right], \tag{2}$$

Each agent decides on whether or not to formalize production in the second period by comparing $V(1;\alpha,\phi,\theta)$ and $V(0;\alpha,\phi,\theta)$. Let $\mu(\alpha,\phi,\theta)$ denote agent θ's net value from going formal when the quality of public services and infrastructures is $X = \alpha\phi$:

$$\mu(\alpha,\phi,\theta) \equiv V(1;\alpha,\phi,\theta) - V(0;\alpha,\phi,\theta) \tag{3}$$

Observe that the net value from formalizing depends upon the realized formal sector size, α, implying that there are *strategic complementarities* between agents' efforts to formalize, as this concept is used in Matsuyama (1995) and Ray (2000). In particular, assuming $X > 0$, consider the effect of a marginal change in α on the net value from formalizing. If the percentage change in the marginal productivity of infrastructures due to formalization is sufficiently high, the net value from formalizing can be shown to be increasing in α. Specifically, if:

$$\frac{f_X - g_X}{g_X} > \frac{u'\left[g(X,\theta)\right] - u'\left[f(X,\theta)\right]}{u'\left[f(X,\theta)\right]}, \tag{4}$$

then:

$$\mu_\alpha = \beta\phi\left(u\left[f(X,\theta)\right]f_X - u\left[g(X,\theta)\right]g_X\right) > 0, \tag{5}$$

Because of this interdependence of agents' decisions, each agent must form expectations about what other agents will do, when deciding whether or not to go formal. This is due to the fact that the quality of the public infrastructure depends on how many agents contribute to its financing, and in turn, this quality affects the net value from formalizing, as shown in (5). Assuming that indifferent agents always choose to formalize, if agent θ predicts that the realized formal sector size will be α^e, he will formalize in the second period if and only if $\mu(\alpha^e,\phi,\theta) \geq 0$, while he will opt for the status quo in the second period if $\mu(\alpha^e,\phi,\theta) < 0$.

Note that condition (4) will not hold if $X = 0$. In particular, given $\phi > 0$, one can use (2) and (3) to show that $\mu(0,\phi,\theta) < 0$, implying that when agent θ predicts that no one will go formal in the second period, it is optimal for him to follow suit.

3 Equilibrium analysis

In accordance with the literature on strategic complementarities (e.g. Katz and Shapiro, 1985), it will be assumed that agents have identical expectations of formal sector size, and that, in equilibrium, agents'

expectations are fulfilled.[2] While investigating the existence of an equilibrium, we will keep track of the realized formal sector size, α.

Definition 1 *A fulfilled expectations equilibrium (FEE) is a realized formal sector size α such that (i) agents' expectations are fulfilled (i.e., $\alpha = \alpha^e$), and (ii) all agents' decisions are optimal.*

The following Lemma guarantees the existence of a FEE.

Lemma 1 *Given $\phi > 0$, if in addition to condition (4) we have:*

$$\frac{f_\theta - g_\theta}{g_\theta} > \frac{u'[g(X,\theta)] - u'[f(X,\theta)]}{u'[f(X,\theta)]}, \quad \text{for } \alpha > 0, \tag{6}$$

then, there exists a continuously differentiable function ρ such that $\theta^* = \rho(\alpha;\phi)$ and $\rho_\alpha < 0$.

Proof. Consider an indifferent agent, i.e., one such that $\mu(\alpha,\phi,\theta) = 0$. Then note that by construction,

$$\mu_\theta = u'(\theta - \phi) - u'(\theta) + \beta\left(u'[f(X,\theta)]\, f_\theta - u'[g(X,\theta)]\, g_\theta\right).$$

Given $\phi > 0$, and for all $\alpha > 0$, the properties of u combined with condition (6) imply that $\mu_\theta > 0$. As a result, the Implicit function thorem may be applied to establish the result. ■

Condition (6) states that the rate at which the productivity premium for formalization increases following an increase in the agent's endowment of the productive asset θ has to be sufficiently high.

By the Implicit function theorem, there exists a $\phi-$family of closed subset of $(0,1]$, spanned by ϕ, and denoted by Γ_ϕ such that, given $\phi > 0$, $\theta^* = \rho(\alpha;\phi)$ and $\mu[\rho(\alpha;\phi), \alpha, \phi] \equiv 0$, for all $\alpha \in \Gamma_\phi$. Given our normalization of the total population size and the definition of Ψ, the realized formal sector size is given by:

$$\alpha = 1 - \Psi[\rho(\alpha;\phi)]. \tag{7}$$

We can now state and prove the following proposition.

Proposition 1 *Under the conditions of Lemma 1, there exists a fulfilled expectations equilibrium.*

Proof. We are to show that the fixed point problem in (7) is well defined, i.e., it admits a solution. To show this, first note that, by Lemma 1, $\rho(\alpha;\phi)$ is continuous in Γ_ϕ. Second, given the properties of the asset cumulative distribution function, Ψ, it is clear that the function $\Psi[\rho(\alpha;\phi)]$ is continuous in α as a continuous function of a continuous function. The result then follows from Brouwer's fixed point theorem. ■

[2] See Matsuyama (1995) for a defense of this assumption.

Note that depending on the functions u, f, g, and Ψ, and on the level of ϕ, the fixed point problem in (7) can admit multiple solutions. In characterizing the structure of these equilibria, we will investigate the possibility of symmetry-breaking in the adoption of compulsive measures against informalization of production. In other words, we will seek the answer to the following question: Why do some countries enforce legislation against informalization of production and others do not? To address this question, we will stress the role played by the interactions between the economy's historical legacy as described by its initial conditions, and self-fulfilling prophecies as induced by the complementarity of agents formalization efforts. The initial conditions on which we will focus are given by the asset distribution Ψ along with its moments, and ϕ, the lump sum tax which we take as a proxy of the tax burden faced by agents who elect to formalize.

4 Historical legacy and self-fulfilling prophecies

In this section, we explore the nature of aggregate forces that determine the structure of equilibrium formal sector sizes. Since by Lemma 1, $\rho(\alpha;\phi)$ is a strictly decreasing function of α, it is clear from equation (7) that, given the properties of the asset distribution function, Ψ, a sufficient condition for an equilibrium with incomplete formalization to exist is that, given ϕ,

$$\Psi\left[\rho(1;\phi)\right] > 0, \tag{8}$$

where $\rho(1;\phi)$ is the level of asset of an agent indifferent between formalizing and not formalizing when everyone else has formalized. There is incomplete formalization when informal methods of production coexist with formal methods. $\Psi\left[\rho(1;\phi)\right]$ measures the total number of agents for which it is not optimal to formalize, whatever the choice of other agents. Were condition (8) also necessary for the existence of an equilibrium with incomplete formalization, clearly, complete formalization ($\alpha = 1$) would have been a unique equilibrium in economies with initial conditions summarized by $\Psi\left[\rho(1;\phi)\right] = 0$, and legislation against informalization would be redondant. However, as shown in the following proposition, condition (8) is only sufficient.

Proposition 2 *Complete informalization ($\alpha = 0$) is always a FEE, while complete formalization ($\alpha = 1$) is a FEE if and only if:*

$$\Psi\left[\rho(1,\phi)\right] = 0. \tag{9}$$

Proof. To prove the first claim, suppose that all agents expect nobody to formalize in the second period, i.e., $\alpha^e = 0$. In equilibrium, these expectations will materialize if and only if, for all θ, $\mu(0,\phi,\theta) < 0$, which is true by construction. The proof of the second claim follows from (7). ■

In the equilibrium with complete informalization, the status quo prevails and only the cottage-industry technology is operated. In contrast, in the complete formalization equilibrium, the economy switches from low- to high-productivity technologies. This switch is made possible by the provision of a shared infrastructure, which creates a productivity premium for formalization.

Note that while the existence of a FEE with complete informalization ($\alpha = 0$) is independent of the economy's initial conditions, that of a FEE with complete formalization ($\alpha = 1$), in contrast, depends crucially on these conditions. In fact, the existence of an equilibrium with complete informalization is purely driven by expectations, while the existence of a FEE with complete formalization is driven jointly by expectations and initial conditions. Figure 1 illustrates the effect initial conditions have on the structure of equilibria. The 45^0-line is the locus of all points such that $\alpha = 1 - \Psi[\rho(\alpha; \phi)]$. The dotted curve displays equilibria when condition (9) is violated (i.e., $\Psi[\rho(1, \phi)] > 0$). In that case, a FEE with complete formalization does not exist. The solid curve displays equilibria when condition (9) is satisfied. In that case, the FEE with complete formalization and the one with complete informalization both exist. Since from (5), $\mu_\alpha > 0$, it can be shown that the equilibrium with $\alpha = 1$ Pareto-dominates the equilibrium with $\alpha = 0$.

According to proposition 2, therefore, one of the main implications for development policy of incorporating circularities in the economic system is that the strategic complementarities that they entail combine with initial conditions to explain cross-country differences in the overall performance of the production system. In a country in which everyone can afford to formalize ($\Psi[\rho(1, \phi)] = 0$), there is a role for the enforcement of a ban against informal activities. This ban will help coordinate decisions towards the Pareto-superior equilibrium where high-productivity technologies are adopted. As long as there exists a FEE with complete formalization which Pareto-dominates other equilibria, informalization of production is likely to disappear if expectations are properly coordinated. In contrast, in an economy in which a positive segment, $\Psi[\rho(1; \phi)]$, of the population cannot afford to formalize, the formal-informal dualism in the organization of production is inevitable, as complete formalization is not a FEE, so that there is no coordination mechanism to seek.

In fact, condition (9) is more likely to be violated in poor countries than in rich countries. Take two countries with asset distributions identical in all respects but their mean. In the first country, condition (9) is satisfied, while in the second, it is not. Then, necessarily the second country is the one with lowest mean asset. Of course, two countries with identical *per capita* asset levels may find themselves with asymmetries in their menus of equilibria. Then it must be that the one for which full formalization is not an equilibrium is more unequal than the other. The asset distribution is in fact a fundamental source of symmetry-breaking, whether by its first or its second moment. In absence of a massive inflow of assets from abroad, the second moment is a good target for a correcting policy. If we are concerned with

differences in physical capital, redistribution is one such policy. If it is rather the distribution of human capital that is problematic, then subsidized education may provide an adequate policy instrument.

Consider the following example: in countries where education resources are unequally distributed across individuals, with a small minority being well educated while the large majority is uneducated, condition (9) is likely to be violated. In African countries, particularly resource-based African countries, ethnic divisions diverge resources away from the education and health needs of the majority of the population (Easterly, 2000), thus making informal, low-productivity activities more attractive to this majority. A policy that would help achieve complete formalization may be one that first corrects history by altering the distribution of productive assets (improving access to quality education, is an example). Once history is corrected so that an equilibrium with complete formalization exists, enforcement of a ban against informal activities can be Pareto-improving. This, of course, is easier said than done. The correcting policy may not itself be Pareto-improving. Agents in the upper tail of the asset distribution may prefer the status quo to a combination of the correcting policy and the subsequent move towards full formalization. If ethnic divisions are the key determinant of the asset distribution, correcting policies are likely doomed to upset.

Another history-correcting policy that has been advocated in the literature is a reduction in the tax burden ϕ, which would enable all agents to formalize. We explore this idea next.

Effects of an exogenous reduction in the lump sum tax

Fortin et al. (1997), and Ihrig and Moe (2000) address the issue of the tax burden as a possible impediment to formalization. They find a positive correlation between the tax rate and the size of the informal sector. In both these models, since the tax rate does not feed back into the production system, the possibility of circularity that we explore is abstracted away. Incorporating this circularity and the strategic complementarities it generates, raises the issue of whether the tax burden could be that easily manipulated by policy makers seeking to eliminate informalization. We address this issue in the context where all the tax proceeds feed back into the production.[3] Specifically, when the lump sum tax financing the provision of the public infrastructure is fixed at ϕ, and $\Psi\left[\rho\left(1;\phi\right)\right] > 0$, we ask whether one can always find a smaller tax burden $\phi' < \phi$ such that $\Psi\left[\rho\left(1;\phi'\right)\right] = 0$. A necessary condition for

[3]Clearly, not all tax revenues collected from the formal sector feed back into production. A fraction of them is often consumed by the government, and yet another fraction may be allocated to uses that do not directly benefit the tax-payer. For example a tax on firm profit may be used in a way that does not directly benefit the firm which pays it. Therefore a more realistic approach will be to divide the tax revenue in two parts: one part that is allocated away from the production system, and another that feeds back into it. By focusing on the case where the fraction of tax revenue that feeds back into the production system equals one, we only seek to highlight the possibility that reducing the tax burden altogether may be counter productive.

an exogenous reduction in the per capita lump sum tax to generate a FEE with complete formalization is that:

$$\Psi'\left[\rho(\alpha,\phi)\right]\frac{\partial\rho(\alpha,\phi)}{\partial\phi}>0, \tag{10}$$

for all α. Since $\Psi'>0$ by assumption, the above necessary condition reduces to $\partial\rho(\alpha,\phi)/\partial\phi>0$. The latter condition states that the level of asset of an agent indifferent between formalizing and not formalizing, given α, declines with a reduction in the formalization cost (i.e., the lump sum tax, ϕ). We ask whether condition (10) can be satisfied. We begin our inquiry with the following lemma.

Lemma 2 *Let condition (4) hold. If, in addition,*

$$u''\left[f(X,\theta)\right]\left(f_X\right)^2+u'\left[f(X,\theta)\right]f_{XX}<u''\left[g(X,\theta)\right]\left(g_X\right)^2+u'\left[g(X,\theta)\right]g_{XX}, \tag{11}$$

Then, there exists a threshold tax level, $\phi(\alpha)$, such that $\mu_\phi>0$ if $\phi<\phi(\alpha)$ and $\mu_\phi\leq 0$ if $\phi\geq\phi(\alpha)$ (with equality only if $\phi=\phi(\alpha)$).

Proof. Taking the partial derivative with respect to ϕ of the net value from formalizing yields:

$$\mu_\phi=\beta\left(u'\left[f(X,\theta)\right]f_X-u'\left[g(X,\theta)\right]g_X\right)-u'\left[\theta-\phi\right]. \tag{12}$$

Under condition (4), it is clear that the first term on the right-hand-side of (12) is positive, while the second term is negative. The threshold lump sum tax level $\phi(\alpha)$ is therefore solution to $\mu_\phi=0$. By condition (11), the function $\eta(\phi)=\beta\left(u'\left[f(X,\theta)\right]f_X-u'\left[g(X,\theta)\right]g_X\right)$ is a decreasing function of ϕ. Hence the result. ■

Condition (11) is a purely technical condition. For an appropriate choice of functional forms for u, f, and g, this condition can easily obtain. $\mu_\phi>0$ implies that raising the level of the lump sum tax financing public infrastructure increases the net value from formalizing the organization of production, whereas $\mu_\phi<0$ means the reverse. Therefore, as long as $\phi<\phi(\alpha)$, reducing ϕ will cause the net value from formalizing to decline, for all θ. The opposite will occur if $\phi>\phi(\alpha)$. Figure 2 illustrates the trade-off between the future marginal gain from higher quality infrastructures and the current marginal loss from a higher tax rate.

Proposition 3 *Let conditions (4), (6) and (11) hold. Suppose $\alpha=1$. Then $\partial\rho(\alpha,\phi)/\partial\phi<0$ if $\phi<\phi(\alpha)$ and $\partial\rho(\alpha,\phi)/\partial\phi\geq 0$ if $\phi\geq\phi(\alpha)$ (with equality only if $\phi=\phi(\alpha)$).*

Proof. Recall the expression $\mu\left[\alpha,\phi,\rho\left(\alpha;\phi\right)\right]\equiv 0$ for all $\alpha\in\Gamma_\phi$. Taking the partial derivative of μ with respect to ϕ, rearranging terms yields

$$\frac{\partial\rho(\alpha,\phi)}{\partial\phi}=-\frac{\mu_\phi}{\mu_\theta},$$

where $\mu_\phi = \mu_\phi[\alpha, \phi, \rho(\alpha;\phi)]$ and $\mu_\theta = \mu_\theta[\alpha, \phi, \rho(\alpha;\phi)]$. Observe that $\mu_\theta > 0$ by condition (6). The result follows from Lemma 2, for μ evaluated at $\rho(\alpha, \phi)$. ■

Proposition 3 states that depending on whether the initial level of the lump sum tax, ϕ, is above or below a specific threshold, a marginal reduction in the level of this lump sum tax may or may not cause a decline in the level of asset required in order for an agent to be indifferent between formalizing and not formalizing. Since the threshold $\phi(\alpha)$ is endogenous, there is no *a priori* reason to expect that the condition $\phi > \phi(\alpha)$ required for a reduction in the lump sum tax level to boost formalization will be met. Therefore, reducing the tax burden can be counter-productive, contrary to what is predicted from history-dependent models (e.g. Fortin et al., 1997 and Ihrig and Moe, 2000). This is due to the circularity between the quality of infrastructure and the size of the formal sector. An exogenous reduction in the level of the lump sum tax can in fact preclude the existence of a FEE with complete formalization.

5 Discussion and conclusion

We have worked throughout under the assumption of no-enforcement, therefore focusing on self-enforcing equilibria. We believe this assumption is not unreasonable when it comes to poor countries. In fact, where 60% of the labor force belongs to the informal sector, banning informality is a challenge to which few governments, even the most authoritarian of them, would survive. Monetary sanctions are limited by the ability of the poor to pay them, whereas jail terms are limited by the capacity of prisons, which, one can bet, does not include 60% of the labor force. Remaining sanctions, such as corporate punishments, are hardly feasible considering again the number of those to be so punished.

In richer countries, in which everyone can afford to go formal, once we abstract from moral hazard issues as we do in this paper, enforcement does not pose much difficulty. Our results, however, show that bans in that case are in effect self-enforcing. The role of the ban, when it is imposed, is that of a signal. In the set of all equilibria available to the rich country, the ban points to the relevant focal point. Of course, moral hazard problems and congestion considerations may somewhat temper this result and explain the survival of a small informal sector in rich countries.

What this paper has achieved is a "big push" theory based on a move towards formalization in a model in which differences in the behaviors of countries' arise endogenously. The "big push," or the absence of it, is not due to expectations only, but depends on the existence or not of an equilibrium towards which to "push." Industrialized countries are not smarter than developing countries, they may simply have a wider set of equilibria. Why this is so may come from differences in ethnic polarization and its resulting inequality of productive assets. Widening the set of equilibria requires policy intervention.

We highlight redistribution or subsidized education as two possible, yet not always Pareto improving, solutions.

As for a reduction in the tax burden, its effects are mitigated. Given that it may have a negative impact on infrastructure quality, there exist situations in which making it cheaper to formalize makes more people go informal. Our results therefore suggest that caution is needed when using such simple-minded policy, often recommended in the literature as the solution to informalization.

All these results were obtained in a heterogeneous-agent model. In this model, the returns from going formal depend on the agents' endowment of productive asset, but also on the number of people who formalize. Hence agents play a coordination game, with the possibility of multiple equilibria. Only for some countries, most likely rich countries, however, does our model generate an equilibrium with full formalization and high-productivity technologies. In fact, in equilibrium, countries differ not because of an inability to coordinate to the same equilibrium, but rather because of the availability of equilibria on which to coordinate.

In the history versus expectations debate, our model gives an important role both to expectations and to history. History determines the wealth distribution of countries. The wealth distribution determines the number of equilibria available, and expectations do the rest, that is the selection of equilibria.

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Figure 1:

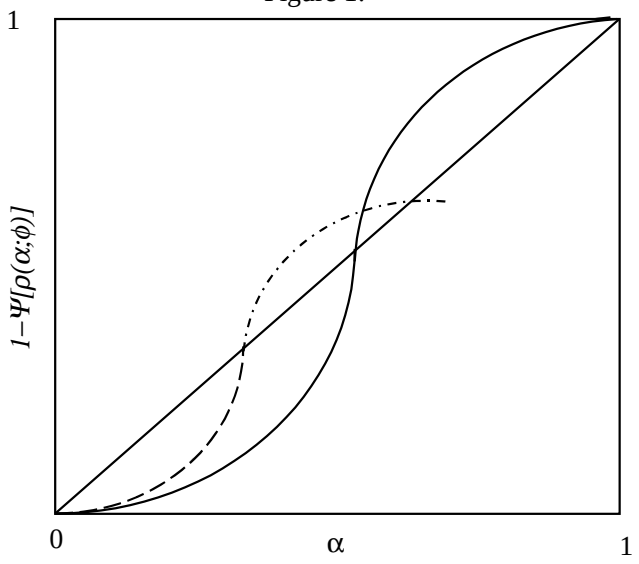

Figure 2: