Perceptions on Governance Effectiveness and Informality: A Self-fulfilling Equilibrium

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ABSTRACT

Motivated by empirical evidence suggesting a close link between weak institutional quality and informality, this paper proposes a game-theoretical model that explores how perceived governance effectiveness in public service provision determines a firm's decision to be formal or informal under incomplete information with regard to other firms' perceptions. By deploying a "global games" approach, the model characterises the size of informality as a unique self-fulfilling equilibrium outcome, which increases as governance effectiveness declines. The results indicate that, for a range of governance effectiveness level, informality arises inefficiently as a result of a coordination failure; that the effect of tax increase on the size of informality exhibits a U-shaped relationship, low and high tax rates being associated with a greater size of informality; and that the optimal fiscal policy maximising the *ex ante* welfare of the representative firm results with excessive taxation.

Keywords: Informal sector; institutional quality; global games.

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1 Introduction

Defined as a set of economic activities that take place outside the framework of bureaucratic establishments (aside from crime and domestic labour), the informal economy includes enterprises, workers, as well as consumers, which are all connected in a myriad ways (see, e.g., Hart, 2008; Pickhardt and Shinnick, 2008). In their case studies ranging from New York City and Madrid to Uruguay and Colombia, Portes and Haller (2005) vividly shows the ways through which informality is exhibited in both developing and developed countries. Indeed, in an attempt to quantify the extent of informality, Buehn and Schneider (2007), while acknowledging the presence of methodological problems in estimating its magnitude by virtue of the subject, computes that informality is quite widespread in developing countries (around 50 percent of their GDPs) and certainly not an insignificant matter in advanced nations (around 20 percent of their GDPs).

Informality manifests in many guises, from unregistered street vendors who sell almost anything from plastic toys to HI-FI equipment, elbow-to-elbow on busy streets, to big manufacturing industries that underreport their turnovers or, perhaps more intelligently, subcontract some of their activities to firms that are prone to employ informal labour. These all imply that informality will also have a rich array of effects on the economy and societal life (for a selection of studies, see Perry et al., 2007; World Bank, 2007; Gatti and Honorati, 2008; Pickhardt and Shinnick, 2008; Oviedo et al., 2009). Although the added entrepreneurial spirit occasionally observed in the shadow economy (as lucidly discussed in *The Other Path* by de Soto, 1989) deserves mention, informality has almost always been seen as a hampering factor in the development of economies, mainly due to the under-provisioning of publicly-provided goods (for an early contribution, see Loayza, 1997).

As is well known, the propensity of economic agents to free-ride in the provision of non-excludable and non-rivalrous goods continues to occupy a pivotal role in the field of public economics, following Samuelson's (1954) initial setting (see also Musgrave, 1987). If those involved in the informal economy cannot be excluded from using such goods–e.g. public

roads–financed by the formal economy, the standard free-riding response would be to remain informal. Although the informality born from free-riding is definitely not insignificant, the literature has generally conceived informality within the club goods framework, where non-rivalry continues to stand but exclusion is considered possible (Buchanan, 1965). Thus, formality refers to paying taxes in order to become a member of the club and access to collectively-produced non-rivalrous goods that would be expected to increase firms' profits, as in the case of law and order: formal firms would benefit from the legal system in the case of a business dispute whereas informal ones would not. Furthermore, although informal operators refrain from paying taxes, the flip side is that there usually exists an associated cost of being detected and punished accordingly. Economic agents are therefore expected to conduct a cost-and-benefit analysis before they decide where to position themselves on the formality-informality scale. Efforts to explain informality as a choice outcome for economic agents take this cost-and-benefit framework as a point of departure, as Gerxhani (2004) and Oviedo et al. (2009) discuss thoroughly in their survey studies.

More specifically, the bulk of the economic literature focuses on variations in firm-specific characteristics that act as explanatory variables in determining whether to be formal or informal. Given an economic environment characterised by issues including institutional quality, financial market development, tax burden and the extent of regulation, firms' decisions are conceived to be derived from their heterogeneities, captured by variations in, *inter alia*, technology, initial wealth and size. Attempts have almost always been made to capture the interdependencies between firm-specific variations and the parameters of the economic environment. A sampling of the extensive research in this area includes, for instance, Chong and Gradstein (2007), who proposed a formal model where a positive relationship exists between income inequality among economic agents and informality, a relationship that is amplified under weak institutional quality (as proxied by return to rent-seeking activities). Dabla-Norris et al. (2008), on the other hand, found that the heterogeneity of a firm's productivity is negatively correlated with informality; they also claim that the weaker the institutional quality (as proxied by legal enforcement), the larger the informal sector. Finally, in a recent study,

Dreher et al. (2009) captured the relationship between legal enforcement, informality and the extent of corruption, given that firms vary in earning ability.

This line of research is obviously illuminating to the extent that firm characteristics and the quality of the institutional environment can be observed via objective measures–as generally noted by existing empirical studies (see the above mentioned papers as well as other studies such as Johnson et al., 1998; Friedman et al., 2000; Torgler and Schneider, 2009). However, economic agents also have perceptions, which may very well affect their behaviour. An obvious case in this sense would be where firms vary in their perceptions of institutional quality (such as to what extent regulations are enforced and how effectively taxes are used). Since perceptions are formed through a set of signals and experiences (viz. past performance of the government, the media and assessments by other entrepreneurs [Oviedo et al., 2009]) that are likely idiosyncratic, they are subjective and thus not observable. In settings where perceptions do matter, this unobservability could create a strategic uncertainty in the sense that a firm's behaviour would depend not only on the perceptions of that firm, but on those of others as well. How, then, might perceptions, which have so far remained unexplored in the literature, be incorporated into a formal model that aims to explain informality?

Motivated by such concerns, this paper provides a game-theoretical model that captures the relationship between how firms perceive effective governance (the efficient use of tax revenues) and their decision to be formal or informal under incomplete information. The model therefore takes into account firms' perceptions of how effective the state is in making use of collected taxes, as well as their beliefs about the perceptions of other players. In order to highlight the effect of perceptions on the choice of informality, it is assumed that firms are *ex ante* identical. Formality is conceived here as a club good, providing exclusive benefits to its members in return for tax payments. Informality, on the other hand, does not involve tax payments, but disallows its members to benefit from public services and carries the risk of being detected and held liable to a fine. Furthermore, club goods are viewed as requiring a minimum amount of tax revenue to cover their fixed costs. Firms' actions thus exhibit strategic complementarities in the sense that their incentive to operate formally grows as the

number of firms choosing to be formal increases. When the state of fundamental, i.e. the level of governance effectiveness, is common knowledge among firms (which is the benchmark case), the game has multiple equilibria depending on its level: in the low states of the world (viz. effectiveness is low), nobody participates in the formal sector; whereas in the high states of the world (viz. effectiveness is high), everyone does. In the intermediate values of the state of the fundamentals, there are two pure-strategy equilibria, where all firms are either formal or informal.

The novelty emerges when a small noise is introduced to governance effectiveness, i.e. when firms form their own subjective perceptions. Consequently, a unique equilibrium outcome can be identified for any realised effectiveness level. If firms doubt that public funds will be used effectively and furthermore believe that a sufficiently large number of firms think the same, they may suspect that collected taxes will not meet the threshold and hence the club good will not be provided–and therefore choose be informal. On the other hand, if they trust the government and believe that a sufficiently large number of firms do as well, they will likely think that collected taxes will warrant the provision of the club good–and choose to be formal. Thus, the unique equilibrium outcome is driven by self-fulfilling beliefs. In order to formally analyse this situation, the paper employs the "global games" technique (as first introduced by Carlsson and van Damme, 1993, and developed by Morris and Shin, 1998, 2003).

There are indeed models that capture informality as a self-fulfilling outcome (see, e.g., Johnson et al., 1998; Friedman et al., 2000; Dessy and Pallage, 2003). Yet the characterisation of these models under complete information setting is destined to provide multiple equilibria. Thus, the choice of picking one among many turns out to be based on an *ad-hoc* criterion. In our model, however, the level of incomplete information on governance effectiveness, together with an appropriate tool to analyse such cases (global games), enables us to determine the informality size as a unique equilibrium outcome, which may be seen as another contribution of the paper.

The paper is structured as follows: the benchmark model is established in Section 2; incomplete information is introduced in Section 3; a comparative statics analysis is performed

on the *ex ante* size of informality by altering the tax rate in Section 4; the optimal fiscal policy is investigated in Section 5; Section 6 presents extensions; and finally Section 7 concludes the paper.

2 The benchmark model

2.1 The environment and entry to club (formal sector) game

There are a continuum of firms with a unit mass, indexed by $i \in [0, 1]$. Firms are identical, and each is endowed with a technology that generates a profit $\pi > 0$. Each firm chooses an action, $a_i \in \{0, 1\}$, where 0 and 1 indicate participation in the informal and the formal sector, respectively. The fraction of firms who choose to participate in the formal sector is denoted by $F = \int_0^1 a_i di$.

Those who choose to participate in the formal sector pay a per-head tax $t > 0$ and benefit from the public service if provided. The total tax collected is therefore $T = tF$.

The public service considered is a club good, which excludes non-payers. We assume that it increases the productivity of firms that are in the club, has a fixed cost $C > 0$, and is financed by collected taxes. We hereby consider services that likely require significant fixed costs, such as law-and-order and access to publicly-provided R&D. Should tax revenues cover its fixed cost, then the public service is provided; otherwise, the tax revenue is burned. We assume that $t \geq C$, so if a sufficiently large number of firms paid taxes, the public service would be provided.

The quality of the public service provided depends on effective governance. The type of the government is characterised by a state of fundamentals θ, which is an index of effective governance, a number in $[0, 1]$. Let $q(\theta)$ denote the quality of the public service, where $q(\cdot)$ is a strictly increasing function of θ. At the outset, we assume that $q(\theta) = \gamma\theta$, where $\gamma > 0$ is the marginal return from public service.

If provided, firms in the formal sector would benefit from the public service in terms of increased productivity, which depends on its quality. Thus, the payoff of a formal firm is

$[1+\gamma\theta]\pi - t$. The firm would not enjoy a boost in productivity only when the level of trust is at its lowest level. And finally, if the public service was not provided, then the payoff of the firm in the formal sector became $\pi - t$. We assume that $t < \pi$.

Firms that choose not to participate in the formal sector, on the other hand, pay no taxes but are unable to benefit from the public service because of its club good nature. In addition, the government audits firms randomly, and if a firm is caught then the government captures its profit as a fine. Let $k(\theta)$ denote the probability of being caught and penalized, with the assumption the more the effective the government is the higher the success rate of the audit would be. We posit that $k(\theta) = \theta$. Thus, the expected payoff of a firm operating in the informal sector is $[1-\theta]\pi$. We further assume that the expected fine, $\theta\pi$, will just cover the auditing expense of the government, and thus may be seen as a deadweight loss.

Summarizing the above discussion, the payoff of a firm is

$$u_i(a_i, F, \theta) = a_i[(1 + \mathbb{1}(C \leq tF)\gamma)\theta\pi - t] + (1-\theta)\pi, \tag{1}$$

where $\mathbb{1}$ is an indicator function.

In this economy, the action of firms, a_i, and the proportion of the population that chooses the formal sector, F, are strategic complements. The more people in the formal sector, the more likely that the public service will be provided, and therefore the more likely that any firm's best action would be to participate in the formal sector.

2.2 Entry decision of the firms

When the governance effectiveness is very low, the quality of public service (if provided) and the probability of getting caught in the informal sector will also be very low. Even if all firms were in the formal sector (thus the public service was provided), the best response of a firm would be to stay informal regardless of its belief about what others will do. Denote $\underline{\theta}(t) \equiv t/\pi(1+\gamma)$ as the value of θ at which a firm is indifferent to being formal or informal when the public service is provided. Define $[0, \underline{\theta}(t))$ as the lower dominance region.

When the governance effectiveness is very high, on the other hand, the probability of being caught is so high that, even if there are no firms in the formal sector (thus the public service is not provided), the best response of a firm would be to stay formal. Denote $\overline{\theta}(t) \equiv t/\pi$ as the value of θ at which the firm is indifferent to being formal or informal when the public service is not provided. Define the region $(\bar{\theta}(t), 1]$ as the upper dominance region.[2]

Observing that for all t, $\underline{\theta}(t) < \overline{\theta}(t)$, the space of fundamentals are partitioned into three categories. When θ is in the lower dominance region, every firm would choose the informal sector, irrespective of the proportion of other firms in the informal sector. When θ is in the upper dominance region, firms would prefer being in the formal sector, irrespective of the proportion of firms in the formal sector. When $\underline{\theta}(t) \leq \theta \leq \overline{\theta}(t)$, a firm's decision to participate in the formal sector would depend on the proportion of firms in the formal sector. There are multiple equilibria in this region due to the self-fulfilling nature of the beliefs. For a given level of θ, if everyone believes that the public service will be provided, then everyone will participate and the public service will indeed be provided and everyone's belief will therefore be fulfilled in the equilibrium. If, on the other hand, firms believe an insufficient number of players will be in the formal sector and the public service will thus not be provided, then they will choose to stay out of the formal sector and again their beliefs will be fulfilled in the equilibrium.

The game among firms when θ is in the intermediate region is a coordination game with two pure strategy equilibria, one of which is Pareto superior. As stated in the Introduction section, earlier literature studying informality addressed the self-fulfilling nature of informality and discussed the two equilibria that may arise, failing to come up with a satisfactory equilibrium selection criterion other than relying on an *ad hoc* selection of one of the equilibria based on initial conditions. However, as discussed by Morris and Shin (2003), this multiplicity of equilibria can be an artifact of a common knowledge assumption on the fundamentals. In the following section, as we drop the common knowledge assumption and introduce a small amount of uncertainty concerning the governance effectiveness in the model, we show that

[2]Under the assumption that $C \leq t < \pi$ there will be non-trivial upper and lower dominance regions.

each state of fundamentals will give rise to a unique equilibrium outcome.

3 Firms with private signals

We hereby assume that firms do not observe the true value of the governance effectiveness θ. Firms have common prior for θ and believe that it is drawn from a uniform distribution over $[0, 1]$.

When the true state is θ, firm i receives a signal $x_i = \theta + \epsilon_i$, where ϵ_i is independently and uniformly distributed over $[-\epsilon, \epsilon]$. The signal can be thought of as the firm's private opinion regarding the governance effectiveness. Based on the signal observed, the firm decides whether to participate in the formal or informal sector.

There are two roles attributed to private signals. First, they provide information on the governance effectiveness, hence on the expected quality of the public service and the effectiveness of auditing activity. The lower the signal, the lower the expected quality of the public service and the probability of getting caught and thus the higher the incentive to choose the informal sector. Second, they give information on other firms' signals, which helps a firm infer what others will do. A firm that has a low opinion regarding the governance effectiveness will believe others also think the government is not trustworthy and that the public service is less likely to be provided–hence it will probably choose to be informal.

Once firms have decided to enter either the formal or the informal sector, the government observes the realized proportion of firms in the formal sector. If $tF \geq C$, then the the public service will be provided at the quality level $\gamma\theta$. The sequencing of when the government observes the true θ–be at the beginning of the game or following the firms' entry decision– has no importance at all for our analysis, for it cannot be used instrumentally, since the government has no active role in our model.

The payoffs of the game are as described in Section 2. We characterize the Bayesian Nash equilibrium of the game among the firms. As in the complete information model, there are ranges of good and bad fundamentals, at which a firm's best response is independent of its

beliefs about the actions of other. Recall that $\underline{\theta}(t)$ is the lowest value of θ below which the firm will choose to be informal. As the difference between the firm's signal and the true θ is at most ϵ, a firm will choose to be informal whenever it observes a signal $x_i < \underline{\theta}(t) - \epsilon$. As t increases, the threshold $\underline{\theta}(t)$ increases also. Since $t \geq C$, when $\underline{\theta}(C) > 2\epsilon$, there will be feasible values of θ for which all firms receive signals that lead them to believe that θ is in the lower dominance region, for any $t \geq C$.[3] Similarly, if a firm receives a signal $x_i > \bar{\theta}(t) + \epsilon$, it will choose to be formal. Since $\bar{\theta}(\pi) = 1$, there exists an ϵ for every $t < \pi$ such that $\bar{\theta}(t) < 1 - 2\epsilon$, and there will be feasible values of θ for which all firms receive signals that lead them to believe that θ is in the upper dominance region.

As discussed in global games theory (Morris and Shin, 2003), the game has a unique equilibrium outcome.[4] In this equilibrium, strategies are cut-off rules.

Proposition 1. *There is a unique equilibrium in which firms choose to be informal if they observe a signal below the threshold*

$$\theta^*(t) \equiv \frac{t}{\pi[\gamma(1 - \frac{C}{t}) + 1]} \tag{2}$$

and be formal above.

The equilibrium behaviour of firms is standard in global games. We provide the intuition of the Proposition 1 here, referring the reader to Morris and Shin (2003) for a formal treatment.

Suppose all firms follow the above threshold strategy. Now consider a marginal firm that receives the signal $\theta^*(t)$. What are its beliefs about the proportion of firms which are formal? In the unique equilibrium, this will be equal to its beliefs about the proportion of firms which have observed signals above $\theta^*(t)$. Thus, given the threshold strategy of firms, the proportion

[3]While conducting our analysis we focus on the case when the noise in the signal approaches to zero; thus, it is sufficient to assume $\frac{C}{(1+\gamma)\pi} > 0$.

[4]Global games have been used to model speculative attacks in currency markets (Morris and Shin 1998, Guimaraes and Morris, 2007), debt crisis (Morris and Shin, 2004), bank runs (Goldstein and Pauzner, 2005), and regime changes (Edmond, 2008).

of firms that choose to be formal is the proportion that observes a signal above $\theta^*(t) + \epsilon$. Because θ is uniformly distributed, the firm will have a uniform belief on those firms choosing to be formal.

Now if the noise is small, the behaviour of the marginal firm will be close to that of a firm who knows θ and has a belief over its uniform distribution. The public service will be provided if the proportion of firms that are formal is at least C/t. Thus, the expected return of being formal is

$$\int_0^{C/t} (\pi - t) dF + \int_{C/t}^1 \left[(1 + \gamma\theta)\pi - t\right] dF. \tag{3}$$

The return of being informal, regardless of whether the public service is provided or not, is

$$\int_0^1 [1 - \theta]\pi dF. \tag{4}$$

The marginal firm that observes $\theta^*(t)$ will be indifferent to being formal and informal when the expected return of being formal equals the expected return of being informal. Thus, the threshold $\theta^*(t)$ solves

$$\theta \left[1 + \gamma \left(1 - \frac{C}{t}\right)\right] = \frac{t}{\pi}. \tag{5}$$

The left-hand side of the equation is the expected marginal benefit from being in the formal sector (through increased quality), where $1 - \frac{C}{t}$ is the probability that the public service will be provided. The right-hand side is the marginal cost of being in the formal sector.

From Proposition 1 we can calculate, at every realisation of governance effectiveness θ, the proportion of firms who are formal.[5] Let $F(\theta, \theta^*(t))$ be a function that specifies the proportion of firms who are formal when the governance effectiveness is θ and all firms follow the threshold strategy given in Proposition 1. Then, in equilibrium, the proportion of firms who are formal is given by $F(\theta, \theta^*(t)) = prob(\theta \geq \theta^*(t) + \epsilon)$. All firms are formal if true θ is greater

[5]The following line of argumentation follows Goldstein and Pauzner (2005).

than $\theta^*(t)+\epsilon$, since all firms will receive signals above $\theta^*(t)$. All firms are informal if true θ is less than $\theta^*(t)-\epsilon$, since all firms will receive signals below $\theta^*(t)$. Finally, $F(\theta, \theta^*(t))$ increases linearly between $\theta^*(t)-\epsilon$ and $\theta^*(t)+\epsilon$ as both θ and ϵ are uniformly distributed. Thus we have:

Corollary 1. *Given t, the proportion of firms in the formal sector depends only on the fundamentals and is given by*

$$F(\theta, \theta^*(t)) = \begin{cases} 0 & \text{if} \quad \theta \leq \theta^*(t) - \epsilon \\ \frac{1}{2} + \frac{\theta - \theta^*(t)}{2\epsilon} & \text{if} \quad \theta^*(t) - \epsilon \leq \theta \leq \theta^*(t) + \epsilon \\ 1 & \text{if} \quad \theta \geq \theta^*(t) + \epsilon. \end{cases} \tag{6}$$

Note that the proportion of the population who is in the formal sector is an increasing function of true θ. As $\theta^*(t) \in (\underline{\theta}(t), \bar{\theta}(t))$, there are regions of fundamentals where being informal is not a dominant strategy, yet firms choose to be informal. This outcome is entirely driven by low expectations, corresponding to a coordination failure.

After setting out the model, we now turn our attention to the effect of tax on the size of informality, as being the only policy tool in our model.

4 The effect of tax on the size of informality

Corollary 1 presented the *ex ante* size of informality in this economy. Now, we analyze the effect of tax on the size of informality.

First, differentiating $\theta^*(t)$ we obtain

$$\frac{d\theta^*}{dt} = \frac{\gamma(1 - \frac{2C}{t}) + 1}{\pi \left[\gamma(1 - \frac{C}{t}) + 1)\right]^2}. \tag{7}$$

Increasing tax, t, has two effects on the threshold signal. First, it increases the cost of entry to the club. Second, it reduces the threshold rate of formal firms required to warrant the provision of the club good, thus increasing the probability that the club good will be pro-

vided. If $\gamma \leq 1$, the numerator in expression (7) is positive since we assumed that $C \leq t$. Therefore, $d\theta^*/dt$ is always positive. The increase in the marginal expected benefit of being formal (rather than informal) via the increased probability of club good's being provided does not compensate for the net cost of being formal. Therefore, higher tax requires higher θ to make a firm indifferent to being formal or informal. On the other hand, when $\gamma > 1$, the net balance of both effects is not monotone. For $t < \hat{t}$, the threshold θ is decreasing in t, and for $t > \hat{t}$, it is increasing, where $\hat{t} \equiv \frac{2\gamma C}{1+\gamma}$. Note that $\hat{t} \in (C, \pi)$, if the cost of public service is not too large (precisely if $C < \left(\frac{1+\gamma}{2\gamma}\right)\pi$). Thus, we have the following proposition.

Proposition 2. *When $\gamma \leq 1$, the higher the taxes, the higher the size of informality. When $\gamma > 1$, the size of informality first decreases then increases in t.*

Observe that for the case of $\gamma > 1$, when the tax is set very low, firms would refrain from joining the formal sector for fear that the collected amount will be insufficient to finance the public service; whereas when the tax is set very high, firms would again keep out of the formal sector, this time thinking that the cost of entering it will not justify benefits from the public service–a Laffer curve effect.

For the rest of the analysis, where we will be discussing the optimal fiscal policy, we will focus on the more interesting case of $\gamma > 1$.

5 Optimal fiscal policy

We characterize the optimal fiscal policy of a benevolent government and ascribe to her the objective of maximizing the expected welfare of the firms.[6] When there is complete information and firms coordinate on the Pareto superior equilibrium outcome, which is everyone

[6]In our basic model, the government announces fiscal policy *ex ante* and commits to it. It could be argued that the government knows its true type when it decides on the optimal fiscal policy. However, if this is the case, then rational players should take into account the informational content of the announced fiscal policy in forming their best response. See Angeletos et al. (2006) for signaling in global games.

formal, the *ex ante* expected welfare of a representative firm is

$$W(t;\underline{\theta}(t)) = \int_0^{\underline{\theta}(t)} [1-\theta]\,\pi d\theta + \int_{\underline{\theta}(t)}^1 [(1+\gamma\theta)\pi - t] d\theta. \tag{8}$$

The *ex ante* welfare depends on all realisations of θ. When $\theta \leq \underline{\theta}(t)$, the firm is informal and receives $[1-\theta]\,\pi$. When $\theta \geq \underline{\theta}(t)$, the firm is formal and receives $[(1+\gamma\theta)\pi - t]$. Recalling that $\underline{\theta}(t)$ is increasing in t, maximizing the expected welfare subject to the budget constraint yields the first best tax rate $t^{FB} = C$.

When there is incomplete information, for a given tax rate t, the *ex ante* expected welfare of the representative firm is

$$W(t;\theta^*(t)) = \int_0^{\theta^*(t)} [1-\theta]\,\pi d\theta + \int_{\theta^*(t)}^1 [(1+\gamma\theta)\pi - t] d\theta. \tag{9}$$

Similiar to the above case, the *ex ante* welfare depends on all realisations of θ. When $\theta \leq \theta^*(t)$, the firm is informal and it receives $[1-\theta]\,\pi$. When $\theta \geq \theta^*(t)$, the firm is formal and it receives $[(1+\gamma\theta)\pi - t]$.

Proposition 3. *The welfare maximizing tax is t^*, where $C < t^* < \hat{t}$.*

Proof. The *ex ante* welfare is rewritten as

$$W(t;\theta^*(t)) = \pi - t[1-\theta^*(t)] - \frac{\pi}{2}[\theta^*(t)]^2 + \frac{\gamma\pi}{2}(1-[\theta^*(t)]^2). \tag{10}$$

The expected welfare of the representative firm is made up of profits, minus the expected tax payment, minus the expected fine paid if the firm is informal, plus the expected gain from public service if the firm is formal.

Taking the derivative of (10) with respect to t, we obtain

$$\frac{dW(t;\theta^*(t))}{dt} = -\left[1-\theta^*(t)\right] - \pi\left[(1+\gamma)\theta^*(t) - \frac{t}{\pi}\right]\frac{d\theta^*(t)}{dt}. \tag{11}$$

The second term in brackets is always positive because of equation (5). When $t \geq \hat{t}$, $\theta^*(t)$ is non-decreasing in t. Thus, for $t \geq \hat{t}$ we have $dW(t;\theta^*(t))/dt \leq 0$. For $t < \hat{t}$, $\theta^*(t)$ is decreasing in t. At $t = C$, $dW(t;\theta^*(t))/dt > 0$ if $C(1-\gamma+\gamma^2) > \pi$ and at $t = \hat{t}$, $dW(t;\theta^*(t))/dt < 0$.[7] Furthermore, the second order derivative of $W(t)$ with respect to t is

$$\frac{d^2W(t;\theta^*(t))}{dt^2} = \frac{d\theta^*(t)}{dt} - \pi\left\{\left[(1+\gamma)\theta^*(t) - \frac{t}{\pi}\right]\frac{d^2\theta^*(t)}{dt^2} + \left[(1+\gamma)\frac{d\theta^*(t)}{dt} - \frac{1}{\pi}\right]\frac{d\theta^*(t)}{dt}\right\}. \quad (12)$$

Next, we show that $\theta^*(t)$ is convex in t. Differentiating equation (7) with respect to t, we get

$$\frac{d^2\theta^*}{dt^2} = \frac{2C^2\gamma^2}{t^3\pi\left[\gamma(1-\frac{C}{t})+1)\right]^3}, \quad (13)$$

which is always positive–thus, $\theta^*(t)$ is convex in t.

Therefore, the second order derivative of $W(t;\theta^*(t))$ with respect to t is negative when $t < \hat{t}$. Hence, $W(t;\theta^*(t))$ is concave in $t \in [C,\hat{t}]$, implying that there exists $t^* \in (C,\hat{t})$ such that, for $t < t^*$, welfare decreases in t, and for $t > t^*$, welfare increases in t. Q.E.D.

Note that under incomplete information, there is excessive taxation, $t^* > C$. Taking the model presented here as a base one, we can make extensions to incorporate various additional dimensions that have so far not been considered. Thus in the next section, we explore two paths to extend our model. The first considers a case where, in addition to a club good, a public one is also provided through the taxes collected. The second presents an environment where firms are assumed to be heterogeneous with respect to size.

[7] Recall that when $\gamma > 1$ and $C < \pi(1+\gamma)/2\gamma$, there exists $\hat{t} \in (C,\pi)$. Now we require that $C > \pi/(1-\gamma+\gamma^2)$. A simple algebra shows that the two conditions are simultaneously satisfied when $\gamma > 1$.

6 Extensions

6.1 Public good and club good

Consider a case where the government, rather than spending all taxes collected on a club good, allocates the tax revenues between the club good (which is excludable) and the public one (non-excludable).

We modify the model as follows. Let $\alpha \in [\underline{\alpha}, 1]$ be the proportion of tax revenues spent on the club good.[8] The government announces α as part of its fiscal policy and commits to it. As before, assume that C is the fixed cost of the club good. The public good has no fixed cost and its production exhibits constant returns to scale in that every dollar spent in public good returns a service of a dollar worth.

If $\alpha tF \geq C$, then the club good is provided and the rest of the budget is spent on the provision of public good. If $\alpha tF < C$, then all revenue collected is spent on the public good and no club good is provided.

Then, the payoff of a firm is

$$\begin{aligned} u_i(a_i, F, \theta) &= a_i[(1 + \mathbb{1}(C \leq \alpha tF)\gamma)\theta\pi - t] + (1-\theta)\pi \\ &+ tF - \mathbb{1}(C \leq \alpha tF)[(1-\alpha)tF + C]. \end{aligned} \tag{14}$$

The marginal firm observing $\theta^*(t)$ will be indifferent to being formal or informal when the expected returns of being formal equals the expected returns of being informal.

$$\begin{aligned} &\textstyle\int_0^{C/\alpha t}[\pi - t(1-F)]dF + \int_{C/\alpha t}^1[(1+\gamma\theta)\pi - t(1-\alpha F) - C]dF = \\ &\textstyle\int_0^{C/\alpha t}[(1-\theta)\pi + tF]dF + \int_{C/\alpha t}^1[(1-\theta)\pi + \alpha tF - C]dF. \end{aligned} \tag{15}$$

Thus, the threshold θ is

$$\theta^*(t;\alpha) \equiv \frac{t}{\pi[\gamma(1 - \frac{C}{\alpha t}) + 1]}. \tag{16}$$

[8] We rule out the case where all tax revenues are spent on public good. We also restrict the parameter space to cases where $C < \underline{\alpha} t < t < \pi$.

Observe that $\alpha = 1$ brings us back to the main model. Similar to the base model, for $\gamma > 1$, the threshold θ decreases in t for $t < \frac{2\gamma C}{\alpha(1+\gamma)}$ and then increases. As for α, the higher the α the lower the threshold θ. Thus, we have

Proposition 4. *The size of informality increases as the proportion of taxes spent on public goods increases.*

As expected, the provision of a public good suffers from the free-rider problem. When revenues are spent completely on the club good, $\alpha = 1$, the resulting inefficiency (in terms of firms coordinating on being informal even though it is not the dominant strategy) is solely due to the coordination problem. As α decreases, the government allocates part of the revenues to providing the public good and the size of informality further rises due to free-riding. Thus, the increase in the size of informality when $\alpha < 1$ when compared to $\alpha = 1$ is attributed to the free-rider problem.

6.2 Heterogeneity

In the base model, firms were assumed to be identical *ex ante*. Now, consider that there are two types of firms. Firms are endowed with technologies that generate profits $\pi_S < \pi_L$, for small- and large-sized firms, respectively. The proportion of large firms in the population is λ and the proportion of small firms is $1 - \lambda$.[9] Here we consider the case where the profit of small firms is assumed to be so low that even when the quality of the public service is at the highest level, joining the formal sector is not worthwhile, i.e. $(1 + \gamma)\pi_S < C$.[10] The rest of the model is as before.

Small firms will always choose to be informal regardless of the behaviour of larger firms, who will play the coordination game among themselves as described in the base model. A

[9]Here we assume that there is a critical mass of large-sized firms, $\bar{\lambda}$, for the problem not to be trivial, and we further assume $C < \bar{\lambda}t < t < \pi$.

[10]The case where the profits of small firms are marginally lower than those of large ones is not considered here, since it would complicate the analysis to an extent that surpasses the scope of this paper.

large firm believes that firms that choose to be formal are uniformly distributed in $[0, \lambda]$. The marginal large firm observing $\theta^*(t;\lambda)$ will be indifferent to being formal or informal when the expected returns of being formal equals the expected returns of being informal.

$$\int_0^{C/t} (\pi - t)dF + \int_{C/t}^{\lambda} [(1+\gamma\theta)\pi - t]\, dF = \int_0^{\lambda} [1-\theta]\pi dF. \tag{17}$$

Thus, the threshold $\theta^*(t;\lambda)$ solves

$$\theta\left[1+\gamma\left(1-\frac{C}{\lambda t}\right)\right] = \frac{t}{\pi}. \tag{18}$$

Observe that $\lambda = 1$ brings us back to the base model. As λ decreases, i.e. the proportion of large firms in the economy decreases, the threshold level of governance effectiveness increases, implying larger proportion of firms being informal.

Given a threshold strategy and a tax rate t, the proportion of firms being formal is

$$F(\theta, \theta^*(t;\lambda)) = \begin{cases} 0 & \text{if} \quad \theta \leq \theta^*(t;\lambda) - \epsilon \\ \lambda\left(\frac{1}{2} + \frac{\theta - \theta^*(t;\lambda)}{2\epsilon}\right) & \text{if} \quad \theta^*(t;\lambda) - \epsilon \leq \theta \leq \theta^*(t;\lambda) + \epsilon \\ \lambda & \text{if} \quad \theta \geq \theta^*(t;\lambda) + \epsilon. \end{cases} \tag{19}$$

7 Concluding Remarks

In this paper, we modelled the effect of perceptions of governance effectiveness on informality size. To this end, a strategic-form game was constructed among firms that decide to participate in either the formal or the informal sector. Members of the formal sector pay a tax to enter the club and benefit from productive public services, while others avoid taxes but also relinquish the right to benefit from increased productivity and face a fine in case they are caught.

In a game of complete information regarding governance effectiveness, which was our benchmark model, the game was found to have Pareto-rankable multiple equilibria depending

on the value of effectiveness. When firms had incomplete information on governance effectiveness, on the other hand, they formed their own perceptions. In the unique Bayesian Nash equilibrium of the game, firms follow threshold strategies and choose to be formal if a signal of effectiveness is observed above a certain threshold, and choose to be informal otherwise. However, in this unique equilibrium, they may coordinate on the risk-dominant one, an equilibrium that is not always Pareto superior. More specifically, there are levels of governance effectiveness where firms in equilibrium will choose to be informal despite the fact that being formal is the Pareto-dominant outcome for all–a consequence that emerges as a result of coordination failure.

Having pinned down the unique equilibrium of the game, we characterised the probability of a firm being informal in this economy and labelled it as the *ex ante* measure of informality. The size of the formal sector was found to increase with governance effectiveness for any given level of tax rate, a result which conforms with the empirical findings of Johnson et al. (1998), Friedman et al. (2000), Chong and Gradstein (2007), Dabla-Norris et al. (2008) and Dehrer et al. (2009).

By using the described model, we furthermore conducted comparative statics and showed, first of all, that as the tax rate (entry fee to the club) increased, informality size first declined (as in Friedman et al., 2000, and Elgin, 2010) and then increased for a given level of governance effectiveness and a sufficiently large marginal return from public service. Second, we characterised the optimal fiscal policy of a benevolent government whose objective is to maximise the *ex ante* welfare of the representative firm. We found, as expected, that when information is incomplete the optimal tax rate exceeds that compared to when information is complete.

Finally, among possible paths, we extended the model first by considering a government that allocated its revenues both on club goods and public goods, and second by incorporating heterogeneity among firms in terms of size. The former line of extension allowed us to differentiate between the effect of coordination failure and that of free-riding on informality size. The latter, on the other hand, paralleled the existing literature that grounds the coexistence

of formal and informal firms on the heterogeneity of firm characteristics and showed that at sufficiently high levels of effectiveness the economy may embody both formal and informal firms.

Overall, the paper provides a fresh perspective to the literature on informality. First, it introduces an additional dimension in shaping the size of the informal sector, that being the varying perceptions of economic agents on governance. Second, it suggests that using the strategic-form game with incomplete information–known as "global games"–best suits the problem at hand. Third, as a result, characterising the size of informality as a unique outcome of the game was made possible. Fourth, it is observed that in this setting informality may well arise inefficiently as a result of a coordination failure.

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