Tax Evasion, Tax Policies and the Role Played by Financial Markets.

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Abstract

In a dynamic general equilibrium model with credit constraints and heterogeneous firms I show that both tax policies and domestic financial market development (FD) can lead to lower informality. Tax policies are more effective in reducing informality since they directly increase the cost of informal production but they have limits, trade-offs and costly general equilibrium effects. FD lowers formal borrowing costs which increases the marginal benefit of hiring in the formal sector. Wage rate increases driving down informal production. Formal output, employment, tax revenue and welfare all increase with FD and counter or offset the negative effects of tax policies.

Journal of Economic Literature Classification: E60, H26, O11, O17.

Keywords: Informal sector, tax policies, heterogenous firms, financial frictions, volatility.

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1 Introduction

Developing and emerging market economies are characterized by large informal sectors, weak and inefficient tax administration systems and under-developed financial markets. Given this scenario, how important are tax policies vis-a-vis domestic financial market development (FD) as tools to reduce informality? I measure effectiveness not only by the reduction in informal sector size but also by the effect each policy has on formal sector output and employment, tax revenue and welfare (measured by aggregate consumption).

In their empirical work, Dabla-Norris and Gradstein (2008) find evidence that tax and regulation burden, financial market development and the quality of the legal system are important determinants of informal sector size while Dabla-Norris and Koeda (2008) find informality to be robustly and significantly associated with lower access to and use of bank credit. They also find that the negative correlation between informality and bank credit is stronger in countries with weaker tax administration.

Financial sector improvement has also been linked to increased tax revenue generation (Petrescu, 2013). We confirm this and other results using data for 15 developing countries from Latin America and Asia, chosen from the upper, middle and lower end of the informal sector size distribution in Schneider (2010). These studies along with our empirical analysis point towards a strong association of FD and tax policies with informality. Thus improving FD and tax administration should lower informal output and employment. This paper quantifies the degree of effectiveness of such policy measures. It also identifies key interactions and general equilibrium effects of these policies which limit or extend their effectiveness. These limits and trade-offs along with the general equilibrium effects shed light on the most efficient policy-mix to tackle informality.

I define the informal sector as firms that engage in complete tax evasion. In a simple dynamic general equilibrium model I assume that formal firms pay tax on their output while informal firms do not. Every period entrepreneurs can borrow against a fraction of their

declared output. This makes informal producers more borrowing constrained than their formal counterpart since they hide all their output. Two other features distinguish formal from informal firms; the latter are significantly less productive and more labor intensive. These informal sector features are in keeping with the findings in La Porta and Shleifer (2008).

Tax policies refer to the trio of a tax on formal sector output, the probability of being audited by the government and a penalty tax which is imposed on a firm that is caught hiding. I find that while tax policies significantly reduce informal sector size, they are associated with negative general equilibrium effects. A higher probability of audit (enforcement), for instance, is very effective in reducing informality, especially when it includes a penalty tax upon being caught. Informal output's share falls from close to 50% when enforcement is near zero to 9%, the level of informality observed in the US, when enforcement is high enough. However, such high enforcement is also associated with lower total employment, wages and welfare measured in terms of aggregate consumption. This is because at high levels of tax enforcement the decline in informal sector is large. It drives down informal labor demand and the competitive wage rate falls causing formal labor demand and output to increase but not enough to offset the fall in labor demand from the informal sector. Thus total employment, wages and aggregate consumption fall with stronger enforcement. Government revenue increases but at a diminishing rate.

As far as the effect of tax rate on informality is concerned, the model generates a positive relationship between the two, i.e., a higher tax rate gives rise to a larger informal sector. The result is straightforward given a higher tax on formal output directly raises the cost of formality and causes the informal sector to expand. As in Amaral and Quintin (2006) and Ihrig and Moe (2004), I assume here that tax revenues are wasted. However, similar results are obtained in the literature under different assumptions of government expenditure. For example, Loayza (1996) models the government's provision of public goods and services explicitly in an endogenous growth framework. In Prado (2011), households derive utility from

both private and public goods consumption. Both studies find informality to be increasing in the tax rate. I adhere to the assumption of wasteful government expenditure for simplicity given that an increase in the cost of formal operations seems to be the dominant effect of a rise in tax rate in an economy with informal production.

Empirically, a positive relationship between taxes and informality is reported by Frey and Pommerehne (1984), Johnson et al. (1997, 1998), Tanzi (1999), Dabla-Norris and Gradstein (2008) and Schneider et al. (2010) while Friedman et al. (2000) and more recently Aruoba (2010) find a negative correlation between the two. We test the relationship for our 15 country sample and find a positive correlation between taxes and informality (Figure 1), which confirms the model generated results. Elgin and Solis-Garcia (2014), show that a negative relationship between taxes and informality can exist in the presence of a high degree of tax enforcement. In our benchmark model the level of enforcement is close to 0, as will be discussed later, hence very low. As taxes are raised weak enforcement makes it easier for the informal sector to grow giving rise to the aforementioned positive relationship. When enforcement is raised in our model, the effect of tax on informality is considerably weakened as discussed in Section 4.3. I also find that as tax rates are progressively lowered, the decline in informality falls while the loss in tax revenue rises.

Although less effective than taxes and enforcement, FD causes a robust and monotonic decline in informal sector size and has a positive effect on all the major indicators of the benchmark economy. FD works by relaxing the borrowing constraint which reduces the formal sector's cost of borrowing and increases formal labor demand causing wages to rise. Since labor is perfectly mobile between sectors, this increases labor costs for the informal sector, reducing their labor demand and output. Thus formal output, total employment, aggregate consumption, wages and government revenue all increase with FD.

1.1 Related literature

The effect of tax policies on informality has been extensively studied in the literature. Models where the informal sector arises from incomplete enforcement of taxes or regulations include Rauch (1991), Dabla-Norris et al. (2008) and de Paula and Scheinkman (2007). Ihrig and Moe (2004) compare the effects of taxes and enforcement on the informal sector size in a dynamic partial equilibrium model where the agent has an option to be informal. Ulyssea (2010) develops a two-sector matching model that incorporates the features of Latin American labor markets and studies the effect of payroll tax, enforcement and entry costs for Brazil. He finds that while increasing enforcement is effective in reducing informal sector size it does not increase firms' or workers' welfare neither does it contribute to increasing productivity or allocative efficiency. Prado (2011) uses a general equilibrium model to quantitatively investigate the interaction between a firm's choice to be formal or informal and government policy on taxes and enforcement. His main focus is the effect of policy on the choice to be formal or informal. Ordonez (2014) provides a quantitative assessment of the effects of incomplete tax enforcement on labor productivity and output.

However, unlike the above papers my focus is on financial frictions which is a distinguishing feature of economies with large informal sectors. Specifically I exploit the idea that these frictions affect formal and informal sectors heterogeneously and study the resulting effects of tax policies and FD on informality and the aggregate economy. Models that highlight the role played by official sources of financing as one of the main costs of operating underground are Dabla-Norris and Feltenstein (2005), Amaral and Quintin (2006), Quintin (2008), de Paula and Scheinkman (2010) and D'Erasmo and Boedo (2012). These papers, however, focus on the choice to become informal or the emergence of the informal sector in the presence of financial and other costs while I take the informal sector as given. By assuming the presence of an informal sector with largely different characteristics from the formal sector, I adhere to the spirit of a dual economy model advocated by La Porta and Shleifer (2008) for developing economies.

This paper is closely related to Antunes and Cavalcanti (2007) who study the importance of regulation costs and the level of financial contract enforcement in accounting for the difference in informal sector size and per-capita income across countries. While regulation costs in their model can be likened to a tax on formal firms my measure of tax policy is much wider including the probability of audit and a penalty tax in addition to the formal sector tax rate. Moreover, borrowing constraints arise endogenously in my model as in Kiyotaki and Moore (1997, 1998) while they focus on costly contract enforcement. They find that both regulation costs and contract enforcement are equally important for informality and equally unimportant for per-capita income in developing countries. My results indicate that while tax policies are important for reducing informality, FD is unambiguously more effective for increasing formal output, total employment, tax revenue and welfare. Thus I focus on a larger number of policy tools and on a wider measure of aggregate variables to determine policy effectiveness and find that policy effectiveness varies depending on their levels and interactions with other policies.

My model is closely related to Mitra (2013) who studies the link between informality and macroeconomic volatility. However, Mitra (2013) assumes that informal sectors hide a fixed proportion of their income and are hence only partially excluded from financial markets. The proportion of hidden output is then varied exogenously to study the effect of informality. In this paper informal firms hide all of their output such that their entire production is underground and by implication they are completely excluded from formal credit markets. Thus any change in policy endogenously changes the informal sector size in my model. In this sense my model is closer to the dual economy setting advocated by La Porta and Shleifer (2008) for developing economies.

The rest of the paper is laid out as follows: Section 2 presents some empirical evidence related to taxes, FD and informality in developing economies, Section 3 describes the model environment and shows the basic mechanism that can lead to the relationships uncovered in Section 2, Section 4 discusses the equilibrium properties, calibrates and analyzes quan-

titatively the dynamic effects of FD and tax policies and Section 5 discusses various policy implications and concludes.

2 Empirical Evidence

In this section I present some evidence of the relationship between taxes, FD and the informal sector for 15 developing and emerging market economies. Informal sector output share as a percentage of GDP is obtained from Schneider (2010) while share of informal labor in total employment is obtained from the International Labor Organization (Statistical Report, 2012). According to Schneider (2010), the average informal **output** share in 88 developing countries, between 1996-2007, was 36%. Of the 88 countries, Bolivia had the highest informal output share at 67% of GDP and Singapore had the lowest at 13%. The ILO (2012) reports on average informal **employment** share for 47 developing countries and lists the average at 54%, matched by Mexico and followed closely by Zimbabwe (52%) and Egypt (51%). India tops the list with the largest informal sector employment share at 83%. The 15 countries in my sample consists of 5 countries each from the top, bottom and middle of the distribution of informal sector output share in GDP from Schneider (2010). All countries are from Latin America and Asia.

The level of FD is the domestic private credit to GDP ratio in these countries for 2012 obtained from the World Bank web site. The tax rate is the total tax that businesses were subject to as a fraction of their commercial profits between 2012-2013 obtained once again from the World Bank database. This measure is widely available across countries especially for developing and emerging economies of Latin America and Asia. Aruoba (2010) uses the income tax rate in studying the relationship between tax rate and informal sector and countries from these regions are largely absent in his 34 country sample due to non-availability of data. For this reason he also uses tax revenue as a fraction of GDP as an alternative measure of tax. I report correlations of informality with tax revenue (as a %

of GDP) as well data (for 2012) for which is also obtained from the World Bank website. We also locate the rank of each country in our sample in the *Paying Taxes* (2014) report compiled by the World Bank, IFC and PwC which looks at tax regimes in 189 countries and ranks the countries according to the ease of paying taxes for businesses for the period 2004-2012. A larger number in these tables implies a lower rank and a more complex and resource-consuming tax structure. We report correlations of informality with these ranks as well.

The following results emerge from our analysis:

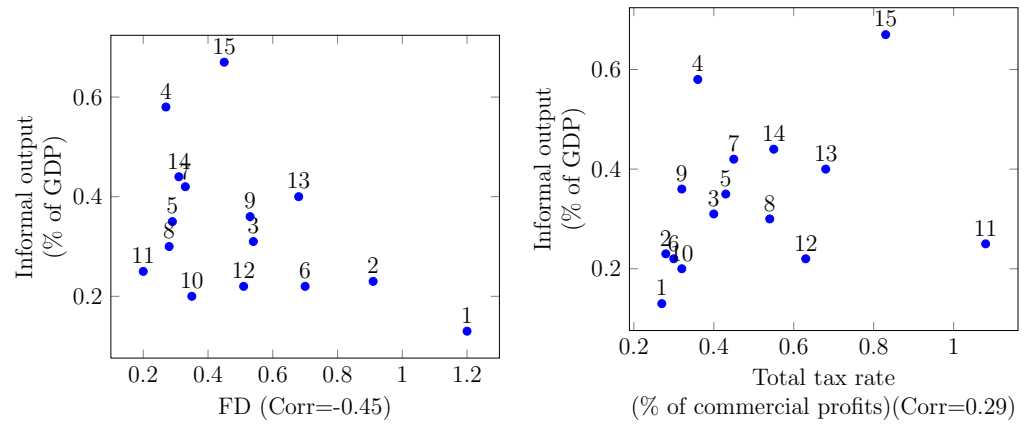
i) FD and informal sector size are negatively correlated such that an increase in FD reduces informality.

ii) Tax rate and informality are positively correlated implying informality increases with tax rate. I find no relationship between tax revenue and informality.

iii) FD and tax rates are negatively correlated such that higher levels of FD are associated with lower tax rates while FD and tax revenue are positively correlated implying that higher FD generates higher revenues.

iv) There is a positive correlation between the rank in Paying Taxes and informal sector size meaning that the more difficult and complicated the tax code (a larger number as rank), the larger is the informal sector size.

Each numbered point on the scatter plots in Figure 1 represents a country in our sample. The names of the countries, their rank in 'Paying Taxes', the level of FD, the total business tax as a percentage of commercial profits and tax revenue as a percentage of GDP are given in Table A1 in the appendix. We present our model in the next section.



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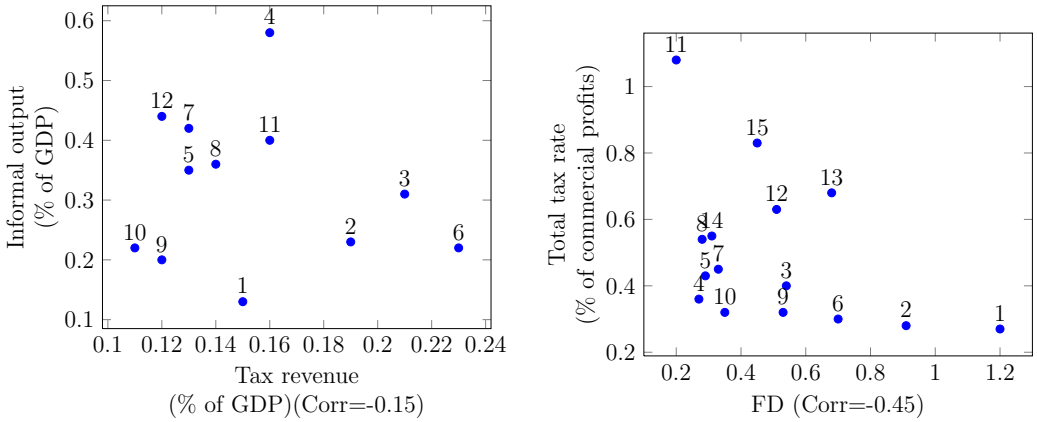

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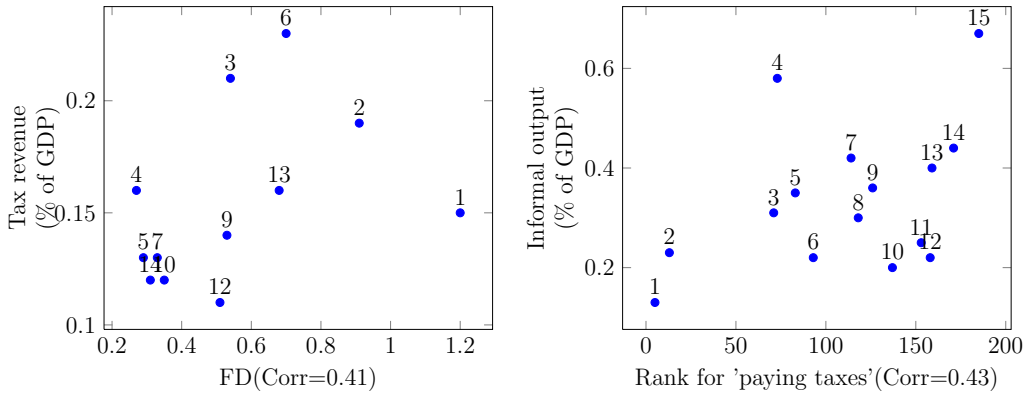


(c)

Figure 1: Informal output share from Schneider (2010), 'Paying Taxes' rank from Doing Business Database, total tax rate, tax revenue and FD (domestic private credit to GDP ratio) from the World Bank website.

3 Model

The economy consists of a representative formal entrepreneur, a representative informal entrepreneur, a representative household and a government. Both entrepreneurs produce a homogenous good using labor and technology but the informal producer hides her output in order to avoid paying taxes. Entrepreneurs are assumed to be impatient, so they discount the future at a higher rate than the households. This assumption ensures that in equilibrium entrepreneurs borrow from the household and the borrowing constraint binds. The household supplies labor optimally to the two sectors.

The entrepreneurs maximize consumption according to,

$$\text{Max } E_t \sum_{t=0}^{\infty} \gamma^t \ln c_{i,t}, \tag{1}$$

,

where $i = 1, 2$ stands for formal and informal entrepreneurs respectively. c_t is their consumption at period t and γ is the discount factor.

The production technology of the entrepreneurs is given by,

$$y_{i,t+1} = A_{i,t}(l_{i,t})^{v_i}, \tag{2}$$

where $y_{i,t+1}$ is output at date $t+1$ using labor $l_{i,t}$ at date t as in Aoki, Benigno, and Kiyotaki (2006). v_i's are the labor share in income of the formal and informal entrepreneurs. As in Ihrig and Moe (2001) and Busato and Chiarini (2004) I assume them to be different to account for the fact that the tax evading firms operate with higher labor intensity (see also Fortin, 1994, Pratap and Quintin, 2008 and La Porta and Shleifer, 2008). $A_{i,t}$ is productivity that is known at date t and follows an AR1 process. Labor hired in period t generates output in period $t+1$ indicating that there is a working capital constraint in production. This is a common feature of production in developing countries where part or all of the input cost has

to be paid for before production can be completed (see for instance, Neumeyer and Perri, 2005 and Li, 2011).

Following Busato and Chiarini (2004) and D'Erasmo and Boedo (2012), the informal entrepreneurs, operate on a lower scale and with lower productivity than the formal sector. The assumption of different productivities is consistent with the evidence provided by Pratap and Quintin (2008) and La Porta and Shleifer (2008). I follow Kaas (2009) then in modeling the difference in productivities between the two sectors in the following way: the formal sector's productivity is given by $A_{1,t} = A_t$. The informal productivity can then be characterized by $\phi = A_{2,t}/A_{1,t}$ such that $0 < \phi \leq 1$. Thus if the formal sector's technology is at the frontier and follows an AR(1) process, the informal sector's productivity adjusts according to ϕ.

Kiyotaki & Moore (1997) type credit constraints arise endogenously as lenders cannot force borrowers to repay their debts unless these are secured by collateral. Under this condition only formal entrepreneurs can borrow from households because they can use their declared output as collateral. Their borrowing constraint is given by,

$$R_t b_{1,t} \leq \theta y_{1,t}, \tag{3}$$

where R_t is the gross interest rate, $b_{1,t}$ is the amount of borrowing by the formal entrepreneurs and θ is the fraction of output up to which entrepreneurs can borrow and can be plausibly assumed to represent factors like intermediation costs, debt enforcement, availability of credit market instruments and quality of financial markets and institutions. That is, when θ is high financial markets and institutions are more developed, debt enforcement high and intermediation costs low. $\theta = 0$ corresponds to an economy with no FD while $\theta = 1$ represents a high level of FD such that entrepreneurs can borrow up to the full amount of their income.

Informal entrepreneurs do not pay tax on output and thus face the following borrowing

constraint,

$$R_t b_{2,t} \leq 0.$$

In equilibrium the borrowing constraints for both formal and informal entrepreneurs bind such that $R_t b_{1,t} = \theta y_{1,t}$ and $R_t b_{2,t} = 0$. The two entrepreneurs differ in the flow-of-funds constraints they face since one of them pays tax and can participate in financial markets while the other doesn't pay tax and nor can borrow. The expected income of the informal entrepreneur is given by,

$$\begin{aligned} E(y_{2,t}) &= (1-p)y_{2,t} + p(1-c\tau)y_{2,t} \\ &= (1-pc\tau)y_{2,t}, \end{aligned}$$

where p is the probability of being detected. With a probability $(1-p)$ informal entrepreneurs retain their income $y_{2,t}$, but with probability p they are caught evading taxes and have to pay the penalty, c on top of the regular tax rate leaving them with $(1-c\tau)y_{2,t}$.

Then the informal sector's budget constraint is given by,

$$c_{2,t} + R_t b_{2,t-1} + w_t l_{2,t} = (1-pc\tau)y_{2,t} + b_{2,t}.$$

So consumption ($c_{2,t}$) and wage bill on the left is financed by expected income plus net borrowing, which is effectively 0, in the right. w_t is the real wage rate and I assume perfect labor mobility such that wages are equalized across sectors. Thus I do not distinguish between formal and informal labor in light of the lack of strong evidence that such labor market segmentation exists in developing economies (see Amaral and Quintin, 2008 for a discussion). Households supply labor optimally to the two sectors in return for the market wage rate, w_t.

As in Ihrig and Moe (2001) my measure of enforcement is composed of two parts - a probability p of being detected, and a penalty, c such that when caught, the agent must pay a tax on output at the rate of $c\tau$. When penalties are absent or $c = 1$, the value of $pc\tau$ ranges from 0 to τ . In the presence of a penalty ($c > 1$), however, the upper bound on the value of $pc\tau$ is greater than the tax rate in the formal sector. Thus as in Ihrig and Moe (2001) modest changes in the enforcement parameter ($pc < 1$) can be interpreted as increases in the probability of detection without substantial penalties while $p.c > 1$ represents quantitatively large penalties along with increased policing.

The budget constraint of the formal entrepreneurs is given by,

$$c_{1,t} + R_t b_{1,t-1} + w_t l_{1,t} = (1 - \tau) y_{1,t} + b_{1,t}.$$

They do not evade taxes and their consumption and wage bill on the left hand side is financed by their after tax income $(1 - \tau)y_{1,t}$ and net borrowing $(b_{1,t+1} - R_t b_{1,t-1})$ on the right hand side.

Households

Households do not own any production technology. They supply labor and lend to the formal sector. The household's problem is given by,

$$\text{Max} \qquad E_t \sum_{t=0}^{\infty} \beta^t (c_{3,t} - \frac{l_{s,t}^{1+\frac{1}{\eta}}}{(1 + \frac{1}{\eta})}), \tag{4}$$

where c_3 is household consumption and β is the household discount factor. Notice that households and entrepreneurs have different discount factors. Specifically, $\beta > \gamma$ such that entrepreneurs are impatient. This is a common assumption in the literature on collateral constraints and allows for credit flows (Campbell and Hercowitz (2005), Iacoviello (2005),

Iacoviello and Minetti (2007), Iacoviello (2008), Iacoviello and Neri (2010)). Labor supply in period t is given by $l_{s,t}$.

Households are subject to the flow-of-funds constraint

$$c_{3,t} + Rb_{3,t-1} = w_t l_{s,t} + b_{3,t}.$$

Households choose consumption, labor supply and lending $(c_{3,t}, l_{s,t}, b_{3,t})$ to maximize utility subject to their flow-of-funds constraint above.

Government

There is a government which taxes the entrepreneurs and uses all of it to finance wasteful consumption,

$$g = \tau y_1 + pc\tau y_2.$$

where g is government consumption expenditure, τy_1 is revenue collected from the formal sector and $pc\tau y_2$ is the expected revenue from the informal sector.

Market for labor clears when the total labor demanded by the formal and informal sectors is equal to the total labor supplied by the households such that,

$$l_{1,t} + l_{2,t} = l_{s,t}.$$

The bond market clears such that net borrowing is 0.

$$b_{1,t} + b_{2,t} + b_{3,t} = 0.$$

Recall $b_{2,t} = 0$ for all t.

The aggregate resource constraint is then given by,

$$c_{1,t} + c_{2,t} + c_{3,t} + g_t = y_{1,t} + y_{2,t}.$$

Definition of Equilibrium

Given productivities, $A_{i,t}$, and a list of policies [τ, p, c, θ] a competitive equilibrium is a list of consumption plans, production plans and debt positions $[c_{i,t}, l_{i,t}, b_{i,t}]$, for $i = [1, 2]$, for the entrepreneurs; a list of consumption plans and debt positions $[c_{3,t}, b_{3,t}]$ for the household; and prices, $[w_t, R_t]$ such that (i) $c_{i,t}, l_{i,t}, b_{i,t}$ maximize entrepreneur i's [$i = 1, 2$] expected utility subject to their budget and debt constraints (zero-debt constraint for the informal entrepreneur). (ii) $c_{3,t}, b_{3,t}$ maximize the household's expected utility subject to its budget constraint. (iii) Markets for labor and goods clear and net borrowing is 0.

4 Results

The first order conditions of the entrepreneurs are,

$$w_t \frac{1}{c_{1,t}} = (\gamma \frac{1}{c_{1,t+1}}(1-\tau) + \lambda\theta) v_1 \frac{y_{1,t}}{l_{1,t}} \quad (5)$$

$$w_t \frac{1}{c_{2,t}} = (\gamma \frac{1}{c_{2,t+1}}(1-pc\tau)) v_2 \frac{y_{2,t}}{l_{2,t}} \quad (6)$$

$$\frac{1}{c_{i,t}} = E_t[\gamma R_{t+1} \frac{1}{c_{i,t+1}} + \lambda_i R_t], \quad (7)$$

where λ_i is the Lagrange multiplier for the borrowing constraints faced by the entrepreneurs. Equations (5) and (6) are the first order conditions with respect to labor for the formal and informal entrepreneurs respectively. The marginal benefit of hiring one unit of labor for the formal sector is given not only by its marginal product but also by the marginal benefit of being able to produce and hence borrow more. Equation (7) relates the marginal benefit of

borrowing to its marginal cost.

The first order conditions with respect to labor and consumption of the households are given by,

$$l_{s,t}^{(1-\eta)} = w_t \tag{8}$$

$$\frac{1}{c_3} = \beta R_t E_t \frac{1}{c_{3,t+1}}, \tag{9}$$

where (8) gives the total labor supplied by the households as a function of the wage rate and (9) is the euler equation of households which implies that households are indifferent between consuming 1 unit today or R_t units tomorrow discounted at the rate β.

At steady state, equations (7) and (9) together give,

$$\lambda = (\beta - \gamma)1/c_1 > 0, \tag{10}$$

which implies that for fluctuations around a deterministic steady state the borrowing constraint is always binding for the formal entrepreneurs. This sector can therefore always benefit from FD which implies a rise in θ.

Using (10) above in the steady state versions of (5) and (6) then dividing (5) by (6) and simplifying gives,

$$\frac{l_2^{1-v_2}}{l_1^{1-v_1}} = \left(\frac{(1 - pc\tau)\phi}{(1-\tau) + \frac{(\beta-\gamma)\theta}{\gamma}} \right) \frac{v_2}{v_1}, \tag{11}$$

Or,

$$s = \left(\frac{(1 - pc\tau)\phi}{(1 - \tau) + \frac{(\beta - \gamma)\theta}{\gamma}} \frac{v_2}{v_1} \right)^{\frac{1-v_1}{1-v_2}}, \tag{12}$$

where $s = l_2/l_1$.

Here $\delta s/\delta p < 0$ and $\delta s/\delta \tau > 0$. So the size of the informal sector depends negatively on enforcement and positively on tax rates as in the literature on the informal sector (Ihrig and Moe, 2003; Johnson et al., 1998). From (12), it also follows that $\delta s/\delta \theta < 0$, that is, informality is negatively related to FD implying that FD causes a fall in the size of informal sector employment relative to the formal sector.

4.1 Calibration

It is important to emphasize that my focus is not on the size of the informal sector, but on its dynamics for different tax policies and FD levels. Thus while standard parameters have been assigned established values from the literature, some non-standard parameters, like enforcement, have been calculated to generate average informality in developing economies as reported in ILO (2012) and Schneider (2010). Sensitivity of results to these parameters are also discussed.

The time period is a quarter. I set the discount factor of the households in the model to $\beta = 0.99$ corresponding to a quarterly interest rate of 1% (Aguiar and Gopinath, 2007, set $\beta = 0.98$). The entrepreneurs' discount factor is set to $\gamma = 0.90$, such that $\gamma < \beta$ by a wide enough margin to guarantee the impatience motive of the entrepreneurs and to allow for the borrowing constraint to always bind. This value of γ is in the ballpark of the values estimated in the literature and quite commonly used in calibrating models with collateral constraints (see among others, Campbell and Hercowitz (2005), Iacoviello (2005), Iacoviello and Minetti (2007), Iacoviello (2008), Iacoviello and Neri (2010)). Robustness analysis with

values of γ between 0.88 and 0.95 leave model dynamics unchanged.

I set the value of η, the Frisch elasticity of labor supply, to 5, higher than that suggested by micro studies (Hall, 2009; Kimball and Shapiro, 2008) but lower than that used in macro models (King and Rebelo, 1999; Rotemberg and Woodford, 1998; Woodford, 2003). Results are not very sensitive to values of η.

The formal sector's labor share in output is set at the standard value of $v_1 = 0.60$. The informal sector operates with a more labor intensive technology relative to the formal sector (see Pratap and Quintin, 2008 and La Porta and Shleifer, 2008) and is assigned a higher labor share in income as is standard for models in the literature on informal sector (Ihrig and Moe, 2001 and Busato and Chiarini, 2004). I assume a benchmark value of $v_2 = 0.70$ such that $v_2 > v_1$. This is in line with the value used by Koreshkova (2011) and estimated by Fortin et al. (1994) for the U.S. and Canada respectively. Since estimates of informal labor share in developing countries are hard to find, I adhere to the benchmark value of 0.70 in my simulations and conduct robustness checks with higher v_2. Results for $v_2 = 0.80$ are reported in Table A2 in Appendix. While a higher informal labor share lowers the steady state shares of informal employment and output (implied by equation 12), the numbers are still quite large and within the range of informal sector sizes found in developing countries (see Schneider, 2010, Table 3.3.1). More importantly, the relative changes in informal sector size and other macroeconomic variables in response to changes in FD and tax policies remain unaffected. So our policy implications remain unchanged.

I assume informal firms to be less productive than formal ones, Specifically literature has shown the informal sector to be about 30 to 40% less productive than the formal sector (Taymaz, 2009) and accordingly I set the productivity ratio parameter $\phi = 0.70$, so that there is a productivity gap of 30% between the sectors. θ is a free parameter that measures FD whose effect on informality in particular and the aggregate economy in general is the main focus and is varied from 0 to 1 to arrive at results, however, where required I set the value of θ to 0.50 which is the average level of FD for developing economies in the World

Bank (2011) database.

Next we calibrate the tax parameter τ, once again utilizing the large amount of tax information contained in *Paying Taxes* (2014). It reports that the total business tax rate, which measures the amount of taxes and mandatory contributions payable by businesses after accounting for allowable deductions and exemptions as a share of commercial profits ranged from 25% in the Middle East to a little over 60% in Latin America in 2012. For our benchmark calibration therefore, we set $\tau = 0.25$ and vary it in Section 4.3 for our quantitative analysis.

Enforcement related data is the toughest to compile across countries and one variable on which least information in available except that in developing and emerging market economies enforcement tends to be very small (Ihrig and Moe, 2001). I calculate pc from estimates of equation (12) using informal sector employment shares from the ILO (June, 2012) report and the parameter values assigned above. The value of pc that emerges is small indeed at about 1%. Thus I assign $pc = 0.01$ as the benchmark value for enforcement in my model and vary it from this very low value to a value of up to 3 (at which point the informal sector size is close to 0 in the model) in order to study its effects on informality and the aggregate economy.

Finally, I use the standard assumption for the volatility of aggregate productivity shocks in emerging market economies and set it to a higher value of σ equal to 0.016 reported in the literature in order to account for the fact that these economies usually experience more volatile business cycles (Aguiar and Gopinath (2007), Neumeyer and Perri (2005)). The persistence parameter is set to $\rho = 0.95$ as is standard for quarterly calibration in business cycle literature.

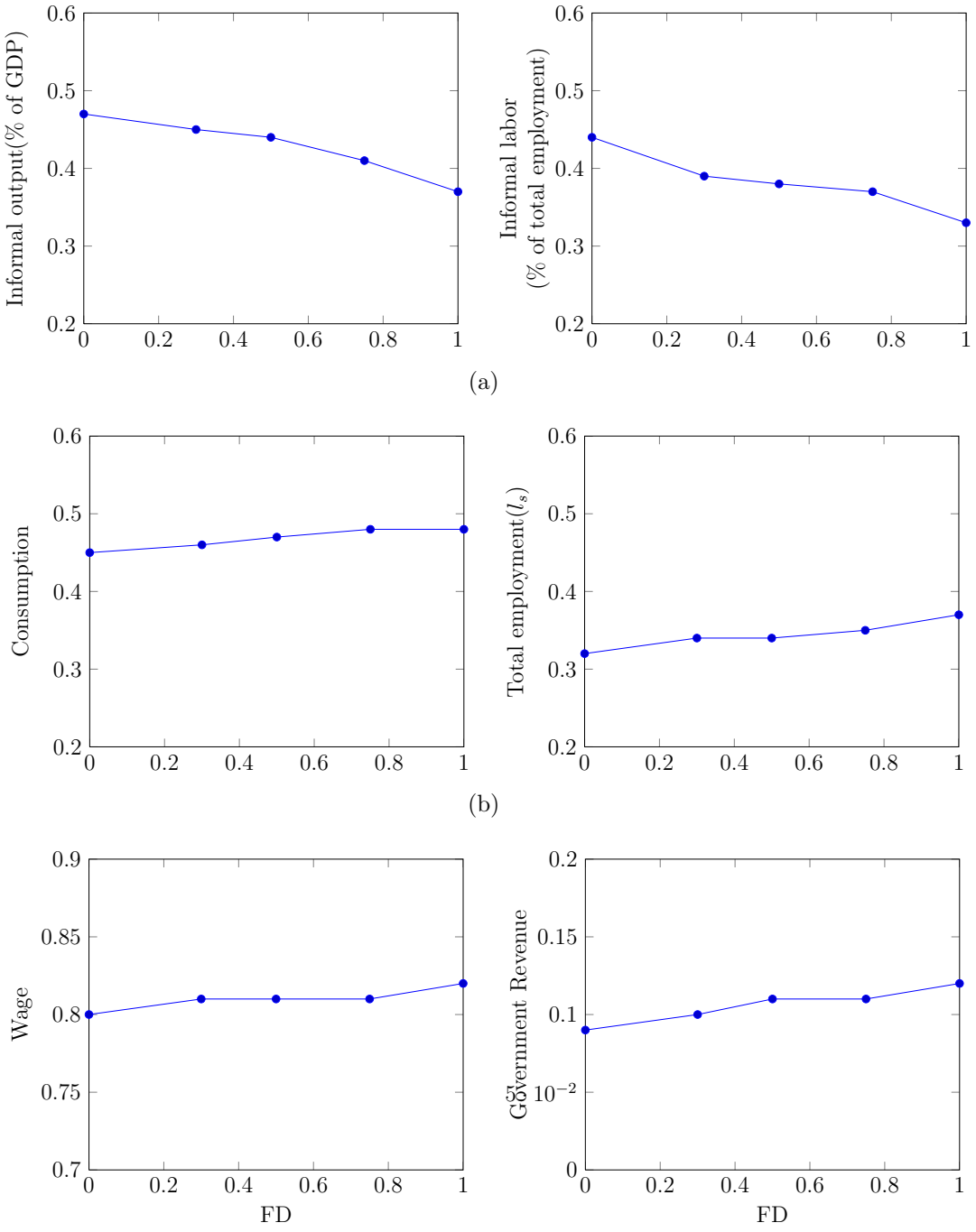


Figure 2: Effect of increasing FD

4.2 Effect of FD

Figure 2 plots a negative relationship between FD and informality as suggested by our empirical analysis in Section 2. Without financial development ($FD = 0$) and given the benchmark values of tax rate and enforcement, the relative size of informal sector output that emerges is high at 47%, while informal employment is 44% of total employment. With FD informal output and employment share fall steadily such that at $FD = 1$, when firms are using their entire current period output as collateral, informal output and employment share fall by 21% and 24% respectively compared to when $FD = 0$.

An increase in FD from the benchmark value of 50% for developing countries to $FD = 1$ causes a 16% decline in informal output share and a 14% decline in informal employment as a fraction of total labor supplied. Formal output increases by 10%, the wage rate by 1% and aggregate consumption increases by 2%. Tax revenue is higher by 1%.

FD relaxes the borrowing constraint and makes borrowing cheaper. This causes formal labor demand and the wage rate to rise. Formal output increases but the higher competitive wage rate lowers informal labor demand and their output falls. The direct effect of FD on the formal sector implies formal output rises more than informal production falls. Net labor demand and total employment increase. Following from the formal sector's budget constraint their consumption increases because borrowing and formal sector production are both higher. Household consumption also rises due to higher wages and interest income. Thus aggregate consumption increases with FD in Figure 2. The model also generates a positive correlation between FD and tax revenue as in Section 2. As the formal sector expands with FD the amount of tax revenue generated increases.

4.3 Effect of tax policies

First, we look at the effect of increasing enforcement or pc where p is the probability of audit and c is a penalty tax as a percentage of the tax evaded. Recall that the benchmark

calibration of this parameter was kept very low in order to have the model generate the average size of informal output and employment share seen in developing and emerging market economy. In this section we increase the value of pc steadily from 0.01 to 3 (when informal sector size is close to 0) while FD and the tax rate are kept fixed at the benchmark levels of 0.50 and 0.25 respectively.

From Figure 3(a) it is clear that enforcement is very powerful when it comes to reducing informal sector size. With high enough enforcement informal employment and output can be reduced to 0. More specifically, raising enforcement from 1% to 50% decreases informal output share, y_i by 25% while informal employment's share, l_2/l_s, drops by 24% both drops being higher than what going from $FD = 0$ to $FD = 1$ achieves in Figure 2. If enforcement is such that $pc = 2$ - for example a 50% probability of being audited combined with a penalty of 4 times the prevailing tax rate - it reduces the informal sector's share of output to a low 9% which is comparable to the size of informality found in the US (8% of GDP). Thus stronger enforcement can be effectively used to achieve a smaller informal sector size or eliminate informality completely as obtained with $pc \sim 3$ in Figure 3.

However, from Figure 3 it is also clear that consumption, employment and the wage rate decline with enforcement. The loss in aggregate consumption is especially large at 8% as enforcement is raised from the benchmark 1% to 50%. The wage rate falls by 2%, formal employment increases by a small 3%. Total employment falls by 9% justifying the fall in consumption. Government revenue increases by 2%.

Enforcement directly raises the cost of informality which reduces informal production. Since labor demand from the informal sector falls, the wage rate declines and increases the formal sector demand for labor and hence formal output increases. The decline in informal production (25%), however, far exceeds the rise in formal output (3%) causing a net decline in labor demand and the wage rate. Aggregate consumption declines as the wage rate, output and total employment fall. Government revenue increases more at first but dampens as enforcement is strengthened.

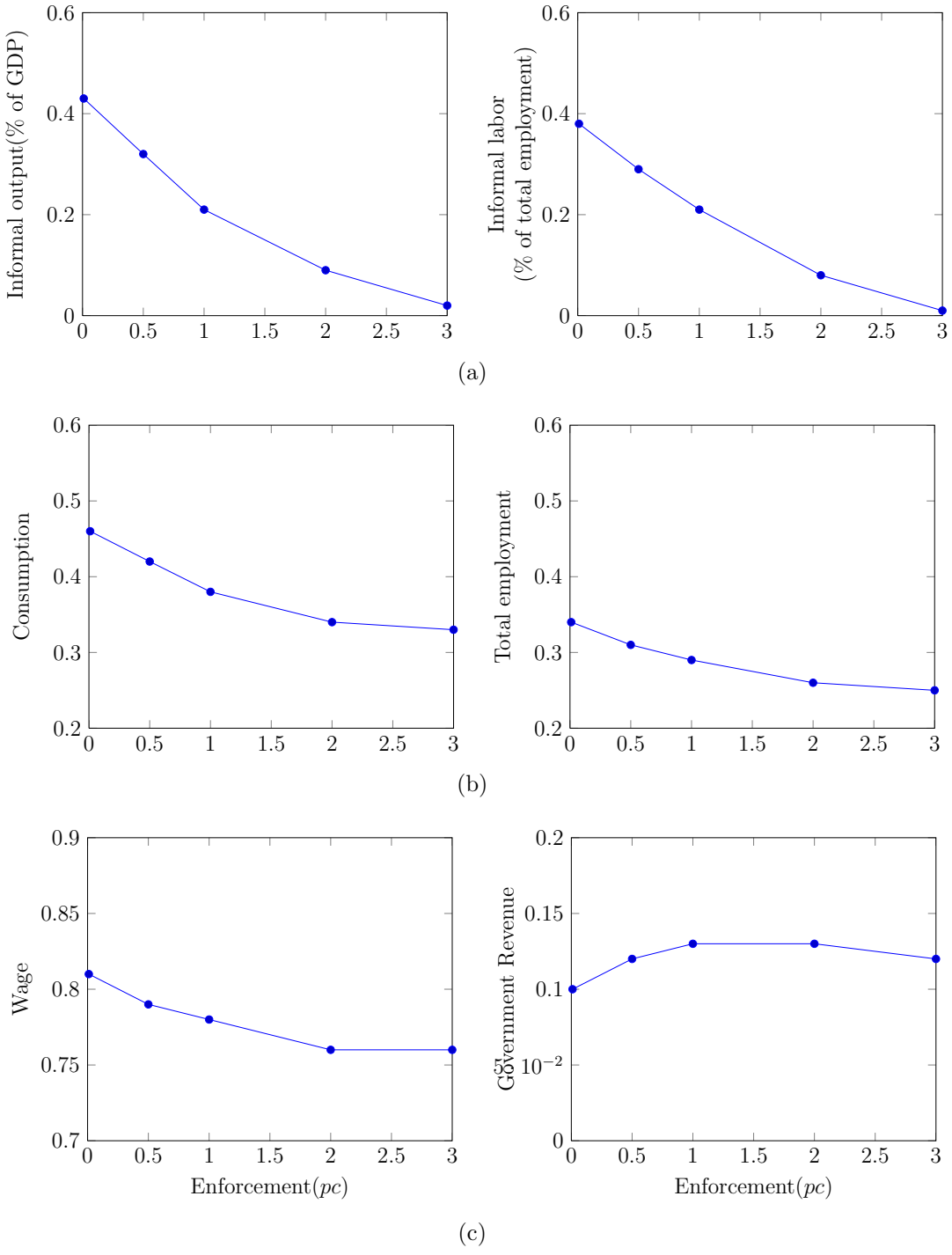


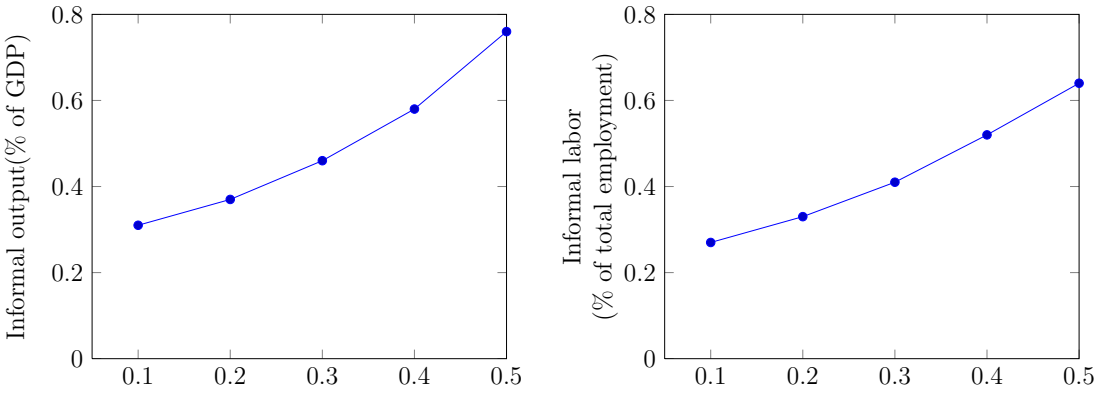
Figure 3: Effect of increasing enforcement

As the tax rate is increased the size of informal output and employment both increase rapidly as seen in Figure 4. Going from $t = 0.30$ to $t = 0.40$ informal output share, y_i increases by 26% and gives rise to an informal output share of 58%. At $t = 0.50$ informal output is one of the largest generated by the model at 76% [1] (see Table A1). This implies then that reducing taxes would rapidly shrink the informal sector size. In fact, reducing taxes from 30% to 20% reduces informal output by 19% as a share of GDP. Reducing taxes further to 10% reduces informal output by a further 16%. However, even at a tax rate of 10%, the model generates a high y_i of above 30% of GDP implying that beyond a certain point, lowering taxes alone does not affect the informal sector significantly.

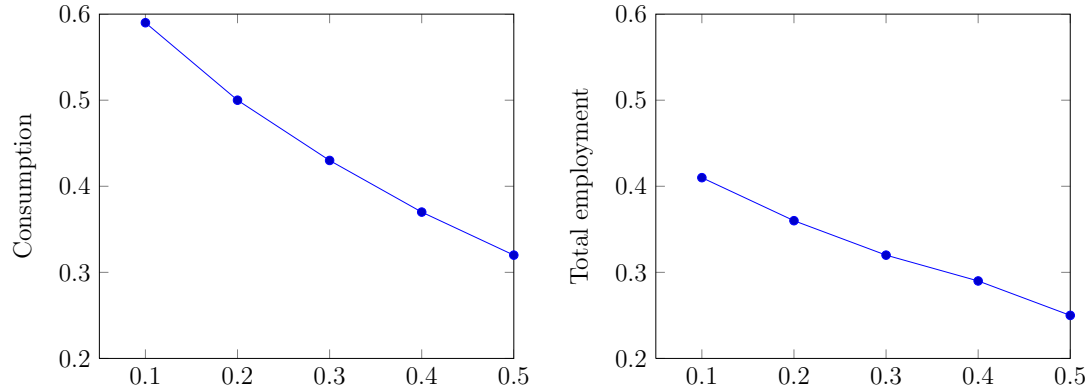
As far as other indicators are concerned reducing the tax rate from $\tau = 0.4$ to $\tau = 0.3$ raises formal output by 19%, total employment by 10%, wage rate by 3% and aggregate consumption by a huge 16% (Figure 4(b) and (c)). At lower tax rates, the cost of operating formally falls and the formal sector expands. Formal labor demand and the wage rate increases. Rising income and employment causes aggregate consumption and hence welfare to increase.

Government revenue falls by 8% as taxes are reduced from 40% to 30%. However, revenue falls more rapidly when taxes are already low. More specifically reducing the tax rate from 50% to 10% leads to a total revenue loss of over 60%. However, 92% of the loss occurs when the tax rate is reduced from 20% to 10%. Going from 50% to 40% only reduces revenue by 8% of the total fall. As discussed above, after sufficient lowering of the tax rate very little shrinking of the informal sector share occurs for further lower taxes. In other words, the fall in informal sector and the rise in formal sector is higher for initial reductions in tax rates but after a point no further changes in informal or formal sector size occurs. Thus the expansion of the tax base with lower taxes ceases after a certain low rate of tax is reached and government revenue starts to register large drops.

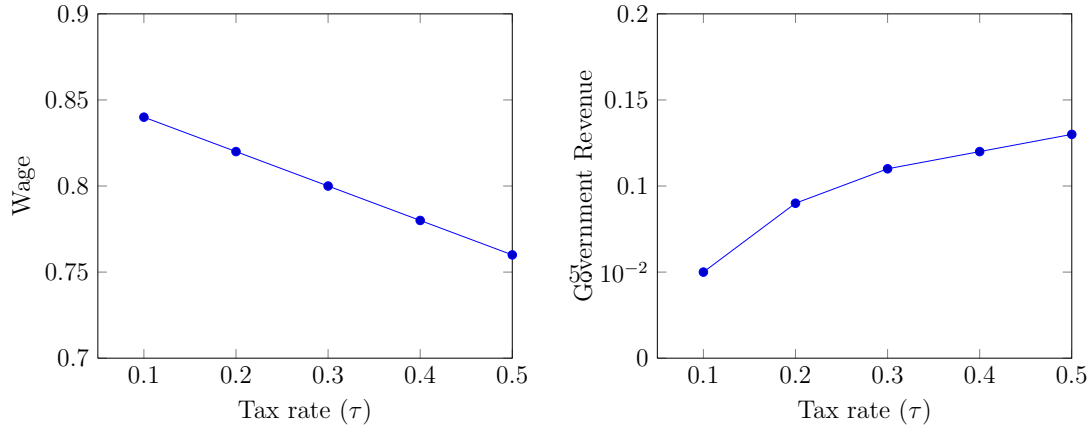
[1] In our sample, Bolivia has the highest informal sector output share at 67% and one of the highest tax rate at 83%



(a)



(b)



(c)

Figure 4: Effect of increasing the tax rate (τ)

4.4 FD under different tax policies.

In this section I study the effect of increasing FD under different combinations of tax rates and enforcement. For simplicity I assume no penalty tax ($c = 1$) in this section, so enforcement is given by the probability of being audited ($0 < p \leq 1$). The role of the penalty tax is to make enforcement more stringent and irrespective of the prevailing tax rate or FD it shrinks the informal sector size substantially compared to if no penalty is imposed.

The tax policy combinations in Table 1 are i) Low Enforcement, Low Tax, ii) Low Enforcement, High Tax, iii) High Enforcement, High Tax and iv) High Enforcement, Low tax, where low enforcement refers to $p = 0.1$, high enforcement is $p = 0.7$, high tax refers to $\tau = 0.40$ and low tax is $\tau = 0.20$.

Table 1 presents the quantitative changes in informality due to FD under each policy environment. For any level of FD, lowering taxes or raising enforcement is best for reducing informal output and employment. However, allowing for FD alongside always leads to a larger drop in informal sector size and more importantly, FD offsets the negative general equilibrium effects of tax policies. Apart from providing a robustness analysis of the effect on informality of FD and tax policies, this table also compares the effectiveness of these policies when used together versus when they are used alone.

Firstly, for any level of FD, the following observations emerge from Table 1 regarding the joint effect of tax rate, τ and the probability of audit, p: i) Increasing enforcement is more effective in reducing informality in a high tax environment rather than a low tax environment. ii) Lowering the tax rate is more effective in reducing informality in a low enforcement environment rather than a high enforcement environment. In Table 1, let us consider the case when $FD = 0$. When p is high, going from high tax to low tax reduces the informal sector output by 7%. However, when p is low, going from high tax to low tax reduces informal sector output share by a much more substantial 44%. On the other hand, when the prevailing tax rate is low, going from low to high p reduces informality by around 14%. However, when

taxes are high, increasing p is much more effective in that it shrinks informality by around 50%. Thus the effect of τ on informality depends negatively on p while the effect of p on informality depends positively on τ. In other words, lowering tax rate lowers informality more when policing is low. Similarly, increased policing lowers informality more when taxes are high. Both effects are little or not influenced by the level of FD.

This implies that while both a lower tax rate and a high level of enforcement are desirable for lower informality, when used together there is a trade-off between these policy parameters which can be effectively exploited to afford some flexibility in setting policy. In other words, governments can choose to focus on either lowering taxes or raising enforcement and not both to achieve significant reduction in informal sector size. For instance, if tax rates are sufficiently low, a lower enforcement rate may suffice to reduce informality by a sizeable amount over time. This may be an attractive option for an economy that does not want to or may not have the resources to spend on additional enforcement. Similarly, simply raising the enforcement level may allow a government to tax businesses at a high rate while still reducing informality sizeably as seen in Table 1. However, it is important to remember from the discussion above that too high an enforcement and too high a tax rate are not good policies for the aggregate economy.

We next study the role played by FD for different tax policies.

When taxes are low At $FD = 0$, going from Low Enforcement to High Enforcement reduces informal output's share in formal output, y_i, by 14%, aggregate consumption, c, falls by 4%, formal sector output and wage rate remain the same while labor supply falls by 5%.

If FD is also simultaneously increased from $FD = 0$ to $FD = 1$, then going from Low to High Enforcement, y_i falls by 21%, aggregate consumption rises by 5%, formal output by 16%, wages by 3% and labor supply by 11%. Thus FD totally offsets the negative effects of high enforcement while reducing informality more.

When taxes are high At $FD = 0$, going from Low Enforcement to High Enforcement reduces y_i by 48%, informal employment share falls by 46%, aggregate consumption, falls by 24%, formal sector output rises by 7%, wage rate falls by 5% and labor supply falls by 20%. Government revenue increases by 25%. Recall increased enforcement is more effective when taxes are high.

If FD also increases to $FD = 1$, y_i falls by 60%, informal employment share by 55%, aggregate consumption falls by 15%, formal output rises by 28%, wages fall by 3% and labor supply by 4%. Government revenue now increases by 42%. In this case, FD again reduces informality more while countering the negative effects of enforcement, however, clearly enforcement is too high even at $FD = 1$ and either enforcement or taxes need to be lowered in order to reduce or reverse the fall in welfare.

When enforcement is low At $FD = 0$, going from High Tax to Low Tax reduces y_i by 44%, informal employment share by 43%, aggregate consumption rises by 70%, formal sector output rises by 61%, wage rate rises by 8% and labor supply increases by 52%. Government revenue falls by 42%.

If FD also increases to $FD = 1$, y_i falls by 55%, informal employment share by 56%, aggregate consumption rises by 85%, formal output rises by 82%, wages increase by 12% and labor supply by 76%. Increase in government revenue remains the same at 42%. Thus taxes have a significant positive effect on the economy except on government revenue. Given the huge reduction in informality along with the significant increases in formal output, employment and welfare, either taxes or enforcement can be raised in this case to stem the large fall in government revenue.

When enforcement is high At $FD = 0$, going from High Tax to Low Tax reduces y_i by 6%, informal employment share in total labor supply falls by 7%, aggregate consumption doubles, formal sector output rises by 50%, wage rate rises by 14% and labor supply increases by 80%. Recall that when enforcement is very high reducing taxes is less effective for reducing informality, however, the effect of lowering taxes on the formal sector is quite large.

If FD also increases to $FD = 1$, y_i falls by 24%, informal employment share by 30% aggregate consumption increases by more than double, formal output rises by 73%, wages increase by 17% and labor supply now doubles with high enforcement.

5 Conclusion

Important implications for policy emerge for developing and emerging market economies with large informal sectors, weak tax administration and poorly developed financial markets. Firstly, whatever the stage of development improving tax administration and developing domestic financial markets are important for reducing informality. Improving tax administration implies lowering of taxes on the formal sector and increasing enforcement. Three points emerge from this study in this regard i) while lowering tax rates greatly reduces informality and has a positive effect on all aggregate variables except government revenue, once taxes are sufficiently low further lowering of taxes have very little impact on informality while causing substantial revenue losses, ii) sufficiently high enforcement can eliminate informality completely but higher enforcement comes at the cost of lower total employment (net labor demand falls), wages and welfare (aggregate consumption) and iii) increasing enforcement is more effective in reducing informality when taxes are high while lowering the tax rate is more effective when enforcement is low. These three findings together point to the existence of complementarities and trade-offs between enforcement and tax rate that can be utilized to arrive at the right tax policy environment which promotes progressive shrinking of the informal sector but without the negative impacts on formal output, employment, welfare and government revenue.

FD contributes importantly to the policy mix above by providing an additional channel for reducing informality while generating significant positive general equilibrium effects. For instance, increasing FD from 50% (the average level of financial market development in developing economies) to 100% reduces informal activity by 16% as a share of GDP while

increasing enforcement from the benchmark 1% to 50% causes a 25% drop in informality. Similarly lowering the tax rate from 30% to 20% causes a 19% drop in informal output share. Thus FD while less effective than tax policies, also causes significant reductions in informality. More importantly, however, the positive general equilibrium effects of FD counter and even offset the negative aggregate effects of tax policies, especially the loss of welfare with enforcement and the fall in revenue with lower taxes.

FD works by relaxing the borrowing constraint which directly affects the formal sector which can now borrow more. This increases formal labor demand and output. The wage rate rises lowering informal sector's labor demand and in turn their output falls. Total formal output, employment, government revenue and welfare thus increase with FD and counters or offsets the effects of tax policies outlined above.

Thus policies promoting domestic financial development are equally important for shrinking the informal sector. This paper highlights that while the right tax policy mix is very effective, arriving at it may need some experimenting given some of their limitations. FD however, has an overall positive effect in addition to lowering informality. Studying the implications of a more realistic theory of government expenditure is an interesting future extension of this work.

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Table 1: Effect of FD under different policy environments

	FD (θ)		
	0	0.5	1.0
Low enforcement, low tax			
$y_i(\%)$	0.36	0.31	0.29
$\frac{l2}{ls}$	0.32	0.27	0.25
y_f	0.45	0.48	0.51
c	0.56	0.58	0.61
g	0.05	0.05	0.05
w	0.82	0.84	0.85
l_s	0.38	0.41	0.44
Low enforcement, high tax			
$y_i(\%)$	0.64	0.55	0.50
$\frac{l2}{ls}$	0.56	0.48	0.45
y_f	0.28	0.31	0.34
c	0.33	0.35	0.36
g	0.12	0.13	0.14
w	0.76	0.77	0.78
l_s	0.25	0.27	0.29
High enforcement, high tax			
$y_i(\%)$	0.33	0.30	0.25
$\frac{l_2}{l_s}$	0.30	0.27	0.25
y_f	0.30	0.33	0.36
c	0.25	0.27	0.28
g	0.15	0.16	0.17
w	0.72	0.74	0.75
l_s	0.20	0.22	0.24
High enforcement, low tax			
$y_i(\%)$	0.31	0.26	0.25
$\frac{l_2}{l_s}$	0.28	0.23	0.21
y_f	0.45	0.49	0.52
c	0.54	0.56	0.59
g	0.06	0.06	0.06
w	0.82	0.83	0.84
l_s	0.36	0.39	0.42

Table 1: y_i is informal sector output as a fraction of formal output y_f, l_2/l_s is informal sector labor as a share of total employment, c is total aggregate consumption, g is government revenue and w is the real wage.

A Appendix

A.1 Countries used in Figure 1 along with tax complexity ranking and financial development

Number	Country	FD	Paying taxes	Tax rate	Informal output share	Tax revenue
1	Singapore	1.2	5	0.27	0.13	0.15
2	Mauritius	0.91	13	0.28	0.23	0.19
3	Turkey	0.54	71	0.40	0.31	0.21
4	Peru	0.54	0.73	0.36	0.58	0.16
5	Egypt	0.29	83	0.43	0.35	0.13
6	Israel	0.70	93	0.30	0.22	0.23
7	Philippines	0.33	114	0.45	0.42	0.13
8	Mexico	0.28	118	0.54	0.30	-
9	Nepal	0.53	126	0.32	0.36	0.14
10	Indonesia	0.35	137	0.32	0.20	0.12
11	Argentina	0.20	153	1.08	0.25	-
12	India	0.51	158	0.63	0.22	0.11
13	Brazil	0.68	159	0.68	0.40	0.16
14	Sri Lanka	0.31	171	0.55	0.44	0.12
15	Bolivia	0.45	185	0.83	0.67	-

Table A1: FD in column 2 is private credit to GDP ratio from the World Bank database. Paying taxes in column 3 is the ranking obtained from the index of the same name in the World Bank *Doing Business* database. Tax rate and tax revenue are obtained from the World Bank website. Informal output share in column 4 is obtained from Schneider (2010)

A.2 Sensitivity analysis for informal sector labor share (v_2)

	Financial Development (θ)		
	0	0.50	1.0
y_i	0.32	0.28	0.26
$\frac{l2}{ls}$	0.37	0.31	0.29
y_f	0.37	0.40	0.43
c	0.40	0.42	0.43
g	0.09	0.1	0.11
w	0.79	0.80	0.81
l_s	0.30	0.32	0.34
$\sigma(c)/\sigma(y)$	1.06	1.00	0.94

Table A2: Sensitivity analysis, effect of FD when $v_2 = 0.80$. y_i is informal sector output as a fraction of formal output y_f, l_2/l_s is informal sector labor as a share of total employment, c is total aggregate consumption, g is government revenue and w is the real wage.