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Abstract

Tax enforcement consistently lowers informality in the literature whereas the evidence is mixed for other factors affecting informality. Using several different samples of countries corresponding to different development levels, we find Rule of Law, the proxy for tax enforcement, to have a significant and robust effect on informality according to the continuous treatment test due to Belloni et al. (2014), which allows for uncertainty in the set of control variables via the use of a heteroscedasticity-robust Lasso method. A general equilibrium framework with heterogeneous firms and financial frictions further shows enforcement is welfare-reducing for low to moderate costs of enforcement.

Journal of Economic Literature Classification: O11, O17, I30, H26.

Keywords: Lasso, Informal sector, welfare, tax enforcement, borrowing constraints, tax evasion.

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1 Introduction

Studies on the determinants of the informal sector find overwhelmingly that tax enforcement (or lack thereof) is a key driver of informality. In fact, better enforcement related institutions is viewed as the main reason why informal sectors are smaller in developed and significantly larger in developing and emerging market economies. We review the empirical and theoretical literature, focusing first on studies relating informal sector size to tax enforcement, and subsequently on those relating informality to its other potential determinants. Additionally, we extend the empirical analysis in Liu-Evans and Mitra (2019) who find an important role for the rule of law measure in their dataset in determining informal sector size using the rigorous lasso treatment test due to Belloni et al (2014). Rule of law is the most common proxy for tax enforcement in empirical studies (see for example, Johnson et al 1998; Schneider et al, 2010; Kuhn, 2014) and we provide further evidence of its effect on informality following Liu-Evans and Mitra (2019).

Given the important role of tax enforcement in determining informality, we also study the welfare effect of higher tax enforcement in a general equilibrium model of formal and informal firms with financial frictions. We find evidence in the literature of significant costs of enforcement, especially in developing economies. Yet existing theoretical frameworks assume tax enforcement to be costless. Incorporating a positive cost of tax enforcement in our model, we quantitatively analyze the effect of enforcement on welfare for a range of such costs, and varying levels of taxation and financial development. We show that tax enforcement reduces welfare, measured by aggregate private consumption, for low to moderately high costs of enforcement.

While numerous papers have studied the effect of tax enforcement on informality only a couple of papers have focused on its welfare effects. Ulyssea (2018) finds tax enforcement causes a significant decrease in (firm and worker) informality through a decline in the number of informal firms. This leads to an increase in inefficient entry and regulation costs associated with the formal sector in his model which overwhelms the rise in tax revenue from greater enforcement and reduces welfare. Meghir et al (2015) find, in contrast, welfare is increasing in the level of enforcement. In their model, increasing enforcement

increases coverage of costly regulations (they do not however consider a cost of entry as in Ulyssea (2018)), but the reallocation of workers from less to more productive firms which increases productivity and output has the dominant effect on welfare.

Our theoretical framework adds to this literature by considering the role of costly tax enforcement in a set-up with representative formal and informal firms and financial frictions. We define informal firms as those that do not report their output or income to the tax authorities for the explicit purpose of avoiding the payment of taxes on such income or profits. Tax enforcement is, as in Allingham and Sandmo (1972), the probability of being audited or visited by a tax authority and any associated fines or penalties payable if found evading. Higher tax enforcement lowers informal activity in our model causing consumption associated with informal entrepreneurs to drop. In the absence of any cost of enforcing, the fall in informal sector consumption is offset by a rise in household consumption as the additional tax revenue generated from higher enforcement is transferred lumpsum to households. In the presence of costly enforcement, the net increase in tax revenue is lower than in the costless-enforcement case. We calibrate the model and find that for plausible parameter values and low to moderate costs of enforcement, the fall in informal sector consumption is larger than the rise in household consumption, causing welfare to decline with rising enforcement. The strength of the enforcement-welfare relationship depends on the prevailing level of enforcement and government size.

It is important to emphasize that in both our literature review and theoretical framework, we focus on income or profit tax enforcement (or firm informality) as opposed to the enforcement of labor taxes and regulations (or worker informality)¹. Since informal firms are the largest employers of informal workers, however, we expect tax enforcement, by targeting informal firms, to move firm and worker informality in the same direction. This is in fact demonstrated by Ulyssea (2018) who takes both worker and firm informality into account in his theoretical framework. He finds labor (regulation) enforcement has an ambiguous impact on worker informality since such regulation reduces worker informality in formal firms but increases the number of informal firms thereby moving worker and

¹See Bosch et al (2012), Almeida and Carneiro (2012) and references within for papers focusing on labor or worker informality.

firm informality in opposite directions. Tax enforcement on the other hand, by reducing the number of informal firms which are the main employers of informal workers, causes a reduction in both firm and worker informality. Thus firm and worker informality move jointly in response to tax enforcement in Ulyssea (2018). This is the case in our framework by default since we do not distinguish between formal and informal workers. That is, all workers in our model employed in informal firms are informal workers while those employed in formal firms are formal workers. Thus a decline in firm informality caused by tax enforcement automatically results in lower worker informality in our model. Moreover, as outlined earlier, Ulyssea (2018) finds a negative impact of tax enforcement on welfare, in line with the results of our theoretical analysis which does not explicitly account for labor informality. We do not therefore expect the addition of worker informality to materially alter the main mechanisms and results of our simpler framework given our specific focus on the role of tax enforcement.

The main difference in this context, between the frameworks of Ulyssea (2018), Meghir et al, (2015) and ours, lies in the source of the distortions that arise with tax enforcement. In Ulyssea (2018) and Meghir et al, (2015), the distortions, such as regulation and entry costs, arise in the formal sector. In our model the distortion arises from a direct cost of enforcing which, according to the literature we review, is substantial, especially in developing economies.

The rest of the paper is organized as follows: Section 2 reviews the literature, Section 3 presents our empirical analysis, Section 4, lays out our theoretical framework, Section 5 focuses on the quantitative analysis of the model, and Section 6 concludes.

2 Literature review

In this section we review the theoretical and empirical literature on the determinants of informality. We focus on tax enforcement first, following which we discuss the roles of formal sector registration, tax rates and financial development, all of which have been identified in the literature as being important drivers of informality.

2.1 Tax enforcement

Allingham and Sandmo (1972) provide the first theoretical framework for studying tax evasion, based on the criminal activities model of Becker (1968). They model tax enforcement as a combination of the probability of detection and a penalty rate (payable if detected), and show that the amount of declared income is always increasing in both the probability of detection and the penalty rate. Many papers since have either followed or built upon their theoretical framework, including the current one.

Ihrig and Moe (2004) shed light on the evolution of the informal sector and the role of government taxation policies in this sector, in a dynamic partial equilibrium set-up. They recommend a policy combination of lower taxes and higher enforcement with penalties to reduce the informal sector size while maintaining or increasing tax revenue. They find that the existence of an informal sector gives rise to lower levels of output and capital stock but higher levels of utility. This last is because going from an economy with only formal production and taxation, to an economy with informal sector and taxation, implies lower output and savings; but output falls less than savings does, causing consumption and therefore utility to rise.

Prado (2011) builds a general equilibrium framework in which low productivity firms locate in the informal sector. He uses cross-country data on taxes, measures of informality, and measures of regulation (entry and compliance costs, red tape, etc.) to back out how high enforcement levels must be country by country to make the theory match the data. He finds that developing economies tend to have much larger informal sectors and lower levels of enforcement. Among developed economies, countries that have high regulation and entry costs are the ones with high enforcement levels. He conducts a welfare analysis focusing on policy reforms that centre around the reduction of regulation costs.

Kuhn (2014) focuses on a model of the informal sector in developed countries, which, she argues, has different characteristics relative to informal sectors in developing economies. Particularly, she does not differentiate between the formal and informal sector on the basis of productivity, financial constraints, registration or start-up costs. In her model, entrepreneurs decide how much of their production to keep informal, where informality

carries a risk of getting caught, taxed, and fined. She finds, differences in tax rates can explain around 23% of the informality in the data while tax enforcement, plays a much larger role, raising the models explanatory power to 72%.

In a general equilibrium model of occupational choice, Ordonez (2014) includes a tax collection policy with limited enforcement. Individuals have heterogeneous entrepreneurial abilities and each face a discrete occupational choice: whether to be a formal entrepreneur, an informal entrepreneur or an employee. If formal, the entrepreneur pays taxes, if informal, the entrepreneur faces a probability of being caught that depends positively on the amount of capital hired. The model is calibrated using data for Mexico, an economy where 31% of the employees work in informal firms. He finds that under complete tax enforcement, Mexico's labor productivity and output would be 17% higher due to tax informality being completely eradicated. Note however, in this paper complete enforcement is defined as a combination of raising the probability of detection and lowering the tax rate to keep revenue unchanged.

Focusing on empirical studies, Johnson, Kaufmann, and Shleifer (1998) use a broad data set covering the OECD, Latin America, and transition economies and find that the unofficial economy accounts for a larger share of GDP when there is more corruption and when the rule of law is weaker. Specifically their results suggest that it is not necessarily more regulation or higher taxes that increases the size of the unofficial economy but how strong or effective the rule of law is that matters most. Friedman et al (2000) similarly find, across 69 countries, that tax rates and the rule of law shrink informal activity while corruption causes it to expand. The effect of taxes, however, disappear in their study when they control for income while the strong role played by the rule of law remains.

Dabla-Norris et al (2008) use an integrated data set to test the channels affecting the degree of informality across developed and developing countries. They build on a simple general equilibrium framework with enforcement measured by a probability of detection and associated fines as in the previously discussed studies. In line with the predictions of their analytical framework and empirical works discussed earlier, they find the quality of the legal framework is crucially important in determining the size of the informal sector.

The significance of taxes, regulations, and financial constraints is reduced in the context of a well-functioning legal system in their results.

Alm, Cox and Sadiraj (2020) develop a dynamic theoretical model in which an individual's compliance decision in the current period depends on the individual's audit history from earlier periods. Their model distinguishes between compliance conditional on no previous audits and compliance conditional on previous audits, on the basis of which they discriminate in their empirical analysis among forward-looking, myopic and naive behaviors. They experimentally test their model by reporting the results from the first tax compliance experiment run in Colombia and confirm that tax compliance rates increase with greater enforcement. Other experimental studies based on specific developing economies, which we draw upon next, confirm this result, and also provide insights into the high costs associated with increasing formal sector enforcement.

Benhassine et al (2018), for example, conduct a randomized experiment in Benin where tax inspectors physically visit informal business premises to explain to business owners the benefits from formalization and provide training, help with opening a bank account if they registered and finally, offer tax mediation services. They find a 9.6 percentage points increase in registration when firms are given information (about the benefits from formalizing) and training, a 13 percentage points increase when firms are also provided with support to open bank accounts and a 16.3 percentage point increase when in addition, firms are provided with tax mediation services. This last item of support was especially important for those informal businesses that were regularly visited by tax inspectors for bribes. The authors report however, that this formalization does not bring firms higher sales or profits, and the associated cost involved, of formalizing these firms, this way exceeds the added taxation they will pay over the next decade. A supplementary treatment that provided information in the form of leaflets and a verbal explanation, in this study, found information alone had no impact.

De Mel et al (2013) similarly find that providing information about the registration process and reimbursing the direct costs are not enough to increase formal registration in Srilanka. Payments equivalent to one-half to one month (alternatively, two months) of

the median firm's profits leads to registration of around one-fifth (alternatively, one-half) of firms.

In Belo Horizonte, Brazil De Andrade et al. (2016) test which government actions work to encourage informal firms to register. They find zero or negative impacts of information and free cost treatments and a significant but small increase in formalization from inspections. The local average treatment effect estimates of the inspection impact are larger, providing a 21 to 27 percentage point increase in the likelihood of formalizing. Their results show that most informal firms will not formalize unless forced to do so, suggesting that formality offers little private benefit to these firms.

The papers discussed in this section unequivocally find that firm tax enforcement lowers informality. Moreover, a group of these papers, especially regional experimental studies, but also others (like Prado, 2011) suggest high costs associated with such enforcement. These costs usually take the form of one or more of: increased visits by tax inspectors, higher amount of time spent per visit, more number of required personnel or direct payments to informal firms. Finally, wherever they are considered, entry or registration costs, taxes and financial development do not play a significant role in driving informal activity in the above experiments. In the rest of this section, we focus on these non-enforcement drivers of informality in the literature more narrowly.

2.2 Other determinants of informality

2.2.1 Registration costs

The studies discussed in the previous section suggest little impact of registration or entry costs in determining informality. This is in contrast to Djankov et al. (2002) who find, across 85 developed and developing economies, that firms have significant entry costs, both in terms of time and monetary fees for registration and licensing. Stricter entry regulation is associated with higher levels of corruption and a larger size of the unofficial economy in their study.

Rothenburg et al. (2016) evaluate the impact of Indonesia's one-stop-shops for business

registration program, a large-scale program that attempted to reduce registration costs. They find both that the program had no effects on firms informality rates, and also that it did not reduce the probability that workers were informally employed. Galian et al. (2017) analyze the impact of the elimination of the initial fixed costs of registration on the decision of informal firms to operate formally in Bogota, Colombia. They find that substantial reductions in the fixed costs of operating formally are not effective in formalization choices, since such reductions had no lasting effect on formalization decisions. Using panel data from the Mexican employment survey, Bruhn (2011) studies the effect of a business registration reform in Mexico. She finds that the reform increased the number of registered businesses by 5 percent in eligible industries. This increase, however, was due to former wage earners opening businesses. Former unregistered business owners were not more likely to register their business after the reform.

2.2.2 Tax rates

Like entry costs, the literature finds mixed evidence of the effect of taxes on informality. For instance, both Johnson et al (1998) and Friedman (2001), discussed earlier, find that higher taxes lower informality but they find the effect vanishes when proper controls (such as rule of law or income) are introduced. Other studies, especially those focusing on developing countries tend to find that informality increases with taxes. For instance, Djankov (2010) present data on effective corporate income tax rates in 85 countries in 2004. And find that, among other things, corporate tax rates are correlated with the size of the informal economy and the results are robust to the inclusion of many controls. Schneider et al. (2010) present estimates of shadow economies for 162 countries, including developing, Eastern European, Central Asian, and high-income countries over the period 1999 to 2007. The driving forces of the shadow economy, according to them, are an increased burden of taxation (both direct and indirect), combined with labor market regulations and the quality of public goods and services. Monteiro et al (2012) evaluate the impact of a program of bureaucracy simplification and tax reduction on formality among Brazilian microenterprises the SIMPLES program. They document an increase of 13 percentage points in formal licensing among retail firms but no impact on construc-

tion, transportation, services and manufacturing sectors. Higher taxes therefore, are not unambiguously associated with higher informality. Mitra (2017) provides an explanation for the mixed results related to taxation and informality. She argues that higher tax enforcement is generally associated with more developed countries and therefore studies focusing on these economies tend to find a negative relationship between taxes and informality while studies focusing on developing economies find the opposite. Mitra (2017) calculates a threshold level of tax enforcement beyond which informality is decreasing in taxes while it is increasing in taxes below this threshold.

2.2.3 Financial development

The level of financial development of an economy is also counted as among the determinants of informality and studied widely. However, as with other non-enforcement related determinants of informality, the results are, at best, mixed here too. Straub (2005) build a model of firms' choice between formality and informality. Complying with costly registration procedures in their model allows the firms to benefit from key public goods, enforcement of property rights and contracts, that make the participation in the formal credit market possible. In a moral hazard framework with credit rationing, their decision is shaped by the interaction between the cost of entry into formality, and the relative efficiency of formal versus informal credit mechanisms and their related institutional arrangements.

Capasso and Jappelli (2013) provide a theoretical and empirical exposition of the relation. In their theoretical set-up agents allocate investment between a low-return technology which can be operated with internal funds, and a high-return technology which requires external finance. Firms can reduce the cost of funding by disclosing part or all of their assets and pledging them as collateral. The disclosure decision, however, also involves higher tax payments and reduces tax evasion. They show that financial development (a reduction in the cost of external finance) can reduce tax evasion and the size of the underground economy. Using Italian microeconomic data they find that local financial development is associated with a smaller size of the underground economy, controlling

for the potential heterogeneity of financial development and other determinants of the underground economy.

Blackburn et al. (2012) study the relationship between the underground economy and financial development in a model of tax evasion and bank intermediation. Agents with heterogeneous skills seek loans in order to undertake risky investment projects. Agents choose how much of their income to declare by trading off their incentives to offer collateral against their disincentives to comply with tax obligations. The key implication of the analysis is that the marginal net benefit of income disclosure increases with the level of financial development. They find that the lower the stage of financial development, the higher is the incidence of tax evasion and the greater is the size of the underground economy. Antunes and Cavalcanti (2007) examine how much of the difference in the size of the informal sector and in per capita income across countries can be accounted for by regulation costs and enforcement of financial contracts. They construct and solve numerically a general equilibrium model with credit constrained heterogeneous agents, occupational choices over formal and informal businesses, financial frictions and a government sector which imposes taxes and regulations on formal firms. The benefit from formalization is better access to outside finance. Their quantitative exercises suggest that regulation costs and not the level of contract enforcement account for differences in the size of the informal sector between United States and Mediterranean Europe. However, for a developing country like Peru, contract enforcement and regulation costs are equally important in accounting for the size of the informal sector. Finally, D'Erasmus and Boedo (2012) provides a model of formal and informal sectors where differences in entry costs and debt enforcement can account for differences in the size of the informal sector and total factor productivity across countries.

3 Revisiting the empirical Rule of Law effect

Liu-Evans and Mitra (2019), while focusing on establishing the relevance of banking sector stability to informal sector size, also conclude that Rule of Law is the most important

institutional variable. Using several different samples of countries corresponding to different levels of financial development, and different sets of control variables (e.g. with and without interaction terms) Rule of Law is selected by the rigorous lasso as an important predictor of informality as a % of GDP (as estimated by Schneider et al, 2010) from a relatively large set of possible control variables. Across these same samples, it is found to be highly significant by the corresponding lasso-based treatment test due to Belloni et al (2014).

We add to this by providing for the Rule of Law effect a similar subsample robustness analysis to what has been presented in Liu-Evans and Mitra (2019) for the banking stability effect. The same methodology is used for estimating and testing the treatment effect of Rule of Law, along with the same data set. In particular, the set of possible control variables and suggested interaction terms sums to 56 variables in total and the observations are for subsamples of 84 countries (by income level, level of financial development, or random), using three-year average values over 2005-7. This included a set of macroeconomic controls, fifteen institutions variables besides Rule of Law, and a measure of bank stability.

The institutions variables are comprised of the six World Governance Indicators made available by the World Bank - *Voice and Accountability*, *Political Stability and Absence of Violence*, *Government Effectiveness*, *Regulatory Quality*, *Rule of Law*, *Control of Corruption* - and ten measures of Economic Freedom supplied by the Heritage Foundation - *Property Rights*, *Freedom from Corruption*, *Government Spending*, *Business Freedom*, *Labor Freedom*, *Monetary Freedom*, *Trade Freedom*, *Investment Freedom*, *Financial freedom*, and *Fiscal Freedom*. The macroeconomic controls sourced from the World Development Indicators dataset at the World Bank are *tax rate* (total tax revenue as a % of GDP), *unemployment*, *inflation* (CPI), the *real interest rate*, and *GDP per capita*. The two financial system variables, *bank stability* (aggregate bank Z-score) and *FD* (Domestic Credit to the Private Sector as a % of GDP), were taken from the Global Financial Development Database (GFDD) provided by the World Bank. Between our institutional variables, other than Rule of Law, and macroeconomic controls we capture all the non-enforcement related potential drivers of informality as identified in the literature review

of Section 2.

The following model is considered for the informal sector size:

$$\begin{aligned} inform_i = & \alpha_0 Rule\ of\ Law_i + \gamma_1' other\ institutions_i + \gamma_2' financial\ system_i \\ & + \gamma_3' macroeconomic_i + \gamma_4' interactions_i + \varepsilon_i \end{aligned} \quad (1)$$

where i is the country index. The term $other\ institutions_i$ is a vector of the 15 measures above, while $financial\ system_i$ is a vector with two entries: $bank\ stability$ and FD . The macroeconomic controls, including $tax\ rate$, are collected in $macroeconomic_i$, while $interactions_i$ is comprised of interactions of $Rule\ of\ Law_i$, and $other\ institutions_i$ with $tax\ rate$ and with FD , and of the interaction of $tax\ rate$ with FD .

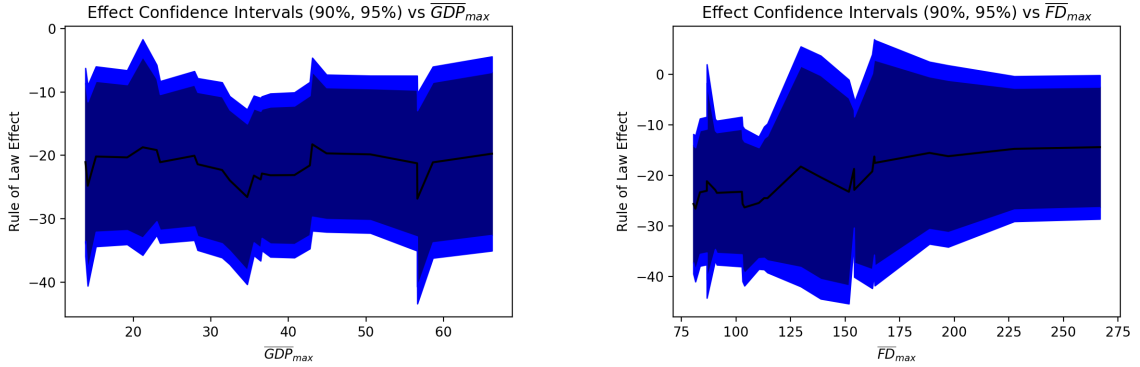


Figure 1: Rule of Law effect by GDP and FD (rolling windows). Left panel: Rule of Law effects and confidence intervals for a rolling window of 60 countries after ordering the countries by GDP, with \overline{GDP}_{max} being the maximum GDP in a given window. Right panel: the same, but ordering by FD, with \overline{FD}_{max} being the maximum FD in a given window

The Rule of Law effect emerges clearly in Figures 1 and 2. The effect is negative throughout, and samples of countries with an insignificant effect are rare. Figure 1 illustrates the estimated effect of Rule of Law on informal sector size for rolling windows of 60 countries ordered by GDP per capita (left) and by FD (right) along with confidence intervals. The effect is negative and, in all but a few windows, significant at the 5% level. The results show that the Rule of Law effect is robust to country income level, and the results provide further support for the robustness of the Rule of Law effect at different levels of FD.

Liu-Evans and Mitra (2019) found the effect to be significant using the whole sample but also for countries with values for the FD measure below 100% and below 75%. Figure 2 illustrates the estimated effect and significance in random subsamples of countries - for the vast majority of subsamples the effect is found to be significant at the 5% level, and it is always estimated to be negative.

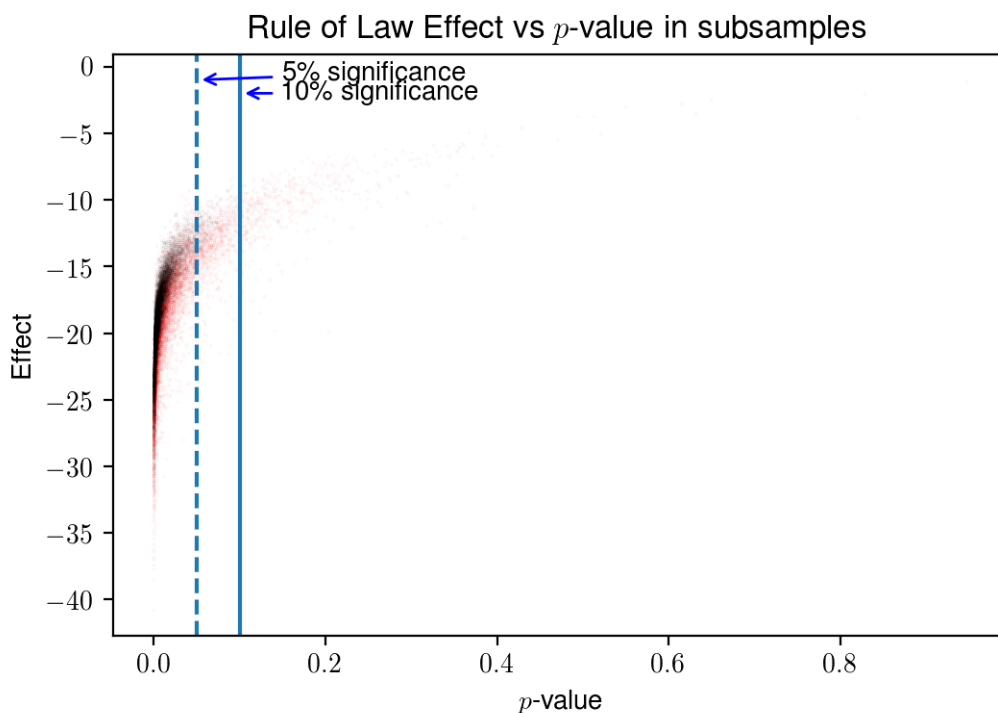


Figure 2: Rule of Law effect in random subsamples of countries. Rule of Law effects and test p -values for 10,000 randomly chosen groups of 70 countries (black dots) and 60 countries (red dots).

The empirical analysis of this section and the papers reviewed in the previous section show that while tax enforcement is unambiguously associated, both theoretically and empirically, with lower informality, the same is not the case with other potential factors affecting informality such as regulation, registration costs, tax rates (and relatedly, tax burden, tax complexity) and financial development. This is not to say that these factors do not play a role. Obviously, as many of the papers discussed in Section 2 find, one or more of the non-enforcement related factors often play a significant role in driving informality. These findings however, are country (or country-groups) or study and context specific. Rule of law, or tax enforcement, for which rule of law is a proxy in this literature,

seems to matter always (and everywhere). This is especially intriguing when considering developing economies, which are often cash-strapped and under pressure to step up their tax enforcement programs. This, along with the substantial costs identified in Section 2 that are associated with higher tax enforcement in these economies, motivates us to understand the welfare effects of tax enforcement. This is what we focus on next.

4 Model with costly tax enforcement

In this section we lay out a simple theoretical framework with formal and informal firms and financial frictions, to understand the welfare effects of tax enforcement in the presence of enforcement costs. The set-up closely follows a non-monetary version of Koreshkova (2006).

The economy is composed of entrepreneurs and households both of whom maximize their discounted lifetime utility from consumption. The main difference between the two is that the entrepreneurs own production technology while the household does not. Entrepreneurs hire labor from households and combine it with technology to competitively produce a homogenous consumption good. Households, aside from supplying labor to entrepreneurs in exchange for a competitive wage, also lend to them.

Entrepreneurs maximize consumption over their lifetime as follows,

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

where $i = 1, 2$ stands for formal and informal entrepreneurs respectively. c is their consumption in period t and γ is the rate at which the entrepreneurs discount the future.

As in Koreshkova (2006), the formal entrepreneur operates a constant-returns-to-scale technology, $y_{1,t+1} = A_{1,t}(l_{1,t})$, while the informal business is subject to decreasing returns to scale, or $y_{2,t+1} = A_{2,t}(l_{2,t})^\alpha$. The latter reflects the fact that informal entrepreneurs face limits in operating their business. This is corroborated by the empirical results of

Taymaz (2009) and the recent work of Amin and Islam (2015). Amin and Islam (2015) list a number of reasons why the cost of informal firms increase as they grow in size, from being targeted by corrupt government officials to being more susceptible to crimes, and being outside the purview of legal protection of the state, these firms may have to devote resources to protect property rights and enforce agreements etc.

y_i is output and l_i is labor in each sector. α is labor's income share and $A_{i,t}$ are the sectoral productivities at date t such that $A_{2,t}/A_{1,t} < 1$. In other words, the informal entrepreneur is less productive than their formal counterpart as documented by Gerxhani (2004) and La Porta and Shleifer (2008) for developing economies.

Labor hired in period t produces output in period $t + 1$ indicating that there is a working capital constraint in production. In other words, labor which is the working capital of the entrepreneurs, needs to be hired and paid for today for output that will only be available tomorrow. This is a common feature of production in developing economies where part or all of the input cost has to be paid for before production can be completed (Neumeyer and Perri, 2005 and Li, 2011). The need to finance the wage bill today creates a need for borrowing. This feature of our model is similar to Aoki, Benigno and Kiyotaki (2010) and Aoki and Nikolov (2015). Following these authors, we allow for limited commitment in credit markets, which implies agents will only honour their promises if it is in their interest to do so. In other words, we assume that a fraction of the output generated by entrepreneurs can be seized by creditors, households in this case, in the event of non-repayment by entrepreneurs. Since creditors already know how much they can plausibly recover in the event of a default, they do not go above this limit when lending in the first place. Hence the collateral constraint takes the form,

$$R_t b_{1,t} \leq \theta y_{1,t}, \tag{2}$$

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 their income up to which they can borrow. θ represents the fraction of the entrepreneurs' income the creditors can recover in case of a default and it can be plausibly thought of as depending on factors like intermediation

costs, debt enforcement, availability of credit market instruments and the quality of financial markets and institutions in the economy. In other words, θ is a measure of the level of financial development and a higher θ implies more developed domestic financial institutions and therefore higher possible borrowing by formal entrepreneurs.

Since borrowing occurs against taxable income and informal firms, by definition, hide their output in order to evade taxes, it implies that the informal sector cannot participate in formal credit markets. We therefore assume the following borrowing constraint for the informal sector,

$$R_t b_{2,t} \leq 0. \tag{3}$$

This discrepancy in borrowing constraints between formal and informal firms has been documented by both micro and macro studies in economics. La Porta and Shleifer (2008) report that in less developed economies, both formal and informal firms perceive a lack of access to finance as an obstacle, but it is a much greater problem for the informal sector. They find that roughly 75.1% of the unregistered informal firms have never had a commercial loan, financing instead 74.9% of investment with internal funds and 10.5% with help from the family. Kenyon (2008) finds that firms that are evading taxes are less likely to undergo an independent audit and are more likely to be asked for informal payments by the tax authorities. As a consequence of the former, they may also be less likely to participate in modern capital markets. We therefore assume that the formal and informal sectors face heterogeneous borrowing constraints. We show later that the borrowing constraints for both formal and informal entrepreneurs are binding in equilibrium, such that $R_t b_{1,t} = \theta y_{1,t}$ and $R_t b_{2,t} = 0$.

Given the definition of informality in Section 1, output in the formal sector is taxed while that in the informal sector is not, implying the following budget constraints for the entrepreneurs,

$$c_{1,t} + w_t l_{1,t} = (1 - \tau)y_{1,t} + b_{1,t} - R_t b_{1,t-1}, \quad (4)$$

$$c_{2,t} + w_t l_{2,t} = (1 - p\tau)y_{2,t} + b_{2,t} - R_t b_{2,t-1}. \quad (5)$$

In both equations, consumption and wage bill on the left is financed by expected after tax income on the right. p is our measure of enforcement - it is the informal agent's probability of being detected. In countries with higher quality of enforcement, that is a better system of audits and fines, p is higher. When caught, if the agent only pays the tax evaded on output at the rate of τ , the value of $p\tau$ ranges from 0 to τ . Alternatively, the informal entrepreneur may be liable to pay a penalty on top of the tax payment. If this penalty is a percent of its output, then the value of $p\tau$ incorporates both the tax rate faced by the formal sector, τ , and the penalty. In this case $p\tau$ can end up being larger than the tax paid by the formal sector. Wage w_t is the real wage and we assume wages are equalized across sectors. Thus we 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, 2006 for a discussion).

The first order conditions (f.o.c.) of the entrepreneurs with respect to labor and borrowing are as follows,

$$w_t \frac{1}{c_{1,t}} = E_t \left(\gamma \frac{1}{c_{1,t+1}} (1 - \tau) + \lambda_{1,t+1} \theta \right) A_{1,t} \quad (6)$$

$$w_t \frac{1}{c_{2,t}} = E_t \left(\gamma \frac{1}{c_{2,t+1}} (1 - p\tau) \right) \alpha \frac{y_{2,t}}{l_{2,t}} \quad (7)$$

$$\frac{1}{c_{i,t}} = E_t \left[\gamma R_{t+1} \frac{1}{c_{i,t+1}} + \lambda_{i,t} R_t \right]. \quad (8)$$

Here λ_i are the Lagrange multipliers for the borrowing constraints faced by the two types of entrepreneurs. Equations (6) and (7) are the f.o.c.'s with respect to labor for the formal and informal entrepreneurs respectively. Entrepreneurs equate the marginal

benefit of hiring an additional unit of labor on the right hand side to its marginal cost on the left which is the wage rate. Note that the marginal benefit of hiring one unit of labor in the formal sector is given not only by its marginal product which is $A_{1,t}$ units of additional output weighted by the marginal utility from additional consumption stemming from it next period, but also by the marginal benefit of being able to borrow more next period. The latter is denoted by the second term of the equation ($\lambda_{t+1}\theta A_{1,t}$) which gives the additional borrowing that these entrepreneurs can do next period from their additional output weighted by the lagrange multiplier. This additional term which depends on the financial development parameter θ , is missing from the labor demand equation of the informal entrepreneurs in equation (7). This makes sense, since these entrepreneurs do not participate in formal credit markets and hence their demand for labor is unaffected by the financial development parameter θ . Equation (8) is the f.o.c. with respect to borrowing for the entrepreneurs where $i = [1, 2]$ stands for formal and informal entrepreneurs respectively. These equations are used later to determine the steady state levels of borrowing by the entrepreneurs.

Households do not own any production technology. They supply labor and lend to the formal sector. They derive utility from consumption and disutility from labor and solve the following problem,

$$\text{Max} \quad \sum_{t=0}^{\infty} \beta^t \left(\ln c_{3,t} - \psi \frac{l_{s,t}^{1+\frac{1}{\eta}}}{(1+\frac{1}{\eta})} \right),$$

where c_3 is household consumption, l_s is labor supplied and β is the household discount factor. ψ is a disutility parameter. Note that as is standard in the literature on collateral constraints, we assume $\beta > \gamma$ which means that entrepreneurs are more impatient than the household (Campbell and Hercowitz (2005), Iacoviello (2005), Iacoviello and Minetti (2007), Iacoviello (2008), Iacoviello and Neri (2010)). This assumption ensures that in equilibrium entrepreneurs borrow from the household and the borrowing constraint

matters as shown in the next section.

Households are subject to the following flow-of-funds constraint:

$$c_{3,t} + R_t b_{3,t-1} = w_t l_{s,t} + b_{3,t} + T R_t. \quad (9)$$

They choose consumption, labor supply and loans to be made every period $(c_{3,t}, l_{s,t}, b_{3,t})$ to maximize utility subject to this constraint. Their first order conditions are given by,

$$\frac{w_t}{c_{3,t}} = l_{s,t}^{1/\eta} \quad (10)$$

$$\frac{1}{c_{3,t}} = \beta R_t E_t \frac{1}{c_{3,t+1}}, \quad (11)$$

where (10) is the total labor supplied by the households and (11) is the Euler equation of households which states that households are indifferent between consuming 1 unit today or R_t units tomorrow, discounted at the rate β .

A government collects $\tau y_{1,t}$ from the formal sector with certainty and $\tau y_{2,t}$ from the informal sector with a probability p , where p is the level of enforcement and total revenue from enforcement is $p\tau y_{2,t}$. As in Prado (2011), we assume that enforcement comes at a cost, given by, $g_{e,t} = kp\tau y_{2,t}$. The government also spends on goods and services produced in the economy $(g_{n,t})$ and such spending is denoted by a fraction μ of total formal output of the economy such that, $g_{n,t} = \mu y_{1,t}$, $\mu \in [0, 1]$. Remaining tax revenues are transferred back to the household. The budget constraint of the government is then given by,

$$G_t = T_t - T R_t. \quad (12)$$

Where $G_t = g_{e,t} + g_{n,t}$ and $T_t = \tau y_{1,t} + p\tau y_{2,t}$.

Market clearing requires total labor demanded equals labor supplied $(l_{1,t} + l_{2,t} = l_{s,t})$, total borrowing equals lending, $(b_{1,t} + b_{2,t} + b_{3,t} = 0)$, and the goods market clears such

that, $(c_{1,t} + c_{2,t} + c_{3,t} + g_{e,t} + g_{n,t} = y_{1,t} + y_{2,t})$.

Steady state analysis

Equation (8) at steady state can be written as,

$$1 = (\gamma + \lambda_i c_i)R, \quad (13)$$

while from equation (11),

$$R = 1/\beta. \quad (14)$$

Substituting equation (14) into (13) and solving for λ_i gives us,

$$\lambda_i = (\beta - \gamma)1/c_i > 0. \quad (15)$$

Recall λ_i is the lagrange multiplier associated with the entrepreneurs' borrowing constraints and from equation (14) this multiplier is positive implying that the borrowing constraint is binding for both entrepreneurs, that is, $R_t b_{1,t} = \theta y_{1,t}$ and $R_t b_{2,t} = 0$ in equilibrium.

Equation (15) can be substituted into the steady state versions of equations (5) and (6) to give us the steady state values of l_1 and l_2 . Their ratio then gives us the steady state informal sector size as follows.

$$l_2 = \left(\frac{\gamma(1 - p\tau)\alpha\phi}{\gamma(1 - \tau) + (\beta - \gamma)\theta} \right)^{\frac{1}{1-\alpha}}. \quad (16)$$

From equation (16), it is straightforward to see that $\frac{\delta l_2}{\delta p} < 0$. That is, a rise in enforcement, p , lowers the informal sector size, l_2 . This confirms the well-known result in the literature that higher tax enforcement reduces informality. We are however, interested in understanding how tax enforcement affects welfare, given its effectiveness in lowering informality and hence its desirability as a policy tool in economies with large informal sectors. Writing equation (12) as,

$$\begin{aligned}
TR &= T - G, & (17) \\
&= \tau y_{1,t} + p\tau y_{2,t} - g_{e,t} - g_{n,t} \\
&= (\tau - \mu)y_1 + (1 - k)p\tau y_2,
\end{aligned}$$

it is clear that transfers are negatively related to enforcement costs k . As costs increase, transfers to households fall causing household consumption to rise less with enforcement. For large enough k , an increase in enforcement causes the rise in TR to be small enough such that the resulting increase in household consumption is lower than the decrease in the informal entrepreneur's consumption, causing welfare to fall. Let us call this the critical value of k for ease of reference.

Note also from equation (17) that TR is decreasing in μ , the non-enforcement related, unproductive government expenditure parameter. An implication of this is that the critical value of k is lower for higher μ . Intuitively, a larger share of tax revenues spent on unproductive government expenditures implies household transfers are smaller to begin with. Thus household consumption changes less with enforcement making changes in the informal entrepreneur's consumption play a larger role in determining the effect on aggregate consumption. In other words, for the same increase in enforcement, the fall in informal sector's consumption has a larger effect on welfare when μ is higher. Thus when μ is higher, the critical values of k is smaller. We study these effects quantitatively in the next section after assigning plausible values to the model's parameters based on

aggregate data from developing economies using both the literature and our dataset from Section 3.

5 Quantitative results

Calibration

We assume the model's time period to be an year and set the household discount factor to $\beta = 0.94$, corresponding to an annual interest rate of 6% in developing economies (similar to Chatterjee and Turnovsky, 2018; Ozbilgin, 2010; Aguiar and Gopinath, 2007). As noted in Chatterjee and Turnovsky (2018) the value of the discount factor for developing economies tend to be slightly higher than that used in macro-growth literature to reflect the relative impatience of households in these economies as well as higher mortality rates which end up raising the rate of time preference. The entrepreneurs' discount factor is set to $\gamma = 0.80$, such that $\gamma < \beta$ which guarantees the impatience motive of the entrepreneurs relative to the households in the economy and makes the borrowing constraints bind.

We set η , the Frisch elasticity of labor supply, to a standard value of 2 (Cho and Cooley, 1994, 1995). ψ , the disutility parameter of the household, is set to 1 which ensures that the household spends a third of their time working, that is, $l_s = 0.3$. The elasticity of labor in informal production, α is set to 0.68, in line with Koreshkova (2006) and Turnovsky and Basher (2009). Let $A_2/A_1 = \phi$, $\phi < 1$. Assuming the productivity of the formal sector as numeraire, we set $\phi = 0.48$, consistent with the evidence in La Porta and Shleifer (2008).

Total tax rate as a share of commercial profits is from the WDI database used in our empirical analysis in Section 3. We calibrate the tax rate to $\tau = 0.4$ which is the average tax rate in the sample excluding countries with either financial development (FD) or tax rate above 100%. The FD parameter, θ , measured as domestic credit to private sector (% of GDP) in the WDI, is set to the average of 0.5 in our sample. We conduct sensitivity analyses using alternative values of tax rates and FD in Section 5.2 below.

The cost of enforcement, k , is the fraction of tax revenues spent on enforcement related

activities. As mentioned earlier developing economies are mainly characterized by a large number of very small firms and the cost of increasing monitoring of a large number of small firms is likely to be substantial. In the study by Benhassine et al (2017) discussed in Section 1, for instance, the cost of increasing enforcement exceeds the increase in tax revenue generated, implying $k > 1$. Prado (2011) assumes $k = 1$, which implies that all revenues earned via tax enforcement is used up in the process. Since the purpose of this paper is to understand how the enforcement-welfare relationship is affected by enforcement costs, we assume a range of values for k in this paper. More specifically, we assume $k = \{0, 0.5, 1, 1.25\}$.

The government expenditure parameter, μ , is important for how enforcement costs affect the enforcement-welfare relationship as discussed above. To calibrate this parameter, for the same set of countries used to parametrize tax rate above, we use the general government final consumption expenditure (% of GDP), from the WDI database. This value ranges from 5% in Bangladesh to 20% in Brazil and South Africa and these are all high informality economies according to Schneider et al (2010, Table 3.3.5, pp 25) (30-40% informal output share). We therefore consider once again a range for μ given by, $\mu = \{0, 0.1, 0.2\}$ in the quantitative exercises below.

5.1 Results

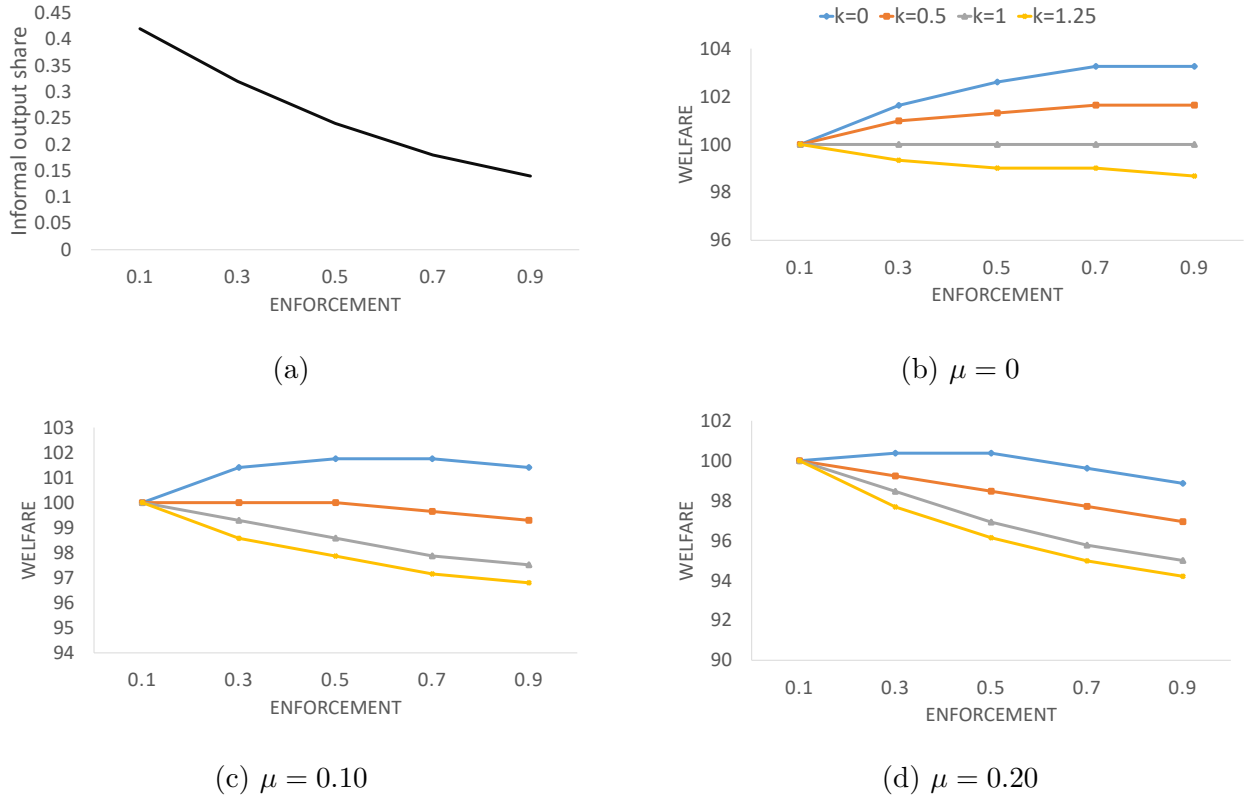


Figure 3: Response of informality and welfare (indexed) to enforcement changes for different enforcement costs (k) and unproductive government expenditures (μ). Informality is defined as the ratio of informal to formal output (y_2/y_1).

As predicted by equation (16), informality falls with enforcement in panel (a) of Figure 3. It decreases from 42% at $p = 0.1$ to 14% at $p = 0.9$, a 67% drop. While this drop in the informal sector size is unaffected by changes in enforcement costs (k) or government expenditures (μ), from panels (b) to (d), it is clear that the effect of enforcement on welfare varies with changes in k and μ . For ease of comparison of the slopes (that is *changes* in welfare with enforcement), we index all curves in panels b-d such that their initial values are always 100. In other words, steeper slopes imply larger changes in welfare.

When $\mu = 0$, there is no unproductive expenditure and enforcement is welfare-increasing for all $k < 1$ in panel (b). At $k = 1$ welfare is unaffected by enforcement changes and at $k = 1.25$, welfare falls with enforcement. Thus, absent any non-enforcement related unproductive government spending, enforcement is welfare-reducing when enforcement

costs are significantly high, that is, when costs exceed the tax revenues generated from the enforcement increase. Specifically, as enforcement (p) rises from 0.1 to 0.9, welfare rises by 3.3% when $k = 0$, by 1.6% when $k = 0.5$, remains unchanged at $k = 1$ and falls by 1.3% when $k = 1.25$.

For $\mu = 0.1$, in panel c, enforcement is welfare-reducing for all non-zero values of k considered. In other words, for the same increase in enforcement as above, welfare increases by 1.4% at $k = 0$, falls by 1% when $k = 0.5$, falls by 2.5% when $k = 1$ and falls by 3.2% when $k = 1.25$.

Finally, at $\mu = 0.2$, enforcement is welfare-reducing even when $k = 0$. Specifically, in this case, for the same increase in p , welfare falls by 1% when $k = 0$, falls by 3.1% when $k = 0.5$, falls by 5% at $k = 1$ and falls by 5.8% when $k = 1.25$. Thus welfare losses stemming from raising enforcement is large in economies with significant inefficiencies in government spending and positive enforcement costs serve to multiply the effect. That is, when μ is large, then even with costless enforcement, the share of additional tax revenues generated by higher enforcement, that is transferred to households, is too low to increase household consumption enough to offset the fall in informal sector consumption. In this case, an increase in enforcement reduces welfare even if it costs little or nothing to do so.

p	$k = 0$				$k = 0.5$				$k = 1$			
	0.10 (I)	0.5 (II)	0.9 (III)	$(III)/(I)$	0.10 (I)	0.5 (II)	0.9 (III)	$(III)/(I)$	0.10 (I)	0.5 (II)	0.9 (III)	$(III)/(I)$
c_1	0.004	0.005	0.006	1.5	0.004	0.005	0.006	1.5	0.004	0.005	0.006	1.5
c_2	0.04	0.022	0.011	0.275	0.04	0.022	0.011	0.275	0.04	0.022	0.011	0.275
c_3	0.242	0.262	0.272	1.12	0.24	0.256	0.265	1.10	0.238	0.250	0.258	1.08
C	0.285	0.29	0.289	1.01	0.283	0.284	0.281	0.99	0.282	0.278	0.275	0.975

Table 1: Changes in sectoral consumption with enforcement for different values of k , for $\mu = 0.1$

Table 1 presents the breakdown of aggregate private consumption by sector. Note that while there is a large increase in formal entrepreneur's consumption (c_1) with enforcement, the share of this entrepreneur's consumption in the total is quite small at 1-3% and therefore, it does not affect the welfare results in any key way. The main trade-off is between the falling consumption of the informal entrepreneur and the rising consumption of the household as enforcement increases. Informal entrepreneur's consumption falls

substantially with enforcement while household consumption rises. While the change in informal sector consumption with enforcement is much larger than that of the household, the latter's share in aggregate consumption is by far the largest (85-94% depending on p and k), causing small changes in this sector's consumption to matter a lot.

Aggregate consumption rises with enforcement for $k = 0$ but falls for the positive values of k considered. Again, the main reason is that higher enforcement costs make for smaller increases in household transfers as discussed in Section 3, causing the increase in household consumption with rising enforcement to be lower. This is clearly seen in Table 1, where c_3 increases by 12%, 10% and 8% respectively for $k = \{0, 0.5, 1\}$. Since the two entrepreneurs do not receive any transfers from the government, the change in their consumption with enforcement is not affected by a varying k . Initially, for $k = 0$, the increase in household consumption is large enough that it overwhelms the decrease in informal sector consumption causing aggregate consumption and hence welfare to rise. As k rises and the % increase in household consumption falls, eventually the net increase in household consumption falls short of the decrease in informal sector consumption causing welfare to decline as is the case under $k = 0.5$ and $k = 1$ in Table 1. All these values (in Table 1) are obtained under a fixed μ of 0.1.

5.2 Sensitivity analysis

In this section we briefly present results of the model for i) a lower tax rate and ii) a higher level of financial development, than in the benchmark model. The idea is to test if the results are sensitive to either of these key variables since degrees of taxation (τ) and financial market development (θ) differ across the range of the developing economies considered in the previous section. The calibration of the benchmark model in considers an average of the values of these variables in the data but the truth is, these values can vary significantly across countries. Moreover, the informal sector literature often finds important roles for both tax rates and financial development in determining informality, although there is a general lack of consensus on the direction and significance of these effects (Friedman et al, 2000; Straub, 2005; Dabla-Norris et al, 2008). Particularly, the

results on tax rates seem to differ based on whether developed, developing or transition economies are considered (see for example, Thieben (2003), Aruoba (2010) and Mitra (2017)).

Welfare						
k	$\tau = 0.3$			$\theta = 0.75$		
	$p = 0.1$	$p = 0.9$	% change	$p = 0.1$	$p = 0.9$	% change
0	0.374	0.374	0%	0.324	0.324	0%
0.5	0.373	0.369	-1.1%	0.32	0.318	-0.6%
1	0.372	0.363	-2.4%	0.032	0.312	-2.5%
1.25	0.371	0.36	-3%	0.32	0.309	-3.4%

Table 2: Sensitivity analysis of welfare changes with enforcement (for $\mu = 0.1$)

In Table 2, we present the welfare changes due to the same increase in enforcement as in Section 4 above and for the same set of enforcement costs but first, for a lower tax rate and second, for a higher level of financial development. We keep the value of μ , the level of unproductive government expenditures, fixed at $\mu = 0.1$ in these exercises. Note that for the costless enforcement case of $k = 0$, there is no change in welfare with enforcement, under both alternatives. Moreover as in the benchmark case in Section 4.2 with $\mu = 0.1$, in Table 2 enforcement is welfare-reducing for all non-zero values of k considered. Specifically, the change in welfare for positive enforcement costs ranges between -0.6% to -3% in Table 2, rendering the model's results quite robust to alternative parameter values for taxation and financial development.

6 Conclusion

The literature unequivocally finds a negative impact of tax enforcement on the share of informal activity in an economy. This is in contrast to other potential drivers of informality (like tax rates, financial development, formal sector registration or entry costs etc.) the effects of which are not always clear cut. Liu-Evans and Mitra (2019) find rule of law (the closest proxy to tax enforcement and widely used in empirical studies) is the most important institutional variable for determining informal sector size. Out of sixteen measures of institution quality considered, and after allowing for a large number

of interaction terms via a robust lasso methodology, the World Governance Indicator measure Rule of Law was selected throughout and found to be highly significant. We provide further robustness analysis in this paper of the effect of rule of law on informality using the same methodology as these authors.

Given the unambiguous effect of tax enforcement on informality both in the literature and in our data, and the substantial enforcement costs in developing economies identified by the literature, we also study the welfare effect of firm tax enforcement. We do so in a simple general equilibrium framework with representative formal and informal firms and financial frictions. Welfare, measured by aggregate private consumption, falls with rising enforcement for low to moderately high enforcement costs under plausible parameter values. Our results suggest, stepping up enforcement is not always the most desirable policy tool in the presence of a large informal sector. It is better in these cases, to look at other country- or region-specific drivers of informality, a host of which have been discussed in the literature review section of this paper, to lower informality without sacrificing welfare.

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