

Borradores Departamento de Economía

N° 54

Enero de 2015

Informality and Macroeconomic Volatility: Do Credit Constraints Matter?

Elaborado por:

Catalina Granda-Carvajal

Este documento fue elaborado en el marco del proyecto de investigación “Restricciones de endeudamiento en el sector informal: Implicaciones para la volatilidad macroeconómica”, financiado por el CODI en virtud de la convocatoria *Apoyo al primer proyecto de profesores de la Universidad de Antioquia 2011*, y constituye una versión sustancialmente revisada del tercer capítulo de la disertación doctoral de la autora.



**FACULTAD DE CIENCIAS
ECONÓMICAS**

**DEPARTAMENTO DE
ECONOMÍA**

Medellín - Colombia

La serie Borradores Departamento de Economía está conformada por documentos de carácter provisional en los que se presentan avances de proyectos y actividades de investigación, con miras a su publicación posterior en revistas o libros nacionales e internacionales. El contenido de los Borradores es responsabilidad de los autores y no compromete a la institución.

[Click aquí para consultar todos los borradores en texto completo](#)

*Informality and Macroeconomic Volatility:
Do Credit Constraints Matter?*

Catalina Granda-Carvajal*

*1 Introduction - 2 The model - 3 Calibration - 4 Results - 5
Concluding remarks – References - Appendices*

Abstract:

Hiding operations from tax collectors increases information asymmetries between borrowers and lenders and ultimately reduces firms' access to finance. However, credit-constrained entrepreneurs can still fund investment by paying it out of their own savings. This paper studies these implications of borrowing constraints characterizing the informal sector for macroeconomic volatility. To this end, the author develops a simple dynamic stochastic general equilibrium model featuring tax avoidance and evasion opportunities. In the model, registered production not only is the basis to determine tax liabilities, but also serves as collateral for securing debts. Such a framework allows for endogenization of the extent of undeclared activity, and for analyzing the effect of informality on aggregate fluctuations through computational experiments. These experiments show that the borrowing-constrained informal sector exerts a non-negligible influence on the cyclical volatility of consumption and investment. Some qualifications and extensions conclude this work.

Keywords: Informal economy, tax evasion, credit constraints, macroeconomic volatility.

JEL codes: E26, E32, E44, H26, O17

* This paper is an extensively revised version of the third chapter of my dissertation. I am indebted to Christian Zimmermann and Shalini Mitra for valuable comments in earlier stages. I also have benefited from suggestions from seminar participants at the University of Connecticut, University of Münster, Bocconi University, Université du Maine and Universidad de Antioquia. In particular, I would like to thank Jordi Caballé, Stéphane Gauthier, François Langot, Julio Leal-Ordóñez, Remberto Rhenals, Bernd Theilen and one anonymous referee for encouragement and helpful discussions. All errors, however, are my own. Financial assistance from Universidad de Antioquia through the CODI Research Fund is gratefully acknowledged.

1 Introduction

This paper addresses the implications for macroeconomic volatility of credit constraints characterizing the informal economy. It has been well documented that firms in such an economy typically under-report their operations and do not resort to formal capital markets (Straub, 2005). While this *modus operandi* enables them to hide their activities from tax collectors, it also reflects information asymmetries between borrowers and lenders that reduce incentives for financiers to loan. This argument is formalized here through a simple dynamic stochastic general equilibrium model featuring several attributes observed in corporate income tax structures and debt enforcement procedures around the world. In such a framework, the extent of unrecorded production is endogenized allowing for computational experiments to analyze how the extent of undeclared activity and its determinants affect the cyclical volatility of macroeconomic aggregates like consumption and investment.

Firms engaged in the informal sector must trade off the potentially larger profits from lack of transparency with the higher risk of detection and the lower access to credit that the concealment decision entails. While their incentives to operate informally are shaped by the possibility of reducing or eliminating tax liabilities and avoiding presumably burdensome regulations, being outside the government's purview also means they may not have access to markets for external finance and formal contract enforcement mechanisms. Banks and other financial institutions are generally unwilling to grant credit to enterprises that lack proper documentation. Moreover, if to evade taxes companies do not officially declare all assets, their ability to use them as collateral for loans is limited. Their financial statements, further, may not provide an accurate representation of their financial soundness and economic prospects, thereby reducing their attractiveness to potential lenders.^[1]

These observations have recently found support in a number of theoretical and empirical studies focusing on the relation between access to credit and the extent of the shadow economy. Ellul *et al.* (2012) argue that the trade-off between the funding benefits and the tax costs of accounting transparency varies considerably across firms and countries depending on the corporate tax rate, the degree of tax enforcement and on a company's need for external finance. Furthermore, Gatti and Honorati (2008) and Dabla-Norris and Koeda (2008) find evidence that higher tax evasion is significantly and robustly associated with lower access to formal credit, with a higher reliance on informal sources of financing (e.g. family, friends and money lenders), and with firms' propensity to report availability of finance as an obstacle to their operations. Such findings are certainly in line with Capasso and Japelli (2013) and Bose *et al.* (2012), who show that financial and banking development play an important role in reducing the size of shadow economic activities.

^[1] Conversely, it is likely that the same information that is used to signal creditworthiness to financial institutions make firms operations easier to monitor for tax purposes (see Gordon & Li, 2009).

One criticism that can be raised on these studies is that they tend to ignore the possibility of self-financing. In contrast to this view, the literature dealing with general-equilibrium models of heterogeneous agents that are subject to borrowing constraints and idiosyncratic productivity shocks posits that credit-constrained firms can accumulate internal funds to substitute for the lack of external finance. Moll (2014), in this regard, underscores productive entrepreneurs that cannot acquire capital in the market may still self-finance investment in the sense of paying it out of their own savings. Furthermore, Covas (2006) shows that the interaction of uninsurable production risks and financial frictions induces in poorly diversified entrepreneurs a strong precautionary savings motive that in turn leads to capital over-accumulation.

While the existing literature on the macroeconomic implications of financial restrictions characterizing the unofficial economy focuses on growth and development (see, e.g., La Porta and Shleifer, 2008; Dabla-Norris and Feltenstein, 2005), very few studies have addressed the consequences on short-run aggregate fluctuations. Restrepo-Echavarría (2014) documents a systematically high correlation between the relative volatility of cyclical consumption to output and the extent of the unrecorded sector. Furthermore, Ferreira-Tiryaki (2008) and Granda-Carvajal (2010) present evidence suggesting that countries with a sizeable shadow economy tend to undergo increased volatility of output, investment and consumption over the business cycle. This evidence is partially challenged by Finkelstein Shapiro (2015), who finds no significant relationship between informality and output volatility once it is controlled for other determinants of the variability of output.

To explain these patterns of aggregate volatility, Finkelstein Shapiro (2015) shows that the root cause of changes in informal sector size matters for the relationship between informality and both long- and short-run macroeconomic performance. In addition, Restrepo-Echavarría (2014) argues that poor measurement of the informal sector complements other mechanisms proposed in the literature on emerging market economies to account for high consumption volatility. Mitra (2013) resorts to one of such mechanisms, a working capital constraint, to claim in favor of the seemingly counterfactual idea that informality lowers consumption volatility by offsetting the effect of financial development. Finally, Ferreira-Tiryaki (2008) conjectures that a large informal sector leads to higher volatility because firms therein are credit constrained and thus cannot smooth fluctuations in cash flows. Despite their focus on financial issues, none of the latter studies takes the role of firms' potential self-financing into account.

This paper addresses the implications for macroeconomic volatility of informal firms' borrowing constraints using a simple dynamic stochastic general equilibrium model featuring tax evasion opportunities. The proposed approach has some similarity to Jermann and Quadrini (2012), in that firms prefer debt over equity due to its tax advantage. In the model, registered activity not only is subject to taxation, but also can be used to signal creditworthiness to potential lenders. Hence tax evasion has two countervailing effects on firms' access to finance: On the one hand, it worsens the terms and conditions of loan contracts by reducing the collateral that can be offered for securing debts. On the other hand, the concealed liabilities enable investment financing by raising internal sources of funds.

While the former effect lowers the amount of credit provided and causes aggregate volatility to rise, the latter one leads to a fall in the relative variability of consumption and investment.

The paper is organized as follows. Section 2 describes the model in detail. Then, the model is calibrated in the third section. Section 4 displays the results of computational experiments allowing for variations in the determinants of the extent of undeclared production, among other relevant parameters. These experiments support the prevalence of a self-financing channel, so that credit constraints in the informal sector exert a volatility-lowering influence on aggregate fluctuations. The last section concludes by highlighting some possible extensions and qualifications.

2 The model

This section develops a simple dynamic stochastic general equilibrium model with credit constraints and tax evasion opportunities. The model is similar to the one of Jermann and Quadrini (2012) in that the tax structure matters for the relevance of the borrowing constraint. Such a feature is aimed to bring the financially-constrained informal sector into the picture while conveying a likely representation of tax policy as observed in both developed and developing countries (see Gordon and Li, 2009).

The economy is populated by the government, a large number of identical firms, and a large number of identical households, all of whom are infinitely lived. The government enforces a monitoring system for tax evasion and uses revenue to finance a stream of non-productive services. Firms maximize discounted profits contingent on the possibility of being discovered operating informally. Furthermore, they are allowed to claim the interest paid on borrowed funds as deductible from their taxable income. They finance capital investment through borrowing, but the value of their debt cannot exceed the amount of official earnings. Hence registered cash flows not only are subject to taxation, but also ensure lenders that debts will be fully secured. These features overall induce a variety of trade-offs in the choice of tax evasion that are at the heart of the model's predictions.

2.1 Households

Households derive utility from consumption c_t . They rent labor l_t and lend b_t^H to firms at a wage w_t and the agreed net interest rate r_t . Furthermore, they earn real dividend income d_t and receive a lump-sum transfer T_t from the government.

Assuming logarithmic utility and inelastic labor supply (i.e. $l_t = 1$), the representative household's problem is given by

$$\max_{c_t, b_{t+1}^H} E_0 \sum_{t=0}^{\infty} \beta^t \log(c_t)$$

$$\text{subject to } c_t + b_{t+1}^H = d_t + w_t l_t + (1+r_t)b_t^H + T_t$$

and the Euler equation for loans is:

$$\frac{1}{c_t} = \beta E_t \left(\frac{1}{c_{t+1}} \right) (1+r_{t+1}). \quad (1)$$

2.2 Firms

Competitive firms in this economy purchase labor services and borrow from households to produce a homogeneous good y_t . Technology is specified as follows:

$$y_t = A_t k_t^\alpha l_t^{1-\alpha}, \quad (2)$$

where A_t is a total factor productivity shock (expressed in logarithms) following the autoregressive process

$$A_t = \rho A_{t-1} + e_t, \quad e_t \approx NIID(0, \sigma^2). \quad (3)$$

Consistent with the typical timing convention, capital is chosen at time $t-1$ and predetermined at time t . It evolves according to the law of motion $k_{t+1} = i_t + (1-\delta)k_t$, where i_t is investment and δ is the depreciation rate.

Firms are assessed a tax on their corporate income at a fixed rate τ . However, they are allowed to deduct the interest paid on borrowed funds from calculation of their tax base as given by the expression $y_t - w_t l_t - r_t b_t^F$. Such a tax advantage, as shown below, generates a preference for debt financing that induces entrepreneurs to leverage up.

In addition to tax avoidance opportunities, the representative firm chooses to hide a fraction $\eta_t \in [0,1]$ of its activities in order to escape the tax and regulatory burden. Yet it faces the prospect of getting caught and forced to pay the entirety of its tax obligations with an endogenous probability $\phi(\iota, \eta_t) = \varphi(\iota)\eta_t$, where ι represents the monitoring effort of the revenue collection agency such that $\frac{\partial \phi}{\partial \iota} = \frac{d\varphi}{d\iota} > 0$. This detection probability is linear in η_t to convey the idea that having murky accounts, given a firm's scale, induces the authorities to classify the concerned activities as suspicious.

Upon finishing production, the representative firm pays its wage bill $w_t l_t$ and last period loan payment $(1+r_t)b_t^F$. Then it signs a new loan contract. It is assumed that, in case of default, a bankruptcy procedure liquidating the firm takes place such that a fraction $\theta \in (0,1)$ of the expected value of next period registered production can be repossessed by lenders. Tax is senior to this recovery process. Thus, the firm faces the following collateral constraint:

$$b_{t+1}^F \leq \theta E_t[(1-\tau)(1-\eta_t)y_{t+1}]. \quad (4)$$

Of the other part, creditors must incur the remaining proportion of the liquidation value $(1-\theta)E_t(1-\tau)(1-\eta_t)y_{t+1}$ as a transaction cost. The collateral constraint aims to convey the idea that lenders can only seize those assets that have been officially declared by the firm in the face of default. Note that the collateral share serves as a proxy for the quality of the financial system and of institutions. This is in line with Djankov *et al.* (2008), who find that the efficiency of debt enforcement procedures is strongly correlated with legal origins and credit market development.

Furthermore, the amount firms are allowed to borrow is decreasing in their degree of tax non-compliance, η_t . This is consistent with the assumption of ‘book-tax conformity’, which in the present setting means that the representative firm cannot report different earnings to both tax authorities and lenders. This assumption suggests that increasing tax evasion has two countervailing implications for firms’ access to finance: On the one hand, it reduces the collateral that can be offered for securing debts, and thus worsens the terms and conditions of loan contracts. On the other hand, the successfully concealed income $(1-\phi_t)\tau\eta_t y_t$ enables them to raise internal sources of funds.

Given these circumstances, the representative firm’s cash flow is given by

$$\pi_t = (1-\tau)(y_t - w_t - r_t b_t^F) - i_t + b_{t+1}^F - b_t^F + (1-\phi_t)\tau\eta_t y_t, \quad (5)$$

which can be decomposed into after-tax dividends

$$d_t = (1-\tau)\left[(1-\eta_t)y_t - w_t - r_t b_t^F\right] - i_t + b_{t+1}^F - b_t^F \quad (6)$$

and unreported profits $(1-\phi_t)\tau\eta_t y_t$. Such profits are not redistributed to households but plowed back into the firm as inside funding. Along with Equation (4), Equation (5) implies that the tax gains obtained via greater evasion reduce the cash flow earnings that the firm can pledge to external investors.

The representative firm maximizes discounted profits with the stochastic discount factor of the household, $\gamma_t \equiv \beta E_t \left(\frac{c_t}{c_{t+1}} \right)$. Thus, the firm's problem is

$$\max_{l_t, k_{t+1}, b_{t+1}^F} E_0 \sum_{t=0}^{\infty} \gamma_t \pi_t,$$

subject to (5) and (4).

Letting μ_t denote the time- t Lagrange multiplier associated to the borrowing constraint, firms' behavior is characterized by the Euler equations:

$$\frac{\tau}{1-\tau} [1 - \phi_t - \varphi(t)\eta_t] y_t = \theta E_t \mu_t y_{t+1} \quad (7)$$

$$\gamma_t = E_t \gamma_{t+1} \{1 + (1-\tau)r_{t+1}\} + \gamma_t \mu_t \quad (8)$$

$$\gamma_t = E_t \{ \gamma_{t+1} [1 - \tau + (1 - \phi_t)\tau\eta_t] + \gamma_t \mu_t \theta (1 - \tau)(1 - \eta_t) \} \alpha A_{t+1} k_{t+1}^{\alpha-1} + \gamma_{t+1} (1 - \delta), \quad (9)$$

and by the first-order condition determining labor demand

$$w_t = \left\{ 1 + \frac{\tau}{1-\tau} \eta_t (1 - \phi_t) \right\} (1 - \alpha) A_t k_t^{\alpha}. \quad (10)$$

Equation (7) states that the firm evades to the point where the marginal tax savings equal the expected value of foregone borrowing opportunities. In other words, firms choose their degree of non-compliance to lower their burden of taxation; but, in doing so, they expose themselves to a higher cost of credit, and thereby to a reduction in the volume of loans and subsequent investment. This equation thus underlines the trade-off involved in a firm's decision to conceal (or disclose) the proceeds from its activities as well as its countervailing implications for access to finance.

Furthermore, Equation (8) relates the marginal benefit of borrowing to its marginal cost. Also, Equation (9) shows that the opportunity cost of withholding one unit of capital equals the expected discounted marginal product of capital. Note that borrowers internalize the effects of their capital stock in their financial constraints, so that the marginal benefit of withholding one capital unit is given not only by its marginal product but by the marginal benefit of being able to borrow more.

Finally, note that firms internalize the corporate income tax structure and their compliance behavior in their loan and factor demands. The latter can be clearly seen in Equations (9) and

(10), which show that tax evasion supplements the marginal products of capital and labor. As for the former, deductibility of interest payments proves to be the main incentive for borrowing.

2.3 Government

The government produces unproductive services and makes transfer payments each period by collecting taxes on corporate income. Government consumption is assumed to follow a stochastic process given by

$$g_t = G_t y_t, \quad (11)$$

where G_t is a random variable. As the government does not issue any debt, the flow budget constraint is

$$g_t + T_t = \tau[(1 - \eta_t)y_t - w_t - r_t b_t^F] + \theta E_t(1 - \eta_t)\tau y_{t+1} + \phi_t \tau \eta_t y_t \quad (12)$$

every period. Note that the tax avoidance opportunities associated to firms deducting interest payments on their debts lead to a government revenue loss that in the public finance literature is known as tax expenditures.

Equation (11) can be alternatively expressed as

$$g_t + T_t = \tau(y_t - w_t - r_t b_t^F) + \theta E_t(1 - \eta_t)\tau y_{t+1} - (1 - \phi_t)\tau \eta_t y_t, \quad (13)$$

where the third term on the right hand side reflects the amount of taxes on informal activities that go undetected. Since firms manage to dodge these liabilities, they are subtracted from what otherwise would be total tax revenue. In this regard, this term accounts for the so-called tax gap, that is, the difference between the amount of tax legally owed and the amount actually collected by the government.

2.4 Equilibrium

A competitive equilibrium for this economy consists of a sequence of prices $\{w_t, r_t\}_{t=0}^{\infty}$; a list of consumption plans and debt positions for households $\{c_t, b_{t+1}^H\}_{t=0}^{\infty}$; a list of production and evasion plans and debt positions for firms $\{\eta_t, l_t^d, k_{t+1}, b_{t+1}^F\}_{t=0}^{\infty}$, and the policy function g_t such that:

- households maximize utility,
- firms maximize profits,

- the government balances its budget,
- individual and aggregate decisions are consistent, i.e. $k_t = K_t$, and
- markets for goods, labor and loans clear.

Note that the market clearing conditions imply that each agent's decision rules satisfy the resource constraint:

$$c_t + i_t + g_t = [1 - (1 - \phi_t)\tau\eta_t]y_t. \quad (14)$$

Also, equilibrium in the loans market means that borrowing must equal savings every period, that is,

$$b_t^H = b_t^F. \quad (15)$$

Lastly, demand for labor by firms is equal to labor supply by households

$$l_t^d = 1. \quad (16)$$

In addition to the above, the equilibrium share of output that firms leave 'off the books' is characterized in the following:

Proposition 1 The fraction of output that the representative firm keeps unrecorded at the steady state is given by

$$\eta_{ss} = \frac{1 - \theta(1 - \beta)(1 - \tau)}{2\varphi(t)},$$

where it follows that $\frac{\partial \eta_{ss}}{\partial \theta} < 0$, $\frac{\partial \eta_{ss}}{\partial \tau} > 0$, and $\frac{\partial \eta_{ss}}{\partial t} < 0$.

Proof. See Appendix B.

Proposition 1 implies that the extent of unreported activities depends positively on the tax burden, and is negatively related to the level of enforcement and financial development. These connections have been extensively confirmed in the literature on informality and the shadow economy. While the former two relations have been claimed to be among the main features of the informal sector (see Ihrig & Moe, 2004), recent studies have shed light on the different channels involved in the link between financial depth and tax evasion (see, among others, Capasso & Jappelli, 2013; Ellul *et al.*, 2012; Dabla-Norris & Koeda, 2008).

To complete the characterization of the equilibrium, the following proposition states the conditions for a binding borrowing constraint.

Proposition 2 At steady state, the borrowing constraint holds with equality if $\tau > 0$.

Proof. See Appendix A.

Note that Proposition 2 can be formally proven only for the steady state. Therefore, the collateral constraint is binding as long as interest payments are deductible from corporate earnings, a feature of the tax structure that induces entrepreneurs to raise funds through debt financing. This feature indeed conveys a likely representation of tax policy, and thus is consistent with plausible parameterizations of the model.

3 Calibration

The system of equations used to compute the dynamic equilibria of the model depends on a set of twelve parameters. Of these, eleven can be obtained by resorting to related studies: the subjective discount factor (β), the capital income share (α), the depreciation rate (δ), the degree of financial development (θ), the corporate income tax rate (τ), the steady-state share of activity left 'off the books' (η_{ss}), and the parameters pertaining to the properties of shocks (the autocorrelation coefficients and the standard deviations).

To begin, the values for the technology and preference parameters are common in the business cycle literature. Since the time period is set to one year, the values of the discount factor and the depreciation rate are 0.95 and 0.1. The capital income share also is set at 0.36. As for the borrowing constraint, the World Bank's *Doing Business* project reports that the liquidation cost for an average firm in the U.S. has been about 7% of estate since 2006. Subtracting this value from the unity leads to the collateral share used here.

The parameter value pertaining to taxation, $\tau = 0.4136$, is obtained from the OECD Tax Database (2012). Specifically, it averages out a series of the combined federal and state statutory corporate income tax rate covering the period 1981-2012. The steady-state share of activity hidden from the revenue authority is taken from Schneider, Buehn and Montenegro (2010), who use the dynamic multiple input multiple indicator approach to provide an estimate of the size of the shadow economy of about 8.6% of GDP during 1999-2007.

Moving on to the enforcement parameter, the endogenous detection probability is assumed to take the form $\varphi(\iota)\eta_t = \iota\eta_t$, so that φ is linear in ι . This functional form facilitates computing the steady-state probability of detection by making use of the relation stated in Proposition 1 and the parameter values above. Thus, the probability $\phi_{ss} = 0.4864$ is obtained such that ι approximates 5.6554. This probability is a bit higher than the one backed out by Prado (2011) for the U.S., but it still lies within the same author's estimates for OECD countries.

Finally, the value of the autocorrelation coefficient for the productivity shock is $\rho = 0.95^4$. This value comes from adjusting the common coefficient used to match quarterly fluctuations to take account of annual frequencies. A similar criterion is followed to choose the standard deviation of the innovation, as it is set to the conventional 0.007. Likewise, the steady-state share of government expenditures in total output is estimated by averaging out the ratio of government consumption expenditures to GDP during 1970-2011. Further, the values

characterizing the distributional properties of government expenditure shocks are taken from Braun (1994). All the parameter values mentioned above are summarized in Tables 1 and 2.

Table 1: Model parameters

β	α	δ	τ	θ	ϕ_{ss}	η_{ss}
0.95	0.36	0.10	0.414	0.93	0.486	0.086

Table 2: Parameter values for structure of shocks

Parameter	Description	Value	Source
G_{ss}	Steady-state share of government expenditure in output	0.190	BEA, 1960-2006
ρ	Persistence of productivity shocks	0.814	DSGE literature
ρ_g	Persistence of government expenditure shocks	0.702	Braun (1994)
σ	Standard deviation of productivity shocks	0.007	DSGE literature
σ_g	Standard deviation of government expenditure shocks	0.036	Braun (1994)

4 Results

The following experiments consider the implications for macroeconomic volatility of variations in key parameters of the model. It is worth noting that the main purpose of these experiments is not to determine whether the model can capture particular stylized facts about the U.S. economy, but to make a specific point through a series of numerical simulations. Overall, the results confirm the underlying intuition explained in previous sections and reveal some suggestive connections.

Note that the time series generated in the simulations are logged and detrended using the Hodrick-Prescott filter with a smoothing parameter of 100. Throughout the policy experiments and sensitivity exercises, the relative standard deviation –that is, the ratio of the standard deviation of the variable in question to the standard deviation of output– quantifies the volatility of investment and consumption.

4.1 Policy experiments

In this section, the results of experiments pertaining to policy variables such as the tax structure and its enforcement are analyzed. Also, the effects of changes in the degree of financial development are considered.

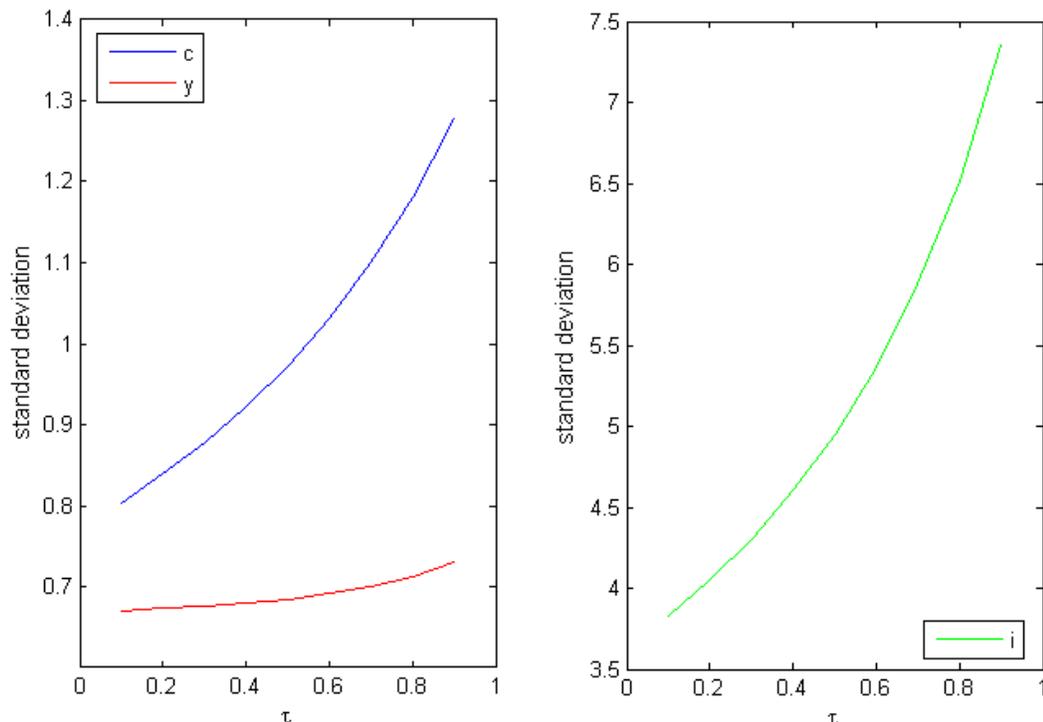
4.1.1 Corporate tax rate

The first experiment considers changes in the tax structure. In this respect, Figure 1 shows a substantial increase in the relative standard deviations of consumption and investment as the corporate income tax rate is raised, thus suggesting that higher taxes lead to greater aggregate volatility.

Intuitively, a higher burden of taxation reduces the expected return on investment and consumption while increasing their variance. This intuition is certainly reflected in the patterns of macroeconomic volatility seen above, even if the variability of output exhibits a tenuous rise. This latter pattern, nevertheless, seems to contradict the findings of Posch (2011), who claims taxes ultimately affect output volatility.

Furthermore, a higher burden of taxation induces firms to hide a larger share of their revenues from both tax authorities and lenders, thereby restricting investment financing through borrowing. Tax seniority upon default compounds to this financial friction, making firms even more credit constrained as taxes are raised. All these responses, as a result, support lower and more volatile investment and consumption.

Figure 1: Corporate tax rate and macroeconomic volatility



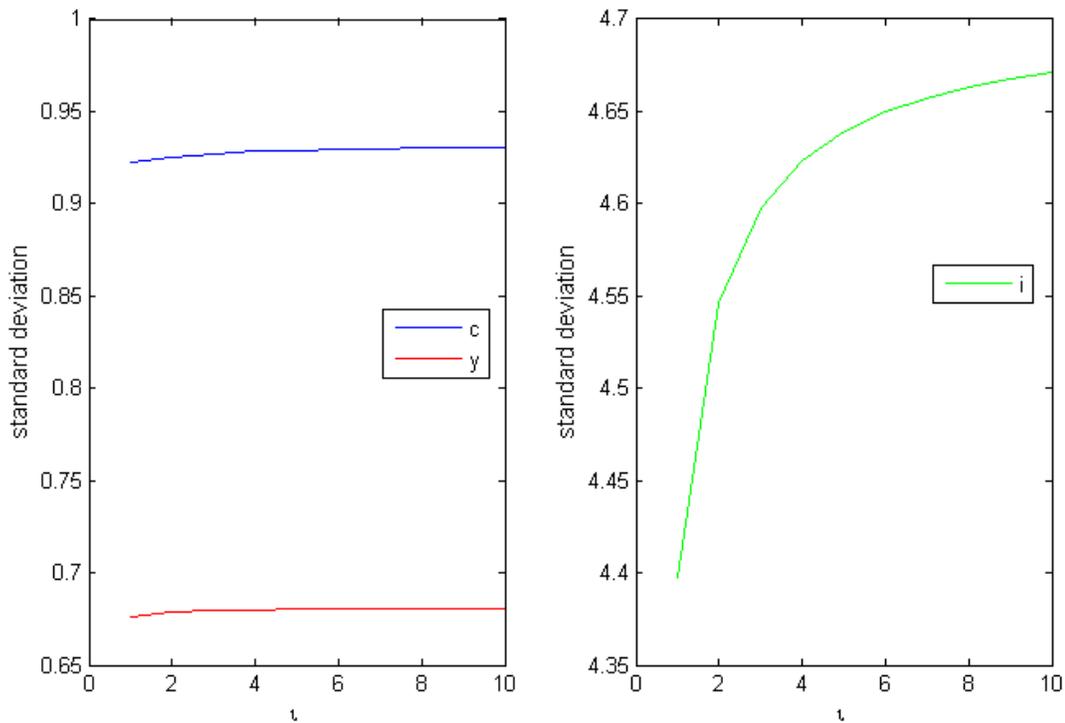
4.1.2 Tax enforcement

As with increments in the corporate tax rate, macroeconomic volatility may increase when the exogenous enforcement parameter rises. Indeed, Figure 2 shows that investment exhibits slightly more fluctuations over the business cycle as ι is allowed to vary between 1 and 10, and thus the monitoring effort is strengthened. These patterns of aggregate behavior take place while the steady-state fraction of unrecorded production decreases considerably.

The rationale for these patterns of both aggregate volatility and tax evasion lies in the deterrent effect of greater enforcement, which induces firms to report a larger share of their activities and increase their expected tax payments.^[2] Due to the endogenous character of the detection probability, such patterns stand in accordance with the previously described taxation results to various degrees.

^[2] Given that its determinants are not being altered, the probability of detection remains constant at steady state. To see this, confront Proposition 1 and ϕ 's functional form.

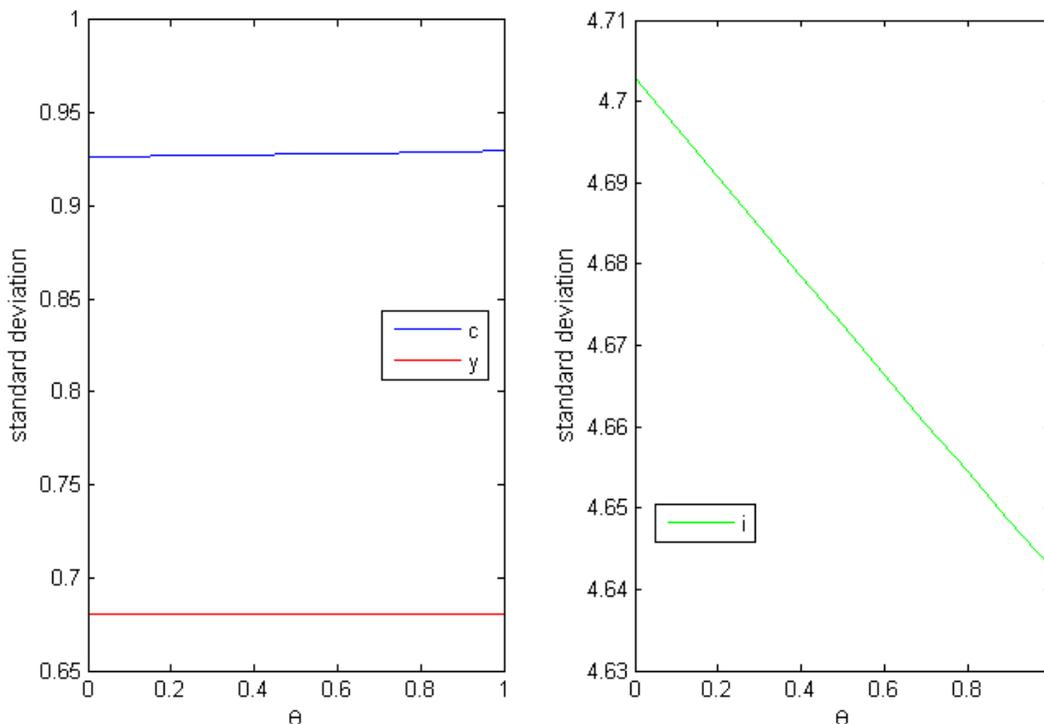
Figure 2: Tax enforcement and macroeconomic volatility



4.1.3 Financial development

Credit constraints arise endogenously in the model because lenders cannot force borrowers to repay their debts unless these are secured by collateral. In such a context, the fraction of the pledgeable asset that is lost in debt enforcement is given by the extent and quality of the financial system. Thus, a high value of θ indicates a lower liquidation cost, and hence a more developed financial sector, compared to a low θ , which points to inefficient enforcement procedures inherent to underdeveloped credit markets. Furthermore, higher financial development exerts a detrimental influence on the degree of tax non-compliance as stated in Proposition 1.

Figure 3: Financial development and macroeconomic volatility



The existing literature dealing with financial markets has shown that credit frictions may be a powerful transmission mechanism that propagates and amplifies shocks. However, the patterns of aggregate volatility displayed in Figure 3 convey a mixed picture. On the one hand, consumption remains roughly as volatile. On the other hand, the relative standard deviation of investment slightly decreases as financial development rises and thus inefficiencies in the liquidation of the collateralized asset become smaller. In this case, as Mendicino (2012) claims, credit frictions limiting the amount of borrowing to a small fraction of the liquidation value of capital makes the amplification generated by the collateral constraint significant, even under standard assumptions about the utility function and the production process.

Complementary experiments (not shown here) suggest that these patterns of aggregate volatility hold at both high and low degrees of tax non-compliance. These results certainly contrast those found by Mitra (2013), who claims the informal sector weakens the working capital channel of financial development and thereby exerts a downward pressure on the variability of consumption. As can be inferred from the present study, distinct mechanisms are at the core of our discrepancies on the effect of credit market depth on macroeconomic volatility for different levels of informality.

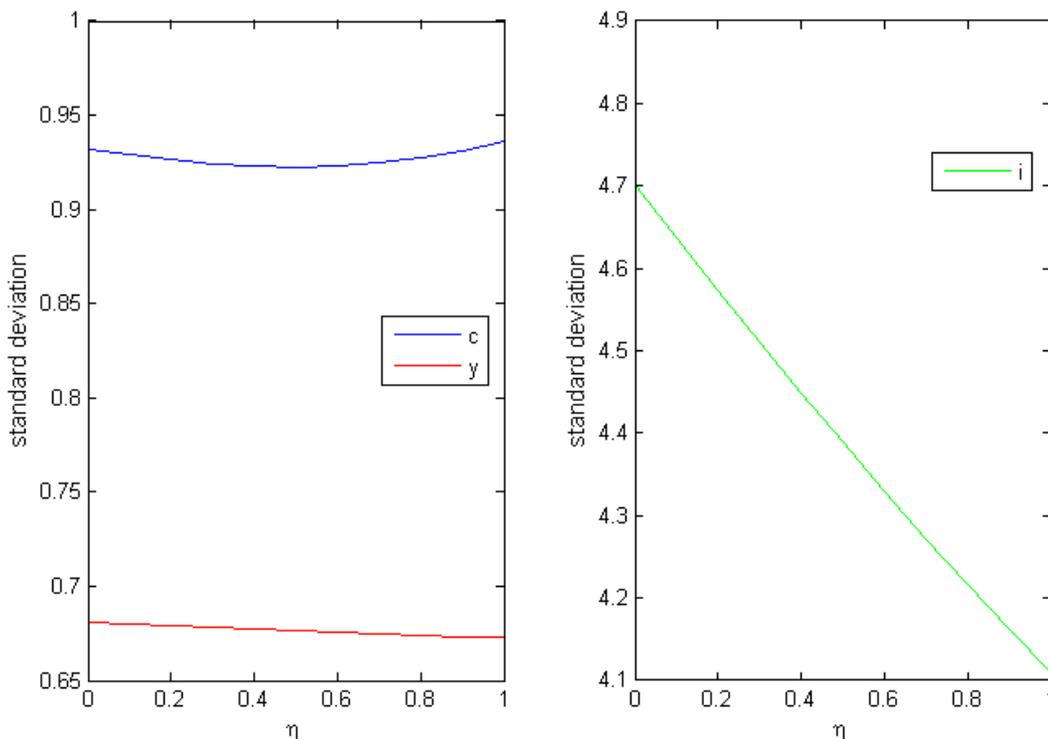
4.2 Further experiments: An exogenous share of undeclared activity

The experiments below allow one to examine a particular case of the model economy in which both the share of unreported production and the detection probability are taken as exogenous. Admittedly, the aim of these experiments is not to explain the emergence of an informal sector, but rather to analyze the consequences of such a sector's inherent financial constraints for aggregate fluctuations assuming its existence as given. The resulting patterns also can be compared with those of related studies.

Figure 4 shows how macroeconomic volatility behaves as the share of production that firms leave off the books is allowed to vary. Note that $\eta=0$ implies full compliance with the existing taxes and regulations, whereas $\eta=1$ denotes complete tax evasion. It can be seen that the relative standard deviation of investment declines in a small but non-negligible manner, while output and consumption variability remain approximately constant despite increases in the extent of unreported activity.

While at odds with the literature, these patterns of macroeconomic volatility can be explained in terms of the mechanisms at work in the model. Specifically, tax evasion plays two conflicting roles in the economic environment: On the one hand, it tightens the borrowing constraint by rendering a fraction of output non-collateralizable, thus hindering investment and consumption smoothing (via dividends). On the other hand, the tax liabilities firms manage to conceal from the revenue collection authority constitute a form of savings that supports investment and thereby consumption smoothing. Though the former role causes aggregate variability to rise, tax savings counteract limited access to finance and lead to a fall in the relative volatility of consumption and investment.

Figure 4: Extent of informality and macroeconomic volatility

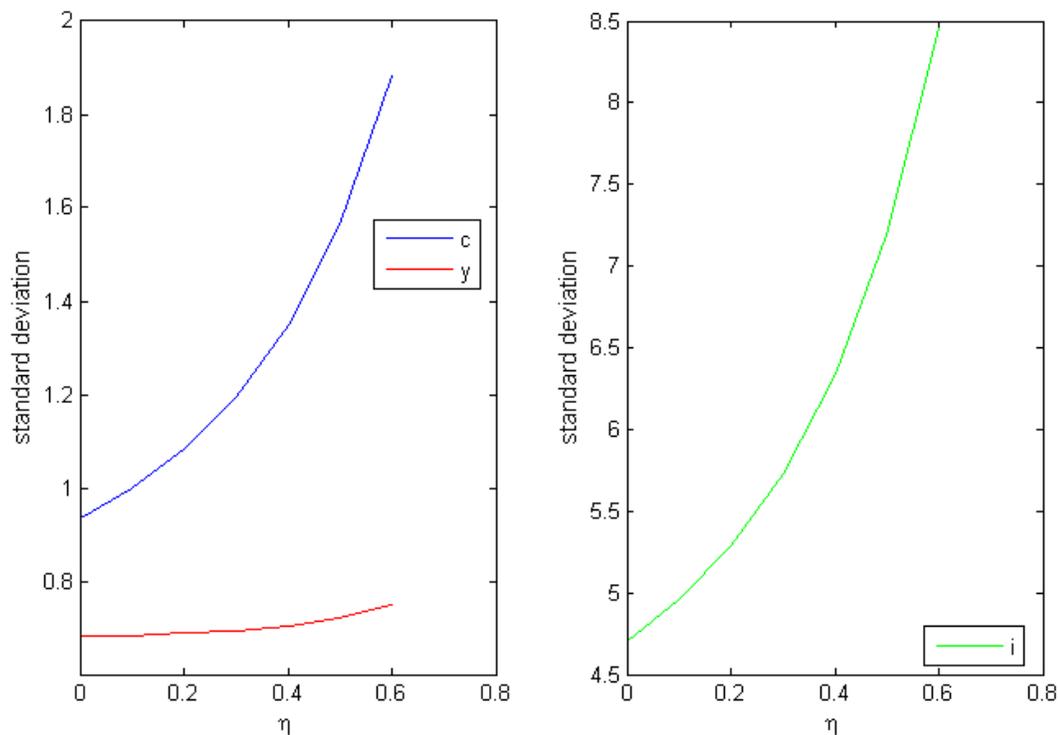


The effect of evasion-induced savings can be best seen by comparing both the benchmark economy and the setting above with one in which diverted cash flow earnings are not plowed back into the firm as internal funding, thus comprising a private benefit to the entrepreneur. Since the amount firms are allowed to borrow is decreasing in their degree of informality, economies wherein less activity is reported to the tax authorities presumably exhibit tighter financial conditions. As limited access to external finance further magnifies the propagation of productivity shocks, consumption and investment are expected to be more volatile.

In line with this conjecture, the relative volatility of consumption and investment increase monotonically with the extent of unrecorded activity.^[3] These patterns of cyclical behavior are illustrated in Figure 5, which also shows that the standard deviation of output remains approximately constant despite variations in the extent of tax non-compliance. Thus, even though these results do not seem to fully confirm Ferreira-Tiryaki's (2008) empirical analysis, they certainly support Finkelstein Shapiro's (2015) and Restrepo-Echavarría's (2014) findings regarding the relationship between informality and macroeconomic volatility.

^[3] Numerical simulations using Dynare yield convergence problems after $\eta = 0.6$.

Figure 5: Macroeconomic volatility when undeclared output is private gain



Finally, it is worth noting that higher tax evasion contributes to increase internal sources of funds not only at the present time, but also in future periods. This effect is due to the constraints evasion impose on borrowing possibilities, as these prevent firms from incurring financial costs. Note, further, that such an effect of tax non-compliance offsets the cash flow effects attributable to tax avoidance by reducing after-tax profits, hence limiting the potential for additional savings via tax-deductible interest payments.

5 Concluding remarks

The present paper addresses the implications for macroeconomic volatility of borrowing constraints characterizing the informal sector. To this end, it develops a simple dynamic stochastic general equilibrium model featuring financial frictions and tax evasion opportunities. In the model, firms operating unofficially are subject to credit rationing, which reduces loans in relation to their non payment of taxes. This assumption is consistent with the observation that it may be more difficult for tax evaders to access external finance because doing so entails official documentation, especially if lenders require collateral and if the process of hiding economic activity involves concealing the true ownership of assets. After identifying the determinants of the extent of the unrecorded sector, some computational experiments allow one to examine how informality and its determinants affect aggregate volatility.

This paper contributes to better understand the trade-offs involved in the choice of tax evasion, as well as the implications of policies addressing this phenomenon for aggregate fluctuations. The proposed model, in particular, highlights two countervailing consequences of tax non-compliance for firms' access to finance: On the one hand, it worsens the terms and conditions of loan contracts by reducing the collateral that can be offered for securing debts. On the other hand, the successfully dodged liabilities amount to a form of savings that raises internal funds. While the former lowers the amount of credit provided and thus causes macroeconomic volatility to rise, the latter counteracts lack of access to outside financing and leads to a fall in the relative variability of consumption and investment.

As it stands, firms in the model face a binding borrowing constraint in equilibrium. This feature relies on the assumption that interest payments are deductible from taxable income, thereby incentivizing entrepreneurs to raise funds through debt financing. Two other important assumptions underlying the proposed mechanism are book-tax conformity and tax seniority in the event of default. A high degree of alignment between tax and financial reporting implies that the extent of transparency chosen by the representative firm affects not only its tax liabilities, but its debt capacity as well. Tax seniority, in turn, further toughens the financial friction. All these assumptions are aimed to convey a realistic characterization of tax policy and are at the heart of the results.

Provided that the firm reinvests the proceeds of undeclared activity, the findings in this paper do not support the stylized facts reported by Finkelstein Shapiro (2015), which state that countries with a sizeable shadow economy exhibit higher volatilities of consumption and investment. Moreover, these findings contrast a variety of mechanisms suggested in business cycle studies dealing with labor informality (Restrepo-Echavarría, 2014; Mitra, 2013). To the extent that the model presented here addresses informality only at the firm level, comprehensive consideration of the characteristics and dimensions associated to the unofficial sector emerges as a potential improvement. In this regard, accounting for self-financing as a substitute to lack of external funds through models with heterogeneous agents stands as a worthy path to pursue.

References

- Bose, N., Capasso, S. and Wurm, M.A. (2012), "The impact of banking development on the size of shadow economies", *Journal of Economic Studies*, Vol. 39 No. 6, pp. 620-638.
- Braun, R.A. (1994), "Tax disturbances and real economic activity in the postwar United States", *Journal of Monetary Economics*, Vol. 33 No. 3, pp. 441-462.
- Bureau of Economic Analysis (2014), "SNA and the NIPAs", available at: <http://www.bea.gov/national/sna.htm> (accessed 6 February 2014).
- Capasso, S. and Jappelli, T. (2013), "Financial development and the underground economy", *Journal of Development Economics*, Vol. 101 No. C, pp. 167-178.
- Covas, F. (2006). "Uninsured idiosyncratic production risk with borrowing constraints", *Journal of Economic Dynamics and Control*, Vol. 30 No. 11, pp. 2167-2190.

- Dabla-Norris, E. and Feltenstein, A. (2005), “The underground economy and its macroeconomic consequences”, *Journal of Policy Reform*, Vol. 8 No. 2, pp. 153-174.
- Dabla-Norris, E. and Koeda, J. (2008), “Informality and bank credit: Evidence from firm-level data”, Working Paper No. 08/94, International Monetary Fund, April.
- Djankov, S., Hart, O., McLiesh, C. and Shleifer, A. (2008), “Debt enforcement around the world”, *Journal of Political Economy*, Vol. 116 No. 6, pp. 1105-1149.
- Ellul, A., Jappelli, T., Pagano, M. and Panunzi, F. (2012), “Transparency, tax pressure and access to finance”, Discussion Paper No. dp705, Financial Markets Group, June.
- Ferreira-Tiryaki, G. (2008), “The informal economy and business cycles”, *Journal of Applied Economics*, Vol. 11 No. 1, pp. 91-117.
- Finkelstein Shapiro, A. (2015), “Institutions, informal labor markets, and business cycle volatility”, *Economía (Journal of LACEA)*, forthcoming.
- Gatti, R. and Honorati, M. (2008), “Informality among formal firms: firm-level, cross-country evidence on tax compliance and access to credit”, Policy Research Working Paper No. 4476, The World Bank, January.
- Gordon, R. and Li, W. (2009), “Tax structures in developing countries: Many puzzles and a possible explanation”, *Journal of Public Economics*, Vol. 93 No. 7-8, pp. 855-866.
- Granda-Carvajal, C. (2010), “The unofficial economy and the business cycle: A test for theories”, *International Economic Journal*, Vol. 24 No. 4, pp. 573-586.
- Ihrig, J. and Moe, K.S. (2004). “Lurking in the shadows: the informal sector and government policy”, *Journal of Development Economics*, Vol. 73 No. 2, pp. 541-557.
- Jermann, U. and Quadrini, V. (2012), “Macroeconomic effects of financial shocks”, *American Economic Review*, Vol. 102 No. 1, pp. 238-71.
- La Porta, R. and Shleifer, A. (2008), “The unofficial economy and economic development”, *Brookings Papers on Economic Activity*, Vol. 39 No. 2, pp. 275-363.
- Mendicino, C. (2012), “On the amplification role of collateral constraints”, *Economics Letters*, Vol. 117 No. 2, pp. 429-435.
- Mitra, S. (2013), “Informality, financial development and macroeconomic volatility”, *Economics Letters*, Vol. 120 No. 3, pp. 454-457.
- Moll, B. (2014). “Productivity losses from financial frictions: Can self-financing undo capital misallocation?”, *American Economic Review*, Vol. 104 No. 10, pp. 3186-3221.
- OECD Center for Tax Policy and Administration (2012), “OECD Tax Database”, available at: <http://www.oecd.org/tax/tax-policy/tax-database.htm> (accessed 7 October 2012)
- Posch, O. (2011), “Explaining output volatility: The case of taxation”, *Journal of Public Economics*, Vol. 95 No. 11, pp. 1589-1606.
- Prado, M. (2011), “Government policy in the formal and informal sectors”, *European Economic Review*, Vol. 55 No. 8, pp. 1120-1136.
- Restrepo-Echavarría, P. (2014), “Macroeconomic volatility: The role of the informal economy”, *European Economic Review*, Vol. 70, pp. 454-469.
- Schneider, F., Buehn, A. and Montenegro, C. (2010), “New estimates for the shadow economies all over the world”, *International Economic Journal*, Vol. 24 No. 4, pp. 443-461.
- Straub, S. (2005), “Informal sector: The credit market channel”, *Journal of Development Economics*, Vol. 78 No. 2, pp. 299-321.
- The World Bank (several years), “Doing Business”, available at: <http://www.doingbusiness.org/> (accessed 12 February 2014).

Appendices

A Proof of Proposition 2

The first order condition of the household with respect to savings b_t^H is summarized by

$$\frac{1}{c_t} = \beta E_t \left(\frac{1}{c_{t+1}} \right) (1 + r_{t+1}).$$

At steady state, this condition reduces to

$$1 + r_{ss} = \frac{1}{\beta}. \quad (\text{A.1})$$

Now, the first order condition of the firm with respect to borrowings b_t^F can be summarized by

$$1 - \mu_t = \gamma \{ (1 - \tau) r_{t+1} + 1 \}.$$

At steady state, this condition reduces to

$$\frac{1 - \mu_{ss}}{\gamma_{ss}} = (1 - \tau) r_{ss} + 1. \quad (\text{A.2})$$

Substituting (13) into (14), and taking into account that $\gamma_{ss} = \beta$, one gets that

$$1 + r_{ss} - \frac{\mu_{ss}}{\beta} = (1 - \tau) r_{ss} + 1;$$

which, after some simplification, becomes

$$(1 - \beta) \tau = \mu_{ss}. \quad (\text{A.3})$$

Hence, a necessary condition for $\mu_{ss} > 0$ is that $\tau > 0$.

B Proof of Proposition 1

The first order condition of the firm with respect to the fraction of output hidden from the tax authority η_t is given by

$$\frac{\tau}{1-\tau} [1 - \phi_t - \varphi(t)\eta_t] y_t = \theta E_t \mu_t y_{t+1}.$$

At steady state, this condition reduces to

$$\frac{\tau}{1-\tau} [1 - \phi_{ss} - \varphi(t)\eta_{ss}] = \theta \mu_{ss}. \quad (\text{B.1})$$

Substituting condition (A.1) into (B.1), one gets that

$$\frac{1 - 2\varphi(t)\eta_{ss}}{1-\tau} = \theta(1-\beta);$$

which, after some algebraic manipulations, becomes

$$\eta_{ss} = \frac{1 - \theta(1-\beta)(1-\tau)}{2\varphi(t)}. \quad (\text{B.2})$$

From Equation (B.2), it can be ascertained that

$$\frac{\partial \eta_{ss}}{\partial \theta} = -\frac{(1-\beta)(1-\tau)}{2\varphi(t)} < 0 \quad (\text{B.3})$$

$$\frac{\partial \eta_{ss}}{\partial \tau} = \frac{\theta(1-\beta)}{2\varphi(t)} > 0 \quad (\text{B.4})$$

$$\frac{\partial \eta_{ss}}{\partial t} = \frac{[1 - \theta(1-\beta)(1-\tau)]}{2[\varphi(t)]^2} \frac{d\varphi}{dt} < 0, \quad (\text{B.5})$$

where property (B.5) comes from the detection probability characteristic that $\frac{d\varphi}{dt} > 0$.

Borradores del CIE

No.	Título	Autor(es)	Fecha
01	Organismos reguladores del sistema de salud colombiano: conformación, funcionamiento y responsabilidades.	Durfari Velandia Naranjo Jairo Restrepo Zea Sandra Rodríguez Acosta	Agosto de 2002
02	Economía y relaciones sexuales: un modelo económico, su verificación empírica y posibles recomendaciones para disminuir los casos de sida.	Marcela Montoya Múnera Danny García Callejas	Noviembre de 2002
03	Un modelo RSDAIDS para las importaciones de madera de Estados Unidos y sus implicaciones para Colombia	Mauricio Alviar Ramírez Medardo Restrepo Patiño Santiago Gallón Gómez	Noviembre de 2002
04	Determinantes de la deserción estudiantil en la Universidad de Antioquia	Johanna Vásquez Velásquez Elkin Castaño Vélez Santiago Gallón Gómez Karoll Gómez Portilla	Julio de 2003
05	Producción académica en Economía de la Salud en Colombia, 1980-2002	Karem Espinosa Echavarría Jairo Humberto Restrepo Zea Sandra Rodríguez Acosta	Agosto de 2003
06	Las relaciones del desarrollo económico con la geografía y el territorio: una revisión.	Jorge Lotero Contreras	Septiembre de 2003
07	La ética de los estudiantes frente a los exámenes académicos: un problema relacionado con beneficios económicos y probabilidades	Danny García Callejas	Noviembre de 2003
08	Impactos monetarios e institucionales de la deuda pública en Colombia 1840-1890	Angela Milena Rojas R.	Febrero de 2004
09	Institucionalidad e incentivos en la educación básica y media en Colombia	David Fernando Tobón Germán Darío Valencia Danny García Guillermo Pérez Gustavo Adolfo Castillo	Febrero de 2004
10	Selección adversa en el régimen contributivo de salud: el caso de la EPS de Susalud	Johanna Vásquez Velásquez Karoll Gómez Portilla	Marzo de 2004
11	Diseño y experiencia de la regulación en salud en Colombia	Jairo Humberto Restrepo Zea Sandra Rodríguez Acosta	Marzo de 2004
12	Economic Growth, Consumption and Oil Scarcity in Colombia: A Ramsey model, time series and panel data approach	Danny García Callejas	Marzo de 2005
13	La competitividad: aproximación conceptual desde la teoría del crecimiento y la geografía económica	Jorge Lotero Contreras Ana Isabel Moreno Monroy Mauricio Giovanni Valencia Amaya	Mayo de 2005
14	La curva Ambiental de Kuznets para la calidad del agua: un análisis de su validez mediante raíces unitarias y cointegración	Mauricio Alviar Ramírez Catalina Granda Carvajal Luis Guillermo Pérez Puerta Juan Carlos Muñoz Mora Diana Constanza Restrepo Ochoa	Mayo de 2006
15	Integración vertical en el sistema de salud colombiano: Aproximaciones empíricas y análisis de doble marginalización	Jairo Humberto Restrepo Zea John Fernando Lopera Sierra Sandra Rodríguez Acosta	Mayo de 2006
16	Clometrics: a market account of a scientific community (1957-2005)	Angela Milena Rojas	Septiembre de 2006
17	Regulación ambiental sobre la contaminación vehicular en Colombia: ¿hacia dónde vamos?	David Tobón Orozco Andrés Felipe Sánchez Gandur Maria Victoria Cárdenas Londoño	Septiembre de 2006

18	Biology and Economics: Metaphors that Economists usually take from Biology	Danny García Callejas	Septiembre de 2006
19	Perspectiva Económica sobre la demanda de combustibles en Antioquia	Elizeth Ramos Oyola Maria Victoria Cárdenas Londoño David Tobón Orozco	Septiembre de 2006
20	Caracterización económica del deporte en Antioquia y Colombia: 1998-2001	Ramón Javier Mesa Callejas Rodrigo Arboleda Sierra Ana Milena Olarte Cadavid Carlos Mario Londoño Toro Juan David Gómez Gonzalo Valderrama	Octubre de 2006
21	Impacto Económico de los Juegos Deportivos Departamentales 2004: el caso de Santa Fe De Antioquia	Ramón Javier Mesa Callejas Ana Milena Olarte Cadavid Nini Johana Marín Rodríguez Mauricio A. Hernández Monsalve Rodrigo Arboleda Sierra	Octubre de 2006
22	Diagnóstico del sector deporte, la recreación y la educación física en Antioquia	Ramón Javier Mesa Callejas Rodrigo Arboleda Sierra Juan Francisco Gutiérrez Betancur Mauricio López González Nini Johana Marín Rodríguez Nelson Alveiro Gaviria García	Octubre de 2006
23	Formulación de una política pública para el sector del deporte, la recreación y la educación física en Antioquia	Ramón Javier Mesa Callejas Rodrigo Arboleda Sierra Juan Francisco Gutiérrez Betancur Mauricio López González Nini Johana Marín Rodríguez Nelson Alveiro Gaviria García	Octubre de 2006
24	El efecto de las intervenciones cambiarias: la experiencia colombiana 2004-2006	Mauricio A. Hernández Monsalve Ramón Javier Mesa Callejas	Octubre de 2006
25	Economic policy and institutional change: a context-specific model for explaining the economic reforms failure in 1970's Colombia	Angela Milena Rojas	Noviembre de 2006
26	Definición teórica y medición del Comercio Intraindustrial	Ana Isabel Moreno M. Héctor Mauricio Posada D	Noviembre de 2006
Borradores Departamento de Economía			
27	Aportes teóricos al debate de la agricultura desde la economía	Marleny Cardona Acevedo Yady Marcela Barrero Amortegui Carlos Felipe Gaviria Garcés Ever Humberto Álvarez Sánchez Juan Carlos Muñoz Mora	Septiembre de 2007
28	Competitiveness of Colombian Departments observed from an Economic geography Perspective	Jorge Lotero Contreras Héctor Mauricio Posada Duque Daniel Valderrama	Abril de 2009
29	La Curva de Engel de los Servicios de Salud En Colombia. Una Aproximación Semiparamétrica	Jorge Barrientos Marín Juan Miguel Gallego Juan Pablo Saldarriaga	Julio de 2009
30	La función reguladora del Estado: ¿qué regular y por qué?: Conceptualización y el caso de Colombia	Jorge Hernán Flórez Acosta	Julio de 2009
31	Evolución y determinantes de las exportaciones industriales regionales: evidencia empírica para Colombia, 1977-2002	Jorge Barrientos Marín Jorge Lotero Contreras	Septiembre de 2009
32	La política ambiental en Colombia: Tasas retributivas y Equilibrios de Nash	Medardo Restrepo Patiño	Octubre de 2009
33	Restricción vehicular y regulación ambiental: el programa "Pico y Placa" en Medellín	David Tobón Orozco Carlos Vasco Correa Blanca Gómez Olivo	Mayo de 2010

34	Corruption, Economic Freedom and Political Freedom in South America: In Pursuit of the missing Link	Danny García Callejas	Agosto de 2010
35	Karl Marx: dinero, capital y crisis	Ghislain Deleplace	Octubre de 2010
36	Democracy and Environmental Quality in Latin America: A Panel System of Equations Approach, 1995-2008	Danny García Callejas	Noviembre de 2010
37	Political competition in dual economies: clientelism in Latin America	Angela M.Rojas Rivera	Febrero de 2011
38	Implicaciones de Forward y Futuros para el Sector Eléctrico Colombiano	Duvan Fernando Torres Gómez Astrid Carolina Arroyave Tangarife	Marzo de 2011
39	Per Capita GDP Convergence in South America, 1960-2007	Danny García Callejas	Mayo de 2011
40	Efectos del salario mínimo sobre el estatus laboral de los jóvenes en Colombia	Yenny Catalina Aguirre Botero	Agosto de 2011
41	Determinantes del margen de intermediación en el sector bancario colombiano para el periodo 2000 – 2010	Perla Escobar Julián Gómez	Septiembre de 2011
42	Tamaño óptimo del gasto público colombiano: una aproximación desde la teoría del crecimiento endógeno	Camilo Alvis Cristian Castrillón	Septiembre de 2011
43	Estimación del stock de capital humano bajo la metodología Jorgenson-Fraumeni para Colombia 2001-2009	Juan David Correa Ramírez Jaime Alberto Montoya Arbeláez	Septiembre de 2011
44	Estructura de ingresos para trabajadores asalariados y por cuenta propia en la ciudad de Ibagué	José Daniel Salinas Rincón Daniel Aragón Urrego	Noviembre de 2011
45	Identificación y priorización de barreras a la eficiencia energética: un estudio en microempresas de Medellín	Juan Gabriel Vanegas Sergio Botero Botero	Marzo de 2012
47	El tiempo, el éter que lo cubre todo: Un análisis de la temporalidad en la economía política de Karl Marx	Germán Darío Valencia Agudelo	Septiembre de 2012
48	Características de la Población Ocupada en Colombia: Un análisis del perfil de los formales e informales	José Daniel Salinas Rincón Sara Isabel González Arismendy Leidy Johana Marín	Octubre de 2012
49	Desarrollo económico Territorial: El caso del Cluster TIC, Medellín y Valle de Aburrá. Propuesta de fomento y consolidación de la industria de Contenidos Digitales	Felipe Molina Otálvaro Pablo Barrera Bolaños Tulio Montemiranda Aguirre	Noviembre de 2012
50	Análisis de la interacción entre las autoridades monetaria y fiscal en Colombia (1991-2011). Una aplicación desde la teoría de juegos	Sebastián Giraldo González Edwin Esteban Torres Gómez Ana Cristina Muñoz Toro	Enero de 2013
51	Tangible Temptation in the Social Dilema: Cash, Cooperation, and Self Control	Kristian Ove R. Myrseth Gerhard Riener Conny Wollbrant	Mayo de 2013
52	Análisis de las disparidades regionales en Colombia: una aproximación desde la estadística espacial, 1985 – 2010	Jhonny Moncada Osmar Leandro Loaiza Quintero	Octubre de 2013
53	Modelo VECM para estimar relaciones de largo plazo de un indicador de liquidez y sus determinantes	Wilman A. Gómez John F. Lopera	Noviembre de 2013
54	Informality and Macroeconomic Volatility: Do Credit Constraints Matter?	Catalina Granda Carvajal	Enero de 2015