Tax Toleration and Tax Compliance: How Government Affects the Propensity of Firms to Enter the Unofficial Economy

Douglas A. Hibbs Gothenburg University
Violeta Piculescu Gothenburg University

How do government-supplied institutional benefits and the taxation and regulation of producers affect the propensity of private firms to enter the unofficial economy and evade taxation? We propose a model in which the incentive of firms to operate underground depends on tax rates relative to firm-specific thresholds of tax toleration that are decisively affected by quality of governance—in particular by the presence of high-grade institutions delivering services enhancing official production that anchor profit-maximizing firms to the official economy. Some key predictions of the model concerning the determinants of firms' tax toleration and tax compliance receive broad support from empirical analyses of enterprise-level data from the World Bank's World Business Environment Surveys.

Unofficial production of goods and services is a big deal—an activity engaged in by millions of firms employing hundreds of millions of workers and producing trillions of dollars of output internationally.[1] The lion's share of research on the determinants of the scale of the unofficial economy investigates cross-national patterns among aggregate economic and institutional variables. The micro political-economic mechanisms by which institutions, policies, and related factors influence the productive behavior of firms are much less well documented and understood, though empirical studies based on national aggregates sometimes

draw inferences about the micro processes that might underlie the macro political-economic relationships uncovered.[2]

This article focuses explicitly on the productive activity of private firms, which compared to individuals are relatively unaffected by moral sentiments—by the guilt and shame individuals may feel when evading taxation and failing to comply with other legal obligations. We propose a microlevel model specifying how institutional benefits, taxation, and government regulations rationally influence a profit-maximizing firm's production choices. Unlike models that have firms making "all

[1] Unofficial economic activity is defined here as production and sale of goods and services that evade official registration and taxation. Such activity is undertaken either by firms that are not registered officially, or by firms that are registered officially but produce and sell at least part of their output unofficially. Common labels used in place of "unofficial" are hidden, parallel, underground, shadow, informal, black, and unobserved. Schneider and Enste (2002) provide detailed discussion of various definitions of the concept and estimates of aggregate national magnitudes.

[2] Loayza (1996), Johnson, Kaufmann, and Shleifer (1997), Johnson, Kaufmann, and Zoido-Lobaton (1998), and Friedman et al. (2000) are important examples of research investigating model-derived relationships among government policies, institutions, and the underground economy with empirical data for country aggregates. Johnson et al. (2000) investigate similar empirical relationships in firm-level data for five East European transition countries without reference to an explicit model.

ISSN 0092-5853

or nothing" choices about producing officially or unofficially,[3] a central prediction of the model is that profit-maximizing firms frequently will operate simultaneously in both production modes. Moreover, contrary to a traditional view that high tax rates are intrinsically a major cause of large shadow economies, the model implies that the incentive of firms to produce underground and evade taxation depends on statutory tax rates relative to firm-specific, rationally calibrated thresholds of tax toleration. The concept of firm-specific tax toleration helps explain why tax compliance and unofficial production vary so greatly across enterprises operating in the same national political-institutional environment and facing the same government regulations and tax rates.

The rest of the article is organized as follows. The production setting of profit-maximizing firms that optimally allocate labor and capital to official production, unofficial production, or both is defined in the next section. Official production is subject to taxes and regulations, but it benefits from government supplied and coordinated institutional services unavailable to underground operations. Unofficial production, on the other hand, escapes regulations and taxation of profits and labor, but it requires firms to bribe enforcement authorities who aim to maximize their own income from public employment and bribes, subject to the likelihood of being discovered selling corruption and suffering the penalties associated therewith. In this setting the circumstances under which a firm will undertake at least some of its production underground and evade taxes are derived. A central condition underlying unofficial production and tax evasion is that statutory tax rates exceed firm-specific thresholds of tax toleration. Toleration thresholds are determined, among other things, by government-supplied institutional benefits available only to official production and by political-institutional variables affecting the costs of corruption required to produce unofficially. At the end of this section some implications of the model for the responses of a firm's official, unofficial, and total output to changes in tax rates and changes in tax toleration induced by shifts in outside policy variables affecting the demand for and supply of corruption are illustrated graphically.

The model's predications concerning the determinants of firms' tax toleration and tax compliance are tested empirically in the third section by ordered logit regression analyses based on interview data obtained from managers of 3,686 enterprises distributed over 55 countries by the World Bank's World Business Environment

Surveys (WBES 2000; see note 28). Both structural and reduced form regression equations yield broad support of the model's testable implications. Observations about the policy implications of the theory and evidence are developed in the final section.

The Setting

Consider private firms endowed with fixed stocks of capital $\bar{K}$ and variable labor requirements in two nonexclusive modes of potential production: official production yielding declared output y_o that is subject to taxation, and unofficial production yielding undeclared output y_u that evades taxation. L_o denotes labor employed officially and L_u denotes labor employed unofficially. Assume that wage rates w are the same for all workers but that an employer's labor cost in official activity is $(1 + t_w) \cdot w$, where the labor tax rate t_w subsumes the formal payroll tax rate t^L and regulations on officially employed labor R^L that impose costs that are functionally equivalent to conventional labor taxes.[4] k denotes the fraction of its capital that the firm allocates to official production and $(1 - k)$ is the fraction allocated to unofficial production.[5] A firm's total output y_{total} is the sum of its official output y_o and its unofficial output y_u. y_{total} may be comprised of separate production chains operating independently at different locales in official y_o and/or unofficial y_u mode, or by parallel operation of the two modes at one venue.

y_o production is represented by the following Cobb-Douglas type (constant returns to scale) technology:

$$y_o = B^\delta (k \bar{K})^\alpha L_o^\beta, \quad \alpha + \beta + \delta = 1, \quad \alpha, \beta, \delta > 0. \tag{1}$$

B denotes the productive value of institutional services available *only* to official activity,[6] such as contract enforcement and protection of property by police and judicial authorities, customs and export subsidies and services, and official banking services.[7] It excludes public

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[3] In Johnson, Kaufmann, and Shleifer (1997), for example, the quality of institutions and governance drive firms into an activity equilibrium allowing only one of two stable states: totally official and totally unofficial.

[4] We could allow the wage rate w to vary between a firm's official and unofficial operations, w_o and w_u, but so doing would not change the model's implications so long as wage costs (as opposed to wage rates) remained higher in official production—a condition which is achieved in the present setup by the payroll tax factor $(1 + t_w)$.

[5] Hence the model abstracts from capital accumulation and each firm's allocation of its capital endowment $\bar{K}$ reveals its disposition to engage in official and unofficial production.

[6] For simplicity we assume there are no "user costs" attached to B; providing for them would add little to the formal analysis.

[7] It is easy to think of concrete examples of institutional services tied to official production and its inputs (the official part of total production), even among firms simultaneously engaged in official and unofficial activity using a mix of official and unofficial inputs in

goods like a nation's communication and transport infrastructures and public health and education systems that benefit both official and unofficial producers and their employees as well as other aspects of institutional capacity that do not directly affect productive efficiency. The productive contribution of B will generally depend both on firm-specific attributes—for example, size, area of activity, complexity of legal organization, managerial sophistication[8]—and on the country-specific availability of institutional services of given quality. Hence even among firms with high need of institutional services owing to their characteristics, inputs of B may be low because of generic deficiencies of national capacity.

Production of unofficial, untaxed output y_u can take no benefit of government institutional services. In principle, y_u and y_o denote goods and services of the same kind and quality. However, in order to employ capital and labor underground and avoid confiscation of unofficial output by omniscient bureaucrats, firms pursuing unofficial operations must engage in corrupt transactions with enforcement officials—tax authorities, health and safety inspection agents, construction site inspectors, and so

forth.[9] Inputs of bureaucratic corruption are therefore necessary for a firm to produce and market unofficial output. The quantity of those inputs is denoted by units of "C." Unofficial production technology has the same parameters and functional form as official technology:

$$y_u = C^\delta((1-k)\bar{K})^\alpha L_u^\beta. \qquad (2)$$

By contrast to some previous studies that view corruption and bribery as forces driving firms out of official production into the underground economy,[10] equation (2) is based on the idea that the "grabbing hands" of corrupt bureaucrats serve as "helping hands" allowing firms to exploit profitable opportunities by producing unofficially.

A profit-maximizing firm needs to decide how much labor to employ officially and unofficially,[11] how to distribute its capital stock between the two production modes, and how much corruption to buy from corruptible bureaucrats.[12] Firms are price takers and output prices are normalized to 1 so that revenue is coterminous with output. The firm maximizes net revenue π by solving the problem

$$\max_{k, L_o, L_u, C} \pi$$
$$= (1-t)\left[y_o - (1+t_w)\,w\,L_o\right] + \left[y_u - w\,L_u - mC\right]$$
$$s.t.\ 0 \le k \le 1;\ C, L_o, L_u \ge 0;\ and\ eqs.\ (1)-(2)$$
$$(3)$$

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tandem at one venue to produce a homogeneous stock of goods or services y_{total}, which consequently is partly official and governed by y_o technology and partly unofficial and governed by y_u technology. Here are a few: Smaller-scale construction companies are known to undertake some jobs unofficially and others officially, perhaps unbeknownst to their customers. Payment disputes in the industry are commonplace, yet builders cannot seek judicial relief for money owed for unofficial jobs and cannot appeal to police or courts when materials are stolen from black construction sites or are stolen by workers employed black in otherwise white projects—both being common problems in the industry. Manufacturers producing for export cannot take advantage of government export subsidies and payment insurance schemes if the volumes involved are suspiciously large relative to officially declared, taxed labor inputs and output. Restaurants and independent hotels are known to employ some staff officially and others unofficially (cleaning and maintenance personnel, for example) with an eye to hiding from taxation corresponding shares of revenues. Use of standard banking services for wage payments or recourse to law enforcement agencies in cases of alleged theft and other forms of employee malfeasance are problematic for workers engaged unofficially. The same problems face enterprises supplying home services—gardening, cleaning, pool maintenance, and the like.

[8]The assumption that firms differ with respect to their need for and effective use of institutional services is consistent with some existing firm-level empirical evidence. For example, in their analysis of enterprises in transition economies, Johnson, McMillan, and Woodruff (2002) found that court enforcement of contracts is more important to firms establishing new business relationships than to established firms and is more important to industries with a relatively low specificity of investments. Data presented in Batra, Kaufmann, and Stone (2003) indicate that small firms by comparison to medium and large firms are less constrained by customs procedures, whereas small- and medium-sized firms are more constrained than large ones by access to official banking institutions.

[9]The productive activity we model is not criminal in the sense that it would be legal if undertaken in the official, taxed economy. In other words, we are not dealing with activities generally treated as criminally illegal (and frequently controlled by criminal organizations), such as the drug trade, smuggling, and prostitution.

[10]See, for example, Choi and Thum (2005), Johnson, Kaufmann, and Shleifer (1997), and Friedman et al. (2000).

[11]Firms are assumed to be able to allocate labor freely between official and unofficial activity. Treating labor as a passive resource is of course an abstraction from the real world in which workers as well as firms face incentives and disincentives to participate in the underground economy. The seminal economic analysis of tax compliance among utility-maximizing individuals is Alingham and Sandmo (1972). Sandmo (2005) reviews developments in this tradition over the generation following the original 1972 article.

[12]Firms producing officially may also pay bribes to obtain or to speed up delivery of B from recalcitrant government authorities. (See Shleifer and Vishny 1993.) And both official and unofficial producers may engage mafia-type organizations to obtain criminally (and, indeed, sometimes more effectively) such official services as contract enforcement. No attempt to model such complications and attention is confined to the bureaucratic corruption and bribery necessary for a firm to produce in the underground economy. Incorporating bribery to official activity would lead to results dependent upon relative corruption in the two sectors, without qualitatively affecting our conclusions. The pathbreaking study of Peru by De Soto (1989) found that bribe payments by unofficial businesses vastly exceeded those made by official businesses.

where m denotes the unit price of C, and the tax rate t subsumes the formal profit tax rate t^F and regulatory burdens on official activity R^F that are analogous to taxes.

The Bureaucrat's Problem

In any given jurisdiction corruption is supplied monopolistically by a representative public official (a "bureaucrat") who is responsible for enforcing the tax code and other regulations. The enforcement bureaucrat is assumed able to accurately detect a firm's unofficial activity but is willing to overlook it if compensated sufficiently by illegal payments.[13] The bureaucrat receives a salary equal to S. If involved in corrupt transactions and not caught, the bureaucrat enjoys additional income from bribes equal to $m \cdot C$. If discovered to be selling corruption, the bureaucrat loses employment and pays a fixed penalty P. The bureaucrat's expected income $E(y_b)$ then is

$$E(y_b) = \theta (S + mC) - (1 - \theta) P \qquad (4)$$

where $(1 - \theta)$ is the probability that the bureaucrat is discovered to be selling C.

The probability θ is determined by an exogenous (unmodeled) mechanism exposing corruption

$$\theta = e^{-\mu C}, \quad \mu > 0. \qquad (5)$$

At any given C, μ determines the effectiveness of exposure procedures, which will tend to vary with firm-specific characteristics affecting the visibility of transactions in the corruption market.[14] Note that $\frac{\partial \theta}{\partial C} = -\mu e^{-\mu C} < 0$, so that the more units of corruption sold by the bureaucrat, the higher the chances $(1 - \theta)$ of being caught and penalized. However, if the exposure mechanism is weak (μ is small), the probability of being caught tends to be small, even when C is large.[15]

The bureaucrat's problem is to set a price m per unit of corruption that maximizes expected income (4), subject to (5) and the firm's demand for corruption. The optimal solution to the bureaucrat's problem yields the supply relation[16]

$$m = \frac{\mu (S + P)}{1 - \mu C}. \qquad (6)$$

Equation (6) implies that enforcement bureaucrats will supply corruption and overlook tax evasion only if firms will pay a unit price m higher than a minimum defined by $\underline{m} = \mu(S + P)$. The minimum acceptable price $\underline{m}$ rises as the bureaucrat's salary S increases, as the mechanism for exposing corruption becomes more effective (as μ increases), and as punishment becomes more stringent (as P increases). In other words, the higher are μ, S, and P, the more costly it is to induce bureaucrats to supply corruption. And the greater is the demand for corruption, the higher is the unit price of C acceptable to bureaucrats at given risks of exposure and punishment. Equation (6) also implies that a finite positive equilibrium price for corruption can exist only when $C < \frac{1}{\mu}$, reinforcing the point that the less effective are procedures for detecting corruption, the less constrained is its supply from the bureaucracy and the higher is the likelihood that a market for corruption will exist.[17]

Along with institutional services B directly affecting productivity of official activity, national realizations of μ, S, and P comprise important aspects of a country's broader institutional capacity. If that broader national capacity were introduced explicitly and indexed by $\bar{B}$, then B, μ, S, and P would be constituent components. B and $\{\mu, S, P\}$ are treated as structurally distinct even though they generally will be correlated positively by virtue of an underlying common national determinant $\bar{B}$ left outside the model's formal setup to economize on notation.[18]

[13] The setup below draws on the pioneering article of Becker and Stigler (1974) and the subsequent more complex model of Mookherjee and Png (1995), which is oriented to firms that pay bribes in order to evade pollution regulations. Models composed of the interplay of three constituents—an outside exposure or monitoring mechanism, and buyers and sellers of corruption—owe much to Klitgaard (1988). The seminal work launching modern political-economic analysis of corruption more generally is Rose-Ackerman (1978).

[14] The most important characteristics affecting visibility and hence the magnitude of μ are likely to be aspects of firm size—for example, the magnitudes of the firm's capital stock $\bar{K}$ and its labor force L.

[15] If the exposure likelihood of corrupt transactions were affected, say negatively, by their aggregate nationwide incidence ("$\bar{C}$"), then multiple equilibria may arise of the sort studied by Andvig and Moene (1990) and Nabin and Bose (2008). We make no attempt to analyze such complexities here.

[16] Proofs of all results asserted in this article are given in an Appendix of Proofs available at www.douglas-hibbs.com.

[17] Complicit firms are not punished in the same fashion as enforcement authorities discovered selling corruption because profit from unofficial production in (3) is not affected directly by the exposure probability $(1 - \theta)$. Instead exposure effectiveness depresses profit via the positive effect of μ on the price of corruption m. Modifying the structure of penalties and costs falling on bureaucrats and firms yields analytical results qualitatively similar to those derived for the present model, though some plausible variations complicate enormously the comparative statics.

[18] Illustrated graphically:
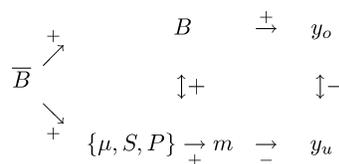
where single-headed arrows indicate structural-causal relations and double-headed arrows represent noncausal correlations. Hence the broader underlying institutional capacity $\bar{B}$ exerts direct positive

Indeed there is some gain in so doing because focusing on components of $\bar{B}$ like B and $\{\mu, S, P\}$ allows theoretical analysis later in this section of specific proximate demand- and supply-side determinants of unofficial activity and tax evasion, and at the same time it does not detract from the empirical analyses reported in the third section.

Unofficial Production and the Existence of Corruption Markets

Assume that the firm has perfect information about the bureaucrat's supply schedule in (6). For given positive values B, t, t_w, μ, S, and P, the firm's maximization program in (3) admits two solutions: (1) an interior solution where the firm allocates capital and labor to both official and unofficial production, and (2) a corner solution where labor and capital are allocated wholly to official production. In the first case the firm enters into corrupt transactions with bureaucrats in order to protect its unofficial output, whereas in the second the firm has no incentive to evade taxes and produce unofficially, and thus has no need of C.[19] The two cases are now considered sequentially.

When the firm finds it optimal to produce in both modes simultaneously $(k < 1)$, the profit-maximizing levels of output are

$$y_o = \left(\frac{Bm}{\delta}\right)(1-t)^{\frac{\alpha}{\delta}}\left(\frac{1}{1+t_w}\right)^{\frac{\beta}{\delta}} \tag{7}$$

$$y_u = \left(\frac{\delta}{m}\right)^{\frac{\delta}{\alpha}}\left(\frac{\beta}{w}\right)^{\frac{\beta}{\alpha}}(1-k)\bar{K} \tag{8}$$

where the share of capital allocated to official production is $k = \frac{(1-t)^{\frac{\alpha+\delta}{\delta}}B(\frac{1}{1+t_w})^{\frac{\beta}{\delta}}}{(\frac{\delta}{m})^{\frac{\alpha+\delta}{\alpha}}\bar{K}(\frac{\beta}{w})^{\frac{\beta}{\alpha}}}$. Intuitively, equations (7)–(8) can be interpreted as saying that the firm decides how

causal effect on official production y_o via B and negative causal effect on unofficial production y_u via $\{\mu, S, P\}'s$ positive effect on corruption prices m, as shown ahead in the main text by equations (7) and (8).

[19]The third hypothetical possibility in which the firm operates wholly in the unofficial sector emerges only in the fanciful case of confiscatory taxation $(t = 1)$ or, more realistically, when official institutional services are either not needed by the firm or are not provided to any meaningful extent by government $(B = 0)$. Small operations delivering personal services (often single-person "firms") probably are the most common example of cases in which the productive value of B is practically zero. The WBES (2000) data used for empirical testing in the third section were obtained from firms legally registered and, therefore, not engaged exclusively in unofficial production.

much output to produce in each mode by first determining the maximum output it could produce unofficially where it avoids taxes on profits and labor. Setting $k = 0$ on the right side of (8) gives notional maximum unofficial output as $y_u^{\max} = (\frac{\delta}{m})^{\frac{\delta}{\alpha}}(\frac{\beta}{w})^{\frac{\beta}{\alpha}}\bar{K}$. The firm then implicitly trades off part of $y_u^{\max}$ for taxable output y_o up to the point where institutional benefits to official production compensate the firm for the tax liabilities incurred by producing officially. It follows that the firm will find it profitable to operate to some degree unofficially $(k < 1$ and $y_u > 0)$ only if

$$\left(\frac{\delta}{m}\right)^{\frac{\alpha+\delta}{\alpha}}\left(\frac{\beta}{w}\right)^{\frac{\beta}{\alpha}}\bar{K} > (1-t)^{\frac{\alpha+\delta}{\delta}}\left(\frac{1}{1+t_w}\right)^{\frac{\beta}{\delta}}B. \tag{9}$$

For a given capital stock $\bar{K}$, condition (9) indicates that the firm engages in tax evasion when cheap corruption and relatively low wage costs affecting unofficial activity combine with high tax rates on profits and labor and deficient institutional services affecting official activity.

Recall from the analysis of the bureaucrat's problem that a positive supply of corruption requires m to be above the minimum price $\underline{m} = \mu(S + P)$. The firm, on the other hand, needs to pay bribes to purchase C only if it produces unofficially $(y_u > 0)$, which by (9) requires that

$$m < \delta\left(\frac{\bar{K}}{B}\right)^{\frac{\alpha}{\alpha+\delta}}\left(\frac{\beta}{w}\right)^{\frac{\beta}{(\alpha+\delta)}}(1-t)^{-\frac{\alpha}{\delta}}(1+t_w)^{\frac{\beta\alpha}{\delta(\alpha+\delta)}}. \tag{10}$$

The right side of (10) therefore defines the upper bound of C's unit price, which will be denoted $\bar{m}$. Corrupt transactions between firms and bureaucrats will exist only if $\underline{m} < \bar{m}$, that is, only if

$$\mu(S + P)$$
$$< \delta\left(\frac{\bar{K}}{B}\right)^{\frac{\alpha}{\alpha+\delta}}\left(\frac{\beta}{w}\right)^{\frac{\beta}{(\alpha+\delta)}}(1-t)^{-\frac{\alpha}{\delta}}(1+t_w)^{\frac{\beta\alpha}{\delta(\alpha+\delta)}}. \tag{11}$$

When (11) holds, firms and enforcement bureaucrats will agree on a unique price for units of C and an active corruption market enabling unofficial production will exist.

The firm's demand for corruption, implied by the first-order condition for C in (3), is

$$C = \left(\frac{\delta}{m}\right)^{\frac{\alpha+\delta}{\alpha}}\left(\frac{\beta}{w}\right)^{\frac{\beta}{\alpha}}(1-k)\bar{K} \tag{12}$$

where recall that k is a positive function of B, m, and w and a negative function of t, t_w, and $\bar{K}$ (see equation 8). Figure 1 uses sensible values for terms in the corruption supply and demand functions (equations 6 and 12) to

FIGURE 1 Prices and Quantities in the Corruption Market
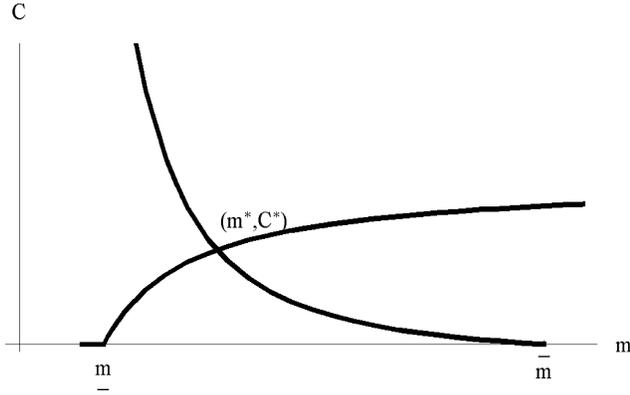
When a firm is willing to pay a price per unit of C exceeding the minimum price $\underline{m}$ acceptable to enforcement bureaucrats, an active market for corruption will exist with equilibrium (m^*, C^*).

show that a unique equilibrium (m^*, C^*) exists in the admissible range $(\underline{m}, \bar{m})$.[20]

Tax Toleration and Tax Compliance

In addition to defining conditions for the existence of a corruption market, equation (11) has important implications for the impact of profit taxation on tax compliance and the unofficial economic activity. Solving (11) for the profit tax rate on the left side shows that unofficial production emerges when

$$t > \underline{t}$$

$$\underline{t} \equiv 1 - \left(\frac{\delta}{\mu(S+P)}\right)^{\frac{\delta}{\alpha}} \left(\frac{\bar{K}}{B}\right)^{\frac{\delta}{\alpha+\delta}} \left(\frac{\beta}{w}\right)^{\frac{\beta\delta}{\alpha(\alpha+\delta)}} (1+t_w)^{\frac{\beta}{\alpha+\delta}}. \tag{13}$$

[20]A more formal demonstration runs as follows. The optimal relation (6) implies the supply function $C^S(m) = \frac{m - \mu(S+P)}{\mu m}$. Equation (12) gives demand as $C^D(m) = (\frac{\delta}{m})^{\frac{\alpha+\delta}{\alpha}} (\frac{\beta}{w})^{\frac{\beta}{\alpha}} (1-k)\bar{K}$. As illustrated in Figure 1, at $C^S(\underline{m}) = 0$, $C^S(\underline{m}) < C^D(\underline{m})$, and at $C^D(\bar{m}) = 0$, $C^D(\bar{m}) < C^S(\bar{m})$. Since $C^S(m)$ is monotonically increasing in m and $C^D(m)$ is monotonically decreasing in m, it follows that there exists a unique value m^* in the interval $(\underline{m}, \bar{m})$ such that $C^S(m^*) = C^D(m^*)$. Therefore, when the maximum unit price a firm is willing to pay for C is higher than the minimum unit price the bureaucrat is willing to accept, they will always find a price m^* they can agree upon. When condition (11) does not hold, $\underline{m} > \bar{m}$ and the firm will not purchase corruption required to produce unofficially and evade taxes. Consequently, there will be no transactions for C and an active corruption market will not exist. The conventional price-quantity axes in Figure 1 are interchanged because the forgoing argument is somewhat easier to interpret from the graph lines when C is on the vertical axis and m is on the horizontal.

$\underline{t}$ may be interpreted as the firm's threshold of tax toleration. What matters for a firm's optimal production strategy is not the absolute rate of profit taxation, but instead the magnitude of $\underline{t}$ relative to the rate a firm perceives to be "worth paying" in light of institutional benefits available only to official activity and the cost of corruption required to produce unofficially. In terms of variables amenable to policy influence, (13) says that tax toleration increases with firm-specific institutional benefits B and corruption prices $\underline{m}$, where the latter are determined by firm-specific effectiveness of corruption exposure μ and nation-specific bureaucratic salaries plus penalties $S + P$. On the other hand, toleration of taxation falls as the relative price of labor deployed in official production $(1 + t_w)$ rises.

When the profit tax rate facing a firm is below its toleration threshold, the value of tax evasion in the underground economy is outweighed by a combination of the cost of corruption necessary to produce unofficially and profitable opportunities in taxable activity where production benefits from government-supplied institutional services. Consequently when $t \leq \underline{t}$, unofficial production and corruption are nil, and firms comply fully with the tax code. Formally, this case represents a corner solution to the firm's problem in (3) with $k = 1$, $y_u = 0$, and $C = 0$. Total output (y_{total}) at the corner is

$$y_o = B^{\frac{\delta}{\alpha+\delta}} \bar{K}^{\frac{\alpha}{\alpha+\delta}} \left(\frac{\beta}{(1+t_w)w}\right)^{\frac{\beta}{\alpha+\delta}} = y_{total}. \tag{14}$$

An implication of the equilibrium results is that it is possible for government to impose high rates of profit tax without triggering large diversions of resources to underground production and large-scale tax evasion *if* political authorities are able to raise B, μ, S, and P enough to create even higher thresholds of tax toleration for most firms. This connection of tax compliance and tax toleration among firms in the model is comparable to the concept of "fiscal exchange" between citizens and government developed in studies of tax compliance among individuals. High tax compliance and positive perceptions of fiscal exchange arise when taxpayers regard the tax system as fair and responsive to citizen preferences, financing government programs delivering personal benefits and public goods citizens approve of. (See, for example, Alm, Jackson, and McKee 1993; Cummings et al. 2005; Feld and Frey 2007; Pommerehne, Hart, and Frey 1994; Pommerehne and Weck-Hannemann 1996; Roberts and Hite 1994; and Schloz and Lubell 1998.) Yet the correspondence is far from perfect. As mentioned earlier, firms inherently are less susceptible than individuals to behavioral pressure from moral sentiments. The anguish

**FIGURE 2   Optimal Output Levels as the Profit
            Tax Rate Varies**
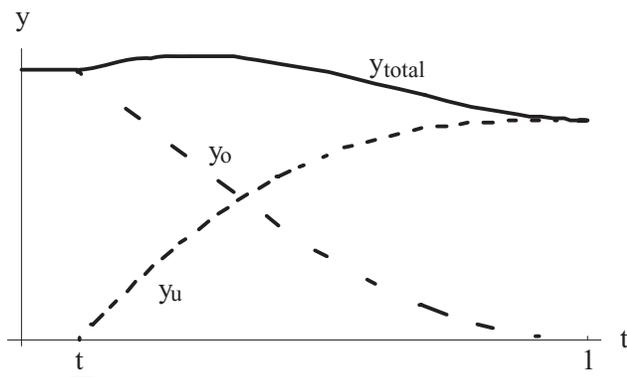
Official output y_o decreases and unofficial output y_u increases
monotonically as the tax rate t rises above a firm's tax toleration
threshold $\underline{t}$. Consequently the official output share $y_o/(y_o + y_u)$
decreases, but the firm's total output $y_{total} = (y_o + y_u)$ may expand
or contract, depending on the initial condition of t. At $t < \underline{t}$ all
production is official, and at $t = 1$ all production is unofficial.

of bad conscience may weigh upon individuals; rational
calculations of the bottom line drive the firm.

Figure 2 depicts the pattern of a representative firm's
production choices as the profit tax rate t varies around
a fixed threshold of tax toleration $\underline{t}$. The constituents of t
(the profit tax rate proper t^F, and regulations on official
producers R^F) are of course core policy instruments in
any national political economy. Total output in Figure 2
cumulates the firm's official and unofficial production.

In the graph region where $t < \underline{t}$ (to the left of $\underline{t}$ on
the horizontal axis) all of a firm's production is official;
$y_{total} = y_o$. As t rises above the threshold $\underline{t}$, firms begin to
find unofficial activity profitable and they produce y_o and
y_u simultaneously. The response of production decisions
to increases of the profit tax rate among firms perceiving
$t > \underline{t}$ and, consequently, already evading taxes to some
degree, is composed of direct and indirect effects. Tax
rate hikes directly depress marginal returns on labor and
capital in official production, which by itself prompts
firms to shift resources to unofficial activity—k falls and
y_u rises (equation 8). Higher underground production,
however, requires bigger inputs of corruption, and the
associated upward shift in demand for C prompts an
upward adjustment of the price m (equation 6) in the
corruption market, which mutes the increase in unoffi-
cial activity ultimately induced by a higher t (equations
7–8).[21] Nonetheless, in the range $t > \underline{t}$, higher tax rates

unambiguously lead to equilibrium increases of y_u and
decreases of y_o and, therefore, to decreases in the share of
official output in a firm's total production.[22]

The effect of changes to profit tax rates on a firm's
total output, $y_{total} = y_o + y_u$, depends on t's initial con-
dition. As suggested by Figure 2, in the range $t >> \underline{t}$ an
increase in t induces a decline in official output that more
than offsets the corresponding rise of unofficial output,
thereby contracting the firm's aggregate production.[23]
The reason is that when profit tax rates are relatively high,
firms tend to be heavily engaged in unofficial production
and to be paying high prices for the big quantities of cor-
ruption required to sustain the large scale of underground
operations. As a result, increases to already high tax rates
yield only modest expansions of the firm's unofficial ac-
tivity, and these are more than offset by contractions of its
official output. Hence the firm's total output declines. At
lower initial tax rates, however, the firm's aggregate out-
put may well increase due to increases of profit taxation
because the tax-induced expansion of its unofficial pro-
duction exceeds the associated tax-induced contraction
of its official production.[24] The implications for interna-
tional patterns in macroeconomic performance depend
on the distribution across countries of national rates of
profit tax t in relation to firm-specific levels of tax toler-
ation $\underline{t}$. And the implications for government objectives
in various countries—for example, maximization of ag-
gregate official output or perhaps even aggregate income
altogether, official plus unofficial—depend on national
distributions of firm-specific tax toleration in relation to
the common tax rate facing all firms in a country.[25]

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would be higher, in the absence of interactions in the corruption
market between firms and bureaucrats over the price of C that
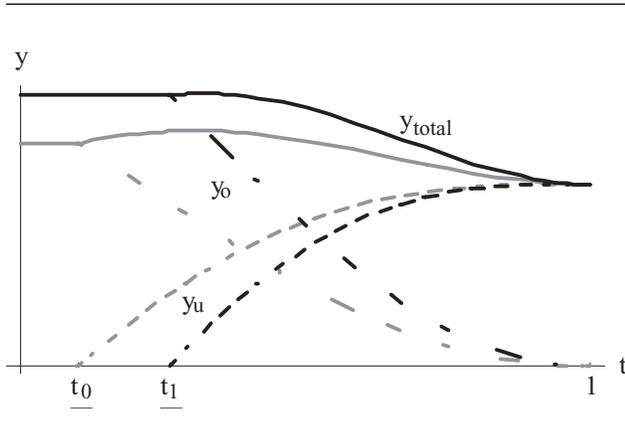prompt bureaucrats to adjust m in response to shifts in the demand
for corruption.

[22]Formally, for any $t > \underline{t}$ it can be shown that $\frac{\partial \ln m}{\partial \ln t} > 0$, $\frac{\partial \ln C}{\partial \ln t} > 0$, $\frac{\partial \ln y_o}{\partial \ln t} < 0$, $\frac{\partial \ln y_u}{\partial \ln t} > 0$, and $\frac{\partial \ln(\frac{y_o}{y_o + y_u})}{\partial \ln t} < 0$. More detailed analysis
of the comparative statics appears in the Appendix of Proofs.

[23]Specifically, $\frac{\partial \ln(y_o + y_u)}{\partial \ln t} < 0$ if $t > \frac{\delta}{\alpha + \delta}(1 - C\mu)$.

[24]Note that results here and ahead assume firms do not internal-
ize potential feedback from increased official production to higher
government tax revenues, which in turn might finance lower tax
rates or improved government services benefiting official produc-
tion. The impact of an individual firm's production choices on
government resources is negligible and so potential feedback ef-
fects rationally would be disregarded in optimal decision making.

[25]This and related themes are pursued at greater length in the con-
cluding section. Descriptive statistics reported in the third section
indicate that within-country dispersion of tax toleration and its
determinants are large.

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[21]In other words, the impact of tax rate changes on a firm's output
decisions would be stronger, and the equilibrium level of corruption

FIGURE 3 Output Effects of an Improvement to Institutional Benefits B

An increase in B raises a firm's threshold of tax toleration from $\underline{t}_0$ to $\underline{t}_1$. Optimal production decisions under $\underline{t}_1$ are shown by the black graph lines and under $\underline{t}_0$ by the grey graph lines. At any given tax rate t, the rise in $\underline{t}$ prompts the firm to produce more official output y_o, and less unofficial output y_u. The increase of y_o always exceeds the decrease of y_u, and so total output y_{total} rises along with the official output share $y_o/(y_o + y_u)$.

FIGURE 4 Output Effects of an Increase in Corruption Exposure Effectiveness μ
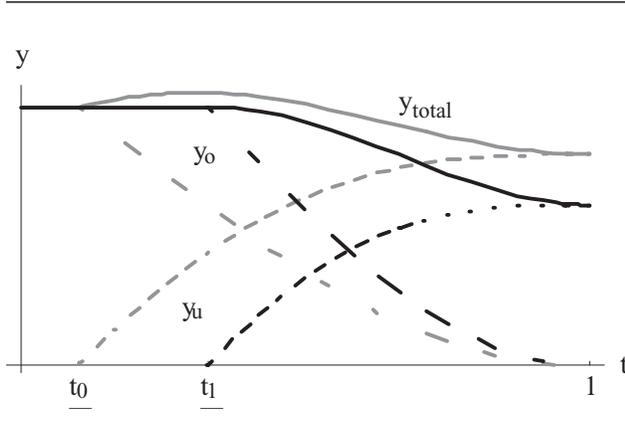
An increase in μ raises a firm's threshold of tax toleration from $\underline{t}_0$ to $\underline{t}_1$. Optimal production decisions under $\underline{t}_1$ are shown by the black graph lines and under $\underline{t}_0$ by the grey graph lines. The increase of tax toleration induced by higher μ prompts less unofficial and more official production among firms with $t > \underline{t}$. However, the decline of y_u is bigger than the rise of y_o, and so although the official output share $y_o/(y_o + y_u)$ rises, total output y_{total} falls. Production choices of firms with $t < \underline{t}$ are not affected by changes in μ.

Demand- and Supply-Side Determinants of Tax Toleration and Compliance

Now consider how movements in tax toleration affect a firm's optimal production decisions. Figures 3 and 4 illustrate the effects of changes in tax toleration originat-

ing with an increase to institutional services B and with an increase to the effectiveness of corruption exposure μ, respectively. Recall that B is a principal determinant of the demand for corruption, whereas μ is a key variable affecting the supply side of the corruption market. Along with the demand-side variable t_w and the supply-side variables S and P, the availability and quality of institutional services and the effectiveness of corruption detection are potential policy instruments that could be used by national authorities to influence tax toleration, and through that route tax compliance and underground production.

Figure 3 graphs how firms' profitable production possibilities shift owing to an increase in B raising tax toleration from $\underline{t}_0$ to $\underline{t}_1$, with other outside variables held constant. The enhancement of B induces all firms to increase official output (equations 7 and 14). Moreover, firms initially operating to some degree unofficially whose tax toleration threshold is pushed above the profit tax rate by improvement to institutional services (firms with $\underline{t}_0 < t < \underline{t}_1$) will cease producing underground. Firms already active underground whose new toleration threshold remains below the profit tax rate (firms with $\underline{t}_0 < \underline{t}_1 < t$) will continue operating unofficially, but will reallocate some resources out of unofficial production to official production. Hence both official output y_o and the share of official output in total output $\frac{y_o}{y_o + y_u}$ increase with improvements to B. And although transaction prices for corruption m will adjust downward in response to the across-the-board decline in demand for corruption, in equilibrium both the level and the price of corruption will be lower in the wake of the expansion among all firms of both official and total production.[26]

Figure 4 illustrates the output effects of an increase in the effectiveness of the corruption exposure mechanism μ that raises the firm's threshold of tax toleration from $\underline{t}_0$ to $\underline{t}_1$, with other outside variables again held constant. An increase in μ contracts the supply of corruption, which induces higher official production and lower unofficial production among all firms with initial condition $t > \underline{t}$. By contrast to B, however, μ is not a factor of production and it therefore exerts no influence on the output decisions of firms with initial condition $t < \underline{t}$, that is, among firms initially active wholly in the official economy. In this sense the carrot of improved institutions has wider impact than the stick of improved detection of corruption because the former affects the behavior of all firms.

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[26] Formally, it can be shown that $\frac{\partial \ln C}{\partial \ln B} < 0$, $\frac{\partial \ln m}{\partial \ln B} < 0$, $\frac{\partial \ln y_u}{\partial \ln B} < 0$, $\frac{\partial \ln y_o}{\partial \ln B} > 0$, $\frac{\partial \ln(y_o + y_u)}{\partial \ln B} > 0$ and, $\frac{\partial \ln(\frac{y_o}{y_o + y_u})}{\partial \ln B} > 0$. Changes to t_w yield the same pattern of effects but with opposite signs.

Moreover, unlike the case of improvements to institutional benefits, which always raise total as well as official production, improved detection of corruption does not yield higher total output because the ensuing decline of the firm's unofficial output exceeds the growth of its official output. Intuitively, the explanation of this result may be described by the following sequence of events. The heightened probability of being caught and punished for selling corruption brought about by an increase to μ leads income-maximizing enforcement bureaucrats to require higher unit prices m to supply given quantities of corruption. More expensive corruption reduces firms' demand for inputs of C necessary to produce unofficially without affecting the marginal products of inputs to official production. With lower unofficial production and higher exposure probability, the quantity of corruption decreases and its price increases. In the new environment firms will tend to transfer some of their resources to official production, but only to the extent that additional official profits compensate for the unofficial profits forgone due to higher costs of corruption. Firms that in the first instance were evading taxes will sometimes even find it profitable to exit the underground economy completely (firms with $\underline{t}_0 < t < \underline{t}_1$). Yet like firms that remain to some degree in the underground economy under $\underline{t}_1$, the expansion of official production among exiting firms will not fully compensate for loss of unofficial output. Consequently, among firms initially located in the range $t > \underline{t}$, increases to μ yield rises in the official share of output but declines in aggregate output.[27]

Some Empirical Evidence

From late 1999 to mid-2000 the World Bank sponsored interviews with managers of more than 10,000 enterprises in 80 countries covering the main regions of the world—

the World Business Environment Surveys (WBES 2000).[28] The interviews dealt, among other things, with managers' perceptions of the operational difficulties posed by taxation, government regulations, corruption of public officials, functioning of the judiciary, and access to financial services. The surveys also obtained reports about the degree of tax compliance among firms. The WBES data make possible rough empirical tests of key implications of the model concerning (1) some direct determinants of firm-level toleration of taxation, and (2) direct and indirect determinants of the share of total output declared officially and subjected to tax among firms.

Empirical analyses were undertaken for a subset of the enterprises sampled. First, because the model pertains to the behavior of private firms, the public sector firms surveyed are excluded. Second, enterprises in African countries are excluded because in that region the data were obtained predominately from mail surveys, rather than from in-person interviews which were undertaken everywhere else. Postal survey data are far less reliable than the personal interview data.[29] Finally, the usable sample was reduced further due to missing data for one or more variables in the multivariate analyses. Sample attrition from this source included all Middle Eastern countries. All told, the regression analyses ahead are based on a common sample of personal interview responses from managers of 3,686 firms distributed over 55 countries.

Tax Toleration

A central message of the model is that a firm's propensity to produce officially and pay taxes is driven by the gap between its tax toleration $\underline{t}$ and tax rate t. Let i be an index for firms and j an index for countries. Because the profit tax rate subsumes conventional country-level rates t_j^F, and regulations on official activity which generally impact individual firms in different ways R_{ij}^F, profit tax rates are firm-specific: $t_{ij} = t(t_j^F, R_{ij}^F)$. Similarly, because the labor tax rate subsumes conventional national payroll rates t_j^L, and labor regulations R_{ij}^L which generally affect

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[27]More precisely, as shown in the Appendix of Proofs, even though an increase in μ has a positive effect on a tax-evading firm's official production, $\frac{\partial \ln y_o}{\partial \ln \mu} > 0$, and on its official share of total production, $\frac{\partial \ln\left(\frac{y_o}{y_o + y_u}\right)}{\partial \ln \mu} > 0$, the effect on its total output is negative, $\frac{\partial \ln(y_o + y_u)}{\partial \ln \mu} < 0$. The effects of changes in S and P are qualitatively the same.

As noted earlier, institutional benefits B and effectiveness of corruption exposure μ will generally be imperfectly correlated positively because both reflect an underlying generic capacity of the state. Hence the opposite responses of total output to shifts in B and μ depicted in Figures 3 and 4, respectively, will to some degree be offsetting if both variables move at once; nonetheless it is illuminating to understand the partial-conditional effects of those distinct channels of influence.

[28]The raw WBES (2000) data and documentation are available at http://www.ifc.org/ifcext/economics.nsf/Content/ic-wbes. The WBES (2000) raw data, external data on labor and corporate tax rates, as well as precise specifications of procedures generating working variables from the raw data and of all statistical results in this article are contained in Stata 9.2 do and dta files posted at www.douglas-hibbs.com.

[29]Among other problems, the African postal surveys yielded very low response rates and implausibly low reports of tax evasion—hardly surprising in view of the fact that respondents were asked to commit reports of illegal behavior to writing.

firms in different ways, labor tax rates are firm-specific: $t_{w_{ij}} = t_w(t_j^L, R_{ij}^L)$.

The expression defining $\underline{t}_{ij}$ in (13) indicates that tax toleration is affected negatively by payroll tax rates $t_{w_{ij}}$ which determine the relative wage costs in official as compared to unofficial production and vary over firms in every country, and is affected positively by institutional benefits B_{ij} which likewise vary over firms in every country. Tax toleration is also positively affected by two variables that we could not measure: total wage costs in unofficial production w_{ij}, and corruption price minima $\underline{m}_{ij} = \mu_{ij}(S_j + P_j)$ which vary over firms (owing to firm-specific visibility effects embodied in the detection parameter μ_{ij}) in various countries (owing to national salary levels S_j and malfeasance penalties P_j). However, some of the positive effects of w_{ij} and $\mu_{ij}(S_j + P_j)$ on t_{ij} will be picked up by the size of firms' capital stock $\bar{K}_{ij}$, a variable that is well measured by the WBES. $\bar{K}_{ij}$ positively affects tax toleration by increasing the visibility of corruption and its exposure μ_{ij}, which in turn raises corruption price minima $\underline{m}_{ij}$. $\bar{K}_{ij}$ also will tend to raise wages w_{ij} via so-called efficiency wage policies associated with large, capital-rich firms. Through those indirect channels $\bar{K}_{ij}$ will exert positive effect on tax toleration. But the direct effect of $\bar{K}_{ij}$ on $\underline{t}_{ij}$ in (13) is negative.[30] Consequently the net effect of a firm's capital stock on tax toleration is ambiguous. The functional relations in terms of observables are

$$\underline{t}_{ij} = F\left[\overset{+}{B_{ij}},\ t_w\left(\overset{-}{t_j^L}, \overset{+}{R_{ij}^L} \right),\ \overset{+/-}{\bar{K}_{ij}} \right] \qquad (15)$$

where the expected sign of $F'(\cdot)$ appears above each term on the right side of (15).

Tax toleration $\underline{t}_{ij}$ is measured by the following WBES question: "*Please judge on a four point scale how problematic are high taxes for the operation and growth of your business*" with ordered response categories *1 = 'major obstacle' 2 = 'moderate obstacle' 3 = 'minor obstacle' and 4 = 'no obstacle'*.[31] The aim is to tap an underlying continuum running from low to high values of firm-specific tax toleration. A potential deficiency, however, is that when toleration is genuinely low (because taxation is in fact perceived to be a major problem), firm managers may nonetheless reply "*no obstacle*" because they are easily

able to evade taxes by shifting operations underground, thereby conflating the concept of tax toleration with acts of tax evasion and weakening the observed connection between the two. Although serious in principle, this fundamental source of measurement error is not likely to be quantitatively important because the incidence of negligible toleration registered by the interviews is so low: only 9% of responses fall in the "*no obstacle*" category, whereas fully 58% of firm managers regarded taxes as a "*major obstacle*" with another 22% perceiving taxes as a "*moderate obstacle*."[32]

Institutional services B_{ij} are measured by the WBES question "*Please judge on a four point scale how problematic are these different regulatory areas for the operation and growth of your business*" for items pertaining to access to financial services, functioning of the judicial system, and customs procedures. The response options for each item are again scaled *1 = "major obstacle"* to *4 = "no obstacle."* A composite index of B_{ij} was constructed by taking the arithmetic average of the scale values across the three items, yielding 10 exclusive ordinal categories running from 1 to 4 by increments of one-third.

A composite measure of *regulations on official activity* imposing burdens on official producers R_{ij}^F, which are analogous to conventional profit taxes, was constructed in the same way as B_{ij} by averaging the 4-point scale responses to "*how problematic are*" questions dealing with business licensing, environmental regulations, fire and safety regulations, and foreign exchange regulations. The resulting composite variable for R_{ij}^F had 13 exclusive categories running from 1 to 4 by increments of one-fourth. *Labor regulations* affecting officially employed labor R_{ij}^L, which are akin to conventional payroll taxes, were measured by 4-point scale responses to the same question regarding perceptions of problems created by government labor regulations.

Capital assets of firms $\bar{K}_{ij}$ are measured by the WBES question asking managers to "estimate [the value of] your firm's fixed assets—land, buildings, equipment." Common responses in the country surveys fall into 10 categories ranging from less than 250,000 USD to 500,000,000 USD or more. Though truncated at the upper end, these data supply good calibration of physical capital stocks.

The WBES data provide no defensible empirical measure of $\underline{m}_{ij} = \mu_{ij}(S_j + P_j)$—the minimum price of corruption necessary to induce enforcement officials to overlook unofficial production and tax evasion among firms in various countries—or for other combinations of

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[30]In a model of unofficial production and tax evasion among firms in which capital accumulation is endogenous, Busato et al. (2008) obtain theoretical results implying that direct fiscal subsidy of capital formation (as opposed to tax deductions for investment spending) gives firms incentive to divert resources to unofficial activity and tax evasion.

[31]To ease interpretation of regression results in the next section the response codes in the raw WBES (2000) questionnaire data which ran from 1 = *No obstacle* to 4 = *Major obstacle* were reversed in this and other "obstacle" questions discussed ahead.

[32]The percentage frequency distribution for $\underline{t}$ in the sample of 3,686 firms is

1='major'	2='moderate'	3='minor'	4='no(ne)'
58%	22%	11%	9%

TABLE 1   Descriptive Statistics

Variable	Analysis Level		Mean	St. Dev.	Min	Max
Tax Toleration, $\underline{t}_{ij}$	Firms (3686)	overall	1.7	0.98	1	4
(1=Major Obstacle	Countries (55)	between		0.47		
to 4=No Obstacle)		within		0.87		
Institutional Services, B_{ij}	Firms (3686)	overall	2.6	0.73	1	4
(1=Major Obstacle to	Countries (55)	between		0.37		
4=No Obstacle)		within		0.65		
Labor Regulations, R^L_{ij}	Firms (3686)	overall	2.8	1.1	1	4
(1=Major Obstacle to	Countries (55)	between		0.57		
4=No Obstacle)		within		0.93		
Regulations on Official	Firms (3686)	overall	3.0	0.72	1	4
Activity, R^F_{ij}	Countries (55)	between		0.32		
(1=Major Obstacle to		within		0.65		
4=No Obstacle)						
Capital Assets, $\bar{K}_{ij}$	Firms (3686)	overall	108,595	197,376	125	500,000
(1000s USD)	Countries (55)	between		117,204		
		within		165,938		
Tax Compliance, $\frac{y_o}{y_o+y_u}{}_{ij}$	Firms (3686)	overall	79	27	25	100
midpoint values for 7	Countries (55)	between		16		
categories of % Sales		within		23		
Reported (25% to 100%)						
% Corporate Tax Rate, t^F_j	Countries (55)	overall	30	6.3	15	45
% Payroll Tax Rate, t^L_j	Countries (55)	overall	28	13	4.2	53

Notes: Index i denotes firms and j denotes countries. Statistics for % Sales Reported are computed from midpoint values but ordinal categories 1 to 7 are used as the dependent variable in the ordered logit regressions in Table 2. Mean/variance statistics for the ordinal response variables should be interpreted with caution even though Wald and likelihood ratio tests support treating log values as interval independent variables in the ordered logit regressions in Table 2.

μ_{ij}, S_j, and P_j that affect equilibrium corruption prices and production decisions. As noted earlier, some corruption price effects will be picked up by $\bar{K}_{ij}$ because the visibility and exposure of corrupt transactions are likely to increase with firm size.

Measurement of remaining variables in (15) is more straightforward. The *corporate tax rate* t^F_j is measured by the top marginal tax rate on corporate profits in each country for year 2000,[33] and the *payroll tax rate* t^L_j is measured by social security contribution rates for year 1999.[34] Descriptive statistics reported in Table 1 show that among variables varying by i and j, within-country

[33]Data are from the World Tax Database maintained by the Ross School of Business at the University of Michigan and are available at http://www.bus.umich.edu/otpr/otpr/introduction.htm. Measurement of effective rather than top rates might have been better suited to the analysis, but relevant data are not available.

[34]Contributions pertaining to old age, disability and death, sickness and maternity, work injury, and unemployment were summed. The data mix contributions from employers and employees in the various payroll systems. The constituent data are from *Social Secu-*

standard deviations are 1.4 to 2.0 times the magnitude of between-country standard deviations, implying that firm-specific characteristics affecting those variables are generally much more dispersed than country-specific attributes.

Tax Compliance and the Official Share of Production

The WBES data also allow empirical tests of the model's implications concerning determinants of tax compliance as registered by the share of output declared officially and subject to tax. Figures 2–4— and the associated theoretical analyses—implied that the share of taxed, official output in total output $(\frac{y_o}{y_o+y_u})_{ij}$ is negatively related to the gap between tax rates t_{ij} and levels of tax toleration $\underline{t}_{ij}$, where $\underline{t}_{ij}$ is in turn a function of the outside variables on the

rity Programs Throughout the World, available from the U.S. Social Security administration.

right side of (15). The measurement metrics of t_{ij} and $\underline{t}_{ij}$ are incompatible, so direct computation of tax gaps is infeasible. The model nonetheless implies the following pattern of empirical relations:[35]

$$\left[\overset{+}{B}_{ij}, \ t_w \left(\overset{-}{t^L_j}, \ \overset{+}{R^L_{ij}} \right), \ \overset{+/-}{\overline{K}_{ij}} \right] \Rightarrow \overset{+}{\underline{t}}_{ij} \Rightarrow$$
$$t \left(\overset{-}{t^F_j}, \ \overset{+}{R^F_{ij}} \right) \Rightarrow \left(\frac{y_o}{y_o + y_u} \right)_{ij} \quad (16)$$

Tax compliance as revealed by the official share of total output $(\frac{y_o}{y_o+y_u})_{ij}$ is measured by responses to the WBES question "*Recognizing the difficulties many enterprises face in fully complying with taxes and regulations, what percentage of total sales would you estimate the typical firm in your area of activity reports for tax purposes?*"[36] The response options common to all countries in the analysis fall into seven categories with irregular intervals ranging from "*< 50%*" sales reported up to "*100%*" sales reported.[37] Descriptive statistics in Table 1, computed from midpoint values of the seven "% sales reported" categories, show that the standard deviation around the mean value of 78% is more than 1.4 times higher within countries than between them—a pattern similar to the dispersions of other variables varying across firms and countries. Since all firms sampled were legally registered, it appears that simultaneous activity in the official and unofficial economy is a quite common state of affairs, a result consistent with a central feature of the theoretical model developed in previous sections.

Regression Analyses

Table 2 reports three ordered logit regressions implied by the testable implications of the theoretical model. With one exception (Institutional Services in the first regression), independent variables are specified in logarithms.

[35]The expected signs of the analogous-to-tax, regulation variables R^L_{ij} and R^F_{ij} are opposite to those of the conventional tax variables t^L_j and t^F_j because responses are coded 1 = Major Obstacle to 4 = No Obstacle, implying that regulatory costs decline with higher code values.

[36]The WBES naturally did not ask managers directly to acknowledge criminal behavior and for this reason the tax evasion question was phrased with reference to "*the typical firm in your area of activity.*" Such questions are commonly interpreted as revealing firms' own behavior; see, for example, Johnson et al. (2000), Batra, Kaufmann, and Stone (2003), and Svensson (2003). Nonetheless, the underlying behavior of interest is necessarily measured imprecisely.

[37]The percentage frequency distribution for the seven response categories in the sample of 3,686 firms is

1 =< 50%	2 = 50 − 59%	3 = 60 − 69%	4 = 70 − 79%	5 = 80 − 89%	6 = 90 − 99%	7 = 100%
16%	7%	5%	8%	11%	12%	41%

Coefficient estimates therefore represent effects of proportional movements in each independent variable on the probabilities of various categorical responses implied by the ordered logit estimator. Those specifications implicitly assume that the ordinal independent variables can be treated as interval—an assumption supported by standard Wald and likelihood ratio tests showing that inclusion of a separate dummy indicator variable for each linearly independent ordinal category adds no explanatory power to what is delivered by the single ("interval") log-variable specifications.[38]

Model (1) pertains to the determinants of Tax Toleration $\underline{t}_{ij}$ summarized by equation (15) and the top-left part of (16). All determinants of $\underline{t}_{ij}$ in the regression are highly significant statistically and have signs consistent with the underlying theoretical model,[39] apart from log Payroll Tax Rate which is correctly signed but has a p-value of only 0.2. More important, the substantive effects implied by the ordered logit regression coefficients are large. Institutional Services B exerts the biggest influence on Tax Toleration. B is also the only independent variable in Table 2 requiring ordinal representation by dummy indicator variables for response categories. Recall that B scale values range over 10 ordered categories spanning 1 to 4 by increments of one-third. Coefficients of the indicator dummies increase monotonically with the scale values but to conserve space only estimates for the lowest $B = 1.33$ and highest $B = 4.0$ scale categories are reported in Table 2. ($B = 1$ is the omitted category. It includes 2% of the 3,686 cases and its effect is absorbed by the logit cut-point constants.)

To gauge magnitudes, consider a maximal improvement to the Institutional Services index from $B = 1$

[38]"Linearly independent" means that in the presence of an "interval" variable (whether it be in log or nonlog form only affects parameter scales) and the cut-point constants of the ordered logit estimator one includes in test regressions N-2 category dummies, where N is the total number of a variable's ordinal categories. Testing setups are described by Long and Freese (2006, chap. 9.1).

Regressions based in the form of those reported in Table 2 with independent variables expressed in nonlog metrics yield the same pattern of results, but log-variable specifications yield somewhat better chi square significance statistics for the models entertained. A parallel set of regressions including (additive) fixed sectoral effects was also undertaken to take account of the possibility of correlated errors across firms within a sector (agriculture, manufacturing, construction, services, and "other"). Point estimates and significance levels from those regressions were nearly identical to those reported in Table 2. The various test results comprise many big tables and can be generated by running Stata files posted at www.douglas-hibbs.com.

[39]Recall, however, that the model did not make an unambiguous prediction for the sign of a firm's capital stock, $\overline{K}_{ij}$. The significant positive coefficient implies that the indirect effects of $\overline{K}_{ij}$ dominate the direct effects, but this cannot be taken as evidence one way or the other of the model's validity.

TABLE 2   Regressions

Dependent Variables:	Tax Toleration $\underline{t}_{ij}$ (1 = Major Obstacle to 4 = No Obstacle)	Tax Compliance $\frac{y_o}{y_o+y_u\,ij}$ (1 = < 50%, 2 = 50–59%, 3 = 60–69% . . . 7 = 100%)	
Model:	(1)	(2)	(3)
	structural form	reduced form	structural form
Institutional Services, $\ln(B_{ij}+1)$		1.45 (0.263 | 0.000)	
category 2, $B_{ij}=1.33$	0.879 (0.388 | 0.0229)		
category 10, $B_{ij}=4.0$	2.88 (0.482 | 0.000)		
Payroll Tax Rate, $\ln(t_j^L+1)$	−0.259 (0.201 | 0.197)	0.0113 (0.206 | 0.956)	
Labor Regulations, $\ln(R_{ij}^L+1)$	1.20 (0.308 | 0.000)	−0.225 (0.132 | 0.0888)	
Corporate Tax Rate, $\ln(t_j^F+1)$		−0.822 (0.204 | 0.000)	−0.574 (0.150 | 0.000)
Regulations on Official Activity, $\ln(R_{ij}^F+1)$		−0.0675 (0.279 | 0.809)	0.549 (0.262 | 0.0358)
Capital Assets, $\ln \bar{K}_{ij}$	0.111 (0.028 | 0.000)	0.0861 (0.0191 | 0.000)	
Tax Toleration, $\ln(\underline{t}_{ij}+1)$			0.733 (0.203 | .000)
Wald tests support interval assumptions for ordinal variables	yes	yes	yes
Wald χ^2 | p-value to reject restriction $F'(\cdot)=0$ at $\underline{t}=4$	NA	8.13 | 0.229	2.14 | 0.544
Overall Model Wald χ^2 | p-value	159 | 0.000	61.8 | 0.000	19.2 | 0.000
N Firms | N Countries	3686 | 55	3686 | 55	3686 | 55

Notes: Estimation method is ordered logit with robust standard errors (clustered by country). In parentheses (standard error \| p-value). Index i denotes firms and j denotes countries. In Models (2) and (3) independent variables are interacted with a "lower tax tolerance" dummy variable LT, where $LT=0$ if $\underline{t}=4$ (taxes pose "no obstacle"), else $LT=1$. Recall that R_{ij}^L and R_{ij}^F are scored 1 = Major Obstacle to 4 = No Obstacle and are therefore expected to have signs opposite to those of the associated conventional tax rate variables t_j^L and t_j^F.

to $B=4$ holding other variables constant at their means. Computations using estimates for Model (1) indicate this enhancement to B would lower the probabilities a representative firm would perceive taxes as a *major obstacle* ($\underline{t}=1$) by 0.55 or as a *moderate obstacle* ($\underline{t}=2$) by 0.06, while raising the probabilities of taxes being viewed as a *minor obstacle* or *no obstacle* at all ($\underline{t}=3,4$) by 0.14 and 0.46, respectively. Those are big tax toleration effects.

The impact of shifts in log Labor Regulations is less dramatic, yet also sizeable. A maximal shift (from the perception that labor regulations are a *major obstacle* to *no obstacle*) decreases the probability that taxes would be regarded as a *major obstacle* by 0.25, and increases the probabilities of responses in the *moderate, minor*, and *no obstacle* categories by 0.11, 0.08, and 0.06, respectively.

The impact of increases to a firm's log Capital Assets are on balance positive but much weaker than other independent variables, perhaps because the direct and indirect effects already described tend to offset one another. Computations show that in order for an increase in $\ln \bar{K}$ to have as much effect on Tax Toleration as the shift in $\ln R^L$ discussed above, a typical firm would have to experience a sea change in its capital endowment—from next to nothing all the way up to the measured maximum of a half-billion U.S. dollars.

Regression Models (2) and (3) investigate the determinants of Tax Compliance $\frac{y_o}{y_o+y_u}$ as measured by the WBES interview data on % Sales Reported to tax authorities. Model (2) is the reduced form of the causal relations sketched in equation (16). Model (3) is the structural

form. In both models independent variables are interacted with a binary variable LT identifying firms whose managers to some degree perceive taxes as problematic for business operations: $LT = 1$ when $\underline{t} = 1$, 2, or 3 (taxes pose *"major," "moderate,"* or *"minor"* obstacles); $LT = 0$ when $\underline{t} = 4$ (taxes pose *"no obstacle"*). The latter firms, which comprise 9% of the sample, are the ones depicted in Figure 2 as located to the left of $\underline{t}$. The theoretical model implies that among those firms Tax Compliance is not affected by the relative magnitudes of log Corporate Tax Rates and log Tax Toleration in structural form (Model 3), or by the relative magnitudes of $\ln t^F$ and the determinants of $\ln \underline{t}$ in reduced form (Model 2).[40] Test statistics reported in the bottom part of Table 2 demonstrate that the restrictions to the ordered logit regressions imposed by the LT interactions—namely $F'(\cdot) = 0$ at $\underline{t} = 4$—cannot be rejected with any confidence.

Estimation of the reduced-form ordered logit model for Tax Compliance yields highly significant and substantively big effects for log Institutional Services and log Corporate Tax Rates, small and significant effects for log Capital Assets,[41] and insignificant effects for the Regulations and Payroll Tax Rate variables $\ln R^L$, $\ln R^F$, and $\ln t^L$. As was true for Tax Toleration, perceived usefulness of Institutional Services exerts great influence on Tax Compliance. For example, a maximal improvement to $\ln B$, with other variables held at mean values, decreases the probability a typical firm's Tax Compliance would fall in the bottom category (0–50% Sales Reported) by 0.40, whilst increasing the probability of full Tax Compliance (100% Sales Reported) by 0.46. A maximal increase in $\ln t^F$ (from log 15% to log 45.5%) also has big effects. Computations show that an escalation of Corporate Tax Rates of this magnitude lowers the probability of full Tax Compliance by around 0.62 and raises the probability of all other categories, with much of the shift (0.23 probability points) heaped at the bottom 0–50% range of Tax Compliance.

The theoretical structure summarized in equation (16) asserts that a firm's threshold of tax toleration encapsulates the effects of the institutional environment and other reduced-form independent variables on a firm's incentive to remain in the official taxed economy, as opposed to operating underground. Model (3) estimates that structure directly with an ordered logit regression of

Tax Compliance on $\ln \underline{t}$, $\ln t^F$, and $\ln R^F$ alone. The results strongly support the prediction that increases to log Tax Toleration positively affect Tax Compliance, thereby offsetting at least to some degree the negative effects on Compliance exerted by Corporate Taxes and Regulations. Taken together, the empirical results are broadly supportive of the underlying theory about how quality of governance affects the propensity of profit-maximizing firms to remain in the official taxed economy, as opposed to evading taxes and producing underground. Indeed, the correspondence of theory and evidence appears particularly strong in view of the noisy, interview-based measurements of the model's key variables.

Concluding Observations

The central implication of theoretical and empirical results in this article is that markets for corruption arise and big migrations out of legal production into the underground economy occur when large numbers of firms perceive taxes as not "worth paying"—an unfortunate circumstance that was summarized in terms of profit taxes imposed on producers in the official economy relative to firms' thresholds of tax toleration. Tax toleration is driven by firm-specific appraisals of the availability, quality, and usefulness of government services supporting official activities, by taxes and regulations on officially employed labor, by the compensation of enforcement authorities, and by the effectiveness of detection and punishment of bureaucratic malfeasance. Because most of those determinants differ across firms, tax toleration and tax compliance vary among producers facing the same rates of conventional profit taxation and operating in the same national political-institutional environment.

Firms without much intrinsic need of government institutional services will likely always be tempted to produce unofficially and evade taxation unless tax rates are negligible or corruption prices are extremely high. The latter would tend to be the case when enforcement authorities are handsomely compensated, when they stand high chances of being caught selling corruption, and when they are stringently penalized for any malfeasance discovered. Though government policy clearly can affect such supply-of-corruption variables, it can do little to influence the appetite for tax evasion among firms that inherently have little or no interest in official institutional services, no matter how well tuned and accessible those services might be. Yet such firms are likely to be small (and in many cases single-person operations, like the home-cleaning help engaged unofficially by many readers of this article) and at the margins of many economies.

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[40]Tax Compliance among the 9% of firms with $LT = 0$ ($\underline{t} = 4$) is given statistically by the cut-point constants of the ordered logistic models.

[41]As before, the results for $\ln \bar{K}$ say little about the applicability of the model to the data because the direct negative and indirect positive effects of capital endowments on a firm's incentive to produce officially may tend to offset one another.

Most big players in an economy potentially take great productive benefit of formal institutional services, and their propensity to remain in the official, tax-paying economy can therefore be influenced by government efforts to build and sustain institutions of quality. Firms with substantial intrinsic need of services will tend to develop high tax toleration, if appropriate institutions are in place. Government fiscal policy is then less constrained—with high tax toleration, relatively high taxes on official productive activity may be imposed without great fear of inducing a mass exodus of tax-paying producers into the black economy.

Heterogeneity of tax toleration among firms has implications for the aggregate effects of policies targeted on the scale of the shadow economy and tax evasion. Depending on how many and to what extent firms within a country have incentive to produce underground and evade taxation, policies regarding profit taxation and the employment conditions of enforcement bureaucrats may create trade-offs between containment of tax evasion and the overall level of economic activity. For instance, strengthening incentives of enforcement officials to remain honest reduces bureaucratic corruption and unofficial economic activity at the cost of depressing total output among evading firms, without affecting the productive activity of nonevading firms. If the economy is dominated by firms with low thresholds of tax toleration, then higher bureaucratic salaries and better corruption detection mechanisms may yield only modest expansions of official production and contractions of total output. Casual observation of the situation in many developing countries, and some developed ones too, suggests that stamping out unofficial economic activity would on the whole depress aggregate income and economic well-being.

The likely effects of policies addressing tax evasion by lowering profit tax rates are more ambiguous. In developing countries, where many firms are likely to be small and heavily involved in unofficial activity, reduction of profit tax rates will help reduce underground production, raise tax compliance, and increase national output. Profit taxation policy, however, exerts less impact in countries where many firms operate on the border of their tax tolerance, in the sense that their tax toleration threshold is lower than but close to the statutory tax rate. In such cases the first-order effects of reductions to profit tax rates would tend to shrink aggregate income.

Yet the model implies that a trade-off of a smaller underground economy at the cost of lower aggregate output does not arise with policies that affect institutional services and taxes and regulations on officially employed labor. Such policies influence all firms in the economy because they affect the productivity and profitability of factors deployed in official production. Government-supported institutions directly benefiting production, for example, have the advantage of giving tax-evading firms incentive to reduce their unofficial operations, while also inducing higher levels of output among all firms in the economy, regardless of their location on the continuum of tax compliance. This theoretical implication may help explain the strong positive correlation between indicators of institutional quality and estimated levels of total and official aggregate national output reported in many macrolevel empirical studies.

Our firm-level analysis rightly treated institutional benefits and taxes as unconnected outside variables because any particular firm would correctly perceive a choice to evade taxes and regulations by producing unofficially as having negligible impact on the government's resources and its capacity to deliver services from which the firm might profit. However, in the macro political economy those variables are intimately connected, if only because public institutions of high quality require commensurately large investments of public revenue raised by taxation.[42] In principle a virtuous circle is possible in which high taxes and high tax compliance coexist amicably because important producers are anchored firmly in the official economy, supplying the tax revenues required to build and sustain well-functioning institutions that underpin high toleration of taxation.

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[42]Important macro-oriented studies by Loayza (1996) and Friedman et al. (2000) take note of the endogenous linkage between taxation and institutional quality.

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