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Avoiding the Value Added
Tax: Theory and Cross-
Country Evidence

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AVOIDING THE VALUE ADDED TAX: THEORY AND CROSS-COUNTRY EVIDENCE

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ABSTRACT/RESUME

Avoiding the value added tax: Theory and cross-country evidence

This paper develops a differential game of tax avoidance by modelling the interactions between a taxpayer and the tax authority. This framework is particularly useful for explicitly modelling situations of conflict. The solution to the game is a non-co-operative Nash that depends on the resources that need to be used by the tax authority to enforce legislation and the cost to be borne by the taxpayer in tax compliance, provided that the curvature of the utility functions is bounded. Empirical evidence is provided for the value added tax (VAT) using a cross-section of OECD and non-OECD countries. OECD indicators of tax administration efficiency are included in the regressions. The empirical findings show that VAT efficiency, defined as the ratio of collections as a share of consumption to the statutory rate, rises the lower the VAT rate, the lower the share of administrative costs in tax revenue (proxying for the efficiency of tax administration), the more pro-competition the regulatory framework in product markets (measuring non-tax incentives for non-compliance) and the better the country's governance indicators (regulatory quality, rule of law and government effectiveness).

This paper is forthcoming in the Public Finance Review.

JEL codes: H26, E62, C70

Keywords: value added tax, evasion, avoidance, differential game

Évasion de la TVA : Théorie et Comparaisons Internationales

Ce document développe un jeu différentiel des évasions fiscales en modélisant les interactions entre les contribuables et les administrations fiscales. Ce cadre est particulièrement adapté à la modélisation des situations de conflit. La solution du jeu est un équilibre de Nash non-coopératif qui dépend des ressources dont ont besoin les administrations fiscales pour appliquer la législation et les coûts imputés aux contribuables dans le respect des obligations fiscales, à condition que la dérivée première de la fonction d'utilité soit bornée. L'analyse empirique utilise la TVA d'un échantillon de pays de l'OCDE et non-OCDE. Les indicateurs OCDE d'efficacité des administrations fiscales sont intégrés aux régressions. Les résultats montrent que l'efficacité de la TVA (définie comme le ratio entre les revenus de la TVA divisé par la consommation et le taux de la TVA), augmente inversement au taux de la TVA et à la part des coûts administratifs dans les revenus des impôts (un indicateur d'efficacité des administrations fiscales). Par contre, l'efficacité de la TVA augmente proportionnellement au biais pro-compétition des réglementations des marchés des produits et aux indicateurs de bonne gouvernance (qualité des réglementations, règle de droit et efficacité du gouvernement).

A paraître prochainement dans Public Finance Review.

JEL classification : H26, E62, C70

Mots clés : taxe à la valeur ajoutée, TVA, évasion, jeu différentiel

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Avoiding the value added tax: Theory and cross-country evidence

By
Luiz de Mello¹

1. Introduction

The literature on tax evasion/avoidance, surveyed by Slemrod and Itzhaki (2000), focuses on the incentives facing taxpayers not to comply with the tax code and the instruments at the disposal of the tax authority to identify and curb abuse. The theory, pioneered by Allingham and Sandmo (1972), uses a principal agent setting to model the interactions between the tax authority and the taxpayers. Account is taken of the costs of compliance, which are borne by the taxpayer, and those of enforcement, which accrue to the tax authority, as well as the taxpayers' degree of risk aversion. The theory's predictions are relatively straightforward: the level of the tax burden, the complexity of the tax code and inefficiency in tax administration are the main culprits for non-compliance. Attention is most often focused on direct taxes, rather than indirect taxes, such as the VAT.

Against this background, this paper's contribution is two-fold. *First*, the interactions between the taxpayer and the tax authority are modelled in a differential game, instead of a principal agent, framework. This modelling strategy is novel, because differential games have not yet been used widely in tax theory.² They are nevertheless particularly appealing for modelling situations of conflict explicitly as an optimal control problem. The different payoffs of the taxpayer and the tax authority can be modelled separately, and a law of motion for the variable describing the players' moves can be defined explicitly. The solution to the game, which follows the "tax as a gamble" tradition of Allingham and Sandmo (1972), is shown to be a non-co-operative Nash that depends on the resources deployed by the tax authority to enforce the tax legislation and the cost to be borne by the taxpayer in tax avoidance/evasion, provided that the curvature of the utility function of the taxpayer and that of the tax authority is bounded.

Second, the focus of the empirical analysis will be on the VAT. In doing so, the paper aims to shed additional light on the determinants of compliance with a tax that is considered less prone to evasion than other direct and indirect taxes on account of the self-enforcing incentives created by the invoice-credit mechanism for collection. Taxpayers have a strong incentive to purchase taxable inputs from registered taxpayers, because they cannot otherwise claim a credit when selling their output. Invoices therefore provide a good "audit trail" that facilitates the detection of non-compliance.³ A focus on the VAT is also

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1. I am indebted to Jim Alm and Diego Moccero for their valuable comments but remain solely responsible for any remaining errors and omissions. Special thanks go to Mee-Lan Frank for excellent technical preparation.
 2. See Dockner *et al.* (2000) for more information on the solution of differential games and applications to economics and management science. The literature offers important applications in management science (Feichtinger, 1983a and 1983b; Erickson, 1995), industrial economics (Bower *et al.*, 1996) and political economy (Balakrishnan and Eliashberg, 1995). General theoretical considerations on differential games are found in Kamien and Schwartz (1981), Basar and Olsder (1982), and Chiang (1992).
 3. This self-enforcement property was taken into account by de Paula and Scheinkman (2006) in a model of informality, which they tested using Brazilian firm-level data. The authors found that informality was higher, controlling for other determinants, in sectors where the VAT is not collected based on the

important, because revenue from this tax already accounts for a high (and rising) share of collections in the OECD area and beyond. Some countries are adopting the VAT to replace sales taxes (Australia recently, for example), while others are shifting the composition of the tax take away from direct taxes as a means of alleviating the tax burden on capital and labour. Developing countries are also adopting the VAT as trade liberalisation is reducing their traditional reliance on import duties as a means of raising revenue.

Empirical evidence will be based on VAT efficiency (*i.e.* the ratio of collections as a share of consumption to the statutory tax rate), rather than direct estimates of non-compliance, which tend to be overly sensitive to the estimating methodology. Because tax evasion is not observable directly, it needs to be estimated. An option for doing so is to compare actual and potential revenue, where the latter is computed for a potential tax base estimated from the national accounts (for recent surveys see Schneider, 2004, and Alm *et al.*, 2006). The main weakness of this method is that it requires considerable judgement on the part of the analyst to accurately define the potential tax base by taking into account the relevant provisions of the tax code, including exemptions.⁴ Alternatively, tax compliance can be inferred from audit records (see Engel *et al.*, 1998 and 2001, for an empirical analysis based on Chilean data). But it is difficult to deal with the problem that audits are carried out on businesses/individuals that are perceived by the tax authority as having a higher probability of non-compliance in the first place, which creates an identification problem for the econometrician. Essentially as a result of these methodological difficulties, estimates of VAT non-compliance vary considerably across countries.⁵

Of course, non-compliance is not the only culprit for low tax efficiency. It also depends on the breadth of the relevant tax bases, which depends on the tax code. Some effort will therefore be needed to capture these effects. In addition, emphasis will be placed in the empirical analysis on measuring the quality of tax administration using a dataset compiled by the OECD for its member countries and selected non-members. Empirical analysis has so far suffered from a dearth of such internationally comparable indicators, including the cost of tax administration, and the effectiveness of audits and other supervisory instruments, among others. Omission of such indicators biases parameter estimates, because it underestimates enforcement effects. Indicators of regulatory restrictiveness in product markets and governance in general (rule of law and quality of the bureaucracy) will also be considered as non-tax proxies for non-compliance. Again, the empirical literature on tax evasion has so far omitted such controls, thereby understating the burden of regulation, which may encourage non-compliance, on tax efficiency. However, a variety of governance indicators have been experimented with as predictors of business informality (Friedman *et al.*, 2000; Krakowski, 2005). Political economy indicators, such as the durability of the political regime, have been used by Aizenman and Jinjark (2005) as determinants of VAT efficiency. Agha and Haughton (1996) is a precursor in the empirical analysis of the determinants of VAT efficiency based on the differences in VAT systems across countries.

invoice-credit mechanism, but by presumptive methods. For more information on these collection mechanisms currently in place in Brazil, see de Mello (2008).

4. Measurement errors in the national accounts, which are far from negligible, also complicate the analysis. Moreover, the methodology does not allow for distinguishing tax avoidance, which is not unlawful, from outright evasion, which is.
5. In the European Union, evasion rates are estimated to have ranged from about 2.5% of the computed potential tax base in the Netherlands to over 34% in Italy on average during 1994-96 (Nam *et al.*, 2003). In Chile, the evasion rate is estimated at about 21% of the potential tax base on average during 1996-2000 (SII, 1996 and 2005), or at about 24% of average real sales, and to exhibit considerable disparity across sectors, ranging from 73% in retailing to 13% in hotels and restaurants (Engel *et al.*, 1998). In the case of Colombia, VAT evasion is estimated at about 28% in 1994, with a higher rate for domestically-produced goods and services than for imports (Steiner and Soto, 1998). An important consideration is that evasion rates are interrelated across taxes. In the case of Chile, for example, about three-quarters of the estimated non-compliance with the income tax are estimated to stem from VAT evasion (Jorratt and Serra, 1999).

The main empirical findings of the paper are that VAT efficiency is inversely related to the statutory rate and the share of tax administration costs in tax revenue (proxying for tax administration efficiency). VAT efficiency also tends to be higher in countries where the regulatory framework in product markets is pro-business and governance (regulatory quality, rule of law and government effectiveness) is strong. Moreover, VAT productivity does not seem to differ in a statistically significant manner between OECD members and non-members. Finally, the ratio of administrative costs to tax revenue is the best-performing indicator of tax administration quality used in the empirical analysis, with other metrics, such as the ratio of audit and other non-audit verification assessments to net revenue having a much lower predictive power.

The paper is organised as follows. Section 2 describes the theoretical model. Section 3 reports the empirical findings based on a sample of OECD and non-OECD countries. Section 4 concludes.

2. The theoretical model

Following the seminal work of Allingham and Sandmo (1972), tax compliance is conventionally modelled on the basis of the incentives facing the taxpayer for abiding by the tax code (which depend predominantly on the tax rate and the complexity of tax legislation) and the costs he/she incurs to conceal tax liabilities and/or to exploit loopholes in the law. The decision to evade is affected by the quality of tax administration, given that taxpayers who are suspected of non-compliance are likely to be audited and punished, if caught. In turn, the tax authority faces a cost of enforcement. In a broad class of models, solution to the tax game depends on the taxpayer's degree of risk aversion. The distinction between evasion, which is illegal, and lawful avoidance, which arises from the presence of loopholes in the law, as well as tax arbitrage, is not essential in these "tax evasion as a gamble" theoretical models.

Against this background, it is convenient to model the interactions between the payoff of the taxpayer and that of the tax authority using a differential game. This modelling strategy is novel in the tax evasion literature, which tends to define the utility functions of the taxpayer and that of the tax authority independently.⁶ Differential games originated in optimal control theory and are especially suited to model situations of conflict, because they seek a balance of optimal strategies followed by two opposing players. Differential games belong to a sub-class of dynamic games referred to as state space games, where a state variable describes the state of a dynamic system at any point during the game. Differential-game modelling therefore requires the definition of a state variable to describe the players' moves and their differential equations of motion. Instead, in a principal agent setting, the solution to the problem follows from an incentive-compatibility constraint, rather than the solution of an optimal control problem for the players' payoffs and a law of motion for the state variable. The precursors to differential games are the pursuit-evasion games used in a military context (see Isaacs, 1999, for more information). In a basic setting, there are two players with conflicting goals, such as the case of a taxpayer and the tax authority. The model presented below follows the tradition of the police/thief differential game modelled by Sethi (1979) and Feichtinger (1983a and 1983b) in that enforcement costs are taken into account and the payoffs are modelled jointly, but differs from it in the definition of the state variables and the hazard function.

The differential tax compliance game can be defined as follows. Without loss of generality, and following the literature, the terms tax avoidance and evasion are used interchangeably. There are two players: a taxpayer, labelled P , and the tax authority, labelled A . The utility functions are denoted $u^k(\tau^k)$, for $k = (A, P)$, where τ^k denotes the tax liability. The utility function captures parameters such as "tax morality", or a preference inherent to the taxpayer for complying (or not) with the tax code. Let $u^P < 0$

6. Interactions between tax policy and tax administration are examined by Tanzi and Pellechio (1996), among others.

and $u^{P''} > 0$, for $\tau^P > 0$, and $u^{A'} > 0$ and $u^{A''} < 0$, for $\tau^A > 0$, such that an increase in declared tax liability reduces (increases) utility for the taxpayer (the tax authority), where $u^{k'} = \frac{du^k(\tau^k)}{d\tau^k}$ and $u^{k''} = \frac{d^2u^k(\tau^k)}{d(\tau^k)^2}$ for $k = (A, P)$. The taxpayer may comply with tax legislation with a probability $0 \leq \xi \leq 1$ or not, in which case the probability of non-compliance is $(1 - \xi)$. The decision on how much tax liability to declare to the tax authority is taken by the taxpayer at the beginning of the game and is not adjusted during the game. At the same time, the tax authority has a view of how much tax the taxpayer should pay. Let also $u^P(\tau^A) = 0$ and $u^A(\tau^P) = 0$.

Let there be an audit function, h , so that the probability of being audited, provided that the taxpayer is not complying with the tax code, increases with the gap between the tax liability assessed by the tax authority and the amount declared by the taxpayer, $\tau^A - \tau^P$.⁷ This audit function determines the law of motion of the probability of compliance, such that:

$$\frac{\dot{\xi}}{1 - \xi} = h(\tau^A - \tau^P), \text{ with } h'' = 0, h(\tau^A) = 1 \text{ and } h(0) = \bar{h} > 0. \quad (1)$$

Let the audit function be additively separable, and let there be a cost of enforcement (measured in utility terms), including that of carrying out audits and other assessment functions, to be borne by the tax authority, $p^A > 0$. Assume that this enforcement cost is independent of the tax liability gap ($\tau^A - \tau^P$) at no loss of generality and, for simplicity, that it is equal to the tax filing cost to be borne by the taxpayer in the case of full compliance, $p^A = p^P$. In addition, when non-compliance is detected, the delinquent taxpayer pays a penalty equal to K^P (also measured in utility terms), which is for simplicity independent of the tax liability gap and that $K^P = -K^A$, for $K^P > 0$.⁸ In other words, non-compliance gives the taxpayer a payoff of $u^P(\tau^P)$ with probability $1 - \xi$, for $\tau^P \leq \tau^A$, net of the tax filing cost (p^P , with probability ξ) and the non-compliance penalty if caught (K^P , with ξ). If the tax authority believes the taxpayer is not complying based on its assessment of his/her tax liability, its payoff is $u^A(\tau^A)$ with probability $1 - \xi$, net of administrative costs (p^A , with probability ξ) and the non-compliance penalty paid by the taxpayer (K^P , with ξ).

Both the taxpayer and the tax authority solve the problem of maximizing discounted utility over time, once all costs/benefits of compliance/enforcement and non-compliance penalties have been factored in, subject to Equation (1). The maximization problem can be formalised as follows.

$$\max_{\tau_i} J^i = \int_0^{\infty} e^{-\rho t} [u^i(\tau^i)(1 - \xi) - p^i \xi - K^i \dot{\xi}] dt, \quad (2)$$

-
7. This audit function is not based on the idea of an endogenous audit rule, according to which taxpayers do face a pre-determined probability of being audited, but one that depends on the information reported to the tax authority in tax returns. See Alm and McKee (2000) for more discussion and evidence.
 8. The assumption of symmetry in the enforcement/avoidance costs and that the non-compliance penalty is invariant to the tax liability is for simplicity only.

such that $h(\tau^A - \tau^P) = \frac{\xi}{1-\xi}$, where $\xi \geq 0$, $i = A, P$, and ρ is a discount rate, which is assumed for simplicity to be the same for the taxpayer and the tax authority.

Problem (2) is a differential game. The solution is not sub-game perfect, because it is not a Nash equilibrium for every sub-game with different starting conditions (Kamien and Schwartz, 1981; Shubik, 1982).

The Hamiltonian associated with Problem (2) is defined as:

$$H^i = [(u^i(\tau^i) + (\mu^i - K^i)h(\tau^A - \tau^P))(1-\xi) - p^i \xi], \quad (3)$$

where μ^i is the adjoint variable (shadow price) associated with the control problem.

The first-order conditions are:

$$\mu^i = K^i - \frac{u^{i'}}{h'}, \text{ for the non-trivial case where } \xi < 1. \quad (4)$$

Taking Equation (4) into account, the first-order condition for the constraint ($\frac{\partial H^i}{\partial \xi} = -\dot{\mu}^i + \rho\mu^i$) becomes:

$$\dot{\mu}^i = u^i(\tau^i) - \frac{u^{i'}}{h'} h(\tau^A - \tau^P) + p^i + \rho(K^i - \frac{u^{i'}}{h'}). \quad (5)$$

The transversality condition is standard: $\lim_{t \rightarrow \infty} H^i(t) = 0$. Differentiating Equation (4) with respect to time and substituting it into Equation (5) yields:

$$-\frac{u^{i''}}{h'} \dot{\tau}^i = u^i(\tau^i) - \frac{u^{i'}}{h'} h(\tau^A - \tau^P) + p^i + \rho(K^i - \frac{u^{i'}}{h'}). \quad (6)$$

By Equation (6), equilibrium is reached ($\dot{\tau}^i = 0$) if and only if:

$$h(\tau^A - \tau^P) = \frac{h'}{u^{i'}} [u^i(\tau^i) + p^i + \rho K^i] - \rho. \quad (7)$$

Letting $\varepsilon(\tau^i) = \frac{u^{i'}}{u^i(\tau^i)} h(\tau^i)$, $\alpha^i = 1 - \frac{h'}{\varepsilon(\tau^i)}$, and $\beta^i = \frac{(p^i + \rho K^i)h'}{u^{i'}} - \rho$, Equation (7) can be re-written as:

$$h(\tau^A) = \frac{1}{\alpha^i} [\beta^i + h(\tau^P)]. \quad (8)$$

Substituting Equation (8) into Equation (1), and recalling that equilibrium is reached when $\dot{\xi} = 0$, yields:

$$\left[\left(\frac{\beta^i}{\alpha^i} - \left(1 - \frac{1}{\alpha^i} \right) h(\tau^P) \right) (1 - \xi) \right] = 0. \quad (9)$$

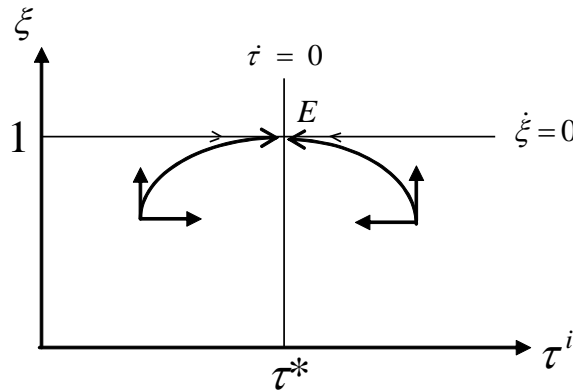
By Equation (9), either $\xi = 1$, which is trivial, or $h(\tau^{P*}) = \frac{\beta^i}{\alpha^i - 1}$.

To see that the solution of Problem (2) is a Nash-equilibrium, using Equations (6) and (1), and assuming that $u^{i''''} = 0$, consider the system below:

$$\begin{bmatrix} \dot{\tau}^i \\ \dot{\xi} \end{bmatrix} = \begin{bmatrix} \bar{h} + \frac{h'u^{i'}}{u^{i''}} - \rho & 0 \\ h'(1 - \xi) & -\bar{h} \end{bmatrix} \begin{bmatrix} \tau^i - \tau^{i*} \\ \xi - \xi^* \end{bmatrix}. \quad (10)$$

Equation (10) can be written as $\dot{x} = Ax$ for $x = (\tau^i \quad \xi)'$, such that the roots (λ_1 and λ_2) of the characteristic equation of matrix A ($\lambda^2 - trA + |A|$, where $trA = \lambda_1 + \lambda_2$ is the trace of A and $|A| = \lambda_1\lambda_2$ is the determinant of A) are $\lambda_1 = -\bar{h}$ and $\lambda_2 = \bar{h} + \frac{h'u^{i'}}{u^{i''}} - \rho$. If $\bar{h} + \frac{h'u^{i'}}{u^{i''}} < \rho$, then $\lambda_2 < 0$ and the solution to system (10) is a stable node, given that $\lambda_1 < 0$. This implies that the curvature of the utility function is bounded: $1 + B < \frac{\rho}{h'}$, where $B = \frac{u^{i'}}{u^{i''}}$. The solution to Equation (10), E , is depicted in Figure 1. Because the equilibrium point is a stable node, all trajectories below the $\dot{\xi} = 0$ locus, where by Equation (1) $\xi = 1$, around E , converge to E . Finally, if $\tau^{P*} = 0$, then $\beta^i = 0$, by Equation (9), and $\tau^{A*} = 0$, by Equation (8). It then follows from $\beta^i = 0$ that $p^i = \frac{\rho}{h'}(u^{i'} - K^i)$.

Figure 1. The Nash equilibrium



This model is general enough to encompass the VAT. It is often argued that the use of the invoice-credit mechanism for collection makes the VAT self-enforcing, as taxpayers have strong incentives to trade with registered taxpayers to be entitled to a credit. In doing so, their tax liability can be reduced. The cost of enforcement facing the tax authority can therefore be argued to be lower than in the case of a tax that does not exhibit this self-enforcing property. In this case, the enforcement cost borne by the tax authority falls relative to the compliance cost facing the taxpayer. The assumption that $p^A = p^P$ may therefore be somewhat stronger in the case of VAT compliance than another tax. It is easy to see that this assumption is by no means essential in the game. Relaxing it would affect the equilibrium level of tax liability, but not the stability properties of the game.

3. The empirical evidence

The estimating equation

By Equation (9), the equilibrium level of tax liability is $\tau^* = \frac{\beta}{\alpha - 1}$. It depends on the parameters of the utility functions of the taxpayer and the tax authority (captured by ε), the shape of the audit function (h'), the compliance costs borne by the taxpayer and the tax authority p , the non-compliance penalty (K) and the discount factor (ρ). The model predicts that the equilibrium level of tax liability depends positively on the penalty for non-compliance and the compliance costs.

Since tax avoidance is not observed directly, and country-specific information is overly sensitive to differences in the methodology used to quantify unpaid taxes and is not readily available in a comparable manner for a large enough set of countries, the option of gauging the extent of non-compliance by the VAT's C-efficiency, which is calculated by dividing the VAT's revenue-to-consumption ratio by its statutory rate, becomes appealing.⁹ To the extent that avoidance reduces revenue for a given tax rate, it lowers C-efficiency. Of course, C-efficiency also depends on specific features of the VAT code, including exemptions and the level of the business registration threshold, which narrow the tax base, and the extent of zero-rating, which creates a credit and therefore reduces net revenue, among other factors.¹⁰ Therefore, it should be recognised that the use of C-efficiency as a proxy for tax avoidance is not without problems, but unavoidable against the backdrop of severe data constraints.

Letting the tax administration costs depend ultimately on the efficiency of tax administration and those to be borne by the taxpayer on the complexity of the tax code and on the level of the tax rate, which creates incentives for non-compliance, the equation to be estimated below can be defined as follows:

$$P(r_n) = a_1 + a_2 r_n + a_3 T_n + a_4 F_n + a_5 X_n + e_n, \quad (11)$$

where $P(r_n) = \frac{R_n}{r_n}$ denotes C-efficiency in country n , R_n is the ratio of VAT revenue to consumption, r_n is the statutory VAT rate, T_n is a measure of tax administration quality, F_n is an

9. See Baca-Campodonico *et al.* (2006) for evidence on evasion of bank transactions taxes based on tax productivity equations.

10. While business registration thresholds vary considerably across countries, exemptions typically affect agricultural goods and selected inputs, fuels, passenger transport, and selected financial transactions and services. See Ebrill *et al.* (2001) for more information.

indicator of regulatory restrictiveness, X_n is a vector of additional variables included in the regression to capture non-tax determinants of C-efficiency, and e_n is an error term.

The empirical study which uses an estimating strategy that is closest to the one pursued below is Aizenman and Jinjark (2005). They extend a model by Cukierman, Edwards and Tabellini (1992), which focuses on the relationship between tax reform and political instability. The Aizenman-Jinjark regressions use tax C-efficiency and effective collection (*i.e.* VAT revenue divided by value added) as the dependent variables and are based on a much larger data set, comprising both OECD and non-OECD countries. Nevertheless, they do not include the tax rate or indicators of tax administration quality, regulatory restrictiveness in product markets and governance among the regressors. These explanatory variables are important because, based on the differential game above, VAT avoidance depends on the incentives facing the taxpayer for not complying with the tax code, which includes the level of the tax rate and regulatory restrictiveness, and the efforts deployed by the tax authority to enforce compliance.

The data

The empirical evidence to be reported below is based on a cross-section of OECD and a few non-OECD countries.¹¹ It uses OECD data on VAT collections and indicators of quality of tax administration. Information on statutory VAT rates is available from PricewaterhouseCoopers and has been used widely in cross-country empirical work on the VAT. The World Bank's *Doing Business* and GRICS (Governance Research Indicator Country Snapshot) indicators are used to capture the quality of governance, in the case of GRICS, and the regulatory framework in product markets, in the case of the *Doing Business* indicators. The 2003 version of the *Doing Business* indicators is used, because the OECD indicator of tax administration efficiency is available for 2003. The GRICS indicator of government effectiveness, regulatory quality and rule of law are available for all countries included in the sample from 1996. The data used in the analysis are for 2000 so as to allow for a lag relative to 2003, the date for which VAT collection data are available.

Other variables are used to capture the effect of non-tax determinants on C-efficiency, including trade openness (*i.e.* share of exports and imports in GDP) and the urbanisation rate. Trade openness proxies for the relative ease of collection of import duties in relation to the taxation of domestic consumption, and the urbanisation rate proxies for the size of agriculture in GDP, a sector where tax avoidance (due to informality) tends to be pervasive in many countries and where special payment and filing regimes are in place in most countries. Based on the empirical literature (Aizenman and Jinjark, 2005), these variables are powerful determinants of VAT efficiency. The rate of growth of GDP is often used as an additional regressor on account of the fact that tax collection tends to rise faster in a growing economy.¹² To avoid biases related to the potential endogeneity of some of these variables, a time lag is considered, and the data refer to the average of the relevant variables over the period spanning 1995 through 2000.

On the basis of the descriptive statistics reported in Table 1, there appears to be considerable variation across countries in VAT rates and revenue yields, but less so in C-efficiency. Regional patterns appear to be of little use to highlight common features in VAT taxation: while some countries levy a relatively uniform rate, such as Chile, for example, others in the same region have a complicated rate structure, such

11. The full sample of 42 countries includes all OECD countries that have a VAT, in addition to Argentina, Brazil, Chile, China, Cyprus, Estonia, Latvia, Lithuania, Malta, Russia, Singapore, Slovenia and South Africa.

12. This is based on Andreoni's (1992) model. Accordingly, taxpayers are credit constrained and penalties are high on tax evasion. In this set-up, taxpayers chose to evade taxes in bad times and to repay them in good times so as to smooth income over the business cycle.

as Brazil, even though the efficiency of the VAT is comparable in these countries. Within the OECD area, Italy and Austria have the same statutory rate of 20%, but Italy has lower efficiency. As noted above, such variations are related not only to the extent of non-compliance, but also to the fact that many tax codes apply different rates to different goods and services. In addition, several goods/services are exempt from VAT, whereas others are zero-rated.

The results

Preliminary findings are reported in Table 2. A simple model that includes only the tax rate and the tax administration efficiency indicator suggests that VAT efficiency is affected adversely by the level of the statutory rate and the ratio of tax administration costs to net revenue (Model 1). The coefficient on the tax rate is small in magnitude, although it is highly significant, so that the loss in efficiency due to an

Table 1. **Descriptive statistics**

	Mean	Standard deviation	Maximum	Minimum	No. obs.	Source
VAT revenue-to-GDP ratio (2003) ¹	7.0	2.0	10.1	1.8	42	OECD
VAT rate	17.5	5.0	25.0	5.0	42	PricewaterhouseCoopers
VAT C-efficiency	0.6	0.2	0.9	0.1	42	Author's calculation
Ratio of administrative costs to 100 units of net revenue (2000-04 average, in per cent)	1.4	1.7	11.4	0.5	39	OECD
Doing business indicators (2003)						World Bank
Time to start a business (days)	36.6	30.2	152.0	2.0	37	World Bank
Procedures to start a business (number)	8.2	3.9	17.0	2.0	37	World Bank
Cost to start a business (per cent income per capita)	11.0	10.2	40.4	0.0	37	World Bank
Governance indicators						
Government effectiveness	1.2	0.7	2.3	0.1	43	World Bank
Regulatory quality	1.0	0.5	2.1	0.0	43	World Bank
Rule of law	1.2	0.7	2.1	0.1	43	World Bank
Trade openness (share of imports plus exports in GDP, in per cent, 1995-2000 average)	78.7	46.2	236.7	18.9	43	World Bank (WDI)
Rate of growth of urbanisation (in per cent, 1995-2000 average)	1.1	0.9	3.6	0.1	44	World Bank (WDI)

1. The figure for Brazil is available from national sources and refers to the ICMS, a state-level VAT, and the PIS-Pasep, a federal tax. The VAT rate refers to the average of these two rates (weighted by revenue collection).

Source: OECD (2006), Tax Administration in OECD and selected non-OECD countries, PricewaterhouseCoopers and World Bank.

Table 2. VAT efficiency: OECD and non-OECD countries

	Dep. Var.: VAT C-efficiency ¹							
	1		2		3		4	
VAT rate	-0.01	***	-0.01	***	-0.01	***	-0.01	***
	(0.003)		(0.003)		(0.003)		(0.003)	
Tax administration efficiency	-0.02	***	-0.02	***	-0.02	***	-0.02	***
	(0.003)		(0.004)		(0.005)		(0.004)	
Trade openness			0.00	**	0.00	**	0.00	**
			(0.000)		(0.000)		(0.000)	
Urbanisation rate			0.00		0.00		0.00	
			(0.001)		(0.001)		(0.001)	
Non-OECD member					0.01			
					(0.048)			
Number of years VAT has been in place							0.00	
							(0.001)	
Intercept	0.66	***	0.63	***	0.63	***	0.53	***
	(0.057)		(0.118)		(0.118)		(0.121)	
Number of observations	38		37		37		37	
F test (<i>p</i> value)	0.00		0.00		0.00		0.00	
R-squared	0.20		0.28		0.28		0.28	
VAT rate endogenous ? (<i>p</i> value)	0.17		0.24		0.16		0.33	

1. The tax administration efficiency indicator is the ratio of administrative costs to net revenue. Heteroscedasticity-corrected standard errors are reported in parentheses. Statistical significance at the 1 and 5% levels is denoted by respectively (***) and (**). All models are estimated by OLS. The VAT rate correlates used in the endogeneity test are the ratio of total tax revenue to GDP and the total salary cost of tax administration.

Source: Author's estimations.

increase in the VAT rate is relatively modest.¹³ The strong significance and negative sign of the estimated coefficient of the tax rate is consistent with the cross-country results reported by Agha and Haughton (1996) that high VAT rates discourage compliance.¹⁴ The coefficient on the tax administration efficiency indicator is negative, suggesting that a higher share of administrative costs in revenue – denoting lower efficiency in tax administration – is associated with lower, not higher, VAT efficiency. The estimated coefficient is not sensitive to the inclusion of the control variables in the regression (Model 2). Trade openness is positively signed and statistically significant, which is in line with the fact that it is often easier to levy VAT on imports, rather than on domestically produced goods and services. The urbanisation ratio is also positively signed, as expected, given the difficulty to levy VAT on agricultural and subsistence-related activities. However, the urbanisation rate is not statistically significant, a finding that may be attributed to the fact that most countries in the sample are already highly urbanised.

The hypothesis that VAT efficiency differs between the OECD and non-OECD countries in the sample was tested by including a dummy variable identifying the OECD countries (Model 3). The results

13. This is consistent with the evidence reported by Silvani and Wakefield (2002) for a sample of 22 countries in the 1990s. They show that, if the tax rate is raised by one percentage point, productivity falls by 3.6%. Their estimation nevertheless does not take into account other determinants of productivity, such as the quality of tax administration, among others.
14. The finding is in contrast with that reported by Friedman *et al.* (2000) that high tax rates discourage business formality. Although they do not focus on the VAT, the authors test a business informality model in which the tax rate has two potentially offsetting effects: it creates incentives for non-compliance, but also allows the government raise revenue to finance law and order, which encourages compliance.

show that VAT efficiency does not differ in a statistically significant manner across country groupings. Interaction terms between the OECD membership dummy and the tax rate and the tax administration efficiency indicator were also experimented with, but found to be statistically insignificant at classical levels. This finding confirms the hypothesis that OECD membership is not an important determinant of VAT productivity in the sample under examination. The results are also robust to the inclusion of a dummy variable identifying the emerging-market economies within the OECD area (Czech Republic, Hungary, Korea, Mexico, Poland, Slovak Republic and Turkey), in addition to the non-OECD countries in the sample (not reported). Inclusion of the number of years since VAT was introduced as an additional regressor to measure VAT administration efficiency does not change the results qualitatively (Model 4). This indicator was found by Agha and Haughton (1996) to be a powerful determinant of VAT compliance, but more recent studies have failed to find a strong correlation between VAT efficiency and the VAT age indicator (Aizenman and Jinjarak, 2005).

The VAT rate may be endogenous due to Laffer-curve effects; therefore, it is important to test for endogeneity. To do so, the determinants of the tax rate that are uncorrelated with VAT efficiency were selected on the basis of the raw correlations between the VAT rate and the potential correlates available in the data set. The ratio of total tax revenue to GDP, the average rate of change in the urbanisation rate over the period 1995-2000 and the salary cost of tax administration were found to be correlated with the VAT rate at the one percent level of significance. The rate of growth of urbanisation was nevertheless not retained, because it was not found to be significant at classical levels in a regression of the VAT rate on its correlates, as well as the regressors included in the productivity equation. The test statistics reported for each model are the *p*-values associated with an *F* test for the exclusion of the residuals of the VAT rate regression from the productivity regressions. The test statistics suggest that the VAT rate is not endogenous, which validates the estimation of the regressions by OLS.

A number of robustness checks were carried out. Other OECD indicators of tax administration efficiency, such as the share in net revenue of assessment values of audits and non-audit procedures and the share of tax administration staff allocated to audit activities, were experimented with instead of the ratio of administrative costs to revenue. Although signed as expected, the estimated coefficients (not reported) were not found to be statistically significant at classical levels. This is possibly due to a loss in degrees of freedom, especially when the ratio of value of assessments based on non-audit verification procedures to net revenue was used, because information is valid only for a smaller set of countries (20 countries in the sample). Including average GDP growth during 1995-2000 as an additional control variable does not affect the results qualitatively, but this variable is highly correlated with trade openness and the urbanisation rate, and is therefore omitted from the full set of controls. Neither are the results affected by the inclusion of a dummy variable to identify Cyprus (not reported), a country that has the highest ratio of tax administration cost to revenue in the sample. A relative income variable, defined as per capita income (measured in PPP terms) in relation to that of the United States, was also experimented with as an additional regressor, but was found to be statistically insignificant (not reported). Finally, an effort was made to control for the level of the registration threshold for VAT, but data are only available for a small sub-set of countries.¹⁵

The models reported in Table 3 include indicators to capture the effect on VAT efficiency of governance and stringency of the regulatory framework in product markets. The indicators are included in the regressions one at a time to maximise the number of degrees of freedom, given the sample size

15. Several OECD countries do not have a registration threshold (Belgium, Italy, Korea, Mexico, among others), and, where in place, the level of this thresholds varies considerably: in the range of 60-70% of manufacturing enterprise turnover in Iceland and New Zealand and less than 10% in Denmark, France and Germany, for example. See OECD (2006) for more information.

Table 3. VAT efficiency: Regulatory restrictiveness

Dep. Var.: VAT C-efficiency¹

	<i>Doing Business</i> indicators						GRICS indicators					
	Procedures to start a business		Time to start a business		Cots to start a business		Government effectiveness		Regulatory quality		Rule of law	
VAT rate	-0.01 (0.003)	***	-0.01 (0.003)	***	-0.01 (0.003)	***	-0.01 (0.003)	***	-0.01 (0.004)	***	-0.01 (0.003)	***
Tax administration efficiency	0.12 (0.038)		-0.03 (0.034)		-0.03 (0.032)	***	-0.02 (0.004)	***	-0.02 (0.004)	***	-0.02 (0.004)	***
PMR/Governance indicator	-0.02 (0.005)	***	-0.00 (0.001)	**	-0.01 (0.003)	*	0.09 (0.038)	**	0.08 (0.045)	*	0.09 (0.032)	***
Trade openness	0.00 (0.001)		0.00 (0.001)		0.00 (0.001)		0.00 (0.000)	**	0.00 (0.000)	**	0.00 (0.000)	**
Urbanisation rate	0.00 (0.001)		0.00 (0.002)		0.00 (0.002)		0.00 (0.002)		0.00 (0.001)		0.00 (0.001)	
Intercept	0.87 (0.109)	***	0.66 (0.144)	***	0.80 (0.132)	***	0.62 (0.119)	***	0.58 (0.147)	***	0.61 (0.115)	***
Number of observations	32		32		32		37		37		37	
F test (<i>p</i> value)	0.00		0.00		0.00		0.00		0.00		0.00	
R-squared	0.39		0.28		0.37		0.44		0.36		0.46	
VAT rate endogenous (<i>p</i> value)	0.92		0.63		0.91		0.20		0.15		0.23	

1. The tax administration efficiency indicator is the ratio of administrative costs to net revenue. Heteroscedasticity-corrected standard errors are reported in parentheses. Statistical significance at the 1, 5 and 10% levels is denoted by respectively (***), (**) and (*). All models are estimated by OLS. The VAT rate correlates used in the endogeneity test are the ratio of total tax revenue to GDP and the total salary cost of tax administration.

Source: Author's estimations.

constraints imposed by the data. As discussed above, a more restrictive regulatory environment is hypothesised to encourage non-compliance because it fosters informality, which reduces the efficiency of the VAT for a given tax rate. Overall, the results are supportive of this hypothesis. Other indicators were experimented with, including those of overall administrative regulation and burden on entrepreneurship, which were signed as expected but not a classical level of significance.¹⁶

The *Doing Business* indicators measuring difficulties in starting a business in terms of the number of procedures, the time they take and their costs, are all negatively associated with VAT efficiency at classical levels of significance. Trade openness and the tax administration efficiency indicators nevertheless lose significance when the *Doing Business* indicators are included in the regressions. The findings also suggest that poor governance (measured by the World Bank's GRICS indicators of quality of regulations, rule of law and government efficiency) is associated with low VAT efficiency. Unlike the regressions that included the *Doing Business* indicators, trade openness and the tax administration efficiency indicator remain statistically significant and are correctly signed. The GRICs indicators were experimented with by Krakowski (2005) and found to be by and large poor predictors of business informality in cross-country regressions.

4. Conclusions

This paper modelled VAT evasion using a differential game between the taxpayer and the tax authority. The solution to the game was shown to be a non-co-operative Nash equilibrium that depends on the resources that need to be devoted by the tax authority to enforce the tax legislation and on the cost to be borne by the taxpayer in tax avoidance/evasion, provided that the curvature of the utility functions of the taxpayer and of the tax authority is bounded. Empirical analysis in this area is complicated by the fact that tax evasion is not observable directly. Estimates based on tax audits and/or computations of potential tax bases are overly sensitive to differences in the estimating methodological and are not readily available in a comparable fashion for a sufficiently large set of countries. To overcome this data constraint, evidence was reported for VAT efficiency, defined as the ratio of collections as a share of consumption to the statutory rate, using a cross-section of OECD and non-OECD countries.

The novelty of the empirical analysis is the use of a set of cross-country indicators of tax administration efficiency constructed by the OECD. Such indicators, which are shown to be important determinants of tax evasion, have so far been overlooked in the empirical literature. Additional indicators of restrictiveness in product market regulations and governance were also used in the analysis. The main findings are that, controlling for a number of non-tax determinants, VAT efficiency rises the lower the statutory rate, the lower the share of administrative costs in tax revenue (proxying for the efficiency of tax administration), the more pro-business the regulatory framework in product markets and the better the country's governance indicators (regulatory quality, rule of law and government effectiveness). There does not appear to be a discernible difference in VAT productivity between OECD and non-OECD countries in the sample, despite considerable cross-country differences in VAT revenue yields and statutory rates, or between the non-OECD countries and the emerging-market economies in the OECD area, on the one hand, and the other OECD countries, on the other.

16. This finding is in line with those reported by Friedman *et al.* (2000) using the Heritage Foundation and Freedom House indicators of regulatory burden in that regulation that stifles competition discourages compliance.

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