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Land taxes in a Latin American context

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Abstract

Since Henry George (1839-1897) economists have been arguing that a tax on unimproved land is an ideal tax on efficiency grounds. Output taxes, on the other hand, have distortionary effects on the economy. This paper shows that under asymmetric information output taxes might be used along with land tax in order to implement an optimal taxation scheme in a Latin American context, i.e., where land rental markets are relatively thin, land property provides non-agricultural payoffs and there is nonrevenue objectives of land taxation. Also, the model has two implications that can be tested empirically: (i) there is evasion when schemes based only on land taxes are implemented; (ii) this evasion is more severe for large landholders.

JEL Classification: H21, H26, Q15

Key words: Optimal taxation, tax evasion, land use.

1 Introduction

Taxes on land are among the oldest forms of taxation. Arnott and Stiglitz (1979), extending the so-called Henry George theorem, demonstrate that a tax on land rents is not only efficient, but the only tax instrument necessary to finance a pure public good in large economies where the differential land rents are well defined and the distribution of economic activity over space

is Pareto optimal. On the other hand, land taxation is one of the few cases of a lump-sum tax, since it is based on assets rather than on agricultural production. However, while land taxation enjoys striking advantages from a theoretical point of view, it remains barely used in developing countries. Trying to explain this fact, Skinner (1991a) indicates two major drawbacks of land taxes relative to output taxes - it increases risk borne by farmers and it also entails high administrative costs. Hoff (1991) points to the use of a mix of land and output taxes as an attempt to mitigate the adverse effect of a pure land taxation regime in an economy with imperfect insurance markets.

In this paper, the mix of land and output taxes arises as the optimal taxation instrument in an economy where farmer's ability, and therefore land use, is private information. We show that the problem of informational costs raised by Skinner (1991a) can be at least partially resolved in a typical Latin American country by using an output tax as a part of the tax mechanism. This additional component takes advantage from the fact that the information about agricultural output is more reliable than self-reported indicators of productivity.

Many countries in Latin America have attempted to implement progressive land taxes in order to induce large landholders to use their land more intensively rather than to finance local government. Progressive tax rates are treated as a means of dissuading land speculation, inducing large landowners to sell out or use land more efficiently. Implementation of this instrument has been disappointing - farmers often find ways around such taxes.[1] In Brazil, for example, the enactment of the Land Statute in 1964 imposed nonrevenue functions on land taxation, which in principal was took on the job of assisting public land redistribution policies.[2] Since then, the land tax mechanism aims at imposing penalties on unimproved land. Nevertheless, the original objectives of the tax were not achieved. Land taxes in Brazil had never constituted a good source of revenue and further, hardly managed to achieve any of the desired changes in the rural environment.

Land ownership in the model can be used for agricultural production or for other non-agricultural purpose. Land is used not only as a productive asset but also as a source of other benefits - *"as a hedge against inflation, as an asset that can be liquidated to smooth consumption in the face of risk, as collateral for access to loans, as a tax shelter, or as a means of laundering illicits funds"* [De Janvry, Key and Sadoulet (1997)]. Therefore, we consider a continuum of types of producers who are differentiated by their proclivity for non-agricultural activity and agricultural productivity. Each producer's type

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[1] Cf. e.g. Binswanger, Deininger and Feder (1995), Deininger and Feder (2000), Bird and Slack (2002).
[2] See Oliveira (1993).

constitutes private information and the area under cultivation is not observed.

Land rental markets in Latin America are underdeveloped. Typically only 5 to 10% of the land is rented out, which is remarkably low when compared to United States or Europe patterns. A large body of literature has been theoretically addressing the reasons for the imperfections in the land rental market.[3] Many reasons provide explanations for a reduction in the share of output appropriated by the tenants. Specifically, a factor that is likely to be important in most Latin American countries is the landlord's fear of loss of the land [Macours, De Janvry and Sadoulet (2001)]. In the absence of a land rental market, the farmers with low agricultural productivity cannot use their titles to obtain non-agricultural gains and also lease-out their land to other farmers for agricultural production. The only option for them is to retain a portion of their tracts in the form of idle land. Although farmers with low agricultural productivity choose separately farm size and cultivated area, those with high agricultural productivity and low non-agricultural yields choose only the farm size, since they are constrained by the no rental market constraint. The no rental market constraint determines two groups of farmers: those who face a one-dimensional problem of maximization and those who have two different choices (farm size and cultivated area).

Summarily, we study the problem of optimal taxation in an economy where (i) there are nonrevenue objectives of land taxation; (ii) land provides both agricultural and non-agricultural payoffs; and (iii) the land rental market is imperfect. The main result is that relying only on land tax is optimal only when the social planer information about farmers is complete or when farmers do not hold unimproved land; otherwise, the optimal scheme is a linear combination of output and land taxes. Under additional assumptions regarding the relationship between the agricultural and non-agricultural productivities for different farmers, we show that a tax mechanism based solely on land taxes can be implemented for small farms because they have no idle land. This is consistent with the Brazilian experience with land taxation, where the difficulty of accurately appraising the concept of area utilized determined high evasion and underreporting, specially for large landholdings.

This paper attempts to fill a gap among optimal taxation models under asymmetric information, in the tradition initiated by Mirlees (1971), and the land taxation models mentioned above. The mechanics of our model is quite similar to that of Stern (1982). Asymmetric information about farmers introduces a role for output taxes, even considering their distortionary effect. The mix of

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[3] The basic arguments are: risk sharing [Cheung (1969)], hidden actions and moral hazard [Stiglitz (1974); Ghatak and Pandey (2000); Eswaran and Kotwal (1985)], screening [Hallagan (1978) and Allen (1982)] and limited liability constraints [Shetty (1988); Laffont and Matoussi (1995)].

output and land taxes arises as a solution for the typical trade-off between rent extraction and distortion commonly observed in adverse selection models.

The plan of the paper is as follows. Section 1 introduces and analyzes the basic model. In Section 2, we link tax evasion to farm size using an additional assumption about the ordering of farmers types and present, as an example, the Brazilian experience with land taxation. The discussion about the assumptions adopted, the generality of the results and implications for public policies is made in Section 3. Concluding comments are offered in Section 4.

2 The Model

We consider a heterogeneous population of farmers indexed by $\theta \in \Theta = \left[\underline{\theta}, \overline{\theta}\right]$, distributed according to the distribution function F. The parameter θ reflects the technology available for each farmer, indicating the revenues obtained from agricultural and non-agricultural land use.

The analysis is carried out in a partial equilibrium environment. The price obtained for agricultural output is normalized at 1, an unlimited quantity of land is available at price p and each harvested hectare costs w. For the sake of simplification, we assume that labor and other inputs are used in fixed proportions with land at a cost w per hectare. Both production and land are perfectly homogeneous.

A farmer of type θ who holds T hectares of land, grows A and pays a transfer t to the social planner, obtains profits given by:

$$\Pi = Q\left(A, \theta\right) + \phi\left(T, \theta\right) - wA - pT - t, \tag{1}$$

where Q and ϕ are respectively the agricultural and non-agricultural production functions, with $Q_A > 0$, $Q_{AA} < 0$, $\phi_T > 0$, $\phi_{TT} < 0$, $Q_A\left(0, \cdot\right) = \infty$, $Q_A\left(\infty, \cdot\right) = 0$, $\phi_T\left(0, \cdot\right) = \infty$ and $\phi_T\left(\infty, \cdot\right) = 0$.

In order to simplify the analysis, we assume θ affects Q and ϕ linearly.[4] The technology is such that θ is positively related to the non-agricultural benefits and marginal benefits of landholding. The effect of θ on Q is considered later. Initially, it can be positive or negative. These preliminary functional-form hypothesis are summarized as:

Assumption A1: $Q_{\theta\theta}\left(x, \theta\right) = \phi_{\theta\theta}\left(x, \theta\right) = 0$, $\phi_\theta\left(x, \theta\right) > 0$ and $\phi_{T\theta}\left(x, \theta\right) > 0$ for every $x \in \Re$ and $\theta \in \Theta$.

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[4] This condition avoids assumptions regarding third derivatives which generally have little economic insight.

We assume there is no rental market and hence the choice of each producer must respect the condition $A \leq T$. Thus, based on a taxation scheme t, farmers are faced with the program:

$$\max_{A,T} \Pi \quad \text{st.} \quad A \leq T. \tag{P}$$

Individuals decide to participate whenever $\Pi \geq 0$.

The social planner's utility function is defined by

$$U = t - \lambda \phi \left(T, \theta \right), \tag{2}$$

where $\lambda \in [0,1]$ is the social cost attributed to the non-agricultural use of land. This reduced-form utility means that the social planner designs a tax mechanism in order to maximize the tax revenue and to hinder the non-agricultural motive of landholding.

2.1   The first-best case

Initially, we consider the design of a tax mechanism in an environment of complete information, i.e., we assume the social planner can exactly observe the type of agents and manages to establish tax collection rules that consider precisely the willingness of each producer to use land for agricultural production or not. This is an initial analysis to establish the benchmark case.

Under complete information, the social planner can determine the allocations for each producer via a punitive taxation scheme. The choice of the tax scheme is restricted only by the participation constraint (IR) and the absence of a land rental market (RM). The first-best program in this case defines the optimal taxation mechanism for a producer of type θ:

$$\max_{t,A,T} U \tag{P.FB}$$

subject to

$$\Pi \geq 0, \tag{IR}$$

$$A \leq T. \tag{RM}$$

First, note that (IR) is binding. Otherwise, the social planner could reach a higher level of U increasing t marginally, without violate (IR) or (RM). Therefore, the transfers required by the optimal tax scheme represent all the producer's profits.

Substituting (IR), the solution of (P.FB) is given by the following system of

equations:[5]

$$Q_A\left(A^*,\theta\right) = w + \mu^*, \tag{3a}$$
$$(1-\lambda)\,\phi_T\left(T^*,\theta\right) = p - \mu^*, \tag{3b}$$
$$\mu^*\left(A^* - T^*\right) = 0, \tag{3c}$$
$$t^* = Q\left(A^*,\theta\right) + \phi\left(T^*,\theta\right) - wA^* - pT^*; \tag{3d}$$

where μ^* is the Lagrangian multiplier corresponding to the constraint (RM).

Define $\Theta_C = \{\theta \in \Theta : \mu^* > 0\}$ and $\Theta_U = \Theta - \Theta_C$. While farmers in Θ_C (constrained farmers) harvest all land they have, those in Θ_U (unconstrained farmers) hold some amount of idle land.

When $\lambda = 0$, the social planner is not bothered by the non-agricultural use of land, and the choices of A and T are not affected by the tax mechanism. If $\lambda = 1$, equation (3b) determines that $\Theta_C = \Theta$, i.e., there is no idle land in the optimal taxation scheme. The shadow price of the rental market constraint in the latter case becomes constant and equal to the price of land for all $\theta \in \Theta$.

The following result shows that the optimal tax scheme under complete information can be implemented by pure land taxes.

Proposition 1 *The solution to the optimal taxation problem (P.FB) can be decentralized through a menu of linear taxes of the form:*

$$t = \beta^* T + \gamma^*,$$

where $\beta^* = \lambda \phi_T\left(T^*,\theta\right) = \frac{\lambda}{1-\lambda}\left(p - \mu^*\right)$ *and* $\gamma^* = t^* - \beta^* T^*$.

PROOF. Consider $t = \beta^* T + \gamma^*$, where β^* and γ^* are defined as above. The first-order conditions for (P) can be written as:

$$Q_A\left(A,\theta\right) = w + \mu,$$
$$\phi_T\left(T,\theta\right) = p + \beta^* - \mu,$$
$$\mu\left(A - T\right) = 0.$$

Using the definition of β^* it is easy to check that the system above is equivalent to the system (3). The value of γ^* adjusts the level of the transfers in order to satisfy (IR) with equality.

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[5] Hereafter, for the ease of notation, we write $\mu^*\left(\theta\right)$ as μ^*, $A^*\left(\theta\right)$ as A^*, $T^*\left(\theta\right)$ as T^*, and so on.

Proposition 1 shows that the social planner can implement the optimal tax scheme under complete information offering a pair (β^*, γ^*) to the producer of type θ. Solving (P), each farmer chooses the amounts of A and T determined by (P.FB). The tax rate increases with λ and mitigates non-agricultural purposes of landholding. If $\lambda = 0$, the government does not distort the choice of the farm size by not taxing the ownership of land. If $\lambda = 1$, on the other hand, there is no idle land after taxation.

In Θ_U, we get a flat rate $\beta^* = \frac{\lambda}{1-\lambda} p$ which does not vary according to the type of producer. Thus, the model shows that in a context of complete information, one may use a single rate for all producers operating with unimproved land.

If the social planner could precisely observe landowner productivity parameters, there is a pure land tax scheme capable of implementing the optimal taxation schedule. In this solution, if $\lambda > 0$, the social planner discourages the non-agricultural use of land, and with $\lambda = 1$, there would be no idle land in equilibrium.

2.2 The second-best case

Consider now a more realistic case in which θ is private information. The choice of the optimal taxation scheme becomes a typical mechanism design problem. The revelation principle ensures it is sufficient to concentrate on a direct mechanism that induces truthful revelation of the firm's cost parameter. Each mechanism is an allocation determined by a set of three functions (t, A, T) defined on Θ and should be interpreted as the principal collecting a tax t in exchange for a choice (A, T).

Let $\Pi(\hat{\theta}|\theta)$ the payoff of a producer of type θ who declares to be type $\hat{\theta}$, i.e.,

$$\Pi(\hat{\theta}|\theta) = Q\left(\hat{A}, \theta\right) + \phi\left(\hat{T}, \theta\right) - w\hat{A} - p\hat{T} - \hat{t}.$$

where $\hat{A} \equiv A\left(\hat{\theta}\right)$, $\hat{T} \equiv T\left(\hat{\theta}\right)$ and $\hat{t} \equiv t\left(\hat{\theta}\right)$. The truth-telling requirement establishes a restriction on the set of all feasible mechanisms which can be summarized in the following definition.

Definition 2 *An allocation (t, A, T) is implementable if, and only if,*

$$\Pi\left(\theta|\theta\right) \geq \Pi(\hat{\theta}|\theta) \quad \forall \, \theta, \hat{\theta} \in \Theta. \tag{4}$$

Every implementable allocation is such that the agent is interested in revealing his correct type rather than untruthfully declaring himself to be of some other type. Therefore, equation (4) is a translation of the revelation principle for which the next result establishes a more tractable form based on Guesnerie and Laffont (1984).

Lemma 3 *If the allocation (t, A, T) is implementable and piecewise $\mathcal{C}^1$ then*

$$\frac{d}{d\theta} \Pi(\theta | \theta) = Q_\theta(A, \theta) + \phi_\theta(T, \theta), \qquad (IC_1)$$

and

$$Q_{A\theta}(A, \theta) \dot{A} + \phi_{T\theta}(T, \theta) \dot{T} \geq 0, \ \ a.s. \ in \ \Theta. \qquad (IC_2)$$

Additionally, (IC_1) and (IC_2) are sufficient for implementability if (t, A, T) is continuous with absolutely continuous first derivatives.

PROOF. *see appendix.*

The optimal mechanism design problem is represented by the following maximization program:

$$\max_{\{t, A, T\}_{\theta \in \Theta}} \int_\Theta [t - \lambda \phi(T, \theta)] \, dF(\theta) \qquad (P.SB)$$

subject to (IC_1), (IC_2),

$$\Pi(\theta | \theta) \geq 0, \qquad (IR_\theta)$$

and

$$A \leq T. \qquad (RM_\theta)$$

In order to solve the program above using the standard techniques, we need a condition of sorting regarding the effect of θ on Q and ϕ.

Assumption A2: $Q_\theta(x, \theta) + \phi_\theta(x, \theta) > 0$ for every $x \in \Re$.

Assumption (A2) establishes that, holding the farm size fixed, farmers with higher values of θ can obtain a larger payoff. Under (A2), conditions (RM_θ) and (IC_1) imply (IR_θ) is binding only for $\theta = \underline{\theta}$. Otherwise, the social planner could improve by increasing t_θ without violating the constraints.

Integrating (IC_1) by parts and substituting into $(P.SB)$ we get:

$$\max_{\{t,A,T\}_{\theta \in \Theta}} \int_{\Theta} \Psi(A, T, \theta) \; dF(\theta)$$

subject to (IC_2), (IR_θ) and (RM_θ), where

$$\Psi(A, T, \theta) \equiv Q(A, \theta) - wA + (1 - \lambda)\phi(T, \theta) - pT - \frac{1 - F(\theta)}{f(\theta)}(Q_\theta(A, \theta) + \phi_\theta(T, \theta)).$$

Notice that $\Psi_{AT} = 0$. We make the following assumption to assure the use of a first-order approach for the maximization program above:

Assumption A3: Ψ is concave and has a unique interior maximum for each $\theta \in \Theta$.

Ignoring (IC_2), the first-order conditions of $(P.SB)$ are given by:

$$\Psi_A(A^{**}, T^{**}, \theta) = \mu^{**}, \tag{5a}$$
$$\Psi_T(A^{**}, T^{**}, \theta) = -\mu^{**}, \tag{5b}$$
$$\tilde{\mu}(A^{**} - T^{**}) = 0. \tag{5c}$$

Define a transfer profile given by $t^{**} = Q(A^{**}, \theta) - wA^{**} + \phi(T^{**}, \theta) - pT^{**} - \int_{\underline{\theta}}^{\theta} Q_\theta(A^{**}, \hat{\theta}) + \phi_\theta(T^{**}, \hat{\theta}) \, d\hat{\theta}$, obtained from the integration of (IC_1). If (IC_2) is verified for every pair (A^{**}, T^{**}) in Θ, the solution of $(P.SB)$ is completely defined by the system (5) and t^{**} under $(A3)$. Otherwise, the "ironing principle" would be used in the solution. We avoid this possibility by imposing the next two assumptions.

Assumption A4: (Monotone hazard-rate condition) $\dfrac{d}{d\theta}\left(\dfrac{f(\theta)}{1 - F(\theta)}\right) \geq 0$.

Assumption A5: $Q_{A\theta}(x, \theta) + (1 - \lambda)\phi_{T\theta}(x, \theta) \geq 0$ for every $x \in \Re$.

Assumptions $(A4)$ and $(A5)$ are commonly adopted in the literature. Condition $(A4)$ is satisfied for several common distributions such as the uniform, normal, logistic and exponential, for example. Assumption $(A5)$ is a sorting condition establishing that a marginal increase in θ determines an increase on the total revenue from landholding, even if $Q_{A\theta} < 0$. This assumption is the single crossing condition applied to our model. The next result shows that $(A1)$-$(A5)$ are sufficient to characterize (5) as the unique solution for $(P.SB)$.

Lemma 4 *Suppose that (A1)-(A5) are satisfied. Then the solution of (P.SB) is determined by the system (5) along with t^{**}.*

PROOF. *see appendix.*

The result above shows that the best direct revelation tax mechanism is given by the triple (t^{**}, A^{**}, T^{**}). Under this mechanism, each farmer is induced to announce that his type is the true θ receiving the allocation (A^{**}, T^{**}) and paying t^{**}. However, there are more reasonable mechanisms which yield the same results derived above. The implementation of the optimal solution via a menu of linear taxes is presented on next proposition. Similarly to the first-best case, let $\tilde{\Theta}_C = \{\theta \in \Theta : \mu^{**} > 0\}$ and $\tilde{\Theta}_U = \Theta - \tilde{\Theta}_C$.

Since θ is the only private information of farmers, the social planner can infer a specific set of achievable allocations. We can define $\Omega_i = \{(Q,T) : Q = Q(A^{**}, \theta)$ and $T = T^{**}$ for some $\theta \in \tilde{\Theta}_i\}$, $i \in \{C, U\}$, and $\Omega = \Omega_C \cup \Omega_U$ as the set of feasible allocations. The social planner knows that any pair (Q,T) which is not in Ω is not compatible to the rational behavior of the farmers.

Proposition 5 *Under (A1)-(A5), the solution of (P.SB) can be decentralized by a menu of linear taxes through the following mechanism: (i) the social planner announces a tax schedule based on the observable variables T (farm size) and Q (agricultural output) of the form*

$$t(Q,T) = \alpha(Q)Q + \beta(T)T + \gamma(Q,T);$$

(ii) given the tax schedule $t(Q,T)$ farmers of each type choose Q and T; (iii) the social planner observes T and Q and collects $t(Q,T)$. The tax schedule is such that $\alpha(Q) = 0$ whenever exists some T for which $(Q,T) \in \Omega_C$ and γ does not distort the choice of Q and T, i.e., $\gamma_Q(Q,T) = \gamma_T(Q,T) = 0$ for all $(Q,T) \in \Omega$.

PROOF. *see appendix.*

The total tax is constituted by a three-part tariff: an output tax, a land tax and a fixed part. Proposition 5 shows that the scheme put forward as a solution for the model with complete information cannot be implemented under asymmetric information, i.e., it is not possible to implement the optimal

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tax mechanism relying only on land taxes. For farmers with idle land it is necessary the use of output taxes along with land taxes in order to obtain the optimal allocation. Notice that the fixed part does not alter the choices of the cultivated area A and farm size T and it is used only to extract rent from the farmers.

3 Farm size and Tax Evasion

This section examine some implications of the previous analysis for land taxation in Latin American countries, exploring the contents of Proposition 5. Despite the absence of a land rental market, there is a consensus regarding the existence of a dualism in agrarian organization in Latin America. Small farmers with high yields per hectare coexist with less productive large landholders. We adopt the next assumption to concentrate our analysis to this Latin American situation.

Assumption A6: $Q_{A\theta}(x, \theta) < 0$ for every $x \in \Re$.

Under (A6), the types of farmers are such that a higher θ refers to an increase in the non-agricultural land benefits and a decrease in the agricultural productivity of land. Farmers with high θ obtain profits mostly from non-agricultural land use, experiencing lower agricultural productivity. As a consequence, those farmers are expected to have larger tracts with a smaller cropped area. In other words, assumptions (A1) and (A6) are sufficient to generate an inverse relationship between farm size and agricultural productivity.[6]

Lemma 6 *Assume (A1)-(A6). There exists at most one critical type $\tilde{\theta} \in \Theta$ such that $\tilde{\Theta}_C = [\underline{\theta}, \tilde{\theta})$ and $\tilde{\Theta}_U = [\theta^*, \bar{\theta}]$. Also, $\dot{T}^{**} = \dot{A}^{**} > 0$ for all farmers in $\tilde{\Theta}_C$, $\dot{T}^{**} > 0$ and $\dot{A}^{**} < 0$ for all farmers in $\tilde{\Theta}_U$.*

PROOF. *see appendix.*

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[6] This inverse relationship between farm size and productivity can be theoretically explained either by interaction of different market imperfections (Feder, 1985; Eswaran and Kotwal, 1986) or by a self-selection argument (Assunção and Ghatak, 2003). The empirical evidence is vast including; for example, Berry and Cline (1979), Rosenzweig and Binswanger (1993), Benjamin (1995), Barret (1996) and Lamb (2003).

Lemma 6 has two important consequences. First, all types are revealed after taxation and they can be described by the farm size - formally, T^{**} is an one-to-one function. Second only small farmers (those with $T^{**}(\theta) < T^{**}(\tilde{\theta})$) are restricted by the rental market constraint. It is also straightforward to obtain a similar result from (A6) to the complete information case.

Assumption (A6), through lemma 6, provides an easier interpretation for the contents of proposition 5. The output tax rate should be zero for small farmers who are restricted by the absence of a land rental market, operating without idle land. As the farm size and the level of idle land rise, the output rate rises as well, while the land tax rate decreases. Even though the tax on output causes a distortion in resource allocation, its use is justified by its ability to compose an implementable (or self-revealing) taxation mechanism, specially for large landholders. The next proposition summarizes these findings.

Proposition 7 *Under (A1)-(A6), the optimal land taxation problem is such that: (i) there is evasion when a pure land tax regime is used and $\Theta_U \neq \varnothing$; (ii) evasion is more severe for large landholders (those with $T^{**}(\theta) > T^{**}(\theta^*)$).*

An example: the Brazilian experience

Land tax (Rural Property Tax - ITR) in Brazil, since its creation through the Land Statute of 1964, has been used to support public policies for land redistribution. Nevertheless, there is a high level of evasion and default that hinders its efficiency as an instrument of landholding policy. Two large-scale reforms of ITR were carried out, in 1979 and 1996, but the results have not sufficed to overcome the associated problems. According to the current scheme, the rate would vary from 0.03% to 20% of the land value. The rates differ only by degree of utilization and total area, and there are sharply progressive rates in relation to area and regressive ones for the percentage of cropped area, so that productive properties are benefited.

In an economy such as Brazil's, where producers operate with idle land and the government is often in the dark as to the true productivity parameters of the agricultural and non-agricultural activities available to various landholders, proposition 5 shows that there are no tax rates able to make ITR an optimal taxation scheme. The use of an output tax becomes necessary so that producers with better access to non-agricultural activities will pay their share of the tax burden.

A natural way to implement this result, using the prexistent and well-defined strucuture of the output tax (ICMS), is to consider the tax rate a function of the farm size and the total output tax collected per hectare. The degree

of use, which is a non-observable variable, should be replaced by the amount of ICMS collected per hectare. This implementation has a great potential to improve not only the application of ITR but also the collection of ICMS. The scheme proposed implies an additional cost to the evasion and default of ICMS given by the increase in the ITR tax rate. Therefore, this new reformulation constitutes a new step toward more reliable tax institutions. Note that only the information about the ICMS is required in this scheme. Hence, there is no need for large modifications in the existent institutions and mechanisms.

This inability to implement ITR as a solution to the problem with asymmetric information gives theoretical support to what the government found by comparing declared against actual data. According to the Presidential Press Office, the percentage of value declared in relation to the real one in the 1980s varied from 20% for properties of less than 10 hectares down to only 1.2% for large properties of over 10 thousand hectares. The area reported as usable was far short of the true figure as well, with large landowners declaring around 50% and small ones 94% of the real measure. This casual evidence is compatible not only with the inadequacy of a pure lad tax regime but also with the fact that small producers, in general with no idle land, are more likely to correctly declare their land use.

4 Discussion

We have used a model to study an optimal tax mechanism design problem in the context of a typical Latin American country. In this section, we describe the role of each key ingredient in our main results.

Some authors recognize that a tax on land have both fiscal and non-fiscal effects. Although it can be an important source to finance local governments, it must also be considered from a more general policy perspective. Land taxes can be an alternative to traditional confiscatory land reform programs. Land taxes might provide an incentive for greater density and best use of land. Based on this literature, our analysis have also considered nonrevenue objectives for land taxation. [7]

In a more general scenario, we could consider the social planner's utility function as $U(t, A, T) = t - \psi(A, T)$, where ψ is strictly decreasing in A and increasing in T. In other words, the social planner could promote agricultural production and avoid large landholdings. [8] In this case, it is straightforward to

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[7] E.g. Binswanger, Deininger and Feder (1995), Deininger and Feder (2000), Bird and Slack (2002).

[8] This functional form includes the cases in which the social planner combat idle

check that the use of output tax is always required in a linear implementation of the optimal taxation scheme, even in the complete information case. Therefore, relying only on land tax would not be optimal even if the productivity parameter was publicly observed.

On the other hand, the utility function we have used provides a meaningful benchmark. It allows us to analyze the need of output taxes as part of the optimal tax mechanism. A comparison between Proposition 1 and Proposition 5 reveals that asymmetric information may lead the need of output taxes along with land taxes in order to control both cultivated area and farm size.

Another key feature of our analysis is the non-agricultural component of land demand. As mentioned before, many reasons have contributed to distort the allocation of land in favor of large landholders, specially in Latin American countries. In terms of the model, this is represented by the function $\phi(T, \theta)$, which is essential for our analysis. If $\phi(T, \theta) = 0$ for all T and θ, no idle land would exist in equilibrium. In this case, all farmers exploit the full agricultural capacity of their holdings, keeping $A = T$. Therefore, $\Theta_U = \tilde{\Theta}_U = \varnothing$ and the optimal tax mechanism can be implemented using only the tax on land in both cases - complete or incomplete information. The output tax is required when there is a separation between the choice of cultivated area and farm size.

Finally, we have assumed that the land rental market is absent. If the land rental market is perfect, the need of output taxes to implement the optimal tax instrument would be even stronger. An easy way to think about the impact of a perfect rental market in the model is to set the Lagrangian multipliers of (RM) and (RM_θ) equal to zero to discard these constraints. As a consequence, the optimal scheme under asymmetric information becomes a mix of land taxes and output taxes for every farmer. For the complete information case, land taxes continue to be able of implementing the optimal taxation. However, a significant change occurs to the relationship between farm size and tax evasion. Despite of the farm size, the tax on land is not able to implement the optimal tax scheme in the incomplete information case. Therefore, there is no clear relationship between farm size and tax evasion.

5 Conclusion

This paper presents a model of asymmetric information in which a mix of ouput and land taxes arises as a means of implementing an optimal taxation mechanism. The model is stripped down to highlight characteristics commonly

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land, measured as T/A or $T - A$.

observed in Latin American countries. The role of each one in our main propositions is discussed in last section.

The mechanics of our results is the following. The absence of a land rental market restrain the cultivated area to be not larger than the farm size. As a consequence, depending on the proclivity of agricultural and non-agricultural land use, farmers have one or two key decisions to make. Whenever the land rental market constraint is binding, the cultivated area is equal to the farm size and there is only one relevant choice. On the other hand, if the land rental market constraint is not binding (the case with idle land), farmers choose both farm size and area under cultivation. While we need only one tax instrument in the first case, the second one requires two of them. Therefore, output taxes have a key effect in the taxation of those farmers operating with idle land, even considering its distortionary effect.

The lack of a land rental market along with the assumption regarding the inverse relationship between farm size and productivity explain not only the evasion of land taxes but also why it is more severe for large landholders. Small farmers do not operate with idle land due to their higher agricultural productivity. Hence, a land tax scheme is more likely to be effective for them.

The present model can be useful for issues of land policy in Latin American countries. Appropriate land taxes might correct land prices in economies where they are above the discounted present value of agricultural inflows, inducing land redistribution from large landowners to more productive small peasants [Deininger and Feder (2000)]. We have argued that the implementation of such taxes comprises both land and output taxes.

Appendix

PROOF. [Lemma 3] Let (t, A, T) be an implementable allocation piecewise $\mathcal{C}^1$. Thus, for every $\theta \in \Theta$,

$$\Pi\left(\theta|\theta\right) \geq \Pi\left(\hat{\theta}|\theta\right) = \Pi\left(\hat{\theta}|\hat{\theta}\right) + \left[Q\left(\hat{A}, \theta\right) - Q\left(\hat{A}, \hat{\theta}\right)\right] + \left[\phi\left(\hat{T}, \theta\right) - \phi\left(\hat{T}.\hat{\theta}\right)\right],$$

where $\hat{A} \equiv A\left(\hat{\theta}\right)$ and $\hat{T} \equiv T\left(\hat{\theta}\right)$. Hence,

$$\Pi\left(\theta|\theta\right) - \Pi\left(\hat{\theta}|\hat{\theta}\right) \geq \left[Q\left(\hat{A}, \theta\right) - Q\left(\hat{A}, \hat{\theta}\right)\right] + \left[\phi\left(\hat{T}, \theta\right) - \phi\left(\hat{T}.\hat{\theta}\right)\right],$$

and, switching θ and $\hat{\theta}$, dividing by $\left(\theta - \hat{\theta}\right)$ and taking $\hat{\theta} \to \theta$, the function Π is proved to be piecewise $\mathcal{C}^1$ and

$$\frac{d}{d\theta}\Pi\left(\theta|\theta\right) = Q_\theta\left(A, \theta\right) + \phi_\theta\left(T, \theta\right) \quad a.s. \text{ for all } \theta \in \Theta.$$

Repeating this computation considering $\left(\theta - \hat{\theta}\right)^2$, we get

$$Q_{A\theta}\left(A, \theta\right)\dot{A} + \phi_{T\theta}\left(T, \theta\right)\dot{T} \geq 0 \quad a.s. \text{ for all } \theta \in \Theta.$$

PROOF. [Lemma 4] Notice that we only need to check condition (IC_2) for every $\theta \in \Theta$. For all $\theta \in \Theta_C$, we can differentiate (5) to obtain $\dot{A}^{**} = \dot{T}^{**} = -\frac{\Psi_{A\theta} + \Psi_{T\theta}}{\Psi_{AA} + \Psi_{TT}}$. Hence, (IC_2) can be written as

$$-\frac{\left(Q_{A\theta} + \phi_{T\theta}\right)\left(\Psi_{A\theta} + \Psi_{T\theta}\right)}{\Psi_{AA} + \Psi_{TT}} \geq 0.$$

Assumption (A3) assures that the denominator is always negative. Substituting the definition of Ψ, the numerator can be expressed by

$$-\left(Q_{A\theta} + \phi_{T\theta}\right)\left[Q_{A\theta} + (1 - \lambda)\phi_{T\theta} - \left(Q_{A\theta} + \phi_{T\theta}\right)\frac{d}{d\theta}\left(\frac{1 - F}{f}\right)\right],$$

which is nonpositive under (A4) and (A5).

For $\theta \in \Theta_U$, we get $A^{**} = -\frac{\Psi_{A\theta}}{\Psi_{AA}}$ and $T^{**} = -\frac{\Psi_{T\theta}}{\Psi_{TT}}$. Substituting Ψ, condition (IC_2) becomes

$$-\frac{\left(Q_{A\theta}\right)^2\left[1 - \frac{d}{d\theta}\left(\frac{1-F}{f}\right)\right]}{\Psi_{AA}} - \frac{\left(\phi_{T\theta}\right)^2\left[1 - \lambda - \frac{d}{d\theta}\left(\frac{1-F}{f}\right)\right]}{\Psi_{TT}} \geq 0,$$

which is true under (A3) and (A4).

PROOF. [Proposition 5] Let $Q = Q(A, \theta)$ denote the agricultural production. Since $Q_A(A, \theta) > 0$, we can use the implicit function theorem to define a function $A = A(Q, \theta)$. Given the linear tax scheme $t(Q, T) = \alpha(Q)Q + \beta(T)T + \gamma(Q, T)$, a type θ farmer chooses agricultural production and farm size in order to solve:

$$\max_{t,A,T} \ Q + \phi(T, \theta) - wA(Q, \theta) - pT - t(Q, T)$$

subject to $A(Q, \theta) \leq T$. The first-order conditions of this choice, after some manipulation, is given by:

$$Q_A = w + \mu + \alpha Q_A + \alpha' Q_A Q = w + \mu + \frac{d}{dA}(\alpha Q) \tag{6}$$

and

$$\phi_T = p - \mu + \beta + \beta' T = p - \mu + \frac{d}{dT}(\beta T), \tag{7}$$

where μ is the Lagrangean multiplier. From (6) and (7) we can define α and β in order to match the solution of system (5).

For every $\theta \in \Theta_U$, the following differential system can define α and β in order to implement the optimal tax mechanism.

$$\frac{d}{dA}(\alpha Q) = \frac{1 - F}{f} Q_\theta$$

and

$$\frac{d}{dT}(\beta T) = \lambda Q_T + \frac{1 - F}{f}.$$

The solution of this system is given by:

$$\alpha(Q) = \frac{1}{Q} \int_{\left\{ \tilde{Q} \in \text{proj}_Q \Omega_U : \tilde{Q} \leq Q \right\}} \frac{1 - F}{f} \frac{Q_\theta}{Q_A} d\tilde{Q}$$

and

$$\beta(T) = \frac{1}{T} \int_{\left\{ \tilde{T} \in \text{proj}_T \Omega_U : \tilde{T} \leq T \right\}} \left[\lambda \phi_T + \frac{1 - F}{f} \phi_\theta \right] d\tilde{T}.$$

Analogously, for every farmer of type $\theta \in \Theta_C$, the optimal tax mechanism can be implemented by $\alpha(Q) = 0$ and

$$\beta(T) = \frac{1}{T} \int_{\left\{ \tilde{T} \in \text{proj}_T \Omega_C : \tilde{T} \leq T \right\}} \left[\lambda \phi_T + \frac{1 - F}{f} (Q_\theta + \phi_\theta) \right] d\tilde{T}.$$

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