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A decision support model for tax revenue collection in Greece

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ABSTRACT

In the midst of the financial crisis currently unfolding in Greece, tax revenue collection is considered a top priority. This work describes a dynamic, Markov-based decision support model, aimed at predicting the behavior of a risk-neutral enterprise in Greece, and at evaluating tax policies before they are implemented. We use our model to i) analyze the effectiveness of an alternative taxation option periodically offered by the Greek government, ii) show that in the current environment, a rational enterprise has no incentive to disclose its profits, and iii) identify "virtuous" combinations of parameters which lead to full disclosure of profits.

1. Introduction

Faced with perhaps its most serious debt crisis in modern history, Greece is currently implementing a series of austerity measures and reforms. One of the central components prescribed in the "rescue package" overseen by the EU and the IMF calls for a dramatic increase in tax revenues and the minimization of tax evasion, the latter being one of the country's most serious and persistent problems.

The basic components of the current tax system for incorporated entities are a flat tax rate (currently set at 24%) on profits, random audits for identifying tax evaders, and monetary penalties for under-reporting income. Typically, the government does not have adequate information on a firm's profits, which may be manipulated through a variety of methods. Two of the most often used include i) manipulation of financial statements to under-report income, and ii) invoices (often issued by another, usually short-lived firm) that document supposed expenses and are used to offset profits.

Penalties for tax evasion depend on the amount of unreported income, and the time elapsed since the offense took place. Specifically, a firm found to have concealed income must pay any tax originally due on that income, plus a 2% monthly penalty on that tax. Thus, "older" tax evasion decisions are potentially more costly than recent ones. The total penalty amount is subject to a 2/3 "discount" for prompt settlement once the evasion is discovered, and is capped at twice the original tax owed.

The firm's[1] true profit may be revealed by performing an audit. Because of scarce resources, Greece can only audit a limited number of cases each year, estimated at approximately 5%. Thus, in an effort to collect revenue and promote full disclosure, the government retains the right to audit businesses "retroactively" for up to five years in the past. Any tax evasion activity beyond that horizon is essentially capitalized by the firm. Because of this, the audit probability is comparatively higher for firms which have not been audited for the last four years.

A somewhat unusual feature of the Greek tax system is that the government periodically offers businesses the option to "close" past tax declarations to any audits, for a fee which is to be paid for each tax year a business would like to exempt from possible audits. Because the statute of limitations on tax declarations is usually five years, the government has in the past offered this option in roughly five-year intervals. This "closure option" can be viewed as a kind of middle ground: it may allow an entity to cover-up past transgressions, at some cost, but it also provides the government with some tax revenue (if a sufficient number of businesses opt to use it), although that revenue may be less than what is properly owed. For our purposes, the option works roughly as follows. The government declares that closure will be available in the current fiscal year and will cover a given number of years in the past. The firm files this year's tax statement as usual, and declares some nominal profit. It pays any tax owed on that profit, plus a fixed amount for each fiscal

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[1] Here, we will use the word "firm" to mean incorporated entities in Greece, or elsewhere, that operate following the international accounting standards, commonly known in Europe as S.A. (Société Anonyme).

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year it wants to cover under the closure option. In exchange for that additional amount, the government agrees to consider the past tax statement(s) as truthful and never audit them.[2] If a firm does not avail itself of the closure option, it may find itself with a higher probability of being audited, as many of its peers effectively "remove" themselves from the audit pool. The most recent closures have been occurring roughly every 4–5 years during 1998–2006 (e.g., [9,10]). It is clear that Greece considers closure to be an integral part of the tax system, and a new round took place in 2010. Currently, the effectiveness of the closure option is unclear, and there is a widespread feeling that the auditing system and level of penalties are not adequate to prevent tax evasion.

The purpose of this work is to describe a decision support model which incorporates the salient features of the Greek tax system currently in place, as it pertains to firms. Our model, in the form of a dynamical system with inputs, is mainly designed to explore an enterprise's propensity to "cheat" under various scenarios, as the latter seeks to maximize the present value of her long-term expected profits. The main parameters of the model will be the tax rate, the probability of the firm being audited, the probability of the government offering the closure option in any given year, the cost of the option to the firm, and the penalty for unreported profits. We will describe the firm's evolution within the tax system by means of a Markov decision process. Our main goal is to compute the optimal behavior expected of a "typical" risk-neutral rational enterprise and identify the states in which tax evasion is an optimal policy for the firm. This will allow us to i) "chart" in our parameter space the region(s) which lead to honest behavior (i.e., full disclosure of profits) and maximization of government revenues, and ii) evaluate the closure option as a revenue-collecting measure and determine whether it promotes or deters tax evasion. We are also interested in knowing the extent to which a firm's decisions in the current year depend on past decisions, e.g., its tax evasion policy within the last five years. We expect that for certain parameter values, which we would like to compute, the firm's optimal decisions will be independent of past behavior.

The proposed model may be useful as a tool for gauging the effectiveness of the current system, and for guiding future tax policy. Besides evaluating tax policies before they are implemented, our model can help identify those which are both financially responsible and business-friendly, in the sense that they are harsh enough to make tax evasion unprofitable, but no harsher.

1.1. Related work

Relevant work in the DSS literature includes [15] who applied Bedford's law to tax evasion and other types of financial fraud, and [4], who presented a numerical study of [15] using a genetically optimized artificial neural network. The work in [12] examined the strategic use of deceptive language in managerial financial fraud via linguistic cues and suggested the use of linguistic analysis by auditors to flag questionable financial disclosures. Early work on models for optimal taxation begins with [1] who proposed a macroeconomic equilibrium model for optimal taxation, based on portfolio allocation. In that work, an agent decides the optimal allocation of her gross income between a risky asset (undeclared income) and a risk-free asset (income disclosed). Several improvements on that model followed in subsequent work, including [2] which concentrated purely on the effects of increased probability of detection on the agent's level of evasion, and [5] where it was argued that the basic model was not adequate to describe tax evasion, and that tax rates should also be considered along with enforcement. See also [14] for a treatment of taxation from the point of view of dynamical systems and optimal control. Some discussion regarding the criteria based on which the agent makes tax evasion decisions can be found in [6]. The work in [16] considered the trade-off between fines and audit probabilities, and discussed government policies that account for the firm's attitude toward risk.

Other works, such as [8,7] went on to introduce the morality of taxpayers and auditors as variables. In [11], "morality" is captured by assigning premiums to auditors that reveal tax evasion, in order to counter the incentive for accepting bribes. More recent work regarding optimal taxation includes [19], who explored a model for linear taxation with a non-zero minimum tax. With respect to Greece, the tax evasion literature (most notably [13,18]) provides some theoretical and empirical discussion but little hard analysis.

To the best of the authors' knowledge, there have been no decision support models, and little examination of optimal taxation from the point of view of the firm (i.e., not in macro-economic terms) which aims to maximize the present value of her expected income through tax evasion. Furthermore, there have been no rigorous studies of the "closure option" and its effects on tax revenues; despite this, Greece recently announced a new round of closure for 2011, apparently in an effort to offset reductions in other income streams. These facts, combined with the urgency of Greece's current situation, highlight the need for decision tools that will allow one to test the effectiveness of various taxation scenarios, and to assess the policy of closurein particular. This work aims to contribute precisely in that direction.

The remainder of this paper is structured as follows: In Section 2 we describe the dynamics of a decision process in which an enterprise's after-tax profit are determined each year by its own actions (e.g., by deciding how much profit to reveal, and whether to make use of the closure option), as well as the actions of the government (e.g., tax penalty levels, number of audits mounted and whether to offer the closure option). We pose an optimization problem whose solution, obtained via dynamic programming, determines the firm's behavior, and thus the expected revenue collected by the government. In Section 3 we obtain and discuss numerical results for various scenarios of practical interest, depending on whether closure is available or not.

2. Model

We consider a firm which, at the end of each fiscal year, must declare its net profit to the government or tax authority. We proceed to describe the core components of our model, in the form of an Markov decision process which captures the salient features of the Greek tax system. We will make use of the following notation. The integer $k=0, 1, 2,...$will denote discrete time, and x_k will be the value of the quantity x at time k. Individual elements of a vector, x, or matrix M, will be indicated by $[x]_i$ and $[M]_{ij}$, respectively. Finally, $0_{i\times j}$ will denote a i-by-j matrix of zeros.

2.1. State space

We will let $s_k \in \mathcal{S}$ be the tax status of a representative firm in year k, with

$$\mathcal{S} = \{V_1, \ldots, V_5, O_1, \ldots, O_5, N_1, \ldots, N_5\}, \tag{1}$$

where

- V_i: the firm is being audited so that its true income for the last $i=1, \ldots, 5$ years is verified.
- O_i: the firm has decided to use the closure option and has neither employed closure nor been audited in the past $i=1, \ldots, 5$ years,

[2] There are certain safeguards in place to ensure that, for example, a firm must declare some minimum profit if it wants to "close", or must calculate its closure cost as a fraction of gross sales instead of net revenues. The precise amount is determined by the government each time the option is offered.