Journal of Public Economics 128 (2015) 59–72

Contents lists available at ScienceDirect

Journal of Public Economics

journal homepage: www.elsevier.com/locate/jpube

Global inspection games☆

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ARTICLE INFO

Article history:
Received 7 October 2013
Received in revised form 1 April 2015
Accepted 30 April 2015
Available online 30 May 2015

JEL classification:
H26
D82
D84
C72
C91

Keywords:
Coordination/global games
Common shocks
Asymmetric information
Expectations
Tax evasion
Experimental economics

ABSTRACT

In the tax evasion game – a typical example of "inspection game" – audits are costly and audit probabilities are determined by the tax agency based on the tax returns submitted by taxpayers. We find that if taxpayers' incomes are correlated (e.g., when they are subject to a common shock) the optimal audit probability for low declarations is an increasing function of the average declaration, as the latter is an informative signal of the realized level of income. Since a taxpayer's optimal declaration is an increasing function of the probability of an audit, the optimal auditing rule creates incentives for taxpayers to coordinate their declarations. The resulting coordination game features multiplicity of equilibria and thus "strategic uncertainty" about the equilibrium that will be selected.

When we add a source of "fundamental uncertainty" (about the type of agency taxpayers face), the situation can be realistically modeled as a global game. Further, and unlike the coordination game before, it yields a unique – and usually interior – equilibrium which is consistent with empirical evidence and supported by the data collected in a computerized experiment.

The model can be applied to other "inspection games" of economic interest such as the regulation of industries and the allocation of welfare benefits, among others.

1. Introduction

All over the world, transfers are made based on the reports made by potential beneficiaries: taxpayers file tax returns, welfare recipients declare themselves "needy" (poor, unemployed, ill, etc.), firms in regulated industries give information about their cost structures to the regulator, etc. However, verifying self-reports is often costly for the principal: carrying out a tax audit, authenticating the status of a welfare claimant and finding out the cost structure of a firm require time, effort and resources, all of which have significant opportunity costs.

The problem behind these examples is, at the end of the day, a simple inspection problem. The tax/welfare/regulatory agency only has to ask itself the question: "which taxpayers/claimants/firms should be audited and which ones should not?" This is, as well, the question we will address in this paper. We will use the tax agency's problem as a leading example throughout the paper, but the analysis can be easily adapted to the problem of any other generic inspection agency.

The tax evasion literature suggests a simple answer to the problem: the "cut-off" auditing policy (Reinganum and Wilde (1985)). It is an appealing policy, especiallly since tax agencies worldwide use observable characteristics of taxpayers to partition the population into fairly homogeneous categories in order to better estimate their incomes: ceteris paribus, those who declare well below the cut-off level are likely to be evaders and are audited, while those who declare about or above it are likely to be compliant taxpayers and are not inspected.

The "cut-off" auditing policy, however, can lead to systematic mistargeting in the presence of common shocks: in good years the category would be under-audited (e.g., bars and pubs in a heat-wave); in bad years it would be over-audited (e.g., chicken-breeders in an avian-

☆ I thank Frank Cowell, Bernardo Guimaraes, Georg Weizsacker, Silvia Martínez Gorricho, Oliver Denk, Dan Silverman, seminar participants at the London School of Economics and three anonymous referees for their helpful comments and discussions. I gratefully acknowledge the financial support from the Spanish Ministry of Science and FEDER funds under project SEJ 2007-62656 and from the Spanish Ministry of Economics and Competition under project ECO2012-34928.

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http://dx.doi.org/10.1016/j.jpubeco.2015.04.009
0047-2727/

flu outbreak).[1] To avoid this problem, the agency needs contemporaneous data correlated with the common shock to help it improve its targeting ability. We use as a signal of the shock the profile of taxpayers' declarations, a piece of information that is always and freely available to the agency. We then show that, when the agency faces a taxpayer who declares low income, the optimal auditing strategy (labeled "relative auditing strategy") is (weakly) increasing in other taxpayers' declarations. Intuitively, the higher these declarations, the more likely the shock is a positive one, and so the more likely that someone who declares low income is an evader. Precisely this type of reasoning is presumed to be used by the Internal Revenue Service's "Discriminant Index Function" to determine which taxpayers to audit.[2] Thus, by simply using efficiently the information already available, the tax agency optimally decides to follow a policy that introduces a negative externality among taxpayers: if someone increased her declaration, everyone else's probability of detection would increase. This changes the nature of the evasion problem by creating a coordination game among taxpayers: each one of them has incentives to evade (comply) if others evade (comply) as well.

As a consequence, simplistic, "cat-and-mouse" inspection strategies are ineffective now in this scenario and a more systematic approach is needed to cope with the externalities generated by the agency's optimal policy. We do this by modeling the situation as a global game (Carlsson and van Damme (1993), Morris and Shin (2002b)), which as an added benefit allows us to do away with the multiplicity of equilibria typical of coordination games and with their associated policy design problems. Specifically, we model the agency's innate "toughness" with respect to evasion as a parameter that is its private information and ultimately affects its optimal policy: ceteris paribus, tougher agencies will audit more intensively than softer ones. Thus, taxpayers need to estimate it in order to decide how much income to declare and they do it based on the information available to them: each taxpayer's previous experiences, conversations with friends and colleagues, and interpretation of media news constitute noisy signals of the tax agency's type and are taxpayers' private information. As signals are heterogeneous, different taxpayers are likely to perceive their situations as different from those of others, yet every one of them follows the same income declaration strategy. This leads to the survival of only one equilibrium in which (usually) some people evade and others comply, a result empirically supported and yet unlikely to be predicted by other tax evasion models.

We put our theory to the test via a computerized experiment and find strong support for the model's prediction that the government is better off when using the relative auditing strategy than when using the cut-off rule.

Previous research on the tax evasion area (started by Allingham and Sandmo (1972) and surveyed by Cowell (1990), Andreoni et al. (1998)) did analyze the effect of asymmetric information on the tax evasion game. Some focused on the uncertainty taxpayers face about which equilibrium of the coordination game will be selected ("strategic uncertainty"), usually generated by psychological or social externalities (Benjamini and Maital (1985), Fortin et al. (2007), etc.). Others centered on the "fundamental uncertainty" faced by taxpayers with respect to the agency's type (Scotchmer and Slemrod (1989), Stella (1991), etc.). Unlike them, the present study considers simultaneously both types of uncertainty and thus models the situation as a global game (Carlsson and van Damme (1993), Morris and Shin (2002b)).

The closest references to the present article are Alm and McKee (2004), Basseto and Phelan (2008), Kim (2005) and Ko (2012). In the first one, a laboratory experiment, the auditing policy is chosen in an ad hoc fashion, while in our analysis the agency's optimal strategy is derived, not assumed. Basseto and Phelan (2008) study coordination games between taxpayers and how the choice of tax rates and government expenditure affects the occurrence of the bad equilibrium ("tax riot"), while we analyze how a tax agency – that faces a given tax/spending system chosen by other areas of the government and that it cannot modify – selects its auditing strategy. Methodologically, on top of the "strategic uncertainty" generated by the coordination games analyzed by both Alm and McKee (2004) and Basseto and Phelan (2008), we consider the "fundamental uncertainty" generated by the taxpayers' imperfect information about the tax agency's type and that allows us to model tax evasion as a global game. The last two studies also employ the global game technique we use here, but while Kim (2005) generates the strategic interaction among taxpayers by adding a psychological cost ("stigma") to their utility functions, ours is the result of a rational tax agency that sets its auditing policy to maximize its objective function. Finally, Ko (2012) considers that the government has extra information about taxpayers that it can use to decide who to audit – while we consider the "worse-case scenario" in which it knows nothing but the taxpayers' income declarations – and is primarily concerned with the secrecy of tax agencies' auditing strategies.

The rest of the paper is organized as follows: In Section 2 we analyze the scenario in which the tax agency's type is common knowledge and show that its optimal policy creates a coordination game between the taxpayers. In Section 3 we consider the case in which the tax agency's type is its private information and model the situation as a global game. In Section 4 we discuss the robustness of the theoretical model and in Section 5 we test its predictions via a computerized experiment. Finally, conclusions are provided in Section 6. All proofs are left for Appendix A.1 on page 12.

2. Coordination inspection game (CIG)

The model focuses on the interaction between a tax agency and the taxpayers within a given category. For simplicity, we will use "population of taxpayers" and "common shocks" to indicate the members of the category and the shocks faced by them, and not those of the whole population (i.e., the set which is the union of all categories), unless indicated otherwise.

There is a continuum of taxpayers, uniformly distributed on the $I \coloneqq [0, 1]$ segment and indexed by $i \in I$, and one tax agency. The tax evasion situation is modeled as a one-shot sequential game with the following timing:

1. *Income allocation stage*: Taxpayer i learns her income $y_i \in \mathcal{Y} \coloneqq \{0, 1\}$, which is her private information. Incomes are assumed perfectly

[1] What is really crucial for our results to hold is that there exists an asymmetry in the information regarding the occurrence of the shock, an asymmetry that favors the taxpayers vis-à-vis the tax agency. Clearly the tax agency can observe that there was a heat-wave or an avian-flu outbreak, and thus that there was a positive or a negative shock. But what it does not know (at least as well as the pub owners or chicken-breeders themselves) is how intense the shock was: did the heat-wave increase the profits of pubs by 20%? or only by 10%? or even by 30%? And similar questions can be asked regarding the profits lost by chicken-breeders in the avian-flu outbreak. We simply claim that taxpayers know both the sign and the intensity of the shock, while the tax agency might know the sign but is imperfectly informed about the intensity of the shock. Thus, as long as taxpayers are relatively better informed than the tax agency, our results hold. A more down-to-earth example could be that of fashion and fades in a category. Say, for example, that after a Disney animated movie is released, sales of Disney-related merchandise might be affected positively and thus those stores that sell children clothes, toys and the like, would get a positive shock to their sales and profits. Of course, the tax agency might easily check whether a Disney blockbuster was released the previous year or not, and how well it did in the box office, but only the store-owners will know how much exactly it boosts their sales. Further, store-owners' own experience of the shock is a good estimate of how other stores' profits might be affected, so they are relatively better informed than the agency about it and thus the informational asymmetry between taxpayers and tax agency ensues.

[2] On page 301, Alm and McKee (2004) say: "(…) a taxpayer's probability of audit is based not only upon his or her reporting choices, but also upon these choices relative to other taxpayers in the cohort. In short, there is a taxpayer–taxpayer game that determines each individual's chances of audit selection."