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Citizenship and power in an agent-based model of tax compliance with public expenditure

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ABSTRACT

In this paper we present a model of tax compliance with heterogeneous agents who maximize their individual utility based on income and the conjectured level of per capita public expenditure. We formally include psychological drivers in this model. These drivers affect individual behavior, such as risk aversion, together with appreciation of public expenditure, expectations about peers' compliance and a natural inclination to comply, all of which we summarize in a quality termed "citizenship". The enforcement system, based on random inspections, is standard and only partially known to agents.

The agent-based model is simulated under a variety of settings, representing different "societies". We use the artificial data produced by the model to estimate the effects of taxpayers' traits on personal tax behavior and to build a compliance societal slippery slope. At the individual level, we find a positive dependence of compliance on all variables, with the significant exception of the tax rate, which has a negative impact. As far as societies are concerned, we show how aggregate tax compliance depends on composite indices of citizenship and power, and we find that the former is more important than the latter.

1. Introduction

The problem of tax compliance has always been central to the theory of public finance, and its relevance has increased over time. The seminal models by Allingham and Sandmo (1972) and Yitzhaki (1974) assume a neat rational framework where individual decisions are taken based on a cost-benefit analysis under uncertainty driven by the probability of auditing and the effects of fines. An impressive body of research has built on this approach to overcome limitations, and now incorporates other determinants of behavior and provides more realistic descriptions of observed data. A particularly important issue is excessive tax compliance observed in the real world with respect to the level that the standard model of tax evasion would predict.[1] Another significant issue is the impact of the level of tax rates on compliance which, in Allingham, Sandmo and Yitzhaki's works, is ambiguous or opposite to what is currently supported by common sense[2] or experimental findings. It was influentially pointed out that all tax-related decisions are not purely individual affairs, but depend on the quantity, efficiency and fairness of public expenditure, which should ultimately be financed by tax revenues: with no hope of being exhaustive, see Cowell and Gordon (1988), Cowell (1992), Bordignon (1993) and Rablen (2010) for up-to-date descriptions. Pyle (1991),

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[1] See Bernasconi (1998).

[2] See Bernasconi and Zanardi (2004).

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Andreoni, Erard, and Feinstein (1998) and, more recently, Sandmo (2005) provide well-written summaries of further developments and research themes. After seminal contributions by Schmölders in the 1960s, see Frank and Kirchler (2006), recognition that psychological factors may be relevant for understanding and modeling tax behavior has gained tremendous momentum in the past decade, see Kirchler (2007). Compliance, the result of complex interactions between taxpayers and their respective Government, is situated on a slippery slope, where both trust in authorities and power shape the behavior of a collectivity of agents. Tax morale, see Alm and Torgler (2006), Torgler (2007), and knowledge/perception of the enforcement system are intuitively useful to explain how taxpayers behave; their importance is empirically and experimentally grounded. In our opinion, fewer works have explored how such elements can be introduced to formal models of individual responses. One exception is the rich strand of agent-based models that offer useful insights through numerical simulations of the complex behavior of heterogeneous agents. The seminal contribution in this field can be traced back to Mittone and Patelli (2000), who state that tax evasion can spread among agents like outbreaks. Different types of agents can copy other agents' actions, if this is myopically deemed more convenient and, as a result, in the absence of a sufficient number of audits, evaders multiply at the expense of more honest taxpayers. Since then, other authors have taken similar approaches. For example, a set of distinct types is exogenously assumed to exist, see for instance Hokamp and Pickhardt (2010), who also have agents making random errors in their reported income, and Antunes, Balsa, Respicio, and Coelho (2007) who consider different bounded rational agents. Davis, Hecht, and Perkins (2003) analyze a model with honest and susceptible agents together with evaders and show that if an initially compliant population shifts to evasion, it is difficult to reverse the situation and the number of audits must be increased beyond the level that would have achieved acceptable compliance in the first place.

Agent-based models are able to explore several issues that are difficult to tackle using analytical models. Repeated interaction among heterogeneous agents or between the fiscal administration and the taxpayers can typically be simulated. The model presented in Korobow, Johnson, and Axtell (2007) is an attempt to consider geographical spillovers and "contagion" effects, as agents are networked in localized structures and are aware of their neighbors' actions, facing peer pressure and conformity pressure. It is shown in the paper that substantial sharing of payoff information and tax practices can lead to less compliant behavior. While it is not entirely surprising that one bad apple can spoil the whole basket, the result also illustrates that a certain degree of taxpayers' "impressionability" may be conducive to a relatively high degree of compliance, even in the event of modest levels of auditing.

Despite the risk of increasing the number of parameters, the flexibility of agent-based methodology facilitates great sophistication in the depiction of many realistic features of taxpayers and of the data available to the fiscal authority. Bloomquist (2006) provides a good introduction to the field. He describes the Tax Compliance Simulator where audit efficacy and celerity, together with a host of other parameters, can be changed to test overall compliance and the success of specific auditing schemes with regard to both direct and indirect effects (due to additional revenues from fines and greater compliance of other "forewarned" taxpayers, respectively). Bloomquist (2011) builds on some of the previous ideas to present a situated agent-based model with 85,000 agents who are calibrated using realistic anonymized public data from the US Internal Revenue Service.

At the other extreme, a number of recent papers in the econophysics literature simplify relationships between agents and present terse models of interaction based essentially on the Ising model of ferromagnetism. In Zaklan, Westerhoff, and Stauffer (2009), 1,000,000 agents with "spin" are in contact on a grid; they are subject to local interactions and, possibly, social forces (due to mass media or cultural biases, say). As is typical of similar models, there are critical thresholds of the model's parameters that trigger phase changes. In Pickhardt and Seibold's (2011) recent paper, it is shown that Ising-like models can to some extent reproduce situations in which different types of taxpayer are present.

This paper presents a model with heterogeneous agents who maximize their individual utility based on (after-tax) income and the conjectured level of per capita public expenditure. Agents have different levels of risk aversion, a distinct relative preference for public expenditure, varying confidence in the likelihood that others will pay the amounts due and an innate attitude to comply, which can be associated with cultural traits, social constraints or shame. Hence, their final decisions rest on micro-founded rational behavior, personal characteristics and subjective judgements. The enforcement system, based on random inspections, is only partially known to agents. These agents establish noisy estimates of the auditing probability by meeting other taxpayers and exchanging information about income. In each period, an individual can optimally conceal a certain amount of income based on conjectures about the perceived probability of being audited, the perceived level of public expenditure and the perceived amount of tax paid by other individuals.

We contribute to the literature in two main ways. Firstly, we formally include psychological drivers in the model that affect individual behavior. Some parameters, broadly related to "trust" and tax morale, capture the appreciation of public expenditure and the natural inclination to comply. The combination of the previous ingredients with the expectation that peers will reciprocate appears to be related to "good citizenship", a quality that helps agents to fulfill their civic duties. Hence, our work suggests ways to link conceptual dimensions to specific personal parameters[3] and shows how to combine them to make a citizenship index. Secondly, we use simulated data drawn from a variety of "societies" to estimate a compliance slippery slope and then discuss how individual micro-motives aggregate in a variety of social macro-behaviors. Such a link is commonly drawn in agent-based approaches but, as far as we know, this is the first time a full-fledged slippery slope has been

[3] In some sense, our agent-based model departs considerably from the econophysics paradigm, in which agents are electrons with +1 or −1 spins and have virtually no interiority, to allow for a good deal of nuanced peculiarities to emerge at the individual level.

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