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Predictive analytics and the targeting of audits[☆]

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ABSTRACT

The literature on audit strategies has focused on random audits or on audits conditioned only on income declaration. In contrast, tax authorities employ the tools of predictive analytics to identify taxpayers for audit, with a range of variables used for conditioning. The paper explores the compliance and revenue consequences of the use of predictive analytics in an agent-based model that draws upon a behavioral approach to tax compliance. The taxpayers in the model form subjective beliefs about the probability of audit from social interaction, and are guided by a social custom that is developed from meeting other taxpayers. The belief and social custom feed into the occupational choice between employment and two forms of self-employment. It is shown that the use of predictive analytics yields a significant increase in revenue over a random audit strategy.

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1. Introduction

The standard analysis of tax compliance in Allingham and Sandmo (1972) and Yitzhaki (1974), and much of the literature that has followed, is based on the assumption that taxpayers abide by the axioms of expected utility theory and that audits are random. An exception is the literature on optimal auditing – including Reinganum and Wilde (1985, 1986) and Chander and Wilde (1998) – which characterizes the equilibrium audit strategy as a function of reported income. In practice, the overwhelming majority of audits performed by tax authorities are “risk-based” (in which taxpayers are targeted for audit), with only a small fraction of audits performed on a random basis for statistical purposes. Unlike the presumption of the optimal auditing literature, however, the targeting of risk-based audits is not based solely on the income report. Rather, tax authorities rely on the experience of case officers reviewing returns and, increasingly, on the basis of predictive analytics which applies statistical tools to the data on a set of taxpayers’ characteristics, often in the form of qualitative variables (see Cleary, 2011; Hsu et al., 2015). The expected utility model has also been subject to significant criticism and many alternative models with behavioral foundations have been proposed.

The paper explores the compliance and revenue consequences of the use of predictive analytics in an agent-based model that draws upon a behavioral approach to tax compliance. We use agent-based modelling because this allows us to explore a richer model than is possible in a theoretical analysis but means we rely on simulation to generate our results. The model

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is constructed on the foundation of a social network that governs the interaction between taxpayers and the transmission of information between taxpayers. The information consists of attitudes towards compliance (in the form of a social custom) and beliefs about audits (a subjective probability of being audited). Taxpayers must make an occupational choice between employment and two forms of self-employment. Employment provides a safe income but, because of the third-party reporting of income, there is no possibility of non-compliance. The two self-employment occupations are risky, but non-compliance is possible. Risk averse taxpayers allocate into the occupations so as to maximize expected utility given the expected income and riskiness of each occupation. Given the different levels of risk in the occupations, taxpayers divide among occupations on the basis of risk aversion. This results in self-selection of those who will exploit opportunities for non-compliance into occupations where such opportunities arise.

The predictive analytics investigated in the model are based on Tobit and logit regression models using data from tax returns and from the outcomes of past audits. The Tobit model targets audits on the basis of predicted evasion level and the logit model on the basis of predicted likelihood of non-compliance. The predictive analytics are implemented by simulating the model with random audits for an initial period to acquire audit data, and then using this data to target audits where non-compliance is predicted. It is shown that predictive analytics secure a significant increase in revenue over a random audit strategy.

To give the results validity it is necessary to build the agent-based model on a sound underlying theory of the compliance decision. Our modelling starts from the assumption that taxpayers do not know the audit strategy of the tax authority but must form a belief about the probability of being audited. This is consistent with the idea of behavioral economics that individuals generally do not evaluate risky prospects using the objective probabilities of events but form subjective probabilities (or transform objective probabilities using a weighting function). The subjective probabilities (or, in our terminology, *beliefs*) can differ significantly, and persistently, from the objective probability (Kahneman and Tversky, 1979). There is also empirical (Spicer and Lundstedt, 1976) and experimental (Baldry, 1986) evidence that the individual compliance decision also takes into account social factors such as the perceived extent of evasion in the population. We choose to summarize the range of social factors as the *attitude* of the taxpayer toward compliance. This is essentially identical to the concept of *tax morale* that is prominent in the empirical literature (e.g., Torgler, 2002).

A key feature of our modelling is to make explicit the processes through which the attitude towards compliance and the belief about auditing are formed. Attitudes and beliefs are endogenous and result from the interaction of a taxpayer with other taxpayers and with the tax authority. The importance of interaction makes it necessary to specify the social environment in which it takes place. We do this by employing a social network with a given set of links between taxpayers to govern the flow of information. After each round of audits some of the taxpayers who are linked will meet and exchange information. The likelihood of information transmission is greater between taxpayers in the same occupation.

The paper is structured as follows. Section 2 describes the separate concepts that are built into the model. Section 3 provides analytical details on how these concepts are implemented. Sections 4 and 5 describe the simulation results under a random audit rule and when the audit rule is informed by predictive analytics. Section 6 concludes.

2. Conceptual approach

This section describes the elements that constitute the agent-based model. The purpose of the discussion is to relate these elements to the extensive literature on the individual tax compliance decision. The seminal analyses of the compliance decision by Allingham and Sandmo (1972) and Yitzhaki (1974) are built upon the application of expected utility theory. A standard criticism of this model is that it over-predicts the extent of evasion when evaluated using the objective probability of audit which has motivated the application of ideas from behavioral economics.¹ The behavioral models of the compliance decision are surveyed in Hashimzade et al. (2013).

An important element of our agent-based model is that taxpayers make an *occupational choice* decision prior to the compliance decision. The compliance decision is based on the attitude toward compliance as summarized in a *social custom* and belief about audits captured in a *subjective probability* of being audited. The information used to form attitudes and beliefs is transmitted through meetings between taxpayers governed by a *social network*. Each of these components is now described in greater detail.

2.1. Occupational choice

Occupational choice determines the possibility for engaging in tax evasion. Income from employment is often subject to a withholding tax and/or third-party reporting to the tax authority. For example, the UK Pay-As-You-Earn system involves income tax being deducted by employers and remitted directly to the tax authority. This prevents evasion by employees (unless there is collusion with the employer) and so non-compliance is only possible for taxpayers who are self-employed. Occupations also differ in their traditions concerning payment in cash. Those in which cash payment is common provide the greater opportunity for evasion. Occupational choice has not had a prominent role in the literature on tax evasion despite its clear importance. Exceptions to this are Pestieau and Possen (1981) who model occupational choice, Cowell (1981), Isachsen

¹ It should be noted that Slemrod (2007) gives good reasons why this claim should be treated with caution.

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