Agents that Collude to Evade Taxes

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ABSTRACT

We explore the link between micro-level motivations leading to and being influenced by macro-level outcomes to study the complex issue of tax evasion. If it is obvious why there is a benefit for people who evade taxes, it is less obvious why people would pay any taxes at all, given the small probability of being caught, and the small penalties involved. We use exploratory simulation and progressively deepening models of agents and simulations to study the reasons behind tax evasion. We have unveiled some relatively simple social mechanisms that can explain the compliance numbers observed in real economies. We claim that simulation with multiple agents provides a strong methodological tool with which to support the design of public policies.

1. INTRODUCTION

Tax evasion is a serious economical problem that only recently has started to receive scientific attention [6, 1]. Tax evasion creates in the individual person an idea of social unfairness that can only invite more evasion. Especially in developing countries, the idea of tax evasion, together with the notion of widespread corruption lead to social disturbance, and undermine both individual and group motivation towards better social mechanisms and fairer societies. People have the generalised idea that it is individually compensating to evade taxes, as penalties are low, and the probability of being caught rather small. And in fact this idea is supported by the models that most theories of tax evasion endorse. In such models, tax payers are represented by agents whose utilitarian rationality would inevitably lead to free-riding and evasion. However, the real picture is quite different. People pay far more than utilitarian theories predict.

Our claim is that multi-agent systems (MAS) provide a more effective approach to the study of tax compliance. The main reason behind this belief is that we can consider individual agents endowed with appropriate motivational models to provide an empirically rooted account of their decisions, whereas in traditional economical models the focus is on general laws that can be used to describe the behaviour of any agent. People are different from one another, and from their own motivations and decisions together with the interactions they engage in, a rich and complex macro behaviour emerges. Such macro-level phenomena then influence individual decisions, as much as individual decisions build up the overall behaviour.

Multi-agent-based simulations (MABS) can explore the space of individual mental models, agent interactions and societal mechanisms and provide a deep understanding of the problem that can be used to predict future behaviours of the social system. With such strong explanatory power, policies to reduce evasion can be designed and rehearsed before deploying them in the real world.

In this paper, we present the application of the e*plore methodology to conduct social simulations to study the tax compliance problem. We introduce indirect taxes, which call for even more complex socialisation abilities, since in a transaction all agents must agree about whether to evade.

2. THE EC* MODEL SERIES

In a recent research project, we have used the e*plore methodology to propose the exploration of the tax compliance problem through a series of models. This series of models aims at transversing the space of possible designs by progressively removing simplistic assumptions and criticisms posed to the original model $Ec_0$, which represents the standard economics account of the problem [1, 7].

This strategic exploration of the experiment design space uses a set of techniques and their combinations to evolve models from simpler models, in such a way as to progressively deepen the designs (of agents, of societies, even of experiments) starting from broad but shallow, to finally build up theory from this exploration of models. These techniques include: refining, tiling, adding up, choosing, enlarging, etc.

So, we successively introduced new models with specific characteristics, either at the micro (individual) or at the macro (societal) levels, with some reasons, conjectures or intuitions. $Ec_2$ introduced expanded history in the individual decision; $Ec_3$ proposed agent individuality, whereas $Ec_2$ postulated individual adaptivity; $Ec_5$ introduced sociality, it is the first model where the individual decision depends
on a social perception; $Ec^*_2$ explored one particular type of interaction, imitation; and finally $Ec^*_3$ postulated social heterogeneity, different agent breeds in a conflictual relation. Other models are still being shaped, such as $Ec^*_a$ a model where perception is limited to a $k$-sized neighbourhood.

3. RESULTS OF SIMULATIONS
Along the series of simulations we have run [3, 5], we could unveil some features and mechanisms that can contribute to explain the numbers found in empirical studies.

Memory
In model $Ec^*_2$, we introduced memory effect: agents caught evading would no longer pay only the fine and the due tax, they would also remember for some time that they had been caught. So, when facing a new decision to pay or evade taxes, the agent would take into account the recent past.

History
In $Ec^*_3$, when the central tax authority would find an agent evading there would be no sense in acting only on the present year. It would surely investigate the recent past, to uncover other possible evasions. The probabilistic calculations the agents in $Ec^*_0$ use to decide change substantially, but the points in which individual decision changes are not dramatically different.

Imitation
In $Ec^*_4$, resilient agents would follow their tendency to pay their due taxes independently of the financial inconvenience or utility calculations. Other agents would imitate the behaviours of agents they meet. With such a simple social mechanism (which has deeply rooted psychological support) we could dramatically increase the compliance numbers.

Autonomous Inspectors
We further removed some of the classic criticisms to the standard approach in $Ec^*_4$, by introducing different breeds of agents, one for tax payers, another for tax inspectors. Each inspector autonomously decides whether to perform an audit to a given agent or not. The inspector makes this decision by taking into account his/her personal constraints and expectations about the tax to be collected from the given individual. So, audits are no longer determined by a probability, the probability of being audited is no longer independent of the past or of the other agents being audited, the cost of an audit is not irrelevant anymore, and there is now a limit (a budget for the tax authority and for each inspector) for the number of possible audits.

4. DIRECT VS. INDIRECT TAXES
So far we have only considered direct taxes, which incide over the income of the agent. In our strategy of increasingly considering more complex scenarios, these taxes were the easiest to approach. The decision to comply or evade is entirely up to the individual agent. But with indirect taxes inciding over transactions, the panorama changes completely.

Now, to perform a tax evasion episode, the agent must find an adequate partner who explicitly agrees to this decision. As a consequence, the whole society gets much more complex. Starting from the individual, we have to consider which individual motivation leads to evasion. If this is obvious for the buyer, since he/she will pay less by evading taxes, it is less obvious why the seller would agree. This leads to the need of considering a complex tax structure involving all the participants in the society: the seller also gains from evasion since the evasion episode will necessarily be made outside his/her accounting records, so resulting in a lower revenue, which in turn would subject to direct taxes. Every participant gains, except of course the tax authority. So, in our models, we need not only direct taxes over the individual agents (income taxes) but also over the agents that perform sales (revenue taxes).

This more complex picture of tax evasion implies drastic modifications to our models. Agents have to decide whether to try to evade or not, and after this they have to decide whether to propose evasion to the other party or not. It could be the case that the other agent is a stubborn complier, or even if he is an evader, he would not be available to evade in this particular episode. Another possibility is that the agent is available to take the chance of evading given that enough money is at stake. But this would imply that our agents should have some sense (or reference) about absolute money quantities, which recognisably is a hard endeavour to take on. Or, it could even be the case that he gets offended with the proposal and reports it to the tax authorities. This is a complex world of possibilities and risk.

A Canonical Transaction Model
As before, we opted for taking on the simplest possible model and building up from it. We consider only indirect taxes. Agents live and move in a simulated grid world. Each time they meet they have a chance for a transaction. They decide whether or not to engage into this transaction. If both parties agree to the transaction, they have to decide whether to propose to evade the due taxes. An agent can opt for doing this or not, and the other agent can freely decide to accept or decline the offer. According to their decisions they proceed with the transactions, pay or not their taxes, money changes hands and they get on with their lives. In accordance with the “broad but shallow principle,” most of the quantities involved are constant. The ones that are not are the following: (i) $\rho \in [0, 1]$ represents the propensity to evade tax. An agent rolls a dice and opts for evasion if the number is less than $\rho$; and (ii) $\varphi \in [0, 1]$ represents the individual probability that a transaction occurs.

These very simple mechanisms are a poor substitute for the real motivations involved in such complex decisions. However, at this stage we are interested in getting to know the mechanisms and dynamics of the society that results from such simple-minded agents. Later we can deepen these mechanisms while maintaining control over the simulation.

In a given encounter between two agents, we can easily calculate the probabilities with which transactions or conclusions to evade taxes take place. However, we are more interested in observing the overall measures that different transaction designs lead to.

There are no inputs of money except for the initial amount available in the population. The simulation runs until there are no longer agents capable of performing a transaction, or a certain number of cycles is reached. By that time, most of the money has been collected to the central authority as

1 We thank Tarek el Sehity for pointing this out to us.
5. ANALYSIS OF RESULTS

We have programmed these models in NetLogo 3.0. The first experiments were used to debug, tune up and refine the several components of the system, as well as guide the construction of the models.

The use of e*plore methodology involves a series of techniques that introduce variations in the models of agents, of societies and of experiments, in order to completely travel through the space of possible designs, while gaining insights into the complex problems at hand. These variations start off from simple mechanisms in broad but shallow designs, and proceed by progressive deepening of those mechanisms. The measures we took from these experiments deal with the number of the active agents in the society and the number of collisions to evade taxes. Since there are no injections of capital, the society has no long term sustentability. We could see this happening in all the experiments we run, with strategies a. to e. The differences in duration of the society in terms of active agents have only to do with the pace with which the encounters promote more or less transactions.

Note that to take averages over series of experiments yields some sort of equalisation phenomenon between experiments with different strategies. Each simulation shows its own path and behaviour, according to the series of initial parameters and random events that determine its course. However, when we aggregate these individual measures over a series of runs, these differences get blurred, and the different strategies display seemingly similar figures.

The difference between the measures taken over runs of several strategies does not correspond to the difference between typical runs of the simulations. This is a strong argument to not consider aggregate measures but instead to proceed by progressive deepening of those mechanisms. The measures we took from these experiments deal with the number of the active agents in the society and the number of collisions to evade taxes. Since there are no injections of capital, the society has no long term sustentability. We could see this happening in all the experiments we run, with strategies a. to e. The differences in duration of the society in terms of active agents have only to do with the pace with which the encounters promote more or less transactions.

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