Central European Journal of Economic Modelling and Econometrics

Risk Perception and Risk Attitude on a Tax Evasion Context

Nuno Trindade Magessi*, Luis Antunes†

Submitted: 5.02.2014, Accepted: 30.07.2015

Abstract

When considering tax reporting, taxpayers have an individual attitude towards the risk of being caught evading taxes by the tax authorities. This attitude is interdependent with how this inherent risk is perceived. We propose to analyse this phenomenon through a risk perspective by adding a risk attitude and corresponding perceived probability of being caught evading. In this paper, we study the dynamics of tax evasion under risk perception and attitude, and the consequent propensity of imitators to evade or to comply. Under this proposal, we conduct our experiments through a multi-agent based simulation. Simulation results suggest first that the risk attitude, in conjunction with perceived risk and its consequences are the main reasons to guarantee a low level of tax evasion. Secondly, results also demonstrate a non-linear impact of tax rate, investment interest rate and fines which is especially interesting and non-intuitive.

Keywords: tax evasion, risk attitude, risk perception, multi-agent-based simulation

JEL Classification: H26, H30

*Universidade de Lisboa; e-mail: nmaggessi@hotmail.com
†Universidade de Lisboa; e-mail: xarax@ciencias.ulisboa.pt

1 Introduction

Risk perception is a preponderant concept in what concerns tax evasion. The decision of a taxpayer on evading taxes is preceded by its perception of the risk he or she will incur. Unfortunately, many times the risk and its perception are neglected in the literature. Taxpayers have an intrinsic position about risk, commonly called as risk aversion (Bernasconi, 1998). In this article, we propose to introduce taxpayer's risk relation and their perception of being caught by tax authorities. For that purpose, we adopt a multi-agent based exploratory simulation stance, to analyse the concepts associated with this phenomenon. The challenge is to understand how different perceptions of risk and risk attitude in conjunction with other variables influence the decision of complying or not. Given that, there seem to exist a self-constraint built in the taxpayers' minds, when they present aversion on inherent risk. Behind social motivations affecting individual decisions, taxpayers make judgements about what is going to happen if they evade taxes. One of these judgements concerns their subjective probability of being caught by tax authorities. As a consequence, we formulate new hypotheses and conjectures, providing new insights into the tax evasion problem.

The main issue of this article is to endow the agent involved in tax evasion analyse with a risk perspective, with heterogeneous views of perception and aversion, hence providing a more realistic picture of the taxpayers true thoughts. The idea is not to improve on the agents' prediction capabilities, which would be a difficult endeavour because of the complexity involved in autonomous agents, but also to get sharper insights into a hard and complex this problem. These insights, conjectures and hypotheses add to this issue's knowledge, and help to find new strategies to be taken by policy makers, either at global level or at individual level.

This article is structured as follows: in the next section, we review the state of the art in terms of modelling tax evasion problem. On section 3, we describe the model contemplating perception and risk aversion. Section 4, presents the model results. Finally, on section 5, we draw our conclusions, comparing our results with other studies and we introduce future steps for this research.

2 Reviewing literature about tax evasion

Tax evasion remounts back to the models proposed by Allingham and Sandmo (1972), or by Srinivasan (1973) and sustains upon neoclassical economic theory. The model suits the work done by Becker (1968) about economic crime. According to this model, a taxpayer chooses what amount of his income he might conceal from tax authorities hoping not to be caught. This model was liable to numerous reviewers since it predicts a much higher amount of tax evasion than what is really observed. For instance, the audit likelihood together with the observed level of penalties is extremely low so the expected consequence is tax evasion. Actually, this is not what truly happens (Alm *et*

al., 1992). Therefore, corroborating these developments, the research of the last two decades could be seen as a series of endeavours to expand the known neoclassical model concerning tax compliance, which has been undertaken by individual choice of agents (Levi, 1988). The eighties decade was fruitful on these cases. Numerous contributions were considered in which extensions of the basic model were done allowing nonlinear tax schedules differential taxation of labour and capital home, the effects of inflation or endogenous income. Works from Cowell (Cowell, 1987) and Fishburn (Fishburn, 1981) or Koskela (Koskela, 1983) and Sandmo (Sandmo, 1981) among others are good examples of these extensions. The role of tax authorities was also discussed. Tax authorities are low active to dissuade tax evasion (Polinski and Stavell, 1984). The probability of auditing and the magnitude of the fines are not sufficient to dissuade taxpayers from tax evasion, given the social welfare function.

The interaction between tax authority and the taxpayer was explored from a game theoretical approach. Studies from Corchon (Corchon, 1984) and Greenberg (Greenberg, 1984) or Reinganum and Wilde (Reinganum and Wilde, 1986) and Telser (Telser, 1987) are very elucidative of the dynamics of the game. The analyses of Greenberg are extensible to many types of behaviours as it was confirmed by Reinganum and Wilde. Reinganum and Wide have focus on separating equilibrium while Corchon and Telser have a simple framework to emphasize the fact that perhaps there is no equilibrium in pure games for such games.

Numerous studies have concentrated the core of their research in measuring and justify the ethics and moral of economic agents (Prinz, 2010). They described morale as a kind of implicit motivation like a predisposition to pay taxes (Braithwaite and Ahmed, 2005). Such researches continue to emerge, attempting to illustrate tax morale as a surrogate to the stated tolerance of tax evasion. For that purpose, researchers subdued the phenomena into a dependent variable belonging to a multiple set of regression models. In order to obtain input data for their models, they typically design a survey to collect the data they want. The acquired effects are usually uncertain, setting connections among tax morals, socio demographic and ideological variables (Braithwaite and Ahmed, 2005).

After all these developments, researchers began to notice that standard economic methodology was insufficient to expose the "incomprehensible social atrocity" which is tax evasion (Kirchler, 2007). The last decades have been productive in number of studies that seek to grasp tax evasion from cognitive to social measurements (Beckmann, 2014), with incurrences on regulation (Berger, 2014). Essentially, two different methodologies were tried out: experimental methodology in terms of economic behaviour, and brain science (Weber *et al.*, 2014). Econometrics and psychometrics were used to analyse information aiming at carrying out predictions (Leicester et al, 2012).

More recently, a niche of studies started to use agent based models to recreate tax evasion at an aggregate level. Those studies have uncovered tax evasion, not just confined to a level of prevention but also including other substantial impacts

and dimensions, such as social interdependency. Early attempts were identified on (Mittone and Patelli, 2000), (Davis et al.2003) and the Tax Compliance Simulator – TCS model of (Bloomquist, 2004). TCS model is the indictment of the previous ones, since it includes agents composed by a large number of attributes and becoming more elaborate with respect to the calculus of the audit rate. The advantageous edge is to encompass the frame between the model outcomes and effective data.

A few years ago, the EC* model series (Antunes *et al.*, 2006; Balsa *et al.*, 2006), was built incrementally, with new features being sequentially added to the standard economic model. Authors brought the concept of imitation as one possible behaviour for agents. They also verified that under certain conditions, the ethical attitude of taxpayers is more important to compliance than the perception they have about tax system. The contribution of these series is the inclusion of inspectors with autonomy in terms of decision-making. They moreover claim that evasion of indirect taxes necessarily implies a collusion of interests between purchasers and sellers.

Some years later, and allowed by the social network boom, Networked Agent-Based Compliance – NACSM model (Korobow *et al.*, 2007) tested the effect of social structure, as made up of a set of agents, inside a tax compliance behaviour. The authors used the Moore neighbourhood structure, where each taxpayer has neighbours who affect his choices and decisions. A similar approach was recommended by Zaklan et al.(2009), whose eccentricity was to adjust the ISING physical model to tax research, substituting the particles that interact in distinct paths relying on the temperature, by agents. In this case, taxpayers' behaviour depends from other taxpayers' behaviour on their neighbourhood.

On the other hand, the TAXSIM model of Szabó *et al.* (2008), incorporates four sorts of agents, complemented with some innovative factors like the degree of satisfaction with public services, as was described as one of main reasons to not comply. This degree depends from previous experiences of each agent, aided by the interference of his social network.

More recently, Bloomquist (2011) addressed tax compliance for small business and interpreted as an evolutionary coordination game. He calibrated the model with real data from behavioural experiments. Additionally, Quesada et al, (2012) used a different algorithm based on four different decisional mechanisms: expected utility maximization, social network structure, decisional heuristics, heterogeneity of tax motivations and morale.

Social simulation generates positive expectations about the future knowledge of this phenomenon, independent of existent literature. The biggest problem of other methodologies seems to be the incapacity to integrate all the dimensions involved in tax evasion.

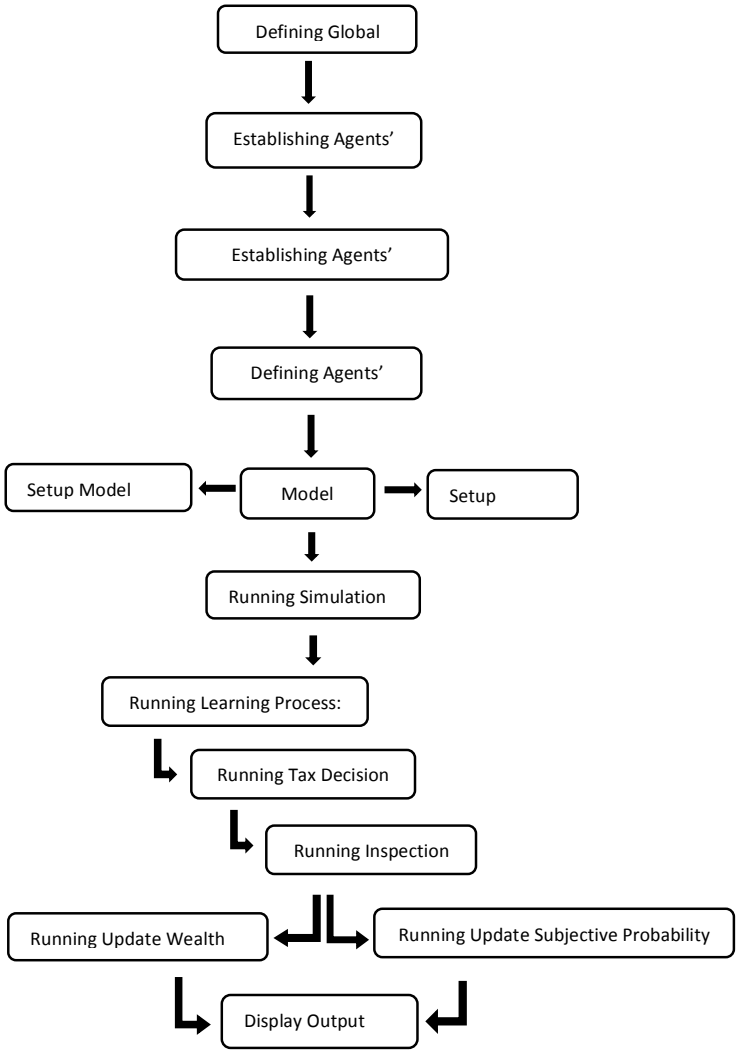
3 Multi-agents model

Our hypothesis is our multi-agent simulation system has the versatility necessary to conduct the experiments focused on tax evasion in what concerns to risk. Heterogeneity and individuality are key characteristics that enforce this methodology in carrying on challenging experiments, defying dogmas and making new discoveries. Before starting to explore our simulation, it is important to underline that we use a simple model, which fits the classical literature about tax evasion. However, it is also important to stress out that our model is not a game theoretical approach and consequently, we are not interested in finding the conditions for reaching some kind of equilibrium. We are more interested about the dynamics of risk attitude and perceived risk in tax evasion. First, we will start by a simple approach, with the intent of securing the stability of this simple model. After this guarantee, we introduce complexity and increment our model, like Hassan *et al.* (2009). The increments of complexity focus on agent autonomy and decision rules, based on risk attitude and perceived risk. Instead of using the risk aversion concept, we preferred to use what we call risk attitude, because risk aversion is a concept that makes sense only associated to the utility function concept. We do not consider utility since, in reality, individuals do not decide based on a utility function Simon (1955). For that reason, we assume that taxpayers are interested in maximizing the value of their wealth. Under this assumption, risk attitude is the predisposition of an agent to take some risk on a future event. In our model, we postulate a new parameter to represent the risk attitude of an agent. We do this with the objective to allow evolution that could lead us to more realistic results. This risk attitude is summarized in a function. If an agent has a high predisposition for risk, he or she will have a distribution mean near 1 for risk attitude and is called a risk-demander. If an agent has a low predisposition for risk, he or she will have 0 or close to it as the mean of distribution. This type of agent is designated as risk-fearful. Consequently, no one is indifferent to risk. Our argument is: if an agent is indifferent to risk, it means that he or she will not be affected by that risk and does not provide any reaction. So there is no risk neutral agent as it is defined by utilitarian literature. This assumption goes to meet reality, where individuals react to any risk they will face. In other words, if an individual is indifferent to a risk situation, it means that according to his perception the risk will not affect him. Meanwhile and in terms of perception we simplified the concept. Risk perception is expressed through the subjective probability of being audit by tax authorities. Nevertheless, we recognise that perception is more complex and requires a deeper specification.

Our starting point was the EC* series (Antunes et al, 2006) and its aggregate perspective; see figure 1. However, even if we start from these models, our target was to enrich the simulator. We do this by adding new variables to illustrate the risk dimension and integrating different categories of agents, each agent category with its own set of motivations and decision procedures. So, we propose to aggregate variables for tax authority and adjust variables specifically for each agent type. We

end up with a description of how interactions among agents can determine risks on their behaviours. Risks are spread by taxpayers, possibly altering the dynamic of interactions.

Figure 1: Agent Based Model



3.1 Taxpayer

Taxpayers are agents that have to choose between (i) taking a risk of being caught by reporting a false income and investing the unreported income at an interest rate β; and (ii) avoiding the risk of being caught, by reporting the true income and losing the extra income generated the invested money. In this model, each taxpayer regularly receives an income of y. From y, the taxpayer can omit z, where $z < y$ and report $x = y - z$. The reported income is subject to a tax rate t. Taxpayers will then pay every year a tax amount of tx or ty, depending on whether or not they hide their income. In general, the tax may not be linear and could be $t(x)$. Unreported income of each taxpayer depends from its own risk attitude and maximum percentage of unreported income in society. Therefore z is obtained by multiplying risk attitude by the income and the percentage of unreported income. Maximum percentage of unreported income is given by λ which follows a gamma distribution as it was described by Salem and Mount (1974). They compared the gamma distribution with a lognormal distribution and concluded that the gamma distribution has a better fit than the lognormal distribution, in terms of collected data. We used in our model the gamma distribution, available inside the software package. The mean of gamma distribution is the expected maximum unreported income percentage in function of gross domestic product per capita. The described variance is the variance of the expected maximum unreported income. Both values are parameters of the model reflecting shape and scale. This results in a value of $\alpha\lambda y$ for unreported income of singular agent. If the taxpayer is caught evading, he will pay the taxes relative to the evaded amount plus a fine θ, plus the taxes related to reported income. This means that a cheater taxpayer has to pay in total $tx+tz+\theta$. Of course, we acknowledge that in some countries the fine is not fixed and varies with yields ranges. But we maintain the fines as fixed amount. Taxpayers have a subjective probability ϕ about being inspected. Consequently, taxpayers think they can gain $z(1+\beta)$ with probability $(1-\phi)$ from unreported money, or loose $tz+\theta$, with probability ϕ.

The income regularly received by taxpayers has two magnitudes: maximum income and minimum income. We use these values to establish the limits of income for tax brackets. Income is generated randomly following a lognormal distribution, from the interval of these values like Clementi and Gallegati (2005) defended. They show that the empirical income distribution is consistent with a two-parameter lognormal and Pareto functions To fit reality, standard deviation of this distribution is equal to the number of echelons of income taxes, which assists us to generate the probabilistic density function among income. Typically, the income distribution is skewed towards higher incomes and justifies our assumption for income.

In all experiments we consider grouped parameters. Some are inherent to the agents, helping us to distinguish the different existing types. There are two types of parameters on this model: they can represent values that are transversal to all agent's (e.g.: tax rate) or values that the individual agent's do not know at all (e.g. real probability of being inspected).

Taxpayers are divided into three categories: risk-fearful agents, risk-demanders and imitators. As it was described earlier, in this model we assume a risk attitude concept, which is the agents predisposition for risk and it is given by a function. Agents have more or less predisposition to risk depending of their fear or greed, and how and how risk experiences had occurred in the past. The risk attitude is generated randomly and by a logarithm function for agents who fear risk and exponential function for agents who demand risk. The argument for using different functions is the fact that individuals predisposition to the risk is different as they recognise the risk event. In terms of subjective probability of being inspected, the case is different and we assume that it follows a normal distribution, since an agent have tendency to have more or less the same pattern of reasoning inside the group he or she belongs to. Taxpayers who are risk-demander and have a high risk attitude perceives a low probability of being audited. So, the mean of distribution is low but the variance is high for this group of taxpayers. On the contrary, taxpayers who have high fear to the risk and has low risk attitude perceived a high probability of being audited. Consequently, the mean is high and variance is small, for this other group of taxpayers. The risk attitude is generated randomly for imitators. Imitators decide to evade, first if the gains of cheating tax authorities are greater than losses and second when they are influenced by the risk attitude of their neighbourhood.
As it was described earlier taxpayers have the objective of maximizing their wealth. In this case, the decision algorithm for evasion is based on a threshold, composed by the supposed risk that each type of taxpayers face. It is given by the multiplication of subjective probability and the sum of the taxes comprised in unreported income with fines. Basically, taxpayers compare the gains obtained by evasion and the incurred risk. In this sense, if the gains obtain by evasion are lower than the expected, taxpayers will not practice tax evasion. If the inverse situation occurs taxpayers will prefer to evade taxes. Taxpayer wealth will or won't reflect the obtained gain depending of taxpayer decision.

3.2 Tax authority

The tax authority is the agent that has the incumbency of enforcing compliance. According to Alm *et al.* (1992), if taxpayers are going to maximise their utility function, it is expectable that rational agents would have no reason whatsoever to comply. So, tax authority uses audits and penalties to enforce tax compliance. In this model, taxpayers have the objective to maximise the value of their wealth, taking into account the risk of being inspected by tax authorities. They have the option of evading or complying in order to achieve their target. Associated to those risks, we assume that a taxpayer is audited with a real probability p and if he/she is caught, his true income y will be discovered.
Some assumptions are necessary to make the model work. For example, audits are determined by a probability over every return filed. Notice that even if probabilities may be convenient a posteriori, describing the returns examined, no tax agency will

exclusively roll dices to decide which return to audit. The probability of an agent being audited is independent of the past. This is unrealistic, since the tax agency will choose to always audit a taxpayer if he has a history of evasion. By auditing the returns, the tax authority will know the true value of income: y. Even nowadays, tax agencies cross all sorts of data from taxpayers in order to verify if they have a hidden income.
Another assumption is to assume a dependency of a taxpayer probability of being audited, from other probabilities. There is a limit for the number of audits to be carried out, which depends on their own costs. More frequently, tax authorities have a budget that determines the maximum number of audits to be performed. On the other hand, taxpayers perform costly efforts to avoid audits. And this impacts the probability of an evader being caught. The tax authority decision rule to audit a taxpayer is based on probability p and is not known by the taxpayers. This is also realistic, as most tax agencies indeed make enormous efforts to keep those rules secret. In a case of a taxpayer being caught, taxpayer wealth will be adjusted by the missing taxes and the resulting penalty.

3.3 Interactions

The model has the intent of simulating a society at an aggregated level. Arising from this, there are two different types of interaction: (1) interaction among the distinct types of taxpayers and (2) the interaction between taxpayers and tax authority. On the first case, we refer to the imitation process and on the second case we refer to the cheating and inspection process. Basically, in terms of imitation, imitators have the option to copy one of the types of taxpayers: taxpayers who fear risk and where we assume they will learn with these agents' experiences or taxpayers who are risk-demanders by looking for an opportunity to increase their wealth. In this sense, the imitation process has underlying process of implicit learning. A learning which depends from the risk attitude faced by each imitator on his neighborhood. A taxpayer will be moving in society, interacting with other taxpayers that will arise. Society is represented by a group of patches, where taxpayers can interact. Patches are the spaces given by coordinates where agents can move. So a patch defines the concept of neighborhood, which means that when two or more taxpayers are within a patch, then they are considered as neighbors.
Nevertheless, we could add another criteria, making the model more complicated and moving away from the scope of this article. In terms of cheating tax authorities, the process occurs if taxpayers decide to evade (based on their risk attitude, perceived risk and confronting it with gains and losses) and if tax authority catches those cheaters, through inspection. Implicitly, agents learn about phenomena, through imitation. This means that when taxpayers interact, some acquire information that others shared about what happened to them, influencing their own predisposition to the risk and their subjective probability of being audited. In the other words, we have a spread of agents' judgments.

4 Simulation results

The output results reported in this section were obtained by conducting experiments in NetLogo framework (Wilensky, 1999). NetLogo is a programmable modelling environment for simulating natural and social phenomena. It is particularly well suited for modelling complex systems and developing them over time.
At this stage of research, we are interested on the role of risk attitude and perceived risk by imitators in tax evasion. The model is flexible to get new insights, taking into account how the several variables influence the system dynamics. So, in this section we will only share relevant results for this article, and present a brief analysis.
We began by simulating results through a combination of parameters, which for us revealed the common reality of a society; see table 1. To set the combination of these parameters we have based on a survey that was launched into a sample of 122 individuals, post-graduate students with some work experience. The survey had the goal to catch the groups behind tax evasion under risk context and select the parameters with the correspondent behaviour.

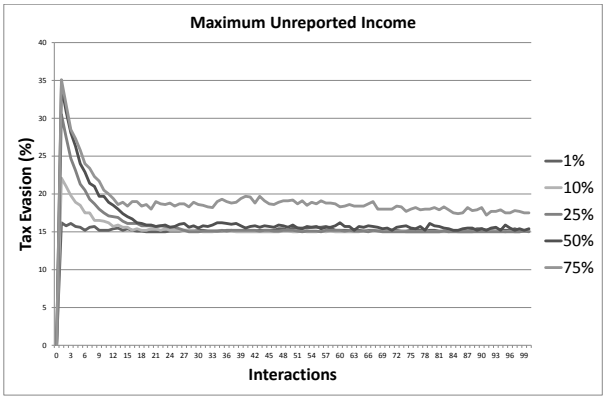
Table 1: Parameters used in the model

Parameter	Unit	Lower limit	Upper limit
Maximum income	€	40,000	80,000
Minimum income	€	0	7,000
Maximum unreported income	%	0	100
Unreported income variance	%	0	100
Tax rate	%	0	100
Audit probability	%	0	100
Fine	€	0	15,000
Interest rate	%	0	100
Number of agents	#	0	1,000

The chosen status quo could be different, since the model has sufficient flexibility to incorporate other society scenarios, combined by other values of parameters. So, our society is composed by a majority of risk fearful representing 60% of taxpayers. Risk-demanders represent 15% of society and imitators represent the remaining 25%. The society of our model is like Portuguese society and it is characterised by an average tax rate of 25% and a fixed fine with a limit of Ú15K. The probability of being inspected rounds 15% and the maximum unreported income in function of gross domestic product is 20%, like it was defended by Cebula and Feige (2011). The investment interest rate faced by taxpayers is in average 7% and the maximum income is the triple of the minimum income.
Following the social structure described above, we did some variations on the model parameters, starting by varying the average percentage of maximum unreported income. The parameter influences the fear of risk since in tax evasion the estimated

percentage of unreported income gives an idea to taxpayers about the dimension of the risk. As we can see in figure 2, as the maximum unreported income increases, tax evasion increases automatically in the first interaction. Then tax evasion decreases to more or less 15%, which is the percentage of risk-demanders in society. These results reveal that at the beginning, the majority of imitators start to evade taxes by copying the behaviour of risk-demanders. However, after the first run, in which some evaders are caught, imitators begin to become more fearful and therefore they start to imitate the behaviour of the risk-fearful.
However, the case is different when the unreported income in society is in average 75% or more. In these cases, tax evasion assumes a value of 17.5%. These results demonstrate that at the beginning, imitators follow the risk-demanders but then they decide to follow risk-fearful. This happens because imitators interact with some risk-demanders who were audited and caught; see figures 2 and 3.

Figure 2: Impact of maximum unreported income parameter variation on tax evasion



Instead, the variance occurred in percentage of unreported income in society does not cause significant changes in the tendency of tax evasion. Variance has an impact similar to the average percentage of unreported income. In the sense that imitators after the first runs adopt the behaviour of taxpayers who have aversion to the inherent risk of tax evasion. When imitators interact with taxpayers who were caught they prefer not to evade taxes; see figures 4 and 5.
However, the variance of unreported income has less influence than average percentage itself. This means that taxpayers are not sensitive to changes in unreported income variance of society.
After analysing the effect of unreported income parameter, we analysed the impact of

Figure 3: Impact of maximum unreported income parameter variation on tax evasion – detailed

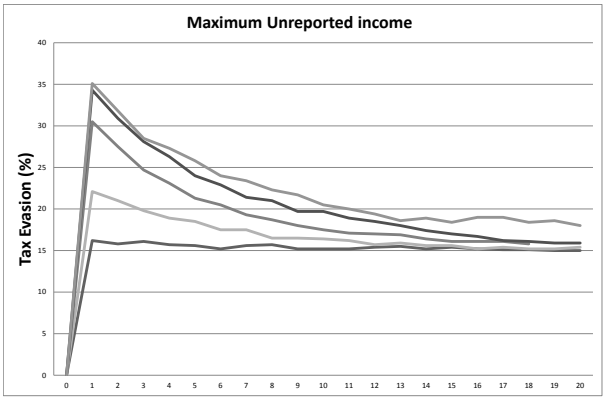
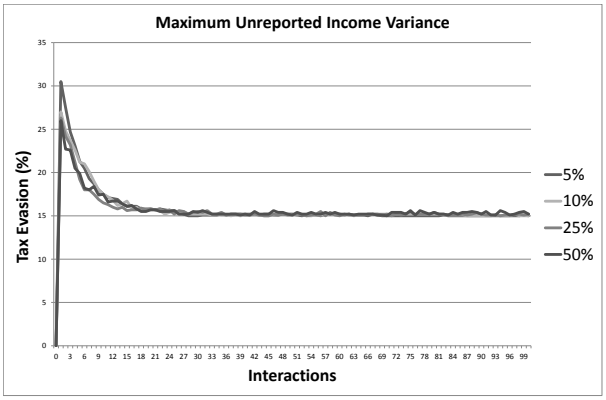
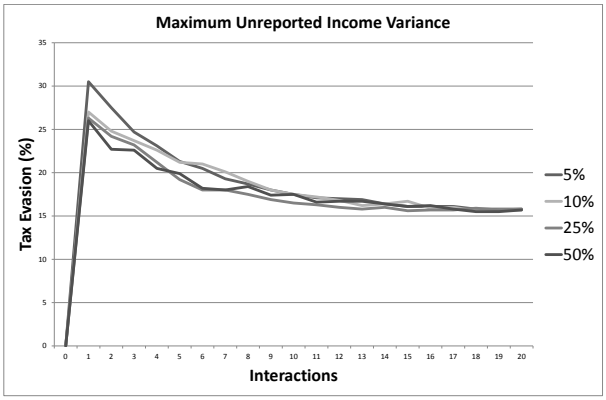


Figure 4: Impact of variations of maximum unreported income variance on tax evasion



changes in the subjective probability of taxpayers in being audit-ed. As we can see on figure 4, the subjective probability has the same course as the unreported income in tax evasion. That is, tax evasion decreases after several interactions between agents. Meanwhile, when tax evasion assumes values around 15% the subjective probability of being audited is high, above 75%. Nevertheless, if we compare the level of tax

Figure 5: Impact of variations of maximum unreported income variance on tax evasion – detailed



evasion in this case with the case provoked by unreported income, we can verify that subjective probability generates more tax evasion than the average unreported income in society. This result expresses the preponderance of subjective probability in relation to the average unreported income in society. Taxpayers are more sensitive to their perception about being audited than to the extent of unreported income in society. The higher is the subjective probability of being audited, the lower is the level of tax evasion in society; see figures 6 and 7.

On the other hand, changes on the variance of the subjective probability do not change the tax evasion level in society; see figures 8 and 9.

Besides of risk attitude and subjective probability, risk is also given by the consequences on taxpayers wealth, if they are caught not complying it. So if taxpayers decide to face the risk associated to tax evasion they may incur in penalties. It makes sense to analyse this risk component. We cannot forget that when a taxpayer is caught, he will eventually interact with other taxpayers and may share that information with them. Thus, the penalties incurred by a taxpayer may affect the attitude towards risk, (and the subjective probability of being audited) of other taxpayers. After we simulated variations on the amount of penalties, we realised that the lower the amount of penalties practiced by tax authorities, the greater the level of tax evasion on society. Penalties have a different impact on tax evasion level in society. Imitators start by copying the behaviour of risk-demanders and then change their preference by imitating the behaviour of risk-fearful. However, imitators turn back on their preferences and start to evade taxes again. The level of tax evasion ends by growing asymptotically to a level of 40%. Clearly we are in front of a non-

Figure 6: Impact of subjective probability variation on tax evasion

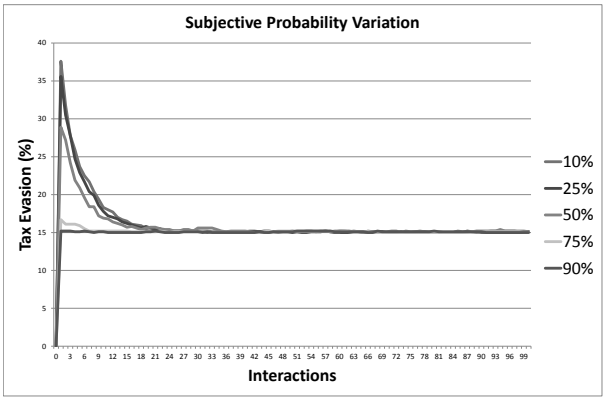
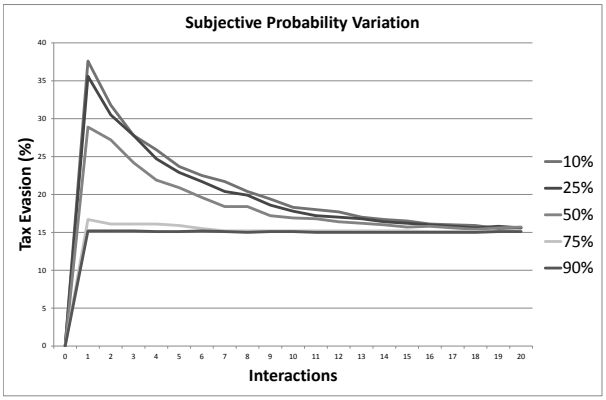


Figure 7: Impact of subjective probability variation on tax evasion – detailed



monotonous function where the consequences of risk has no linear impact on tax evasion. This means that imitators after some twists and turns prefer to follow part of risk-demanders, since it is more beneficial to them; see figures 10 and 11.
On other side, tax rates are intrinsically included on the risk of tax evasion, because taxpayers try to avoid them. Simulations done on the average tax rate practiced in this society demonstrated that tax evasion level is similar to the impact generated by

Figure 8: Impact of variations of the subjective probability variance on tax evasion

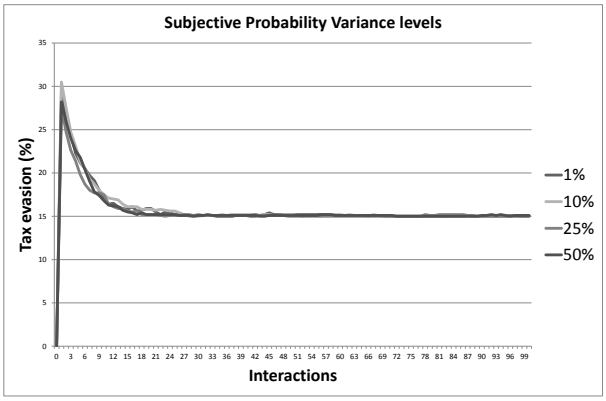
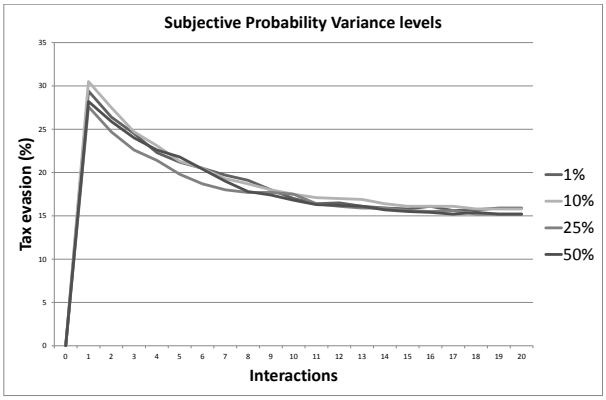


Figure 9: Impact of variations of the subjective probability variance on tax evasion – detailed



variations on unreported income and on subjective probability; see figures 12 and 13. This means that imitators started by evading taxes by following risk-demanders, then they opted to imitate risk-fearful and start to comply, except when the average tax rate in society is extremely high. For example, when tax rates are high in society, around 50%, imitators react negatively and start to evade, increasing the level of tax

Figure 10: Impact of changes in fines on tax evasion

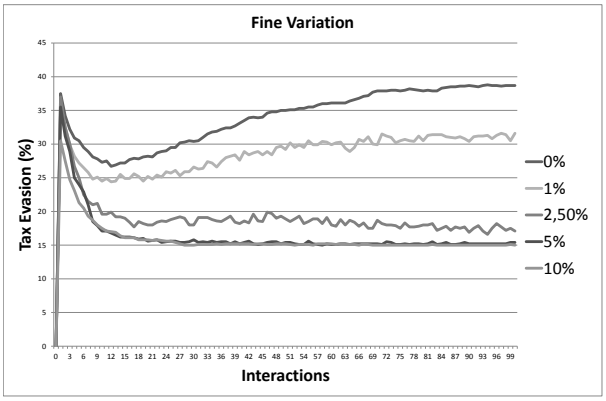
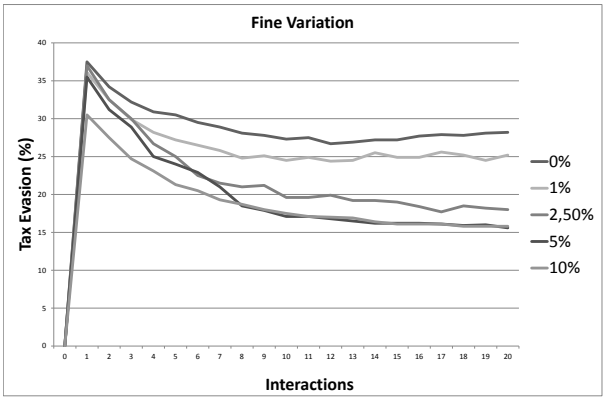


Figure 11: Impact of changes in fines on tax evasion – detailed



evasion in society. It reveals as fines, that an impact of an increase in tax rate could have a sharply non-linear relation with tax evasion. There is some evidence that the implicit function is non-monotonous, generating a sensation of implicit limits for the impacts. This is a different behaviour from other simulations that we have done.
Finally, it is important to analyse the tax evasion level when we change interest rates. Evaluating the impact of interest rates is important, since taxpayers could invest the

Figure 12: Impact of tax rate variations on tax evasion level

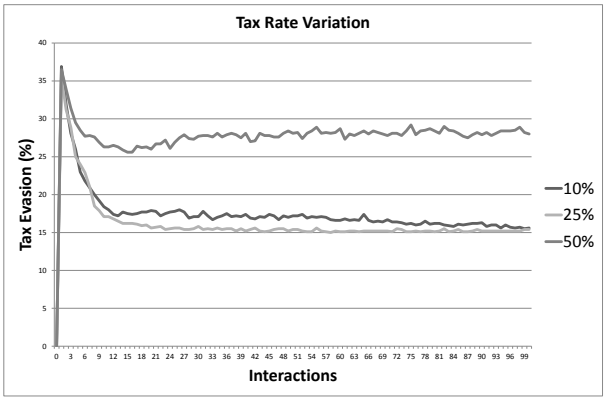
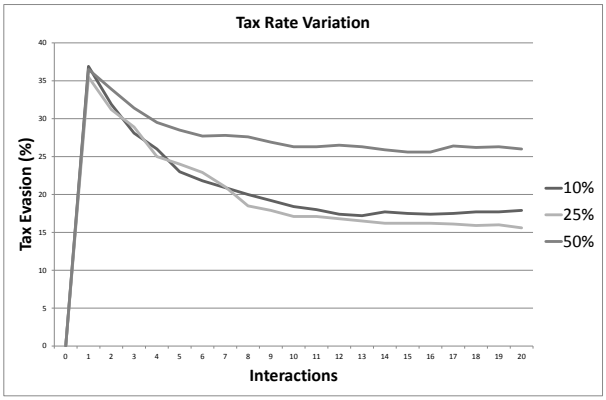


Figure 13: Impact of tax rate variations on tax evasion level – detailed



money that has not been declared. As we can see, tax evasion level increases as the interest rates become higher. However the impact of interest rates on tax evasion has a limit, around 25%; see figures 14 and 15.

Another appointment is to verify that interest rates above 25% have a similar impact that it has an interest rate of 25%. So, imitators start by imitating the risk-demanders, looking to take advantage of the benefits that this investment interest rate can provide

Figure 14: Impact of variations of interest rates on tax evasion

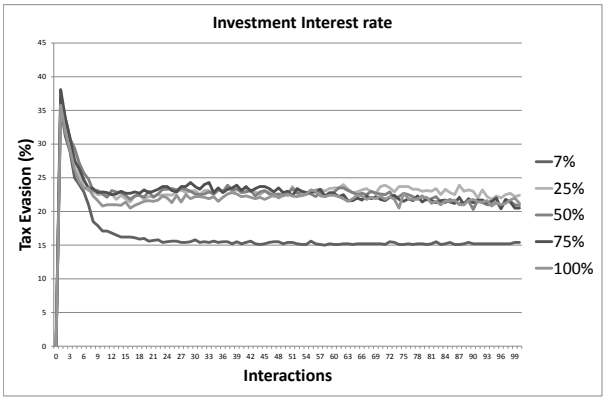
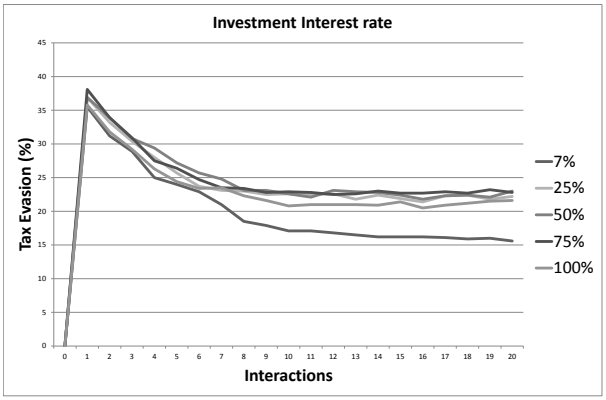


Figure 15: Impact of variations of interest rates on tax evasion – detailed



to taxpayers on increasing the value of their wealth. Then, imitators decide to follow the agents who fear risk as the best procedure to adopt. This happens because agents perceived that the risk inherent to the tax leakage is higher than the expected benefit. However, if the interest rate is low, like 7%, some imitators do not see advantages in doing evasion for these values and they prefer to comply by reporting the right income. So they follow the perspective of risk-fearful agents. If the interest rate

grows to 25% or above, it is more attractive to evade taxes, since it is more profitable. The consequence of this is to imitate the behaviour of risk demanders, since the risk of being caught by the tax authority is compensated by the value obtained by the unreported income invested.

The components of risk, such as fines, generate a different impact on tax evasion level in society, when compared with the effective audit rate or the current average tax rate. While interest rate, audit rate or average tax rate provoke different decisions during the multiple interactions, fines are more incisive when they grow. Fines are more sensitive than other parameters related to gains and losses. These results are in line with what Allingham and Sandmo's (1972) claimed. Penalties control the level of tax evasion. Instead, the subjective probability of being audited and caught by an inspection, symbolising the perception of risk, induces taxpayers to imitate risk-fearful agents after the second interaction. This is the scenario for getting lower levels of tax evasion. There is a correlation between subjective probability and unreported income.

Bernasconi (1998) stated that different orders of risk aversion are the main cause for the low levels of tax evasion. In fact, our results do not corroborate this perspective in full. It is true that a decrease on risk attitude or an increase in risk aversion contribute to a reduction of tax evasion in society. Nevertheless, the perceived risk is more powerful in decreasing the level of tax evasion, because taxpayers react faster and in a concise form to the increments on the perceived probability. This finding has some logic, because risk attitude is determined by the taxpayers' fear of being punished by tax authorities and hence pay additional money. So, risk attitude is interrelated with the magnitude of penalties. Meanwhile, the perceived risk comes from the intrinsic judgement of taxpayers about being audit, which can change tax decision. If a taxpayer perceive a lower probability of being audit, the fear of risk becomes less important.

Risk attitude is a necessary but not sufficient condition to explain the low levels of tax evasion in society. This happens because of two main reasons. First, society is normally composed by more risk-fearful taxpayers than risk demanders, revealing a high level of risk aversion in society. Normally people presents some fear about uncertain situations. Kahneman and Tversky (1979) or Christopoulos *et al.* (2009). Second, the consequences of taking this type of risk, such as having to pay penalties, may be compensated by the benefits provided by unreported income. This is the typical situation, when unreported income is invested at a high interest rate. Independently of the level of risk aversion or the fines, taxpayers prefer to follow the risk-demanders' procedures instead of the ones of risk-fearful. The only condition that has the capacity to modify this preference is the perceived risk given by subjective probability. The other reason that explains the relevance of the perceived probability to avoid the proliferation of tax evasion is the fact that taxpayers make their decisions by weighting the advantages and disadvantages of evading taxes. Kahneman and Tversky (1979).

5 Conclusion and future work

In this article, we incorporated a risk attitude and the perception of risk on the tax evasion phenomenon. Individuals face risky events and take their decisions based on many attributes, among which we have included their own risk attitude and also perception of risk. Our experiments demonstrate that the risk perception of taxpayers, given by the subjective probability of being caught, is more preponderant than other parameters in decreasing tax evasion. This result reveals more preponderance of taxpayers' perception than the consequences of risk itself. Another important achievement is the fact that the impact of tax rate is non-linear on tax evasion. Such impact seems to present a non-monotonous behaviour. The same conclusion could be extrapolated to the impact of fines and investment tax rate, apparently in a more smoothly form. It indicates us the fact that all these parameters have limits for their impact and taxpayers are sensitive to these limits.
Our future steps are to extend this model by deepening the risk perception and associated dimensions. We intend to make risk perception and unreported income dependent on the risk attitude. Another important addition will be to integrate more agent types in the model, namely to include and study the role of accountants, lawyers and banks on the tax evasion phenomena, having in mind a key distinction between tax evasion and tax avoidance.

References

[1] Allingham M.G. and Sandmo A. (1972), Income tax evasion: a theoretical analysis, *Journal of Public Economics* 1, 323–338.

[2] Alm J., McClelland G. H., Schulze W. D., (1992), Why do people pay taxes? *Journal of Public Economics* 48, 21–48.

[3] Bernasconi M., (1998), Tax evasion and orders of risk aversion, *Journal of Public Economics* 67, 123–134.

[4] Antunes L., Balsa J., Moniz L., Urbano P. and Palma C.R. (2006), Tax compliance in a simulated heterogeneous multi-agent society, [in:] *Multi-agent-based Simulation 2005*, [eds.:] Sichman J. S. and Antunes L., LNCS (LNAI), vol. 3891, Springer, Heidelberg.

[5] Balsa J., Antunes L., Respício A. and Coelho H. (2006), Autonomous inspectors in tax compliance simulation, [in:] *Proceedings of the 18th European Meeting on Cybernetics and Systems Research.*

[6] Berger M. (2014), Not so safe haven: reducing tax evasion by regulating correspondent banks operating in the United States, *Journal of International Business and Law* 12, Art. 5.

[7] Becker G. (1968), Crime and Punishment: An Economic Approach, *The Journal of Political Economy* 76, 169–217.

[8] Beckmann K. and Gattke S. (2014), Tax evasion and cognitive dissonance, *Working paper series*, Helmut Schmidt Universität Hamburg, Department of Economics, Fächergruppe Volkswirtschaftslehre, No. 142, April 2014.

[9] Bloomquist K. M. (2004), Modeling taxpayers' response to compliance improvement alternatives, *presented at* the Annual Conference of the North American Association for Computational Social and Organizational Science (NAACSOS), Pittsburgh, PA.

[10] Bloomquist K. (2011), Tax Compliance as an Evolutionary Coordination Game: An Agent-Based Approach, *Public Finance Review* 39, 25.

[11] Braithwaite V. and Ahmed E. (2005), A threat to tax morale: The case of Australian higher education policy, *Journal of Economic Psychology* 26, no. 4.

[12] Christopoulos G.I., Tobler P.N., Bossaerts P., Dolan R.J. and Schultz W. (2009). Neural Correlates of Value, Risk, and Risk Aversion Contributing to Decision Making under Risk, *Neuroscience* 26 (24), 6469–6472.

[13] Clementi F., and Gallegati M. (2005), Pareto's law of income distribution: Evidence for Germany, the United Kingdom, and the United States, arXiv.org, Quantitative Finance Papers physics/0504217. `http://ideas.repec.org/p/arx/papers/physics-0504217.html`

[14] Corchon L. (1984), *A Note on Tax Evasion and the Theory of Games*, Mimeo, Madrid.

[15] Cowell F. (1987), The Economics of Tax Evasion, [in:] *Surveys in the Economics of Uncertainty*, [eds.:] in John D. Hey and Lambert P., Basil Blackwell.

[16] Davis J. S., Hecht G., Perkins J. D. (2003), Social behaviours, enforcement and tax compliance dynamics, *Accounting Review* 78, 39–69.

[17] Feige E., Cebula R. (2011), America's unreported economy: measuring the size, growth and determinants of income tax evasion in the U.S., *MPRA Paper*, 34781, University Library of Munich, Germany.

[18] Hassan S., Antunes L. and Arroyo M. (2009), Deepening the Demographic Mechanisms in a Data-Driven Social Simulation of Moral Values Evolution, [in:] *Multi-Agent Based Simulation IX, International Workshop, MABS 2008*, Springer, 167–182.

[19] Kahneman D., Tversky A. (1979), Prospect Theory: An Analysis of Decision under Risk, *Econometrica* 47 (2): 263–292.

[20] Kirchler E. (2007), *The Economic Psychology of Tax Behavior*, Cambridge University Press, Cambridge.

[21] Korobow A., Johnson C. and Axtell R. (2007), An Agent Based Model of Tax Compliance with Social Networks, *National Tax Journal*, LX (3), 589–610.

[22] Koskela E., (1983), A note on progression, penalty schemes and tax evasion, *Journal of Public Economics* 22, 127–133.

[23] Leicester A., Levell P. and Rasul I. (2012), Tax and benefit policy: insights from behavioural economics, *The Institute for Fiscal Studies* ISBN: 978-1-903274-91-0.

[24] Levi M. (1988), *Of Rule and Revenue*, The University of California Press, Berkeley.

[25] Mittone L. and Patelli P. (2000), Imitative behavior in tax evasion, [in:] *Economic simulations in swarm: Agent-based modelling and object oriented programming*, [eds.:] Stefansson B. and Luna F., Kluwer, Amsterdam, 133–158.

[26] Prinz A. (2010), A Moral Theory of Tax Evasion, *Working Paper*, University of Munster.

[27] Quesada F., Noguera J., Llàcer T. and Tapia E. (2012), Exploring tax Compliance: An Agent Based Simulation, [in:] *26th European Conference on Modelling and Simulation ECMS*, [eds.:] Troitzsch K. G., Möhring M. and Lotzmann U.

[28] Salem A., Mount T. (1974), A Convenient Descriptive Model of Income Distribution: The Gamma Density, *Econometrica* 42, issue 6, 1115–1127.

[29] Simon H. (1955), A behavioral model of rational choice, *Quarterly Journal of Economics* 69, 99–118.

[30] Srinivasan T.N., (1973), Tax evasion: A model, *Journal of Public Economics* 2, 339–346.

[31] Szabó A., Gulyás L. and Tóth I. J. (2008), TAXSIM Agent Based Tax Evasion Simulator, [in:] *5th European Social Simulation Association Conference (ESSA 2008)*.

[32] Weber T., Foken J. and Herrmann B. (2014), Behavioural Economics and Taxation, *Taxation Papers, Official Publications of the European Communities*, European Union 2014 doi:10.2778/32009.

[33] Wilensky U. (1999), NetLogo, `http://ccl.northwestern.edu/netlogo/`. Center for Connected Learning and Computer-Based Modeling, Northwestern University, Evanston, IL.

[34] Zaklan G., Westerhoff F. and Stauffer D. (2009), Analysing tax evasion dynamics via the Ising model, *Journal of Economic Interaction and Coordination* 4, 1–14.