TAX COMPLIANCE, RATIONAL CHOICE, AND SOCIAL INFLUENCE: AN AGENT-BASED MODEL

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Abstract

The study of tax behaviour is a research field which attracts increasing interest from different social and behavioural sciences. Rational choice models have been traditionally used to account for that behaviour, but they face the puzzle of explaining levels of observed tax compliance which are much higher than expected. A number of social influence mechanisms have been proposed in order to tackle this problem. In this article we discuss the interdisciplinary literature on this topic, and we claim that agent-based models are a promising tool in order to test theories and hypothesis in this field. To illustrate that claim, we present SIMULFIS, an agent-based model for the simulation of tax evasion and tax compliance that takes into account different opportunities to evade, and allows to combine rational choice with social influence mechanisms in order to generate aggregated patterns of tax behaviour. We present and discuss the results of a simple virtual experiment in order to show the potentialities of the model.

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Introduction

Social scientists have traditionally offered two broad kinds of explanation for norm compliance: sociologists and sociological theorists have tended to rely on different socialization and internalization mechanisms in order to account for normative conformity, and they have considered the failure of those processes as the main cause of observed deviation rates (Parsons, 1951; Schütz, 1964; Habermas, 1981; Bourdieu, 1980). Economists, on their part, have relied on deterrence theories: rational individuals are expected to comply with norms when the expected utility of compliance is higher than that of non-compliance; therefore the probability and intensity of sanctions and punishments for deviants are key factors to explain the observed levels of norm conformity (Becker, 1968; Baird et al 1994; Katz 1998; Posner 1998). As an economist and sociologist, a classical thinker such as Max Weber was aware of this dual nature of compliance: on the one side, he acknowledged that individuals often act according to norms when it is in their interest to do so, and try to avoid compliance if it is not; but, on the other side, he often noted that normative reasons have their own logic, independent from plain self-interest, and that norms are not always followed in a purely instrumental fashion. Beyond social and economic theorists, a variety of subfields in the social sciences have empirically analyzed the determinant factors of compliance: criminology and the sociology of law, as well as the sociological, psychological and economic study of social norms, moral ideas and practices, or cooperation and altruism, have all provided powerful insights and evidence on these matters. In recent decades, the complexity and diversity of the explanatory factors behind norm compliance has been also incorporated into a research field which is increasingly calling social scientists’ attention: tax compliance and tax evasion.

Tax evasion, usually defined as the voluntary reduction of the tax burden by illegal means (Elffers et al., 1987), is a problem of huge social relevance at present times. This is so, first, because tax evasion reduces the volume of resources available for the public sector. Second, since tax evasion behaviour is not equally distributed among taxpayers, it violates the principles of fairness, equality, and progressivity that the tax system ought to satisfy (IEF 2004, Murphy and Nagel, 2002). Those problems are more pressing in countries that face a high level of fiscal fraud in absolute and relative terms. Besides, reducing tax evasion allows to increase public resources without need to raise tax rates. This is especially interesting when one looks at the difficulties that governments face today in order to achieve public budget equilibrium and fund welfare programs.

Academic researchers who aim to understand the dynamics of tax evasion and tax compliance are increasingly acknowledging the need to include psychological, social, and cultural factors in their explanatory models. Traditional explanations based on deterrence were too often linked to the strict assumptions of rational choice theory

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1 We will take the expressions “tax evasion” and “tax fraud” as equivalent for our purposes, though they might have slightly different meanings in part of the literature on tax compliance.

2 Murphy (2011 and 2012) estimates that the shadow economy in the European Union equals to 22.1% of its GDP (data for 2009). The tax revenue lost represents a 7.04% of EU’s global GDP, which equals to 139.3% of the public deficit of all EU’s countries in 2010.
and the *homo oeconomicus* model (Allingham & Sandmo, 1972). Instead, recent studies focus, for example, on taxpayers’ *tax morale* (their tolerance towards tax fraud), social norms, social interaction effects, ethical values, fairness perceptions, knowledge of the tax system, or attitudes towards government and public expenditure (Alm, 2012; Alm et al., 2012; Braithwaite and Wenzel, 2008; Hofmann et al., 2008; Kirchler, 2007; Kirchler et al, 2010; Meder et al., 2012; Torgler, 2007, 2008).

As a result of all these contributions, a number of key behavioural and sociological questions have emerged in the literature on tax compliance, which go beyond the more traditional ones related with the detection and estimation of the size of tax evasion. For example: Is rational choice theory enough to explain estimated levels of tax compliance? Do taxpayers’ fairness concerns help to explain those levels? What is the effect of social influence on tax behaviour? Can we study tax evasion as an isolated individual behaviour, or are there social interaction effects behind it? It seems clear that those questions have considerable sociological interest, since the dynamics of norm compliance and deviation has always been one of the main objects of study for sociologists. Social interactions and attitudes are likely to become, in addition to purely economic ones, central concerns for all researchers involved in the study of tax compliance in the years to come.

In this article we present and describe an agent-based model designed to help to answer those questions: SIMULFIS. Our main aim is not to show the empirical fit of the model’s results with a particular case or a sample of cases (see Llàcer et al. 2013 for an application to the Spanish case), but, departing from empirically plausible initial conditions and specifications, to explore the logic of different mechanisms which may interact to produce tax behaviour, specifically rational choice and social influence (although we also partially explore the operation of fairness concerns). We will proceed as follows: first we will briefly consider rational choice explanations of tax compliance and their limitations. Second, we will discuss how social influence may enter into a field traditionally dominated by the rational choice approach, and how it may help to introduce more realism in explanatory models of tax behaviour. Third, we will focus on some attempts to build agent-based models in this field. Fourth, we will describe our model by summarizing its main features and their operation. Finally, we will present and discuss the results of a virtual experiment in order to show how SIMULFIS may help to explore the dynamics of different mechanisms of tax compliance.

**The problem of tax compliance**

The first economic model of tax evasion was presented four decades ago by Allingham and Sandmo (1972), soon followed by Srinivasan (1973). Those neoclassical economic models adapted Gary Becker’s ‘economics of crime’ to the study of tax behaviour (Becker, 1968). The aim was to explain deviant behaviour (in this case, tax evasion) as rational choice: each taxpayer decides how much of her income she declares as a function of the benefits of concealing it (given a tax rate and an individual’s income...
level) and the costs of being caught (given a probability of being audited and the amount of the fine).

Usual criticisms of rational choice theory stress its unrealistic assumptions (Boudon, 2009; Elster, 2007:24-26; Hedström, 2005: 60-66): rational individuals form their preferences and take their decisions in an isolated way, with perfect information, known levels of risk aversion, and perfect capacity to estimate expected utilities. However, in the case of tax compliance it is perhaps more acceptable than in other contexts to assume that taxpayers will generally try to estimate and approximate expected utilities of different compliance levels, and often they are assisted by professional lawyers and economists to do so. The problems of rational choice explanations of tax compliance have had more to do with the inaccuracy of their empirical predictions. In fact, the most frequent criticism against the rational choice approach in this field is that it predicts a much more higher level of tax evasion than usually observed or estimated: since audit probabilities and the amount of fines are low in the real world, most taxpayers should rationally evade most of their income, but they actually do not (Andreoni et al., 1998; Bergman and Nevárez, 2005, p. 11; Torgler, 2008, p. 1249). In order to explain observed levels of compliance in most countries, one would have to assume an unrealistic level of risk aversion among taxpayers.

The reason why a rational agent should always evade, and evade as much as he can, is intuitively easy to grasp: since in most countries the audit rates are relatively low, the corresponding low probability of being caught makes it rational to underreport income. Fines would have to be implausibly high in order to make evasion more costly than compliance (Bergman and Nevárez, 2005). Of course, this picture should be nuanced in real world conditions, since audits are not entirely random, and tax authorities often give priority to investigate those taxpayers who have been caught evading in the past. This would mean that a rational agent would have to adjust the expected utility of evasion if he has been caught once, but still the audit probability could be low (even if higher than the average), and of course all taxpayers would always cheat until they are caught once, which is not the case at all. In the same way, if tax rates are very low, the benefit of evading might decrease in comparison with that of paying, but still the rates needed to make compliance a generalized optimal strategy would be implausibly low. Besides, it has been also observed that countries with similar levels of tax enforcement and tax fraud deterrence have very different levels of tax evasion (Bergman and Nevárez, 2005). This fact seems to suggest that other factors different from deterrence and surveillance may strongly affect the behaviour of taxpayers.

One possible explanation of high tax compliance is opportunity-based: most taxpayers are waged employees whose income is automatically reported to the tax authorities by their employers and taxed in the source, so their opportunity to underreport is low or null. Opportunities to evade are indeed important, and we believe that explanatory models of tax fraud should take them into account. However, even wage-earners may have some chances to evade, since getting income from other sources than salaries, participating in the shadow economy, or receiving part of the wage
through channels hidden to the tax authorities, are also extended options in our economic systems.\(^3\)

As a result of the abovementioned problems, research on tax evasion in the last two decades has broadened the traditional neoclassical economic model in order to explain an action (tax compliance) which in many cases appears to be ‘quasi-voluntary’ (Levi, 1988). Among these attempts a remarkable role is played by survey studies which try to measure and explain citizens’ tax morale, understood as an ‘intrinsic motivation’ or ‘internalised willingness’ to pay taxes (Braithwaite & Ahmed, 2005; Torgler, 2007). Such studies seek to explain tax morale by taking declared tolerance towards tax evasion as a proxy, and including it as the dependent variable in regression models. Even though the results are often inconclusive, they give interesting information about some statistical correlations between tax morale and different socio-demographical variables (age, gender, marital status, educational level, or income level), as well as ideological or attitudinal variables (such as religious beliefs, patriotism, or trust in institutions; see useful overviews in Torgler, 2007 and Torgler, 2008).\(^4\) Besides tax morale, factors such as social norms, social influence, fairness concerns, and perceptions of the distributive outcomes of the tax system are increasingly considered as likely determinants of tax compliance (Alm et al, 2012; Braithwaite and Wenzel, 2008; Hofmann et al, 2008; Kirchler, 2007; Kirchler et al, 2010; Meder et al, 2012). All these contributions suggest that the standard economic approach alone is not able to account for a complex social phenomenon such as tax evasion.

Social influence and tax compliance

The mechanisms of social influence

Rational choice models of economic behaviour often ignore that agents do not make economic decisions in a social void, but in the context of a variety of social perceptions and interactions. Specifically, traditional rational choice models of tax compliance have conceived taxpayers as socially isolated decision-makers who are only concerned with deterrence. However, ‘economic’ conduct is also ‘social’, at least in the sense that “the probability of an individual performing a given act depends upon how many others have already performed it” (Hedström and Ibarra, 2010, p. 315).

There are many mechanisms that may create social interaction effects in contexts such as taxpaying behaviour: social norms (social pressure to conform to a given rule of ‘adequate’ or ‘correct’ taxpaying conduct); social contagion or conformity (spontaneous

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\(^3\) Another possible explanation of high compliance levels would be that taxpayers strongly overestimate the odds of being audited. This could be the case for some of them, but again we would have to assume a very unrealistic and systematic bias in people’s beliefs in order to explain observed levels of compliance.

\(^4\) In some countries like Spain there are periodical surveys focused on tax attitudes such as the “Public opinion and tax policy” survey (CIS) and the “Spanish Tax Attitudes and Opinions” survey (IEF), whose data are available for exploitation and analysis. Some works following the tax morale approach have relied on those databases (Alm and Torgler, 2006; Alm and Gómez, 2008; Alarcón, De Pablos and Garre, 2009; María-Dolores, Alarcón and Garre, 2010; Prieto, Sanzo and Suárez, 2006).
convergence to an observed average tax behaviour); strategic interaction (if tax revenue is used to create public goods that benefit everyone, taxpayers may be playing a strategic collective action game or dilemma); rational imitation (under conditions of uncertainty regarding the probability of being audited and caught for tax evasion, adjusting to your neighbours’ level of tax compliance may be a reasonable strategy); learning (if agents can see how others do, they can learn from them and adjust their tax compliance in order to do better themselves); or fairness effects (if agents feel unequally or unfairly treated in comparison with others, they will modify their tax compliance accordingly).

The academic literature on ‘social influence’ processes has not always been clear in adequately distinguishing all these mechanisms, and has used very different terms to designate them (besides ‘social influence’, one may find expressions such as ‘social contagion’, ‘social impact’, ‘social interactions’, ‘fads’, ‘behavioural cascades’, ‘group effects’, ‘bandwagon effects’, ‘social imitation’, ‘social pressure’, ‘social proof’, ‘social conformity’, ‘social multiplier’, and other similar ones). This is in part a consequence of the fact that social influence has been studied independently by different disciplines, mainly by social psychology (see Cialdini & Goldstein, 2004 for a useful review) and sociology (Aberg & Hedström, 2011; Bruch and Mare, 2006; Centola and Macy, 2007; Granovetter, 1973; Manzo, 2013; Rolfe, 2009; Salganik and Watts, 2009; Watts and Dodds, 2009), although in recent decades some economists have also analyzed and modelled it (Becker, 1974; Durlauf, 2001 and 2006; Durlauf and Ioannides, 2010; Glaeser et al., 2003; Manski, 1993a, 1993b, and 2000; Young, 2009).

As a result of this disciplinary dispersion, a systematic taxonomy of mechanisms by which group behaviour has an effect on individual one is still missing, and processes of very different nature are often merged under the label of ‘social influence’ or other similar ones. For example, rational interaction mechanisms such as rational imitation, rational learning, and strategic interaction in social dilemmas often go hand in hand with non-rational ones such as normative social pressure, spontaneous conformity to the observed group behaviour, or fairness concerns. Similarly, there are different ‘social influence’ mechanisms as to what kind of choices they induce in the influenced individuals: while rational imitation, normative social pressure, or social conformity typically lead agents to converge to the average or the most frequent behaviour in the group, generating a pattern of ‘social contagion’, strategic interaction and fairness effects may often lead individuals to make different choices than their neighbours or peers (because they may have incentives to deviate from the equilibrium, or they feel that the group’s behaviour contradicts fairness principles), and learning may lead to contagious behaviour many times, but individuals may also learn from their peers’ failures or suboptimal choices how not to behave (see Figure 1).

In this paper we will be mainly concerned with those mechanisms of social influence that typically lead to the social contagion of a given behaviour. In this sense, assuming that agents affected by those mechanisms will converge to the average behaviour seems the most advisable way of modelling this pattern (Nordblom and Zamac, 2012; Balestrino, 2010). Similarly, Latané’s (1981) theory of social impact states that all else being equal, an agent will tend to conform to the majority’s behaviour
and attitudes in their group. ‘Social proof’ or ‘social validation’ theory (Cialdini and Trost, 1998, p. 171) claims that people tend to view a behaviour as correct to the extent they see others performing it, because they spontaneously use the observed actions of their peers as a standard. Social psychologists have also noted the difference between this informational conformity (the knowledge of others behaviour spontaneously leads an individual to conform to it) and normative social pressure (typically associated with the enforcement of social and moral norms through feelings such as shame or guilt; see Cialdini and Goldstein, 2004, or Deutsch and Gerard, 1955).

Figure 1

*Group effects on individual behaviour*

The economic literature prefers to speak of ‘social interaction’ effects, and distinguishes them from ‘correlated effects’, that is, from those patterns of social convergence that result from the fact that individuals share similar social properties or opportunity structures in the first place, so a similar action pattern may be generated from isolated decisions without need of social interaction (Manski, 2000). As noted by Manzo (2013), in previous work Manski (1993a and 1993b) had offered a more complete typology of effects which might be confounded with ‘social interaction’: ecological effects (shared common factors in the environment, like, for example, tax regulations), contextual effects (shared common social background features, like being
self-employed or having high income), and ‘correlated effects’ (shared common individual characteristics, like similar levels of risk aversion or tax aversion).5

Contextual effects are also called ‘exogenous effects’ by Manski, because agents incorporate them from their past experience and do not change from round to round just by observing others’ behaviour. They contrast with ‘endogenous effects’ (such as social conformity and social learning), by which behaviour may change from round to round depending on peers’ behaviour. Fortin et al (2007) add ‘fairness effects’ (the influence of individuals’ conceptions of fairness on their behaviour) as another kind of exogenous effects. It is worth to note that the greatest part of the sociological tradition have relied exclusively on exogenous factors as a result of a predominant focus on socialization and internalization mechanisms, leaving endogenous effects under analyzed. Figure 1 shows an integrated taxonomy of all these effects together with social interaction ones.

**Social influence in tax compliance research**

If social influence or social interactions effects exist in tax behaviour, their knowledge would be useful for policy objectives such as preventing tax fraud and adequately predicting the effects of tax regulations. It could be expected that social influence mechanisms in the case of tax compliance should be of the informational type, since tax behaviour is private and difficult to observe; in fact, some studies (Bergman and Nevárez, 2005; Torgler, 2007 and 2008) show that information about mean levels of compliance may have an effect on individuals’ decisions to underreport income. However, the possibility of normative social pressure to comply should not be discarded: to be sure, individuals may converge to the mean level of compliance among their peers because they adjust their individual risk estimation of being audited and fined to that of the group (informational mechanism), but also because they infer that compliance at the mean group’s level will not be socially disapproved (normative mechanism).

The operation of social influence mechanisms directly affecting tax evasion behaviour has been questioned by some scholars (Hedström and Ibarra, 2010) on the basis of what we might call the ‘privacy objection’: since tax compliance is taken to be private and unobservable by peers, no social influence could take place. However, as survey studies repeatedly show, citizens usually have an approximate idea on the tax compliance level in their country, region, occupational category, or economic sector (CIS, 2011; IEF, 2012); these ideas may be formed from information received through mass media, personal interaction, or indirect inference (for example, shared social characteristics, when compared with economic lifestyles, may be proxies for inferences about neighbours’ and peers’ tax compliance). Additionally, in countries where there is low tax morale and high social toleration towards tax evasion (such as Spain: Alm and Gómez, 2008; Alarcón et al., 2009; CIS, 2011; IEF, 2012;), it is usual to have access to

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5 Correlated and ecological effects are both included under the first label in Manski (1993a). Manski (2000) also distinguishes between constraint interactions, expectation interactions, and preference interactions, which broadly coincide with Aberg and Hedström’s (2011) classification on opportunity-based, belief-based, and desire-based interactions.
public ‘street knowledge’ about personal tax compliance, and to give and receive advice between neighbours and peers on how to evade. Those studies also show a low risk that others report the authorities if they know about evasion practices. Finally, in some models social influence is triggered by estimated or revealed information on criminal and dishonest behaviour (Diekman et al 2011, Gino et al 2009, Groeber and Rauhut 2010).

It is not surprising, therefore, that the study of tax compliance increasingly considers mechanisms of social influence or social contagion: Myles & Naylor (1996), for example, introduce a social conformity payoff in their model when taxpayers adhere to the social tax compliance pattern. Hedström and Ibarra (2010) allow for an informational social contagion mechanism in their tax evasion model, based on the belief that “if they can do it, I can do it as well” (p. 321). Fortin et al. (2006) introduce social conformity in their econometric model of tax evasion. Nordblom and Zamac (2012) build an agent-based model with social norm conformity and personal norms. Bergman and Nevárez (2005) execute an experiment in order to test social contagion in tax compliance, and the results are positive (subjects increase or reduce compliance in accordance with what they are told that is the mean compliance level of the group). According to Torgler (2008:1251): individuals who have tax evaders as peers or friends in their personal circle are more likely to evade themselves, but he notes that social interactions are one of the most underexplored issues in the field of tax compliance (ibid: 1261).

Agent-based models of tax compliance

Manski (2000) has showed that social interaction effects are very difficult to identify and to distinguish from exogenous and correlated effects with the only aid of statistical methods and data. Besides, quantitative estimation of these effects, as well as establishing the direction of causality between individual and group behaviour, are problematic tasks. However, Manzo (2013) has convincingly argued that agent-based computational models are a useful tool in order to solve all those problems, since they allow to run controlled virtual experiments able to isolate and differentiate concrete social interaction mechanisms and their effects. Some researchers in the tax compliance field have also realised that survey data analysis is insufficient to test properly the causal mechanisms involved in that phenomenon, since the description of statistical correlations does not open the 'black box' of the generative causal processes that bring about the aggregated outcomes (Hedström, 2005). That is why a growing number of studies have recently tried to explain tax evasion by adopting agent-based computational methods (Alm, 2012).

The first attempts to apply agent-based methodology to the study of tax compliance are due to Mittone and Patelli (2000), Davis et al. (2003), and Bloomquist (2004 and 2006); Bloomquist’s model presents a number of interesting features: agents are programmed with a high number of properties, the audit probability and its effects are determined in a complex way, and the results are tested against real data. The model
series EC* by Antunes, Balsa, et al. (Antunes et al., 2006, 2007a, 2007b, 2007c; Balsa et al. 2006) are even more complex by introducing agents with memory, adaptive capacities, and social imitation. The most remarkable novelties in these models are the inclusion of tax inspectors able to decide autonomously and, above all, the explanation of non-compliance with indirect taxes through collusion between sellers and buyers. Similarly, Bloomquist (2011) deals with tax compliance in small business by modelling it as an evolutionary coordination game.

The NACSM model by Korobow et al. (2007) analyses the relationship between tax compliance and social networks. More recently, we find an important group of agent-based models in econophysics which adapt the Ising model of ferromagnetism to the tax field: instead of elementary particles interacting in different ways as a function of temperature, we have individuals behaving in different ways as a function of their level of dependence on their neighbours’ behaviour. The proposals by Zaklan et al. (2008, 2009a and 2009b), Lima (2010), and Seibold and Pickhardt (2013) belong to this group.

The TAXSIM model by Szabo et al. (2008, 2009 y 2010) presents a particularly complex design, since it includes four types of agents (employers, employees, the government, and the tax agency). It also takes into account factors such as agents’ satisfaction with public services, which depends on their previous experience and on that of their neighbours. Hedström and Ibarra (2010) have proposed a social contagion model inspired by the principles of analytical sociology in order to show how tax evasion may spread as an indirect consequence of tax avoidance’s social contagiousness. Similarly, Nordblom and Zamac (2012) have also showed how an agent-based model may account for social conformity effects in order to explain observed differences in tax morale by different age groups. Hokamp (2013) includes different types of taxpayers and some novel aspects like back auditing effects (as in Hokamp and Pickhardt, 2010), and the evolution of social norms over taxpayers’ life cycle. Finally, Pellizzari and Rizzi (2013) build a model where agents pay their taxes according to a perceived level of public expenditure and some psychological variables like trust and tax morale.

In short, social simulation using agent-based models seems a promising research option in a field in which, despite the abundant literature, significant and uncontroversial results have been rare and hardly coordinated.

**A new agent-based model of tax behaviour: SIMULFIS**

As an illustration, we will briefly describe a new agent-based model (SIMULFIS) designed to study tax behaviour, and will show some exploratory results that may help to understand the dynamics of tax evasion. The SIMULFIS project aims...
to provide an agent-based computational tool able to integrate rational behaviour, tax morale (including fairness concerns and normative beliefs) and social influence (understood as any kind of social contagion mechanism) in a computational setting. The model simulates a virtual social environment where a central tax authority implements a fiscal regulation, collects taxes, execute audits and fines, and distribute tax revenues through a social benefit; only those agents with after-tax income under 50% of the median income are eligible for the benefit (this threshold is an exogenous parameter and thus may be manipulated). Agents have a random level of income and occupational status (they can be self-employed or wage-earners), the distribution of which may be empirically calibrated to emulate real cases (in the present version, the values of these parameters are both estimated for the Spanish case). All agents are members of a random or homophilic social network: in the latter case, they have a high fixed probability to share similar occupational status and income level with their neighbours.

Agents’ decision algorithm is structured in the form of four ‘filters’ that affect their decision about how much income they report to the tax authorities: the opportunity, normative, rational choice, and social influence filters. This ‘filter approach’ aims to capture recent developments in behavioural social science and cognitive decision theory which disfavour the usual option of balancing all determinants of decision in a single individual utility function (Bicchieri, 2006; Elster, 2007; Gigerenzer et al., 2011). Therefore, tax compliance is produced by several possible combinations of mechanisms, depending on what ‘filters’ are activated: the model allows to activate and de-activate the normative and the social influence filters; on the contrary, the other two filters (opportunities and rational choice) are always activated, since they are necessary for the agents to make a decision. Therefore, the model allows to analyze four behavioural scenarios: a strict rational choice one (RC), rational choice supplemented by normative or fairness concerns (F+RC), rational choice supplemented by social influence in the form of a social contagion mechanism (RC+SC), and, finally, a scenario where all the filters are activated (F+RC+SC).

**The decision outcome: the ‘fraud opportunity use rate’ (FOUR)**

Since our main focus is behavioural, SIMULFIS outcomes go beyond traditional indicators for compliance (such as the amount of income evaded by agents) towards determining how much relative advantage agents take of their opportunities to evade. Thus we define agent’s ‘fraud opportunity use rate’ (FOUR) as the main dependent variable of the behavioural experiments that SIMULFIS is able to execute (although, of course, economic data on evaded income are also computed).

The basic idea of FOUR is illustrated in Figure 2 with an example: taxpayers A and B have both a gross income of 10, and they both decide to hide 1 (that is 10% of their gross income); but taxpayer A had the chance to hide 5, while taxpayer B could only hide 2. So, though in absolute terms they comply the same, in relative terms
taxpayer B is making use of 50% of his opportunity to evade \( \text{FOUR}_B = 50\% \), while taxpayer A only makes use of 20% \( \text{FOUR}_A = 20\% \).

![Figure 2](image)

Calculating ‘fraud opportunity use rate’ (FOUR): an example

This way of modelling agents’ compliance captures the realistic idea that a sizeable part of tax revenue is often simply ensured by income withholding at source, and therefore reporting it does not depend on agents’ decisions at all. The complication introduced in the model by computing FOUR is theoretically justified because this is a much better indicator of the intensity of agents’ tax fraud efforts than the amount of money evaded or the percentage of their income they evade. As shown by the example in Figure 2, similar percentages of evaded income may reflect very different evasion efforts, and the reverse is also true.

The opportunity filter

In SIMULFIS, contrary to what happens in other models of tax compliance, different types of agents may have different objective opportunities to evade. This is a realistic feature of the model, which contrasts with the widespread traditional ignorance of this fact in tax fraud studies (two exceptions are Robben et al., 1990 and Hedström and Ibarra, 2010). An agent’s opportunity to evade is defined as the percentage of her income she has an objective chance to conceal.

In order to determine some reference values for different agents’ opportunities, we adopt some simple (and arguably realistic) assumptions. For example, it is reasonable to assume that self-employed workers have larger opportunities to evade than wage-earners (since their tax is not withhold at source by tax authorities and there are no third parties who may inform about them, such as employers). We also assume that high income taxpayers (the top decile of income distribution) will have more
opportunities to evade than middle and low-income ones (since the former have access to sophisticated means of tax evasion, to experts’ assessment and help, and to more diversified income sources). We will also assume, however, that low-income wage-earners (the lower three deciles of income distribution) have more opportunities to evade than middle-income ones, since the former have a higher probability of engaging in shadow economy and informally paid economic activities than the latter. Finally, for all agents there is some percentage of their income they cannot conceal, since the government always has some information on at least a minimum portion of every agent’s income.

Following these assumptions, Table 1 shows the reference values adopted so far in SIMULFIS for each category of agents in terms of income level and occupational status.

<table>
<thead>
<tr>
<th>Income Level</th>
<th>Self-employed</th>
<th>Wage-earners</th>
</tr>
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<tbody>
<tr>
<td>High</td>
<td>80</td>
<td>30</td>
</tr>
<tr>
<td>Middle</td>
<td>60</td>
<td>10</td>
</tr>
<tr>
<td>Low</td>
<td>60</td>
<td>20</td>
</tr>
</tbody>
</table>

**Fairness and the normative filter**

The model includes agents’ normative and factual beliefs on the fairness of the tax system. As noted before, the literature on tax compliance has emphasized the important role played by different normative perceptions and attitudes to the tax system and to taxpayers’ behaviour. Conceptions of fairness, reciprocity reasons, or distributive justice principles, may influence individuals’ perceptions on the acceptability of tax rates, personal tax balances, observed levels of compliance, or the degree of progressivity of the tax system (Bazart and Bonein, 2012; Traxler, 2010).

Fortin et al. (2007) have modelled ‘fairness effects’ as exogenous (see above, Figure 1), since they are taken to depend on the agents’ given conceptions of fairness, which are not modified by social interaction. However, in SIMULFIS fairness effects may be modelled partly as endogenous. We define agents’ perception of the fairness of their personal tax balance as an endogenous effect which may lead agents to reject the fairness of the tax system, and, therefore, to evade more. To do that, we define agents’ tax balance in each round as the comparison between the tax they pay and the benefits they get, so they may be net contributors to the system or net recipients. Agents compute their neighbourhood’s tax balance, by observing whether the majority of agents in their neighbourhood (including themselves) are net contributors or net recipients. If an agent is a net contributor while the majority of her neighbours are net recipients she is ‘unsatisfied’; otherwise, she is ‘satisfied’ in terms of fairness.

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7 Hedström and Ibarra (2010, p.326) point out that “real opportunities” of substantial tax fraud “are mainly available to those with sufficient resources” due to their capacity to hire expensive lawyers and accountants.
‘Satisfied’ agents reduce by one third the proportion of income they have opportunity to evade.

This method of ‘social comparison’ allows to treat fairness perceptions as endogenously generated, and tries to capture the well-known findings of the literature on relative deprivation, which show that people’s feelings of satisfaction with their endowments depend more on the comparison with their reference group than on the amount of goods enjoyed in absolute terms (Manzo, 2011). Social comparison of tax balances may lead agents to evade more if they are unsatisfied and do not want to feel they are ‘suckers’.

**The rational choice filter**

Once they have gone through the opportunity and the fairness filters, agents maximize their utility according to the classical Allingham and Sandmo equation (with some modifications such as progressive tax rates and the introduction of a social benefit); in doing so, they take into account tax rates, audit rates, the amount of fines, their income level, and the benefits they may be eligible for. In SIMULFIS, agents’ decision goes beyond binary or ternary choice which is typical in previous models (‘evade/do not evade’, ‘evade more/evade less/do not evade’): they maximize a utility function to decide what percentage of their income they will conceal by calculating the expected utility of a set of eleven outcomes, which result from hiding 100% to 0% of agents’ concealable income by intervals of 10%.

The estimation of the probability of being audited includes two components: first, the audit record of the agent, which tries to capture the observed fact that agents perceived probability of being audited increases if they have been audited in the past, and so incorporates an individual learning mechanism. Second, the audit record of the agent’s neighbourhood in the last round, based on the assumption that agents have at least approximate local knowledge on audit rates; as Fortin et al, 2007, note, the advantage of this assumption is its simplicity; besides, it incorporates a social learning mechanism.

It should be then noted that, despite different filters and mechanisms affecting agents’ final decision on compliance, rational choice has always some weight in the final decision (except under full social influence, as we will see). We take this as a realistic assumption, since an economic decision like tax compliance is almost always rationally considered by taxpayers, and, in most cases, assessed by experts or professionals.

**The social influence or social contagion filter**

SIMULFIS allows to make agents’ decisions sensitive in different degrees to the behaviour of their neighbours through a factor of ‘social contagion’ which makes each agent partially converge to the level of compliance in her neighbourhood. The strength of social influence is determined by an exogenous parameter ($\omega$) equal for all agents, ranging (0,1) from no social influence to full social influence. After applying the rational choice filter, agents’ FOUR ($\alpha_i$) partially or totally converge to the median
FOUR in their neighbourhood \((\alpha_v)\), according to \(\alpha_i + \omega(\alpha_v - \alpha_i)\). The result of this calculation is the agent’s final FOUR. Note that, when \(\omega = 1\) (full social influence), the individual effect of the rational choice filter is cancelled, since all agents totally converge to the mean FOUR of their neighbourhood in the previous round; conversely, when \(\omega = 0\) (no social influence), the agent keeps her FOUR resulting from the rational choice filter.

Compared with other models, SIMULFIS’ main difference is the treatment of social influence as a parameter instead of a fixed factor: it is therefore possible to assign different weights to social influence in agents’ decision algorithm. We also make three assumptions that are usual in other models (Myles and Naylor, 1996; Fortin et al, 2007): first, that contagion takes the form of convergence to the average behaviour. Second, that agents rely on observation of previous behaviour (specifically, in the previous round); this is what Fortin et al. (2007:3) call “myopic expectations”, but we claim that it is realistic, since there is little way of estimating a mean level of tax fraud in a simultaneous way. Third, that agents’ information on others’ tax compliance is most likely to be local. Finally, note that for reasons already mentioned, the mechanism behind social contagion in this case is not normative but cognitive or informational.

**The model dynamics**

When SIMULFIS is initialised, agents randomly receive a salary and a number of neighbours. Then they go through the decision algorithm, and end up making a decision about how much income they report, as a result of the activated behavioural filters. Their salaries are taxed and random audits and fines are executed. Then benefits are paid to those who are eligible, and endogenous parameters are updated for the next period (see Figure 3).
A simple virtual experiment with SIMULFIS

We will now present and discuss the results of a simple virtual experiment in order to show how SIMULFIS may help to explore the dynamics of different mechanisms of tax compliance. Our main aim here is not to show the empirical fit of the model to a particular case, but, departing from empirically plausible initial conditions and specifications, to explore the different effect on tax compliance of different combinations of behavioural filters, under different scenarios of deterrence in terms of audits and fines.

The experimental design can be summarized as follows: we run 256 simulations with 1,000 agents and 100 tax periods for each simulation. We test four behavioural scenarios, which activate different combinations of behavioural filters (recall that the opportunity filter is always activated): in RC agents decide only on the basis of rational choice; in F+RC, agents’ fairness concerns about compared tax balance is added; in RC+SC, rational choice is supplemented with the social contagion mechanism; finally, in F+RC+SC, all filters are active. We also study 16 different deterrence scenarios: audit rates of 3% (a real estimation for Spain), 25%, 50%, and 75%, with fines of 1.5, 2.5, 5, and 7.5 as multipliers of the amount of evaded tax (being the two first values real estimations for Spain). In the two scenarios where the social contagion mechanism is

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8 It should be noted that a complete empirical validation of the model is strongly dependent on the availability of reliable data on tax compliance and tax behaviour in concrete empirical cases.
present, three values for social influence are considered, with $\omega = 0.25, 0.50, 0.75$. All simulations are run with two types of networks: random and homophilic. Some of the exogenous parameters of the model (effective tax rates, income distribution, and the percentage of self-employed taxpayers) are empirically calibrated for the Spanish case. The dependent variables are agents’ FOUR and the amount of income they underreport. The main results can be described as follows.

**Stability**

In all simulations a robust equilibrium seems to be reached after few periods (a usual fact in ABM and behavioural experiments on tax compliance), and the system stabilizes around a certain average level of compliance in terms of agents’ mean FOUR. Figure 4 shows the main trends of tax compliance under different behavioural conditions and deterrence scenarios, with $\omega = 0.5$. All plots of this type show the mean FOUR of the simulations executed for the entire population of agents in each round.

**Figure 4**  
*Mean FOUR by deterrence conditions and behavioural scenarios with $\omega = 0.5$*

**Rational choice overestimates tax fraud**

The results confirm the theoretical implication of rational choice theory that, under low deterrence levels (such as the ones really existing), it is rational for everyone to evade, and to evade as much as possible. In Figure 4, the plot on the upper-left corner shows the (arguably) most realistic conditions in terms of deterrence. In this case, it appears that all agents end up with a FOUR of 100%, which means they are taking full advantage of their opportunities to evade.

Although the aim of this article is not to validate the model empirically, a simple comparison of these results with the estimated volume of tax fraud in Spain may be useful. Different authors estimate that tax fraud represents around 20-25% of the Spanish GNP (Arrazola et al., 2011; GESTHA, 2011; Murphy, 2011 and 2012). Figure 5 shows the results in terms of concealed income when we simulate the four behavioural scenarios under a realistic deterrence level. It seems that the scenarios where social contagion is present are closer to those estimations than the rest. Specifically, the RC+SC scenario seems to predict the most plausible level of tax compliance. This suggests that strict rational behaviour is not enough on its own to generate empirically estimated tax compliance levels.

![Figure 5](image)

*Concealed income/total income ratio by behavioural scenario*

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Graph Line</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>RC</td>
<td>Blue</td>
<td>Only Rational Choice filter activated.</td>
</tr>
<tr>
<td>F+RC</td>
<td>Red</td>
<td>Fairness and Rational Choice filters activated.</td>
</tr>
<tr>
<td>RC+SC</td>
<td>Green</td>
<td>Rational Choice and Social Contagion filters activated.</td>
</tr>
</tbody>
</table>

*audits=3% fines=1.5 ω=0.5*

An example of a more fine empirical comparison may consist on calculating the relative difference between self-employed workers’ and wage earners’ mean underreported income as predicted by SIMULFIS, and compare it to empirical estimations of the same magnitude for Spain (Martínez, 2011). Since the values are broadly similar (the estimated real value is 25-30%, and SIMULFIS predicts 26.9% under the most realistic deterrence condition), we dare to trust that the model is in the right track for achieving good empirical fit in future stages of the project.

**The effect of deterrence**

Figure 4 may also give us a picture of how deterrence affects tax compliance. Audits are a measure of the probability of being punished for tax evasion, and fines capture the intensity of the punishments; the sixteen different audits-fines scenarios shown in the plots capture different combinations of those two components of deterrence. Understanding the relative effects of these two components of deterrence on compliance is important also for policy reasons: it has been often demonstrated that there is a trade-off between severity and probability of punishment (Kahan, 1997, pp.377ss), since raising that probability (what economists of crime call the ‘certainty of conviction’) is often more costly than raising the intensity of punishment, and even inefficient if the resources and efforts needed for effective surveillance are considerable, as is the case with tax supervision. With the aid of an agent-based model, it is possible to assess this trade-off: for example, the plots show that different combinations of audits and fines produce equivalent compliance levels under the same or different behavioural scenarios (for instance, under the RC scenario, a combination of a fine multiplier of 5 and an audit rate of 25% is equivalent to another of a fine multiplier of 2.5 and an audit rate of 50%; both produce a similar compliance level to that under the F+RC+SC scenario with a fine multiplier of 1.5 and an audit rate of 25%).

From the plots in Figure 4 it is also clear, and theoretically to be expected, that higher audits and fines always improve compliance (always decrease mean FOUR), but increasing audits is proportionally more effective than raising fines (except when we pass from fines of 2.5% to 5% of the evaded tax under an audit rate of 25%, where a ‘phase transition’ seems to take place). Interestingly, under the most realistic audit rate (3%), increasing fines does not have an effect on compliance in any behavioural scenario. Conversely, under realistic values for fines (1.5% and 2.5% of evaded income), increasing the audit rate has a more substantial effect under all behavioural scenarios. This may challenge the standard conception that increasing audits is inefficient due to its high cost: as Kahan (1997) notes, when individuals do not decide in an isolated way, high-certainty/low-severity strategies may be better than the reverse due to the signal that individuals get that they will be most likely caught if they cheat. In our model, this is captured by the local way in which agents estimate the probability of being audited and punished.

In order to confirm this trend statistically, a linear regression analysis with FOUR as dependent variable was performed (see Table 2); the results show that audits have a strong effect in decreasing FOUR, which more than triplicate the effect of fines
in all behavioural scenarios. Similarly, in their meta-analysis of laboratory experiments in this area, Alm and Jacobson (2007) find an elasticity of 0.1-0.2 for declared income/audits, but below 0.1 for declared income/fines. (The regression models also included social influence as independent variable in the two behavioural scenarios where it is activated, and the results show that it also has a negative effect on FOUR, which is higher than the effect of fines but lower than that of the audit rate).

Table 2
Results of regression analysis (beta coefficients for each behavioural scenario)

<table>
<thead>
<tr>
<th>Independent variable</th>
<th>Behavioural scenarios</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RC</td>
<td>F+RC</td>
<td>RC+SC</td>
<td>F+RC+SC</td>
</tr>
<tr>
<td>Audits</td>
<td>-0.860</td>
<td>-0.857</td>
<td>-0.724</td>
<td>-0.751</td>
</tr>
<tr>
<td>Fines</td>
<td>-0.295</td>
<td>-0.277</td>
<td>-0.248</td>
<td>-0.245</td>
</tr>
<tr>
<td>Social influence (w)</td>
<td>-</td>
<td>-</td>
<td>-0.415</td>
<td>-0.328</td>
</tr>
<tr>
<td>R squared</td>
<td>0.827</td>
<td>0.842</td>
<td>0.758</td>
<td>0.732</td>
</tr>
</tbody>
</table>


Social contagion has an ambivalent effect on compliance

If we now focus on the effect of the social contagion mechanism we can see that, as confirmed by regression analysis (Table 4), in general it seems to decrease FOUR. Given a deterrence level, and even if social influence has low intensity (w = 0.25; see Figure 7, below), the introduction of the mechanism strongly (and positively) affects compliance. However, an interesting fact is that as deterrence is made harder, the comparative decrease in FOUR is proportionally less intense, until, in the plot on the lower-right corner in Figure 4, scenarios with social contagion (RC+SC and F+RC+SC) become suboptimal in terms of compliance in front of those where the mechanism is absent (RC and F+RC). In other words, deterrence operates a substantial change in the ‘optimality ordering’ of the four behavioural scenarios, with only one exception: F+RC always fares better than RC. This is not surprising, since the F filter was modelled so that it can only improve agents’ compliance. What is unexpected, and absent in usual theoretical expectations in the literature, is that social influence may have an ambivalent relative effect depending on deterrence levels.

To see this more clearly, Figure 6 isolates the variation in mean FOUR that the absence of social contagion would exert, in comparison with the scenarios where it is activated. It is clear that the effect of de-activating the social contagion mechanism on FOUR is positive and marginally decreasing as deterrence is harder, and ends up (at the right side) by being negative (and so, by improving compliance under medium and low deterrence levels).
In each bar, the vertical label contains the percentage of audits and the fine multiplier; the number at the top of the bars is the FOUR difference with the baseline in %.

Figures 7 and Figure 8 confirm that the trends mentioned so far, and specially the ambivalent effect of social contagion, are not substantially affected by different values of \( \omega \) (the social influence coefficient), although these values intensify the tendency correspondingly: a lower value of \( \omega \) makes SI scenarios become suboptimal more slowly as deterrence is harder, while a higher value speeds the pattern up.
Why is this effect taking place? The reason is that social influence makes tax compliance less sensitive to increased deterrence levels: since decisions are interdependent and not only based on individual cost-benefit calculations or normative attitudes, individual decisions on compliance are ‘adjusted’ upwards or downwards depending on the neighbourhood; both trends may partially cancel each other on the global mean, making the difference we are observing. When deterrence is hard enough, scenarios where this ‘adjustment’ does not take place will logically fare better in terms of compliance. This effect is somehow capturing a well-known social phenomena, but one not much studied in the literature on tax compliance: agents who take into account their peers’ decisions when making their own are less likely to change their behaviour (or are likely to change it with less intensity) as an effect of external or hierarchical pressures from above (such as audits and fines). Therefore, the introduction of social influence among rational agents has not the same directional effect on compliance independently of the deterrence level (for a different result see Korobow et al., 2007, p. 608). When deterrence is strong enough, even strict rational agents would comply more than socially influenced ones. This interaction effect, as well as its foundations at the
micro level, would be difficult to observe and analyze without the aid of an agent-based model such as SIMULFIS.

Figure 8

*Mean FOUR by deterrence conditions with $\omega = 0.75$*


The “social influence conception of deterrence” developed by Kahan (1997, p. 351) is close to our interpretation of this result. According to him, the effect of deterrence must be considered in relation with the power exerted by social influence: from a given point, the marginal gain in compliance achieved by higher levels of deterrence may be lower in a situation with social influence than in a situation with isolated rational agents (and the higher is the intensity of social influence, the lower this relative gain will be). In a similar way, our model allows for social contagion to have different effects depending on the neighbourhood, so its aggregated effect may be the net consequence of cancelling out several differences in the direction of the effect (towards a higher or a lower compliance level). The plots show that social contagion attenuates the net effect of deterrence on raising compliance when deterrence is high, and increases it when it is low. Consistently, in Llacer et al. (2013) we also showed that with higher tax rates the same transition starts from a lower deterrence level.
The choice of a deterrence policy should therefore be sensitive to this fact: it should bear in mind not only what ‘price’ is set for tax evasion in terms of the probability and intensity of punishment (as it would do with strict isolated rational agents), but also how that policy is dynamically generating an aggregated behaviour that influences in each round the individual behaviour of each agent, and so on. A major policy implication of this fact is that sometimes it might be more effective to create a given perception of compliance than to increase deterrence. Increasing deterrence is not the only way of increasing compliance: for example, in Figure 4 the introduction of social contagion under audits 3% and fines 1.5% would generate a FOUR reduction of 30 points departing from the rational choice scenario, while increasing fines does not have a substantial effect, and audits would have to be raised to 50% to find a higher FOUR reduction.

**Fairness and network effects**

Figures 4, 7, and 8 also offer a comparative picture of the relative effects on tax compliance of agents’ fairness concerns (applied to their tax balance, as we saw). Of course, when the fairness filter is activated, mean compliance will always increase (that is, mean FOUR will always decrease) in comparison to the rational choice scenario: this is so because satisfied agents will always decrease their FOUR, while unsatisfied agents will just keep all their chances to evade open; however, we observe that even this very simple way of modelling fairness concerns introduces a substantial difference in terms of compliance with the rational choice scenario.

The comparison of the fairness and the social contagion mechanisms may be more informative: when social influence is low (Figure 7), the fairness scenario (F+RC) always outperforms the social contagion one (RC+SC) in terms of compliance; but when social influence is medium or high (Figures 4 and 8), this is only true under high deterrence levels. This effect is similar to the one observed when comparing the social contagion (RC+SC) scenario with the rational choice one (RC): from a given point in terms of deterrence, social contagion stops to be optimal for compliance when compared not only with rational choice alone, but also with rational choice plus fairness concerns. An interesting implication of this is that similar compliance levels may be reached by very different combination of mechanisms.

Finally, the fact that networks are random or homophilic does not seem to have any significant effect on FOUR nor in the volume of underreported income (see Table 3); this suggests that the effects found are robust no matter which network type we have. Thus, an agent-based model like SIMULFIS may be used also to control for ‘correlated effects’ such as that of sharing similar occupational status and income level with your neighbours. If varying the probability of having similar peers in your neighbourhood does not affect substantially the results, this supports the idea that the effect of the social contagion mechanism is genuine.
Table 3

*Effect of the type of network on mean FOUR and underreported income*

<table>
<thead>
<tr>
<th>Behavioural scenario</th>
<th>Network type</th>
<th>FOUR (%)</th>
<th>Volume of underreported income (€)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RC</td>
<td>Homophilic</td>
<td>54.55</td>
<td>3,108,076.46</td>
</tr>
<tr>
<td></td>
<td>Random</td>
<td>54.29</td>
<td>2,966,957.65</td>
</tr>
<tr>
<td>F+RC</td>
<td>Homophilic</td>
<td>36.05</td>
<td>2,004,115.75</td>
</tr>
<tr>
<td></td>
<td>Random</td>
<td>35.98</td>
<td>1,976,998.75</td>
</tr>
<tr>
<td>RC+SC</td>
<td>Homophilic</td>
<td>35.24</td>
<td>2,087,546.86</td>
</tr>
<tr>
<td></td>
<td>Random</td>
<td>34.89</td>
<td>2,106,263.13</td>
</tr>
<tr>
<td>F+RC+SC</td>
<td>Homophilic</td>
<td>25.99</td>
<td>1,561,599.14</td>
</tr>
<tr>
<td></td>
<td>Random</td>
<td>25.62</td>
<td>1,579,478.76</td>
</tr>
</tbody>
</table>


**Final remarks**

In this article we have discussed different theoretical strategies to account for tax compliance behaviour, a research field that is attracting increasing academic attention from social scientists and is also important for policy reasons. We have argued that rational choice explanations of tax compliance face a number of important problems when trying to explain observed levels of compliance and estimated tax evasion. Different social influence mechanisms have been proposed by an interdisciplinary literature in order to improve the explanatory power of behavioural models of tax compliance, but a systematic taxonomy of those mechanisms is still lacking, and often they are under defined. In figure 1, above, we have suggested a tentative taxonomy that should be developed further. We have also discussed how social influence explanations may throw some light on the study of tax compliance, and how agent-based models are a very promising tool to implement and test the associated hypothesis and theories.

As an illustration of the latter, the article has presented SIMULFIS, a computational behavioural model for the simulation of tax evasion and tax compliance. We have designed a simple virtual experiment to test the different effect on tax compliance of different combinations of behavioural filters (rational choice, social contagion, and fairness effects), under different conditions of deterrence in terms of audits and fines. As it was noted, a complete empirical validation of the model is strongly dependant on the availability of reliable data on tax compliance and tax behaviour in empirical cases. However, some conclusions may be drawn from the analysis of the results: first, as suggested by the theoretical literature on tax compliance, strict rational agents would produce much less compliance than it is usually estimated,
except with unrealistically high deterrence levels; this strongly suggests that rational choice theory is not enough on its own to generate empirically estimated compliance levels through simulations, and that additional social mechanisms are necessary in any plausible model of tax compliance behaviour. Second, social influence does not always optimize compliance; particularly, it has been shown that when deterrence is strong, rational and fairness-concerned agents fare better in terms of compliance. The reason of this ambivalent effect of social influence is that its presence, by making agents decisions’ dependent on those of their peers, makes tax compliance level less sensitive to increased deterrence levels. This social effect, as well as its foundations at the micro level, would be difficult to observe without the aid of an agent-based model such as SIMULFIS. Third, the model confirms the results of most experimental studies (Alm and Jacobson, 2007; Franzoni, 2007) that find audits to be comparatively more effective than fines in order to improve tax compliance.

The policy implications of these results seem clear: first, policies to tackle tax evasion should rely more on improving the efficacy of audits, as well as their number and scope, than on raising penalties. Second, a smart use of public information on tax compliance levels may be a forceful weapon to induce taxpayers to comply more. In any case, we would like to emphasize the utility of agent-based models for understanding compliance patterns and, therefore, for assessing public decisions along the many trade-offs involved in tax policy. Agent-based models are flexible tools which offer many possibilities to improve social-scientific knowledge of tax behaviour, a research field that, in Kirchler’s words, is “still in its infancy” (2007, p. xv).
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