Chapter 5
Experimental Economies and Tax Evasion: The Order Beyond the Market

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In this world nothing can be said to be certain, except death and taxes.
Benjamin Franklin

5.1 Introduction

Tax non-compliance and fiscal fraud are giving policymakers all over the world quite a headache, leading them to invest significant efforts and resources in the attempt to tackle the issue of public revenues lost due to tax evasion.

To achieve meaningful results through targeted policy interventions, it is central to understand how people perceive taxes, contributions, and sanctions, along with how they take the decision to comply. Various attempts have been made, starting from the seminal contributions of Allingham and Sandmo (1972) and Yitzhaki (1974), who follow the paradigms of expected utility theory. These two classical theoretical models are presented in Sect. 5.2, as they serve as a starting point for the majority of further developments in the tax-compliance literature. Despite their elegance and insightfulness, the classical models were soon questioned as it was shown that their predictions did not match existing empirical evidence (see, for example, Graetz and Wilde 1985). In fact, people were found to evade much less than what would have been expected from a rational utility maximizer with a reasonable level of risk aversion. Sections 5.3 and 5.4 deal with issues related to the assumption of full rationality and the potential problems arising with the use of expected utility theory.

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The process of cross-checking real data with model prescriptions and the acknowledgment of the limitations of analytic solutions led to modifying the basic research question from, "Why and by how much do people evade taxes?" to "Why do people pay taxes at all?" The answer should ultimately enable policy makers to find a solution to their old dilemma of, "How can compliance be increased even more?"

However, determining the extent of tax evasion is and has always been an understandably challenging task. There are four main methods, according to Andreoni et al. (1998): audit data, survey data, tax amnesty data, and laboratory experiments.

A frequently cited source associated with the first category is the Tax Compliance Measurement Program (TCMP) carried out by the U.S. Internal Revenue Service (IRS) from 1965 to 1988. The TCMP was a program of intensive audits designed to measure the level of noncompliance among the population. The results of the 1988 TCMP show that 40% of the households evaded some income tax, whereas 53% were fully compliant. The remaining 7% instead paid more than what they actually owed.

Yet available data on tax compliance is limited and often unreliable. Audit data does not give sufficient insights, as it is nearly impossible to detect all hidden income. Survey data, on the other hand, is self-reported, which casts reasonable doubt on the truthfulness of the information provided about one's own illicit behavior. To overcome these and other limitations, experimental economics comes into play in the attempt to provide at least a partial fix. By carefully constructing a laboratory environment as described by an economic model (e.g., tax rate, audit frequency, fine rate), the experimenter may observe whether participants behave according to the analytical predictions. Furthermore, marginal effects of single-parameter changes can be isolated *ceteris paribus*, thanks to the controlled setting of the lab. In Sect. 5.5, we will present some results obtained from laboratory experiments on tax compliance.

The body of literature on tax evasion has grown to massive proportions during the last three decades and has become cumbersome to overlook. However, two of the main common findings are that individuals are not homogeneous in preferences and often do not act according to market-based mechanisms. Yet the plurality of stylized determinants of tax compliance and the discovery of the importance of interaction effects and dynamic approaches have given rise to new ways of modeling. Some examples of computer-simulated agent-based models applied to the tax evasion problem are illustrated in Sect. 5.6. The potential benefit of calibrating such models with the results stemming from real "agents" tested in controlled laboratory settings still has to be further explored. This new area of interaction between both Experimental Economics and computer-simulated realities—or an Experimental Economy—could well be one innovative tool to bridge the gap between theoretical modeling and reality on one side, while decreasing the distance between academics and policy makers on the other, thanks to the creation of manipulable interfaces that are also intuitive for non-technical users.

5.2 Classic Modeling of Tax Evasion

A classic approach to the problem of tax evasion is offered by the theoretical model contained in the seminal article of Allingham and Sandmo (1972) (henceforth AS). The model is an adaptation of Gary Becker's work on the Economics of Crime and Punishment (Becker 1974) to the case of tax compliance. The decision on how much to declare of a certain exogenously given income is presented as a gamble with two possible outcomes: being caught and not being caught. The tax authority audits the taxpayer and discovers the understatement with a certain probability p; hence the decision-maker maximizes his expected utility (EU) with respect to the declared amount x according to the following convex combination:

$$EU = (1-p)U\big(v + t(y-x)\big) + pU\big(v - \theta(y-x)\big) \tag{5.1}$$

His overall expected utility is represented as a weighted average of the utilities assigned to the two possible outcomes. The optimum amount of declared income x depends on the proportional tax rate t, the fine rate θ, and the probability of being subject to a random audit p. The utility function $U(.)$ is marginally positive with $U'(.) > 0$ and strictly decreasing with the second order derivative $U''(.) < 0$, which means that the taxpayer is a risk-averse one who prefers a certain outcome to a gamble with the same (or even a higher) payoff in expected terms.

The correct net disposable income in case of full income disclosure is described by $v = y(1-t)$. Thus one can interpret the first part of the expected utility formulation as the situation in which no audit is performed and the utility is given by the argument $(v + t(y-x))$, the correct net income v augmented by what we will call the *cheater's premium*, $t(y-x)$, namely, the part of tax liability he saved by not paying taxes on the undeclared part. The second part of the weighting function describes the situation in which an audit takes place: the undeclared income $(y-x)$ is detected by the authority and the fully taxed correct net income v is reduced by the *cheater's penalty* $\theta(y-x)$, i.e., the fine on the hidden income.

Commonly, decreasing absolute risk aversion is assumed, which describes the fact that—in absolute terms—the amount of risky investments increases with higher disposable income.

The first-order condition (FOC) for the optimal amount of income disclosure[1] of Eq. (5.1) is $\frac{\partial EU}{\partial x} = 0$ and becomes $\frac{U'(y_A)}{U'(y_{NA})} = \frac{(1-p)t}{p\theta}$. We find that in the AS specification an increase in the tax rate t has ambiguous effects. On one hand, the correct net disposable income v decreases, which—under the assumption of decreasing absolute risk aversion[2]—should induce the individual to cheat less, leading

[1] The second-order condition is satisfied by the utility function's being concave.

[2] The concepts of absolute and relative risk aversion have been developed by Arrow (1965) and Pratt (1964) independently. The first measure describes the amount of wealth placed in risky activities in absolute terms and the second expresses this amount in relative percentage terms.

to an income effect. On the other hand, with a higher tax rate, the attractiveness of the *cheater's premium* $t(y-x)$ increases, whereas the *cheater's penalty* $\theta(y-x)$ remains unaffected, which eventually makes tax evasion more profitable (substitution effect). The magnitude and sign of the final response depend on the shape of the utility function, in particular on how fast absolute risk aversion declines and thus its third-order derivative (Andreoni et al. 1998).

With the aim of reflecting the legal framework effective in a number of countries, such as the United States and Israel, in 1974, Shlomo Yitzhaki (1974) introduced a slight modification to the specification of the AS model by making the penalty depend on the evaded taxes instead of the undeclared amount of income. The original expected utility expression becomes

$$EU = (1-p)U\left(v + t(y-x)\right) + pU(v - \theta t(y-x)) \tag{5.2}$$

and we find the following first-order conditions for optimality: $\frac{U'(y_A)}{U'(y_{NA})} = \frac{(1-p)}{p\theta}$. The taxpayer will evade as long as the expected payoff per monetary unit of evasion $1-p-p\theta$ is greater than zero.

By directly comparing the F.O.C. of Eq. 5.2 with the original AS first-order condition, we observe that the proportional multiplicative effect of taxes in the numerator, which made evasion more attractive, disappears and what remains is only the income effect (Slemrod and Yitzhaki 2002). Overall, cheating will be reduced when the tax rate increases. Moreover, both the probability of an audit and the magnitude of the fine have a negative impact on evasion.

The Allingham–Sandmo–Yitzhaki (henceforth ASY) model stands out for its elegance and straightforwardness, and thus became the standard tool, or at least the starting point, in the analysis of the compliance decision. Yet an ever-growing body of empirical and experimental evidence has developed pointing out that the predictions of the ASY model do not fully hold up in reality. In the following sections we will highlight some of the criticisms to this classic utilitarian approach.

5.3 Limits of Rational-Choice Theory

Presenting the decision of tax compliance as an individual-choice problem in order to resolve what could be well defined as an aggregate social problem has proven to lack significant elements that influence the process of human decision-making. The rational choice approach has been widely challenged, as described also by the American economist James M. Buchanan:

> The economist rarely examines the presuppositions of the models with which he works. The economist simply commences with individuals as evaluating, choosing, and acting units. Regardless of the possible complexity of the processes or institutional structures from which outcomes emerge, the economist focuses on individual choices. […] Individuals […] are presumed able to choose in accordance with their own preferences, whatever these may be, and the economist does not feel himself obliged to inquire deeply into the content of these preferences (the arguments in individuals' utility functions). (Buchanan 1987, p. 244)

Standard neoclassical models of economic theory are built on the assumption of individuals' exhibiting rational behavior. Rationality in the economic context is interpreted as the individual's capability of evaluating all possible outcomes in order to take the decision that yields the greatest benefit in terms of utility. Moreover, agents are also assumed to be aware of their own preferences and to be able to maximize their utility function given certain parameters. They do so in a purely self-interested way.

Accordingly, in the classic AS and ASY model of tax compliance the decision of how much to declare from one's income to the tax authority is presented as a relatively simple portfolio choice. Taxpayers must decide how much of their income they wish to allocate to the risky asset (tax evasion) and to the safe asset (tax compliance). Decision-makers are assumed to have full information about the audit probability, the fine, and the tax rate they are supposed to pay and make so-defined "rational choices under uncertainty." The latter is engineered by assigning probabilities to possible outcomes.

Portfolio theory and its basic assumptions of perfect rationality have been widely challenged by the science of behavioral economics, which deals with the social and cognitive aspects in the human decision-making process. By introducing elements of psychology into economic modeling, new points of view have been presented which are not necessarily in contrast with the neoclassical models.

Extensive experimental research has shown that individuals are only boundedly rational (see, for example, Conlisk 1996 for a survey on bounded rationality). The concept was already introduced in the 1950s by the work of Herbert A. Simon and has since been subsequently defined and modeled by numerous authors (Simon 1982; Selten 2001; Simon 1972; Kahneman 2003). Examples of what could be those bounds to full rationality are information asymmetry and cognitive limitations.

How does bounded rationality apply to the tax evasion problem? First, most of the time citizens do not have complete information about the true audit probabilities and form subjective probability beliefs about the frequency of verifications by the tax authority. Also, tax code complexity and bureaucracy can lead to uncertainty not only about the fine parameter θ, but also about the correct tax rate itself, as pointed out by Andreoni et al. (1998, p. 852). Tax complexity leads to the need for tax practitioners and represents a potential source of inequity among the population, in particular with respect to education and socioeconomic status. These regressive effects stemming from inferior capabilities of interpreting the tax code and, as a consequence, finding ways to minimize the tax liability are also mentioned by Vogel (1974).

Second, optimizing a utility function based on some probabilities of possible outcomes might not be a straightforward process for everyone. It is demonstrated by numerous studies, as described in Reyna and Brainerd (2008), that there is a general lack of mathematical proficiency and subsequent difficulty in judging probabilities and risks among the population. Not only is it numeracy, but also tax literacy that plays a role in determining the correct level of the expected-utility parameters to be taken into consideration.

Tax literacy is tightly linked to the aforementioned tax code complexity. The first is the capability of applying the correct tax rate given a certain legal framework,

whereas the latter describes the structure and accessibility of that legal framework. The more complicated the design of the set of rules, the more important the capability to interpret them correctly, in order words, *ceteris paribus*, the marginal return to tax literacy increases.

Finally, it is also assumed that taxpayers take decisions individually and in a self-interested manner, but can we assume this mechanism to be compatible with the very purpose of taxes? Taxes are collected in order to finance public expenditures that again are designed to serve the community of taxpayers. This implies that tax evasion is a form of free-riding. Not paying one's taxes has the effect that the other members of the community have to pay more in order to fund the public collective project. In that sense it might be necessary to consider social interactions and norms in order to capture the role of peer effects, positive and negative reciprocity, and intrinsic motivation in the decision-making process. We will consider these elements more in depth in Sect. 5.5.

5.4 The Expected-Utility Approach Under Scrutiny

In the ASY model the decision to pay taxes is presented as a lottery with two possible outcomes: audited and not audited. Taxpayers are then expected to decide how much to declare based on the probability of being audited and possibly fined. Following this logic and given the population-specific level of risk aversion, it should hence be possible for the lawmaker to provide society with a set of rules defining audit rates, tax rates, and fines which leads to collecting the maximum tax levy in a self-regulatory manner.

Individual heterogeneity is represented with regard to the attitude toward risk and captured by the functional form of the utility function, in particular its curvature. A risk-averse individual is characterized by a concave utility function with a decreasing return to wealth in marginal terms.

The Arrow–Pratt measure of risk aversion in absolute terms describes the relationship between the second-order and the first-order derivative of the utility function, whereas the measure in relative terms describes the level of risk aversion with varying levels of wealth.

The level of risk aversion in the context of tax compliance has been studied by numerous authors. Alm et al. (1992a) showed that estimated Arrow–Pratt levels of relative risk aversion for the United States are incompatible with the empirical evidence of tax compliance. The real levels are between 1 and 2, but only a level of 30 would support observed tax compliance rates. Frey and Feld (2002) find that the observed compliance in Switzerland of 76.52 % would require a value for the parameter of relative risk aversion of 30.75, as opposed to the observed parameter values ranging from 1 to 2.

The empirical calibration values for the model were presented in Alm et al. (1992a), Andreoni et al. (1998), and Bernasconi (1998), with real-world average audit rates ranging between 1 and 3 %, and the penalty rate, which we called θ in our

specification, ranging from 0.5 to 2.0. The return to tax evasion in expected terms can be obtained using $1-p-p\theta$ and results in 91–98.5%; hence all taxpayers should hide some of their income, which stands in contrast with the evidence showing that only 30% of taxpayers actually evade taxes Dhami and Al-Nowaihi (2007). Again, only unreasonably high levels of risk aversion could explain the levels of tax compliance found in reality.

Criticisms to the AS and the ASY models of tax evasion link back to the very same discussions around EUT itself. Decision-makers are defined to be (rational) expected utility maximizers if they meet the four basic criteria of the Von Neumann–Morgenstern specification: (i) Completeness—preferences of individuals are well-defined; hence they are able to choose between two alternatives. (ii) Transitivity—the choices are coherent; i.e., if outcome A is preferred to outcome B and B is preferred to C, then it must be that outcome A is preferred to outcome C. (iii) Independence—if gamble A is preferred to gamble B and another gamble C is added to both of them, then preferences do not change: the new gamble (A + C) must still be preferred to the new gamble (B + C). (iv) Continuity—given the preference ranking $A \succ \mathrm{B} \succ \mathrm{C}$ then there must exist some value of p in a convex combination of A and C which makes the decision-maker indifferent to option B, such that $pA + (1-\mathrm{p})\mathrm{C} \approx \mathrm{B}$.

A challenge to the Von Neumann–Morgenstern utility specification is offered by Kahnemann and Tversky and their work on Prospect Theory (Kahneman and Tversky 1979) and Cumulative Prospect Theory (Tversky and Kahneman 1992), which shows inconsistency in preferences describing the nonlinear subjective reaction to probabilities. Starting from a reference income and moving into the gain domain, preferences are concave, whereas in the loss domain preferences are convex. The aim of determining a reference point from which to depart in defining the gain and the loss domain is to eliminate possible framing effects. Going back to our taxation framework, in Dhami and al-Nowaihi (2007) this reference point is defined as the legal after-tax income.

Moreover, concavity of gains and convexity of losses indicates the presence of a loss aversion, where losses are perceived as worse than gains in relative terms. Cumulative Prospect Theory (CPT) uses rank-dependent expected utility theory in order to define the probability weighting function. In that way decision-makers will tend to overweight low probabilities and underweight high probabilities. In taxation terms, such a mechanism implies that a realistic audit rate of, say, 0.01 is subjectively interpreted as higher. Hence compliance for low audit rates increases with respect to the predictions of standard expected utility theory and is more in line with real world data.

This hypothesis was tested in the laboratory by Alm et al. (1992a). In their experiment they set a cut-off level for the audit probability of 5% below which a risk neutral expected utility maximizer should report zero income. Yet at a level of 2% they still find significant compliance rates of around 50%. Such a result could fit expected utility theory only by assuming extreme values of risk aversion. Still, the results are consistent with the predictions of Cumulative Prospect Theory which allows for subjects to subjectively perceive a higher audit rate than the given one.

They also find that the reactions to increases in audit probabilities are non-linear, with compliance rising less than the audit rate in relative terms.

An additional variation of their experiment consisted in a treatment with no possibility of being detected. Nonetheless, the average compliance rate was 20 % which makes the comparison with the neutral lottery set-up somewhat questionable and files Cumulative Prospect Theory as only a piece of the compliance puzzle.

5.5 Institutions, Social Norms and Psychological Factors—New Evidence from the Lab

Indeed, it has become quite clear that there are several further "ingredients" to be considered in order to get a better picture of the various aspects involved in the tax compliance process, aside from the fine rate, the available income, the audit frequency and the tax rate. The *homo economicus*, the economic man, who is assumed to act rationally and in a self-interested manner, would be better off not paying taxes at all if we consider real-world audit rates, even under the assumption of extreme levels of risk aversion.

In this section, we will present some results of tax compliance experiments testing for the impact of both the classical parameters and behaviorally driven elements which have been gradually introduced in the attempt to accommodate observed tax compliance data.

A typical tax compliance experiment is computer-based and consists of one or more rounds during which subjects are asked to take a decision on how much of their previously assigned income they want to declare to the tax authority, given the audit frequency, the fine in cases of detection and the tax rate. Thereafter their report may be randomly drawn for an audit and if they declared less than their gross income, the penalty is applied.

It is also to be mentioned, however, that experiments in economics are often subject to criticism with regards to their external validity. Guala and Mittone (2005) dedicate a section to the issues related to the tax compliance environment in the laboratory, naming as examples problems of scale, the game-like behavior of subjects, the absence of social incentives (the "real" social environment is not part of the experiment) and the absence of social actors. The authors admit to the difficulty of generalizing laboratory results to the real world due to their inherent context-specificity. Nevertheless, tax experiments may offer valuable cause-effect explanations and might often even be the only chance to get additional data on the behavioral dynamics behind the tax compliance decision (Alm et al. 1992b), given the difficulty of gathering truthful and reliable data on tax compliance.

Another criticism common to laboratory experiments in general is the use of student subjects. This is addressed by Alm et al. (2010) and tested in a tax compliance experiment conducted with both, students and staff. Some variation was introduced between groups with regards to the level of certainty about the tax liability and

the existence of social programs aimed at positively inducing taxpayers (namely Income Tax Credit and Unemployment Benefits). They find that average compliance rates within subjects (staff and students) indeed differ, but that changes within group treatments are alike. Similarly to Guala and Mittone (2005), their findings suggest that laboratory experiments are able to offer insights regarding marginal effects of parameter changes.

5.5.1 Testing the Classic Microeconomic Predictions

Experiments that test traditional microeconomic models such as those we have seen (AS and ASY), focus on manipulations of the enforcement regime, the tax rate and the fine rate. In an experiment conducted on law students, Friedland (1982) found for example that responsiveness to information about threat probability (audit) is higher than to information about threat magnitudes (fines).

Moreover, a number of experiments have been conducted to assess reactions to variations in the tax burdens. The ASY model predicts the compliance rate to be increasing in the tax rate, however, this cannot be confirmed by a number of findings coming from the lab, which is commonly called the Yitzhaki puzzle. Alm et al. (1992b) find that tax evasion increases with the tax burden which is in-line with the empirical findings of Clotfelter (1983), even with the tax rate elasticity being similar[3]. Also the experimental subjects of Bernasconi et al. (2014) tend to increase their compliance when the tax burden decreases and vice versa. In addition they find that the reaction to tax cuts and tax rises is asymmetric with faster reaction to the first than to the latter.

Cultural factors and social norms might also play a role as shown by Alm et al. (1995), whose results will be presented more in detail in the next section. They find that Spanish test subjects behave according to the ASY model, increasing their compliance with higher tax burdens at a positive rate of 0.94 whereas the U.S. subject pool confirms once again previous findings as in Clotfelter (1983) and Alm et al. (1992b) with a negative elasticity of around −0.5.

An attempt to modify the ASY model in order to match the experimental and empirical evidence has been made by Dhami and Al-Nowaihi (2007) who show that under prospect theory, hence depending on the reference point, tax evasion is increasing in the tax rate[4].

Overall, similarly to empirical results, also in the laboratory higher-than-rational levels of compliance are usually observed, which prompted researchers to investigate the role of determinants other than the classical triad of parameters.

[3] around −0.5.

[4] Strictly increasing for interior solutions and non-decreasing in case of boundary solutions when $D^* = 0$ or $D^* = W$.

5.5.2 Tax Compliance as a Social Norm

The juxtaposition of the profit-maximizing *homo economicus* in the Smithian sense with Dahrendorf's more other-regarding *homo sociologicus* became a necessary adjustment in the attempt to disentangle the fundamental drivers of the tax compliance decision.

The latter characterization describes an economic agent who acts according to social norms and exhibits feelings such as guilt and anxiety. Roughly said, social norms are behavioral rules shared by other people who tend to judge them in a similar way. Elster (1989) cites some examples of social norms, such as norms of reciprocity, work norms and norms of cooperation. Special forms of norms of cooperation are given by norms of fairness.

The relevance to the tax compliance decision covers various aspects. First, perceived peer-to-peer fairness which follows a logic similar to: "if others (don't) pay their taxes then I am (not) going to pay them as well". Second, the tax system itself might be evaluated in terms of fairness before taking a compliance decision. The items under scrutiny could be the magnitude of the fine, the frequency and modality of performed audits, the tax progressivity and thus the level of tax equity with respect to one's income. Finally, taxes are levied in order to finance public projects which may lead to an evaluation of the personal gain from paying taxes and receiving public good consumption in return, or also of the efficiency of public spending.

One way to test the relevance of social norms is to conduct cross-country surveys. By comparing responses from different cultures with similar fiscal systems, different tax attitudes and compliance rates emerge. Alm et al. (1995) provide a rough summary of the main findings of such studies. Drivers of tax compliance can be classified into moral (compliers view tax evasion as immoral and "moral appeal" tends to have positive effects on compliance), reputational (low social standing of tax evaders), peer effects (friends of tax evaders tend to evade more), perception of fairness, trust, and social cohesion. Alm et al. (1995) conducted a tax compliance experiment in the laboratory with Spanish subjects replicating an earlier study that was run in the United States. From the comparison of the two studies, it emerges that the Spanish subjects tend to comply less than their American counterparts in absolute terms. In the absence of a public good, with a fine rate of 2, a 30% tax rate, and a 5% probability of being audited, compliance of the American subjects is 27% on average, whereas in Spain it amounts to only 7%. However, the Spaniards turn out to be much more sensitive toward fiscal policies, such as changes in the tax rate, the audit rate, or the magnitude of the fine. While reminding the reader that the only difference between the two experiments lies in the cultural origin of the subject pools, the authors conclude that the social norm of compliance, which can also be defined as "tax morality", might be the reason for the difference in responses. It also emerges that there are different types of taxpayers: those who always comply and those who never comply, utility maximizers, subjects that behave according to prospect theory overweighting low probabilities, highly policy-sensitive subjects, and some who are at times cooperative and at times free-riders.

The power of social norms is also determined by the interaction and enforcement among individuals. The relevance of peer effects is bolstered by Vogel's analysis of a survey with Swedish respondents (Vogel 1974), which shows that contacts with tax evaders decreases tax compliance, weakening the social norm of compliance and, as a consequence, also the stigma of evading. On the other hand, conforming to tax-paying peers might also yield a positive return, based on the individual's level of intrinsic tax morale.

A formal model, which is still embedded in the EUT framework, was developed by Myles and Naylor (1996). Conformity to social groups yields an additional payoff to the taxpayer, which depends on the size of the group itself. Moreover, the non-evasion equilibrium could potentially be turned over by small changes in the tax rate, leading to an evasion epidemic with tipping point behavior.

Tightly linked to the concept of social norms and group conformity are the models considering the psychic costs of evasion, as described by Gordon (1989). The evaded amount becomes a function of an additional parameter which is determined by the personal level of morale and peer effects. The positive relationship between tax morale and tax compliance has been tested and confirmed numerous times in the laboratory (for an extensive survey and discussion of experimental results see Torgler 2002). In a separate article, Torgler (2003) shows empirically that the level of tax morale itself is influenced by formal and informal institutions, such as direct participation rights and trust in the government. He defines tax morale as "the intrinsic motivation to pay taxes" or "the willingness to pay taxes by the individuals."

We have seen that the tax-compliance decision is not only determined by the absolute levels of the classic parameters, which are the fine rate, the tax rate, and the probability of being caught in a random audit. Psychological and cultural factors also play a role, as well as peer interactions. The latter exhibit imitative patterns based on lagged events and give rise to the need for a dynamic modeling approach. In the following section we will present the tool of agent-based modeling, which represents a way to bridle the rise in complexity of stylized facts that potentially influence the tax-compliance decision.

5.6 From Top Down to Bottom Up—From Experimental Economics to an Experimental Economy

The ultimate purpose of research on tax evasion is undoubtedly to find policies able to increase tax compliance and hence the overall tax levy. A number of interplays and complexities characterizing the system (e.g., country) under analysis have to be considered in order to fit the outcome-predicting model as closely as possible to the underlying reality without too much loss of generality.

It is, however, a challenging task and not always possible to disentangle the behavioral and economic elements affecting the tax-compliance decision by analyzing the available empirical data. Parameter values needed for a correct calibration could

be obtained, for example, by performing field studies and conducting laboratory experiments. The idea of using experimental data (but not solely) in order to feed a computer-simulated replica of society was suggested by Duffy (2006), and even though calibration with experimental data has not yet become a widespread habit, we will see one agent-based model that put these suggestions into practice.

Agent-based models offer an alternative approach to deal with complexity, and the available tools make it possible to take interactions and heterogeneities into account without necessarily abandoning the simplicity of representation. It is possible to artificially recreate an experimental economy that reacts according to the model we choose. The parameter values can be calibrated according to experimental or empirical findings; and, most importantly, this technique allows simulation with heterogeneous agents and social interactions in a dynamic environment. The results of agent-based simulations are then compared with real data, allowing for a more detailed understanding of the underlying social and behavioral dynamics.

5.6.1 Group Conformity and Social Norms

Bloomquist (2006) reviewed three agent-based simulation models applied to an environment of tax compliance, namely, Mittone and Patelli (2000), Davis et al. (2003), and Bloomquist (2004).

Mittone and Patelli (2000) use the model of Myles and Naylor (1996) as a basis, which considers group conformity and the social norm of tax compliance. Psychological costs are also included in the model, as originally proposed by Gordon (1989), but without making them depend on the evaded amount. The underlying idea is that, no matter how much income is hidden, once the decision to evade is put into practice, the "honest citizen" status is lost.

Agent heterogeneity is captured by introducing three types of subjects: the honest taxpayer, the imitative taxpayer, and the perfect free-rider, each with his or her own specific utility function. Honest agents achieve positive marginal utility effects from conforming to social rules; free-riders will contribute as little as possible; and imitative taxpayers will use the population mean of compliance as a benchmark, which is also in a way in line with the findings on peer effects described by Vogel (1974) and the findings of Porcano (1988), that the perception of existing evasion has a positive and significant effect on the own level of evasion. Additional utility gains are obtained from the introduction of a public good that depends on the amount of tax levy, as considered by the theoretical model of Cowell and Gordon (1988).

Finally, the behavioral characteristics of single agents are not static, but subject to a stochastic updating process, a genetic procedure where probabilities of type-survival are calculated based on individual utility gains over total population utility gains.

Decision rules on how much to declare follow a learning mechanism with choices being updated based on the success or failure of past compliance decisions.

The random element in the behavioral switching algorithm, in combination with the feature of imitative behavior, triggers a cycle that allows for the model to react to audit rates that are close to zero, pushing compliance to a near-zero level, even if all agents were initially honest.

On the other hand, when audits are introduced, only honest taxpayers remain after a certain number of rounds. It is interesting to notice that the type of audit procedure, uniform versus those aimed at the lower tail of contributions, does not change this result.

Another model considering peer-oriented behavior is the Multi-Agent Based Simulation (MABS) developed by Davis et al. (2003) using the software *Mathematica*. The behavioral classification of taxpayers is similar to the previous model: there are honest, susceptible (to others' behavior), and evading agents.

Initially, there are two randomly assigned types: honest and evading. An honest taxpayer might, depending on the "infection rate," become a susceptible one in case a (randomly chosen) acquaintance happens to be an evader. Susceptible agents form beliefs about the severity of the tax enforcement regime by observing the mean audit frequency of their peers in the previous period. They become evaders if this perceived severity is below a certain threshold. Finally, evaders become honest taxpayers if the belief about the severity of the audit regime is above a certain threshold or if they observe a social norm of tax compliance. The existence of a social norm of tax compliance is confirmed by having a certain number of honest taxpayers among the own acquaintances.

Also, evading agents become honest after a tax audit. The authors follow the literature on availability (Tversky and Kahneman 1973) and vividness, assuming that the subjectively determined probability of being audited is judged to be higher after a recent audit experience. This assumption, however, stands in contrast with the experimental findings of Mittone (2006) and Maciejovsky et al. (2007), who observed negative post-audit responses, which are likely to be due to the so-called Bomb-Crater Effect, according to which most recent events are judged to be unlikely to occur again immediately. A second cause is a loss-repair mechanism as described by Maciejovsky et al. (2007) and suggested also by Andreoni et al. (1998) where the fined taxpayer tries to recover the sum by evading more in the subsequent round.

By manipulating the starting proportion of evading and honest agents and letting the systems evolve over 2,000 rounds, Davis et al. (2003) find that changes in the audit rates from 0.002 to 0.030 in steps of 0.002 lead to "tipping point" behavior with abrupt changes in compliance equilibria. In all set-ups societies converge to total honesty at an audit rate of only 0.03. Although the latter result is not supported by empirical findings, it is still notable that the audit rate may be used as a device to prevent a non-compliance epidemic from happening.

The authors suggest establishing a similar experimental environment with social norms and group conformity in order to confirm the robustness of their finding.

5.6.2 The Tax Compliance Simulator (TCS)—Playing with Complexity

Bloomquist (2004) uses the software NetLogo in order to simulate a more complex agent-based environment. His Tax Compliance Simulator (TCS) is capable of testing the effects of variations in audit rates, fine rates, income visibility (wages and salaries versus other sources of income), auditor efficacy, and audit celerity after the event of an evasion. What is measured are direct effects of audits given by the additional levy, indirect effects of audits experienced by peers, and post-audit responses.

The interface of the TCS is also quite intuitive for a non-technical user and was illustrated in Bloomquist (2006, p. 423). It is composed by various sliders (such as tax rate, audit rate, penalty, etc.) through which it is possible to manipulate the desired parameter values before starting the simulation.

Diagrams at the top show the evolution of the variables of interest, as, for example, the amount of reported tax over time, whereas the distribution dynamic of full evaders, partial compliers, and full compliers appears in the window containing "turtles," the NetLogo labeling of what we called agents.

The TCS features both overweighting of low audit probabilities and overestimation. Taxpayers tend to overweight low probabilities of audit, as predicted by prospect theory (Kahneman and Tversky 1979) and experimentally assessed by Alm et al. (1992). All probabilities were given, but there was still evidence of people typically overweighting these probabilities. Overestimation, on the other hand, is a bias which is a less numerical and more psychological phenomenon: it may depend on the subjects' perception of the auditing mechanism and also past audit experiences, as hypothesized in Kastlunger et al. (2009).

In order to help account for the opportunities to evade, it is possible to determine the percentage of visible income. Visible income being subject to third-party information reporting, such as salaries, is assumed to be entirely declared, which is in line with empirical data. However, once the agent does not declare her full income it is not always true that when an audit is performed, the full evasion is detected. To account for such partial detection, a detection rate is introduced and the cost component of the decision to evade is modified accordingly.

Finally, also borrowing constraints which could incentivize lower compliance and discount rates for delayed detection with respect to the evasion event itself are taken into account.

Unlike the first two models, the TCS uses actual empirical evidence from IRS audit data when calibrating the parameters of the MABS model in order to achieve an outcome which is as close as possible to observed levels of compliance.

5.6.3 Experimental Economics—Calibration with Experimental Data

In an agent-based exercise simulating tax compliance behavior of small-business owners Bloomquist (2011) employs a relatively simple evolutionary game-theoretic

approach and uses experimental data in order to calibrate the model programmed in NetLogo. Taxpayers this time are of four different types: Honest, Strategic, Defiant, and Random. Behavior of small-business owners is hypothesized to be similar to that of laboratory subjects and in order to prove this claim the author relies on third-party experimental results (Alm and Mckee 2006; Alm et al. 2008). In these tax-compliance experiments subjects were tested for various behavioral mechanisms, but for comparability reasons only data of the "no treatment" subject pools was extrapolated for the calibration purpose at issue. Compliance rate histograms clearly exhibit the typical bimodal distribution around zero and one, hence confirming the existence of honest and defiant taxpayers.

Initially the combination of behavioral taxpayer types is selected such that laboratory results in terms of mean and mode are matched as closely as possible. In this first run no neighborhood effects were included because laboratory subjects were not able to see what others were doing. From the comparison of the simulation results for five different audit rates from 0 to 0.40 with and without risk aversion,[5] it can be inferred that the inclusion of risk aversion with probability weighting gives more precise results for audit rates ranging from 0 to 0.10, confirming the findings of Bernasconi (1998).

As a second step four different scenarios[6] of agent-based modeling were matched to real data gathered from the IRS National Research Program (NRP) study. The subsample of individuals with income stemming only from Sole Proprietorship (Schedule C—Profit or Loss From Business) was used and cases of overcompliance were normalized to full compliance. None of these four simulations was able to match the average NRP compliance rate at which point the agent group defined as "random taxpayers" was excluded from the runs, assuming that small-business owners exhibit less random behavior than the students who participated in the lab.

The best match with the new setup was found in absence of neighborhood effects, which is also clear from the comparison of the histogram of compliance rates of the simulation with real data excluding neighborhood effects from playing a dominant role.

5.6.4 A Model of Citizenship

Pellizzari and Rizzi (2014) developed an agent-based model of tax compliance that contemplates two types of agents: taxpayers and the government. Taxpayers maximize their utility based on net income and also considering the perceived level of public expenditure. Again, the role of the public good is considered as being relevant to the tax-compliance decision, but in a more sophisticated and dynamic way than we already saw in Mittone and Patelli (2000). In addition, an array of individual characteristics are included—namely, risk aversion; relative preference for public expenditure; an innate tendency to pay taxes, which we could define as intrinsic

[5] Risk aversion in this case describes the mechanism of overweighting small probabilities of being audited as described (also in Bernasconi, 1998).

[6] Risk aversion versus no risk aversion and neighborhood effects versus no neighborhood effects.

tax morale; and, as in Mittone and Patelli (2000), group conformity modeled as the expectation about other agents' compliance behavior. Audit probabilities are not exactly known and inferred subjectively by observing audit dynamics among peers.

Moreover, the authors propose three different institutional frameworks based on the power a government is able to exert (high, average, and low). The taxpayers are divided into three types based on their level of "citizenship," which is defined as a combination of the preference for public expenditure, group conformity, and tax morale.

Under a weak enforcement regime and with a low level of citizenship the authors observed high levels of tax evasion. Even with high levels of enforcement, full compliance cannot be achieved. Moreover, *ceteris paribus*, the higher the tax rate, the lower the compliance level of their agents. This finding is in contrast with the predictions of the theoretical EUT model developed by Yitzhaki (1974) but confirms a large body of empirical evidence.

Government power still plays a significant role in societies with an average level of citizenship, even though elasticities decrease with respect to low levels of citizenship. Finally, the role of government almost disappears for high levels of citizenship, where tax evasion approaches near-zero levels regardless of the enforcement regime.

Overall, citizenship is found to have a larger marginal effect on compliance than enforcement power by the government, but both concepts are necessary to enhance the level of tax compliance in a society.

To take the findings further, it could also be interesting to read these results in light of the somewhat contrasting prescriptions coming from the literature on motivation crowding-out, surveyed for example by Frey and Jegen (2001): the intrinsic motivation to pay taxes could therefore be decreased by the mere presence of an extrinsic mechanism of punishment.

5.7 Conclusions

The aim of this survey was to take the reader on a tour through the very rich body of existing literature on tax evasion. Not only the plurality of determinants of tax compliance, but also the multiplicity of methodologies and analytical approaches make it a challenging task to provide policy makers with useful indications.

We started from the classical models of tax evasion which represent an ideal starting point for more realistic considerations and modifications. Thereafter, institutional, social and psychological factors, among others, have been found to be highly relevant when a taxpayer decides how much to declare to the tax authority. Also, survey data and laboratory experiments have shown that interaction among taxpayers in the form of peer effects and psychic costs of evasion cannot be disregarded.

As the famous physicist Stephen Hawking so wisely predicted, "the next century will be the century of complexity." We now face the moment in which we have to

tame and coordinate all these different elements in order to maintain the informative value of new findings.

To do so, the *ceteris paribus* approach and the search for equilibria should be relaxed, giving space to a new notion of *ceteris mutabilibus*[7] and asymptotic dynamics. Innovative tools are needed, and the impressive computing power of modern devices serves this purpose well. We presented some examples of agent-based models to provide the reader with food for thought by highlighting their flexibility in accounting for both heterogeneous agents as well as different kinds of parameters, in addition to the possibility for interaction and the dynamic nature of such simulations. Additionally, individual characteristics can be matched with evidence stemming from human subjects tested in the lab, as we have seen in Bloomquist (2011).

The future focus of research on tax compliance should hence be on continuing the multidisciplinary approach in determining the drivers of tax evasion, on one hand, while properly administering, elaborating and integrating old and new findings, on the other, with the final aim being to provide policymakers with ever-improving policy advice on how to increase the overall level of tax compliance.

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[7] "All else changeable."

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