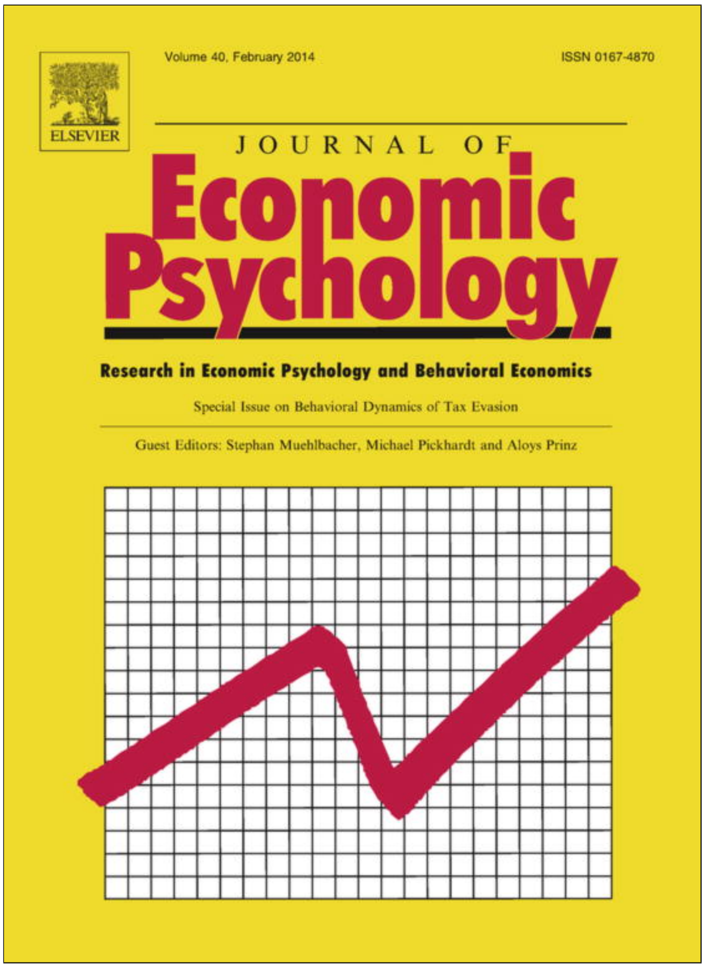
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Reference dependent preferences, hedonic adaptation and tax evasion: Does the tax burden matter?

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ABSTRACT

We study the effects of the tax burden on tax evasion both theoretically and experimentally. We develop a theoretical framework of tax evasion decisions that is based on two behavioral assumptions: (1) taxpayers are endowed with reference dependent preferences that are subject to hedonic adaptation and (2) in making their choices, taxpayers are affected by ethical concerns. The model generates new predictions on how a change in the tax rate affects the decision to evade taxes. Contrary to the classical expected utility theory, but in line with previous applications of reference dependent preferences to taxpayers' decisions, an increase in the tax rate increases tax evasion. Moreover, as taxpayers adapt to the new legal tax rate, the decision to evade taxes becomes independent of the tax rate. We present results from a laboratory experiment that support the main predictions of the model.

1. Introduction

How does the tax burden affect tax compliance? Is the level of the tax burden important to explain cross-country differences in tax compliance? How does a change in the tax rate influence the level of tax evasion?

Although these are fundamental questions to design effective fiscal policies, they have not been considered with the same attention. In this respect, the benchmark analysis is the classical expected utility model developed by Allingham and Sandmo (1972). The authors consider the problem faced by a taxpayer who chooses how much of an exogenous income to report for the payment of a proportional (income) tax. With a given probability, the choice of the taxpayer is audited and, in the case of ascertained evasion, she is convicted to pay (in addition to the taxes) a sanction that is proportional to the evaded income. Under these assumptions, an increase in the tax rate exerts two opposed effects on the choice of the taxpayer. On the one hand, it lowers the after-tax income from full compliance. If the taxpayer has a *decreasing absolute risk aversion* utility function, then the fiscal shock makes her less likely to evade. On the other hand, an increase in the tax burden implies a higher

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return to evading, while the potential penalty remains unchanged. Thus, the net effect of the fiscal change on the level of tax evasion is ambiguous and depends on the specific form of the utility function of the taxpayer. However, as shown by Yitzhaki (1974), if the penalty is proportional to the amount of tax evaded, then the model predicts, under decreasing absolute risk aversion, a positive relationship between the tax rate and the level of income reported by the taxpayer.

The comparative static predictions of the traditional model are not intuitive and have been criticized by those who believe that a rise in the tax burden tends to stimulate (rather than discourage) evasion. Unfortunately, the empirical evidence is not conclusive and, to some extent, seems to depend on the specific features of the econometric strategy employed. Time-series econometric studies using either aggregate or average measures of noncompliance generally find a negative relationship between the tax rate and the level of tax compliance (see Crane and Nourzad, 1987; Poterba, 1987; Pommerehne and Weck-Hannemann, 1996).[1] Cross-sectional studies using data on individual audited tax returns report mixed results. While Clotfelter (1983) finds that the level of the tax burden is positively associated with tax evasion, other contributions document either a nonsignificant correlation (among others, Cox, 1984; Slemrod, 1985; Kamdar, 1995) or (even) a negative relationship (Feinstein, 1991).

Also experimental studies generate ambiguous evidence. Two of the earliest within-subject experiments (Friedland et al., 1978; Baldry, 1987) find that a reduction in the tax rate is associated with a higher level of tax compliance. However, the robustness of this result has been questioned by between-subject designs. Indeed, while in a study conducted on US students, Alm et al., 1992, 1995 observe a positive relationship between the tax rate and the amount evaded, in a subsequent experiment involving Spanish subjects, Alm et al. (1995) document contradictory results.

A possible explanation for this empirical impasse is that tax evasion decisions are more complex than what the classical model postulates. For instance, tax compliance can depend on frames and references, which in turn adapt to circumstances and events.

Cumulative Prospect Theory (Tversky and Kahneman, 1992) represents the leading approach to incorporate the notion of reference dependent preferences in behavioral economic models. According to this theory, rather than being measured in absolute levels, economic outcomes are evaluated as gains or losses relative to a reference. Applications of Prospect Theory to tax evasion have been recently proposed by various researchers (e.g., Shepanski and Shearer, 1995; Bernasconi and Zanardi, 2004; Kirchler, 2007; Dhami and al-Nowaihi, 2007; Rablen, 2010). These contributions have investigated specific aspects of the theory, such as the *subjective weighting of probabilities*, the *diminishing sensitivity* of gains and losses, the property of *loss-aversion*.[2]

While studies have introduced reasonable assumptions on the formulation of references in tax evasion decisions, less attention has been devoted to analyze how taxpayers react and adapt to changes in fiscal conditions over time. In this paper, we extend the existing analysis by considering how the adaptive process of the reference used by the taxpayers in taking their decisions influences the level of tax evasion.

Psychologists use the term *hedonic adaptation* to refer to "*processes that attenuate the long-term emotional or hedonic impact of favorable and unfavorable circumstances*" (Frederick and Loewenstein, 1999, p. 302). By hedonic adaptation, reference dependent preferences tend to adjust to changes in pre-existing conditions such that the behavioral response to repeated stimuli can be limited in time.

Recently, hedonic adaptation has been extensively used by behavioral economists to analyze consumers' habit formation, the response to changes in health conditions and investment decisions (Frederick and Loewenstein, 1999). Moreover, there is substantial evidence showing that reference points adapt to favorable and unfavorable events at a different speed (Arkes et al., 2008, 2010; Lyubomirsky, 2011).

Our analysis offers new insights on how hedonic adaptation affects taxpayers' perception of fiscal variables and their decision to evade. First, we study how taxpayers (instantaneously) react to a change in the tax rate. In particular, we find that an increase in the tax rate discourages taxpayers' compliance. Second, we show that, once taxpayers completely adapt their reference to the new fiscal conditions, the level of tax evasion is independent of the tax burden, a prediction that is also consistent with the old adage in public finance stating that "*an old tax is no tax*"(Bastable, 1892).[3] We find supporting experimental evidence in favor of the predictions of our model. Moreover, in our experiment, we also find that subjects tend to adjust faster to tax cuts than to an increase in the tax rate.

The rest of the paper is structured as follows. In Section 2, we briefly review the literature analyzing the relationship between tax evasion and the tax burden. In Section 3, we present a theoretical framework that introduces reference dependent preferences and hedonic adaptation in a model of tax evasion decisions. In Section 4, we describe the experiment aimed at testing the main theoretical predictions and we present the results. We conclude in Section 5 with a discussion of the policy implications of our analysis.

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[1] Various empirical analyses have also been conducted to study the relationship between fiscal pressure and the size of the shadow economy. In general, times-series analyses conducted within country document a negative effect (among others, Johnson et al. (1997), Giles et al. (2001), Dell'Anno (2007)). On the contrary, cross-sectional analyses involving different countries find either a weak or a nonsignificant relationship between the size of the underground economy and the fiscal burden (see Schneider and Enste (2000) and Torgler and Schneider (2009)).

[2] The analytical features of Prospect Theory are well-known and well-documented by the behavioral literature. For a recent comprehensive discussion of the properties of Prospect Theory, see Wakker (2010).

[3] A related adage is that "*an old tax is a good tax*" (see, Buchanan, 1967). The interest for these adages in the tax evasion literature has been brought to our attention by Dhami and al-Nowaihi (2007).

2. Background

2.1. Classical expected utility approaches

The benchmark model of tax evasion is based on two seminal contributions: Allingham and Sandmo (1972) and Yitzhaki (1974). A taxpayer with gross income $Y > 0$ is required to pay taxes according to a flat tax rate $\tau \in (0,1)$. The tax authority does not observe the gross income of the taxpayer, directly. However, with probability $p \in (0,1)$, the tax authority conducts an audit procedure on the decision of the taxpayer. If audited and found to have concealed part of her income, the taxpayer is convicted to pay the taxes evaded plus a sanction.[4] Thus, the disposable incomes of the tax payer in the two states of the world, not audited (na) and audited (a), are given by:

$$Y_{na} = Y - \tau d, \quad (1)$$

$$Y_a = Y - \tau d - s\tau(Y - d), \quad (2)$$

where $s > 1$ and $d \in [0, Y]$ are the sanction rate inclusive of the penalty surcharge and the reported income, respectively.

Allingham and Sandmo (1972) developed the model as a contribution in the field of the economics of crime. By assuming that the taxpayer maximizes her expected utility, they provide important insights on the determinants of tax evasion, including the predictions on the deterrent effects of both the audit probability and the level of sanctions. However, some implications of the model have been criticized. First, the model predicts that the taxpayer will under-report a part of her income whenever the expected return to one dollar of evaded taxes is positive. In contrast to this theoretical prediction, although in many countries the fiscal parameters entail a positive expected return to tax evasion, not all taxpayers evade.[5] Another controversial prediction is that when τ increases, a taxpayer with a *decreasing absolute risk aversion* (DARA) utility function would increase tax compliance.[6]

Subsequent research[7] has mainly focused on two specific features of the classical model. First, economists have analyzed the effects on tax compliance of labor supply decisions, progressive tax rules and endogenous audit probability. Second, several studies have enriched the original setting by introducing ethical as well as psychological factors (stigma, social norms, morality and the perceived fairness of the tax system) as determinants of the choice to evade.[8] Despite of these promising approaches, assessing how the tax burden affects the level of tax compliance remains an open question.

In the next section, we present an extension of the standard model that is based on two hypotheses. First, taxpayers are endowed with reference dependent preferences that are subject to hedonic adaptation. Second, in deciding whether and how much to evade, taxpayers are affected by ethical concerns.

3. Tax evasion with reference dependent preference and hedonic adaptation

Under reference dependent preferences (as entailed by the classical version of Cumulative Prospect Theory), the objective function of the taxpayer can be written as follows:

$$V(d) = \pi(p)v(Y_a - r) + (1 - \pi(p))v(Y_{na} - r), \quad (3)$$

where r is the 'reference' income that is used by the taxpayer to take her tax decision and $v(\cdot)$ is the reference dependent value function, which is concave in 'gains' and convex in 'losses'. In particular, we assume the original specification of $v(\cdot)$:[9]

$$v(x) = \begin{cases} x^\gamma & \text{if} \quad x \geqslant 0, \\ -\lambda(-x)^\gamma & \text{if} \quad x < 0, \end{cases} \quad (4)$$

where $\gamma \in [0,1]$ and λ (that is typically assumed to be greater than 1) is the parameter that captures loss aversion.[10] $\pi(p)$ and $(1 - \pi(p))$ are subjective weights obtained as non-linear transformations of p and $(1 - p)$, respectively. [11]

As discussed in the introduction, various contributions have focused on specific features of Prospect Theory to accommodate empirical violations of the standard expected utility theory. First, several studies (Alm et al., 1992; Erard and Feinstein, 1994; Bernasconi, 1998) have shown that the tendency to overweight small probabilities according to the transformation

[4] In Allingham and Sandmo (1972), sanctions are computed on evaded income. However, Yitzhaki (1974) noted that sanctions are usually computed as a percentage of the evaded taxes.

[5] See Andreoni et al. (1998) and references in Section 3.

[6] In particular, if the size of the sanction is proportional to the evaded taxes, then an increase in τ only exerts a negative income effect. If the taxpayer has a DARA utility function, she will respond to the fiscal shock by making safer choices. Instead, the predicted response to an increase τ is ambiguous when either the utility function is not of the DARA type or the fine is proportional to evaded incomes (as, in this case, the fiscal shock would exert both a substitution and an income effect – see Allingham and Sandmo, 1972).

[7] See Hashimzade et al. (2012) for a comprehensive survey.

[8] See, for instance, Andreoni et al. (1998), Slemrod and Yitzhaki (2002), Torgler (2007).

[9] See Tversky and Kahneman (1992).

[10] For example, Tversky and Kahneman (1992) estimated a value of λequal to 2.25.

[11] We adopt a rank-dependent specification of the probability weighting function. A large literature has discussed various alternative models, with some authors separately treating the function in the domain of gains and losses (see Wakker (2010), for discussion and references). See Dhami and al-Nowaihi (2007) for a different specification that allows the p parameter to depend on the evaded income.

function $\pi(\cdot)$ can explain why many taxpayers fully comply, even when the expected return to one dollar of evaded taxes is positive. This result does not depend on the specific assumptions to model the reference.

Applications of reference dependent preferences based on Eq. (3) require the specification of the reference income, r. Bernasconi and Zanardi (2004) develop the analysis for an arbitrary r that is included between 0 and the taxpayer's gross income, Y. While this approach offers useful insights on how taxpayers frame the decision to evade, it fails to predict actual behaviors, as results change with the size of the reference. Indeed, the authors show that when the reference income is greater (smaller) than the disposable income under full compliance, $(1-\tau)Y$, the taxpayer responds to an increase in the tax rate by evading more (less).

Elffers and Hessing (1997) and Yaniv (1999) assume that the taxpayer's reference is determined by the difference between her gross income and any advance tax payment. This hypothesis accounts for the so called "withholding phenomenon" (Shepanski and Shearer, 1995), namely the tendency of taxpayers who are under-withheld when filing to evade more than those who are over-withheld. However, a doubtful implication of these models is that when the advance tax payments are null, the reference income always coincides with Y.

Dhami and al-Nowaihi (2007) use the disposable income under full compliance, $Y(1-\tau)$, to specify taxpayers' reference. This is consistent with the idea that taxpayers treat the (current) legal taxes as the status quo. Therefore, relative to the status quo, any tax cut represents a gain and induces the taxpayer to evade less while any increase in the tax burden is perceived as a loss and stimulates tax evasion. An important implication of the model is that the reference is endogenous to the fiscal policy. While we find this argument convincing, we still believe that there are important issues that require further analysis.

A first controversial aspect is whether the reference should be defined according to the taxes legally due or, rather, by (only) considering those the taxpayer feels in her duty to pay. For example, Rablen (2010) has recently argued that the perception of the taxes – as either gains or losses – may depend on the nature of the public expenditure financed through taxation. More generally, there are several dimensions (institutional, ethical, emotional) that influence taxpayers' perception of the "fair" taxes to pay and contribute to the definition of the reference income.

A second issue concerns the assumption that the current legal tax rate always coincides with the status quo. As also highlighted by traditional theories of public finance (see Buchanan, 1967), when a change in the tax rate occurs, taxpayers may require time to adapt to the new fiscal conditions and, during the adjustment process, the status quo can differ from the current legal tax rate. In psychological terms, the problem consists of specifying the adaptive process followed by the taxpayer to adjust her reference when a fiscal shock occurs.

3.1. Hedonic adaptation of the reference point and tax reporting decisions

Given the previous considerations, we model the reference income, r, in Eq. (3) as follows:

$$r = Y(1-\beta\tau_r), \tag{5}$$

$$\tau_r = \alpha\tau + (1-\alpha)\tau_{r-1}. \tag{6}$$

Eq. (5) implies that the taxpayer's reference income, r, depends on her gross income, Y, a reference tax rate, τ_r, and a parameter $\beta \in [0,1]$, which captures her 'moral' attitude to pay taxes. As shown by Eq. (6), τ_r adapts over time according to a first order (adaptive) process of the current legal tax rate, τ, and the reference tax rate used by the taxpayers in the previous reporting period, τ_{r-1}.[12] When $\tau = \tau_{r-1}$, then the legal tax rate, τ , coincides with the reference level, τ_r. However, when an increase in the tax burden occurs, the legal tax rate is different from both the current and the past reference levels, τ_r and τ_{r-1}, respectively. In this case, τ_r adjusts to the legal tax rate over time at a speed that depends on the parameter α. The parameter β represents the fraction of taxes (computed according to the reference tax rate) that the taxpayer feels in her duty to pay for ethical or related reasons. Clearly, when $\beta = 1$, the taxpayer's ethical duty is to pay the full tax burden. On the other hand, if $\beta < 1$, she feels morally entitled to pay less than $\tau_r Y$.

Weighted average (adaptive) processes similar to (6) abound in the literature (see, e.g., Frederick and Loewenstein, 1999; Bowman et al., 1999; Wathieu, 2004). Nevertheless, it is important to remark that perfect weighted average processes represent a simplification of the reality. An interesting (and empirically validated) refinement postulates that people tend to adapt their reference quite fastly to unexpected improvements of their economic conditions, while the adaptation to losses requires more time and can even result in an incomplete process (see Strahilevitz and Loewenstein, 1998; Diener et al., 2006; Arkes et al., 2008, 2010; Lyubomirsky, 2011).

In our context, the asymmetry in subjects' adaptation implies that the value of α is context dependent, being higher in the case of gains and lower in the case of economic deteriorations (Frederick and Loewenstein, 1999). Without loss of generality, the following theoretical analysis is developed under the assumption that α does not depend on the nature of the fiscal shock – either an increase or a decrease in the tax rate. We will come back to this point when we will present our experimental results. [13]

[12] Since all variables but the reference tax rate refer to the current reporting period, in the following analysis we omit the time index.

[13] A different issue concerns the role of expectations, which are known to affect the formation of the reference (Kahneman and Tversky, 1979). Clearly, weighted average (adaptive) processes are coherent with models of adaptive expectations. However, the model can be easily extended to include the effects of exogenous shocks on expectations (see the discussion in the last section of the paper).

Another important qualification concerns the parameter that captures the ethical concerns of the taxpayer, β. Although we treat β as exogenously given, the model can be generalized to a setting in which the ethical concerns depend on behavioral artifacts such as peer effects, social norms, stigma, the (perceived) quality of the fiscal institutions, the (perceived) equity of the fiscal system, emotions (see Torgler (2007) for a review).

Finally, in our model the taxpayer takes her decisions by using a *single* reference that is built on two (main) determinants: adaptation and ethical concerns. Alternative approaches consider a different setting in which agents' decisions involve the use of *multiple* references. In general, models with multiple references are more complex and deliver ambiguous predictions (see Kahneman (1992), for a discussion). We have opted for a more traditional approach as we are (mainly) interested in assessing the effects of a change in a single parameter, the tax burden, on tax evasion decisions.

3.1.1. Static solutions

By Eqs. (1), (2) and (5), the outcomes in the two states of the world, not audited and audited, can be expressed as follows:

$$Y_{na} - r = -\tau d + \beta\tau_r Y, \tag{7}$$

$$Y_a - r = -\tau d + \beta\tau_r Y - s\tau(Y - d). \tag{8}$$

We now compute the optimal reported income that is chosen by the taxpayer by plugging (7) and (8) in the reference dependent value function. We first derive results in the static context in which both τ and τ_r are exogenously given. Then, we use the static solution to analyze the effects of a change in the legal tax rate on the optimal reported income given the adaptive process in (6). [14] We separately analyze two cases: $\tau \geqslant \beta\tau_r$ and $\tau < \beta\,\tau_r$.

Proposition 1. *If $\tau \geqslant \beta\tau_r$, the optimal reported income, d^*, either coincides with the gross income, Y, or is in the interval $[0, \beta\frac{\tau_r}{\tau}Y)$. In the latter case:*

(i) *if $\tau = \tau_r$, d^* only depends on (Y, p, s, β) and is independent of the current tax rate, τ;*
(ii) *if $\tau \neq \tau_r$, d^* increases in the ratio between the reference tax rate and the current tax rate, $\frac{\tau_r}{\tau}$.*

On the one hand, the condition $\tau \geqslant \beta\tau_r$ implies that, if audited, the taxpayer is always in the loss domain, namely $Y_a - r = -\tau d + \beta\tau_r Y - s\tau(Y - d) < 0$. On the other hand, since $Y_{na} - r = -\tau d + \beta\tau_r Y$, in order to be in the gain domain if not audited, the taxpayer must report a fraction of gross income that is not greater than $\beta\frac{\tau_r}{\tau}$ (see Fig. 1a).

As shown by Proposition 1, under Prospect Theory, economic agents may "plunge" from the risk-free corner solution, $d^* = Y$, to an interior solution.[15] Partial plunging can occur at an interior kink even with a piece-wise linear utility function (Schmidt and Zank, 2007). Since we do not restrict the utility function to be linear and provided that, if not audited, the taxpayer ends up in the gain domain, the interior solution can be different from the level that is associated with the kink. It is also important to remind that, in the loss domain, static solutions can be minimia. In Appendix A, we show that the conditions for the optimal reported income to be either interior or at $d^* = Y$ are not straightforward and, in general, require to compare the values of the objective function at the two possible solutions.

It is worth noticing that, as $\beta \in [0,1]$, Proposition 1 also holds in the stationary situation in which $\tau = \tau_r$. In particular, in this case, the optimal level of reported income is not affected by the level of the tax rate.Thus, our simple model offers a theoretical explanation for the puzzling (cross-country) evidence on the relationship between the tax rate and the level of tax evasion. Indeed, by Proposition 1, two countries with the same tax burden can be associated with significantly different levels of tax compliance. Similarly, two countries that present different fiscal conditions can strongly differ in the level of tax evasion.

The condition $\tau \geqslant \beta\tau_r$, with $\tau \neq \tau_r$, includes both the case in which the legal tax rate, τ, is higher than the reference tax rate, τ_r, and the situation in which τ is strictly lower than τ_r, but not as much as to leave, for *any* level of reported income, the taxpayer in the gain domain if not audited. In both cases, the model predicts that the amount evaded is negatively related to the ratio $\frac{\tau_r}{\tau}$. Intuitively, the greater the distance between τ and $\beta\,\tau_r$, the higher the perceived loss associated with tax compliance.

We now turn to the second case in which $\tau < \beta\tau_r$.

Proposition 2. *If $\tau < \beta\tau_r$, then the optimal level of reported income, d^*, is either null or in the interval $\left[\frac{s-\beta\frac{\tau_r}{\tau}}{s-1}Y, Y\right]$. In the latter case, d^* decreases in the ratio between the reference tax rate and the current tax rate, $\frac{\tau_r}{\tau}$.*

On the one hand, if $\tau < \beta\tau_r$, the taxpayer is always in the gain domain if not audited, since $Y_{na} - r = -\tau d + \beta\,\tau_r Y > 0$ for all $d \in [0, Y]$. On the other hand, if $s\tau > \beta\tau_r$, in the state of the world "audited", then, for $d \in [0, \frac{s-\beta\frac{\tau_r}{\tau}}{s-1})$, $Y_a - r = -\tau\, d + \beta\tau_r Y - s\tau(Y - d) < 0$ and the taxpayer is in the loss domain (see Fig. 1b).[16]

[14] See Appendix A for a formal derivation of the results in the propositions.

[15] "Plunging" was first introduced by Yaari (1987) to describe the investment behavior of agents with a linear utility function. In such a setting, depending on the rate of return of the risky asset, agents can either decide to invest their endowment entirely or quit the investment opportunity.

[16] When $\beta\tau_r > s\tau$, $Y_a > 0$, $\forall d \in [0, Y]$. This means that, even if audited, the taxpayer is always in the gain domain. Proposition 2 also applies to this special case.

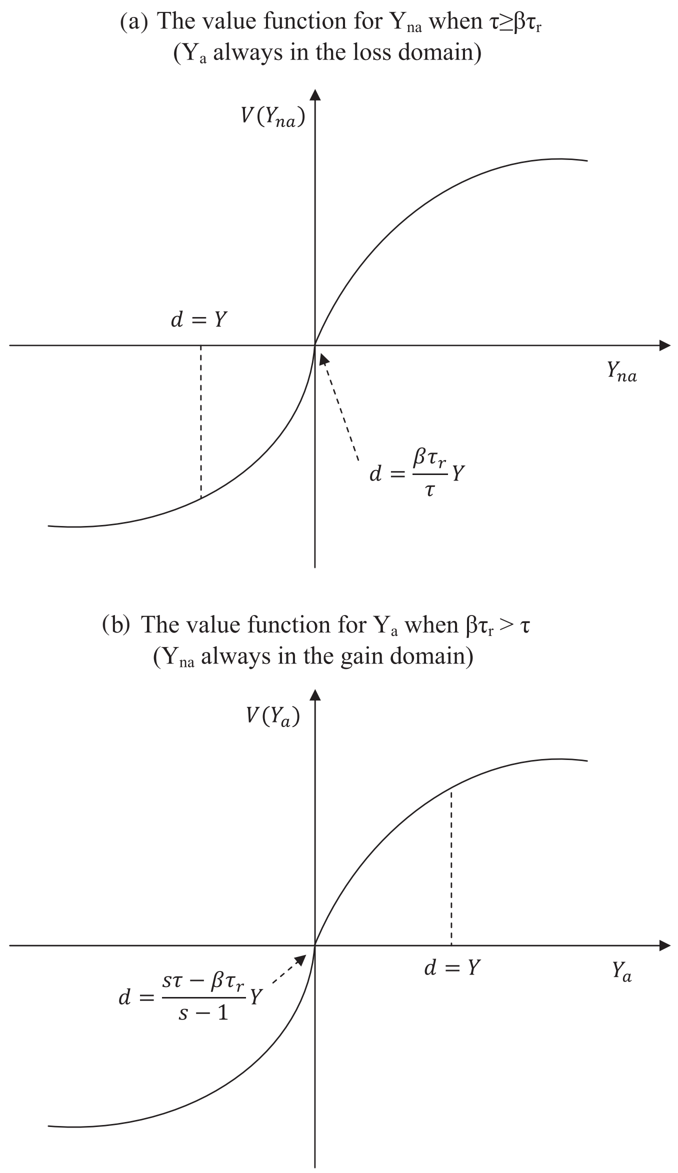

Fig. 1. The value functions in the static solutions.

Also in this case, the taxpayer can switch from the corner solution $d^* = 0$ to an interior solution in the interval $\left[\frac{s-\beta\frac{\tau_r}{\tau}}{s-1}Y, Y\right]$. As before, in order to determine whether the solution is at the corner $d^* = 0$ or in the interior $d^* \in \left[\frac{s-\beta\frac{\tau_r}{\tau}}{s-1}Y, Y\right]$, it is necessary to compare the values of the objective function in the two points $d^* \in \left[\frac{s-\beta\frac{\tau_r}{\tau}}{s-1}Y, Y\right]$ (see Appendix A for details).

It is also important to remark that, depending on the values of the parameters, the interval for the interior solution when $\tau = \tau_r$ (namely $[0, \beta Y)$, see Proposition 1), or when $\tau < \beta\tau_r$ (that is $d^* \in \left[\frac{s-\beta\frac{\tau_r}{\tau}}{s-1}Y, Y\right]$, see Proposition 2), can be either overlapped or disjointed. This implies that it is not possible to say in general whether the optimal reported income is greater or lower in the stationary case $\tau = \tau_r$ or when $\tau < \beta\, \tau_r$. Nevertheless, for the latter case, Proposition 2 shows that, for fixed τ_r, the optimal reported income increases in the legal tax rate τ. Intuitively, if $\tau < \beta\tau_r$ and the taxpayer is in the gain domain, her objective function is concave (see again Fig. 1b) and she takes decisions that are qualitatively similar to those implied by the standard expected utility theory.[17]

3.2. The effects of a change in the legal tax rate

The effects of a change in the legal tax rate on tax evasion are derived by combining the previous results in the static context with the adaptive process of the reference tax rate in Eq. (6).

Starting from a situation in which $\tau = \tau_r$ and $0 < d^* < Y$, suppose that the fiscal authority permanently increases the legal tax rate, τ. By Proposition 1, the taxpayer reacts to the shock by reducing her reported income. However, due to adaptation,

[17] In fact, we recall that the reference dependent value function $v(x) = x^{\gamma}$ in Eq. (4) is, for $x \geqslant 0$ and $\gamma \in [0,1]$, not only concave, but also associated with decreasing absolut risk aversion.

the reference tax rate, τ_r, adjusts upwards to the new fiscal conditions in the following reporting periods. Clearly, during the adjustment process, d^* increases until it converges to the initial level. Fig. 2 shows three possible adjustment processes (Examples 1–3) in case of a piecewise linear value function (namely, when $\gamma = 1$ in Eq. (4)) and an increase in the legal tax rate from 0.27 to 0.38.

Different effects may occur when, starting from a situation in which $\tau = \tau_r$, the fiscal authority permanently decreases τ . Results depend on whether, after the tax cut, the taxpayer ends up in a situation in which $\tau \geqslant \beta\tau_r$ or, rather, $\tau < \beta\tau_r$. Let us start from the first case. By Proposition 1, the optimal reported income now jumps up. However, by the adaptive process of the reference tax rate, the initial increase in d^* is reabsorbed in the following reporting periods. Example 4 in Fig. 2 illustrates the process for a piecewise linear value function and a permanent reduction in the legal tax rate from 0.38 to 0.27.

More complex patterns may arise when the reduction in the legal tax rate implies $\tau < \beta\tau_r$. As indicated above, the taxpayer can react to the shock by either increasing or decreasing her optimal reported income. Nevertheless, by the adaptive process of τ_r and as long as $\tau < \beta\tau_r$, Proposition 2 implies that the reported income increases as τ_r adjusts downwards to the new legal tax rate. However, at a certain point, the adaptive process in Eq. (6) will imply $\tau \geqslant \beta\tau_r$; from that point onwards, as long as the reference tax rate adjusts to the legal tax rate, the reported income decreases (as implied by Proposition 1, point *ii*). Examples 5 and 6 in Fig. 2 reports cases that are based on a piecewise linear value function that are consistent with the previous considerations.

The likelihood of these patterns to emerge depends on the parameters of the model, including the speed of adaptation, α. As discussed in Section 3.1, there may exist asymmetries in the value of α, depending on whether the fiscal shock is internalized by the taxpayer as an improvement or a deterioration of her economic conditions. In particular, while the positive effects of an increase in the legal tax rate on tax evasion can persist for a large number of reporting periods, adaptation to a tax cut can be significantly faster.

Summing up, when the legal tax rate is increased over the reference, optimal reported income always increase as an instateneous effect, whereas when the rate is decreased there may be some ambiguity in the initial response. In any case,

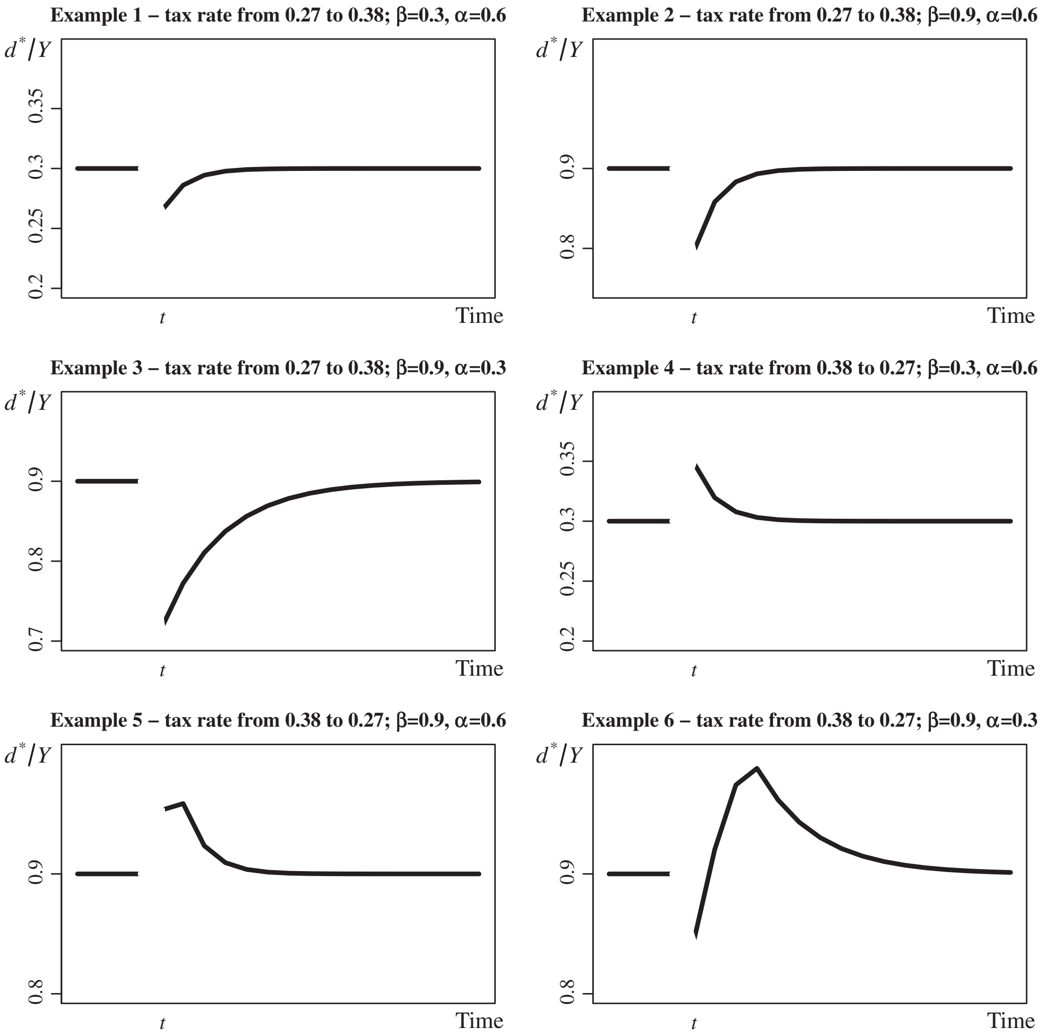

Fig. 2. Predictions of optimal reported income d^*/y for a piecewise linear value function ($\gamma = 1$).

Table 1
Parameters used in the experiment.

Treat.	τ in Ph. 1	τ in Ph. 2	Distribution of *Y*	*s*	*p*	Subjects per session	N. sessions
1	0.27	0.38	Uniform in [120–180]	2	2/20	20	2
2	0.38	0.27	Uniform in [120–180]	2	2/20	20	2
3	0.27	0.27	Uniform in [120–180]	2	2/20	20	1
4	0.38	0.38	Uniform in [120–180]	2	2/20	20	1

according to the adaptive process of the reference tax rate and depending on the speed of adjustment (captured by the parameter α), the model predicts that the effects of the changes of the reported income are only temporary and tend to vanish over time.[18]

4. Experimental analysis

4.1. Design

Our experimental design is aimed at testing the theoretical predictions implied by the model of tax evasion with reference dependent preferences and hedonic adaptation. Each session consisted of two consecutive phases of 12 periods and involved twenty subjects.[19] In every period of the experiment, the computer randomly assigned to each subject a gross income included between 120 and 180 tokens. On the basis of her gross income, each subject decided how many tokens to report knowing that, on the reported amount, she had to pay taxes according to a flat tax rate that was kept constant across the 12 periods of the corresponding phase. Varying subjects' gross incomes over time was intended to rule out potential anchoring effects across repetitions that involved the same decisional task. In order to control for potential income effects due to the size of the gross income, we kept the variance of the (gross) income distribution sufficiently small.

After all participants submitted their reported incomes, two subjects were randomly selected with equal probability and their choice audited. Subjects were informed that the probability of being audited was independent of (actual and past) choices as well as the results of the audit stage in previous periods. If the audited subject under-reported her gross income, then she was convicted to pay, in addition to the legal taxes, a sanction that was equal to the evaded taxes ($s = 2$).

At the end of each period, subjects were informed about their earnings and whether their choices were selected for auditing. Audited subjects also received feedbacks about the outcome of the audit stage. Final monetary earnings were determined according to one phase and one period only. In particular, at the end of the experimental session, the phase and the period used to determine subjects' payments were selected by tossing a coin and randomly picking one of 12 cards, respectively.

The only difference between experimental sessions concerned the tax rates used in the two phases of the experiment. In particular, we ran four treatments with the following sequences of tax rates in the two phases: 27% and 38% in the first treatment; 38% and 27% in the second treatment; 27% and 27% in the third treatment; 38% and 38% in the fourth treatment. Table 1 summarizes the main features of the experimental design.

Overall we ran six experimental sessions: two sessions for treatments 1 and 2 and one session for treatments 3 and 4. The experiment was conducted at Bocconi University, Milan, between April and May 2010 and involved 120 participants, mainly (undergraduate) students in economics. Each subject participated to one session only. At their arrival, subjects were randomly assigned to a computer terminal. Once seated, instructions of the first phase were read aloud by an experimenter. Before the first phase started, control questions were administered and subjects' answers privately checked by experimenters. Instructions with the parameters for the second phase were handled at the end of the first phase and, again, read aloud. To minimize computational mistakes, subjects were also provided with a calculator on the computer screen. The experiment was computerized by using the z-Tree software (Fischbacher, 2007). Final earnings were determined by using an exchange rate of one euro per ten tokens. Subjects were privately paid at the end of the experimental session. On average, subjects earned 12.77 euro in sessions lasting 45 min (including time for instructions and payments). Before leaving the laboratory, subjects filled a short questionnaire containing socio-demographic questions as well as information on their risk attitude and their perception of the tax system.[20]

4.2. Experimental hypotheses

Our analysis focuses on treatments 1 and 2 in which the tax rate changes between the two phases of the experiment. The remaining two treatments (3 and 4), in which the tax rate does not change between the two phases, represent our controls.

[18] This represents an important difference with respect to Dhami and al-Nowaihi (2007). In their model, the reference income is imposed to be equal to the after-tax income and no adaptive process governs the adjustment of the reference over time. This implies that a change in the tax rate exerts permanent effects on the level of tax evasion.
[19] Instructions of the experiment can be found in Appendix B.
[20] The full post-experimental questionnaire is available upon request.

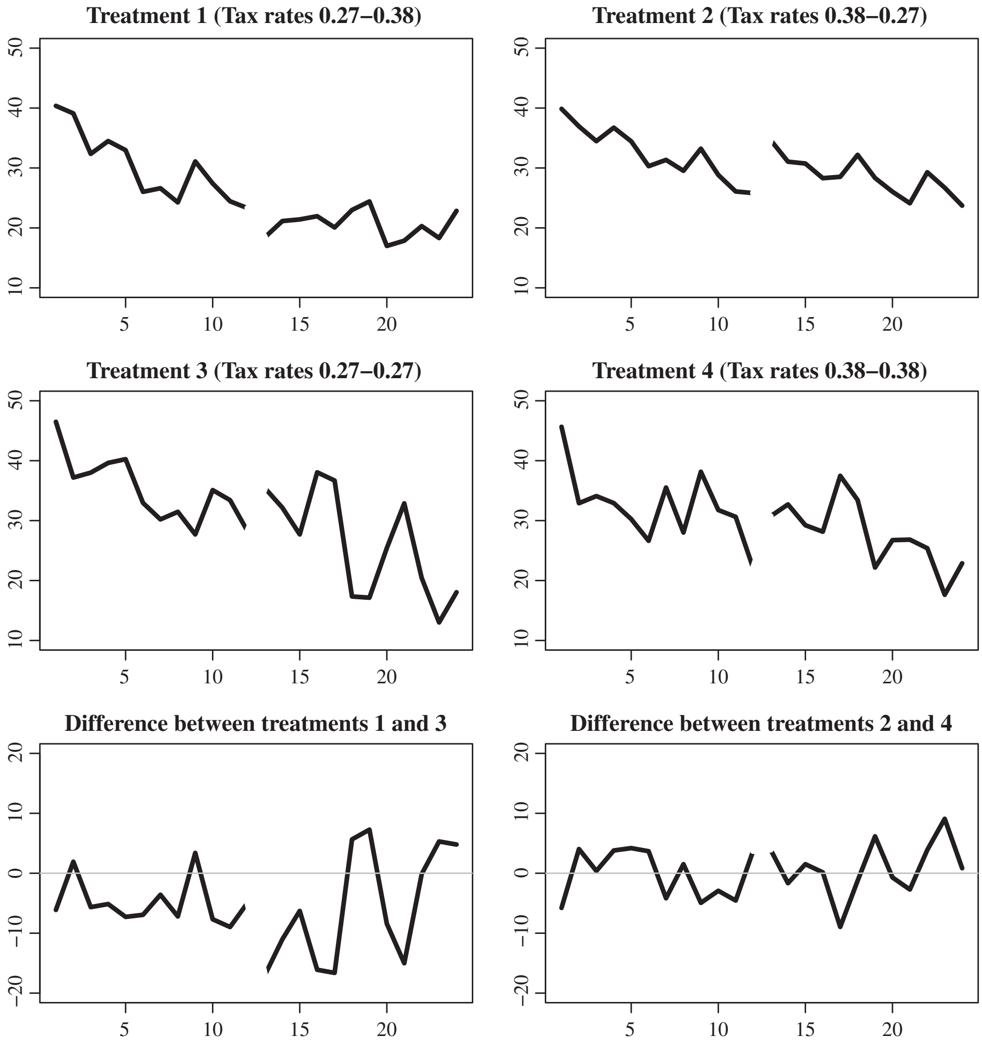

Fig. 3. Average reported incomes (as a percentage of the gross income) in the four treatments.

According to our model, the initial reference tax rate is equal to the legal tax rate that is used in the first phase of the experiment (i.e. 0.27 in treatments 1 and 3; 0.38 in treatments 2 and 4).[21] Therefore, the first testable prediction provided by our model is that, in the first phase, subjects' choices are independent of the tax rate and reported incomes do not differ across treatments.

Moving to phase 2, we are interested in assessing (a) how tax compliance reacts to a change in the tax rate in the first period of the second phase (period 13) and (b) whether subjects' behavior tends to adjust over periods as implied by the adaptive process of the reference tax rate. In particular, we expect that the increase in the tax rate in treatment 1 will cause a decrease in reported incomes in period 13. On the other hand, the effects on reported incomes exerted by a tax cut are ambiguous. Finally, due to hedonic adaptation, any change in the level of reported incomes observed at the beginning of the second phase in treatments 1 and 2 is expected to be temporary and vanish over subsequent periods.

4.3. Results

4.3.1. Overview

Fig. 3 plots the average reported incomes (as a percentage of the gross income) over periods in the four treatments.

Reported incomes decrease over periods of the first phase in all treatments, falling from 40% to 45% of the gross endowment in the first period to 22–28% in period 12. In the first period of the second phase (period 13), we observe a contraction of the average reported income in treatment 1(around 18% of the gross income), while it increases in treatments 2, 3 and 4 (around 31% in treatment 4 and 35% in treatments 2 and 3). The average reported income remains stable over periods 13–24 in treatment 1 while it decreases in treatments 2, 3, and 4. The graphs for the differences between treatments show similar

[21] It is worth noticing that the tax rates 27% and 38% used in our experiment correspond to the central marginal tax rates on incomes in Italy. This was done in order to facilitate the adoption of such references at the beginning of the first phase.

Table 2
Random-effects tobit models.

Dependent variable: reported income	Unrest. model		Rest. model	
	Coeff.	(Se)	Coeff.	(Se)
General controls				
Income	0.099	(0.087)	0.100	(0.087)
Audit in ($t-1$) (dummy = 1)	−27.141***	(5.399)	−27.257***	(5.419)
Tax rate ratio	−5.299**	(2.515)	−5.852*	(2.548)
Risk attitude (self reported)	−17.996***	(1.546)	−17.594***	(1.611)
Constant			142.428***	(18.741)
Period			−3.464***	(0.468)
Controls for ph. 1, 2				
Dum. 0.27 (tr. 1, 3; ph. 1, 2)	148.873***	(18.769)		
Dum. 0.38 (tr. 2, 4; ph. 1, 2)	141.002***	(18.133)		
Period × Dum. 0.27 (tr. 1, 3; ph. 1, 2)	−3.850***	(0.854)		
Period × Dum. 0.38 (tr. 1, 3; ph. 1, 2)	−3.180***	(0.829)		
Controls for ph. 2				
Dum. – ph. 2 ("restart" effect)			26.383***	(6.658)
Dum. 0.27 – ph. 2 (tr. 1, 3; ph. 2)	34.034**	(12.554)		
Dum. 0.38 – ph. 2 (tr. 2, 4; ph. 2)	24.485**	(12.248)		
Dum. 0.27/0.38 – ph. 2 (tr. 1; ph. 2)	−41.701**	(13.458)	−38.523***	(9.896)
Dum. 0.38/0.27 – ph. 2 (tr. 2; ph. 2)	−2.286	(12.075)		
Period × Dum. 0.27/0.38 – ph. 2 (tr. 1; ph. 2)	2.943**	(1.408)	2.564**	(1.216)
Period × Dum. 0.38/0.27 – ph. 2 (tr. 2; ph. 2)	0.755	(1.342)		
Period × Dum. 0.27/0.27 – ph. 2 (tr. 3; ph. 2)	−0.477	(1.809)		
Period × Dum. 0.38/0.38 – ph. 2 (tr. 4; ph. 2)	−1.197	(1.643)		
Log. std. dev. random effect	4.435***	(0.047)	4.446***	(0.046)
Log. std. dev. error	4.168***	(0.022)	4.170***	(0.022)
Obs.	2880		2880	
LL	−7890.466		−7892.343	
Wald χ^2	285.10		272.0	
Prob > χ^2	0.000		0.000	

(Robust) standard errors in parentheses.
* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.

results: the difference between reported incomes in treatments 2 and 4 oscillates around 0; so does the difference between reported incomes in treatments 1 and 3 in the first phase, while in the second phase this difference exhibits high variability around an increasing trend.

Consistent with our theoretical predictions, we do not detect remarkable differences in the average reported income over the periods of the first phase across treatments. Moreover, the first period of the second phase shows that while the increase in the tax rate introduced in treatment 1 is associated with a reduction in the average level of reported incomes, the tax cut in treatment 2 exerts opposite effects. Finally, in line with the adaptation of the reference tax rate, differences across treatments tend to disappear at the end of the second phase.

Fig. 3 also reveals some unexpected effects. First, the average reported income decreases over periods in all treatments. Reasonably, by repeating the decisional task over periods, subjects might have learnt the high (expected) incentive to evade (90 cents per euro of evaded tax). Similar time patterns in tax evasion decisions are documented by other experimental studies (among others, Antonides and Robben, 1995; Maciejovsky et al., 2007 and references therein). Second, we observe a 'restart effect' in treatments 3 and 4 in which the tax rate was kept constant between phases.[22] This might be explained by the fact that subjects tend to reset a 'trial and error' strategy at the beginning of a new sequence of decisions.

In the next sub-section, we employ an econometric analysis that properly accounts for these unexpected effects. First, to test whether subjects' choices in the first phase are independent of the tax rate, we need both the average reported income and the (decaying) time pattern to be invariant across treatments in periods 1–12. Second, in order to correctly assess how subjects instantaneously react (in period 13) to a change in the tax rate, we need to disentangle the variation in the reported incomes that is due to the fiscal shock *per se* from the change caused by the pure restart effect. Finally, given the decaying pattern in the data, we will identify the adaptive process triggered by the fiscal shock by looking at differences in the time trend in treatments 1 and 2 *vis-a-vis* the control treatments.

4.3.2. Regression analysis

Table 2 reports results from two random-effects Tobit models, one restricted and one unrestricted. As the data contain some features that are not present in the theoretical model of Section 3, namely the negative trend and the restart effect,

[22] Andreoni (1988) was the first paper to report a "restart effect" between two identical and consecutive phases in a public good experiment that could not be related to strategic reasons.

we have estimated a reduced-form version capturing stylized facts; estimation of a structural model is left to further work. Both Tobit models use the reported incomes as dependent variable, present left and right censoring limits and account for potential individual dependence over periods.[23]

Both the unrestricted and the restricted models include general controls and phase specific covariates to study the effects of (a change in) the tax burden on subjects' reported incomes. As general controls, we include subject's gross endowment in the period (*Income*), a dummy assuming a value of one if the subject was audited in the previous period and zero otherwise (*Audit in* $(t-1)$) and two variables constructed by using information from the post-experimental questionnaire: a measure of self-reported risk propensity (*Risk attitude*)[24] and a variable that captures the (inverse of the) fraction of legal taxes that the subject perceives as fair to pay (*Tax rate ratio*).[25]

As expected, the coefficient of *Income* is positive, though not significant. The effect of being audited in the previous period is negative and highly significant, in line with previous experiments.[26] The coefficient of *Risk attitude* is negative and highly significant. Finally, coherently with the role played by the ethical concerns of the taxpayer in the theoretical model, we observe a negative and highly significant relationship between *Tax rate ratio*and the reported incomes. [27]

In order to test the main theoretical predictions, the unrestricted model includes a set of phase specific variables. We use two intercept dummies, *Dum. 0.27* and *Dum. 0.38,* as controls for both phases. From period 1 to period 24, *Dum. 0.27* takes a value of one if the treatment is either 1 or 3 and zero otherwise, while *Dum. 0.38* takes a value of one if the treatment is either 2 or 4 and zero otherwise. We also include two interaction terms between a linear time trend that starts from zero in period 1 (*Period*) and the intercept dummies (*Period* × *Dum. 0.27*, *Period* × *Dum. 0.38*) to test whether the effects of the time trend on reported incomes depend on the corresponding tax rate. In line with the initial observations, reported incomes decay over periods as shown by the negative and highly significant coefficient of *Period*. Moreover, the difference between *Dum. 0.27* and *Dum. 0.38* is not significant ($\chi^2 = 0.754$, $p = 0.385$). This result supports the prediction that, when $\tau = \tau_r$, the level of tax evasion is independent of the tax rate. Similar conclusions emerge when we compare the coefficients of the interaction terms *Period* × *Dum. 0.27* and *Period* × *Dum. 0.38* ($\chi^2 = 0.317, p = 0.573$).

Moving to the controls of the second phase, we include an intercept dummy that directly measures the restart effect in treatments 1 and 3 (*Dum. 0.27 – ph. 2*), on the one hand, and in treatments 2 and 4 (*Dum. 0.38 – ph. 2*), on the other hand. Then, we add two intercept dummies for the first (*Dum. 0.27/0.38 – ph. 2*) and the second (*Dum. 0.38/0.27 – ph. 2*) treatment, respectively. *Dum. 0.27/0.38 – ph. 2* (*Dum. 0.38/0.27 – ph. 2*) measures the difference in reported incomes between treatments 1 and 3 (2 and 4) that can be imputed to the increase (decrease) in tax rate after controlling for the restart effect. It is worth noticing that the coefficients of both *Dum. 0.27/0.38 – ph. 2* and *Dum. 0.38/0.27 – ph. 2* provide prima facie evidence of the adaptive process specified in (6). On the one hand, when $\alpha = 1$, taxpayers instantaneously adapt their reference to the new legal tax rate and both the coefficients of *Dum. 0.27/0.38 – ph. 2*and *Dum. 0.38/0.27 – ph. 2* are null. On the other hand, significant coefficients of *Dum. 0.27/0.38 – ph. 2* and *Dum. 0.38/0.27 – ph. 2* indicate that $\alpha \in (0,1)$ and subjects require time to adapt to the change in the tax rate.

Finally, we add a (specific) linear trend for each of the four treatments (*Period* × *Dum. 0.27/0.27 – ph. 2*, *Period* × *Dum. 0.27/0.38 – ph. 2*, *Period* × *Dum. 0.38/0.38 – ph. 2*, *Period* × *Dum. 0.38/0.27 – ph. 2*). In order to avoid interferences with the dummy for the restart effect and facilitate the interpretation of the coefficients in terms of the parameters used in the theoretical framework, we imposed the trends to start from zero in period 13 and end up to a value of eleven in period 24. As shown by the regression, subjects' behavior in the second phase of treatments 2, 3 and 4 is qualitatively similar to that observed in the first phase. The variables measuring the restart effects (*Dum. 0.27 – ph. 2* and *Dum. 0.38 – ph. 2*) are both positive and highly significant, while their difference is not significantly different from zero ($\chi^2 = 0.322$, $p = 0.570$). This suggests that the restart effect observed in these three treatments does not depend on the tax rate used in the second phase.

Concerning the adaptive process of the reference tax rate, *Dum. 0.38/0.27 – ph. 2* is not significant, while *Dum. 0.27/0.38 – ph. 2* is negative and highly significant. Three of the four trends in the second phase, namely *Period* × *Dum. 0.27/0.27 – ph. 2*, *Period* × *Dum. 0.38/0.38 – ph. 2*, *Period* × *Dum. 0.38/0.27 – ph. 2*, are not significant, while *Period* × *Dum. 0.27/0.38 – ph. 2* is positive and significant. Summing up, we detect remarkable differences in behaviors between treatment 1 and the other

[23] The left censoring endpoint is equal to 0, while the right censoring point coincides with the income of the period. The random effect is integrated using Gauss–Hermite quadrature with 32 points. The variances of the estimators are computed using the Hessian. The procedure was implemented in *R* adapting a routine elaborated by Arne Henningsen.

[24] Subjects were asked to report their risk attitude on a scale from 1 to 10. The specific question was: "in a scale from 1 to 10, how would you rate your attitude towards risk: are you a person always avoiding risk or do you love risk-taking behavior?" Where 1 was associated with the statement "I always choose the safest option and try to avoid any possible risk" and 10 referred to "I love risk and I always choose the more risky alternative".

[25] We use information from two questions. First, each subject was asked to report the tax rate that is levied on the (family) income. Second, each subject reported the tax rate that she perceived as fair to pay. To answer to the two questions, subjects were asked to choose one of the following twelve categories: "less than 10%", "between 10% and 15%", "between 15% and 20%", ..., "between 55% and 60%", "more than 60%". Since subjects never reported that it was fair to pay more than what legally due, we define *Tax rate ratio* as the ratio between the legal and the fair tax rate (both evaluated at the mean of the chosen category). This definition ensures adequate variability of the measure.

[26] Two possible explanations have been proposed in order to account for this effect. First, subjects may fail to apply basic principles of probability calculus and misperceive that an audit is less likely immediately after a previous audit (see Mittone (2006), for the first description of the phenomenon). Second, subjects who are audited in a period may try to recover the loss incurred by reducing reported income in the following period (Maciejovsky et al., 2007).

[27] We also consider a different specification in which the variable *Tax rate ratio* is replaced by a gender dummy. While we find that women tend to evade less than men (see Torgler and Valev (2006), for references on the influence of gender on the attitude to evade taxes), the coefficients of the other covariates remain qualitatively unchanged with respect to those implied by the original specification.

conditions. These empirical findings are consistent with the predictions of our theoretical framework. First, subjects respond to an increase in the tax rate by reducing compliance. Second, the effects of the change in the tax rate on subjects' behavior tend to vanish over periods. In addition, our experimental results suggest that subjects instantaneously adapt to a tax cut ($\alpha \simeq 1$ in treatment 2), while they require time to adjust their reference tax rate to the legal level in case of an increase in the tax rate ($\alpha < 1$ in treatment 1).

In order to further validate the previous findings, the last column of Table 1 reports estimates of a restricted specification of our econometric model. A likelihood ratio test indicates that the restricted model is an acceptable restriction of the unrestricted one ($LR = 3.754$, $df = 7$, $p = 0.808$). In the restricted specification we do not control for the tax rate used in the first phase. Indeed, the model includes a (general) *Constant term* – positive and highly significant – and a time trend, *Period* – negative and highly significant. We also include a dummy variable that takes a value of one only in periods 13–24 (*Dum. – ph. 2*) to capture the restart effect observed in the data.

Given the differences between treatment 1 and the other three conditions in the second phase detected by the first specification, the restricted model (only) includes *Dum. 0.27/0.38 – ph. 2*and *Period* $\times$ *Dum. 0.27/0.38 – ph. 2*. As expected, both coefficients are highly significant and with the expected sign: negative for *Dum. 0.27/0.38 – ph. 2* and positive for *Period* $\times$ *Dum. 0.27/0.38 – ph. 2*.

5. Concluding remarks: policy implications

The analysis presented in this paper has several policy implications. It is generally thought that the problem of tax evasion has been exacerbated by the general increase in the tax burden that has occured in several (developed) countries in the second half of the last century (Tanzi and Schuknecht, 1997). A fundamental question suggested by this empirical observation concerns the possibility of using a tax cut as an instrument to reduce tax evasion (Clotfelter, 1983). In contrast to the previous intuition, our study points out that, due to important behavioral factors, the effects of *ad hoc* fiscal interventions on tax evasion can be marginal and limited in time. On the one hand, the hedonic adaptation followed by the reference tax rate over time implies that (permanent) fiscal policies can only exert temporary effects. On the other hand, as observed in our experiment, subjects tend to adapt faster to a tax cut than to an increase in the tax rate. In a fiscal perspective, the previous considerations imply that while tax cuts are expected to exert only marginal effects, the practice of increasing the tax rate can trigger a vicious circle with tax interventions (perhaps designed to catch up with a high level of tax evasion) keeping tax evasion artificially high.

A natural implication of our results concerns the detrimental effects of policy announcements on the level of tax evasion. A large literature has emphasized the role played by beliefs and expectations in forming references. In line with the previous pages, we can reasonably expect the announcement of a tax cut to modify the reference tax rate. In particular, if taxpayers perceive the announcement as credible, they may end up in a situation in which their reference tax rate is smaller than the legal tax rate. Therefore, as suggested by our theoretical framework, the level of tax evasion can positively respond to the policy announcement.

The final lesson to be learned from the present study is that the tax rate should not be used to fight against tax evasion; other factors – including tax morale and other deterrent instruments – are likely to be more effective in the long-run.

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Appendix A. Solution of the maximization problem faced by the taxpayer

In this appendix, we present the solution of the maximization problem stated in Section 3 of the paper and used to derive Propositions 1 and 2 in Section 3.2. The taxpayer chooses the reported income, d, that maximizes the objective function:

$$V(d) = \pi(p) \cdot v(Y_a - r) + (1 - \pi(p)) \cdot v(Y_{na} - r), \tag{A.1}$$

with $v(x)$ that is given by:

$$v(x) = \begin{cases} x^{\gamma} & \text{if} \quad x \geqslant 0, \\ -\lambda(-x)^{\gamma} & \text{if} \quad x < 0, \end{cases} \tag{A.2}$$

where $Y_{na} - r = -\tau d + \beta\tau_r Y$ and $Y_a - r = -\tau d + \beta\,\tau_r Y - s\tau(Y - d)$. In order to solve the maximization problem, we have to specify which part of the value function $v(x)$ – either the gain or the loss domain – is relevant for $(Y_{na} - r)$ and $(Y_a - r)$. In this respect, it is useful to distinguish between two cases: (a) when $\tau \geqslant \beta\tau_r$ and (b) when $\tau < \beta\,\tau_r$. Moreover, since $Y_{na} \geqslant Y_a$, it is useful to consider the following three possibilities:

1. $V(d) = -\lambda \cdot \pi \cdot [\tau d - \beta\tau_r Y + s\tau\,(Y - d)]^\gamma + (1-\pi)[-\tau d + \beta\tau_r Y]^\gamma$, when $Y_{na} \geqslant 0 > Y_a$;
2. $V^{-}(d) = -\lambda \cdot \pi \cdot [\tau d - \beta\tau_r Y + s\tau(Y - d)]^\gamma - \lambda \cdot (1-\pi)[\tau d - \beta\tau_r Y]^\gamma$, when $0 > Y_{na} \geqslant Y_a$;
3. $V^{+}(d) = \pi \cdot [-\tau d + \beta\tau_r Y - s\tau\,(Y - d)]^\gamma + (1-\pi)[-\tau d + \beta\tau_r Y]^\gamma$, when $Y_{na} \geqslant Y_a \geqslant 0$.

Case (a): $\tau \geqslant \beta\tau_r$ (see Proposition 1).

In this case, $Y_a - r = -\tau d + \beta\tau_r Y - s\tau(Y - d) < 0$, $\forall d \in [0, Y]$. Thus, when audited, the taxpayer is always in the loss domain. For $\beta \in [0,1]$, this cas also applies to the stationary situation in which $\tau = \tau_r$. Notice that, if $d > \frac{\beta\tau_r}{\tau}Y$, then $Y_{na} - r = -\tau d + \beta\tau_r Y < 0$ and the taxpayer is in the loss domain even if not audited. In such a case, the objective function is: $V^{-}(d) = -\lambda \cdot \pi \cdot [\tau d - \beta\tau_r Y + s\tau(Y - d)]^\gamma - \lambda \cdot (1-\pi) \cdot [\tau d - \beta\tau_r Y]^\gamma)$. Since $V^{-}(d)$ is convex everywhere, d^* can only be equal to the upper bound of $(\frac{\beta\tau_r Y}{\tau}, Y]$. In order to determine the nature of this static solution, we need to compare $V^{-}(Y)$ with the value assumed by the objective function at an interior solution in $[0, \frac{\beta\tau_r}{\tau}Y]$. When $d \leqslant \frac{\beta\tau_r}{\tau}Y$, the objective function is $V(d) = -\lambda \cdot \pi \cdot [\tau d - \beta\tau_r Y + s\tau\,(Y - d)]^\gamma + (1-\pi)[-\tau d + \beta\tau_r Y]^\gamma$. From the FOC, $\partial V/\partial d = 0$, we obtain the following optimal level of reported income:

$$d^* = Y\frac{\frac{\beta\tau_r}{\tau}(K+1) - s}{K + 1 - s}, \tag{A.3}$$

where $K = \left[\frac{1-\pi}{\pi\lambda(s-1)}\right]^{\frac{1}{\gamma-1}}$. Second order conditions are not trivial in this case because of the convex trait of the objective function when $Y_a - r < 0$. However, by simple algebra, for d that converges to $\frac{\beta\tau_r Y}{\tau}$, $V(d)$ decreases in d. Moreover, when $\frac{1-\pi}{\pi\lambda(s-1)} > \left(\frac{\beta\tau_r}{s\tau-\beta\tau_r}\right)^{1-\gamma}$, then $V(d)$ is decreasing in d at $d = 0$. Therefore, when $\frac{1-\pi}{\pi\lambda(s-1)} > \left(\frac{\beta\tau_r}{s\tau-\beta\tau_r}\right)^{1-\gamma}$, then $V(0) > V^{-}(Y)$ and the optimal reported income is $d^* = 0$. On the other hand, when $\frac{1-\pi}{\pi\lambda(s-1)} < \left(\frac{\beta\tau_r}{s\tau-\beta\tau_r}\right)^{1-\gamma}$, then $V(d)$ is increasing in d at $d = 0$. Therefore, $d^* > 0$, but there is no straightforward second order condition to determine whether the optimal reported income coincides with the interior solution in (A.3) or is equal to $d^* = Y$. In order to determine the nature of the static solution, we need to compute the value of the objective function in the two possible cases. Summing up:

1. if $\frac{1-\pi}{\pi\lambda(s-1)} > \left(\frac{\beta\tau_r}{s\tau-\beta\tau_r}\right)^{1-\gamma}$, then $d^* = 0$;
2. if $\frac{1-\pi}{\pi\lambda(s-1)} < \left(\frac{\beta\tau_r}{s\tau-\beta\tau_r}\right)^{1-\gamma}$ and $V(d^*) > V^{-}(Y)$, then $d^* = Y\frac{\frac{\beta\tau_r}{\tau}(K+1)-s}{K+1-s}$;
3. if $\frac{1-\pi}{\pi\lambda(s-1)} < \left(\frac{\beta\tau_r}{s\tau-\beta\tau_r}\right)^{1-\gamma}$ and $V(d^*) < V^{-}(Y)$, then $d^* = Y$.

The comparative static predictions follow from the interior solution in (A.3). By simple algebra, it follows that $\partial d^*/\partial\tau < 0$. Moreover, since $\left(\frac{\beta\tau_r}{s\tau-\beta\tau_r}\right)^{1-\gamma}$ decreases in τ and $\partial V^{-}(Y)/\partial\tau < 0$, it follows that, as τ increases, $d^* = 0$ becomes more likely to occur than the interior solution in (A.3) which in turn becomes more likely to occur than $d^* = Y$. Moreover, when $\tau = \tau_r$, then the interior solution in (A.3) and $\left(\frac{\beta\tau_r}{s\tau-\beta\tau_r}\right)^{1-\gamma}$ as well as the sign of $[V(d^*) - V^{-}(Y)]$ are independent of τ. Thus, when $\tau = \tau_r$ (the stationary context), the optimal reported income is unaffected by the tax rate.

Finally, it is worth noticing that in case of the piecewise linear utility function (with $\gamma = 1$) used for the simulations presented in the text, the term K in (A.3) goes to $+\infty$. Therefore, d^* in (A.3) converges to $\frac{\beta\tau_r}{\tau}Y$ and the conditions for the solution simplify in: (i)$\frac{1-\pi}{\pi\lambda(s-1)} > 0$ for $d^* = 0$; (ii)$\frac{1-\pi}{\pi\lambda(s-1)} < 0$ and $\pi s < 1$ for the interior solution in (A.3), and (iii) $\frac{1-\pi}{\pi\lambda(s-1)} < 0$ and $\pi s > 1$ for $d^* = Y$.

Case (b): $\tau < \beta\tau_r$ (see Proposition 2).

In this case, $Y_{na} - r = -\tau d + \beta\tau_r Y > 0$, $\forall d \in [0,Y]$. Thus, the taxpayer is always in the gain domain if not audited. If audited, the taxpayer may end up in the loss domain with $Y_a - r = -\tau d + \beta\tau_r Y - s\tau(Y - d) < 0$, when she chooses d in the interval $[0, \frac{s\tau-\beta\tau_r}{\tau(s-1)}Y)$ and $s\tau > \beta\tau_r$. However, it is easy to show that the only possible optimal level of reported income in this interval is $d^* = 0$ (with $V(0) = -\lambda\pi[-\beta\tau_r Y + s\tau\;\; Y]^\gamma + (1-\pi)[\beta\tau_r Y]^\gamma)$. When instead $d \in [\frac{s\tau-\beta\tau_r}{\tau(s-1)}Y, Y]$, then $Y_a - r = -\tau\;\; d + \beta\tau_r Y - s\tau(Y - d) > 0$. The objective function is $V^{+}(d) = \pi \cdot [-\tau d + \beta\tau_r Y - s\tau\;(Y - d)]^\gamma + (1-\pi) \cdot [-\tau d + \beta\tau_r Y]^\gamma$ which is concave everywhere. From the FOC, $\partial V^{+}/\partial d = 0$, we obtain the following optimal level of reported income:

$$d^* = Y\frac{\frac{\beta\tau_r}{\tau}(1 - F) + sF}{(s-1)F + 1}, \tag{A.4}$$

where $F = \left[\frac{1-\pi}{\pi(s-1)}\right]^{\frac{1}{1-\gamma}}$. By simple algebra, it is possible to show that, when $\pi s > 1$, the objective function is increasing everywhere and the optimal reported income is $d^* = Y$. When $\pi s < 1$, then it is either $d^* = Y\frac{\frac{\beta\tau_r}{\tau}(1-F)+sF}{(s-1)F+1}$ or $d^* = 0$ and, in order to determine the nature of the static solution, it is necessary to compute the value of the objective function at the two possible solutions. Summing up:

1. if $\pi s < 1$ and $V(0) > V^{+}(d^*)$, then $d^* = 0$;

2. if $\pi s < 1$ and $V(0) < V^{+}(d^*)$, then $d^* = Y\frac{\frac{\beta\tau_r}{\tau}(1-F)+sF}{(s-1)F+1}$;
3. if $\pi s > 1$, then $d^* = Y$.

The comparative static predictions follow from the interior solution in (A.4). Since $F > 1$ for $\pi s < 1$, then $\partial d^*/\partial\tau > 0$. Moreover, since $\partial V(0)/\partial\tau < 0$, it follows that, as τ increases, the corner solution $d^* = 0$ becomes less likely to occur than the interior solution in (A.4).

Finally, in case of the piecewise linear utility function ($\gamma = 1$), then the term F in (A.4) goes to $+\infty$. Thus, d^* converges to $\frac{s-\beta\frac{\tau_r}{\tau}}{s-1}Y$ and the conditions for the solution simplify in: (i) $\pi s < 1$ and $[1 - \pi(1 + \lambda(s - 1))] > 0$ for $d^* = 0$; (ii) $\pi s < 1$ and $[1 - \pi(1 + \lambda(s - 1))] < 0$ for the interior solution in (A.4); (iii) $\pi s > 1$ for $d^* = Y$.

Appendix B. Instructions of the experiment

[Instructions were originally written in Italian. Across treatments, instructions only differed in the tax rates that were used in the first and in the second phase.]

B.1. Instructions

Welcome. Thanks for participating in this experiment. If you follow the instructions carefully you can earn an amount of money that will be paid to you in cash at the end of the experiment. In this experiment, there are 20 participants. You will know neither the identity nor the earnings of the other participants. During the experiment you are not allowed to talk or communicate in any way with other participants. If you have any questions raise your hand and one of the assistants will come to you to answer it. The rules that you are reading are the same for all participants.

B.2. General rules

In this experiment you will participate to two consecutive phases. At the end of the experiment, one of the two phases will be randomly selected by tossing a coin and used to determine the final earnings of participants. The instructions for the second phase will be distributed at the end of the first phase. During the experiment, your earnings will be expressed in tokens. At the end of the experiment, your final earnings will be converted into euro at the rate 10 tokens = 1 euro.

B.3. First phase

The first phase consists of 12 consecutive periods in each of which you will make only one choice. At the end of the experiment, if the first phase will be used to determine participants' payments, your final earnings will depend on the results of one period only. In particular, the period used to determine participants' final earnings will be randomly selected by drawing one of 12 cards, numbered from 1 to 12.

B.4. Your task in each period of the first phase

In each of the 12 periods of the first phase, you have to choose which share of income to report in order to pay taxes. In particular, in each of the 12 periods of the first phase, the computer will randomly and anonymously assign an amount of tokens included between 120 and 180 tokens. For simplicity, let us refer to this amount of tokens as the gross income. Given your gross income, you have to choose how many tokens to report. On the reported amount of tokens, you will pay taxes according to a flat rate of XX%. You can report any number of tokens included between 0 and your gross income.

In each of the 12 periods of the first phase, the amount of tokens you have chosen to report can be randomly selected for auditing to verify the correspondence of your choice with respect to your gross income. In the case your choice is not selected for auditing, then your earnings in the period is given by your gross income minus the taxes computed on the amount of tokens you have reported. In the case your choice is selected for auditing and the amount of tokens you have reported is lower than your gross income, then your earnings in the period is given by your gross income minus the taxes computed on your gross income minus a fine that is equal to the taxes you have not paid. Of course, if the amount of tokens you have reported is equal to your gross income, then the auditing procedure does not imply any fine.

B.5. The auditing procedure

At the end of each period, after all the choices have been made, each subject is randomly and anonymously assigned one of 20 cards, numbered from 1 to 20, by the computer. Then, the computer randomly selects two of the 20 cards. The choices made by the owners of the two cards will be audited. The auditing procedure is anonymous. Therefore, participants whose choices have been audited are privately informed about the results of the auditing procedure. Finally, notice that the probability to be audited in a given period does not depend on the results of the auditing procedures conducted in previous periods.

B.6. Second phase

The instructions for the second phase are the same of those used in the first phase. In particular, the second phase consists of 12 consecutive periods in each of which you will make only one choice. At the end of the experiment, if the second phase will be used to determine participants' payments, your final earnings will depend on the results of one period only. In particular, the period used to determine participants' final earnings will be randomly selected by drawing one of 12 cards, numbered from 1 to 12.

B.7. Your task in each period of the second phase

As in the previous phase, in each of the 12 periods of the second phase, you have to choose which share of income to report in order to pay taxes. In particular, in each of the 12 periods of the second phase, the computer will randomly and anonymously assign a gross income in tokens included between 120 and 180 tokens. Given your gross income, you have to choose how many tokens to report. On the reported amount of tokens, you will pay taxes according to a flat rate of XX%. You can report any number of tokens included between 0 and your gross income.

In each of the 12 periods of the second phase, the amount of tokens you have chosen to report can be randomly selected for auditing to verify the correspondence of your choice with respect to your gross income. In the case your choice is not selected for auditing, then your earnings in the period is given by your gross income minus the taxes computed on the amount of tokens you have reported. In the case your choice is selected for auditing and the amount of tokens you have reported is lower than your gross income, then your earnings in the period is given by your gross income minus the taxes computed on your gross income minus a fine that is equal to the taxes you have not paid. Of course, if the amount of tokens you have reported is equal to your gross income, then the auditing procedure does not imply any fine.

B.8. The auditing procedure

At the end of each period, after all the choices have been made, each subject is randomly and anonymously assigned one of 20 cards, numbered from 1 to 20, by the computer. Then, the computer randomly selects two of the 20 cards. The choices made by the owners of the two cards will be audited. The auditing procedure is anonymous. Therefore, participants whose choices have been audited are privately informed about the results of the auditing procedure. Finally, notice that the probability to be audited in a given period does not depend on the results of the auditing procedures conducted in previous periods.

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