The excess burden of tax evasion - An experimental detection-concealment contest*

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Abstract

We present an experimental study on the wasted resources associated with tax evasion. This waste arises from taxpayers and tax authorities investing costly effort in the concealment and detection of tax evasion. We show that these socially inefficient efforts - as well as the frequency of tax evasion - depend positively on the prevailing tax rate, but not on the fine which is imposed in the event of detected tax evasion. Tax evasion is less frequent, though, than a model with risk neutral taxpayers predicts. We find evidence that this is due to individual moral constraints rather than to risk aversion.

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1 Introduction

It is not clear what the welfare implications of tax evasion are. Some authors believe that tax evasion itself constitutes a deadweight loss for society (e.g. Usher, 1986). Some others point out the difficulty to asses its welfare effects, since the state of the economy, the efficiency of the prevailing tax system, and social preferences over income distributions are unknown (see Cowell, 1990, chp 7). In any case, tax evasion causes two additional types of social costs: First, taxpayers invest effort and money in order to conceal tax evasion.[1] Second, tax authorities bear the costs of auditing in order to detect tax evasion.[2] Hence, a given tax system does not only influence the amount of tax evasion or the size of a country's shadow economy (Schneider and Enste, 2000); it also has immediate consequences for the extent of wastefully invested resources in the concealment-detection contest between taxpayers and tax authority. Tax enforcement and concealment going along with cheating are costly not only for the individuals involved, but also for a society, since these resources could otherwise be used for productive purposes. Consequently, this cost can be viewed as a further excess burden of taxation a society has to bear.

In this paper, we are interested in the influence of a tax system on these wastefully invested resources. We present a model of a concealment-detection contest between taxpayer and tax authority. The taxpayer can invest some of his income in order to shelter his evasion behaviour while the tax authority spends resources on detection after having observed the taxpayer's reported income.[3] The probability that tax evasion is detected decreases with the taxpayer's concealment investment and increases with the authority's detection effort.[4] In our model, we are able to investigate how tax rates and fines influence not only tax

[1] Think, for instance, of a taxpayer spending money for bribes or forgoing possible interest payments in order to shelter black money abroad. Of course, some forms of tax evasion might actually relieve the taxpayer of compliance costs. For instance, non-lodgment is basically tax evasion through doing nothing. Yet, those forms of tax evasion might be less successful than those which entail substantial costs.

[2] Think of hiring more tax administrators to monitor tax reports or of investing in better detection technology, which have been shown empirically to reduce tax evasion (see, for instance, Cebula, 2001).

[3] This sequential structure implies that our model belongs to the group of game-theoretic models of the interaction of taxpayers and tax authorities. On overview of this group of models and a comparison to the second dominant group in this area (the principal agent approach) is provided in Andreoni et al. (1998).

[4] Uncertainty about fiscal parameters (like the prevailing tax rate or success of an audit) has been shown to influence taxpayer compliance (Alm et al., 1992c). Our model also bears elements of uncertainty since the success of an audit is uncertain. Compared to Alm et al. (1992c), for instance, we have, however, a richer structure by explicitly modeling the (socially inefficient) concealment and detection costs.

evasion, but also the resources wastefully invested for detection and concealment. Hence, we can determine the degree of social (in)efficiency of different tax regimes. The less resources are wasted in the contest, the more efficient is the tax-collection and enforcement system. Our theoretical model predicts that efficiency decreases with higher tax rates, while the influence of fines is more complicated to predict.

Allowing for concealment and detection efforts describes the tax-evasion decision more realistically than conventional models in the tradition of Allingham and Sandmo (1972) where taxpayers have no means of covering their evasion and audit rates are exogenously fixed. Of course, there are some papers which consider the possibility to conceal tax evasion (like Cremer and Gahvari, 1994) or which acknowledge that investing in income-detection technologies might raise the probability of a successful audit by the tax authority (like Usher, 1986). However, these previous papers do not examine the extent of wastefully invested resources in the context of tax evasion. Rather, Cremer and Gahvari (1994) concentrate on the influence of tax evasion and concealment on the design of an optimal linear income tax, and Usher (1986) studies the effects of concealment and detection effort on the marginal costs of public funds. Therefore, our paper can be considered the first one to address the excess burden of tax evasion through concealment and detection costs.

Note that our model will not consider the possible repercussions of public goods provision through taxation on tax evasion. Based on equity theory (Walster et al., 1978), one can expect less tax evasion when taxes are used to provide public goods (see Falkinger, 1988). However, the experimental evidence is not unambiguous on this issue (see Kim, 2002). We, therefore, do not pursue this avenue of research, partly also because we think that adding public good provision might confound the pure effects of the tax regime on the degree of wastefully invested resources. Furthermore, it seems reasonable to assume that a single taxpayer considers his tax contributions negligible for the whole amount of taxes available for a society to provide public goods. Another avenue of research that we do not pursue is the inclusion of different types of information about a taxpayer, from which the tax authority might infer the taxpayer's audit class (Scotchmer, 1987). The latter is defined as information about the taxpayer (like his profession or age) which is correlated with his true taxable income. In our model, the tax authority is only informed about the taxpayer's reported income, but not about any correlates. In reality, it is true that audit classes might be useful for targeting audits optimally, but to study the excess burden of tax evasion it does not seem necessary to start with different audit classes.

We test our model predictions in a controlled laboratory experiment. Experimental economics provides an ideal methodological tool to measure the influence of different tax regimes on wastefully invested resources for concealment or detection of tax evasion. Experimentation in the laboratory is defined by controlled manipulation of independent treatments (inducing different tax regimes) and randomized assignment of participants to those treatments. If differences between experimental groups on dependent variables (i.e., concealment and detection effort) can be observed, these differences can be attributed causally to differences in treatments (here: combinations of tax rates and fines). In the field, it is much more problematic to study the efficiency costs of tax rates and fines for the following reasons. (1), it is hard to determine how precisely to measure concealment and detection efforts. On the side of the tax authority it might be feasible to approximate detection costs by the costs for monitoring tax declarations, whereas on the side of the taxpayers it is less clear which kind of expenditures (legal advice, bribes, expenses, forgone gains etc.) should be subsumed under concealment costs. (2), even if there were consensus on how to measure the efficiency costs, it would be next to impossible to get field data from taxpayers, because expenditures associated with illegal tax evasion are unlikely to be revealed voluntarily. (3), given that one had found a way around problem (2), to study the comparative static effects of different tax regimes would still require the random and controlled exposition of taxpayers and tax authorities to different tax regimes. This is rather problematic in reality, because 'real-life experiments' with tax regimes bear problems of control, and applying different tax rates or fines to different taxpayers in the same jurisdiction is legally impossible on grounds of equal treatment of taxpayers. Of course, this is not to say that field experiments cannot shed light, for instance, on the influence of audit rates on tax evasion.[5] Slemrod et al. (2001) report a field experiment in Minnesota on the effects of an increased probability of audit on taxpayer's tax returns. They find that an increased probability of audit has a positive effect on declared tax liability for low- and middle-income taxpayers, but the reverse effect for high-income taxpayers. Even though highly original in their 'experimental' design, one weakness of

[5] Taking into account reason (2) from above, it may not come as a surprise that there are no studies yet on the influence of tax regimes on taxpayers' concealment efforts, but only on tax authorities' efforts on tax evasion.

Slemrod et al. (2001) is the fact that the increased probability of audit was indicated in a letter such that a certain taxpayer "had been selected at random to be part of a study that will increase the number of taxpayers whose 1994 individual income tax returns are closely examined" (p. 463). The authors themselves acknowledge that there is no control on how field participants interpreted this loose information and how that affected their income reports. A similar problem of control in the field is present in a recent study by Wenzel and Taylor (2004) on the effects of tax-reporting schedules on tax returns. They find that only a combination of both specific instructions on compliance ('education') and surveillance ('deterrence') lead to less tax evasion, whereas each single component has no effect. One of the shortcomings of this study is the fact that it remains unclear how the differently formulated letters (cooperative vs. deterring) from the Australian Taxation Office were perceived by the rental property owners and affected their tax reports.

In our experimental design, it is possible to satisfy the needs (1) through (3) discussed above and hence we can reliably test the efficiency-cost effects of different tax regimes, i.e. of tax rates and fines. However, we are aware that the reliability and internal validity of laboratory experiments come at a cost. It is less clear how results in the laboratory can be generalized to behaviour in the field. External validity is always an issue if laboratory experiments are concerned. However, due to the mentioned difficulties in field data collection in the case of tax evasion and the practical importance of assessing the excess burden of tax evasion we believe that laboratory experiments are a legitimate method of investigation for our question.

We find in our experiment that higher tax rates clearly increase the size of wastefully invested resources, whereas higher fines do not have a significant influence on efficiency, i.e. they have no systematic effect on concealment and detection costs. Tax evasion itself is also higher with higher tax rates, whereas it does not depend on the size of the fine. A further finding of our experiment is that subjects do not permanently evade taxes, despite a design in which tax evasion is a better than fair gamble such that risk neutral taxpayers should evade taxes all the time. Alm et al. (1992a) have already put forward that the real puzzle in tax evasion is why people do pay taxes rather than why they try to evade them. Like in the real world, we can observe in our experiment taxpayers truthfully revealing their income to the tax authority. A widely used explanation for this puzzle (see e.g. Baldry, 1987, Gordon, 1989, or Myles and Naylor, 1996) is the existence of some psychological cost of cheating. Our model can be extended to account for such costs. In the extension with moral costs, the theoretical model predicts that taxpayers without any scruples always evade while taxpayers with moral constraints are at least sometimes honest. We use this prediction in our laboratory experiment to identify whether moral constraints really play a role in taxpayers' evasion behaviour. We find that the existence of moral costs is a valid explanation for honesty, which better fits the data than explaining truthful declaration by assuming strong risk aversion.

The remainder of the paper is organized as follows: Section 2 introduces the basic model and derives the main predictions for the parameter settings used in the experiment. Section 3 is devoted to our experimental results on the influence of tax rates and fines on behavior in the detection-concealment contest. Section 4 analyzes individual behaviour more closely and provides some interpretations for behaviour deviating from the model predictions. A conclusion is offered in Section 5.

2 Model and experimental design

In this section, we explain the timing, information, and payoff structure underlying the experiment. The experimentally implemented structure follows the theoretical model developed in Bayer (2003). This model follows the tradition of the non-commitment tax-evasion games initiated by Reinganum and Wilde (1986). We chose the approach where the tax authority cannot commit beforehand to a certain audit strategy, but decides on the audit effort after receiving the tax return. The reason for this choice is our belief that this is the more realistic case. The alternative principal-agent approach pioneered by Border and Sobel (1987) where the tax authority can commit to an audit strategy seems less realistic. The reasons are twofold: Firstly, the equilibria for optimal audit and fine schemes are usually somewhat unsettling as there is no tax evasion and the authority only audits truthfully revealing taxpayers. Secondly, for these optimal audit and fine schemes to work taxpayers would have to know them and would have to believe that the authority is committed to them. Neither are very realistic.[6]

[6] Authorities in some countries even try to keep their strategies secret as they believe that the resulting uncertainty increases compliance (see, for instance, Alm et al., 1992c).

The novelty of our model comes from the combination of allowing the taxpayer to invest concealment effort and the tax authority to invest into the detection of tax evasion. This setup leads to a concealment-detection contest between the taxpayer and the authority, where the efforts exerted for concealment and detection decide over the probability that tax evasion can be proven. This makes it possible to investigate the connection between tax rates, fines and the frequency of evasion in a more complex environment than with models of only one-sided investment. However, the more interesting new implication of the model is the possibility to investigate how tax rates and fines influence the extent to which resources are unproductively wasted in the process of tax sheltering and detection.

In what follows we briefly present the model and its equilibrium predictions for the parameters chosen for our experimental study. We begin with the timing.

2.1 Timing

Timing and information structure within one experimental round are the following:

1. Nature determines the actual income $Y \in \{0, y\}$. The probability that $Y = y$ is earned is given by λ. This probability is common knowledge.
2. The taxpayer observes Y.
3. The taxpayer makes an income declaration $D \in \{0, y\}$ and exerts a concealment effort $E \in \{0, 1, ..., 10\}$.
4. The authority observes the declaration D but not the concealment effort E.
5. The authority chooses a detection effort $A \in \{0, 1, ..., 10\}$.
6. Nature decides whether the actual income is verifiable in court. The verification probability depends on the efforts and is given by $P(A, E)$, which is specified below.
7. Taxpayer and authority are informed whether a fine is due. Taxpayers receive their ex post net income U and the authority receives the revenue R, respectively. Both players do not receive any information about the efforts of their opponents.

2.2 Action spaces and payoff structure

In this section we explain the underlying payoff structure for the experiment and comment on the possible actions the subjects can take.

- We restrict the income distribution to two values 0 and y. Consequently, we restrict the possible income declaration to be dichotomous as well:

$$\begin{aligned} Y &= \begin{cases} y & \text{with probability} \quad \lambda \\ 0 & \text{with probability} \quad 1-\lambda \end{cases} \\ D &\in \{0, y\} \end{aligned}$$

- In order to keep the experiment simple we only allow for integer values of the efforts. The feasible efforts (A, E) range from 0 to 10.

- Effort costs are linear for both tax authority and taxpayer. One unit of concealment effort costs the taxpayer c^e experimental money units while for the authority the detection cost per effort unit is given by c^a.

- As the verification-probability function we use:

$$P(A, E) = \begin{cases} 1 & \text{if} \quad A, E = 0 \\ \frac{A}{A+E} & \text{else} \end{cases} \quad . \tag{1}$$

  This probability function is widely used in the contest literature. Combined with linear detection and concealment costs we achieve that the marginal cost of influencing the verification probability in the favoured direction increases for both the authority and the taxpayer. This seems to be a realistic feature, since authorities and tax evaders should use the cheapest means of detection and concealment respectively, before more expensive measures are taken.

- The tax system is linear and the fine is proportional to the taxes evaded. The potential fine if evasion took place can be expressed as $f \cdot t \cdot y$, where t is the tax rate and f denotes the fine parameter.

Given this underlying structure the expected payoff per round for a taxpayer depending on his declaration behaviour and true income becomes:

$$EU(Y = y) := \begin{cases} (1-t)y - c^e \cdot E & \text{for} \quad D = y \\ y - P(A^E, E) \cdot f \cdot t \cdot y - c^e \cdot E & \text{for} \quad D = 0 \end{cases} \tag{2}$$

$$EU(Y = 0) := \begin{cases} -t \cdot y - c^e \cdot E & \text{for} \quad D = y \\ -c^e \cdot E & \text{for} \quad D = 0 \end{cases} \tag{3}$$

where A^E denotes the expected detection effort of the authority. It is immediately clear that a taxpayer with $Y = 0$ should declare zero income. Then without evasion to conceal, the optimal concealment effort should by zero as well.

The expected payoff for the authority ER can be written as:

$$ER(A) := \begin{cases} \mu \cdot P(A, E^E) \cdot f \cdot t \cdot y - c^a \cdot A & \text{for} \quad D = 0 \\ t \cdot y - c^a \cdot A & \text{for} \quad D = y \end{cases}, \tag{4}$$

where μ is the belief that a zero declaration comes from a taxpayer who has an actual income of y and E^E denotes the expected concealment effort conditional on tax evasion taking place. We see easily that a tax authority that observes a declaration of $D = y$ should not exert any detection effort.

The first-order condition for an optimal detection effort choice of the authority observing a zero declaration is given by

$$\frac{\partial ER(A, D=0)}{\partial A} = \frac{\mu \cdot E^E \cdot f \cdot t \cdot y}{(E^E + A)^2} - c_a = 0 \tag{5}$$

The first-order condition for an evading taxpayer with respect to her concealment effort is given by

$$\frac{\partial EU(E, D=0, Y=y)}{\partial E} = \frac{A^E \cdot f \cdot t \cdot y}{(E + A^E)^2} - c_e = 0 \tag{6}$$

Solving (5) and (6) simultaneously gives the optimal efforts in case of:

$$A^*(D = 0) = \begin{cases} \mu \cdot f \cdot t \cdot y \cdot c^e \cdot \phi & \text{if} \quad D = 0 \\ 0 & \text{if} \quad D = y \end{cases} \tag{7}$$

$$E^*(Y = y, \ D = 0) = \mu \cdot f \cdot t \cdot y \cdot c^a \cdot \phi, \tag{8}$$

where

$$\phi := \frac{c^a}{(\lambda c^e + c^a)^2}.$$

We now look for a pure strategy evasion equilibrium. In such an equilibrium a taxpayer always evades whenever she earned the income. Then in equilibrium the authority's belief μ that a zero declaration comes from an evader has to be equal to the prior probability λ that the income was earned:

$$\mu^* = \lambda.$$

The taxpayer's expected payoff from evasion has to be higher than the payoff for truthful declaration for such an equilibrium to exist:

$$EU(D = 0, Y = y, E^*, A^*) \geq (1 - t)\, y$$

which leads to the following condition on parameters:

$$f \leq \frac{1}{1 - c^a \phi}. \tag{9}$$

Note that this equilibrium is the unique Perfect Bayesian Nash equilibrium for all parameter configurations that satisfy (9). For parameter values violating the condition above, the marginal concealment cost and the fine are too high for always evading to be profitable. Taxpayers then choose to mix between evasion and truthful declaration. It can be shown that the equilibrium evasion probability α^* conditional on having earned the income y and on violating condition (9) can be written as:[7]

$$\alpha^* = \frac{\eta(1-\lambda)\left(\sqrt{f} - \sqrt{f-1}\right)}{\lambda\left((1-\eta)\sqrt{f-1} - \eta\sqrt{f}\right)}, \tag{10}$$

where $\eta = c_a/c_e$ is the comparative advantage in concealment over detection. It is possible to show that lower fines increase the probability of evasion for parameter settings where evading with certainty does not pay.[8] Note that here equilibrium efforts A^* and E^* decrease if the equilibrium evasion probability α^* decreases. This is driven by the feature that the equilibrium beliefs for evasion μ^* decrease if α^* decreases. In this formulation the tax rate should have no influence on the evasion probability.

[7] For the derivation see Bayer (2003).

[8] This is true, since $\partial \alpha^* / \partial f < 0$ for $\alpha^* \in [0, 1]$.

2.3 Parametrization and predictions

We set up four different treatments by exogenously varying tax rates and fines. Tax rates could be either 25% (T_l) or 40% (T_h). Fines were proportional to the evaded tax in case of detection, by either adding a surcharge of 25% (F_l) or of 100% (F_h) to the evaded tax.[9] This was implemented by setting the fine parameter $f = 1.25$ and $f = 2$, respectively. The fine - of course - also had to be paid to the tax authority. The taxpayer's payoff per round was calculated by subtracting taxes, the fine (if any) and concealment costs from the taxpayer's effective income, which was randomly drawn in every round and could either be 1000 Taler or zero. The probability λ for an income of 1000 was set to 0.8 for all treatments. The marginal cost of concealment effort c^e was 20 Taler in all four treatments. The marginal cost of detection effort c^a amounted to 40 Taler throughout the experiment. Additionally, we awarded a base payment of 450 Taler to the tax authorities.[10] This was done in order to prevent large differences in period profits of taxpayers and authorities, in order to eliminate behavioural effects stemming from inequality aversion.

We chose the parameters such that evasion, given optimal efforts, always pays for risk neutral taxpayers. Therefore, we might expect that a taxpayer always evades if his income is 1000. In fact the expected declaration should always be zero. The authority's believed probability that a zero-declaration is fraudulent should be equal to the earnings probability, i.e. $\mu^* = \lambda = 0.8$. Solving for the optimal effort and taking the experiment's discontinuous action space into account gives the following prediction of optimal efforts, as summarized in Table 1:

		treatment(tax/fine)			
optimal effort of	actual/observed action	T_lF_l	T_lF_h	T_hF_l	T_hF_h
taxpayer (E^*)	- evasion	3	5	5	8
tax authority (A^*)	- declare = 0	1	2	2	3

Table 1: *Optimal efforts for risk-neutrality*

[9] The 25% surcharge e.g. is applied in the United States for the "failure to report or pay taxes". A 100% surcharge is levied in Switzerland for evasion. Some countries have even higher fines, e.g. in Singapore a tax evader has to pay up to 400% of the evaded taxes in fines.

[10] Note that this does not have any impact on the equilibrium prediction.

With these equilibrium efforts we can calculate the expected efficiency. The expected waste per period is given by:

$$W := \lambda c_e E^* + c_a A^*.$$

Then the expected efficiency V in percent is given by one minus the ratio of expected waste to expected income.

$$V := 1 - \frac{W}{\lambda y} \tag{11}$$

This yields the predicted efficiency per treatment stated in Table 2. We see that higher fines should decrease efficiency for given tax rates, as higher tax rates do for given fines.

	treatment(tax/fine)			
predicted	T_lF_l	T_lF_h	T_hF_l	T_hF_h
efficiency	0.89	0.80	0.80	0.69

Table 2: *Predicted efficiency per treatment*

Note that the predicted efficiency levels rely on the prediction that the taxpayers always evade. However, full evasion is only optimal if taxpayers are not too risk-averse or morally constrained by scruples. If taxpayers do not evade with certainty then the effect of higher fines on efficiency is not necessarily negative. On the one hand, higher fines will increase the agents' incentives to exert concealment and detection efforts as the "prize" for winning the contest increases. On the other hand, higher fines will decrease the evasion frequencies as the consequences of being caught are becoming more severe for the taxpayer. This directly reduces waste, because concealment efforts are exerted less often. Moreover, the reduced evasion probability has a second, more indirect, waste-reducing effect: The decreased probability of evasion reduces the detection incentives - and therefore efforts - of the authority. Furthermore, anticipating the reduced detection effort of the authority, a taxpayer will reduce its effort, too. Whether the total effect of higher fines on efficiency is positive or negative depends strongly on the strength of the deterrence effect of fines if taxpayers evade only sometimes.

3 Results

The experimental sessions were run with the help of z-Tree (Fischbacher, 1999) from January to March 2004 at the University of Innsbruck. Two persons, called taxpayer and tax authority were paired for 20 rounds.[11] The proceedings within a period followed the timing described above. After each round the taxpayers and authorities were informed whether the contest had led to proven evasion. Additionally the subjects were told their period payoffs. No information about the opponent's effort or payoff was revealed.[12] For each treatment, we ran three sessions with 20 participants each, yielding 30 independent observations (pairs of taxpayer and tax authority) per treatment. The average age of our 240 student participants was 23.2 years, with 42% being female. About 73% of participants were enrolled in business or economics, most of the others studied law, medicine or psychology. On average, sessions lasted 45 minutes. At the end of the experiment, 1000 Talers were exchanged for 1.2 Euro. Average earnings were 12.3 Euro.

3.1 Descriptive overview

Table 3 presents some descriptive statistics of the experimental data. Recall that the actual gross income is determined by a random draw (with 80% probability for gross income $Y = 1000$, and 20% probability for $Y = 0$).[13] Declared income can be either 1000 or zero. If a subject gets $Y = 1000$, but declares zero income, he is classified as evading the tax. The relative frequency of tax evasion ranges from 49% in treatment T_lF_h (with low taxes, but a high fine) to 68% in treatment T_hF_l (with high taxes, but a low fine). Even though it would be optimal for risk-neutral subjects to evade all the time, many subjects mix in their decision between evasion and truthful declaration.[14] On average,

[11] See the Appendix for a translation of the instructions.

[12] This information structure was chosen for reasons of comparability to reality. There the tax authority does not find out whether tax evasion has taken place, unless an audit is successful in detecting evasion. We conducted some sessions where the subjects had full information about past effort choices and payoffs of the opponents. This alternative setting did not change the qualitative results of the present paper.

[13] In order to guarantee the same gross income across all treatments, we let in each round 8 out of 10 taxpayers receive an income of $Y = 1000$. The 8 subjects were determined by a random number, with those 8 with the highest random number getting $Y = 1000$. Participants were not aware of this procedure, but were only informed about the 80% probability for receiving $Y = 1000$.

[14] The discussion of possible reasons for truthful declaration will follow in Section 4.

tax evasion is detected by the tax authority in about one third of cases, ranging from 31% in T_lF_l to 39% in T_hF_l. Of course, the probability of detection is dependent on the taxpayers' and the tax authorities' efforts for concealment and detection, which will be discussed in detail in section 3.3 and which are summarized in Table 4 below. Taxpayers' profits are highest in treatment T_lF_l and lowest in treatment T_hF_h; the reverse holds true for tax authorities.

	treatment(tax/fine)			
Averages per treatment ($N = 30$ per treatment)	T_lF_l	T_lF_h	T_hF_l	T_hF_h
Relative frequency of tax evasion	0.54	0.49	0.68	0.63
Relative frequency of detected tax evasion	0.31	0.36	0.39	0.32
Profit taxpayer	12159	11405	10096	9481
Profit tax authority	9703	10123	9864	11281
Student of economics and business (1 = yes) ($N = 60$)	0.70	0.77	0.77	0.67
Gender (1 = female) ($N = 60$)	0.40	0.49	0.37	0.42
Age ($N = 60$)	23.3	22.2	23.6	23.9

Table 3: *Descriptive data*

3.2 Frequency of evasion

Even though the theoretical prediction would be full evasion in any treatment, we find that the frequencies of evasion are well below one hundred percent in all treatments. So we can explore how the evasion frequencies vary with tax rates and fines. Given that we cannot reject the null hypothesis that actual evasion frequencies are sampled from a normal distribution ($p > 0.4$; Kolmogorov-Smirnov-test), we can apply an analysis of variance (ANOVA) to study the main and interaction effects of our two experimental factors, the tax rate and the fine. The ANOVA shows that evasion frequencies depend only significantly on the tax rate ($p < 0.01$), but that the fine ($p > 0.3$) and the interaction term ($p > 0.5$) are not significant. In fact, looking at Table 3 shows that the evasion frequencies are rather close to each other and insignificant when one controls for the tax rate (54% in T_lF_l vs. 49% in T_lF_h, respectively 68% in T_hF_l vs. 63% in T_hF_h). However, when controlling for the size of the fine, a variation in the tax rate leads to large and significant differences in tax evasion (54% in T_lF_l vs. 68% in T_hF_l, $p < 0.05$; respectively 49% in T_lF_h vs. 63% in T_hF_h, $p < 0.1$; t-tests).[15]

Figure 1 shows the development of tax evasion frequencies in intervals of five rounds. Interestingly, evasion frequencies start out at almost identical levels in all treatments. The observation that evasion frequencies are not different for early rounds[16] while for later rounds a significant difference can be found is striking, but not entirely surprising. Recalling that the feedback subjects receive after each round is very limited, we may expect that it takes some rounds until behavioural adjustments due to learning occur.[17] In fact, looking at the second half of the experiment, there is a clear separation of treatments with respect to the frequency of tax evasion. Applying an ANOVA to rounds 11-20, we find again a strong main effect of taxes ($p < 0.001$), but no significant effects of the fine ($p > 0.1$) or the interaction term ($p > 0.5$).

Result 1 *Tax rates are the main factor explaining tax evasion, whereas the size of the fine and the interaction of taxes and fines have no significant impact.*

3.3 Concealment and detection efforts

3.3.1 Mean efforts

Table 4 shows average efforts of taxpayers in case of tax evasion and of tax authorities when they observe a declaration of zero income. Figures in brackets refer to the ex-post optimal efforts, given the actual play of the opponent, i.e. the taxpayer's relative

[15]Note that p-values refer to two-tailed tests. Given that our prior concerning the direction of the difference is confirmed, one might want to consider one sided p-values, which can be obtained by dividing the p-values by two.

[16]Note that in Rounds 1-5, the evasion frequencies are amazingly close together in all treatments, narrowly ranging from 0.59 in T_hF_l to 0.63 in T_lF_h. We find no significant difference in any pairwise comparison for these rounds.

[17]We ran some additional sessions with full information about the opponent's effort choice in the previous round. In these sessions, separation of treatments with respect to evasion frequencies occurs much earlier than in our incomplete information setting presented in this paper. Basically, evasion frequencies across all 20 rounds in the full information setting mirror the evasion frequencies in the second half of the incomplete information setting. This suggests that there is only a slow learning process going on in our setting due to its limited feedback.

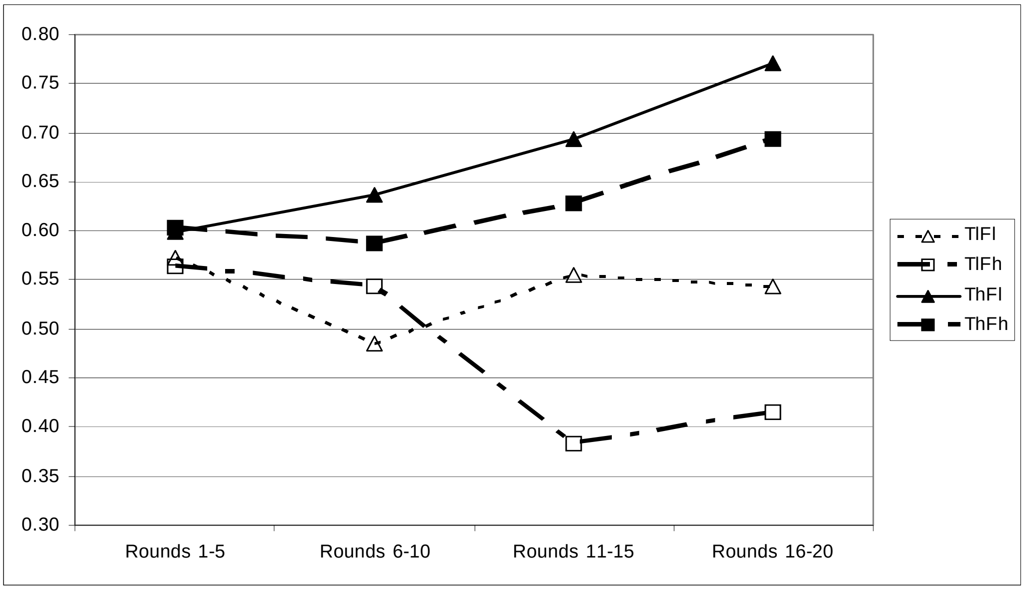

Figure 1: Evolution of evasion frequencies

frequency of tax evasion and his average efforts in case of evasion, or the tax authorities detection efforts. Note that figures in brackets are different from the ex-ante optimal effort levels in equilibrium, as stated in Table 1 above. Comparing the ex-ante optimal effort levels for risk-neutrality in Table 1 with the figures for actual effort in Table 4 shows that actual efforts are clearly higher than the ex-ante optimal ones in all treatments but T_hF_h. Given that Figures in Table 1 assume full evasion with probability one and given that actual evasion frequencies are the range from 49% to 68% (see Table 3) one can consider actual effort levels as excessively high, because efforts should decrease with lower evasion probabilities. The latter fact explains also why the ex-post optimal effort levels of tax authorities in Table 4 are lower than the ex-ante optimal ones in Table 1.

	treatment(tax/fine)			
	T_lF_l	T_lF_h	T_hF_l	T_hF_h
Taxpayers' concealment efforts in case of evasion	6.88	7.23	7.98	8.01
	(3.56)	(5.41)	(5.76)	(8.21)
Tax authorities' detection efforts if $D = 0$	4.02	4.30	5.18	4.36
	(0.13)	(0.52)	(0.57)	(2.33)

(In parentheses we report the average optimal efforts given the actual play of the opponent.)

Table 4: *Average efforts per round*

Testing for treatment differences in taxpayers' concealment efforts in case of evasion by an ANOVA[18] we find again only a main effect of the tax rate ($p < 0.05$), but no significant influence of the fine ($p > 0.6$) or the interaction term ($p > 0.6$). That means that effort levels in case of evasion are significantly higher in case of high tax rates and a given fine than in case of low tax rates. Variations of the fine (under a given tax rate), however, do not cause significantly different effort levels.

The picture is similar with respect to tax authorities' detection efforts when they observe a zero declaration. Although there is no significant treatment effect when we consider all 20 rounds, we find a significant influence of the tax rate ($p < 0.05$; ANOVA) when looking only at rounds 11-20.[19] Again, the fine and the interaction term are insignificant. In sum, the evidence concerning effort levels supports the general thrust of our first result that tax rates, but not fines, are the main driving factor for behavior.

Result 2 *Higher tax rates lead to higher concealment and detection efforts, while fines have no unequivocal influence.*

3.3.2 Distribution of efforts

Figure 2 shows on its left hand side the frequency distribution of tax authorities' detection efforts if a declaration of zero was observed and on its right hand side taxpayers' concealment efforts if they evaded the tax. We see that the distributions differ considerably between treatments with different tax rates (between panels), but not for different fines (within panels). For high tax rates (see the bottom two panels of Figure 2) the relative frequency of very high concealment and detection efforts is greater than under low tax rates (the top two panels).[20]

[18] The two null hypotheses of a normal distribution of (a) taxpayers' concealment efforts, and (b) tax authorities' detection efforts can not be rejected ($p > 0.4$ in both cases; Kolmogorov-Smirnov-test).

[19] Tax authorities' effort levels per zero declaration in rounds 11-20 are 3.17 in T_lF_l, 3.61 in T_lF_h, 4.93 in T_hF_l, and 4.17 in T_hF_h.

[20] For instance, whereas concealment efforts of 10 occur in only 22% (24%) of cases in the low tax treatment T_lF_l (T_lF_h), 42% (52%) of taxpayers choose the maximum effort in the high tax treatment T_hF_h (T_hF_l). For a statistical analysis of differences in means see the previous subsection.

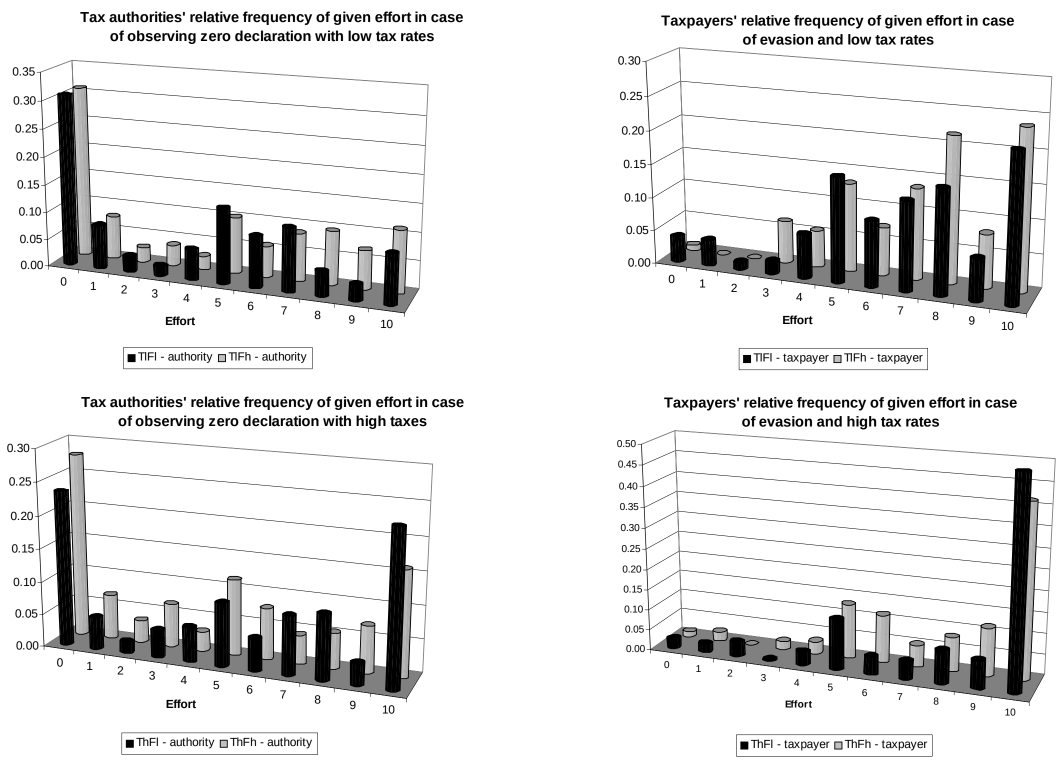

Figure 2: Distribution of concealment and detection efforts

Furthermore we see that for tax authorities, exerting either no effort or a very high effort seem to be focal points under the high tax-rate treatments (bottom panel on the left-hand side). With low tax rates, however, choosing zero effort is by far the most prominent choice in about one third of cases (top panel on the left hand side). The latter is an indication that tax authorities are relatively good in anticipating the truthfulness of the taxpayer's declaration under low tax rates.

Taxpayers' effort distributions are very similar for treatments with the same tax rates, while they differ considerably for different tax rates but the same fine. To back up this observation statistically we pooled the effort data over all experimental periods and ran Kolmogorov-Smirnov tests. For taxpayers' efforts, the treatments with the same tax rates were the only two pairs of empirical distributions where the null hypothesis of equal distributions could not be rejected on the 5% level (T_lF_l vs. T_lF_h $p > .2$; T_hF_l vs. T_hF_h $p > .06$).[21]

[21] Authorities' effort distributions were found to be different even for the treatments with the same tax rates. Hence, not only the tax rate, but also the size of the fine has an influence on the distribution of their detection efforts. However, recall that means of detection effort depend only on the tax (and only in rounds 11-20).

Result 3 *The distribution of taxpayers' concealment efforts is driven by the tax rate rather than the magnitude of the fine.*

3.3.3 Correlation of efforts

Finally, we examine the correlation between taxpayers' and authorities' efforts in order to check whether pairs unknowingly coordinate on similar effort levels. This might happen - even in the absence of information on the other's effort - because high effort levels of the other party might make the other party much more successful in detecting or concealing tax evasion, which could only be counterbalanced by own higher efforts. Likewise, low efforts of the other party (with an ensuing low probability of detecting or concealing tax evasion) might make own high efforts less necessary.

For the analysis, we consider only those cases where the taxpayer actually evades the tax. That means we exclude all cases where the taxpayer reports his income truthfully. If real income $Y = 1000$, there are no efforts because there is nothing to conceal, respectively to detect. If real income $Y = 0$, the taxpayer chooses no effort (which was enforced by the computer program), but the tax authority might choose a positive effort. Since the latter effort would be paired with a zero effort of the taxpayer, we excluded these cases.

Across all treatments, average efforts (in case of actual evasion) are significantly positively correlated within pairs (with correlation coefficient $r = 0.25$; $p < 0.01$; $N = 120$). This means that high efforts of the tax authority are typically associated with high efforts of the taxpayer. The correlation is also positive in any of our treatments, but with the exception of treatment $T_l F_h$ it is not significant due to the lower number of observations.

Result 4 *Efforts of authority and taxpayer are positively correlated, even though both parties are not informed about each other's efforts.*

3.4 Efficiency and tax revenue

3.4.1 Efficiency

We turn to the analysis of the efficiency levels in different treatments. Here efficiency refers to the amount of income that is not wasted in the detection-concealment contest. We calculate an efficiency measure for every pair of subjects. This measure gives the percentage of income created in a relationship that is not invested into wasteful detection and concealment. Table 5 includes the average efficiency levels and Figure 3 shows the distribution of efficiency levels in different treatments. On average, efficiency is highest in T_lF_l and lowest in T_hF_l. With respect to the distribution of efficiency we find that 43% of pairs in the low-tax low-fine treatment (T_lF_l) achieve more than 90 percent efficiency, whereas only 13% of pairs succeed in reaching such a high efficiency level in the high-tax low-fine treatment (T_hF_l). Checking for treatment effects by an ANOVA[22] yields again a significant tax effect ($p < 0.001$), but no effects of the fine ($p > 0.5$) or the interaction term ($p > 0.1$).

Treatment	T_lF_l	T_lF_h	T_hF_l	T_hF_h
Actual efficiency	87.4	86.1	79.9	83.0

Table 5: *Efficiency by treatment (in percent)*

Result 5 *Higher tax rates lead to lower efficiency, while the influence of fines is not significant.*

3.4.2 Tax revenues

It is interesting to check whether the sacrifice of some efficiency by increasing tax rates at least induces a higher revenue for the government. The surprising answer is that this is

[22]The distribution of efficiency levels is not significantly different from a normal distribution ($p > 0.8$; Kolmogorov-Smirnov-test).

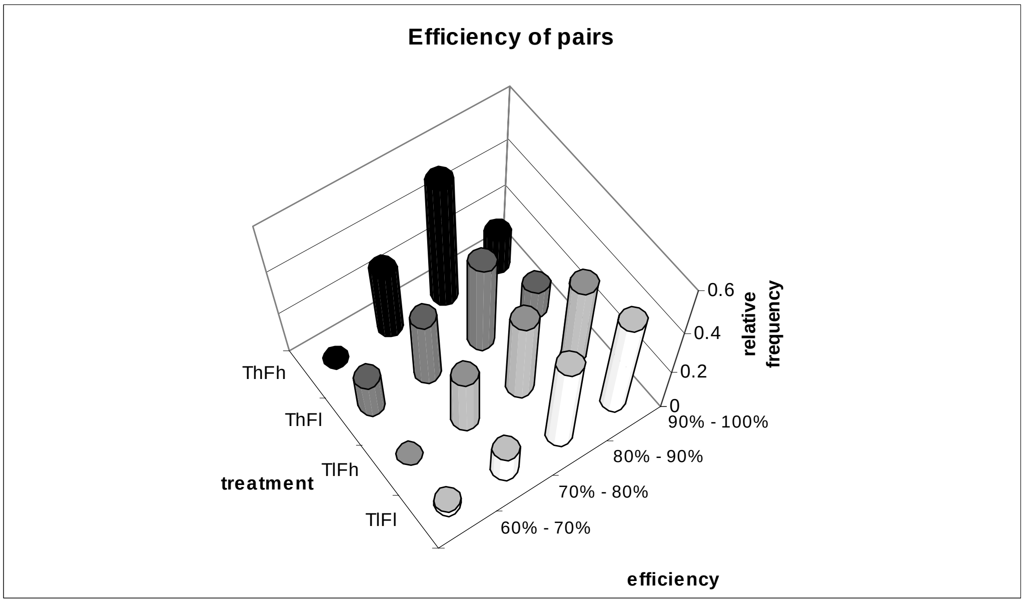

Figure 3: Efficiency levels of pairs by treatment

not necessarily true if one takes the detection effort into account. Table 6 summarizes the average revenue (summed over all 20 rounds) per pair and treatment. Higher tax rates lead to slightly higher tax revenues, higher taxes recovered by audits, and higher revenues from fines (controlling for fine size). However, if enforcement costs of the tax authority are taken into account, we see that they are larger than the sum of taxes recovered by audits and fines in any treatment. This means that tax authorities suffer a loss from exerting effort to audit tax declarations. Ex post, tax authorities would have earned more if they had refrained completely from auditing. Adding the first four rows in Table 6 yields the total net revenues for tax authorities. With the exception of treatment T_hF_h, total net revenues are rather similar and not significantly different between the other three treatments. In T_hF_h, they are about two and a half times as high as in the other treatments ($p < 0.01$ in any pair wise comparison to the other treatments; t-test), indicating that higher taxes lead to an increase of net revenue, but only when they are backed up by high fines. If high taxes are combined with low fines, net revenues are not significantly different from net revenues with low tax rates. The final row in Table 6 reports the costs of raising one unit of additional revenue. If that were taken as a measure of the efficiency of a tax system, the high-tax high-fine treatment (T_hF_h) would have to be considered as the most efficient, since it costs on average one unit of money for detection to reap one additional unit of money from recovered taxes and fines. The other three treatments do significantly worse, with the highest costs of 2.4 units for detection to generate one unit of revenue in treatment T_lF_l. Note that the different aspects of efficiency discussed here and in the previous subsection do not contradict each other. From the viewpoint of the tax authority, high taxes and high fines (in T_hF_h) are relatively most efficient (even though the additional costs for audits match their additional revenue exactly), whereas from the viewpoint of society they lead to the highest amount of unproductively invested resources in T_hF_h. The reverse argument holds for T_lF_l.

Revenue (averages per pair)	treatment(tax/fine)			
	T_lF_l	T_lF_h	T_hF_l	T_hF_h
(1) Tax revenue	1867	1900	2107	2560
(2) Taxes recovered by audits	667	708	1707	1293
(3) Fines	167	708	427	1293
(4) Enforcement costs	−1997	−2327	−3323	−2665
Total net revenue for tax authority [$\sum(1)-(4)$]	704	989	918	2481
Net revenue in percent of income	7.3	9.8	9.3	22.0
Costs of one unit of additional revenue [$\frac{(4)}{(2)+(3)}$]	2.4	1.6	1.6	1.0

Table 6: *Revenues of tax authorities by treatment*

Result 6 *Higher taxes lead only to higher net revenue for the government if combined with high fines.*

3.5 The effects of detected tax evasion

In this section, we are going to examine taxpayers' and tax authorities' future play after tax evasion was detected. In principle, the detection of tax evasion in round t can have two different effects on the taxpayer's side. Either the taxpayer switches to truthfully reporting the full income in the next round when he has income $Y = 1000$, or the taxpayer sticks to evading taxes by declaring zero income, but changes his concealment effort. The tax authority can react to detected tax evasion by changing the detection effort in the next round when the taxpayer declares zero income.

In total, tax evasion was detected and a fine had to be paid in 390 out of 1121 cases of tax evasion. Table 7 summarizes taxpayers' and tax authorities' reactions to detection in round t. The first row (1) indicates the average relative frequency of truthful declaration in the next round with $Y = 1000$. The share of truthful declarations after having been caught ranges from 33% in T_lF_l to 53% in T_hF_l, but neither an ANOVA nor any pairwise comparison yields any significant treatment effect. Note that the frequency of truthful declaration is in general only slightly higher than the overall compliance rates in the treatments T_lF_h, T_hF_l, and T_hF_h (compare the first row in Table 7 with the first row in Table 3 where you can calculate the compliance rate by $1-$ evasion rate). In the treatment T_lF_h the switching rate is even smaller than average compliance. This suggests that in terms of evasion the experience of being caught has only a small deterrence effect.

Relative frequency of	T_lF_l	T_lF_h	T_hF_l	T_hF_h
(1) truthful declaration$^+$	0.53	0.43	0.33	0.46
(2) increasing concealment effort$^\#$	0.71	0.83	0.62	0.72
(3) increasing detection effort*	0.21	0.16	0.27	0.31
Average absolute change in effort units in case of				
(4) increase of concealment effort$^\#$	4.25	5.34	5.95	5.09
(5) decrease of concealment effort$^\#$	3.50	6.00	5.80	3.93
(6) increase of detection effort*	2.20	1.64	1.45	2.44
(7) decrease of detection effort*	3.20	4.02	5.75	5.69

$^+$ data refer to the next round with $Y = 1000$.
$^\#$ data refer to the next round with $Y = 1000$ and $D = 0$.
* data refer to the next round with $D = 0$.

Table 7: *Reaction to detection in round t*

Yet, detection has a strong effect on the other strategic variable of the taxpayer, his concealment effort (see row (2)). If taxpayers continue to evade taxes in round $t + 1$ (or the next round with $Y = 1000$) after detection in round t, their concealment effort increases, on average, in about 70% of cases. The relative frequency of increasing the concealment effort is significantly higher than a random draw in any treatment ($p < 0.05$, binomial test), but there are no significant treatment effects. Even though row (2) shows that taxpayers increase their effort in case of continuing evasion much more often than they decrease it, rows (4) and (5) indicate that the absolute change in effort levels is not significantly different for either increasing or decreasing effort.

Strikingly, tax authorities react differently in their effort choice to detection in round t. Authorities seem to believe that past detection is a strong deterrent. This can be seen in two ways. First, the next time a taxpayer declares zero income ($D = 0$) after detection in round t, detection effort is increased in less than one third of cases with the high tax rate and in only about one fifth of cases with the low tax rate (see row (3)). An ANOVA yields a weakly significant tax effect ($p < 0.1$). In each single treatment, the decrease in detection effort is significantly smaller than a random draw ($p < 0.05$, binomial test). Second, tax authorities reduce their detection effort by more units than they increase it in each single treatment (see rows (6) and (7)), with a weakly significant difference between decrease and increase in both high-tax treatments ($p < 0.1$; t-tests). For row (7) an ANOVA also yields a significant tax effect ($p < 0.05$), but no effects of the fine ($p > 0.6$) or the interaction term ($p > 0.6$).

Result 7 *After detected tax evasion, taxpayers do not switch to truthful declaration more often than they do on average. Rather, they increase their concealment effort in order to reduce the probability of being caught. However, tax authorities reduce their detection effort in a large majority of cases when they observe the next zero declaration.*

4 Why do people pay taxes?

In this section we explore briefly why taxpayers in the experiment did not always evade taxes, even though this would have been profitable. Since it was not the main purpose of our experiment to address this question, there may be many different possible explanations our experimental design cannot discriminate between. This section gives some ex-post interpretations, which, although plausible, should be further examined by experiments tailored to discriminate between those and possible alternative explanations.

There are two main reasons why people would choose not to evade even if the evasion is a better than fair gamble: risk aversion and moral constraints. Recall that a taxpayer should always evade if his utility from being honest is smaller than the expected equilibrium utility from evasion. To be willing to mix between truthful declaration and evasion the following has to hold, where (C1) is for expected utility theory and (C2) is for expected value maximization with moral constraints, which cause some moral cost K in case of evasion.[23]

$$U(Y_h) = [1 - p(A^*, E^*)]\, U(\overline{Y}) + p(A^*, E^*) U(\underline{Y}) \quad \text{(C1)}$$

$$Y_h = [1 - p(A^*, E^*)] \left[\overline{Y} - K\right] + p(A^*, E^*) \left[\underline{Y} - K\right] \quad \text{(C2)}$$

Here Y_h is the net income for truthful declaration, $\overline{Y}$ the gross income for successful evasion, and $\underline{Y}$ gives the payoff if evasion is detected. We see that for (C1) under risk aversion ($U' > 0$ and $U'' < 0$) the expected payoff for evasion has to be greater than the certain net income after truthful declaration. This directly follows from Jensens' Inequality. The same is true for the moral constraint condition (C2). There the expected payoff from evading has to exceed the certainty equivalent by the moral cost K. If we now compare the payoffs in the experiment with the certainty equivalent we find that on average the taxpayers earned less than they would have if they had always declared truthfully. This is also confirmed by a statistical test. The payoffs for the taxpayers are significantly smaller than the net income after truthful declaration ($p < 0.05$, $N = 120$).[24] Consequently, both hypotheses alone cannot explain that taxpayers were sometimes honest. On the contrary, this finding even suggests that taxpayers were risk-loving. This immediately becomes plausible if one takes the framing of the situation into account. Taxpayers earn an income and then have to pay taxes. If taxpayers use their gross income as a reference point the tax liability is perceived as a loss. According to Prospect Theory (Kahneman and Tversky, 1979) people are loss-averse. A further indication for loss-aversion are the high efforts in the experiment (compared to efforts predicted under risk-neutrality). It is possible to show that loss-aversion tends to increase efforts.[25]

If taxpayers are loss-averse, it still remains to be explained why they frequently truthfully reported their income. The reason why that may have been the case becomes clearer if we look at some subjects showing the rather radical behaviour of always truthfully reporting the income. In the experiment 2.5 percent of the taxpayers always reported their gross income correctly. There is no utility function (not even extreme risk-aversion) that can explain this behaviour. For an explanation we come back to moral constraints. Allowing

[23] A hybrid equilibrium where the taxpayer mixes between truthful revelation and evasion if he earned the income requires that the taxpayer is indifferent between evasion and non-evasion in that case.

[24] We calculated and used the difference between actual payoff and hypothetical honesty payoff for every taxpayer over the 20 rounds for the statistical test.

[25] Proofs for some utility functions can be obtained from the authors.

for moral constraints, i.e. an additional psychological cost K of non-compliance, this behaviour can be explained. Then the honest taxpayers chose to truthfully reveal their income because they had very high scruples.[26]

So a combination of loss-aversion and scruples is a plausible explanation for the behaviour of taxpayers. Their behaviour, however, might be highly influenced by the tax authorities' detection efforts. In the low tax treatment the authorities' behaviour is roughly consistent with the prediction of our model. The fact that in the high tax treatments tax authorities frequently switch from very high to very low detection efforts and vice versa is a bit puzzling. Our tentative explanation would be that the perceived intentions play a role. A higher tax widens the payoff spread for the authority between tax compliance and evasion. Therefore the intention of an evader as perceived by the authority should be worse under higher tax rates. So if people react to bad intentions with punishment (see Charness and Rabin, 2002, or Falk et al., 2003) then the high efforts could be explained by the attempt to punish the taxpayer. These high efforts, though, are very expensive, such that a subject only wants to punish if it is certain enough that the opponent cheated.[27]

5 Conclusion

Tax evasion is a pervasive phenomenon in most countries. Besides having a negative effect of cutting the state's budgetary scope, tax evasion may entail an excess burden by inducing both taxpayers and tax authorities alike to invest unproductively and waste resources in order to conceal or detect tax evasion.

Based on the model of Bayer (2003) we have experimentally tested the influence of tax rates and fines on the size of the excess burden of tax evasion. In line with the model's predictions, we have found that higher tax rates lead, ceteris paribus, to an increase in the

[26] Note that anticipation of a very high detection effort by the authority or reputation-building was not the reason for taxpayers being truthful. The tax authorities who faced zero-declarations of permanently honest taxpayers frequently anticipated this and repeatedly chose a detection effort of zero. So a one-off evasion would have been very profitable in monetary terms.

[27] The tax authority's mixing between very high and very low efforts alternatively can be the result of overconfidence with respect to the guess whether the taxpayer cheated or not, leading to beliefs close to 0 or 1. It is not clear however, why this should happen under high tax rates only.

amount of wastefully invested resources. Fines, however, do not have a significant influence on the inefficiencies created by the tax collection and enforcement system. Hence, tax rates, but not fines or the interaction of fines and taxes, are the driving force for a tax regime's excess burden.

Tax rates have also been shown to be the main factor for explaining the frequency of tax evasion. Our result that higher tax rates typically lead to more evasion, while the impact of fines is small and insignificant, is consistent with the experimental literature (see for example Friedland et al., 1978; Baldry, 1987; Alm et al. 1992b). The econometric evidence from field studies on the effect of taxes on evasion is less clear. Clotfelter(1983), Christian and Gupta (1993), and Joulfaian and Rider (1996), for instance, find a positive relationship. However, Alm et al. (1990) and Feinstein (1991) find the opposite. The different methodological approaches of measuring tax evasion in the various field studies might explain the partly contradictory econometric evidence. In the laboratory, it is relatively easier and much more standardized how to measure the extent of tax evasion and the influence of tax rates. Therefore, the consistency of experimental results might reflect one of the advantages of laboratory methods in the field of tax evasion.

There is another aspect in the tax evasion literature which has been addressed in this paper, but where experimental and econometric field studies have come to opposite conclusions. This is the deterrence effect of past audits. In experimental studies usually the experience of being audited and/or caught has a strong deterrence effect for the future, while in econometric studies hardly any deterrence effect is found (see Andreoni et al., 1998, pp. 843f. for a review of the literature concerning this point). Our design and results offer an explanation for this puzzle. In earlier experiments subjects did not have the possibility to invest in concealment, so their only possible reaction to a detected evasion was to keep evading or to switch to truthful declaration. Many subjects chose the latter in order to avoid being caught again. In our experiment, as in reality, caught evaders had two ways of avoiding future detection. Again they can report truthfully or they can reduce the detection probability by a higher investment in concealment. Many subjects chose the latter option. This finding seems to be able to reconcile econometric and experimental findings on the deterrence effect of past audits.

Finally, our results have shown that subjects evade taxes considerably less often than would be optimal for risk-neutral taxpayers. Hence, it is the puzzle already put forward by Alm et al. (1992a), i.e. why people do pay taxes rather than why they try to evade them. This puzzle has been accounted for in an extended model which assumes moral constraints or scruples on the side of taxpayers. Such moral constraints may provide an effective deterrent to tax evasion. The perception of the tax system to be fair, government spending to be efficient and politicians to be men of integrity has been shown to reduce tax evasion (Pommerehne and Weck-Hannemann, 1996; Torgler, 2003). The underlying reason for this finding might be that these perceptions foster positive attitudes toward the state and taxation, which become behaviourally relevant by increasing tax-evasion scruples and thus reduce tax evasion.

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Appendix - Experimental instructions

Instructions (originally in German)

We provide the instructions for the T_hF_h-treatment. In treatments with the low tax rate (T_lF_x) the tax rate was set at 25% instead. In treatments with the low fine (T_xF_l), the fine consisted of the evaded tax plus an additional payment of one quarter of the evaded tax.

Welcome to the experiment!

We kindly ask you not to talk to other participants until the end of the experiment.

In this experiment, there are two different roles, *taxpayer* and *tax authority*. The experimental currency is denoted as Taler. The exchange rate is set at

$$1000 \text{ Taler} = 1.2 \text{ Euro.}$$

One taxpayer and one tax authority will be paired for the whole experiment, i.e. there are fixed pairs. The experiment consists of 21 identical rounds. The first one of these will be a trial round which will not be paid.

A. Sequence of events in each round

At the start of each round there is a random draw on the taxpayer's income in this round. With a probability of 80% the taxpayer receives 1000 Talers as income. With a probability of 20% the taxpayer's income is zero.

The *taxpayer* gets informed about his income (either 0 or 1000 Taler) and has to decide whether or not to *declare* his income to the tax authority (either 0 or 1000 Taler). Furthermore, the taxpayer has to decide on a *concealment effort* (ranging from 0 to 10 points).

Positive concealment effort causes costs, which will be specified below. The higher the chosen concealment effort, the less likely it becomes that the tax authority will be able to verify the taxpayer's real income.

The *tax authority* learns about the taxpayer's declared income. Note that the tax authority gets no information about the real income of the taxpayer, nor about the taxpayer's concealment effort. The tax authority has to choose a *detection effort* (ranging from 0 to 10 points). Positive detection effort is costly. The higher the chosen detection effort, the more likely the tax authority will be able to verify the taxpayer's real income.

The combination of concealment effort and detection effort determines the probability of verifying the taxpayer's real income, as will be explained in detail below. Given this probability, a random draw will determine whether the taxpayer's real income will be verified or not.

After each round both the taxpayer and the tax authority will be informed about whether the real income could be verified by the tax authority, but not about the other's effort level.

B. Payoffs per round

1. Taxpayer's payoff

payoff = real income - taxes - potential fine - costs of concealment effort

- Taxes: Declared income * tax rate: The tax rate equals 40%.
- Fine: The taxpayer has to pay a fine in case he/she has declared zero income although real income is 1000 Talers, *and* if the tax authority was able to verify the real income. The fine consists of the evaded tax (= real income * tax rate = 400 Taler) plus an additional payment of equal size (= 400 Taler). Hence, the potential fine amounts in total to 800 Taler.
- Costs of concealment effort:

Concealment effort (points)	0	1	2	3	4	5	6	7	8	9	10
Costs (in Taler)	0	20	40	60	80	100	120	140	160	180	200

2. Tax authority's payoff

payoff = basic wage + taxes + potential fine - costs of detection effort

- Basic wage: 450 Taler
- Taxes: Declared income * Tax rate (40%)
- Fine: If the real income is verified and the taxpayer declared less than his/her real income, the tax authority receives the fine of 800 Taler (for the composition of the fine see above).
- Costs of detection effort:

Detection effort (points)	0	1	2	3	4	5	6	7	8	9	10
Costs (in Taler)	0	40	80	120	160	200	240	280	320	360	400

C. The probability of detection

The following table shows, how the combination of concealment effort and detection effort determines the probability of verifying the real income. Figures in the table denote percentages.

		Detection effort										
	Points	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
Concealment effort	*0*	100	100	100	100	100	100	100	100	100	100	100
	1	0	50	67	75	80	83	86	88	89	90	91
	2	0	33	50	60	67	71	75	78	80	82	83
	3	0	25	40	50	57	63	67	70	73	75	77
	4	0	20	33	43	50	56	60	64	67	69	71
	5	0	17	29	38	44	50	55	58	62	64	67
	6	0	14	25	33	40	45	50	54	57	60	63
	7	0	13	22	30	36	42	46	50	53	56	59
	8	0	11	20	27	33	38	43	47	50	53	56
	9	0	10	18	25	31	36	40	44	47	50	53
	10	0	9	17	23	29	33	38	41	44	47	50

Example: If the tax authority chooses a detection effort of 7 points and the taxpayer a concealment effort of 2 points, then the detection probability is 78%. Imagine an urn with 100 balls, numbered consecutively from 1 to 100. If in a random draw a ball with a number from 1 to 78 is drawn, then the real income is verified and known to the tax authority. If a ball with a number from 79 to 100 is drawn, the taxpayer's real income remains concealed.