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Sequences of audits, tax compliance, and taxpaying strategies

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ABSTRACT

The effect of different audit patterns on future compliance is studied in two experiments. A repeated measures design is used with participants filing taxes 60 times. Study 1 focuses on taxpayers' immediate reactions to audits and examines whether a strong decrease in compliance following an audit is caused by either misperception of chance or loss repair. The second purpose of this study is to investigate the effect of audit positioning in a "taxpaying life span". The results suggest that the decrease of compliance found after an audit is most likely caused by misperception of chance, while loss-repair tendencies are of moderate relevance. Moreover, results confirm that contrary to later audits, early audit experiences in a "taxpaying life span" lead to increased compliance. Independent of audit positioning, compliance decreases if participants are not audited over an extended period of time. It is hypothesized that just one further audit may suffice to increase compliance again. Study 2 confirms this assumption. The results show the relevance of specific audit patterns on tax compliance.

1. Introduction

This paper presents two laboratory experiments, which assess the effectiveness of different patterns of audits sequences over the "life span" of tax filing and sheds light on taxpayers' behavior following sequences of audits and fines.

In deciding whether to pay taxes, citizens are essentially confronted with a social dilemma and therefore, the rationality model in economics suggests that most taxpayers would be tempted to evade taxes in the absence of audits and fines for evasion (e.g., Allingham & Sandmo, 1972; Chung, 1976; Dawes, 1980; Messick & Brewer, 1983; Srinivasan, 1973). The expected utility framework developed by von Neumann and Morgenstern (1944) and applied to tax decisions by Allingham and Sandmo (1972), suggests that in deciding whether to pay taxes or not, taxpayers compare the burden of paying those taxes against the costs of being subsequently audited and fined.

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However, there is debate regarding whether audits and fines can actually deter evasion, with some studies suggesting that they can, while others report only weak effects (for reviews see Andreoni, Erard, & Feinstein, 1998 and Kirchler, 2007). Besides Allingham and Sandmo's rational choice approach, it should also be pointed out that there are a number of other approaches towards studying tax compliance or evasion. These include rank dependent expected utility, prospect theory, overweighting of small probabilities or models including psychological and sociological perspectives (e.g., Alm, McClelland, & Schulze, 1992; Bernasconi, 1998; Bernasconi & Mittone, 2003; Bernasconi & Zanardi, 2004; Kirchler, Hoelzl, & Wahl, 2008; Weigel, Hessing, & Elffers, 1987).

In this paper, we consider audits and fines exclusively, focusing on the patterns of audits and fines in a sequence of tax filing periods. To date, paying taxes as a repeated duty with random audits or audits following a specific pattern has not been studied empirically. However, the experience of being audited, and of possible fines, may influence further decisions on cooperation or evasion. Taxpayers' compliance can either be enforced through the auditing outcome or lead to increased evasion in the following years: taxpayers might assume that a subsequent audit is unlikely and therefore, take the risk to cut taxes in the subsequent filing period. Moreover, previous fines could fuel the motivation to compensate the experienced loss by saving taxes in the future. It is both theoretically relevant and important for practical implementation to know what strategies taxpayers apply after having experienced an audit and possibly been fined. It should be interesting, what patterns of audits are likely to deter tax evasion, no matter whether compliance decreases owing to misperceived probability or to the motivation to compensate for an experienced loss.

Extending the example to future tax behavior in general, tax compliance may not only depend on sequential audit experiences but also on the time when audits were first experienced. Guala and Mittone (2005) and Mittone (2006) report that early audit experiences and possible fines can, on the one hand, cause a taxpayer to overestimate audit probability and the extent of fines. On the other hand, audits and fines experienced later in one's "tax life" could lead to the perception of audits being relatively unlikely, and thus, increase evasion. Moreover, the actual loss caused by a fine could already have been compensated for by past tax evasion.

The present research uses laboratory experiments to investigate the dynamics of taxpaying behavior. Laboratory experiments are often chosen as a suitable method to analyze tax compliance and their advantages and disadvantages are well documented (Alm, 1991; Alm, Jackson, & McKee, 1992; Torgler, 2002; Webley, Robben, Elffers, & Hessing, 1991). Reliable data from the field are difficult to obtain; while self-reported data may be affected by social desirability and, therefore, may not reflect the actual size of tax non-compliance. Experiments are useful to test internal consistency of theories and the results can at least be cautiously generalized for developing strategies against tax non-compliance and for formulating advice to tax policy professionals.

The remainder of this paper is organized as follows: next, the literature related to repeated audits is reported. Sections 2 and 3 present the first and second studies. In Section 4, results, implications, and limitations of the study are discussed.

1.1. The bomb crater effect

Following the framework of Bayesian updating, taxpayers with low a priori certainty of audit estimations revise their estimation of audit probability upward after experiencing an audit, whereas taxpayers with high a priori audit certainty estimations reduce their estimations of audit probability if no audits occur. According to these assumptions, audited taxpayers thereafter estimate audit probability higher than non-audited taxpayers and should therefore be more deterred from evasion. As pointed out by Pogarsky and Piquero (2003), in criminology, a reverse or "positive" effect of punishment on offenders' behavior has been identified. Sanctioned offenders seem to be more prone to offend again and, compared to the non-punished, they estimate the probability of further punishment as rather low. This result was, in part, explained by the authors referring to the gambler's fallacy (Gilovich, 1983, quoted in Pogarsky & Piquero, 2003).

Guala and Mittone (2005) and Mittone (2006) studied tax behavior in laboratory experiments by simulating tax filings over a "taxpaying life span." Hypothesizing that sequential tax filing and audit experiences may affect participants' attitudes to risk and consequently their behavior, they investigated the influence of audit probability and patterns of audits over 60 periods. The most robust finding was a strong decrease in taxpayers' compliance immediately after an audit. This finding was termed the "bomb crater effect." The expression derives from the behavior of soldiers during World War I. Soldiers are said to have preferred bomb craters as hideouts, believing that it was highly unlikely that a bomb would explode again at exactly the same place. Generalizing to tax payments, rather than becoming compliant, people could evade more after an audit, assuming that the probability of a subsequent audit is low.

Maciejovsky, Kirchler, and Schwarzenberger (2007) also investigated the effects of audit probabilities and sanctions with a special focus on taxpaying behavior at different time lags between audits. Depending on the time lag between audits, compliance decreased strongly after an audit had occurred and increased slowly in the subsequent rounds. The results suggest that participants conceived the probability of subsequent audits to be marginal that confirms misperception of chance as the main cause of the bomb crater effect. The assumption that the strong decrease of compliance after audits and fines was due to loss-repair tendencies was only indirectly confirmed.

The bomb crater effect may originate from either misperception of chance or result from the motivation to compensate for a loss experienced in the past after being audited and fined for evasion. Misperception of chance describes the mistaken estimation of the appearance of an event with a known probability distribution as more or less likely depending upon recent

occurrences (Tversky & Kahneman, 1974). A phenomenon sometimes confounded with the bomb crater effect is the gambler's fallacy. However, the bomb crater effect is a similar but independent phenomenon (see also Mittone, 2006, p. 824).[2]

Recent studies about the impact of audits on subsequent compliance have shown that the decline in compliance after an audit can also be observed in real taxpaying situations. Bergman and Nevarez (2006) analyzed VAT data from individual tax return information between 1997 and 2000 in Argentina and Chile. Results suggest that the impact of audits on future compliance is doubtful, especially with regard to some taxpayers. Audits reduce the compliance of evaders, whereas they may have a positive effect on honest taxpayers. Furthermore, sanctioned taxpayers compensate for additional assessments and fines produced by audits. Fines for underreporting and evasion after audits were positively correlated. The authors argue that taxpayers who evade more are less deterred by audits.

Erard (1992) quoted a study by Long and Schwartz (1987), who compared randomly audited tax returns in 1969 and 1971 from the IRS Taxpayer Compliance Measurement Program (TCMP) and found that audits in 1969 had only a minor effect on the frequency of non-compliance in 1971, and no effect on the average magnitude of evasion. Using official data from IRS, Erard (1992) analyzed the effect of large audit assessments on taxpayers' compliance in the subsequent year. He analyzed compliance of evaders and found that they declared more taxes in the following year. However, the author interprets the increase of compliance, at least to some extent, as regression effects. In a second study, Erard (1992) compared compliance of two selected groups, one recently audited and one not audited. The relationship between experienced audit and tax compliance was not positive, but the results were inconclusive, unstable, and varied depending on the method of analysis.

The inconclusive results lead to the question of whether the strong decrease of compliance immediately after an audit is due to misperceived probability or to loss-repair tendencies.

1.2. Conditional audit selection rules

The effect of special audit selection rules compared to random audit selection on tax compliance has been studied by Collins and Plumlee (1991) and Alm, Cronshaw, and McKee (1993) and others. Collins and Plumlee (1991) investigated the effect of a random audit selection scheme, a cut-off rule scheme, where only the two lowest payments were audited, and a conditional scheme with given *ex ante* chances for being in the low income or high income group, using the cut-off rule only for the latter. Compliance was lowest in the random audit scheme condition. Taxpayers seemed to be more "intimidated" by a strategic audit scheme than by random audits.

Also, Alm et al. (1993) found that endogenous audit selection rules are more effective in preventing evasion than random audit selection rules. Random audit selection rules were compared to a cut-off rule, a conditional future audit rule where future audit probability depended on taxpayers' past compliance, and a conditional back audit rule where past filing behavior was audited if taxpayers were detected as cheating in one round. The highest impact on compliance was obtained by a cut-off rule scheme.

While some dynamic aspects of taxpaying have been studied through applying audit selection rules, the patterns and special positioning of audits have not yet been addressed. In this paper we study the effect of audit patterns, that is, the impact of setting audits at various intervals over the life-span of a taxpayer and investigating its influence on compliance.

1.3. The echo effect

Audits experienced early in one's "tax life" may lead to an overestimation of audit probabilities in general and influence taxpayers' risk perceptions. This effect can be explained by the availability heuristic (Tversky & Kahneman, 1973), implying that people estimate the probability of future audits on the basis of the frequency of already experienced audits.

Laboratory experiments suggest that the early experience of audits leads to higher compliance at later stages in "tax life" (Benjamini & Maital, 1985; Spicer & Hero, 1985; Webley, 1987). Mittone (2006) studied the effect of early and late audit experiences by auditing some participants in the first 30 rounds only, and the others in the second half of a total of 60 rounds. Participants being audited during the early rounds evaded significantly less and remained at a more compliant level over the remaining rounds. In contrast, the group that was audited only in the second half of the rounds was found not to react to the late audits with higher compliance. This phenomenon was termed the "echo effect," illustrating the reverberations of audits that enforce compliance over a certain time period.

1.4. Reinforcement schedules: borrowing ideas from operant learning theory

Learning theories may be suited to explain the effect of specific audit patterns and, in particular, the bomb crater effect and echo effect. Rooted in the law of effect (Thorndike, 1898), operant conditioning theory (Skinner, 1938) suggests that the

[2] In accordance with the gambler's fallacy, after several rounds without audits the probability of an audit should be overestimated and compliance should constantly increase and remain at a high level until the expected audit occurs. In fact, no similar increase in compliance after several non-audited rounds was observed by Guala and Mittone (2005) and Mittone (2006). In conclusion, the gambler's fallacy leads to the assumption that after a sequence of repeated audits a round without audit would be expected and taxpayers should decide to evade or to reduce compliance.

appearance of a particular (individual) behavior is shaped by reinforcement. Rewards lead to a repetition, whereas punishments cause a decrease of the reinforced behavior. After a specific behavior is learned by operant conditioning and no further reinforcement is provided, the behavior is continued during a latency phase until extinction occurs. In a series of laboratory experiments with pigeons, Ferster and Skinner (1957) studied the effect of numerous reinforcement schedules on learning processes. Optimal learning was found to demand continuous reinforcement at the beginning (i.e., reinforcement of every response), and intermittent reinforcement (i.e., reinforcement of some responses) afterwards. This schedule leads to a durable latency period with the learned behavior being more resistant to extinction. A fixed-ratio schedule (reinforcement of every *n*th behavior) leads to post-reinforcement pauses of responding followed by accelerated responses until the next reinforcement occurs (Angermeier, 1994; Ferster & Skinner, 1957; for an overview of reinforcement schedules see Skinner, 1969). In this case reinforcement works as a discriminative stimulus, indicating that no reinforcement follows immediately after a previous reinforcement. Under variable reinforcement schedules post-reinforcement pauses appear less. In general, it reminds us of evasion following immediately after an audit, which was termed the bomb crater effect.

While operant conditioning emphasizes the effectiveness of positive rewards on desired behavior, most traditional tax systems are solely targeted at punishing evasion. However, punishment might only lead to suppression of undesirable behavior that re-emerges when punishment stops or when the punishing authorities are no longer present (Estes, 1944). Moreover, punishment can lead to negative emotions towards the punishing authorities and to revenge-seeking behavior which leads to increased evasion in the long run (Kirchler, 2007). Furthermore, when not audited or detected, successful evasion is positively reinforced and lowers the deterrent effect of audits and fines (Antonides & Robben, 1995).

Borrowing ideas from operant learning theory and reinforcement schedules, various audit patterns should differ in efficiency to increase tax compliance (Kirchler, 2007): continuous reinforcement at the beginning, followed by intermittent audits should be more efficient than audits at fixed-ratio intervals.

1.5. Hypotheses

Based on the theoretical considerations, the following hypotheses are tested:

1. Compliance over the experimental "tax life span" is higher if the audit pattern is continuous at the beginning and intermittent afterwards as compared to a fixed-ratio audit pattern.
2. Bomb crater effect: immediately after an audit, compliance decreases. This could be due to misperceived probability and loss-repair tendencies. If misperceived probability accounts for the bomb crater effect, it should be suppressed if audits take place continuously over some consecutive periods at the beginning of tax filing and randomly afterwards.

3(a). Echo effect: participants who are audited at the beginning of their "tax life" are expected to be more compliant compared to participants audited at a later stage.

3(b). The echo effect diminishes when audits are absent over a longer period of tax filings.

2. Study 1

2.1. Participants

Participants were recruited via announcements on the bulletin board of the Faculty of Economics, University of Trento, Italy. Overall, 120 undergraduate business students participated (56% females, 44% males; age ranging between 18 and 27 years, $M = 21.72$, $SD = 1.85$).

2.2. Experimental design and procedure

Four conditions were realized: a control condition and three experimental conditions. In each condition each subject filed 60 rounds of taxes. During the 60 rounds nine audits were implemented. In the control condition these nine audits were distributed randomly over the 60 rounds. In experimental condition E1, all nine audits occurred within the first 20 rounds. Three audits were positioned right at the beginning of tax filing, in the first, second, and third rounds. The remaining six audits were spread over rounds 4 through 20, with two further continuous audits after rounds 9 and 10. In the remaining 40 rounds no audits occurred. In condition E2, there were no audits during rounds 1–19 and 40–60. All audits were concentrated between rounds 20 and 39. Also under this condition, there were three audits right at the beginning, whereas the remaining audits were positioned between rounds 23 and 39, with two further continuous audits after rounds 28 and 29. In experimental condition E3, all audits were placed within the first 20 rounds, every second round, that is, after rounds 2, 4, 6, 8, 10, 12, 14, 16, and 18.

The experiment was conducted in a computerized laboratory (Computable and Experimental Economics Laboratory of the University of Trento, CEEL). Sessions were conducted in groups of 15 participants, with two sessions per experimental condition. Since participants were paid for participation on the basis of their performance, and in order to guarantee anonymity, they were given a code when entering the laboratory which was recorded in the participant's file on the computer. Participants were instructed that the experiment simulated a real taxpaying context, and that they had to file their tax returns

after being provided with a constant income of 1000 ECU[3] in each round. They were informed that the tax rate was 20%, and that in the case of detection they had to refund the evaded taxes and to pay a fine that corresponded to the evaded sum multiplied by three. The probability of being audited was 15%.[4]

After the task, participants answered control questions (e.g., "The probability of being audited was very low."; "I gave up using a strategy to increase my income because there was no way to control the audits."; answers were given on scales ranging from 1 = no agreement to 5 = strong agreement). At the end of the experiment, participants were paid in relation to their performance. On average, they earned 10 Euros (SD = 3.55). The experiment took approximately 1 h.

2.3. Results

First, compliance over the 60 tax filing rounds in the control condition and the three experimental conditions are studied. Second, the bomb crater effect is tested, possible prevention of the bomb crater effect by continuous audits is investigated, and causes of the bomb crater effect are analyzed. Third, the effect of audit positions on taxpayers' compliance and the echo effect are investigated.

2.3.1. Audit patterns and compliance

Fig. 1a–d illustrates the development of tax payments over 60 rounds in the four conditions. Mean tax payments over all rounds were analyzed by a one-way analysis of variance with conditions as independent factor. No significant differences emerged ($F(3, 116) = 0.44$, $p > .05$). However, comparison of overall tax payments including fines in the four conditions yielded significant differences ($F(3, 116) = 4.41$, $p < .01$, $\eta^2 = .10$). Least significant differences (LSD post hoc test) revealed that in the condition with fixed audits every second round (E3), participants had paid less taxes and fines (M = 7963.17, SD = 2888.20) than in the other three conditions (M = 9620.11, SD = 2041.30). Participants in E3 evaded more successfully and had to pay less fines compared to participants in the other conditions. This might be attributed to the transparent audit pattern, which was easily seen through by the participants. Table 1 presents average tax payments over the 60 rounds, total tax payments including fines, and the number of compliant and non-compliant taxpayers.

2.3.2. The bomb crater effect and suppression of the bomb crater effect

The effect of experimental conditions, amount of taxes paid in the previous round, and of previous audits (1 = audit, 0 = no audit) and fines on the decision to be compliant or not (1 = compliance, 0 = evasion) was tested by a random effects probit model. As shown in Table 2, the analysis revealed a significant positive effect of previous tax payments, a negative effect of audits, and a slight positive effect of fines on the decision to be compliant in the following round. In addition to the above reported results, experimental conditions E1 and E2 also positively influenced the decision to be compliant.

In conditions E1 and E2 the relation between audit after the previous round and the probability of being compliant was positive. In both conditions participants were more likely compliant immediately after being audited, compared to the control condition, where audits negatively influenced the decision to be compliant. These results confirm the assumption that continuous audits suppress the bomb crater effect. If audits are positioned continuously over some consecutive rounds at the beginning of a tax filing sequence and randomly afterwards, the characteristic decline of compliance immediately after an audit can, indeed, be suppressed. Moreover, it seems that compliance even increases after almost each audited round (see also Fig. 1b and c), an effect which can be called the "jump effect."

The reported results show that the bomb crater effect can be suppressed by continuous audits, suggesting that misperception of chance is a strong determinant of the bomb crater effect. Moreover, if misperception of chance causes the bomb crater effect, participants should be less compliant in subsequent rounds, independent of whether they were compliant or they evaded and were fined in the previous round. If loss-repair accounts for the bomb crater effect, only participants who were fined in the audit round (t_0) should increase evasion in the following round (t_1), whereas compliant participants should tend to remain compliant.

To analyze the causes of the bomb crater effect, we used tax payments from the control condition and counted the frequencies of compliance and non-compliance at t_1, dependent on compliance and non-compliance at t_0. Table 3 presents information on compliant and non-compliant cases in the audit rounds and compliance in the following round, respectively. Overall, in 45.2% of the audited cases, participants did not change their behavior from t_0 to t_1; they were either compliant or non-compliant to the same degree in both filing rounds. Focusing on compliant cases in t_0, in 52.7% of compliant audited cases tax payments were reduced to some extent in t_1 (21.8%) or participants evaded completely (30.9%) in t_1. By contrast, only in 36.9% of non-compliant cases at t_0 participants reduced their tax payments (9.4%) or evaded completely (27.5%) at t_1; whereas, 19.4% of the non-compliant cases showed increased or total compliance after the audit. These results do not confirm loss-repair tendencies but suggest misperception of chance.

[3] ECU = experimental currency unit.

[4] An anonymous referee pointed out that it probably would have been better not to tell participants that the probability of being audited is 15%. Although the prior estimate of the audit odds is 0.15 (based on the instructions), a particular subject who experiences a higher audit frequency might revise this probability upwards which could potentially lead her to distrust the remaining instructions and the setting. However, we chose to inform participants about audit probability in order to be consistent with previous experiments conducted by Luigi Mittone and collaborators.

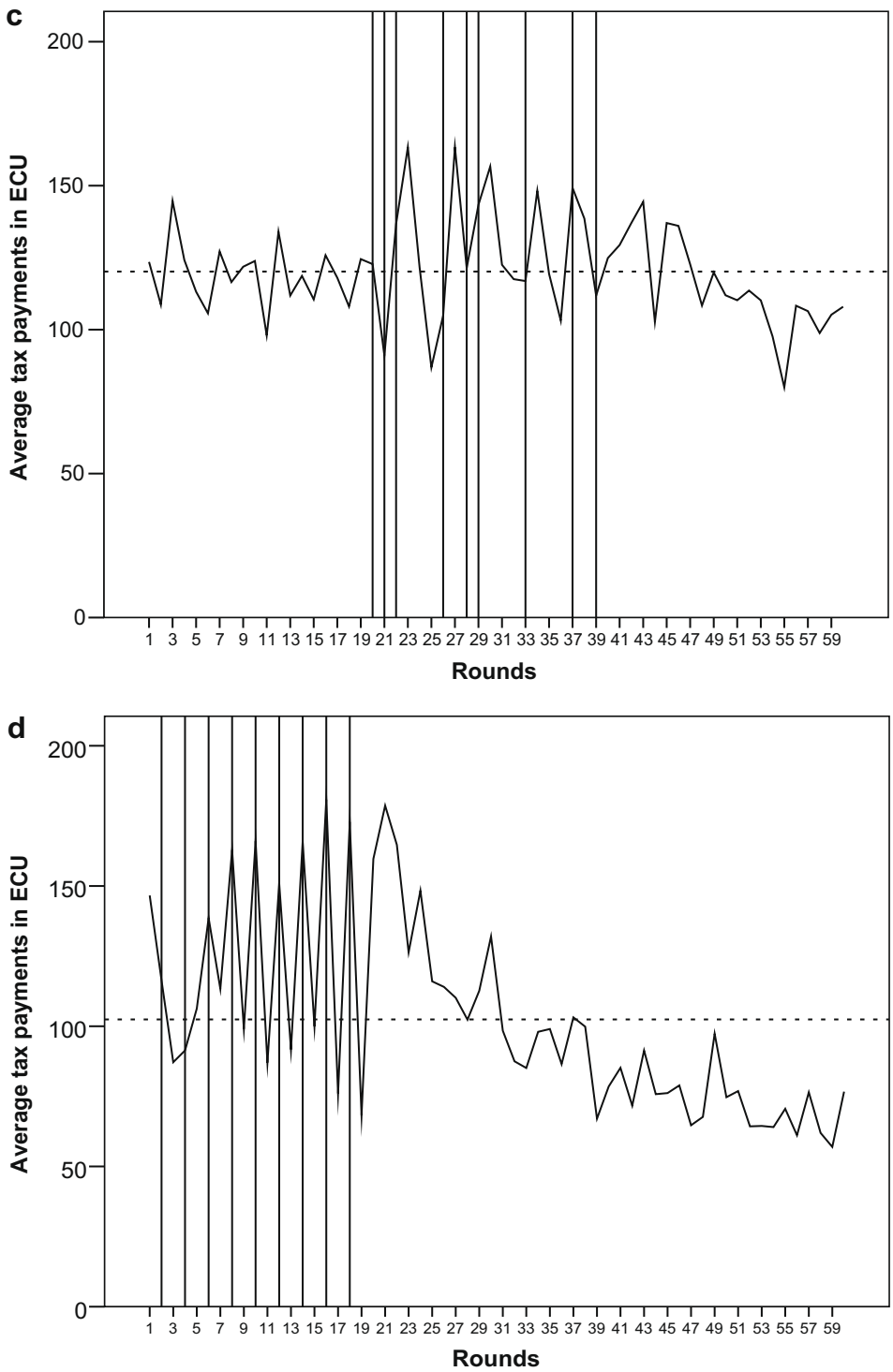

Fig. 1. (a) Average tax payments in the control condition (C). (b) Average tax payments in experimental condition E1. (c) Average tax payments in experimental condition E2. (d) Average tax payments in experimental condition E3. *Note*. The curve gives the average tax payments of the sample; the horizontal line gives the overall mean for the condition; the vertical lines mark the audits.

However, loss repair does play a role, albeit a minor one, in the decision to evade taxes. Loss repair can be tested by computing the correlation between tax payments of non-compliant participants at t_0 and t_1. If participants tried to get back the

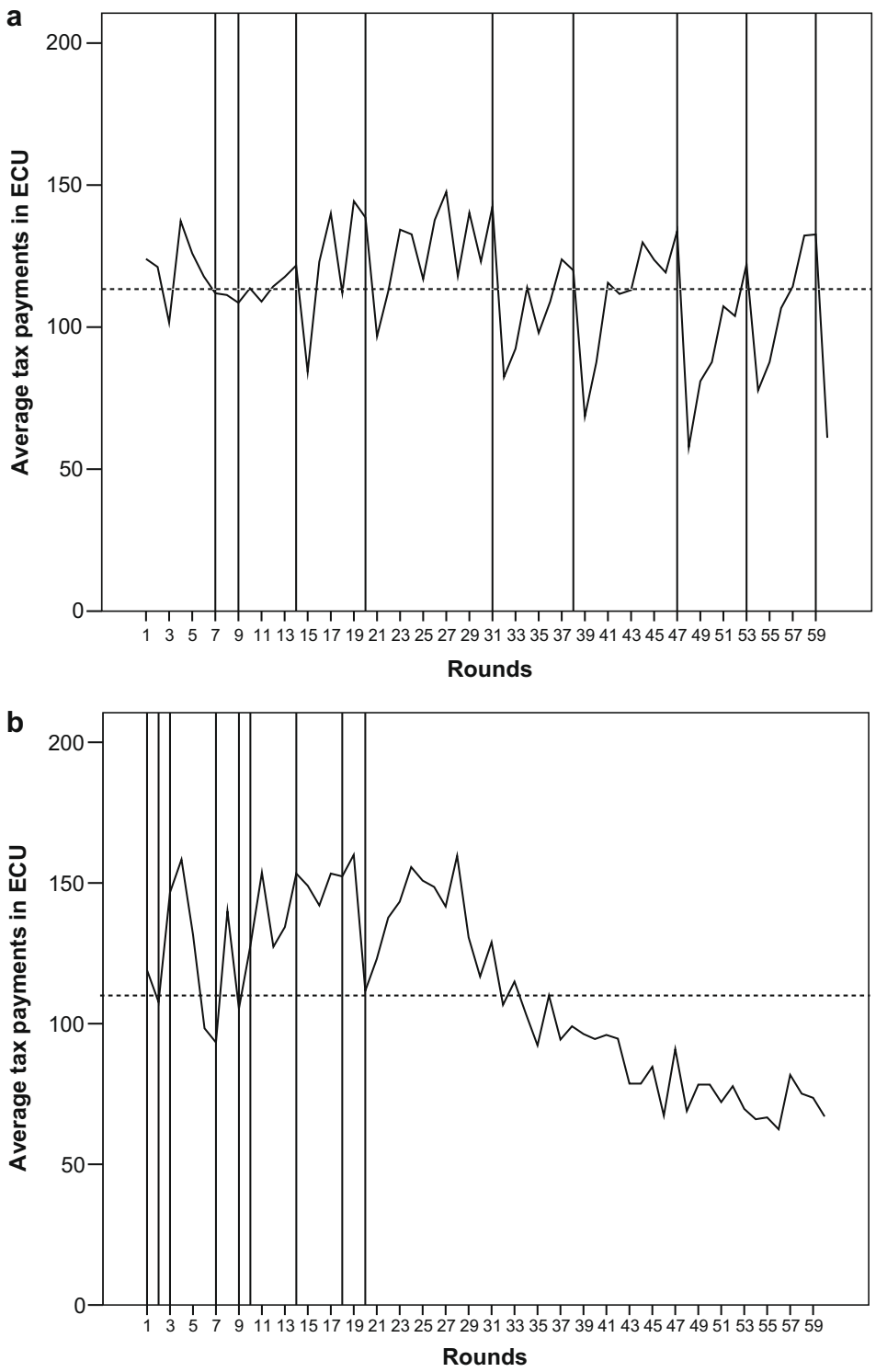

Fig. 1 *(continued)*

money paid for evading in the former round, the correlation between fines and compliance in the following round should be negative. Non-compliant participants evading the same amount in t_0 and t_1 and participants with increasing compliance at t_1 were excluded from the analysis. The correlation between experienced fines and compliance at t_1 was highly significant with $r = -.47$, $p < .01$, $n = 59$, indicating that detection and punishment of non-compliance led to lower compliance in the follow-

Table 1
Tax payments, sum of honest tax filings, number of compliant and non-compliant participants by four conditions.

Condition	Average tax payment per round *M* (*SD*)	Average tax payments over 60 rounds including fines *M* (*SD*)	Sum of honest tax filings by all participants during the 60 rounds (No. of observations = 1800)	No. of participants being compliant over all 60 rounds	No. of participants evading over all 60 rounds
C	113.25 (67.03)	9468.33 (1917.48)	663	1	1
E1	110.70 (57.61)	9373.87 (2328.13)	738	2	0
E2	120.17 (55.91)	10018.13 (1854.92)	760	1	0
E3	102.42 (61.92)	7963.17 (2888.20)	670	0	2

Note: C = control condition; E1 = experimental condition 1; E2 = experimental condition 2; E3 = experimental condition 3; *M* = mean; *SD* = standard deviation.

Table 2
Random effects probit model with compliance as dependent variable and previous tax payments, audits, experimental conditions, and interactions as independent variables.

	Coefficient (standard error)
Amount of tax payments in the previous period	.002** (.0002)
Audit in the previous round	−.688** (.117)
Fines in the previous round	.001** (.0002)
Experimental condition 1 (E1)	.887** (.087)
Experimental condition 2 (E2)	.373** (.106)
Experimental condition 3 (E3)	.028 (.092)
E1 by audit in the previous round	1.209** (.148)
E2 by audit in the previous round	1.277** (.145)
E3 by audit in the previous round	−.002 (.152)
Constant	−1.229** (.074)
/lnsig2u	−.333 (.093)
σ_u	.847 (.039)
ρ	.418 (.023)
Number of observations (Number of participants)	7080 (120)
Wald $\chi^2(9)$	488.14**
chibar2 (01)	1346.41**

Note: *$p < .05$. **$p < .01$.

Table 3
Frequencies and percentages of taxpaying behavior at t_0 and t_1 (control condition).

	Compliant at t_0	Non-compliant at t_0	Sum
No variation in compliance	52 (47.3%)	70 (43.8%)	122 (45.2%)
Increased compliance at t_1	–	10 (6.3%)	10 (3.7%)
Complete compliance at t_1	–	21 (13.1%)	21 (7.8%)
Decreased compliance at t_1	24 (21.8%)	15 (9.4%)	39 (14.4%)
Complete evasion at t_1	34 (30.9%)	44 (27.5%)	78 (28.9%)
Total	110 (100%)	160 (100%)	270 (100%)

Note: t_0 = audit round; t_1 = round after audit.

ing round. In conclusion, the bomb crater effect is likely caused by misperception of chance; in some cases, however, taxpayers may also try to compensate their loss caused by fines.

2.3.3. The echo effect

In studies by Mittone (2006) audits had a weak effect on compliance if they did not occur in the first 30 rounds but at a later stage. In contrast to the earlier studies, in the actual experimental design the audits concentrated on 20 rounds in order to observe compliance during an extended period after the auditing phase. An additional modification was the implementation of continuous audits. In E1, audits were placed within the first 20 rounds, whereas in E2, the same audit pattern was applied for rounds 20 to 39. For testing the development of tax payments in E1 and E2, the 60 rounds were divided into 10-round sections and analyzed by a repeated 2 by 6 analysis of variance with conditions (E1, E2) as between-subject factor, 10-round sections (rounds 1–10, rounds 11–20, rounds 21–30, rounds 31–40, rounds 41–50, and rounds 51–60) serving as within-subject factor and compliance (tax payments) as dependent variable. The interaction effect between conditions and 10-round sections reached significance ($F(2.77, 160.62) = 8.65$, $p < .01$, $\eta^2 = .13$). Differences in compliance between the sections ($F(2.77, 160.62) = 14.72$, $p < .01$, $\eta^2 = .20$) were also significant, but should be interpreted with care because of the significant interaction effect. The main effect of the conditions ($F(1, 58) = 0.42$, $p > .05$) was not significant.

Table 4
Paired samples *t*-test for 10-round sections in experimental conditions E1 and E2.

Condition	10-Round sections	*M* (*SD*)		*t* (*df*)	*p*	*d*
E1	*1–10*	*122.80*	*(54.72)*			
	11–20	*143.70*	*(51.36)*	*−3.07 (29)*	*<.01*	*.39*
	21–30	140.78	(59.74)	.47 (29)	>.05	–
	31–40	104.04	(75.66)	4.69 (29)	<.01	.54
	41–50	81.65	(77.19)	3.50 (29)	<.01	.29
	51–60	71.21	(78.02)	2.24 (29)	<.05	.13
E2	1–10	120.92	(58.99)			
	11–20	117.21	(71.54)	.64 (29)	>.05	–
	21–30	*128.91*	*(52.09)*	*−.96 (29)*	*>.05*	–
	31–40	*125.21*	*(58.43)*	*.51 (29)*	*>.05*	–
	41–50	124.95	(69.29)	.05 (29)	>.05	–
	51–60	103.82	(70.57)	4.10 (29)	<.01	.30

Note: *M* = mean; *SD* = standard deviation; *t* = *t*-value; *df* = degrees of freedom; *p* = significance level; *d* = effect size; 10-round sections in italics represent the audit phase; the *t*-test refers to the comparisons between the mean tax payments in one 10-round section and the previous 10-round section.

As Table 4 shows, participants who learned in the first rounds of their "tax lives" that fiscal audits are highly uncommon (E2) did not change their behavior even when audits started to occur frequently. In other words, participants who were not audited at the beginning were not affected by later audits. In E1, comparing the first section with audits (rounds 1–10) with the second section (rounds 11–20), tax payments increased significantly. In both conditions E1 and E2, compliance remained stable during the ten-round section following the audits and decreased afterwards. Although these results confirm the echo effect, it was weaker than expected, since payments dropped significantly in the sections without audits.

2.3.4. Compliance after audits

Regarding the echo effect, participants who were audited at the beginning of their "tax life" decreased their payments earlier than expected from the results reported by Mittone (2006). Participants in the later audit conditions showed, in contrast, a more stable behavior over all 60 rounds. The assumption that people who are not audited in early rounds would develop their "individual" strategy, is enforced by the responses to the control item "I gave up using a strategy, because there was no chance to control anything." Participants in E1 expressed having less control over audits, whereas those in E2 felt they had some control over audits ($M_{E1} = 3.00$, $SD_{E1} = 1.29$; $M_{E2} = 2.40$, $SD_{E2} = 1.00$; $t(58) = 2.01$, $p < .05$; $d = .52$).

The behavior of the participants in E1 reminds of a "cops and robbers" situation (Kirchler et al., 2008). When participants expected audits, they were compliant and, to a great extent, they evaded when they felt "safe." They decreased their payments significantly when not being audited for more than 10 rounds (see Table 4). Moreover, their tax payments dropped constantly until the end of the experiment. In E2, a significant decrease of payments was also observed during the final 10 rounds compared to the previous 10 rounds.

In conclusion, the results confirm the echo effect. However, they also show that compliance does not remain stable over time but declines if no audits occur for a long while. It can be questioned whether some sparse audits after a longer period of no audits would suffice to increase compliance to the former level. A second experiment was designed to assess whether tax compliance rises if just one audit is set at a later point in time, after a long period without audits (see Study 2).

3. Study 2

The reduced echo effect in Study 1 inspired investigation of a more efficient audit pattern by considering two assumptions: (a) continuous audits are relevant, however, two continuous audits may suffice to suppress the bomb crater effect; (b) if no audits have occurred for a longer period of time and compliance starts to decrease, one further audit may lead to increasing compliance and extension of the echo effect. These assumptions were tested in a second study, conducted in May 2007.

3.1. Participants

Participants were recruited via announcements on the bulletin board of the Faculty of Economics, University of Trento, Italy. Overall, 60 undergraduate business students participated (35% females, 65% males; age ranging between 18 and 32 years, $M = 22.40$, $SD = 2.32$).

3.2. Experimental design and procedure

The second study consisted of two experimental conditions. In the first condition (E1*) eight audits were placed within the first 20 rounds with two continuous audits at the beginning of tax filing. The position of the following six audits corresponded to E1 (Study 1) and the ninth audit was placed after round 31. This pattern was chosen in order to analyze whether

a reduction to two continuous audits at the beginning suffices to suppress the bomb crater effect and serves to extend the echo effect. The second experimental condition (E2*) consisted of the same audit pattern as E1* but with audits placed between rounds 20 and 51.

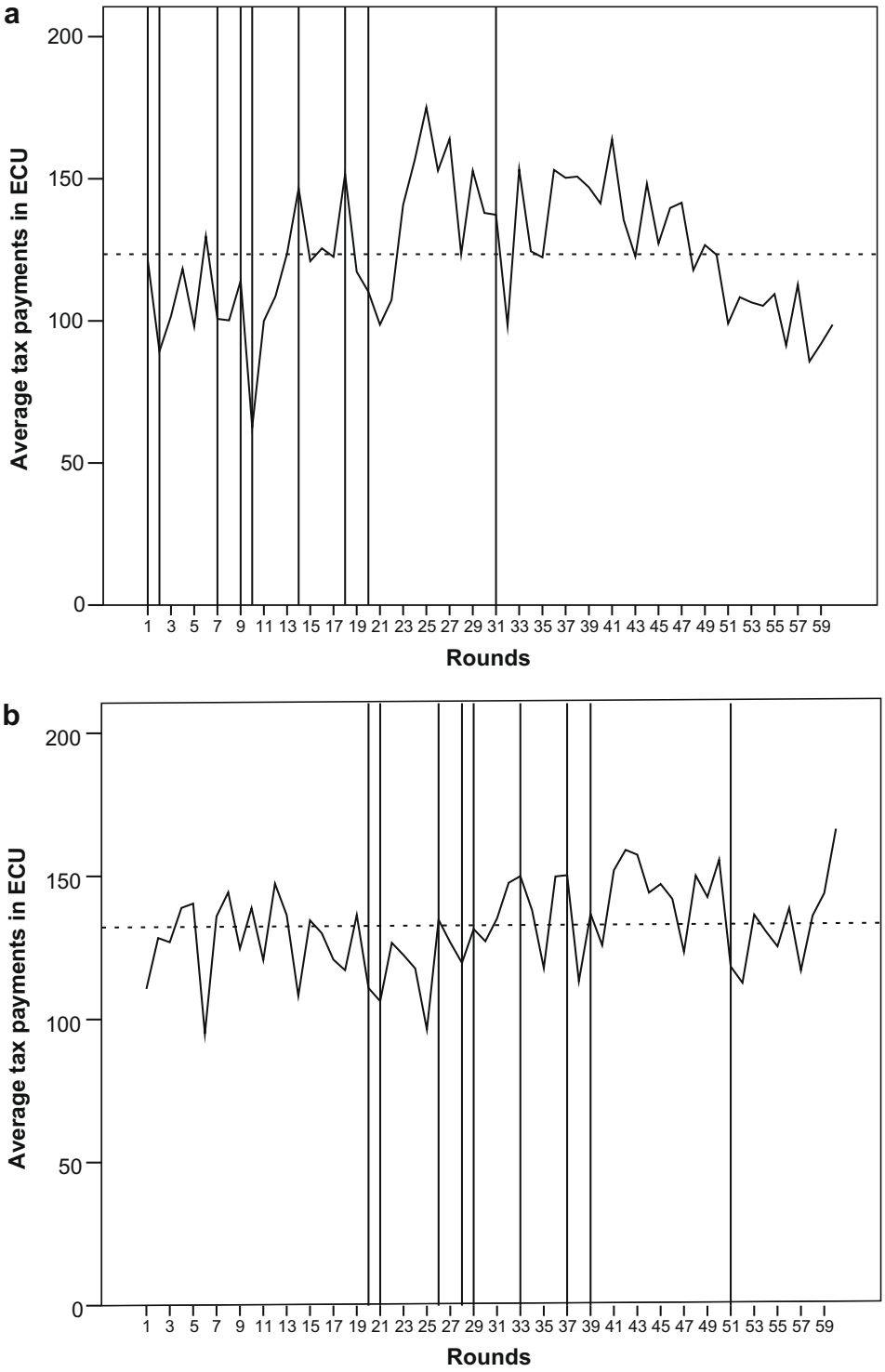

Fig. 2. (a) Average tax payments in experimental condition E1*. (b) Average tax payments in experimental condition E2*. *Note*. The curve gives the average tax payments of the sample; the horizontal line gives the overall mean for the condition; the vertical lines mark the audits.

Table 5
Descriptive results of payments and evasion in experimental conditions E1* and E2*.

Condition	Average tax payment per round *M* (*SD*)	Average tax payments over 60 rounds including fines *M* (*SD*)	Sum of honest tax filings by all participants during the 60 rounds (No. of observations = 1800)	No. of participants being compliant over all 60 rounds	No. of participants evading over all 60 rounds
E1*	123.45 (46.90)	10 471.73 (1678.58)	819	1	0
E2*	132.13 (50.74)	10 489.93 (1281.16)	885	2	0

Note: *M* = mean; *SD* = standard deviation.

The experimental setting was identical to the previous experiments. Participants were provided with 1000 ECU; they paid taxes on their voluntarily reported income, faced the same audit probability as in Study 1, and paid the same fine for evasion. At the end of the experiment, participants were paid relative to their performance. On average, participants earned 10 Euros (*SD* = 3.57). Again, complete anonymity was assured. An experimental condition took approximately 1 h.

3.3. Results

Average payments in each filing round in E1* and E2* are shown in Fig. 2a and b and in Table 5. The average payments per round, as well as the sum of honest tax filings did not differ between the two conditions and were similar to Study 1.

3.3.1. Suppression of the bomb crater effect by two continuous audits

As in Study 1, a random effects probit model was used to analyze determinants of the decision to be compliant or to evade. Table 6 shows that compared to E1*, where audits show no significant effect on the decision to be compliant, in E2* audits influenced the probability of being compliant positively. In other words, audits enhanced compliance significantly in E2* but did not influence compliance to the same degree in E1*. The results suggest that two continuous audits may suffice to suppress the characteristic decrease in compliance after audits.

3.3.2. Extension of the echo effect

In Study 1, a smaller echo effect was observed than in previous studies (Mittone, 2006). This could be due to the extension of the non-audited section in Study 1. Therefore, in the present conditions the long stage without audits was reduced by placing one audit after round 31 in E1*, and correspondingly, after round 51 in E2*. Again, the 60 rounds were divided into 10-round sections and analyzed by a repeated 2 by 6 analysis of variance with condition (E1*, E2*) as between-subject factor, 10-round sections as within-subject factors and compliance (tax payments) as dependent variables. The interaction effect between conditions and 10-round sections reached significance ($F(3.18, 184.48) = 5.34$, $p < .01$, $\eta^2 = .08$). Differences in tax payments between the sections were also significant ($F(3.18, 184.48) = 6.61$ $p < .01$ $\eta^2 = .10$), whereas the main effect of the conditions was not significant ($F(1, 58) = 0.47$, $p > .05$).

In Study 2, the echo effect was more pronounced than in the previous one (see Fig. 3a and b). Participants in E1* increased their average tax payments during the intensive auditing phase and even during the subsequent section. They remained compliant during two more "decades" (rounds 21–30 until 41–50) before they significantly decreased their payments. Participants in E2* demonstrated stable compliance during the first half of the experiment, even after audits had started. They

Table 6
Random effects probit model with compliance as dependent variable and previous tax payments, audits, experimental conditions (E1*, E2*), and interactions as independent variables.

	Coefficient (standard error)
Amount of tax payments in the previous period	.001 (.0003)
Audit in the previous round	−.116 (.117)
Fines in the previous round	−.0004 (.0002)
Experimental condition 2* (E2*)	.284* (.114)
E2* by audit in the previous round	.408** (.139)
Constant	−.294** (.076)
/lnsig2u	−.182 (.113)
σ_u	.913 (.052)
ρ	.455 (.028)
Number of observations (number of participants)	3540 (60)
Wald $\chi^2(5)$	35.04**
chibar2 (01)	982.46**

Note: *$p < .05$. **$p < .01$.

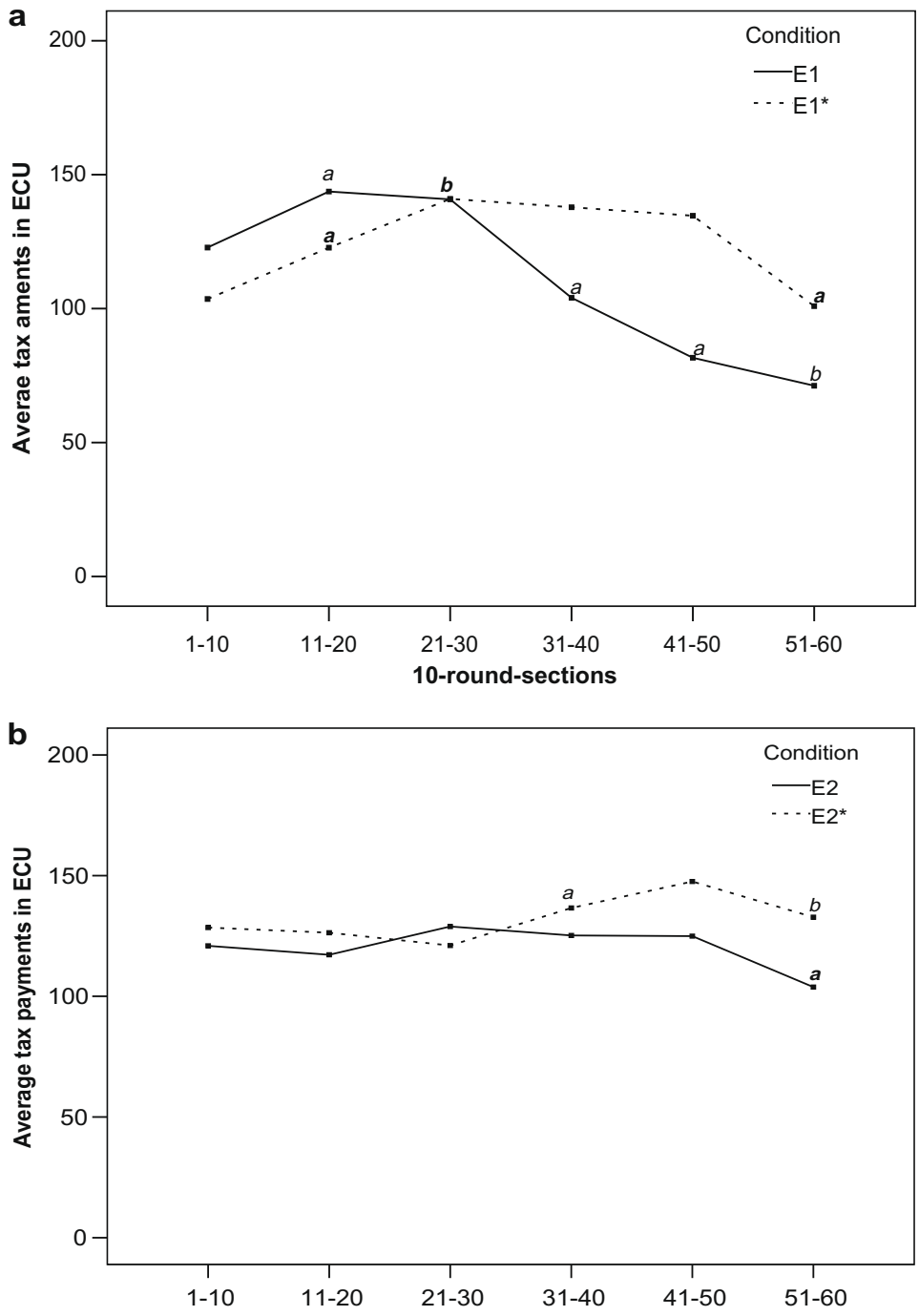

Fig. 3. (a) Development of tax payments in experimental conditions E1 and E1*. (b) Development of tax payments in experimental condition E2 and E2*. *Note*. The curves give the average tax payments; *a* = significant increase or decrease in payments compared to the previous section $p < .01$, *b* = significant increase or decrease in payments compared to the previous section $p < .05$.

increased their payments during the second part of the intensive auditing phase, but remained at the higher level only for one further decade, before decreasing payments again.

In Study 2, participants became compliant during the intensive auditing phase and their level of compliance remained also more stable in the early audit condition. To achieve stable compliance after a period of audits – as predicted by the echo effect – it seems to be necessary to set at least one audit at a later stage.

4. Discussion

The aim of the presented studies was to investigate the effect of audits on taxpayers' future compliance in general, and the sequential effects of repeated audits in particular. It is shown that the effectiveness of audits and fines – suggested by the standard economic model as the most relevant determinants deterring from tax evasion – cannot completely be confirmed. Especially, the finding of the bomb crater effect, shows that, rather than increasing or strengthening compliance, audits can lead taxpayers to develop strategies to "escape" and thus have the opposite than expected effect. This was also shown by results of the study by Bergman and Nevarez (2006) about VAT compliance. Owing to misperceived probability of audits, taxpayers may feel safe after having been audited and cut their tax share. Also, taxpayers experiencing an audit and paying fines may try to get back the lost money in subsequent periods. While the so-called bomb crater effect occurred when audits were set randomly, tax compliance can increase under conditions of continuous auditing ("jump effect"). In this latter case, participants learned that evasion immediately after an audit does not pay because the possibility of being audited in the subsequent rounds is as high as audits after a sequence of periods without audits.

As shown by Mittone (2006) and also by Benjamini and Maital (1985), Spicer and Hero (1985), Webley (1987), and others, our results also suggest that early audits have an impact on taxpayers' compliance. Participants learned to be compliant when audited at an early stage of their "tax filing lives." Participants who were not audited at the beginning of the experimental rounds may have formed their "personal" view about the occurrence of audits and developed a strategy regarding their tax payments. When audits started, they did not change their strategy and continued paying the share which they had paid in the previous rounds. While the echo effect in Study 1 was not enduring over the full length of the experiment, it was possible to re-establish it in Study 2 by placing just one audit after compliance had started to decline.

The results of both studies presented in this paper suggest a weaker echo effect than reported by Mittone (2006). While in the former studies audits were placed either during the first or second 30 rounds of a total of 60 tax filing rounds, in this study we concentrated audits in 20 rounds either at the beginning of a "tax filing life" or in the second third, and allowed for a long phase of "extinction." Indeed, the echo effect endured over some rounds and faded away afterwards. However, as Study 2 shows, to boost compliance it sufficed to apply just one audit after compliance started to decline.

Overall evasion was not influenced by the audit patterns realized in Study 1 and 2. However, it is shown that an audit pattern with repeated audits leads to a higher probability to be compliant compared to a random audit pattern. Furthermore, it was found that an audit pattern which is easily seen through is disadvantageous for the community, as it leads to lower tax revenues. Indeed, if taxpayers are tempted to predict audits in order to comply if it pays, but to evade if the risk of audit is low, then unpredictable audit patterns are likely to be more efficient than others.

Finally, it should be emphasized that we are not assuming that audits and fines are the most efficient strategy to strengthen cooperation. This is especially true if the interaction climate is characterized by mutual trust between taxpayers and authorities (Kirchler, 2007; Kirchler et al., 2008). To achieve higher compliance in general, several authors have suggested introducing rewards in addition to the conventional penalty system (e.g., Falkinger & Walther, 1991; Feld, Frey, & Torgler, 2006). Further research on audit schemes manipulating fines in the case of evasion and rewards in that of full compliance might shed further light on the effectiveness of audits, fines, and incentive systems.

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