Killing two birds with one stone: Reducing fiscal and welfare loss of tax evasion

Rostislav Staněk · Ondřej Krčál

Received: date / Accepted: date

Abstract Tax evasion constitutes a fiscal loss to the tax authority and a welfare loss for the society because it induces socially wasteful activities during which taxpayers spend real resources in order to hide their undisclosed income. We develop a theoretical model that explores the effect of audit selection rules on the losses from tax evasion. In the proposed experimental design, we test the main prediction of the model, that the competitive audit selection mechanism reduces both the fiscal and welfare loss of tax evasion. Furthermore, our model shows that a higher basic audit probability motivates taxpayers to increase their socially wasteful activities. Our experimental results confirm the predictions of the model. Our paper shows not only that the competitive audit selection mechanism provides an additional benefit if socially wasteful concealment activities are possible, but also its relative advantage compared to an increase in the audit probability.

Keywords Tax evasion · Concealment activities · Audit selection mechanism

JEL classification H26

1 Introduction

In the biggest tax evasion prosecution in U.S. history, Walter Anderson was charged with using a complex scheme to conceal approximately $450 million in earnings between 1995 and 1999 from the US authorities. This scheme involved the formation of offshore firms in the British Virgin Islands and Panama, with the aim of concealing Mr. Anderson’s investments in several telecommunications companies whose stock prices increased dramatically during the 1990s.1 Walter Anderson was

Rostislav Staněk, Ondřej Krčál

by no means alone in the shady business. The so-called Panama Papers\(^2\) suggest not only that people avoid and evade taxes on a scale larger than previously suspected, but also that people are willing to pay a substantial amounts of money for the concealment services these firms offer. And the activities revealed by Panama papers represent just the tip of the iceberg. In the United States, the average annual tax gap in 2008–2010 was estimated at $458 billion, which corresponds to the compliance rate of 81.7% (IRS, 2016). Similarly, concealment activities may include not only the high-end services of offshore companies, but also various other costly actions such as keeping two sets of books, making false entries in books and records, claiming false or overstated deductions on a return, hiding or transferring assets or income, etc.\(^3\)

As shown in these examples, tax evasion constitutes not only fiscal losses for governments, but also creates welfare losses by inducing socially wasteful activities, e.g. by making taxpayers spend real resources in order to conceal their taxable income. In this paper, we study how these fiscal and welfare losses are influenced by two parameters of the audit selection mechanism (ASM): The basic probability that a taxpayer is selected for audit and the sensitivity of a taxpayer’s audit probability to income reported by her and by other taxpayers (this parameter will be also called \textit{competitiveness} of the ASM). We formulate a model of tax compliance in a world where costly concealment activities are possible. The model predicts that increasing competitiveness of the ASM reduces both the fiscal and social loss of tax evasion, while increasing the basic audit probability reduces the fiscal loss but increases the social loss of tax evasion. Using experimental methods, we confirm that increasing competitiveness of the ASM leads to better outcomes than increasing the audit probability.

There is a large economic literature on tax compliance (see Torgler, 2002; Slemrod, 2007; Alm, 2012, for surveys). This paper builds on two strains of this literature: on papers studying endogenous audit selection mechanisms, and on the literature on tax evasion concealment. In an endogenous ASM, the audit probability depends not only on the income reported by the taxpayer, but also on the reported incomes of other taxpayers. Two forms of endogenous audit mechanisms have been examined in the experimental literature. The mechanism proposed by Alm and McKee (2004) uses the relative ranking of taxpayers based on their reported income within a group of taxpayers with the same income. The taxpayer with the lowest reported income is selected for audit. Alm and McKee show that this mechanism results in higher tax compliance than a random audit selection rule. On the other hand, Gilpatric, Vossler, and McKee (2011) (henceforth GVM) assume that the tax office has noisy but unbiased information about the actual income of taxpayers. The tax office then audits the taxpayers with the largest observed tax fraud, which equals the difference between the noisy observation of the actual income and the reported income. This structure can be generalized to an audit selection rule where the probability of being audited is an increasing function of the difference between taxpayers observed tax fraud and the average observed tax fraud in the peer group. The results of GVM’s analysis confirm that such a rule results in higher tax compliance. This is also found by Cason et al (2016).

\(^2\) The Panama Papers are 11.5 million documents of the Panamanian law firms Mossack Fonseca leaked on 15 April 2016 (Harding, 2016).

In this paper we follow Alm and McKee (2004) in assuming that we are able to divide the taxpayers in groups with the same income. In a real tax enforcement setting, tax authorities would need to observe not only reported incomes, but also several other characteristics of taxpayers. These characteristics would be used to match taxpayers in peer groups. A successful matching should generate peer groups containing taxpayers with similar incomes. Taking advantage of the same-income assumption, we follow GVM in proposing an endogenous ASM in which the audit probability a taxpayer is increasing in the difference between the average reported income of her peer taxpayers and her reported income.

The literature on tax evasion concealment focuses mainly on the effects of tax rate and tax penalty on concealment activities. Bayer (2006) provides a theoretical model in which detected tax evasion depends on the taxpayers investment into concealment activities and the auditors investment into detection. The audit is therefore modeled as a detection-concealment contest. Bayer and Sutter (2009) study this situation experimentally. They find that concealment activities depend positively on the tax rate and do not depend on the penalty imposed when tax evasion is detected. In contrast to these studies, our theoretical model and experimental design studies the effect of audit probability and competitiveness of the ASM on tax compliance and concealment activities.

The rest of the paper is structured as follows. Section 2 introduces the theoretical model. Section 3 translates the model into an experimental design. Section 4 presents the results of the experiment and Section 5 concludes.

2 Model

In the model, the taxpayers choose not only how much income to disclose but also how much to invest into tax concealment activities. This investment determines the probability that the undisclosed income is verifiable by tax authority when the taxpayer is selected for audit.

2.1 Timing of the model

The timing of the model is as follows:

1. Each taxpayer is endowed with the same income $I$.
2. The taxpayer declares his taxable income $r \in [0, I]$ and chooses the probability $p$ that the undisclosed income is verifiable by the tax authority given that the taxpayer is selected for audit. The reported income $r$ is subject to the tax rate $\tau$. The choice of the verification probability $p$ induces monetary costs $c(p)$ where $c(1)$ is decreasing and convex function, $c(1) = 0$ and $c(0) \to \infty$.
3. The audit selection rule decides whether the taxpayer is selected for audit or not. If the taxpayer is selected for audit, the nature decides whether the tax evasion is verifiable or not. If the taxpayer is audited and the tax evasion is verifiable, the taxpayer has to pay the fine which is equal to the undisclosed income $z = I - r$.

The audit selection rule determines the probability $\Pi$ that the taxpayer is selected for audit. We examine two audit selection rules. The random selection
rule states that each taxpayer may be selected for audit with the same probability $\Pi = \pi$. When the endogenous audit selection rule is applied, the audit probability depends on the income reported by the taxpayer and also on the income reported by other taxpayers $\Pi(r_i, r_{-i}, \pi, \beta)$ where $\pi$ and $\beta$ are parameters that define the audit selection rule. Parameter $\pi$ defines the basic audit probability and parameter $\beta$ defines the sensitivity of the audit selection rule to the disclosed income (competitiveness). The endogenous audit selection rule has the following properties:

1. The audit probability is decreasing in the reported income $\Pi'_r < 0$.
2. If the reported income is the same for all taxpayers, then the audit probability is $\pi$, i.e. $\Pi = \pi$ if $r_i = r_{-i}$.
3. The higher is the parameter $\beta$ the higher is the sensitivity of the audit probability with respect to the undisclosed income, i.e. $\Pi''_{r\beta} < 0$ or alternatively $\Pi''_z > 0$.
4. Random audit selection rule is a special case of the endogenous audit selection rule, i.e. $\Pi = \pi$ if $\beta = 0$.

We assume that the taxpayer is risk-neutral. His expected payoff is therefore given as follows

$$U(r_i, r_{-i}) = \Pi(r_i, r_{-i}) p_i (1 - \tau) + (1 - \Pi(r_i, r_{-i}) p_i) (I - \tau r_i) - c(p_i). \quad (1)$$

The first term is the taxpayer’s payoff when he is audited and tax evasion is verifiable. The second term is the taxpayer’s payoff when the undisclosed income is successfully evaded. The last term $c(p_i)$ represents the cost of the tax concealment activity.

2.2 Equilibrium

By taking derivatives according to the variable $r_i$ and $p_i$, we obtain the following first order conditions which implicitly define the best response functions.

$$-\Pi(I - r_i) - c'(p_i) = 0 \quad (2)$$
$$-\Pi'_r p_i (I - r_i) - \tau + \Pi p_i = 0 \quad (3)$$

By restricting our attention to symmetric equilibrium $(r^*, p^*)$, we get the equilibrium conditions. There are four possible equilibrium situations.

1. Interior solution

$$-\pi(I - r^*) - c'(p^*) = 0 \quad (4)$$
$$-\Pi'_r p^*(I - r^*) - \tau + \pi p^* = 0 \quad (5)$$

where the following second order conditions are satisfied

$$c''(p^*) > 0 \quad (6)$$
$$-\Pi''_{rr}(p^*)(I - r^*) + 2\Pi'_r p^* < 0 \quad (7)$$
$$(-c'')(\Pi''_{rr} p^*(I - r^*) + 2\Pi'_r p^*) - (\pi - \Pi'_r(I - r))^2 > 0 \quad (8)$$
2. Partly corner solution with \( p^* = 1 \) and \( r^* \in (0, I) \)

\[
\pi(I - r^*) - c'(p^*) > 0 \quad (9)
\]

\[
-\Pi'_r p^*(I - r^*) - \tau + \pi p^* = 0 \quad (10)
\]

3. Partly corner solution with \( r^* = 0 \) and \( p^* \in (0, 1) \)

\[
\pi(I - r^*) - c'(p^*) = 0 \quad (11)
\]

\[
-\Pi'_r p^*(I - r^*) - \tau + \pi p^* < 0 \quad (12)
\]

4. Corner solution with \( p^* = 1 \) and \( r^* = I \)

\[
\pi(I - r^*) - c'(p^*) > 0 \quad (13)
\]

\[
-\Pi'_r p^*(I - r^*) - \tau + \pi p^* > 0 \quad (14)
\]

2.3 Comparative statics

The aim of this subsection is to show how the equilibrium values \( r^* \) and \( p^* \) depend on the audit selection mechanism. In particular, we are interested in what happens if we change the basic audit probability \( \pi \) or the sensitivity parameter \( \beta \).

Suppose that there is the interior solution. By taking derivatives of the equations (2) and (3) according to \( \beta \) and \( \pi \) we get the following comparative static results.

**The effect of sensitivity**

The effect of the sensitivity parameter \( \beta \) is given by following equations:

\[
p^*_\beta = \frac{\pi r^*}{c''} \quad (15)
\]

\[
r^*_\beta (-\Pi''_r r(I - r^*)p^* + p^* \Pi'_r) + p^*_\beta (\pi - \Pi'_r(I - r^*)) = \Pi''_r p^*(I - r^*) \quad (16)
\]

By substitution we get the effect of sensitivity on reported income

\[
r^*_\beta [c''(-\Pi''_r(I - r^*)p^* + p^* \Pi'_r)) + \pi(\pi - \Pi'_r(I - r^*)) = c'' \Pi''_r p^*(I - r^*)
\]

As the right-hand side is always negative, the effect depends on the sign of the expression in the square brackets on the left-hand side. From the second order condition 8 we can see that this expression is negative if the following condition holds

\[
-c''(-\Pi''_r(I - r^*)p^* + p^* \Pi'_r)) (\pi - \Pi'_r(I - r^*)) > \pi((-c'')(\Pi''_r p^*(I - r^*)+2\Pi'_r p^*))
\]

By substitution from the first order condition (5) and after some algebraic manipulation, we get the following condition.

\[
\Pi''_r(I - r^*)p^*(\tau - p^* \pi) + \Pi'_r p^*(2p^* \pi - \tau) > 0
\]
Given the assumption that the audit probability function $\Pi$ is non-concave with respect to reported income, the condition is satisfied if

$$\tau > 2\pi p^*$$ \hspace{1cm} (17)

Therefore the reported income is increasing in the sensitivity parameter, $r^*_\beta > 0$, under this mild condition. Moreover, it follows from equation 15 that $p^*_\beta > 0$. We can summarize this results in the following proposition.

**Proposition 1**: Suppose that condition 17 holds. Equilibrium reported income is increasing in the sensitivity parameter. Equilibrium probability that the undisclosed income is verifiable is increasing in the sensitivity parameter.

**The effect of basic audit probability**

By applying the implicit function theorem we can see that the effect of basic audit probability on verification probability is given by the following equation

$$p^*_\pi \left[ c'' \left( -\Pi''_{r}(I - r^*)p^* + p^* \Pi'_r(I - r^*) \right) + \pi(\pi - \Pi'_r(I - r^*)) \right] =$$

$$\begin{align*}
&\tau > 2p^*\pi \rightarrow 0 \\
&\tau - 2p^*\pi
\end{align*}$$

$$= (I - r^*)p^* \Pi'_r - \pi p^* + (I - r^*)(\Pi''_{r}(I - r^*)p^*)$$

We know from the previous sections that the expression in the square brackets on the left-hand side is negative if $\tau > 2p^*\pi$. The same condition ensures that the right-hand side of the equation is positive. Henceforth, the probability that the undisclosed income is verifiable is decreasing in the basic audit probability.

The effect of basic audit probability on the reported income is given by the following condition (differentiation of the first equilibrium condition according to $\pi$).

$$-(I - r^*) + \pi r^*_\pi - c'' p^*_\pi = 0.$$ 

As it holds that $p^*_\pi < 0$ it has to hold also that $r^*_\pi > 0$. Proposition 2 summarizes the effect of changes in the basic audit probability parameter.

**Proposition 2**: Suppose that condition (17) holds. Equilibrium reported income is increasing in the basic audit probability parameter. Equilibrium probability that the undisclosed income is verifiable is decreasing in the basic audit probability.

### 3 Experimental design

We test predictions of the model in an economic experiment. Each experimental session consists of 20 rounds. In the treatments with endogenous ASM, the subjects are divided into pairs of peer taxpayers. In order to keep the one-shot incentives of the theoretical model and at the same time have two independent observations per session, the partner for each subject is randomly selected from the same half of subjects participating in a given session.
At the beginning of each round, all taxpayers receive the same income $I = 100$ CZK. Their task is to choose the reported income $r \in (0, 100)$ and the verification probability $p \in (0.25, 1)$. The reported income is taxed at a rate $\tau = 0.6$. Each verification probability entails a concealment cost $c(p) = 20 \left( \frac{1}{p} - 1 \right)$ CZK.

Next, the tax authority selects taxpayer $i$ for audit with a probability
\begin{equation}
\Pi_i = \pi + \beta \left( \frac{r_{i-1} - r_i}{r_{i-1} + r_i} \right),
\end{equation}
where $r_i$ is the reported income of taxpayer $i$, $r_{i-1}$ is the reported income of the peer taxpayer, $\pi$ is the basic audit probability, and $\beta$ determines sensitivity of the ASM to reported incomes (competitiveness). We used $\pi = \{0.4, 0.6\}$ for the basic audit probability and $\beta = \{0, 0.2, 0.4\}$ for the sensitivity parameter. Thus we have six treatments, one for each combinations of $\pi$ and $\beta$ parameters.

If taxpayer $i$ is selected for audit, her true income is verified with the probability $p_i$. If verified, the subject pays a penalty equal to her unreported income $100 - r_i$. The taxpayer $i$’s payoff in a given round is $0.4r_i + (100 - r_i) - c(p_i)$ if she is not selected for audit, or she is selected but her actual income is not verified. Her income is only $0.4r_i - c(p_i)$ if she is selected for audit and her true income is verified.

The experiment was conducted in MUEEL in Brno, the Czech Republic, in October 2016. It was organized using hroot system (Bock et al, 2012) and the experimental environment was prepared in zTree (Fischbacher, 2007). We used neutral instructions (the instructions are available upon request from the corresponding author). We ran 6 sessions—one session per treatment (between-subject design)—with 15–20 participants each. The sessions lasting between 70 and 90 minutes. The total number of participants was 110. The subjects received a show-up fee and payoffs from two randomly selected rounds. The mean payoff was 190 CZK (approx. $7).

4 Results

The main focus of this section will lie in how the treatment variables affect reported incomes and verification probabilities chosen by the experimental taxpayers. Each treatment consists of 20 identical rounds. The experimental situation is quite complex, so we expect that subjects will adjust their choices during the initial periods substantially (learning effect). Indeed, the visual inspection of the data suggests that subject were adjusting their strategy in the first 5–10 periods in most of the sessions. For this reason, we will use only data from the rounds 11–20 in the analysis. Hence our data set contains 10 observations per subject, 1,100 observations in total. Table 1 shows summary statistics for some of the variables.

Our theoretical model suggests that each change in parameters of the ASM affects both choice variables simultaneously. Also, there is a clear strategic substitutability between the parameters. Subjects with a high reported income have a low motivation to incur a costly concealment investment, and vice-versa. So we

---

4 At the time of the experiment, this amount approximately equaled $4, which roughly corresponded to an hourly wage of unqualified student labor in the Czech Republic.
Table 1 Summary statistics

<table>
<thead>
<tr>
<th></th>
<th>Min.</th>
<th>1st Qu.</th>
<th>Median</th>
<th>Mean</th>
<th>3rd Qu.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reported income r</td>
<td>0</td>
<td>25</td>
<td>43.00</td>
<td>48.03</td>
<td>75</td>
<td>100</td>
</tr>
<tr>
<td>Verification probability p</td>
<td>0.28</td>
<td>0.58</td>
<td>0.79</td>
<td>0.77</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Concealment cost c</td>
<td>0</td>
<td>0</td>
<td>5.5</td>
<td>8.7</td>
<td>14.5</td>
<td>51.4</td>
</tr>
<tr>
<td>Audit probability Π</td>
<td>0</td>
<td>0.40</td>
<td>0.52</td>
<td>0.51</td>
<td>0.60</td>
<td>1</td>
</tr>
<tr>
<td>Payoff (CZK)</td>
<td>95</td>
<td>160</td>
<td>190</td>
<td>190</td>
<td>222</td>
<td>314</td>
</tr>
</tbody>
</table>

expect a positive correlation between random errors of regressions that explain reported income and verification probability with the treatment variables. For this reason, we use seemingly unrelated regression models in our analysis.

Furthermore, Table 1 shows that the lowest and highest possible value of the reported income and the highest possible value of verification probability were chosen, so the data is censored. The left column of Table 2 presents OLS regression. In order to deal with the problem of censoring, we use the average reported income and the average verification probability as dependent variables. We find that a more competitive ASM significantly increases income for both changes of $β$ from 0 to 0.2 and from 0 to 0.4. The effect on the average verification probability is positive and statistically significant only for a change of $β$ from 0 to 0.4. The effect of an increase in the base audit probability from 0.4 to 0.6 has no effect on reported income, but significantly reduces the verification probability. The results show that a more competitive mechanism increases compliance and reduces concealment. A higher audit probability, on the other hand, motivates people to conceal more while having no significant effect on tax compliance.

The Tobit-SUR model presented in the right column Table 2 provides very similar results. A more competitive ASM again motivates people to report more and, in the case of a change from $β = 0$ to 0.4, also to conceal less. The increase in the base audit probability has no statistically significant effect on reporting and concealment.

5 Conclusion

This paper examines the effect of two policies on tax compliance and investment in concealment activities. We propose a theoretical model that predicts that a higher audit probability leads to more compliance, but also to higher investment into concealment. On the other hand, a more competitive mechanism is predicted to create more compliance and less concealment. Hence, the endogenous audit selection might reduce both the fiscal and welfare cost of tax evasion.

We test these predictions using an economic experiment. The results are very much consistent with the model. In particular, we find that a high increase in competitiveness of the mechanism increases the reporting and reduces concealment. If the increase is relatively small, the effect on concealment are no longer statistically significant. Furthermore, a rise in the base audit probability leads to more compliance and more concealment, but effects are small and often not statistically significant.

5 The OLS-SUR model gives the same result as a simple OLS regression if the independent variables are the same in both equations.
Table 2: Explaining the reported income and verification probability: OLS and Tobit-SUR model with errors clustered at the level of subject

<table>
<thead>
<tr>
<th>Model:</th>
<th>OLS model</th>
<th>Tobit-SUR model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependent variable:</td>
<td>Average reported income</td>
<td>Individual reported income</td>
</tr>
<tr>
<td>Constant</td>
<td>33.04***</td>
<td>33.27***</td>
</tr>
<tr>
<td></td>
<td>(4.91)</td>
<td>(4.96)</td>
</tr>
<tr>
<td>$\beta = 0.2$</td>
<td>12.64***</td>
<td>13.44**</td>
</tr>
<tr>
<td></td>
<td>(5.83)</td>
<td>(6.36)</td>
</tr>
<tr>
<td>$\beta = 0.4$</td>
<td>21.87***</td>
<td>24.37***</td>
</tr>
<tr>
<td></td>
<td>(5.65)</td>
<td>(6.65)</td>
</tr>
<tr>
<td>$\pi = 0.6$</td>
<td>5.63</td>
<td>8.03</td>
</tr>
<tr>
<td></td>
<td>(4.67)</td>
<td>(5.45)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dependent variable:</th>
<th>Average verification probability</th>
<th>Individual verification probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>0.773***</td>
<td>0.832***</td>
</tr>
<tr>
<td></td>
<td>(0.036)</td>
<td>(0.054)</td>
</tr>
<tr>
<td>$\beta = 0.2$</td>
<td>−0.017</td>
<td>−0.009</td>
</tr>
<tr>
<td></td>
<td>(0.043)</td>
<td>(0.065)</td>
</tr>
<tr>
<td>$\beta = 0.4$</td>
<td>0.097**</td>
<td>0.149**</td>
</tr>
<tr>
<td></td>
<td>(0.042)</td>
<td>(0.062)</td>
</tr>
<tr>
<td>$\pi = 0.6$</td>
<td>−0.068**</td>
<td>−0.084</td>
</tr>
<tr>
<td></td>
<td>(0.034)</td>
<td>(0.055)</td>
</tr>
</tbody>
</table>

Note: $^*$ $p < 0.1$; $^{**}$ $p < 0.05$; $^{***}$ $p < 0.01$

The results of the experiment suggest that a more competitive ASM might reduce both tax evasion and tax concealment, while a more frequent auditing has no significant impact on tax compliance, and even might increase investment in concealment activities. A smarter ASM seems to be superior to a more active ASM. This advantage seems even clearer if we take into account the costs of both policies. While more frequent auditing due to a higher audit probability is bound to increase the administrative costs, the audit frequency under a more competitive ASM remains constant. The only additional costs of the endogenous ASM consist in a system selecting of taxpayers with similar incomes. Hence, the endogenous audit selection mechanism seems to outperform more frequent auditing not only in terms of results, but also in terms of administrative costs.

References