

Tax Compliance: A Behavioral Economics Approach

Thesis submitted for the degree of
Doctor of Philosophy
at the University of Leicester

by

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2016

To Megi and Marta

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Abstract

Tax evasion is one of the key challenges for the policy makers. Designing the optimal tax code requires assessment of taxpayers' compliance behavior. Tax rate, detection intensity, penalty rate - are some of the characteristics considered in models of tax evasion. The central question in tax evasion literature is how changes in fiscal policy parameters affect evasion. The literature on tax evasion can be categorized into two broad groups. The first strand of literature is based on expected utility theory (EU) and the second strand approaches the evasion problem from a behavioral perspective. This dissertation uses a behavioral approach to study tax compliance behavior and contributes to the second group of the literature.

The second chapter of this dissertation investigates tax compliance behavior of individuals with reference dependent preferences and endogenous reference point. The results are derived for the three personal equilibrium concepts of Kőszegi and Rabin (2007). The effects of tax policy parameters on compliance are found qualitatively similar to the results under EU.

Do taxpayers change their tax compliance behavior after the announcement and before the actual enforcement of a new tax rate? This is the central question of the third chapter. Using cumulative prospect theory framework and a reference point adaptation process, the answer is that evasion in the transition period increases following the announcement of the tax rate reduction or increase. An increase in the tax rate increases evasion, whereas reduction of the tax rate reduces evasion in the long run.

The final chapter of this dissertation develops a model of tax compliance behavior with endogenous *social norms*. The implications of the model are that the tax policy parameters not only shape monetary (dis)incentives for compliance, but also determine the strength of the social norm of compliance. The social norm of compliance is weaker under the higher tax rate and the norm is stronger under the stricter tax enforcement regime.

Acknowledgments

First and foremost, I would like to express my sincere gratitude to my supervisors Prof. Sanjit Dhami and Prof. Ali al-Nowaihi for the continuous support throughout my Ph.D. study and for their patience, motivation, and encouragement. I have been extremely fortunate to have supervisors who gave me the freedom to explore on my own, and at the same time guided me when I needed help.

I thank my university friends and fellows for the stimulating discussions, their encouragement and all the fun we had during our Ph.D. journey. Junaid Arshad, Sneha Gaddam, Evangelos Litos and Jingyi Mao deserve a special mention. I highly value their friendship and I deeply appreciate their support during all these years.

I am grateful to the administrative staff of economics department for their help and support, especially Sebastian O'Halloran, Samantha Hill and Eve Danvers. I must also thank the University of Leicester for granting me the graduate teaching assistantship, without which my Ph.D. studies would not have been possible.

I would like to thank International School of Economics at Tbilisi State University and its director Eric Livny for supporting my Ph.D. applications at the initial stage.

Last but not the least, I would like to thank my family for their love and encouragement: my parents, my brother and most of all my loving, patient and supportive wife Megi. Four years ago, short after the start of my Ph.D., my daughter, Marta was born. Her presence has been filling me with enthusiasm that I had never felt before. I would like to thank her for changing my life forever.

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Chapter I

General Introduction

In this dissertation I study tax compliance behavior of individuals with reference dependent preferences and address to the existing puzzles in the tax evasion literature. Using a behavioral economics approach, I investigate the roles of expectations, *hedonic adaptation* and *social norms* in a taxpayer's compliance behavior.

Tax compliance, as a decision problem under uncertainty was first introduced by Allingham and Sandmo (1972). In their model a taxpayer pays taxes on her declared income. The tax authority does not observe the true income of the taxpayer unless an audit is carried out, in which case the true income is learnt with certainty. If the taxpayer is caught underreporting her income, she has to pay the evaded taxes and a penalty. Tax evasion is successful, if an audit does not occur. Therefore, the taxpayer decides what amount of income to declare given the tax environment that is characterized by the tax rate, the penalty rate and the probability of an audit. A simple and tractable setup of their model has clear-cut predictions of the tax evasion behavior under expected utility theory (EU). For instance, an increase in the probability of an audit and the penalty rate has deterrent effects on evasion. Given the structure of the penalty, that is proportional to the concealed income in the model, an increase in the tax rate has ambiguous effect on evasion. Yitzhaki (1974) notes that in practice penalty is proportional to the evaded taxes rather than the concealed income. Then using EU, under the empirically plausible assumption of decreasing absolute risk aversion, an increase in the tax rate reduces evasion at an interior optimum. This counter intuitive result, known as Yitzhaki puzzle, is not supported by the majority of the empirical works (e.g., Friedland et al., 1978; Clotfelter, 1983). In addition, by considering only monetary (dis)incentives for compliance, the Allingham-Sandmo-Yitzhaki model predicts too much evasion relative to the empirically observed levels and generates a puzzling question - why do people pay taxes (Alm et al., 1992; Alm and Torgler, 2011)? The model fails to explain why some people never evade taxes.

In the second chapter, I study the Allingham-Sandmo-Yitzhaki model of tax evasion using the decision theory of Kőszegi and Rabin (2006, 2007). In their theory, a reference point is determined by the expectations an individual held about the outcomes in the recent past. I derive results for the three personal equilibrium concepts of Kőszegi and Rabin (2007) - *choice-acclimating personal equilibrium* (*CPE*), *unacclimating personal equilibrium* (*UPE*) and *preferred personal equi-*

librium (\mathcal{PPE}). I show that the comparative statics results under \mathcal{CPE} and EU are qualitatively similar. \mathcal{CPE} , like EU, incorrectly predicts the compliance-tax rate relation when the psychological cost of evasion is not part of the model and the effect of the tax rate increase on evasion turns ambiguous following the introduction of the psychological cost of evasion. Therefore, \mathcal{CPE} cannot solve the Yitzhaki puzzle. Nonetheless, unlike EU, \mathcal{CPE} can explain why some taxpayers never evade and it predicts higher compliance levels compared to EU. Under \mathcal{UPE} , the effects of the tax policy parameters are also qualitatively similar to those under \mathcal{CPE} and EU. In the existence of multiple \mathcal{UPE} , the concept of \mathcal{PPE} is used to investigate the equilibrium tax compliance behavior of taxpayers.

The third chapter investigates tax compliance behavior of a taxpayer in an environment, where the announcement of a tax rate change precedes the actual enforcement. The work explores cumulative prospect theory-based tax evasion model in the presence of *hedonic adaptation*. It shows that, under some conditions, evasion in the transition period increases following the announcement of the tax rate reduction or increase. The anticipation of tax changes does not incentivize full tax evaders to revise their declaration decision during the transition period and only the behavior of some fully compliant taxpayers is found to be affected by the announcement. The enforcement of a new tax rate is found to have long run effects on evasion - an increase in the tax rate increases evasion, whereas reduction of the tax rate reduces evasion in the long run.

The final chapter of this dissertation develops a model of tax compliance behavior with endogenous *social norms* in the prospect theory framework. The model rests on the following assumptions. First, the strength of the social norm of compliance depends on the overall extent of evasion. Second, taxpayers identify themselves with a group of individuals with the same income levels and internalize the norms that are attributed to this group. Third, taxpayers are guilt averse in the social domain of their preferences. The implications of the model are that the tax policy parameters not only shape monetary (dis)incentives for compliance, but also determine the strength of the social norm of compliance at the equilibrium. An increase in the tax rate is found to weaken the norm of compliance, whereas stricter tax enforcement regime strengthens the norm of compliance.

Chapter II

Tax Evasion with Endogenous Reference Point

1 Introduction

The leading decision theory in neoclassical economics, expected utility theory (EU), has been found inconsistent with numerous empirical phenomena. Among others, EU has generated several puzzles in the tax evasion literature.

Tax compliance, as a decision problem under uncertainty was first introduced by Allingham and Sandmo (1972) in the economics-of-crime framework of Becker (1968). In their model a taxpayer pays taxes on her declared income. The tax authority does not observe the true income of the taxpayer unless an audit is carried out, in which case the true income is learnt with certainty. If the taxpayer is caught underreporting her income, she has to pay the evaded taxes and a penalty. Tax evasion is successful, if an audit does not occur. Therefore, the taxpayer decides what amount of income to declare given the tax environment that is characterized by the tax rate, the penalty rate and the probability of an audit. A simple and tractable setup of their model has clear-cut predictions of the tax evasion behavior under EU. For instance, an increase in the probability of detection and the penalty rate has deterrent effects on evasion. Given the structure of the penalty, that is proportional to the concealed income in the model, an increase in the tax rate has ambiguous effect on evasion. Yitzhaki (1974) notes that in practice penalty is proportional to the evaded taxes rather than the concealed income. Then using EU, under the empirically plausible assumption of decreasing absolute risk aversion, an increase in the tax rate reduces evasion at an interior optimum. This counter intuitive result, known as Yitzhaki puzzle, is not supported by the majority of the empirical works (e.g., Friedland et al., 1978; Clotfelter, 1983). In addition, by considering only monetary (dis)incentives for compliance, the Allingham-Sandmo-Yitzhaki model predicts too much evasion relative to the empirically observed levels and generates a puzzling question - why do people pay taxes? (Alm et al., 1992; Alm and Torgler, 2011)¹ Therefore the model fails

¹The empirical estimates of the probability of an audit, p , take values from 0.01 to 0.03, while the penalty rate, λ , that is paid in addition to the reimbursement of the evaded taxes, ranges from 0.5 to 2 (see e.g., Dhimi and al-Nowaihi, 2007). For these parameter values, the model predicts that virtually all taxpayers evade some taxes as long as the expected return on evasion, $1 - p - p\lambda$,

to explain why some people never evade taxes.

Based on the refutations of EU, numerous alternative decision theories have emerged. In this respect, prospect theory of Kahneman and Tversky (1979) and cumulative prospect theory of Tversky and Kahneman (1992)² have revolutionized the field. Prospect theory (PT) and cumulative prospect theory (CP) are built on the four main blocks: reference dependence, loss aversion, diminishing sensitivity and non-linear weighting of probabilities. Dhami and al-Nowaihi (2007) use CP to study the tax compliance problem and successfully solve the Yitzhaki puzzle. Specifically, the authors find that at an interior optimum tax evasion increases in the tax rate.

Other notable alternatives of EU include rank-dependent utility theory (Quiggin, 1982; 1993), regret theory (Bell, 1982; Loomes and Sugden, 1982) and the theory of disappointment aversion (Bell, 1985; Loomes and Sugden, 1986; Gul, 1991). Rank-dependent utility theory (RDU) uses classical utility function and replaces objective probabilities with decision weights, which are derived using a probability weighting function. Eide (2001) studies the Allingham-Sandmo-Yitzhaki model of tax evasion using RDU and finds that the Yitzhaki puzzle is still in place. Hence, reference dependence and loss aversion appear crucial to reverse the compliance-tax rate relation.

Regret and disappointment are similar reference-effect phenomena by their nature. Regret arises from the ex-post feeling of not having made the right choice, whereas disappointment is incurred when the received outcome turns out smaller than expected. It turns out that RDU is linked with disappointment aversion models in special cases. For instance, Delquié and Cillo (2006) develop a disappointment model, where a received outcome is compared with other individual outcomes of a lottery. Assuming linearity of disappointment and elation functions, the model leads to the rank-dependent representation of the preferences.

More recent theory, developed by Kőszegi and Rabin (2006, 2007), henceforth KR, generalizes prospect theory and links it with disappointment aversion models. In KR framework utility is separable in two components - utility from the final consumption, termed as 'consumption utility' and 'gain-loss utility'. The latter is derived from the comparison of consumption utility from the received outcome with consumption utility from the reference point. Gain-loss utility shares the properties of the prospect theory value function, exhibiting diminishing sensitivity, loss aversion and reference dependence. KR theory specifies the source of a reference

is positive.

²The main difference between these two theories lies in the formation of decision weights.

point formation. A reference point is assumed to be shaped by the expectations an individual held about the outcomes in the recent past. The expectations-based reference point makes KR theory part of the disappointment literature.

KR theory has gained substantial empirical support. Abeler et al. (2011) conduct a real-effort experiment, where subjects can earn a fixed amount or an effort-proportional amount with equal probabilities. The study finds that the effort provision increases in the fixed amount that is set by the experimenter and the finding is explained by the expectations-based reference point. Ericson and Fuster (2011) show that reference points are determined by expectations. In their experiment subjects are endowed with an item and exposed to the probabilistic opportunity to exchange their items for an alternative. The subjects are found more likely to keep their items when the probability of exchange is low. Gill and Prowse (2012) test KR theory and find supportive evidence for the expectations-based reference point. In their experiment subjects perform real effort tasks in a competitive environment. An effort chosen by the first mover is observed by the second mover who then decides how hard to work. The authors find that an effort chosen by the second mover depends on the effort provided by the first mover, which is explained by the KR preferences. Crawford and Meng (2011) use KR theory to explain New York taxi drivers' labor supply.

Motivated by the increasing empirical support of KR theory, this chapter studies the tax compliance behavior of a taxpayer with reference-dependent preferences of KR-type. Three equilibrium concepts of KR theory are investigated in the standard tax evasion model. The first concept, *choice-acclimating personal equilibrium* ($CP\mathcal{E}$), is used in an environment where decisions are made sufficiently in advance of the resolution of uncertainty. The second concept, *unacclimating personal equilibrium* ($UP\mathcal{E}$) applies to an environment where a decision maker makes her decision close to the resolution of uncertainty and the third concept, *preferred personal equilibrium* ($PP\mathcal{E}$), is used in the existence of multiple $UP\mathcal{E}$. The chapter shows that the comparative statics results under $CP\mathcal{E}$ are qualitatively similar to the results under EU. Therefore, $CP\mathcal{E}$ cannot explain the Yitzhaki puzzle. Nevertheless, $CP\mathcal{E}$ can explain why some people never evade taxes and predicts higher compliance levels compared to EU. Under $UP\mathcal{E}$, the effects of the tax policy parameters are also qualitatively similar to those under $CP\mathcal{E}$ and EU. In the existence of multiple $UP\mathcal{E}$, the concept of $PP\mathcal{E}$ is used to investigate the equilibrium tax compliance behavior of taxpayers.

The rest of the chapter is structured as follows. Section 2 provides the basic framework of KR theory. Section 3 outlines the tax evasion model. Section 4

considers tax evasion under $\mathcal{CP}\mathcal{E}$. Section 5 considers tax evasion under $\mathcal{UP}\mathcal{E}$ and Section 6 concludes.

2 Framework of Stochastic and Endogenous Reference Points

Kőszegi and Rabin (2006) develop a general model of reference-dependent preferences under uncertainty. The basic framework of their model is as follows.

An individual's utility depends on the consumption level $c \in \mathbb{R}$ and the reference level $r \in \mathbb{R}$, that captures beliefs of the person about the possible outcomes. The utility from the final consumption level $m(c)$, termed as 'consumption utility', is the classical outcome-based utility. Utility from c with respect to the reference r is termed as 'gain-loss utility' and it is denoted by $n(c|r)$.³ An individual's overall utility is the sum of consumption and gain-loss utilities:

$$u(c|r) = m(c) + n(c|r) \quad (2.1)$$

Uncertainty about the consumption outcome is characterized by the cumulative distribution function $F(c)$. If the reference point r is deterministic, then expected utility of the consumption lottery is given by the following:

$$U(F|r) = \int u(c|r) dF(c) \quad (2.2)$$

The reference point may also be stochastic. Suppose an individual, who is facing uncertain consumption outcomes, has a stochastic reference point, or equivalently - a reference lottery, that is characterized by the cumulative distribution $G(r)$. Then the individual's expected utility of the consumption lottery, conditional on the stochastic reference point, is given by the following:

$$U(F|G) = \int \int u(c|r) dG(r) dF(c) \quad (2.3)$$

An individual compares the realized consumption outcome with all possible outcomes under the reference lottery. Each pairwise comparison yields sensation of either gain or loss. For example, if the reference lottery is a gamble between £10 and £20, then the outcome of £15 feels like a gain relative to £10 and a loss relative to £20.

³In the general model, consumption bundle is multidimensional and both components of the utility, m and n , are additively separable across the dimensions.

Gain-loss utility is tightly related with consumption utility in the following form:

$$n(c|r) = \mu(m(c) - m(r)) \quad (2.4)$$

Gain-loss utility, $\mu(\cdot)$, has the following properties:

1. $\mu(x)$ is continuous for all x , twice differentiable for all $x \neq 0$ and strictly increasing.
2. Reference dependence: $\mu(0) = 0$.
3. Large stakes loss aversion: For $y > x > 0$, $\mu(y) - \mu(x) < \mu(-x) - \mu(-y)$.
4. Small stakes loss aversion: Loss aversion parameter $\theta > 1$ is equal to $\frac{\mu'_-(0)}{\mu'_+(0)}$, where $\mu'_+(0) = \lim_{x \rightarrow 0^+} \mu'(x)$ and $\mu'_-(0) = \lim_{x \rightarrow 0^-} \mu'(x)$.
5. Diminishing Sensitivity: $\mu''(x) \leq 0$ for $x > 0$ and $\mu''(x) \geq 0$ for $x < 0$.⁴

The following linear form has been found to be adequate for small stake gambles:

$$\mu(x) = \begin{cases} \eta x & \text{if } x \geq 0 \\ \eta \theta x & \text{if } x < 0 \end{cases} \quad (2.5)$$

In this formulation, $\eta > 0$ is the weight an individual attaches to gain-loss utility and $\theta > 1$ is the loss aversion parameter.

For illustration purposes, consider the following example of a person with reference-dependent preferences of KR-type.

Example 2.1 *An individual faces an uncertain future. Suppose the realized consumption level can be either c_1 or c_2 and $c_1 < c_2$. The low consumption level, c_1 , is realized with probability p and the high consumption level, c_2 , is realized with probability $(1 - p)$. Hence, the consumption lottery is $\mathcal{L} = (c_1, p; c_2, 1 - p)$. Denote by F the probability distribution of consumption levels. Uncertainty about the future induces the stochastic reference point r , which takes two values, r_1 with probability q and r_2 with probability $(1 - q)$. Hence, the reference lottery is $r = (r_1, q; r_2, 1 - q)$. Denote by G the probability distribution of reference levels. Then using (2.3), expected utility of the lottery is given by the following:*

$$\begin{aligned} U(F|G) &= p[qu(c_1|r_1) + (1 - q)u(c_1|r_2)] \\ &\quad + (1 - p)[qu(c_2|r_1) + (1 - q)u(c_2|r_2)] \end{aligned} \quad (2.6)$$

⁴The properties of gain-loss utility correspond to the properties of the prospect theory value function.

The explanation of (2.6) is as follows. With probability p the realized outcome is c_1 . When c_1 is realized, the individual compares it with r_1 and r_2 separately and the derived utilities are weighted with probabilities q and $(1 - q)$, respectively. With probability $(1 - p)$ the realized outcome is c_2 and the pairwise comparisons with the reference outcomes are conducted in the similar manner. Substitution of (2.1) in (2.6) gives:

$$\begin{aligned} U(F|G) = & \{pm(c_1) + (1 - p)m(c_2)\} \\ & + \{p[qn(c_1|r_1) + (1 - q)n(c_1|r_2)] \\ & + (1 - p)[qn(c_2|r_1) + (1 - q)n(c_2|r_2)]\} \end{aligned} \quad (2.7)$$

The first term in (2.7) is expected consumption utility and the second term is expected gain-loss utility. Further substitution of (2.4) in (2.7) yields:

$$\begin{aligned} U(F|G) = & \{pm(c_1) + (1 - p)m(c_2)\} \\ & + \{p[q\mu(m(c_1) - m(r_1)) + (1 - q)\mu(m(c_1) - m(r_2))]\} \\ & + (1 - p)[q\mu(m(c_2) - m(r_1)) + (1 - q)\mu(m(c_2) - m(r_2))]\} \end{aligned} \quad (2.8)$$

In the model a reference point is fully determined by the expectations an individual held in the recent past. Kőszegi and Rabin (2006) assume that the stochastic reference point of an individual is her rational expectations about the possible outcomes. The expectations are rational if a person correctly predicts the set of outcomes and their probabilities. In *Example 2.1*, this implies that the reference lottery coincides with the consumption lottery $\mathcal{L} = (c_1, p; c_2, 1 - p)$ and hence, the equivalent of (2.6) can be written as follows:

$$\begin{aligned} U(F|F) = & p[pu(c_1|c_1) + (1 - p)u(c_1|c_2)] \\ & + (1 - p)[pu(c_2|c_1) + (1 - p)u(c_2|c_2)] \end{aligned} \quad (2.6')$$

The equivalent of (2.7) is the following:

$$\begin{aligned} U(F|F) = & \{pm(c_1) + (1 - p)m(c_2)\} \\ & + \{p[pn(c_1|c_1) + (1 - p)n(c_1|c_2)] \\ & + (1 - p)[pn(c_2|c_1) + (1 - p)n(c_2|c_2)]\} \end{aligned} \quad (2.7')$$

Observe that $n(c_1|c_1) = n(c_2|c_2) = 0$ because of the 2nd property of gain-loss utility

in (2.4). Taking this into account, the equivalent of (2.8) would be:

$$\begin{aligned}
 U(F|F) &= \{pm(c_1) + (1-p)m(c_2)\} & (2.8') \\
 &+ \{p(1-p)\mu(m(c_1) - m(c_2))\} \\
 &+ \{(1-p)p\mu(m(c_2) - m(c_1))\}
 \end{aligned}$$

(2.8') describes an individual's expected utility of the lottery with rational expectations as her reference point.

Having already described the preferences of an individual, next we consider decision making under uncertainty. To shed light on this issue, I review the main ideas of the follow-up paper by Kőszegi and Rabin (2007). In this paper the authors introduce three concepts of *personal equilibrium*. The concepts are defined depending on how far from the resolution of uncertainty a decision maker makes her decision.

We might find it useful to consider utility over wealth levels instead of consumption levels, i.e., equivalent of (2.1) would be $u(w|r) = m(w) + n(w|r)$, where w stands for the wealth level and r is the reference wealth.

First consider a scenario, where a decision maker correctly predicts the choice set but cannot make the committed choice until shortly before the resolution of uncertainty. Because the decision is made in a short time period, a reference point of the decision maker is a carrier of the past information and it is unchangeable. That is, the expectations are given to her and the choice she makes does not affect those expectations. Hence, the decision maker makes her optimal choice given the expectations. In this case the respective equilibrium concept is *unacclimating personal equilibrium* ($\mathcal{UP}\mathcal{E}$).

Suppose a decision maker is facing the compact choice set $D \subset \Delta(\mathbb{R})$. Each element of the choice set is a probability distribution over the wealth levels. Suppose a selection $F \in D$ is the choice made by the decision maker. Then the definition of $\mathcal{UP}\mathcal{E}$ follows:

Definition 2.1 *A selection $F \in D$ is an unacclimating personal equilibrium ($\mathcal{UP}\mathcal{E}$) if for any $F' \in D$, $U(F|F) \geq U(F'|F)$.*

Therefore, according to *Definition 2.1*, if a decision maker expects to choose F from the choice set D , she should indeed find it optimal to choose F . The optimality of meeting her expectations justifies the rationality of those expectations. At $\mathcal{UP}\mathcal{E}$ a decision maker does not maximize ex-ante expected utility among the available options as it is the case at *choice-acclimating personal equilibrium* ($\mathcal{CP}\mathcal{E}$),

that we define below. Rather, at $\mathcal{UP}\mathcal{E}$ a choice is optimal given expectations at the time of decision making.

To make the concept of $\mathcal{UP}\mathcal{E}$ clearer, consider the following example.

Example 2.2 A decision maker is facing the choice set $D = \{\mathcal{L} = (w - 50, \frac{1}{2}; w, \frac{1}{2}), \mathcal{I} = w - 25\}$. She can either choose the lottery of losing £50 from her current wealth with probability $\frac{1}{2}$ or buy an insurance for £25. Suppose the decision maker expects to buy the insurance. Hence, she has a deterministic reference point that is equal to $(w - 25)$. According to Definition 2.1, buying the insurance is an $\mathcal{UP}\mathcal{E}$ if $U(\mathcal{I}|\mathcal{I}) \geq U(\mathcal{L}|\mathcal{I})$. Then using (2.1), (2.3) and (2.4), we have:

$$\begin{aligned} U(\mathcal{I}|\mathcal{I}) &= m(w - 25) \geq U(\mathcal{L}|\mathcal{I}) & (2.9) \\ &= \frac{1}{2}[m(w - 50) + \mu(m(w - 50) - m(w - 25))] \\ &\quad + \frac{1}{2}[m(w) + \mu(m(w) - m(w - 25))] \end{aligned}$$

For simplicity assume $m(x) = x$. Then from (2.9) follows:

$$\begin{aligned} w - 25 &\geq \frac{1}{2}[w - 50 + \mu(-25)] + \frac{1}{2}[w + \mu(25)] & (2.10) \\ \implies &0 \geq \mu(-25) + \mu(25) \end{aligned}$$

that is true given the property of gain-loss utility $\mu(\cdot)$, that losses bite more than gains of the same magnitude.

If a decision maker has multiple self-fulfilling expectations, there might be multiple $\mathcal{UP}\mathcal{E}$ yielding different expected utilities. In this case, Kőszegi and Rabin (2007) assume that a decision maker chooses the $\mathcal{UP}\mathcal{E}$ with the highest expected utility. Such selection is defined as a *preferred personal equilibrium* ($\mathcal{PP}\mathcal{E}$).

Definition 2.2 A selection $F \in D$ is a *preferred personal equilibrium* ($\mathcal{PP}\mathcal{E}$) if it is an $\mathcal{UP}\mathcal{E}$ and $U(F|F) \geq U(F'|F')$ for all $\mathcal{UP}\mathcal{E}$ selections $F' \in D$.

Now consider a situation, where a decision maker makes her decision a long time before the resolution of uncertainty. In this case the committed decision is incorporated into the reference point. Therefore, the expectations relative to which outcomes are evaluated are influenced by the decision itself. The concept of *choice-acclimating personal equilibrium* ($\mathcal{CP}\mathcal{E}$) applies to this case.

Definition 2.3 A selection $F \in D$ is a *choice-acclimating personal equilibrium* ($\mathcal{CP}\mathcal{E}$) if $U(F|F) \geq U(F'|F')$ for all $F' \in D$.

Unlike to $\mathcal{UP}\mathcal{E}$, at $\mathcal{CP}\mathcal{E}$ a person makes her overall favorite choice. Returning to *Example 2.2*, buying the insurance is a $\mathcal{CP}\mathcal{E}$ if $U(\mathcal{I}|\mathcal{I}) \geq U(\mathcal{L}|\mathcal{L})$. That is:

$$\begin{aligned} U(\mathcal{I}|\mathcal{I}) &= u(w - 25|w - 25) \geq U(\mathcal{L}|\mathcal{L}) \\ &= \frac{1}{2} \left\{ \frac{1}{2}u(w - 50|w - 50) + \frac{1}{2}u(w - 50|w) \right\} \\ &\quad + \frac{1}{2} \left\{ \frac{1}{2}u(w|w - 50) + \frac{1}{2}u(w|w) \right\} \end{aligned} \quad (2.11)$$

Using (2.1), (2.4) and the property $\mu(0) = 0$, we get:

$$\begin{aligned} m(w - 25) &\geq \\ &\frac{1}{2} \left\{ \frac{1}{2}m(w - 50) + \frac{1}{2}[m(w - 50) + \mu(m(w - 50) - m(w))] \right\} \\ &\quad + \frac{1}{2} \left\{ \frac{1}{2}[m(w) + \mu(m(w) - m(w - 50))] + \frac{1}{2}m(w) \right\} \end{aligned} \quad (2.12)$$

Combining the terms in (2.12) gives:

$$\begin{aligned} m(w - 25) &\geq \left\{ \frac{1}{2}m(w - 50) + \frac{1}{2}m(w) \right\} \\ &\quad + \left\{ \frac{1}{4}\mu(m(w - 50) - m(w)) \right. \\ &\quad \left. + \frac{1}{4}\mu(m(w) - m(w - 50)) \right\} \end{aligned} \quad (2.13)$$

If we allow consumption utility to be linear, $m(x) = x$, then (2.13) is simplified to the following:

$$0 \geq \mu(-50) + \mu(50) \quad (2.14)$$

which holds for a loss averse individual.

3 The Model

This section describes a model of tax evasion decision of an individual with reference dependent preferences and endogenous reference point. The setup of the model follows the basic Allingham-Sandmo-Yitzhaki framework, enriched with the consideration of the psychological cost of evasion.

A taxpayer has exogenously given income level, W , not directly observable by the tax authority. Her declared income, D , is taxable at the proportional rate

t , such that $0 < t < 1$. The taxpayer complies with the law if she declares full income for taxation purposes, i.e., $D = W$, otherwise she evades some income, i.e., $0 \leq D < W$. The taxpayer is audited with exogenously given probability, $0 < p < 1$, and when audited, her actual income is discovered without an error. If the taxpayer is detected evading, she has to pay evaded taxes, $t[W - D]$, and a penalty that is proportional to the evaded taxes, $\lambda t[W - D]$, where $\lambda > 0$ is the penalty rate. Therefore, the disposable income of a non-audited taxpayer is given by the following:

$$Y_{NA} = W - tD \quad (3.1)$$

When a taxpayer is audited, her disposable income is:

$$Y_A = [1 - t]W - \lambda t[W - D] \quad (3.2)$$

I assume that a taxpayer is not left penniless in any possible circumstances, i.e., $1 - t - \lambda t > 0$.

If a taxpayer is audited and caught evading, she suffers from social stigma. A taxpayer has an individual-specific stigma rate, s , and the total stigma suffered is proportional to the concealed income, i.e., $s(W - D)$.⁵ There is a continuum of taxpayers who are identical in all respects apart from stigma, which has distribution function $F(s)$ and support $[0, S]$. An individual derives utility from the disposable income and disutility from being caught evading. A taxpayer has the following quasilinear consumption utility function:

$$v(Y_i, s) = u(Y_i) - d \times s(W - D) \quad (3.3)$$

where $i = A$ stands for audit outcome, $i = NA$ stands for non-audit outcome and $u(Y_i)$ is the utility derived from the disposable income. The utility function of the pecuniary outcome is assumed to be twice differentiable, strictly increasing and strictly concave, i.e., $u'(Y_i) > 0$ and $u''(Y_i) < 0$. d is the auditing dummy variable such that:

$$d = \begin{cases} 1 & \text{if } i = A \\ 0 & \text{if } i = NA \end{cases}$$

The reference-dependent preferences of a taxpayer is assumed to be of KR-type. The total utility derived from an outcome is given by the following form:

$$V(Y, s|R) = v(Y, s) + \mu(v(Y, s) - v(R, s)) \quad (3.4)$$

⁵The formulation of stigma is similar to the one used by Gordon (1989).

where $V(Y, s|R)$ is the utility derived from Y , given stigma and conditional on the reference point R . $v(Y, s)$ is consumption utility defined in (3.3). $\mu(x)$ is gain-loss utility, identical to (2.5), where $\theta > 1$ is the coefficient of loss aversion and $\eta > 0$ is the weight attached to gain-loss utility:

$$\mu(x) = \begin{cases} \eta x & \text{if } x \geq 0 \\ \eta\theta x & \text{if } x < 0 \end{cases} \quad (3.5)$$

I solve the model for the three equilibrium concepts of Kőszegi and Rabin (2007): $\mathcal{CP}\mathcal{E}$, $\mathcal{UP}\mathcal{E}$ and $\mathcal{PP}\mathcal{E}$. At first I consider a scenario where decisions are made sufficiently in advance of the realization of an outcome and a decision maker has enough time to get acclimatized to her decision. In this case, the relevant equilibrium concept is *choice-acclimating personal equilibrium* ($\mathcal{CP}\mathcal{E}$).⁶ Afterwards, I consider a scenario where a decision maker takes her decision too close to the resolution of uncertainty. In this case, the relevant equilibrium concept is *unacclimating personal equilibrium* ($\mathcal{UP}\mathcal{E}$).⁷ In case of multiple $\mathcal{UP}\mathcal{E}$, I use the concept of *preferred personal equilibrium* ($\mathcal{PP}\mathcal{E}$).⁸

4 Income Declaration as a $\mathcal{CP}\mathcal{E}$

Consider an environment, where a taxpayer makes a committed declaration decision sufficiently in advance of the realization of an audit outcome. Therefore, the taxpayer has enough time to get acclimatized to her decision. Then, she regards her choice as a reference point by the time of the audit outcome realization.

The choice set of a taxpayer is the interval $[0, W]$. Suppose she commits herself to declaring D from the choice set. Then her stochastic reference point, that is determined by the assumption of rational expectations, coincides with her choice and is given by the following:

$$R = \begin{cases} Y_{NA} & \text{with probability } (1 - p) \\ Y_A & \text{with probability } p \end{cases} \quad (4.1)$$

where Y_{NA} and Y_A are given in (3.1) and (3.2), respectively.

If a taxpayer declares full income, then her reference point is deterministic and equal to the legal after-tax income, $Y_L = (1 - t)W$. The deterministic reference point is a special case of the stochastic reference point.

⁶Definition 2.3

⁷Definition 2.1

⁸Definition 2.2

An individual evaluates her choice in the following manner. She expects the no-audit outcome, Y_{NA} , with probability $(1 - p)$. If the taxpayer is not audited, she derives consumption utility from the realized outcome and gain-loss utility. The latter is a consequence of pairwise comparison of consumption utility from the outcome with consumption utilities from individual reference levels of the stochastic reference point. A rational taxpayer expects an audit and the corresponding outcome, Y_A , with probability p . Respective consumption and gain-loss utilities are also derived for this case. That is, using (3.4) and (4.1), expected utility from the choice vector Y is given by the following:

$$\begin{aligned} V(Y, s|Y) = & (1 - p)\{v(Y_{NA}, s) + (1 - p)\mu(v(Y_{NA}, s) - v(Y_{NA}, s))\} \\ & + p\mu(v(Y_{NA}, s) - v(Y_A, s))\} + p\{v(Y_A, s) \\ & + (1 - p)\mu(v(Y_A, s) - v(Y_{NA}, s)) + p\mu(v(Y_A, s) - v(Y_A, s))\} \end{aligned} \quad (4.2)$$

Substitution of (3.3) into (4.2) yields:

$$\begin{aligned} V(Y, s|Y) = & (1 - p)\{u(Y_{NA}) + (1 - p)\mu(0) \\ & + p\mu(u(Y_{NA}) - u(Y_A) + s(W - D))\} \\ & + p\{u(Y_A) - s(W - D) \\ & + (1 - p)\mu(u(Y_A) - s(W - D) - u(Y_{NA})) + p\mu(0)\} \end{aligned} \quad (4.2')$$

Using gain-loss utility in (3.5), we get:

$$\begin{aligned} V(Y, s|Y) = & (1 - p)\{u(Y_{NA}) + p\eta[u(Y_{NA}) - u(Y_A) + s(W - D)]\} \\ & + p\{u(Y_A) - s(W - D) + (1 - p)\eta\theta[u(Y_A) - s(W - D) - u(Y_{NA})]\} \end{aligned} \quad (4.3)$$

Combining the terms in (4.3) gives:

$$\begin{aligned} V(Y, s|Y) = & [(1 - p) - p(1 - p)\eta(\theta - 1)] \times u(Y_{NA}) \\ & + [p + p(1 - p)\eta(\theta - 1)] \times [u(Y_A) - s(W - D)] \end{aligned} \quad (4.4)$$

Using *Definition 2.3*, a selection $D \in [0, W]$ is a $\mathcal{CP}\mathcal{E}$ if it is a maximizer of (4.4). Since $V(Y, s|Y)$ is a continuous function of D on the non-empty compact interval $[0, W]$, it attains a maximum at some $D^* \in [0, W]$. It turns out that a taxpayer's maximization problem under $\mathcal{CP}\mathcal{E}$ is similar to a RDU maximization problem. Unlike RDU, that uses a probability weighting function to derive decision weights for outcomes, from (4.4) we see that the decision weights under $\mathcal{CP}\mathcal{E}$

depend on the objective probability of an audit, p , the loss aversion parameter, θ , and the weight an individual attaches to gain-loss utility, η .⁹ The decision weights add up to 1, i.e.,

$$[(1-p) - p(1-p)\eta(\theta-1)] + [p + p(1-p)\eta(\theta-1)] = 1 \quad (4.5)$$

The emergence of decision weights in KR theory is totally due to the loss aversion parameter and the weight given to gain-loss utility. For instance, if an individual is not loss averse, i.e., $\theta = 1$, or she does not care about gains and losses, i.e., $\eta = 0$, then we are back to EU. Hence, KR theory implicitly specifies the source of decision weights and, unlike RDU, decision weights can be negative. From (4.4), for any $\theta > 1$ and $\eta > 0$, a decision weight given to the audit outcome is positive and bigger than the objective probability of an audit, i.e., $p + p(1-p)\eta(\theta-1) > p > 0$. A decision weight attached to the no-audit outcome can be non-positive. The following proposition considers a $\mathcal{CP}\mathcal{E}$ declaration of a taxpayer, giving a non-positive decision weight to the no-audit outcome.

Proposition 4.1 *Suppose $\eta \geq \frac{1}{p(\theta-1)}$, then the full income declaration, $D = W$, is the only $\mathcal{CP}\mathcal{E}$.*

Proof. If a taxpayer attaches sufficiently high weight to gain-loss utility, ultimately she assigns a non-positive decision weight to the no-audit outcome, i.e., $\eta \geq \frac{1}{p(\theta-1)} \iff [(1-p) - p(1-p)\eta(\theta-1)] \leq 0$. First suppose $\eta > \frac{1}{p(\theta-1)}$. Then, the maximization of (4.4) requires the minimization of $u(Y_{NA})$ and the maximization of $[u(Y_A) - s(W - D)]$. Using (3.1) and (3.2) and the property $u'(Y_i) > 0$, (4.4) attains its maximum at $D = W$. Next suppose $\eta = \frac{1}{p(\theta-1)}$. In this case, the maximization of (4.4) is equivalent to the maximization of $[u(Y_A) - s(W - D)]$, which occurs at $D = W$. Hence, when $\eta \geq \frac{1}{p(\theta-1)}$, the full income declaration is the only $\mathcal{CP}\mathcal{E}$. ■

Thus KR-theory can explain why some taxpayers never evade. It follows that, assigning a strictly positive decision weight to the no-audit outcome is a necessary condition for the emergence of tax evasion as a $\mathcal{CP}\mathcal{E}$. I consider this condition next. Suppose a taxpayer assigns a positive decision weight to the no-audit outcome, i.e., $0 < \eta < \frac{1}{p(\theta-1)}$. Because the decision weights add up to 1, it follows that $0 < [(1-p) - p(1-p)\eta(\theta-1)] < 1$ and $0 < [p + p(1-p)\eta(\theta-1)] < 1$. Hence, a decision

⁹In this respect, $\mathcal{CP}\mathcal{E}$ is similar to the disappointment aversion model of Delqu e and Cillo (2006), which also results in the rank-dependent representation of the preferences.

maker overweights the probability of an audit, p , and underweights the probability of no-audit occurrence, $(1 - p)$.¹⁰ Thus KR-theory, unlike RDU or PT, introduces probability weighting without recourse to probability weighting functions.

Proposition 4.2

- a) *At a regular interior optimum as a CPÉ, tax evasion is strictly decreasing in the penalty rate, λ , the stigma rate, s , and the probability of an audit, p .*
- b) *At an optimum on the boundary ($D^* = 0$ or $D^* = W$) as a CPÉ, tax evasion is non-increasing in the penalty rate, λ , the stigma rate, s , and the probability of an audit, p .*

Proof. Substituting (3.1) and (3.2) in (4.4) gives:

$$V(Y, s|Y) = [(1 - p) - p(1 - p)\eta(\theta - 1)] \times u(W - tD) \quad (4.4')$$

$$+ [p + p(1 - p)\eta(\theta - 1)] \times [u([1 - t]W - \lambda t[W - D]) - s(W - D)]$$

Differentiation of (4.4') results in the following:

$$\frac{\partial V}{\partial D} = -t[(1 - p) - p(1 - p)\eta(\theta - 1)] \times u'(Y_{NA}) \quad (4.6)$$

$$+ [p + p(1 - p)\eta(\theta - 1)][\lambda t \times u'(Y_A) + s]$$

$$\frac{\partial^2 V}{\partial D^2} = t^2[(1 - p) - p(1 - p)\eta(\theta - 1)] \times u''(Y_{NA}) \quad (4.7)$$

$$+ [p + p(1 - p)\eta(\theta - 1)](\lambda t)^2 \times u''(Y_A) < 0$$

$$\frac{\partial^2 V}{\partial D \partial \lambda} = [p + p(1 - p)\eta(\theta - 1)][t \times u'(Y_A) - \lambda t^2(W - D) \times u''(Y_A)] \quad (4.8)$$

$$\frac{\partial^2 V}{\partial D \partial s} = [p + p(1 - p)\eta(\theta - 1)] \quad (4.9)$$

$$\frac{\partial^2 V}{\partial D \partial p} = [1 + (1 - 2p)\eta(\theta - 1)][t \times u'(Y_{NA}) + \lambda t \times u'(Y_A) + s] \quad (4.10)$$

a) Let $D^* \in (0, W)$ be an interior maximum. Hence, at $D = D^*$, $\frac{\partial V}{\partial D} = 0$ and $\frac{\partial^2 V}{\partial D^2} \leq 0$. Given that $\frac{\partial^2 V}{\partial D^2} < 0$ throughout,¹¹ D^* is a regular point of $\frac{\partial V}{\partial D}$. The concavity of $u(\cdot)$ guarantees that $\frac{\partial^2 V}{\partial D \partial \lambda} > 0$ in (4.8). It is also obvious that $\frac{\partial^2 V}{\partial D \partial s} > 0$ in

¹⁰Overweighting low probabilities and underweighting high ones are also consistent with prospect theory.

¹¹ $u''(\cdot) < 0$ and the decision weights are positive, hence the expression in (4.7) has negative sign.

(4.9). Using our assumption $0 < \eta < \frac{1}{p(\theta-1)}$, it follows that $\frac{\partial^2 V}{\partial D \partial p} > 0$. Hence, applying the implicit function theorem, $D^*(t, s, \lambda, p, W)$ is continuously differentiable with: $\frac{\partial D^*}{\partial \lambda} = -\frac{\partial^2 V}{\partial D \partial \lambda} / \frac{\partial^2 V}{\partial D^2}$; $\frac{\partial D^*}{\partial s} = -\frac{\partial^2 V}{\partial D \partial s} / \frac{\partial^2 V}{\partial D^2}$ and $\frac{\partial D^*}{\partial p} = -\frac{\partial^2 V}{\partial D \partial p} / \frac{\partial^2 V}{\partial D^2}$. The signs of $\frac{\partial D^*}{\partial \lambda}$; $\frac{\partial D^*}{\partial s}$ and $\frac{\partial D^*}{\partial p}$ are the same as the signs of $\frac{\partial^2 V}{\partial D \partial \lambda}$, $\frac{\partial^2 V}{\partial D \partial s}$ and $\frac{\partial^2 V}{\partial D \partial p}$, respectively. Hence, $\frac{\partial D^*}{\partial \lambda} > 0$; $\frac{\partial D^*}{\partial s} > 0$ and $\frac{\partial D^*}{\partial p} > 0$.

b) If $D^* = 0$, then, clearly D^* is non-decreasing. When $D^* = W$, then at $D = D^*$, $\frac{\partial V}{\partial D} \geq 0$. From (4.8), (4.9) and (4.10) we see that $\frac{\partial V}{\partial D}$ is strictly increasing function of λ , s and p , respectively. So, an increase in λ , s or p will make $\frac{\partial V}{\partial D}$ strictly positive, implying that reduction in D will reduce utility. Hence, D^* is non-decreasing in either λ , s or p . ■

The result that the penalty rate and the probability of an audit have deterrent effects on evasion is in accordance with evidence and intuition. An increase in the stigma rate makes a taxpayer more tax compliant, other things being equal, that is also in line with intuition. EU generates qualitatively similar results (see, e.g., Dhimi and al-Nowaihi, 2007) and therefore, $\mathcal{CP}\mathcal{E}$ performs as well as EU in this respect. Quantitatively, the evasion level at an interior optimum under $\mathcal{CP}\mathcal{E}$ is lower than the evasion level at an interior optimum under EU.¹²

Proposition 4.3 *Assuming declining absolute risk aversion (DARA) utility function $u(\cdot)$, at a regular interior optimum:*

1. *tax evasion is strictly decreasing in the tax rate, t , if the stigma rate is zero, i.e., $s = 0$,*
2. *there exists some $s = \bar{s}$, such that tax evasion is increasing in the tax rate for $\forall s > \bar{s}$ and decreasing in the tax rate for $\forall s < \bar{s}$.*

Proof.

1. Let $[(1-p) - p(1-p)\eta(\theta-1)] = 1-q$ and $[p + p(1-p)\eta(\theta-1)] = q$. Then we can rewrite (4.6) in the following form:

$$\frac{\partial V}{\partial D} = -t(1-q) \times u'(Y_{NA}) + q[\lambda t \times u'(Y_A) + s] \quad (4.6')$$

¹²The result follows from the first order condition, $\frac{\partial V}{\partial D} = 0$. Using (4.6), an interior optimum under $\mathcal{CP}\mathcal{E}$ is found as a solution of the following equation: $\frac{\lambda t \times u'(Y_A) + s}{u'(Y_{NA})} = \frac{t[(1-p) - p(1-p)\eta(\theta-1)]}{[p + p(1-p)\eta(\theta-1)]}$. Solving the equation for $\eta = 0$ gives an interior optimum under EU. For $\eta > 0$, the right hand-side of the equation is smaller than for $\eta = 0$. Then using concavity of $u(\cdot)$, the interior declaration for $\eta > 0$ is higher than the interior declaration for $\eta = 0$.

A taxpayer evades some income if $\frac{\partial V}{\partial D}|_{D=W} < 0$, otherwise she declares full income. Using (4.6'), the following is a necessary condition for evasion:

$$\begin{aligned}\frac{\partial V}{\partial D}|_{D=W} &= -t(1-q) \times u'(Y_L) + q[\lambda t \times u'(Y_L) + s] < 0 \quad (4.11) \\ \Rightarrow s &< \frac{tu'(Y_L)}{q}(1-q-\lambda q)\end{aligned}$$

where $Y_L = (1-t)W$ is the legal after-tax income. Let $\frac{tu'(Y_L)}{q}(1-q-\lambda q) = \kappa$. Note that, if the evasion gamble is perceived unfair, i.e., $1-q-\lambda q \leq 0$, then nobody evades. Given that a taxpayer overweights the probability of an audit, i.e., $q > p$, it might be the case that the evasion gamble is actuarially fair, i.e., $1-p-\lambda p > 0$, but the taxpayer perceives it as unfair. If $1-q-\lambda q > 0$, taxpayers with $s < \kappa$ evade some income and those with $s \geq \kappa$ do not evade. Suppose $1-q-\lambda q > 0$ and thus, $\kappa > 0$. Differentiation of (4.6') with respect to the tax rate, t , gives:

$$\begin{aligned}\frac{\partial^2 V}{\partial D \partial t} &= -(1-q) \left\{ u'(Y_{NA}) - tD \times u''(Y_{NA}) \right\} \quad (4.12) \\ &\quad + \lambda q \left\{ u'(Y_A) - t[W + \lambda(W-D)] \times u''(Y_A) \right\}\end{aligned}$$

Let $A(Y) = -\frac{u''(Y)}{u'(Y)}$ be the coefficient of absolute risk aversion. Then from (4.12) we get:

$$\begin{aligned}\frac{\partial^2 V}{\partial D \partial t} &= -(1-q) \times u'(Y_{NA}) \{1 + tD \times A(Y_{NA})\} \quad (4.13) \\ &\quad + \lambda q \times u'(Y_A) \{1 + t[W + \lambda(W-D)] \times A(Y_A)\}\end{aligned}$$

At an interior optimum $\frac{\partial V}{\partial D} = 0$. Hence, using (4.6') we have:

$$(1-q) \times u'(Y_{NA}) = q \left[\lambda \times u'(Y_A) + \frac{s}{t} \right] \quad (4.14)$$

Substitution of (4.14) into (4.13) yields:

$$\begin{aligned}\frac{\partial^2 V}{\partial D \partial t} &= -q \left[\lambda \times u'(Y_A) + \frac{s}{t} \right] \{1 + tD \times A(Y_{NA})\} \quad (4.15) \\ &\quad + \lambda q \times u'(Y_A) \{1 + t[W + \lambda(W-D)] \times A(Y_A)\}\end{aligned}$$

Rearranging the terms in (4.15) results in the following:

$$\begin{aligned} \frac{\partial^2 V}{\partial D \partial t} = & \underbrace{\lambda q t \{ [W + \lambda(W - D)] A(Y_A) - D \times A(Y_{NA}) \}}_I u'(Y_A) \\ & - q \times \underbrace{\frac{s}{t} [1 + tD \times A(Y_{NA})]}_{II} \end{aligned} \quad (4.16)$$

Because of \mathcal{DARA} , $A(Y_{NA}) < A(Y_A)$ and hence term I in (4.16) has a positive sign for any $0 < D < W$. For $s = 0$, term II is zero and therefore $\frac{\partial^2 V}{\partial D \partial t} > 0$. Using the implicit function theorem, $D^*(t, s, \lambda, p, W)$ is continuously differentiable with: $\frac{\partial D^*}{\partial t} = -\frac{\partial^2 V}{\partial D \partial t} / \frac{\partial^2 V}{\partial D^2}$. Given that $\frac{\partial^2 V}{\partial D^2} < 0$ at the interior maximum and $\frac{\partial^2 V}{\partial D \partial t} > 0$, it follows that $\frac{\partial D^*}{\partial t} > 0$, proving the first part of the proposition.

2. Now consider s_1 and s_2 , such that $\kappa > s_1 > s_2$ and examine how $\frac{\partial^2 V}{\partial D \partial t}$ changes when stigma increases from s_2 to s_1 . *Proposition 4.2(a)* suggests that taxpayers with high stigma rate evade less at interior optima, i.e., $\frac{\partial D^*}{\partial s} > 0$. Therefore, $s_1 > s_2 \implies D^*(s_1) > D^*(s_2)$. Using (3.1) and (3.2), it follows that $Y_{NA}(s_1) < Y_{NA}(s_2)$ and $Y_A(s_1) > Y_A(s_2)$. \mathcal{DARA} entails $A(Y_{NA}(s_1)) > A(Y_{NA}(s_2))$ and $A(Y_A(s_1)) < A(Y_A(s_2))$. Concavity of the utility function, $u(\cdot)$, implies $u'(Y_A(s_1)) < u'(Y_A(s_2))$. Then using (4.16), we have $\frac{\partial^2 V}{\partial D \partial t} \Big|_{s=s_1} < \frac{\partial^2 V}{\partial D \partial t} \Big|_{s=s_2}$. Since this is true for any s_1 and s_2 , such that $\kappa > s_1 > s_2$, we conclude that $\frac{\partial^2 V}{\partial D \partial t}$ decreases monotonically in s for all $s < \kappa$. Note that $\frac{\partial^2 V}{\partial D \partial t} \Big|_{s=0} > 0$ and $\frac{\partial^2 V}{\partial D \partial t} \Big|_{s=\kappa-\epsilon} < 0$ for $\epsilon \rightarrow 0$ (Because $D^* \rightarrow W$, term I goes to zero in (4.16) and term II is positive). Therefore, there exists some $\kappa > \bar{s} > 0$ such that $\frac{\partial^2 V}{\partial D \partial t} \Big|_{s=\bar{s}} = 0$. Then using the implicit function theorem, the proposition follows directly.

■

Proposition 4.3 suggests that, at an interior optimum an increase in the tax rate has two opposing effects on evasion. On the one hand, it reduces the disposable income of a taxpayer that makes her reduce the size of the evasion gamble under \mathcal{DARA} . In this case, an increase in the tax rate has a negative income effect on evasion, which is captured by term I in (4.16). On the other hand, the tax rate increase makes the psychological cost of evasion relatively small and this effect tends to increase evasion. In this case, an increase in the tax rate has a positive substitution effect on evasion, captured by term II in (4.16). For the low enough stigma rate, i.e., $0 \leq s < \bar{s}$, the income effect dominates and an increase in the tax rate reduces evasion. For the high enough stigma rate, i.e., $s > \bar{s}$, the

substitution effect dominates and an increase in the tax rate increases evasion. The intuition is that, relatively low stigma rate entails relatively high evasion at an interior optimum (*Proposition 4.2(a)*) and retaining evasion at the original level is more costly under the increased tax rate. Hence, a taxpayer with relatively low stigma rate reduces evasion in response to the tax rate increase. A taxpayer with high enough stigma rate conceals relatively small proportion of her income at an interior optimum. An increase in the tax rate makes the psychological cost of evasion relatively low that facilitates evasion.

Differentiation of $\kappa = \frac{tu'(Y_L)}{q}(1 - q - \lambda q)$ with respect to the tax rate, t , yields

$$\frac{\partial \kappa}{\partial t} = \frac{1 - q - \lambda q}{q} \{u'(Y_L) - tWu''(Y_L)\},$$

which is positive, implying that an increase in the tax rate reduces the share of honest taxpayers with $s \geq \kappa$. In light of the distribution of stigma rates, $F(s)$, the overall effect of the tax rate increase on aggregate evasion is ambiguous - even though the tax rate increase reduces the share of honest taxpayers, at interior optima some taxpayers with relatively low stigma rates reduce evasion and others evade more. It is worthwhile to note that the application of EU to the tax evasion problem gives qualitatively similar results in the presence of psychological cost of evasion (see e.g., Gordon, 1989). Like EU, the application of $\mathcal{CP}\mathcal{E}$ to the original Allingham-Sandmo-Yitzhaki model without psychological cost of evasion generates the Yitzhaki puzzle (*Proposition 4.3(1)*). Hence, we can conclude that KR theory, specifically the concept of $\mathcal{CP}\mathcal{E}$, does not perform better than EU in explaining the compliance-tax rate relation.

5 Income Declaration as an $\mathcal{UP}\mathcal{E}$

In this section I consider a scenario, in which a taxpayer makes her decision too close to the resolution of uncertainty. Then her reference point is a carrier of the past information and the decision cannot change it. Suppose a taxpayer expects to declare some income. Taking these expectations as her reference point, she actually finds it optimal to declare her expected choice. The equilibrium concept, defined as $\mathcal{UP}\mathcal{E}$ (*Definition 2.1*) is applicable to this scenario.

Firstly, I consider the case where a taxpayer expects to evade some but not all income. Next, I turn to the case of full income declaration and lastly, I consider the case of full income evasion.

Suppose a taxpayer expects to evade some but not all income and let $D_e \in$

$(0, W)$ be the taxpayer's expected declaration amount. The following proposition identifies the set of interior selections that can be implemented as an $\mathcal{UP}\mathcal{E}$.

Proposition 5.1 *The expected interior selection $D_e \in (0, W)$ constitutes an $\mathcal{UP}\mathcal{E}$ if it belongs to the range $[D_{EU}, \bar{D}]$, where D_{EU} is the EU maximizing interior optimum and \bar{D} solves for the condition $\frac{p[\lambda t u'(Y_A) + s]}{[1-p]t u'(Y_{NA})} = \frac{1+\eta}{1+\eta\theta}$.*

Proof. The stochastic reference point, induced by D_e , is:

$$R_e = \begin{cases} Y_{NA}^e & \text{with probability } (1-p) \\ Y_A^e & \text{with probability } p \end{cases}, \quad (5.1)$$

where, $Y_{NA}^e = W - tD_e$ and $Y_A^e = [1-t]W - \lambda t[W - D_e]$. Then, using (3.4), expected utility from the choice vector Y is given by the following:

$$\begin{aligned} V(Y, s|R_e) &= (1-p)\{v(Y_{NA}, s) + (1-p)\mu(v(Y_{NA}, s) - v(Y_{NA}^e, s))\} \\ &\quad + p\mu(v(Y_{NA}, s) - v(Y_A^e, s))\} + p\{v(Y_A, s) \\ &\quad + (1-p)\mu(v(Y_A, s) - v(Y_{NA}^e, s)) + p\mu(v(Y_A, s) - v(Y_A^e, s))\} \end{aligned} \quad (5.2)$$

Let $V(Y, s|R_e) = V_1$ for $D \leq D_e$ and $V(Y, s|R_e) = V_2$ for $D \geq D_e$. Firstly consider the case where $D \leq D_e$. Therefore, from (3.1) and (3.2), we have $Y_{NA} \geq Y_{NA}^e$ and $Y_A \leq Y_A^e$. Then, using (3.3) and (3.5) in (5.2), we get:

$$\begin{aligned} V_1 &= (1-p)\{u(Y_{NA}) + \eta(1-p)[u(Y_{NA}) - u(Y_{NA}^e)]\} \\ &\quad + \eta p[u(Y_{NA}) - (u(Y_A^e) - s(W - D_e))]\} + p\{u(Y_A) - s(W - D) \\ &\quad + \eta\theta(1-p)[u(Y_A) - s(W - D) - u(Y_{NA}^e)] \\ &\quad + \eta\theta p[u(Y_A) - s(W - D) - (u(Y_A^e) - s(W - D_e))]\} \end{aligned} \quad (5.3)$$

Combining the terms in (5.3) gives:

$$\begin{aligned} V_1 &= [1-p][1+\eta] \times u(Y_{NA}) \\ &\quad + p[1+\eta\theta] \times [u(Y_A) - s(W - D)] \\ &\quad - [\eta(1-p) + \eta\theta p] \{(1-p)u(Y_{NA}^e) + p[u(Y_A^e) - s(W - D_e)]\} \end{aligned} \quad (5.4)$$

In the case where $D \geq D_e$, we have $Y_{NA} \leq Y_{NA}^e$ and $Y_A \geq Y_A^e$. Then, using (3.3)

and (3.5) in (5.2), we get:

$$\begin{aligned}
V_2 &= (1-p)\{u(Y_{NA}) + \eta\theta(1-p)[u(Y_{NA}) - u(Y_{NA}^e)]\} \\
&+ \eta p[u(Y_{NA}) - (u(Y_A^e) - s(W - D_e))] + p\{u(Y_A) - s(W - D) \\
&\quad + \eta\theta(1-p)[u(Y_A) - s(W - D) - u(Y_{NA}^e)]\} \\
&+ \eta p[u(Y_A) - s(W - D) - (u(Y_A^e) - s(W - D_e))]
\end{aligned} \tag{5.5}$$

Combining the terms in (5.5) results in:

$$\begin{aligned}
V_2 &= [1-p][1 + \eta\theta(1-p) + \eta p] \times u(Y_{NA}) \\
&+ p[1 + \eta\theta(1-p) + \eta p] \times [u(Y_A) - s(W - D)] \\
&- \{\eta\theta(1-p)u(Y_{NA}^e) + \eta p[u(Y_A^e) - s(W - D_e)]\}
\end{aligned} \tag{5.6}$$

The expected interior selection $D_e \in (0, W)$ constitutes an $\mathcal{UP}\mathcal{E}$, if it is actually optimal to declare D_e given the expectation as a reference point. Therefore, D_e is an $\mathcal{UP}\mathcal{E}$ if the objective function in (5.2) attains its maximum at $D = D_e$. Because the objective function is not continuously differentiable at that point, D_e is an $\mathcal{UP}\mathcal{E}$ if and only if $\frac{\partial V_1}{\partial D}|_{D=D_e} \geq 0$ and $\frac{\partial V_2}{\partial D}|_{D=D_e} \leq 0$. Differentiation of the expression in (5.4), using (3.1) and (3.2), and evaluation of the differential at the point $D = D_e$ result in:

$$\frac{\partial V_1}{\partial D}|_{D=D_e} = [1-p][1 + \eta](-t)u'(Y_{NA}^e) + p[1 + \eta\theta][\lambda t u'(Y_A^e) + s] \tag{5.7}$$

Similarly, evaluating the differential of the expression in (5.6) at the point $D = D_e$ gives:

$$\begin{aligned}
\frac{\partial V_2}{\partial D}|_{D=D_e} &= [1-p][1 + \eta\theta(1-p) + \eta p](-t)u'(Y_{NA}^e) \\
&+ p[1 + \eta\theta(1-p) + \eta p][\lambda t u'(Y_A^e) + s]
\end{aligned} \tag{5.8}$$

Using (5.7) and (5.8), the conditions $\frac{\partial V_1}{\partial D}|_{D=D_e} \geq 0$ and $\frac{\partial V_2}{\partial D}|_{D=D_e} \leq 0$ are equivalent to the following:

$$\frac{[1-p][1 + \eta]}{p[1 + \eta\theta]} \leq \frac{\lambda t u'(Y_A^e) + s}{t u'(Y_{NA}^e)} \leq \frac{1-p}{p} \tag{5.9}$$

Rewriting (5.9), $D_e \in (0, W)$ constitutes an $\mathcal{UP}\mathcal{E}$ if and only if the following holds:

$$\frac{1 + \eta}{1 + \eta\theta} \leq \frac{p[\lambda t u'(Y_A^e) + s]}{[1-p]t u'(Y_{NA}^e)} \leq 1 \tag{5.10}$$

Note that $\frac{p[\lambda tu'(Y_A^e)+s]}{[1-p]tu'(Y_{NA}^e)} = 1$ solves for the interior optimum $D_e = D_{EU}$, when a taxpayer complies with EU and maximizes the following objective function:

$$U = (1-p)u(Y_{NA}) + p[u(Y_A) - s(W-D)] \quad (5.11)$$

Hence, $D_e = D_{EU}$ is an $\mathcal{UP}\mathcal{E}$. Observing that $\frac{p[\lambda tu'(Y_A^e)+s]}{[1-p]tu'(Y_{NA}^e)}$ is strictly decreasing in D_e , the lowest possible declaration under $\mathcal{UP}\mathcal{E}$ occurs at $D_e = D_{EU}$. From (5.10) it is also obvious that $\frac{p[\lambda tu'(Y_A^e)+s]}{[1-p]tu'(Y_{NA}^e)} = \frac{1+\eta}{1+\eta\theta}$ solves for the highest possible declaration amount, $D_e = \bar{D}$, under $\mathcal{UP}\mathcal{E}$. The condition in (5.10) is also met $\forall D_e \in (D_{EU}, \bar{D})$. Therefore, the expected interior selection $D_e \in (0, W)$ constitutes an $\mathcal{UP}\mathcal{E}$ if it belongs to the range $[D_{EU}, \bar{D}]$, where D_{EU} is the EU maximizing interior optimum and \bar{D} solves for the condition $\frac{p[\lambda tu'(Y_A)+s]}{[1-p]tu'(Y_{NA})} = \frac{1+\eta}{1+\eta\theta}$. ■

Proposition 5.1 identifies the continuum of interior selections under $\mathcal{UP}\mathcal{E}$. The closed set of the equilibria is bounded below by the interior optimum under classical expected utility theory. Therefore, EU outcome also constitutes an $\mathcal{UP}\mathcal{E}$. The natural question to ask is whether an interior selection under $\mathcal{CP}\mathcal{E}$ belongs to the $\mathcal{UP}\mathcal{E}$ set. The following proposition addresses to this question.

Proposition 5.2 *Interior optimum under $\mathcal{CP}\mathcal{E}$ does not constitute an $\mathcal{UP}\mathcal{E}$. The $\mathcal{CP}\mathcal{E}$ declaration amount is greater than the upper bound, \bar{D} , of the $\mathcal{UP}\mathcal{E}$ set.*

Proof. Using (4.6), the interior declaration amount, $D_{\mathcal{CP}\mathcal{E}}$, under $\mathcal{CP}\mathcal{E}$ satisfies the following first order condition:

$$\begin{aligned} & -t[(1-p) - p(1-p)\eta(\theta-1)] \times u'(Y_{NA}) \\ & + [p + p(1-p)\eta(\theta-1)][\lambda t \times u'(Y_A) + s] = 0 \end{aligned} \quad (5.12)$$

From (5.12), we get:

$$\frac{\lambda tu'(Y_A) + s}{tu'(Y_{NA})} = \frac{(1-p) - p(1-p)\eta(\theta-1)}{p + p(1-p)\eta(\theta-1)} \quad (5.13)$$

Suppose the $\mathcal{CP}\mathcal{E}$ selection belongs to the $\mathcal{UP}\mathcal{E}$ set, i.e., $D_{\mathcal{CP}\mathcal{E}} \in [D_{EU}, \bar{D}]$. Then the condition in (5.10) must be met for $D_{\mathcal{CP}\mathcal{E}}$. Using (5.13) in (5.10), $D_{\mathcal{CP}\mathcal{E}}$ is in the $\mathcal{UP}\mathcal{E}$ set if the following holds:

$$\frac{1+\eta}{1+\eta\theta} \leq \frac{p[(1-p) - p(1-p)\eta(\theta-1)]}{[1-p][p + p(1-p)\eta(\theta-1)]} \leq 1 \quad (5.14)$$

Simplification of (5.14) yields:

$$\frac{1 + \eta}{1 + \eta\theta} \leq \frac{1 - p\eta(\theta - 1)}{1 + (1 - p)\eta(\theta - 1)} \leq 1 \quad (5.15)$$

From (5.15), it is obvious that $\frac{1 - p\eta(\theta - 1)}{1 + (1 - p)\eta(\theta - 1)} < 1$, asserting the result of Section 4 that the income declaration level at the interior optimum under $\mathcal{CP}\mathcal{E}$ is higher than the declaration level at the interior optimum under EU, i.e., $D_{\mathcal{CP}\mathcal{E}} > D_{EU}$. Straightforward calculations show that $\frac{1 - p\eta(\theta - 1)}{1 + (1 - p)\eta(\theta - 1)} < \frac{1 + \eta}{1 + \eta\theta}$, violating the $\mathcal{UP}\mathcal{E}$ condition in (5.15) and implying that $D_{\mathcal{CP}\mathcal{E}} > \bar{D}$. Therefore, the $\mathcal{CP}\mathcal{E}$ declaration level is greater than the upper bound, \bar{D} , of the $\mathcal{UP}\mathcal{E}$ set. ■

Having already identified the interior $\mathcal{UP}\mathcal{E}$ set, we can now investigate which $\mathcal{UP}\mathcal{E}$ declaration is selected by a taxpayer at the equilibrium. In this case, the taxpayer chooses the $\mathcal{UP}\mathcal{E}$ with the highest expected utility and such selection is defined as a $\mathcal{PP}\mathcal{E}$ (*Definition 2.2*).

It is obvious from *Definition 2.2* and *Definition 2.3* that expected utility from each $\mathcal{UP}\mathcal{E}$ selection belongs to the expected utility frontier under $\mathcal{CP}\mathcal{E}$. Because the interior $\mathcal{CP}\mathcal{E}$ declaration, $D_{\mathcal{CP}\mathcal{E}}$, is greater than the upper bound of the $\mathcal{UP}\mathcal{E}$ set, \bar{D} , we can conclude that \bar{D} is a $\mathcal{PP}\mathcal{E}$. *Figure 1* graphically illustrates the case. X -axis of the figure represents a taxpayer's choice set, $D \in [0, W]$ and Y -axis depicts expected utility from a choice with the choice as a reference point. For instance, expected utility from declaring zero income, when a taxpayer expects to declare it, is given by $V(Y_0, s|Y_0)$. The expected utility frontier under $\mathcal{CP}\mathcal{E}$ achieves its maximum at $D = D_{\mathcal{CP}\mathcal{E}}$. All the $\mathcal{UP}\mathcal{E}$ selections, $D \in [D_{EU}, \bar{D}]$, are located to the left of this point, as suggested by *Proposition 5.2*. From the figure we see that for $D \in [D_{EU}, \bar{D}]$, expected utility is maximized at $D = \bar{D}$. Therefore the upper bound of the interior $\mathcal{UP}\mathcal{E}$ set constitutes a $\mathcal{PP}\mathcal{E}$.

Proposition 5.3 *At a regular interior optimum as a $\mathcal{PP}\mathcal{E}$, tax evasion is strictly decreasing in the penalty rate, λ , the stigma rate, s , and the probability of an audit, p .*

Proof. Let us define the function $\bar{V}(D)$ as follows:

$$\bar{V}(D) = \frac{1 + \eta}{1 + \eta\theta} (1 - p) \times u(Y_{NA}) + p[u(Y_A) - s(W - D)] \quad (5.16)$$

Then the interior $\mathcal{PP}\mathcal{E}$ selection, \bar{D} , constitutes an interior maximum for $\bar{V}(D)$

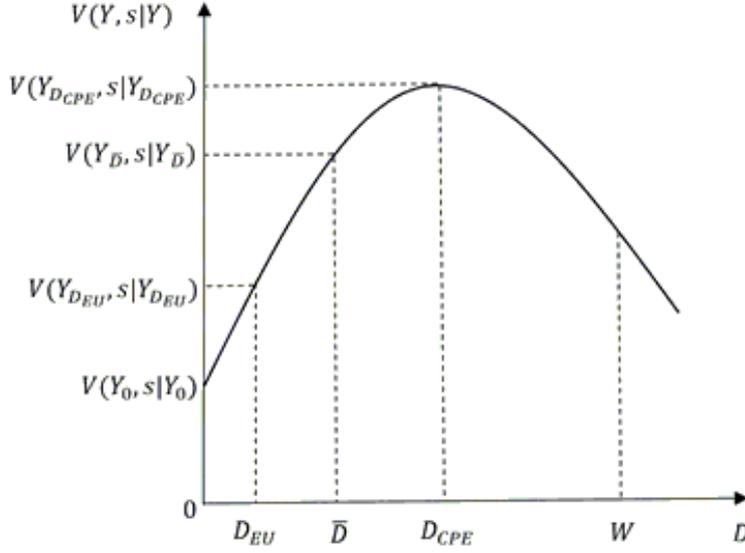


Figure 1: UPE and CPE comparison

and solves the following first order condition:

$$\frac{\partial \bar{V}(D)}{\partial D} = -t \frac{1 + \eta}{1 + \eta\theta} (1 - p) \times u'(Y_{NA}) + p[\lambda t \times u'(Y_A) + s] = 0 \quad (5.17)$$

It is worthwhile to note that the maximization problem in (5.16) is similar to the maximization problem under $\mathcal{CP}\mathcal{E}$ in (4.4). Therefore the results are expected to be qualitatively similar under $\mathcal{PP}\mathcal{E}$ and $\mathcal{CP}\mathcal{E}$. Differentiation of (5.17) yields the following:

$$\frac{\partial^2 \bar{V}(D)}{\partial D^2} = t^2 \frac{1 + \eta}{1 + \eta\theta} (1 - p) \times u''(Y_{NA}) + p(\lambda t)^2 \times u''(Y_A) < 0 \quad (5.18)$$

$$\frac{\partial^2 \bar{V}(D)}{\partial D \partial \lambda} = p[t \times u'(Y_A) - \lambda t^2(W - D) \times u''(Y_A)] > 0 \quad (5.19)$$

$$\frac{\partial^2 \bar{V}(D)}{\partial D \partial s} = p > 0 \quad (5.20)$$

$$\frac{\partial^2 \bar{V}(D)}{\partial D \partial p} = t \frac{1 + \eta}{1 + \eta\theta} u'(Y_{NA}) + \lambda t \times u'(Y_A) + s > 0 \quad (5.21)$$

Note that $\frac{\partial^2 \bar{V}(D)}{\partial D^2} < 0$ and hence, $D = \bar{D}$ is a regular interior maximum of $\bar{V}(D)$. Using implicit function theorem, $\bar{D}(t, s, \lambda, p, W)$ is continuously differentiable with: $\frac{\partial \bar{D}}{\partial \lambda} = -\frac{\partial^2 \bar{V}}{\partial D \partial \lambda} / \frac{\partial^2 \bar{V}}{\partial D^2}$; $\frac{\partial \bar{D}}{\partial s} = -\frac{\partial^2 \bar{V}}{\partial D \partial s} / \frac{\partial^2 \bar{V}}{\partial D^2}$ and $\frac{\partial \bar{D}}{\partial p} = -\frac{\partial^2 \bar{V}}{\partial D \partial p} / \frac{\partial^2 \bar{V}}{\partial D^2}$. The signs of $\frac{\partial \bar{D}}{\partial \lambda}$; $\frac{\partial \bar{D}}{\partial s}$ and $\frac{\partial \bar{D}}{\partial p}$ are the same as the signs of $\frac{\partial^2 \bar{V}}{\partial D \partial \lambda}$, $\frac{\partial^2 \bar{V}}{\partial D \partial s}$ and $\frac{\partial^2 \bar{V}}{\partial D \partial p}$, respectively. Hence, $\frac{\partial \bar{D}}{\partial \lambda} > 0$; $\frac{\partial \bar{D}}{\partial s} > 0$ and $\frac{\partial \bar{D}}{\partial p} > 0$. ■

Proposition 5.3 suggests that the penalty rate, λ , the probability of an audit, p , and the stigma rate, s , have deterrent effects on evasion at the interior \mathcal{PPE} . The results are qualitatively similar under \mathcal{CPE} (*Proposition 4.2(a)*) and EU. The latter is obvious from the proof of *Proposition 5.3*, as we set $\eta = 0$. Quantitatively, as already noted, the evasion level at the interior \mathcal{CPE} is lower than the evasion level at the interior \mathcal{PPE} . Compared to the interior \mathcal{CPE} and \mathcal{PPE} , the evasion level is highest at the interior optimum under EU.

Proposition 5.4 *Assuming declining absolute risk aversion (DARA) utility function $u(\cdot)$, at a regular interior optimum as a \mathcal{PPE} :*

1. *tax evasion is strictly decreasing in the tax rate, t , if the stigma rate is zero, i.e., $s = 0$,*
2. *there exists some $s = \tilde{s}$, such that tax evasion is increasing in the tax rate for $\forall s > \tilde{s}$ and decreasing in the tax rate for $\forall s < \tilde{s}$.*

The formal proof is omitted, since it replicates the steps and goes in line with the proof of *Proposition 4.3*. Like the results under \mathcal{CPE} (*Proposition 4.3*) and EU (Gordon, 1989), at the interior \mathcal{PPE} taxpayers with low enough stigma rate, $s < \tilde{s}$, reduce evasion in response to the tax rate increase and taxpayers with high enough stigma rate, $s > \tilde{s}$, evade more when the tax rate goes up.

Now we turn to the characterization of the cases, in which the full income declaration and the full income evasion constitute an \mathcal{UPPE} . First consider the case of the full income declaration, i.e., $D_e = W$. In this case $D \leq D_e$ for any declaration decision and hence (5.4) and (5.7) apply. $D_e = W$ is an \mathcal{UPPE} if and only if $\frac{\partial V_1}{\partial D}|_{D=W} \geq 0$. Using (5.7), we get:

$$\frac{\partial V_1}{\partial D}|_{D=W} = [1 - p][1 + \eta](-t)u'(Y_L) + p[1 + \eta\theta][\lambda tu'(Y_L) + s] \geq 0 \quad (5.22)$$

where $Y_L = (1 - t)W$ is the legal after-tax income. From (5.22) follows:

$$\frac{\partial V_1}{\partial D}|_{D=W} \geq 0 \iff s \geq t \left[\frac{(1 + \eta)(1 - p)}{p(1 + \eta\theta)} - \lambda \right] \times u'(Y_L) \quad (5.23)$$

Let $\bar{s}_c = t \left[\frac{(1 + \eta)(1 - p)}{p(1 + \eta\theta)} - \lambda \right] \times u'(Y_L)$ be the critical stigma rate. Hence, the full income declaration is an $\mathcal{UPPE} \forall s \geq \bar{s}_c$. Note that $\frac{\partial \bar{s}_c}{\partial \eta} < 0$ and $\lim_{\eta \rightarrow \infty} \frac{(1 + \eta)(1 - p)}{p(1 + \eta\theta)} = \frac{1 - p}{p\theta}$. Thus, when η is infinitely large, the sign of \bar{s}_c depends on the difference $\left\{ \frac{1 - p}{p\theta} - \lambda \right\}$. For the empirically plausible values of λ , p and θ , this difference is positive and

hence, $\bar{s}_c > 0$ when $\eta \rightarrow \infty$.¹³ Because \bar{s}_c is decreasing in η , we get that $\bar{s}_c > 0$ for any $\eta > 0$. Note that the respective critical stigma under EU can be found by setting $\eta = 0$. As a result, the critical stigma rate under EU, is higher than the critical stigma rate under $\mathcal{UP}\mathcal{E}$. It is straightforward to show that $\frac{\partial \bar{s}_c}{\partial t} > 0$, $\frac{\partial \bar{s}_c}{\partial \lambda} < 0$ and $\frac{\partial \bar{s}_c}{\partial p} < 0$. An increase in the tax rate increases the critical stigma rate and makes the full income declaration less likely to constitute an $\mathcal{UP}\mathcal{E}$ for a taxpayer. On the other hand, an increase in the penalty rate and the probability of an audit makes the full income declaration more likely to constitute an $\mathcal{UP}\mathcal{E}$ for a taxpayer.

Now consider the case of the full income evasion, i.e., $D_e = 0$. In this case $D \geq D_e$ for any declaration decision and therefore (5.6) and (5.8) are applicable. $D_e = 0$ constitutes an $\mathcal{UP}\mathcal{E}$ if and only if $\frac{\partial V_2}{\partial D}|_{D=0} \leq 0$. Using (5.8), we get:

$$\begin{aligned} \frac{\partial V_2}{\partial D}|_{D=0} &= [1-p][1+\eta\theta(1-p)+\eta p](-t)u'(Y_{NA}^0) \\ &+ p[1+\eta\theta(1-p)+\eta p][\lambda t u'(Y_A^0) + s] \leq 0 \end{aligned} \quad (5.24)$$

where Y_{NA}^0 and Y_A^0 are disposable incomes for zero income declaration ($D = 0$) in no-audit and audit states, respectively. Using (3.1) and (3.2), $Y_{NA}^0 = W$ and $Y_A^0 = (1-t-\lambda t)W$. From (5.24) we have:

$$\frac{\partial V_2}{\partial D}|_{D=0} \leq 0 \iff s \leq \frac{t(1-p)}{p} \times u'(Y_{NA}^0) - \lambda t \times u'(Y_A^0) \quad (5.25)$$

Let $\underline{s}_c = \frac{t(1-p)}{p} \times u'(Y_{NA}^0) - \lambda t \times u'(Y_A^0)$ be the critical stigma rate for this case. Hence, the full income evasion constitutes an $\mathcal{UP}\mathcal{E}$ for $s \leq \underline{s}_c$. Depending on the parameter values of t , λ and p and the functional form of $u(\cdot)$, \underline{s}_c might be negative. In this case, the full income evasion is not an $\mathcal{UP}\mathcal{E}$, irrespective of the stigma rate. Suppose, $\underline{s}_c > 0$. Note that $\frac{\partial \underline{s}_c}{\partial p} < 0$ and $\frac{\partial \underline{s}_c}{\partial \lambda} < 0$. An increase in the probability of an audit or the penalty rate decreases the critical stigma rate and makes the evasion of all income less likely to constitute an $\mathcal{UP}\mathcal{E}$ for a taxpayer. The effect of the tax rate increase on the critical stigma rate is ambiguous in this case. It is worthwhile to note that \underline{s}_c is also the critical stigma under EU.

We now turn to the characterization of the behavior of the continuum of taxpayers. Note that for various parameter values, either $\bar{s}_c > \underline{s}_c$ or $\bar{s}_c < \underline{s}_c$ (for the specific case, these values can also coincide). Specifically, consider the difference

¹³A realistic value for the probability of an audit, p , lies in the range $[0.01, 0.03]$, the penalty rate, λ , ranges from 0.5 to 2 (See, for example, Dhimi and al-Nowaihi, 2007). Various estimates of the loss aversion parameter, θ , belongs to the range $(1, 5)$ (See, for the brief overview of respective studies, Abdellaoui et al., 2007).

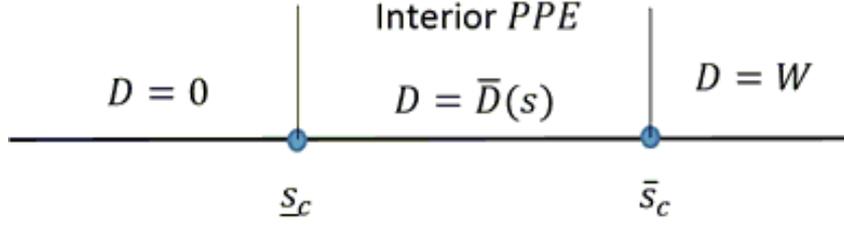


Figure 2: Case 1 - Equilibrium tax compliance behavior under UPE

$(\bar{s}_c - s_c)$, then $\bar{s}_c > s_c$ if the following holds:

$$\frac{1-p}{p} \left[\frac{1+\eta}{1+\eta\theta} u'(Y_L) - u'(Y_{NA}^0) \right] + \lambda [u'(Y_A^0) - u'(Y_L)] > 0 \quad (5.26)$$

Using the concavity of $u(\cdot)$, it follows that $u'(Y_{NA}^0) < u'(Y_L) < u'(Y_A^0)$. Then it is obvious that for the given values of p , λ and θ , (5.26) is satisfied for sufficiently low η . Assume the following holds:

$$\frac{1-p}{p} \left[\frac{1}{\theta} u'(Y_L) - u'(Y_{NA}^0) \right] + \lambda [u'(Y_A^0) - u'(Y_L)] > 0 \quad (5.27)$$

Then $\bar{s}_c > s_c$ for any $\eta > 0$. In this case, in light of the stigma distribution, $F(s)$, we get the following equilibrium behavior of the taxpayers. Taxpayers with low enough stigma, $s \leq s_c$, evade all their income; taxpayers with $s_c < s < \bar{s}_c$ declare their interior \mathcal{PPE} and the taxpayers with high enough stigma, $s \geq \bar{s}_c$, declare all their income. *Figure 2* depicts this case.

Using *Proposition (5.3)* and the detected effects of p and λ on the critical stigma values, we see that the aggregate evasion decreases in the probability of an audit and the penalty rate (the result also holds under EU). Specifically, smaller share of the taxpayers evade all income, greater share complies fully and the evasion at the interior \mathcal{PPE} is lower when p or λ is higher. The effect of the tax rate increase on the aggregate evasion is ambiguous. Even though, an increase in the tax rate reduces the share of the fully compliant taxpayers on the aggregate level, at interior optima some taxpayers with relatively low stigma rates reduce evasion and others evade more. The result is qualitatively similar to the results under \mathcal{CPE} and EU. Therefore, we can conclude that in this case \mathcal{UPE} does not perform better than EU in explaining the compliance-tax rate relation. Although quantitatively the aggregate evasion under EU is higher than under \mathcal{UPE} , as long as EU predicts

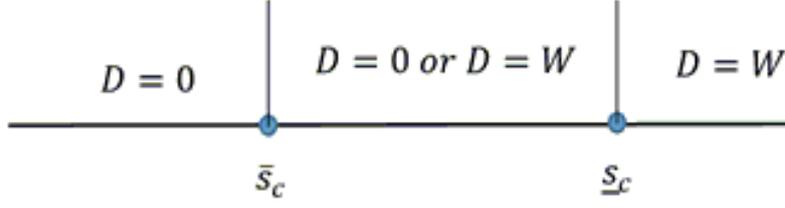


Figure 3: Case 2 - Equilibrium tax compliance behavior under UPE

higher evasion at the interior optimum and smaller share of the fully compliant taxpayers (\bar{s}_c is higher under EU).

In the case, where $\bar{s}_c < \underline{s}_c$, taxpayers either evade or declare all their income. Specifically, taxpayers with $s < \bar{s}_c$ evade all their income; taxpayers with $s > \underline{s}_c$ declare all their income and those with $\bar{s}_c < s < \underline{s}_c$ choose the option with the higher expected utility. The case is depicted on *Figure 3*.

The full income declaration is a $\mathcal{PP}\mathcal{E}$ for a taxpayer with $\bar{s}_c < s < \underline{s}_c$, if expected utility from the $\mathcal{UP}\mathcal{E}$ of truthful declaration is greater than expected utility from another $\mathcal{UP}\mathcal{E}$ of concealing all income, i.e., $V(Y_L, s|Y_L) > V(Y_0, s|Y_0)$, where Y_L is the legal after-tax income induced by the truthful declaration and $Y_0 = (Y_{NA}^0, Y_A^0)$ is the vector of outcomes induced by zero income declaration in the no-audit and audit states. Using (4.4), we have:

$$\begin{aligned}
 V(Y_L, s|Y_L) &= u(Y_L) \text{ and} & (5.28) \\
 V(Y_0, s|Y_0) &= [(1-p) - p(1-p)\eta(\theta-1)] \times u(Y_{NA}^0) \\
 &+ [p + p(1-p)\eta(\theta-1)] \times [u(Y_A^0) - sW]
 \end{aligned}$$

Then, for a taxpayer with $\bar{s}_c < s < \underline{s}_c$ the truthful declaration is a $\mathcal{PP}\mathcal{E}$ if the following holds:

$$\begin{aligned}
 u(Y_L) &> [(1-p) - p(1-p)\eta(\theta-1)] \times u(Y_{NA}^0) & (5.29) \\
 &+ [p + p(1-p)\eta(\theta-1)] \times [u(Y_A^0) - sW]
 \end{aligned}$$

It is obvious that, (5.29) holds for any stigma rate if a taxpayer assigns a non-positive decision weight to the no-audit outcome, Y_{NA}^0 . That is, for sufficiently high η , i.e., $\eta \geq \frac{1}{p(\theta-1)}$, the full income declaration is a $\mathcal{PP}\mathcal{E}$ for a taxpayer with $\bar{s}_c < s < \underline{s}_c$. Therefore, in the case where $\bar{s}_c < \underline{s}_c$ and $\eta \geq \frac{1}{p(\theta-1)}$, at the equilibrium

a taxpayer with $s > \bar{s}_c$ declares all her income and a taxpayer with $s < \bar{s}_c$ declares zero income. Given that $\frac{\partial \bar{s}_c}{\partial t} > 0$, $\frac{\partial \bar{s}_c}{\partial \lambda} < 0$ and $\frac{\partial \bar{s}_c}{\partial p} < 0$, the following implications are derived. In light of the population distribution of stigma rates, $F(s)$, the tax rate increase entails increased overall evasion and hence, the Yitzhaki puzzle is solved on the aggregate level. The overall evasion decreases in the penalty rate and the probability of an audit. This result is also in line with evidence and intuition.

When $\eta < \frac{1}{p(\theta-1)}$ and a decision weight given to the no-audit outcome is positive, the full income declaration or evasion can both emerge as a \mathcal{PPE} for different values of stigma in the range $(\bar{s}_c, \underline{s}_c)$. In this case, an increase in the penalty rate or the probability of an audit increases overall compliance, but the tax rate increase has an ambiguous effect on the overall evasion.

To summarize the findings of this section, the application of the \mathcal{UPE} and \mathcal{PPE} concepts to the tax evasion context, in the one case, entails results that are qualitatively similar to the results under EU, in another case, results that are restrictive in two ways. First, an interior declaration does not emerge as an \mathcal{UPE} and at the equilibrium a taxpayer either declares or evades all her income. Second, solving the Yitzhaki puzzle on the aggregate level requires additional and restrictive assumptions.

6 Conclusion

The empirical evidence shows that people evade more income when the tax rate increases, whereas expected utility theory (EU) predicts the reverse compliance-tax rate relation under the standard portfolio choice model of tax evasion. Moreover, EU overpredicts tax evasion and fails to explain why some people never evade. Motivated by the increasing empirical support of an alternative decision theory of Kőszegi and Rabin (2006, 2007), this chapter has examined the standard model of tax evasion using this theory. The results have been derived for the three personal equilibrium concepts of Kőszegi and Rabin (2007).

The concept of *choice-acclimating personal equilibrium* (\mathcal{CPE}) is used in a scenario, where a taxpayer makes a committed income declaration decision long time before the resolution of uncertainty. Interestingly, the application of \mathcal{CPE} to the tax evasion model results in the rank-dependent representation of the preferences, but unlike RDU or PT, probability weighting emerges without recourse to probability weighting functions. The chapter has shown that the comparative static results of the tax evasion model under \mathcal{CPE} and EU are qualitatively similar. \mathcal{CPE} , like EU, incorrectly predicts the compliance-tax rate relation when the psychological cost

of evasion is not part of the model and the effect of the tax rate increase on evasion turns ambiguous following the introduction of the psychological cost of evasion in the analysis. Therefore, CPE cannot solve the Yitzhaki puzzle. Nonetheless, CPE can explain why some taxpayers never evade and *ceteris paribus*, it predicts higher compliance levels compared to EU.

A taxpayer might not be able to concentrate on the decision making process and make a committed decision sufficiently in advance to the resolution of uncertainty. The concept of *unacclimating personal equilibrium* (UPE) applies to this scenario. The application of the UPE results in the continuum of potential interior selections. It has been shown that, using the concept of PPE , we are always able to identify the interior UPE with the highest expected utility. The chapter has also provided the conditions for the corner UPE declarations and has characterized the behavior of the continuum of taxpayers on the aggregate level. In one case, the results under UPE were found qualitatively similar to those under CPE and EU. In another case, where taxpayers only declare or evade all their income, the Yitzhaki puzzle can be solved under additional and restrictive assumptions.

One may argue that, because the income tax is filed once in a year, a taxpayer has enough time to plan and acclimatize to her declaration decision. Based on this argument, CPE is the relevant concept to investigate the tax evasion decision. Nonetheless, the chapter has solved the model and derived results for all three equilibrium concepts.

Chapter III

Tax Compliance in the Presence of Hedonic Adaptation

1 Introduction

Tax evasion is one of the key challenges for the policy makers. Designing the optimal tax code requires assessment of taxpayers' compliance behavior. Tax rate, detection intensity, penalty rate - are some of the characteristics considered in models of tax evasion. The central question in tax evasion theory is how changes in fiscal policy parameters affect evasion. The literature on tax evasion can be categorized into two broad groups. The first strand of literature is based on expected utility theory (e.g., Allingham and Sandmo, 1972; Yitzhaki, 1974) and the second strand approaches the evasion problem from a behavioral perspective (e.g., Dhimi and al-Nowaihi, 2007; Bernasconi et al., 2014). This chapter uses a behavioral approach to study the dynamics of tax evasion and contributes to the second group of the literature.

A formal theoretical model of income tax evasion was introduced by Allingham and Sandmo (1972) in the economics-of-crime framework. In their model, an expected utility maximizing taxpayer chooses how much income to report for tax purposes. Uncertainty about possible outcomes arises because of an audit probability. If a taxpayer is caught evading, she has to pay the evaded taxes and a penalty that is proportional to the concealed income. The model shows that at the interior optimum, evasion decreases in the probability of an audit and the penalty rate, but the effect of the tax rate change on evasion is ambiguous. Yitzhaki (1974) notes that in practice, penalty is imposed on evaded taxes rather than unreported income. Taking this into account, under the plausible assumption of decreasing absolute risk aversion, the model predicts that evasion declines in response to tax rate increase. This counter intuitive result, known as Yitzhaki puzzle, is not supported by the majority of empirical works. The bulk of the evidence shows that people evade more when tax rate is increased (e.g. Clotfelter, 1983; Pudney et al., 2000). In addition to the Yitzhaki puzzle, expected utility theory (EU) predicts too much evasion. Unrealistically high level of risk aversion is needed to explain the empirically observable volume of tax evasion, e.g., coefficient of relative risk aversion must exceed 30 to explain compliance larger than 90%, while the value

of the coefficient suggested by field experiments is between 1 and 2 (Alm, 2012). Numerous extensions of the basic Allingham-Sandmo-Yitzhaki model have been provided using EU, but the compliance-tax rate relation has not been reversed (See Andreoni et al., 1998; Sandmo, 2005 and Slemrod, 2007 for surveys).

The inconsistencies, generated by the applications of EU in the context of tax evasion, have motivated researchers using alternative decision theories, most notably - prospect theory (Kahneman and Tversky, 1979) and cumulative prospect theory (Tversky and Kahneman, 1992).¹⁴ Alm et al. (1992) run tax compliance experiment and find that subjects overweight low probabilities of audit, which is in line with prospect theory (PT). Yaniv (1999) applies PT, excluding probability weighting but keeping reference dependence and loss aversion, to study advance tax payments as an additional deterrent for tax evasion. Bernasconi and Zarandi (2004) study tax compliance decision in a setting, where a decision maker has a general reference point and conforms to cumulative prospect theory (CP). Dhimi and al-Nowaihi (2007) observe that a general reference point cannot solve the Yitzhaki puzzle, if audited or non-audited taxpayer is found in the same domain. The authors show that, legal after-tax income (status quo) is the only candidate for the reference point to guarantee that a taxpayer is in the domain of gains if not caught evading and in the domain of losses - if caught evading. Using the legal after-tax income as a reference point in the CP framework, the authors find that at the interior optimum tax evasion increases in the tax rate, hence solving the Yitzhaki puzzle. Furthermore, their model calibration shows that predictions of CP matches data better than the predictions of EU. Dhimi and Al-Nowaihi (2010) consider optimal taxation in the presence of tax evasion, documenting the advantage of CP over EU as a better fit to the data. Bernasconi et al. (2014) apply CP to the tax evasion problem in a dynamic setting. The authors introduce a reference point adaptation process induced by the tax rate change. Theoretical predictions of their model are confirmed by a lab experiment, showing that an increase in the tax rate increases evasion and evasion becomes independent of taxes as taxpayers adapt to the new tax rate.

The objective of this work is to address the tax compliance problem in a dynamic setting, where tax rate change is introduced and taxpayers adapt to the change over time. In practice, it takes time to enforce changes entered in the tax

¹⁴The main difference between these theories is the way decision weights are formed. Prospect theory uses non-linear point transformation of probabilities, which might induce stochastically dominated choices. Probability weighting under cumulative prospect theory eliminates this possibility by using cumulative non-linear transformation of probabilities in a manner similar to the rank-dependent utility theory (Quiggin, 1982; 1993).

code of any country. Announcement and enforcement dates of changes entered into the tax code do not coincide in some cases.¹⁵ A typical scenario is as follows: Government initiates a new tax rate to parliament, parliament approves the changes and issues the new tax code with indication of an enforcement date of the new tax rate in it. Thus, taxpayers are informed about the changes, which will be enforced some periods later. A good illustrative example could be the amendment of Georgian tax law (issued on July 15, 2008), which determined an applicable income tax rate to be: 25% until January 1, 2009; 24% during 2009; 22% during 2010; 20% during 2011; 18% during 2012 and 15% starting from 2013.¹⁶

Do taxpayers change their tax compliance behavior after the announcement and before the actual enforcement of a new tax rate? This is a central question of this chapter. If the announcement has a significant effect on tax compliance, policy makers will be eager to know the direction of this effect. This work explores CP-based tax evasion model in the presence of *hedonic adaptation* - the process shaping a reference point over time. It shows that, under some conditions, announcement of tax rate changes has a negative effect on tax compliance during the transition period. The enforcement of a reduced tax rate reduces evasion in the long run, whereas the enforcement of an increased tax rate increases evasion.

The chapter is structured as follows. In section 2, I outline and review two closely related papers of Dhimi and al-Nowaihi (2007) and Bernasconi et al. (2014). Section 3 provides a brief review of hedonic adaptation literature. Section 4 outlines the theoretical framework of reference dependent preferences with hedonic adaptation in the context of tax evasion. Section 5 draws implications and results of the model and section 6 concludes.

2 Related Literature

Dhimi and al-Nowaihi (2007), henceforth DaN, provide a static benchmark model of behavioral tax evasion theory. The authors use all components of CP - reference dependence, diminishing sensitivity, non-linear weighting of probabilities and loss aversion and successfully solve the Yitzhaki puzzle. I outline the model below.

The total taxable income of a taxpayer is exogenously given and denoted by W .

¹⁵Here I assume that the announcement and enforcement do not coincide if time gap exceeds a tax year period. If the tax changes are made within a tax year, occurrence of announcement and enforcement are assumed to be the same.

¹⁶About Changes and Amendments to the Georgian Tax Code; Law of Georgia, document No206; Source and date of publishing - LHG, 15, 22/07/2008. Available at <https://matsne.gov.ge/ka/document/view/18808> (in Georgian only)

She declares income, D , for tax purposes and $0 \leq D \leq W$. A proportional tax rate $0 < t < 1$, is levied on the declared income. If a taxpayer underreports her income, she is caught with probability $p(D)$. The probability of detection is non-increasing in the declared amount, i.e., $p'(D) \leq 0$. If caught, a taxpayer has to pay the evaded tax liabilities, $t[W - D]$, and a penalty that is proportional to the evaded taxes $\lambda t[W - D]$, where $\lambda > 0$ is a penalty rate. In addition, a taxpayer suffers some stigma that is proportional to the concealed income $s[W - D]$, where $s \geq 0$ stands for the stigma rate. There is a continuum of taxpayers with $s \in [\underline{s}, \bar{s}]$ and cumulative distribution $\Phi(s)$.¹⁷ Y_{NC} and Y_C stand for the incomes of a taxpayer in non-audit and audit states, respectively:

$$\begin{aligned} Y_{NC} &= W - tD \\ Y_C &= W(1 - t) - (\lambda t + s)(W - D) \end{aligned} \quad (2.1)$$

Reference income of a taxpayer, R , is assumed to be equal to the legal after tax income (status quo), hence $R = W[1 - t]$. Income relative to the reference point is defined as $X_i = Y_i - R$, where $i = C, NC$ represents two states when a taxpayer is caught and not caught, respectively. A taxpayer is said to be in the domain of gains, when $X_i \geq 0$ and she is in the domain of losses, when $X_i < 0$. Utility function is defined as it is given by Tversky and Kahneman (1992):

$$v(X_i) = \begin{cases} X_i^\beta & \text{if } X_i \geq 0 \\ -\theta[-X_i]^\beta & \text{if } X_i < 0 \end{cases} \quad (2.2)$$

where $0 < \beta < 1$ captures the curvature of the utility function and $\theta > 1$ is a coefficient of loss aversion.

DaN show that a taxpayer is in the domain of losses when caught but in the domain of gains while not caught if and only if the reference point is the legal after tax income:

$$\begin{aligned} X_{NC} &= t[W - D] \geq 0 \\ X_C &= -[\lambda t + s][W - D] \leq 0 \end{aligned} \quad (2.3)$$

¹⁷The importance of social stigma and psychological cost of evasion are also emphasized in Benjamini and Maital (1985) and Gordon (1989).

A taxpayer assigns decision weights to the possible outcomes using probability weighting function ω .¹⁸ Hence, the taxpayer maximizes:

$$V(D, t, s, \lambda, \theta, W) = \omega(p(D))v(X_C) + \omega(1 - p(D))v(X_{NC}) \quad (2.4)$$

Using the utility function in (2.2) and substituting for X_{NC} and X_C from (2.3) into (2.4), we get:

$$V(D, t, s, \lambda, \theta, W) = [W - D]^\beta \{t^\beta \omega(1 - p(D)) - \theta[s + \lambda t]^\beta \omega(p(D))\} \quad (2.4')$$

As a result, DaN show that at an interior optimum tax evasion is strictly increasing in the tax rate, t ; while at the optimum on the boundary tax evasion is non-decreasing in the tax rate.

The model explains main features of tax evasion. The static framework suggests that a taxpayer immediately and fully adjusts her reference point in response to the tax rate change, which may not be the case in a dynamic setting where adaptation might take time. How people form and adjust their reference points is still an open question in the literature.

Bernasconi et al. (2014) make the evasion model dynamic, allowing a reference point to adjust over time. The authors assume that whenever a new tax rate is introduced, a taxpayer starts adjusting her reference tax rate toward the new tax rate. A taxpayer follows a hedonic adaptation process, meaning that as time passes by, she becomes more accustomed to the new tax rate. The authors define the reference income as follows:

$$R = W[1 - \delta t_R] \quad (2.5)$$

where t_R is a reference tax rate and parameter $\delta \in [0, 1]$ captures the taxpayer's "moral inclination towards taxes". The reference tax rate evolves according to a first order adaptive process of the following form:

$$t_R = \alpha t + [1 - \alpha]t_{R-1} \quad (2.6)$$

where t is the actual tax rate, t_R is the reference tax rate in the current period, t_{R-1} represents the reference tax rate in the previous period and α stands for the speed of adjustment. In a stationary tax environment, reference and actual tax

¹⁸ ω is strictly increasing "onto" function $\omega : [0, 1] \rightarrow [0, 1]$, such that $\omega(0) = 0$ and $\omega(1) = 1$

rates coincide, $t_R = t$. If in addition $\delta = 1$, reference income turns to be the same as the one in the DaN model. When the new tax rate is enforced, the reference tax rate may differ from the actual tax rate. Bernasconi et al. (2014) investigate tax compliance behavior of a taxpayer at the interior optimum and find a positive short run effect of the tax rate increase on evasion. Once a taxpayer gets fully adapted to the new tax environment, this effect vanishes. Their results are inconclusive about the effect of the tax rate reduction on evasion. The authors implicitly assume that the announcement and enforcement dates of the new tax rate coincide, hence the new tax rate enters into force immediately after the announcement. In actual practice, there might be a time gap between announcement and enforcement. To analyze the behavior of a taxpayer in this transition period, the model has to be modified.

The theoretical framework of this chapter, outlined in section 4, is based on the benchmark model of DaN. The framework enables us to extend the analysis of Bernasconi et al. (2014) in two directions. First, it allows to distinguish between the effects of announcement and enforcement on evasion. Second, it generalizes the analysis to the aggregate level by considering a continuum of taxpayers.

3 A Note on Hedonic Adaptation

Frederick and Loewenstein (1999) use the term *hedonic adaptation* to refer to "a reduction in the affective intensity of favorable and unfavorable circumstances." Hedonic adaptation in the framework of reference dependent preferences can be captured through an adaptive reference point. An adaptation level or, equivalently, a reference point might be sensitive to the past, current as well as anticipated future stimuli. For instance, British data suggest that reference income in the current period is a function of last year's income, current income and anticipated next year's income (Frederick and Loewenstein, 1999, p 321). Nonetheless, the most common formulation of adaptation level in the literature expresses it as a function of only past stimuli. In this respect, an early formalization of adaptation was suggested by Helson (1947, 1948), who proposed adaptation level to be equal to the average of past stimulus levels. He also specified an individual's hedonic state as a function of the difference in current stimulus and adaptation levels.¹⁹ In Helson's proposed formulation, an individual assigns equal weights to the past stimuli, neglecting the fact that more recent stimulus might have greater effect

¹⁹The notion of hedonic state is equivalent to the notion of value function in PT if the adaptation level is assumed to be a reference point.

than relatively older stimulus levels. On this basis more advanced adaptation processes were introduced (e.g., March, 1988). A typical adaptation process is assumed to be linear of the following form:

$$AL_T = \alpha S_{T-1} + (1 - \alpha)AL_{T-1} \quad (3.1)$$

where AL_T is an adaptation level at time T , S_{T-1} is a stimulus level at time $T - 1$ and $0 < \alpha < 1$ captures the speed of adaptation. This formulation is similar to the reference tax rate formulation, given by (2.6), in Bernasconi et al. (2014).

As noted above, the adaptation level may also depend on anticipated stimulus, a process called *feedforward*. Existence of feedforward phenomenon was documented in animal experiments (e.g., Siegel et al., 1982). Van Praag (1971) and van Praag and van der Sar (1988) provide an evidence for feedforward in a hedonic context. For example, the authors find that income perceived as "sufficient" depends on the anticipated future income.

The evidence shows that people adapt to gains quickly and adaptation to losses is sluggish. Arkes et al., (2008) find that the magnitude of reference point adaptation is significantly larger for the experienced gain than for loss. Lyubomirsky (2011) suggests that adaptation rate to favorable events is higher than to unfavorable events.

In this chapter, I successively use feedforward-based and current stimulus-based adaptation processes to study the effect of anticipation and enforcement of a new tax rate on tax compliance behavior.

4 The Model

The set-up of the model follows DaN, outlined in section 2. For the sake of clear exposition, I abstract from the diminishing sensitivity component of CP and consider the following piecewise linear utility function:²⁰

$$v(X_i) = \begin{cases} X_i & \text{if } X_i \geq 0 \\ \theta X_i & \text{if } X_i < 0 \end{cases}, i = C, NC \quad (4.1)$$

Borrowing the penalty and stigma structures from the DaN model, disposable income Y_i , when caught or not caught evading is given by (2.1). X_i is income relative to the reference income, which is defined in (4.3) below. There is a continuum of taxpayers who are identical in all respects apart from stigma, which has

²⁰Tversky and Kahneman (1992) find that $\beta \approx 0.88$ in (2.2), which is close to 1.

cumulative distribution function $\Phi(s)$ and support $[\underline{s}, \bar{s}]$.

The probability of an audit, p , is constant and independent of the declared income, D . In case of an audit, only the current period is checked. The government announces a new tax rate to be enforced several periods later. Therefore, the enforcement date of the new tax rate is ahead of the announcement date. During the *transition period* (period between announcement and actual enforcement), a taxpayer is obliged to pay the old tax, t . The reference point of the taxpayer might be affected by the anticipated tax change. As a motivating example, suppose the government declares tax rate to be halved some periods later. For a taxpayer, the immediate enforcement may have been beneficial. Facing a time gap before the enforcement of a reduced tax rate might induce the perception of losing income due to paying higher tax rate in the current period. To put it differently, the anticipation of the tax rate reduction might reduce taxpayer's reference tax rate and increase her reference income.

The announcement date is denoted by 0 and the enforcement date by T^* , hence $T = 0, 1, 2, \dots, T^*$. The actual and announced tax rates are denoted by t and t^* , respectively. \bar{t}_T stands for the reference tax rate in period $T \in [0, T^*]$ and it follows feedforward-based adaptive process of the general form:²¹

$$\bar{t}_T = \bar{t}_{T-1} + \alpha_T [t^* - \bar{t}_{T-1}] \quad (4.2)$$

where \bar{t}_{T-1} is the reference tax rate in period $T-1$, $\alpha_T \in [0, 1]$ captures the speed of adaptation in period T and the initial reference tax rate is $\bar{t}_0 = t$. Hence, $\bar{t}_T \in [t, t^*]$ when $t^* > t$ and $\bar{t}_T \in [t^*, t]$ when $t^* < t$. The reference income of a taxpayer in period T is given by the following:

$$R_T = W[1 - \bar{t}_T] \quad (4.3)$$

When a tax rate has been in place for a sufficiently long period of time, the taxpayer's reference tax rate is equal to the actual tax rate $\bar{t} = t$ and we have the case identical to the one described in the DaN static model, where the reference income coincides with the legal after-tax income.

Figure 4 depicts the time flow with announcement and enforcement dates. Before the announcement of the tax rate change, the tax environment is stationary. There are transition periods after the announcement and before the actual enforcement of the new tax rate. After the full adaptation to the new tax rate, the taxpayer is back to the stationary environment.

²¹Note that, after the enforcement of t^* , this general formulation can also represent current stimulus-based hedonic adaptation.

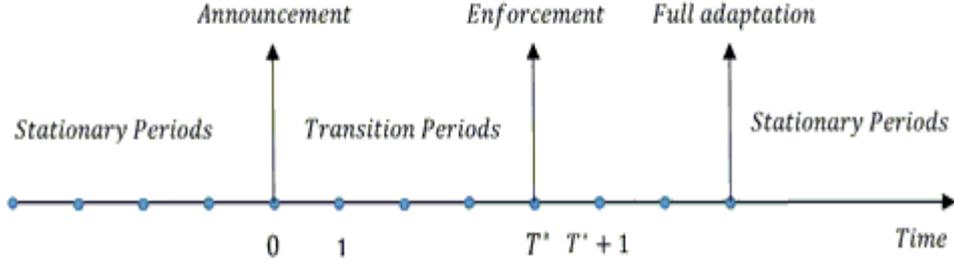


Figure 4: Time flow

Under CP, objective probabilities are transformed into decision weights using the probability weighting function ω .²² In each period, a taxpayer declares income that maximizes her objective function:

$$V = \pi(X_C)v(X_C) + \pi(X_{NC})v(X_{NC}) \quad (4.4)$$

where $\pi(X_C)$ and $\pi(X_{NC})$ are the decision weights given to the outcomes when caught and not caught, respectively. $v(X_C)$ and $v(X_{NC})$ are derived using (4.1).

Firstly, I consider the stationary tax environment before any announcement is made. The stationary solution will serve as a benchmark to evaluate the direction of changes in aggregate evasion due to the announcement of the new tax rate.

5 Static Solution

5.1 Stationary Case

In the stationary tax environment, the reference tax rate coincides with the actual tax rate, $\bar{t} = t$ and the reference income in (4.3) turns to be $R = W[1 - t]$. Then, income relative to the reference point is given by (2.3). When a taxpayer is found in the opposite domains when caught and not caught, which is guaranteed by our

²²Calculation of decision weights for two-outcome lottery under CP:

Given the lottery $L = (x, p ; y, 1 - p)$, such that $x < y$, and the probability weighting function $\omega(p)$, decision weights are calculated as follows:

1. If $0 \leq x < y$. Then $\pi(y) = \omega(1 - p)$ and $\pi(x) = \omega(p + 1 - p) - \omega(1 - p) = 1 - \omega(1 - p)$
2. If $x < 0 < y$. Then $\pi(y) = \omega(1 - p)$ and $\pi(x) = \omega(p)$
3. If $x < y \leq 0$. Then $\pi(x) = \omega(p)$ and $\pi(y) = \omega(p + 1 - p) - \omega(p) = 1 - \omega(p)$

assumption on the reference point (see Dhimi and al-Nowaihi, 2007), decision weights are separately derived for each possible outcome. Specifically, in this case $\pi(X_C) = \omega(p)$ and $\pi(X_{NC}) = \omega(1 - p)$.

Using (2.3), (4.1) and (4.4), a taxpayer maximizes the following objective function:

$$\begin{aligned} V &= -\omega(p)\theta[W - D][\lambda t + s] + \omega(1 - p)t[W - D] \\ &= [W - D] \{t\omega(1 - p) - \theta\omega(p)[\lambda t + s]\} \end{aligned} \quad (5.1)$$

Let $s = \tilde{s}$ be the solution of the equation $t\omega(1 - p) - \theta\omega(p)[\lambda t + s] = 0$. Then $\tilde{s} = \frac{t\omega(1-p)}{\theta\omega(p)} - \lambda t$ and maximization of the objective function in (5.1) gives the following result.

Result 5.1 A taxpayer optimally declares $D^* = 0$ if $s < \tilde{s}$; $D^* \in [0, W]$ if $s = \tilde{s}$ and $D^* = W$ if $s > \tilde{s}$, where $\tilde{s} = \frac{t\omega(1-p)}{\theta\omega(p)} - \lambda t$ is the critical stigma rate.²³

The optimization results in the bang-bang solution. A taxpayer who has low enough stigma rate ($s < \tilde{s}$) evades all the tax liabilities and it is optimal to declare truthfully if the stigma rate is high enough ($s > \tilde{s}$). If the stigma rate coincides with the critical value ($s = \tilde{s}$), a taxpayer is indifferent between any declaration levels from the interval $[0, W]$.²⁴

In the following two subsections I consider two cases: The first, when the reduction in the tax rate is announced and the second, when the income tax is announced to be increased.

5.2 Tax Rate Reduction

5.2.1 Analysis of the Transition Period

Suppose the government announces reduced tax rate, t^* , entering into force some periods later. Hence, $t^* < t$. Because the declaration decisions in different periods are not interdependent, I study the decision problem in a single period, T , after the

²³For the realistic parameter values, the critical stigma is positive. E.g., consider the following parameter values from DaN: $t = 0.3$; $\theta = 2.25$; $p = 0.03$; $\lambda = 1$ and the probability weighting function $\omega(p) = e^{-(\ln p)^{0.5}}$. Then $\tilde{s} \approx 0.43$

²⁴The application of the original CP utility function in (2.2), where $0 < \beta < 1$, also results in the bang-bang solution. Hence, keeping the diminishing sensitivity in the picture does not enrich the result.

announcement and before the enforcement of the new tax rate. The feedforward-based adaptation process, in (4.2), is activated in the transition period. Consider any tax period, T , of the transition, where the reference tax rate has been partially or completely adjusted towards the new tax rate. Hence, $\bar{t}_T \in [t^*, t)$. Let $\bar{t}_T = t - \Delta$, where Δ denotes the aggregate adaptation magnitude of the reference tax rate by the period T and therefore, $0 < \Delta \leq t - t^*$.

If a taxpayer is not audited, using (2.1), (4.3) and $\bar{t}_T = t - \Delta$, her income relative to the reference point is:

$$X_{NC} = t(W - D) - W\Delta \quad (5.2)$$

Technically, the sign of X_{NC} can be positive or negative depending on the choice variable, D .

If a taxpayer is caught evading, using (2.1), (4.3) and $\bar{t}_T = t - \Delta$, her income relative to the reference point is:

$$X_C = -[W - D][\lambda t + s] - W\Delta < 0 \quad (5.3)$$

Given that $D \in [0, W]$ and $\Delta > 0$, an audited taxpayer is in the domain of losses, i.e., $X_C < 0$.

Now we can find a taxpayer's optimal declaration. Firstly, consider the intuitive case, where a non-caught taxpayer is in the domain of gains, i.e., from (5.2) $X_{NC} \geq 0 \implies D \leq \frac{t-\Delta}{t}W$. Then we have:

$$\begin{aligned} X_{NC} &= t(W - D) - W\Delta \geq 0 \\ X_C &= -[W - D][\lambda t + s] - W\Delta < 0 \end{aligned} \quad (5.4)$$

The decision weights are separately derived for the outcomes of different domains. Hence, $\pi(X_C) = \omega(p)$ and $\pi(X_{NC}) = \omega(1 - p)$. Then using (4.1) and (5.4), the objective function in (4.4) takes the following form:

$$\begin{aligned} V &= -\theta\omega(p)\{[W - D][\lambda t + s] + W\Delta\} + \omega(1 - p)[t(W - D) - W\Delta] \\ &= (W - D)\{t\omega(1 - p) - \theta[\lambda t + s]\omega(p)\} - W\Delta\{\theta\omega(p) + \omega(1 - p)\} \end{aligned} \quad (5.5)$$

The optimal declaration depends on the value of the stigma rate. The critical stigma rate satisfies the equality $t\omega(1 - p) - \theta[\lambda t + s]\omega(p) = 0$. It follows that,

the critical stigma rate is the same as the one found for the stationary case: $\tilde{s} = \frac{t}{\theta} \frac{\omega(1-p)}{\omega(p)} - \lambda t$.

Then the domain-specific optimal declaration, when the non-caught taxpayer is bounded to be in the domain of gains, is the following:

$$D^* = 0 \text{ if } s < \tilde{s}; D^* \in \left[0, \frac{t-\Delta}{t}W\right] \text{ if } s = \tilde{s} \text{ and } D^* = \frac{t-\Delta}{t}W \text{ if } s > \tilde{s}. \quad (5.6)$$

Next, consider a case, in which the non-caught taxpayer is in the domain of losses. From (5.2) we have $X_{NC} \leq 0 \implies D \geq \frac{t-\Delta}{t}W$. The taxpayer's income levels relative to the reference point in the no-audit and audit states, respectively, are given by the following:

$$\begin{aligned} X_{NC} &= t(W - D) - W\Delta \leq 0 \\ X_C &= -[W - D][\lambda t + s] - W\Delta < 0 \end{aligned} \quad (5.7)$$

While the both outcomes lie in the domain of losses, decision weights add up to 1 and the weight for the larger loss is derived first. Thus, $\pi(X_C) = \omega(p)$ and $\pi(X_{NC}) = 1 - \omega(p)$. Using (4.1), (5.7) and substituting in (4.4), a taxpayer maximizes the following objective function:

$$\begin{aligned} V &= -\theta\omega(p)\{[W - D][\lambda t + s] + W\Delta\} \\ &\quad +\theta[1 - \omega(p)]\{t(W - D) - W\Delta\} \\ &= \theta(W - D)\{t[1 - \omega(p)] - [\lambda t + s]\omega(p)\} - \theta W\Delta \end{aligned} \quad (5.8)$$

Let $s = \hat{s}$ be the critical stigma rate, that satisfies equality $t[1 - \omega(p)] - [\lambda t + s]\omega(p) = 0$. It follows that, the critical stigma rate, $\hat{s} = t \frac{1-\omega(p)}{\omega(p)} - \lambda t$, differs from the one found for the stationary case, \tilde{s} .

When the non-caught taxpayer is bounded to be in the domain of losses, the domain-specific optimal declaration is:

$$\begin{aligned} D^* &= \frac{t-\Delta}{t}W \text{ if } s < \hat{s}; D^* \in \left[\frac{t-\Delta}{t}W, W\right] \text{ if } s = \hat{s} \\ &\text{and } D^* = W \text{ if } s > \hat{s}. \end{aligned} \quad (5.9)$$

The comparison of the domain-specific results in (5.6) and (5.9) reveals the

global optimum. Making empirically more plausible assumption, $\frac{\omega(1-p)}{1-\omega(p)} < \theta$,²⁵ suffices to identify that $\tilde{s} < \hat{s}$. Then we have three possibilities to consider: $s < \tilde{s} < \hat{s}$, $\tilde{s} < s < \hat{s}$ and $\tilde{s} < \hat{s} < s$.

1. Suppose $s < \tilde{s} < \hat{s}$. In the first case, where $X_{NC} \geq 0$, it is optimal to declare $D^* = 0$ and in the second case, where $X_{NC} \leq 0$, a taxpayer finds it optimal to declare $D^* = \frac{t-\Delta}{t}W$. Note that the later option is also available in the first case but not chosen, implying that $D^* = 0$ is the global maximum and the non-audited taxpayer is in the domain of gains.
2. When $\tilde{s} < s < \hat{s}$, the optimal choice, $D^* = \frac{t-\Delta}{t}W$, is identical under the two cases. Without loss of generality, the non-audited taxpayer is considered to be in the domain of gains.
3. Suppose $\tilde{s} < \hat{s} < s$. In the first case, it is optimal to declare $D^* = \frac{t-\Delta}{t}W$. Observe that this option is also available in the second case, but $D^* = W$ is chosen. Hence, $D^* = W$ is the global maximum and the non-audited taxpayer is found in the domain of losses.

The results are summarized in the following proposition.

Proposition 5.1 *A taxpayer optimally declares $D^* = 0$ if $s < \tilde{s} < \hat{s}$, $D^* = \frac{t-\Delta}{t}W$ if $\tilde{s} < s < \hat{s}$ and $D^* = W$ if $\tilde{s} < \hat{s} < s$.*

In the transition period, where the anticipation of the future tax reduction evokes adaptation, a taxpayer with low enough stigma finds it optimal to conceal all the income. Her behavior is driven by maximization of gains in the no-audit state. The adaptation entails an interior optimum for certain range of stigma. In this case, the behavioral rationale is to avoid losses in the no-audit state. An individual with high enough stigma declares all her income and the full compliance is motivated by minimization of losses in the audit state.

Corollary 5.1 evaluates the change in aggregate evasion during the transition period relative to the stationary environment. The evaluation is based on the concealed income in a way that, a fall in the average declared income is identified with an increase in the average evasion. It is worthwhile noting that, the average evasion coincides with the aggregate evasion in light of the continuum of taxpayers.

²⁵For the most realistic audit probabilities, $p \in [0.01, 0.03]$, and various probability weighting functions, the maximum possible value of the fraction $\frac{\omega(1-p)}{1-\omega(p)}$ hardly exceeds 1, whereas Tversky and Kahneman (1992) estimate the loss aversion parameter, θ , and find that $\theta \approx 2.25$.

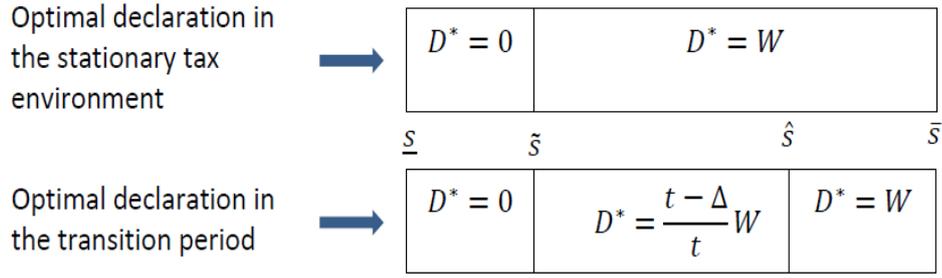


Figure 5: Optimal declaration in stationary and transition periods

Corollary 5.1 *The overall evasion increases in the aggregate adaptation magnitude, Δ . In each tax period of transition, where the aggregate adaptation magnitude is non-zero, i.e., $\Delta > 0$, the aggregate evasion is higher compared to the stationary case.*

Proof. From *Proposition 5.1* it is obvious that the optimal declaration decreases in Δ for $\tilde{s} < s < \hat{s}$ and declaration is independent of Δ otherwise. Hence, the overall evasion increases in Δ . *Figure 5* visualizes *Result 5.1* and *Proposition 5.1*. The same proportion of taxpayers conceal all income under the both cases, whereas certain share of the fully compliant taxpayers under the stationary environment start concealing some income in the transition period. Hence, the overall evasion in the transition period is higher compared to the stationary case, given $\Delta > 0$. ■

The tax rate reduction is a favorable event for a taxpayer, though the anticipation of the tax rate reduction entails the unfavorable transition environment where the taxpayer still pays non-reduced tax rate. Some, otherwise fully compliant, taxpayers find it optimal to underdeclare and mitigate the effect of the unfavorable transition environment. Such taxpayers' evasion decision is motivated by avoiding losses in the no-audit state. Hence, the anticipation of the tax rate reduction increases evasion in the transition period when a taxpayer adapts prematurely to the new tax environment. Evasion is potentially higher when the anticipated tax reduction is significantly large, because it might entail greater feedforward-based adaptation.

5.2.2 Analysis of the Enforcement Period

In this subsection I analyze the effect of the new tax rate enforcement on tax compliance. Firstly, I consider the decision problem of a taxpayer facing a reduced

tax rate with the unchanged reference point, carried over from the last period of transition. Next, I analyze the new tax environment with current stimulus-based hedonic adaptation.

Using (4.3) and substituting for $\bar{t}_T = t - \Delta$, the reference point of a taxpayer at the last period of transition is given by $R = W[1 - (t - \Delta)]$, where Δ is the aggregate adaptation magnitude of the reference tax rate by that period. I assume the following: the adaptation magnitude is positive and the taxpayer is not fully adapted by the end of the transition period, $0 < \Delta < t - t^*$. For the sake of clear exposition, I consider a moderate drop in the tax rate, such that $\frac{t}{1+\lambda} < t^* < t$. Further, at the enforcement period (the tax period, where the taxpayer is obliged to pay the reduced tax rate first time) the applicable reference point is the same as at the last period of transition.

By analogy with (2.1), at the enforcement period a taxpayer's income levels in the no-audit and audit states, respectively, are given by the following:

$$\begin{aligned} Y_{NC} &= W - t^*D & (5.10) \\ Y_C &= W(1 - t^*) - (\lambda t^* + s)(W - D) \end{aligned}$$

Income relative to the reference point, R , in the no-audit state is:

$$X_{NC} = Y_{NC} - R = W(t - \Delta) - t^*D \geq 0 \quad (5.11)$$

The condition $0 < \Delta < t - t^*$ ensures that $X_{NC} \geq 0$ for any $D \in [0, W]$.

Income relative to the reference point of the audited taxpayer is:

$$X_C = Y_C - R = W(t - \Delta - t^*) - (\lambda t^* + s)(W - D) \quad (5.12)$$

The sign of X_C depends on D . Firstly, consider a case, where $X_C \leq 0 \implies D \leq W(1 - \frac{t - \Delta - t^*}{\lambda t^* + s})$. Note that $W(1 - \frac{t - \Delta - t^*}{\lambda t^* + s}) < W$ for any $s \geq 0$.

Because of the opposite domains, $X_{NC} \geq 0$ and $X_C \leq 0$, the applicable decision weights are: $\pi(X_C) = \omega(p)$ and $\pi(X_{NC}) = \omega(1 - p)$. Then using (4.1) and substituting in (4.4), the taxpayer maximizes the following objective function:

$$\begin{aligned} V &= \omega(p)\theta\{W(t - \Delta - t^*) - (\lambda t^* + s)(W - D)\} & (5.13) \\ &+ \omega(1 - p)\{W(t - \Delta) - t^*D\} \\ &= \omega(p)\theta \times W\{(t - \Delta - t^*) - (\lambda t^* + s)\} \\ &+ \omega(1 - p) \times W(t - \Delta) \\ &+ D\{\omega(p)\theta(\lambda t^* + s) - \omega(1 - p)t^*\} \end{aligned}$$

It follows that the domain-specific optimal declaration is:

$$D^* = 0 \text{ if } s < \tilde{s}'; D^* \in [0, W(1 - \frac{t - \Delta - t^*}{\lambda t^* + s})] \text{ if } s = \tilde{s}' \quad (5.14)$$

$$\text{and } D^* = W(1 - \frac{t - \Delta - t^*}{\lambda t^* + s}) \text{ if } s > \tilde{s}'$$

Where, $\tilde{s}' = \frac{t^* \omega(1-p)}{\theta \omega(p)} - \lambda t^*$ is the critical stigma rate for this case. Note that, $t^* < t \implies \tilde{s}' < \tilde{s}$.

Next, consider a case where the audited individual is found in the domain of gains, i.e., using (5.12) $X_C \geq 0 \implies D \geq W(1 - \frac{t - \Delta - t^*}{\lambda t^* + s})$. Then the applicable decision weights are: $\pi(X_C) = 1 - \omega(1 - p)$ and $\pi(X_{NC}) = \omega(1 - p)$. Using (4.1) and (4.4), the taxpayer maximizes the following objective function:

$$V = [1 - \omega(1 - p)]\{W(t - \Delta - t^*) - (\lambda t^* + s)(W - D)\} \quad (5.15)$$

$$+ \omega(1 - p)\{W(t - \Delta) - t^*D\}$$

$$= [1 - \omega(1 - p)] \times W\{(t - \Delta - t^*) - (\lambda t^* + s)\}$$

$$+ \omega(1 - p) \times W(t - \Delta)$$

$$+ D\{[1 - \omega(1 - p)](\lambda t^* + s) - \omega(1 - p)t^*\}$$

It follows that the domain-specific optimal declaration is:

$$D^* = W(1 - \frac{t - \Delta - t^*}{\lambda t^* + s}) \text{ if } s < \check{s}'; D^* \in [W(1 - \frac{t - \Delta - t^*}{\lambda t^* + s}), W] \text{ if } s = \check{s}' \quad (5.16)$$

$$\text{and } D^* = W \text{ if } s > \check{s}'$$

Where, $\check{s}' = t^* \frac{\omega(1-p)}{1-\omega(1-p)} - \lambda t^*$ is the critical stigma rate for this case.

Making empirically more plausible assumption, $\frac{1-\omega(1-p)}{\omega(p)} < \theta$, suffices to identify that $\tilde{s}' < \check{s}'$. The comparison of the domain-specific results in (5.14) and (5.16) reveals the global optimum.

1. If $s < \tilde{s}' < \check{s}'$, in the first case, where $X_C \leq 0$, it is optimal to declare zero income, while in the second case, where $X_C \geq 0$, it is optimal to declare $W(1 - \frac{t - \Delta - t^*}{\lambda t^* + s})$. Noting that the later option is also available under the first case, but not chosen there, we get that $D^* = 0$ is the global optimum.
2. If $\tilde{s}' < s < \check{s}'$, the optimal declarations under the both cases are identical. Hence, the global maximum is achieved at $D^* = W(1 - \frac{t - \Delta - t^*}{\lambda t^* + s})$.
3. If $\check{s}' < \tilde{s}' < s$, in the first case a taxpayer finds it optimal to declare $D^* =$

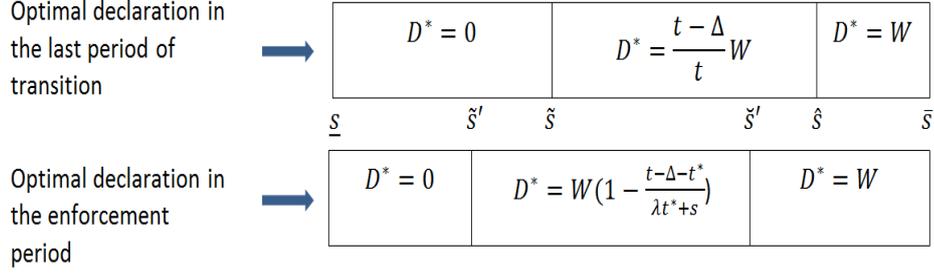


Figure 6: Optimal declaration in transition and enforcement periods

$W(1 - \frac{t-\Delta-t^*}{\lambda t^*+s})$. Having this option also available in the second case, the taxpayer chooses to declare all income. Hence, $D^* = W$ is the global maximum.

These results are summarized in *Result 5.2*.

Result 5.2 In the enforcement period of the reduced tax rate, t^* , the following is optimal to declare for tax purposes: $D^* = 0$ if $s < \tilde{s}' < \hat{s}'$; $D^* = W(1 - \frac{t-\Delta-t^*}{\lambda t^*+s})$ if $\tilde{s}' < s < \hat{s}'$ and $D^* = W$ if $\hat{s}' < s < \bar{s}$.

It is obvious from *Result 5.2* that, higher adaptation magnitude by the end of the transition period entails lower evasion in the enforcement period.

The comparison with the transition period leads to the following proposition.

Proposition 5.2 Let $\omega(p) + \omega(1-p) \leq 1$. If the aggregate adaptation magnitude is high enough, such that $\Delta \geq \frac{t(t-t^*)}{\lambda t^*+t}$, then in the enforcement period evasion is unambiguously lower than the evasion in the last period of transition.

Proof. The condition $\omega(p) + \omega(1-p) \leq 1$ ensures that $\tilde{s}' < \hat{s}$, where $\hat{s} = t \frac{1-\omega(p)}{\omega(p)} - \lambda t$

is the critical value of stigma for the transition period. *Proposition 5.1* and *Result 5.2* are visualized in *Figure 6*. In the enforcement period the proportion of taxpayers evading all taxes is smaller and the proportion of fully compliant taxpayers is larger compared to the last period of transition. The condition $\Delta \geq \frac{t(t-t^*)}{\lambda t^*+t}$ ensures that $W(1 - \frac{t-\Delta-t^*}{\lambda t^*+s}) \geq \frac{t-\Delta}{t}W$, for any $s \geq 0$. Hence, in the enforcement period the aggregate evasion is unambiguously lower than the evasion in the last period of transition. ■

Proposition 5.2 suggests that, if feedforward effect is strong enough during the transition period and hence, the reference point is significantly adapted by the

end of the period, the enforcement of the reduced tax rate induces reduction in evasion. The result is intuitive in a sense that the enforcement of the reduced tax rate is perceived as a gain, that facilitates higher compliance. The comparison with the stationary outcome in *Result 5.1* reveals that in the enforcement period less proportion of the taxpayers evade all taxes compared to the stationary case, but the total effect is ambiguous.

The results of the enforcement period can be generalized to any tax period after the enforcement by allowing current stimulus-based hedonic adaptation, starting from the enforcement period. The general form of hedonic adaptation induced by the current stimulus can also be described by (4.2), but now t^* is the current stimulus and stands for the enforced new tax rate. Consider any tax period after the enforcement and a taxpayer with the aggregate adaptation magnitude, Ω , such that $0 < \Omega \leq t - t^*$. The aggregate adaptation magnitude, induced by the feedforward effect, by the last period of transition is $0 < \Delta < t - t^*$. The current stimulus-based hedonic adaptation entails additional adaptation of $0 \leq \Omega - \Delta \leq t - t^*$. Then we have the generalization of *Result 5.2*, which is restated as follows:

Result 5.2a In any period after the enforcement and Ω being the aggregate adaptation magnitude by that period, it is optimal to declare: $D^* = 0$ if $s < \tilde{s}' < \check{s}'$; $D^* = W(1 - \frac{t-\Omega-t^*}{\lambda t^*+s})$ if $\tilde{s}' < s < \check{s}'$ and $D^* = W$ if $\tilde{s}' < \check{s}' < s$.

Result 5.2a shows that, after the enforcement of the reduced tax rate the aggregate evasion decreases in the adaptation magnitude, implying the lowest level of evasion when a taxpayer is fully adapted to the new tax environment, i.e., $\Omega = t - t^*$. Also observe that in the period of full adaptation and onwards, the aggregate evasion is lower than the evasion in the stationary case. Hence, in the stationary tax environment lower tax rate entails lower evasion.

In a similar vein, generalization of *Proposition 5.2* follows.

Proposition 5.2a Let $\omega(p) + \omega(1-p) \leq 1$. If the aggregate adaptation magnitude is high enough by the end of the transition period, such that $\Delta \geq \frac{t(t-t^*)}{\lambda t^*+t}$, then the aggregate evasion drops in the enforcement period and continues reduction in the subsequent periods as a consequence of further, current stimulus-based hedonic adaptation.

Proof. The first part of the proposition is directly related to *Proposition 5.2*, the second part stems from *Result 5.2a*. ■

To sum up the findings, adaptation in the transition period facilitates evasion. Following the enforcement of the reduced tax rate, higher adaptation results in the lower evasion. In the long term, the tax rate reduction entails the lower aggregate evasion.

5.3 Tax Rate Increase

5.3.1 Analysis of the Transition Period

Now I turn to the case, where the government announces an increased tax rate, $t^* > t$. Consider a moderate increase in the tax rate, such that $t^* < (1 + \lambda)t$. Reference tax rate follows the adaptation process in (4.2) and $\bar{t}_T \in [t, t^*]$.

Consider any tax period, T , of the transition, where the reference tax rate is partially or completely adjusted towards the new tax rate. Thus, we have $\bar{t}_T \in (t, t^*] \implies \bar{t}_T > t$. Let $\bar{t}_T = t + \Delta$, where Δ is the aggregate adaptation magnitude of the reference tax rate by the period T and $0 < \Delta \leq t^* - t < \lambda t$. Then, using it along with (2.1) and (4.3), if a taxpayer is not audited, her income relative to the reference point is:

$$X_{NC} = t(W - D) + W\Delta > 0 \quad (5.17)$$

Given $D \in [0, W]$ and $\Delta > 0$, it follows that an individual is in the domain of gains if not audited for any declaration choice, i.e., $X_{NC} > 0$.

Using (2.1), (4.3) and $\bar{t}_T = t + \Delta$, it follows that when a taxpayer is caught evading, her income relative to the reference point is:

$$X_C = W\Delta - [W - D][\lambda t + s] \quad (5.18)$$

Technically, the sign of X_C can be positive or negative depending on the choice variable, D . Hence, two cases arise for analysis.

If a taxpayer is found in the domain of losses when audited, from (5.18) we have $X_C \leq 0 \implies D \leq W \left[1 - \frac{\Delta}{\lambda t + s}\right]$. Note that $W \left[1 - \frac{\Delta}{\lambda t + s}\right] < W \quad \forall s \geq 0$.

Hence, the taxpayer's income levels relative to her reference point in the no-audit and audit states, respectively, are given by the following:

$$\begin{aligned} X_{NC} &= t(W - D) + W\Delta > 0 \\ X_C &= W\Delta - [W - D][\lambda t + s] \leq 0 \end{aligned} \quad (5.19)$$

The decision weights are separately derived for each outcome in the opposing

domains. Hence, $\pi(X_C) = \omega(p)$ and $\pi(X_{NC}) = \omega(1-p)$. Using (4.1) and (5.19), the objective function in (4.4) takes the following form:

$$\begin{aligned} V &= \theta\omega(p)\{W\Delta - [W - D][\lambda t + s]\} + \omega(1-p)[t(W - D) + W\Delta] \quad (5.20) \\ &= (W - D)\{t\omega(1-p) - \theta\omega(p)[\lambda t + s]\} + W\Delta\{\omega(1-p) + \theta\omega(p)\} \end{aligned}$$

The critical stigma rate satisfies equality $t\omega(1-p) - \theta\omega(p)[\lambda t + s] = 0$. It follows that the critical stigma is the same as the one found for the stationary case, $\tilde{s} = \frac{t}{\theta} \frac{\omega(1-p)}{\omega(p)} - \lambda t$. Maximization of the objective function entails the following domain-specific optimal declaration:

$$\begin{aligned} D^* &= 0 \text{ if } s < \tilde{s}, \quad D^* \in \left[0, W\left(1 - \frac{\Delta}{\lambda t + s}\right)\right] \text{ if } s = \tilde{s} \quad (5.21) \\ &\text{and } D^* = W \left[1 - \frac{\Delta}{\lambda t + s}\right] \text{ if } s > \tilde{s} \end{aligned}$$

If the taxpayer is in the domain of gains when she is audited, from (5.18) we have $X_C \geq 0 \implies D \geq W \left[1 - \frac{\Delta}{\lambda t + s}\right]$. Her income levels relative to the reference point in the no-audit and audit states, respectively, are given by the following:

$$\begin{aligned} X_{NC} &= t(W - D) + W\Delta > 0 \quad (5.22) \\ X_C &= W\Delta - [W - D][\lambda t + s] \geq 0 \end{aligned}$$

The taxpayer is in the domain of gains irrespective of the state occurrence. In this case, the decision weights add up to 1 and the weight for the larger gain is derived first. Thus, $\pi(X_C) = 1 - \omega(1-p)$ and $\pi(X_{NC}) = \omega(1-p)$. Using (4.1) and (5.22), the taxpayer maximizes the following:

$$\begin{aligned} V &= [1 - \omega(1-p)]\{W\Delta - [W - D][\lambda t + s]\} \quad (5.23) \\ &\quad + \omega(1-p)[t(W - D) + W\Delta] \\ &= [W - D]\{t\omega(1-p) - [\lambda t + s][1 - \omega(1-p)]\} + W\Delta \end{aligned}$$

Let $s = \check{s}$ be the critical stigma rate satisfying the equality $t\omega(1-p) - [\lambda t + s][1 - \omega(1-p)] = 0$. Hence, the critical stigma rate is $\check{s} = t \frac{\omega(1-p)}{1 - \omega(1-p)} - \lambda t$ and maximization

of the objective function in (5.23) results in the following domain-specific optimal declaration:

$$D^* = W \left[1 - \frac{\Delta}{\lambda t + s} \right] \text{ if } s < \check{s}; \quad D^* \in \left[W \left(1 - \frac{\Delta}{\lambda t + s} \right), W \right] \text{ if } s = \check{s} \quad (5.24)$$

and $D^* = W$ if $s > \check{s}$

The comparison of the domain-specific results in (5.21) and (5.24) reveals the global optimum. Given the empirically more plausible condition $\frac{1-\omega(1-p)}{\omega(p)} < \theta$, we get $\tilde{s} < \check{s}$. There are three possibilities to consider: $s < \tilde{s} < \check{s}$, $\tilde{s} < s < \check{s}$ and $\tilde{s} < \check{s} < s$.

1. Suppose $s < \tilde{s} < \check{s}$. Then in the first case, where $X_C \leq 0$, it is optimal to conceal all income and in the second case, where $X_C \geq 0$, a taxpayer finds it optimal to declare $D^* = W \left[1 - \frac{\Delta}{\lambda t + s} \right]$. Note that the later option is also available in the first case but not chosen, implying that $D^* = 0$ is the global maximum and the audited taxpayer is in the domain of losses.
2. When $\tilde{s} < s < \check{s}$, the optimal choice, $D^* = W \left[1 - \frac{\Delta}{\lambda t + s} \right]$, is identical under the both cases. Without loss of generality, the audited taxpayer is considered to be in the domain of gains in this case.
3. Suppose $\tilde{s} < \check{s} < s$. In the first case, $D^* = W \left[1 - \frac{\Delta}{\lambda t + s} \right]$ is the optimal choice. Observe that this option is also available in the second case but $D^* = W$ is chosen there. Hence, $D^* = W$ is the global maximum and the audited taxpayer is in the domain of gains.

The results are summarized in the following proposition.

Proposition 5.3 *A taxpayer optimally declares: $D^* = 0$ if $s < \tilde{s} < \check{s}$, $D^* = W \left[1 - \frac{\Delta}{\lambda t + s} \right]$ if $\tilde{s} < s < \check{s}$ and $D^* = W$ if $\tilde{s} < \check{s} < s$.*

In the transition period, where the anticipation of the tax rate increase evokes adaptation, a taxpayer with low enough stigma cost of evasion finds it optimal to conceal all her income. Such taxpayer neglects possible losses she might incur if caught and maximizes gains for the no-audit state. For some moderate range of stigma, an interior optimum emerges and the optimal declaration depends on the stigma rate. A taxpayer with higher stigma rate declares more at the interior optimum. In this case, the behavior of a taxpayer is motivated by increasing gains for the no-audit state without incurring losses in the audit state. A taxpayer with high enough stigma declares full income and by doing so, she secures sure gain irrespective of the state occurrence.

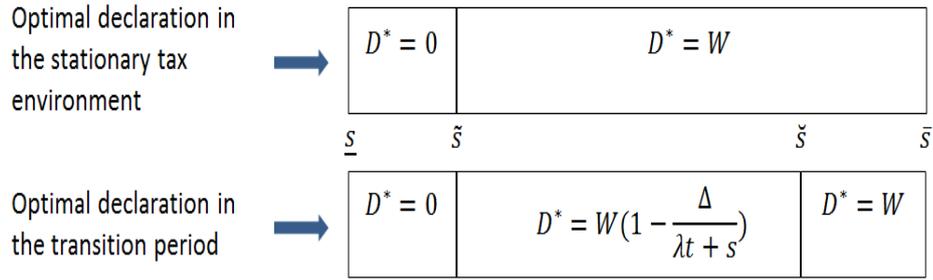


Figure 7: Optimal declaration in stationary and transition periods

Corollary 5.2 *The overall evasion increases in the aggregate adaptation magnitude, Δ . In each tax period of transition where the aggregate adaptation magnitude is non-zero, i.e., $\Delta > 0$, the aggregate evasion is higher compared to the stationary case.*

Proof. The adaptation magnitude does not affect optimal choice if stigma is very low, i.e. $s < \tilde{s} < \check{s}$, or very high, i.e., $\tilde{s} < \check{s} < s$. Optimal declaration decreases in Δ for the moderate values of stigma, $\tilde{s} < s < \check{s}$. Hence, the overall evasion increases in the aggregate adaptation magnitude, Δ , that proves the first part of *Corollary 5.2*. In light of the stationary solution, outlined in *Result 5.1*, *Proposition 5.3* suggests that the share of the taxpayers who conceal all income is the same as in the stationary case. Whereas, some proportion of honest taxpayers paying all the tax liabilities in the stationary case, start concealing some income in the transition period given positive adaptation magnitude, Δ (This can also be seen from *Figure 7*). Hence, the aggregate evasion is higher in the transition period. ■

The tax rate increase is an unfavorable event for a taxpayer, though the anticipation of the tax rate increase entails favorable transition environment where the taxpayer is still obliged to pay the lower old tax rate. Some, otherwise fully compliant, taxpayers revise their declaration decision downwards to fully utilize the favorable transition environment. Such taxpayers underdeclare their income to increase gains in the no-audit state without putting themselves in the domain of losses if audited. Hence, the anticipation of the tax rate increase raises evasion in the transition period when taxpayers adapt prematurely to the new tax environment.

5.3.2 Analysis of the Enforcement Period

This subsection provides an analysis of the optimal declaration decision after the enforcement of an increased tax rate. At first, the effect of the enforcement is investigated, assuming no further adjustment in the reference point. Then, the results are generalized to the case of hedonic adaptation after the enforcement.

Using (4.3) and $\bar{t}_T = t + \Delta$, the reference point of a taxpayer at the last period of transition is given by $R = W[1 - (t + \Delta)]$, where Δ is the aggregate adaptation magnitude by the last period of transition. The following assumptions are made: the adaptation magnitude is positive and the taxpayer is not fully adapted by the end of the transition, i.e., $0 < \Delta < t^* - t$. The applicable reference point in the enforcement period is the same as in the last period of transition.

By analogy with (2.1), at the enforcement period the taxpayer's income levels in the no-audit and audit states, respectively, are given by the following:

$$\begin{aligned} Y_{NC} &= W - t^*D & (5.25) \\ Y_C &= W(1 - t^*) - (\lambda t^* + s)(W - D) \end{aligned}$$

Income of the non-caught taxpayer relative to her reference point, R , is:

$$X_{NC} = Y_{NC} - R = W(t + \Delta) - t^*D \quad (5.26)$$

Whether the taxpayer is found in the domain of losses or gains when she is not audited, depends on her declaration decision, D .

When the taxpayer is audited, her income relative to the reference point is given by the following:

$$X_C = Y_C - R = W[\Delta - (t^* - t)] - (\lambda t^* + s)(W - D) < 0 \quad (5.27)$$

The audited taxpayer is found in the domain of losses, irrespective of her declaration, $D \in [0, W]$.

In order to find the optimal declaration, two cases should be considered. Firstly consider the case, where declaration decision is such that the non-audited taxpayer is found in the domain of gains, i.e., from (5.26) $X_{NC} \geq 0 \implies D \leq W \frac{t+\Delta}{t^*} < W$. In this environment, the following decision weights are applicable: $\pi(X_C) = \omega(p)$ and $\pi(X_{NC}) = \omega(1 - p)$. Using the piecewise linear utility function in (4.1) and

the objective function in (4.4), the taxpayer maximizes the following:

$$\begin{aligned}
V &= \omega(p)\theta\{W[\Delta - (t^* - t)] - (\lambda t^* + s)(W - D)\} & (5.28) \\
&\quad + \omega(1 - p)\{W(t + \Delta) - t^*D\} \\
&= \omega(p)\theta \times W\{\Delta - (t^* - t) - (\lambda t^* + s)\} \\
&\quad + \omega(1 - p) \times W(t + \Delta) \\
&\quad + D\{\omega(p)\theta(\lambda t^* + s) - \omega(1 - p)t^*\}
\end{aligned}$$

The domain-specific optimal declaration, when the non-audited taxpayer is bounded to be in the domain of gains, depends on the value of stigma. $\tilde{s}'' = \frac{t^*}{\theta} \frac{\omega(1-p)}{\omega(p)} - \lambda t^*$ is the critical stigma rate in this case. Then the taxpayer conceals all income if her stigma rate is lower than the critical stigma rate and if her stigma is higher than the critical, she declares maximum possible amount given the constraint of being in the domain of gains while not caught. Hence, the domain-specific optimal declaration is:

$$D^* = 0 \text{ if } s < \tilde{s}'' ; D^* \in [0, W \frac{t + \Delta}{t^*}] \text{ if } s = \tilde{s}'' \text{ and } D^* = W \frac{t + \Delta}{t^*} \text{ if } s > \tilde{s}'' \quad (5.29)$$

Now consider a declaration decision, such that the non-audited taxpayer is found in the domain of losses. That is, from (5.26) $X_{NC} \leq 0 \implies D \geq W \frac{t + \Delta}{t^*}$. The environment determines the applicable decision weights: $\pi(X_C) = \omega(p)$ and $\pi(X_{NC}) = 1 - \omega(p)$. Hence, using (4.1) and (4.4), the taxpayer maximizes the following objective function:

$$\begin{aligned}
V &= \omega(p)\theta\{W[\Delta - (t^* - t)] - (\lambda t^* + s)(W - D)\} & (5.30) \\
&\quad + [1 - \omega(p)]\theta\{W(t + \Delta) - t^*D\} \\
&= \omega(p)\theta \times W\{\Delta - (t^* - t) - (\lambda t^* + s)\} \\
&\quad + [1 - \omega(p)]\theta \times W(t + \Delta) \\
&\quad + \theta D\{\omega(p)(\lambda t^* + s) - [1 - \omega(p)]t^*\}
\end{aligned}$$

Define $\hat{s}' = t^* \frac{1 - \omega(p)}{\omega(p)} - \lambda t^*$ to be the critical stigma rate. Having stigma rate lower than the critical rate, entails declaration of the lowest possible income given the constraint of being in the domain of losses while not caught. A taxpayer with stigma rate higher than the critical, declares all income. Hence, the domain-

specific declaration is:

$$D^* = W \frac{t + \Delta}{t^*} \text{ if } s < \hat{s}'; \quad D^* \in [W \frac{t + \Delta}{t^*}, W] \text{ if } s = \hat{s}' \quad (5.31)$$

and $D^* = W$ if $s > \hat{s}'$

Given the empirically more plausible condition $\frac{\omega(1-p)}{1-\omega(p)} < \theta$, we get $\tilde{s}'' < \hat{s}'$. Then the comparison of the domain-specific maximums in (5.29) and (5.31) reveals the global optimum and leads to the following result.

Result 5.3 In the enforcement period of the increased tax rate, a taxpayer finds it optimal to declare the following: $D^* = 0$ if $s < \tilde{s}'' < \hat{s}'$; $D^* = W \frac{t+\Delta}{t^*}$ if $\tilde{s}'' < s < \hat{s}'$ and $D^* = W$ if $\tilde{s}'' < \hat{s}' < s$.

It is obvious from *Result 5.3* that evasion in the enforcement period decreases in Δ . Hence, higher adaptation by the end of the transition period entails relatively lower evasion in the enforcement period.

Proposition 5.4 Let $\omega(p) + \omega(1-p) \leq 1$. If the aggregate adaptation magnitude is low enough, such that $\Delta \leq \frac{\lambda t(t^*-t)}{\lambda t + t^*}$, then in the enforcement period evasion is unambiguously higher than the evasion in the last period of transition.

Proof. The condition $\omega(p) + \omega(1-p) \leq 1$ ensures that $\hat{s}' > \check{s}$, where $\check{s} = t \frac{\omega(1-p)}{1-\omega(1-p)} - \lambda t$ is the critical stigma for the transition period. Further observe that $\tilde{s}'' > \check{s}$. The resulting scenario is depicted by *Figure 8*. It is easy to see from the figure that, in the enforcement period more proportion conceals all and less proportion declares full income compared to the last period of transition. Furthermore, if $\Delta \leq \frac{\lambda t(t^*-t)}{\lambda t + t^*}$, we get that $W \frac{t+\Delta}{t^*} \leq W [1 - \frac{\Delta}{\lambda t + s}]$ for any $s \geq 0$ and hence evasion in the enforcement period is unambiguously higher than the evasion in the last period of transition. ■

According to *Corollary 5.2*, the overall evasion in the transition period increases in adaptation magnitude, Δ ; whereas, *Result 5.3* suggests that stronger feedforward effect during the transition period results in smaller evasion in the enforcement period. Hence, the evasion increase in the transition period can be interpreted as a substitute for the evasion spike in the enforcement period. As an example, firstly consider the extreme case of no feedforward effect, implying $\Delta = 0$ in the last period of transition. Then, compared to the stationary case evasion is unchanged throughout the transition period. On the other hand this implies highest possible evasion in the enforcement period. Now consider full adaptation

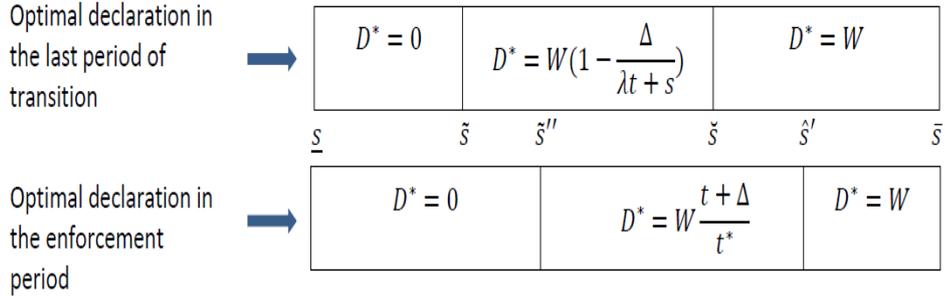


Figure 8: Optimal declaration in transition and enforcement periods

by the end of the transition, implying highest possible evasion in the last period of transition and the lowest possible evasion in the enforcement period.

The results of the enforcement period can be generalized to any tax period after the enforcement by considering current stimulus-based hedonic adaptation, starting from the enforcement period. The general form of hedonic adaptation induced by the current stimulus can also be described by (4.2), where now t^* is the enforced new tax rate and it is interpreted as the current stimulus. Consider any tax period after the enforcement and a taxpayer with the aggregate adaptation magnitude, Ω , such that $0 < \Omega \leq t^* - t$. The aggregate adaptation magnitude, induced by the feedforward effect, by the last period of transition is $0 < \Delta < t^* - t$. The current stimulus-based hedonic adaptation entails additional adaptation of $0 \leq \Omega - \Delta \leq t^* - t$. Then we have the generalization of *Result 5.3*, which is restated as follows.

Result 5.3a In any period after enforcement and Ω being the adaptation magnitude in that period, it is optimal to declare: $D^* = 0$ if $s < \tilde{s}'' < \hat{s}'$; $D^* = W \frac{t+\Omega}{t^*}$ if $\tilde{s}'' < s < \hat{s}'$ and $D^* = W$ if $\tilde{s}'' < \hat{s}' < s$.

Similarly, *Proposition 5.4* is generalized as follows.

Proposition 5.4a Let $\omega(p) + \omega(1-p) \leq 1$. If the aggregate adaptation magnitude (induced by feedforward effect) is low enough by the end of the transition period, so that $\Delta \leq \frac{\lambda t(t^* - t)}{\lambda t + t^*}$, then the overall evasion spikes in the enforcement period and falls in the subsequent periods as a consequence of further,

current stimulus-based hedonic adaptation. In any period with full adaptation, $\Omega = t^ - t$, aggregate evasion is higher than the evasion in the stationary case.*

Proof. The first part of *Proposition 5.4a* is directly related to *Proposition 5.4* and is obvious. As for the second part of the proposition, firstly suppose the full adaptation occurs before the enforcement, $\Omega = \Delta = t^* - t$. Then using *Corollary 5.2*, the evasion is higher compared to the stationary case. If the full adaptation occurs after the enforcement, using *Result 5.3a*, it is optimal to declare $D^* = 0$ if $s < \tilde{s}''$ and $D^* = W$ if $s > \tilde{s}''$. Given that $\tilde{s}'' > \tilde{s}$, more proportion of taxpayers conceals all income when the tax rate is higher. ■

The result is interesting in two ways. Firstly, it is consistent with the evidence that evasion increases in the tax rate. Secondly, the tax rate increase has permanent effect on evasion suggesting that the overall evasion in the stationary environment is higher, if the tax rate is higher. In this respect, the result contradicts the finding of Bernasconi et al. (2014) that in the long run the tax rate increase has no effect on evasion. The explanation of this contradiction lies in the different set-ups of the two theoretical models. Unlike to Bernasconi et al. (2014), who investigate tax compliance behavior of a representative taxpayer at the interior optimum, this chapter studies the aggregate tax compliance behavior of a continuum of taxpayers.

6 Concluding Remarks

The reduced form cumulative prospect theory with piecewise linear utility function in conjunction with hedonic adaptation leads to the clear-cut implications in the context of tax evasion. The analysis presented in the chapter suggests that evasion in the transition period increases following the announcement of the tax rate reduction or increase. The anticipation of tax changes does not incentivize the full tax evader to revise her declaration decision during the transition period. The behavior of the fully compliant taxpayer with moderately high stigma is found to be affected by the announcement.

Reduction of the tax rate is the favorable event as it relieves the tax burden on the fully compliant taxpayer. The premature, feedforward-based adaptation to the favorable event occurring in the future makes the current environment unfavorable. Hence, the announcement of the tax rate reduction generates unfavorable transition environment for the taxpayer, making her revise optimal declaration

downwards. Her choice to underdeclare is motivated by avoiding losses in the no-audit state. The anticipation of the unfavorable increase in the tax rate makes the transition environment favorable and evasion attractive for otherwise fully compliant taxpayer with moderately high stigma. Such taxpayer underdeclares her income to increase gains in the no-audit state without putting herself in the domain of losses if audited. Hence, the anticipation of the tax rate reduction increases evasion in order to mitigate the effect of unfavorable transition environment, while the anticipation of the tax rate increase facilitates evasion to fully utilize the favorable transition environment. The results potentially explain why, in most cases, policy makers introduce and implement tax changes within a tax year, avoiding transition period and the related spike in evasion.

Hedonic adaptation literature, outlined in section 3, suggests that the adaptation rate to favorable events is higher than to unfavorable events. Hence, one might expect that the feedforward-based adaptation is stronger while anticipating the tax rate reduction than the tax rate increase. Strong enough adaptation during the transition period entails drop in evasion following the enforcement of the reduced tax rate. Evasion continues reduction in the subsequent periods as a consequence of further, current stimulus-based hedonic adaptation (*Proposition 5.2a*). Ultimately, at the new stationary environment with lower tax rate, evasion is lower compared to the previous stationary environment with higher tax rate. Hence, a reduction in the tax rate reduces evasion in the long run. Weak adaptation during transition period entails spike in evasion following the enforcement of the increased tax rate. Evasion declines in the subsequent periods, though at the new stationary environment evasion is higher compared to the evasion at the preceding stationary environment (*Proposition 5.4a*). Thus, an increase in the tax rate increases evasion in the long run.

One might ask a question, in which transition environment is evasion higher for identical adaptation regimes? The model predicts that for $\lambda \geq 1$ and the same adaptation magnitude Δ under the two scenarios, aggregate evasion in the transition period is unambiguously higher when the tax rate reduction is anticipated compared to the transition period, where the tax rate increase is anticipated. The result follows from *Proposition 5.1* and *Proposition 5.3*. Hence, evasion under the unfavorable transition environment is higher than evasion under the favorable transition environment even for the identical adaptation regimes.

At last, it needs to be mentioned that there is no direct evidence for the existence of feedforward effect in the context of tax evasion and empirical research has to be done in this respect.

Chapter IV

A Model of Tax Evasion with Endogenous Social Norms

1 Introduction

Economic models of human behavior mainly consider behavior as an outcome of individual choice and heavily use expected utility theory (EU). Theoretical models of tax compliance are not the exception. However, there is a mismatch between the observed levels of tax compliance and the one predicted by EU.

The majority of theoretical works model tax compliance behavior of a taxpayer as an EU-maximizing choice of a risky evasion lottery. A typical model of tax compliance considers a self-oriented economic agent facing monetary (dis)incentives for compliance. A taxpayer pays taxes on his declared income. The tax authority does not observe the true income of the taxpayer unless an audit is carried out, in which case the true income is learnt with certainty. If the taxpayer is caught underreporting his income, he has to pay the evaded taxes and a penalty. Tax evasion is successful if an audit does not occur. Therefore, the taxpayer decides what amount of income to declare given the tax environment that is characterized by the tax rate, the penalty rate and the probability of an audit. By considering only monetary (dis)incentives for compliance, the model predicts too much evasion relative to the empirically observed levels and generates a puzzling question - why do people pay taxes? (Alm et al., 1992; Alm and Torgler, 2011)

Unlike economics, in sociology and social psychology individual behavior is not purely an outcome of individual choice but also an outcome of the social interaction. Individuals, as members of social groups, look at the behavior of others and care about what is acceptable in a social context while making their decisions (Cullis and Lewis, 1997). The concept of a *social norm* is notably relevant here. Social norm is distinguished by the feature that it is process-oriented, rather than outcome-oriented. Social norm is shared by a group of individuals and violation of it induces feeling of guilt, shame, embarrassment and anxiety. Obeying a social norm may also generate positive emotions (Elster, 1989).²⁶

The relevance of social norms has been documented in the tax compliance context. Alm et al., (1999) provide an experimental evidence for the central role of

²⁶For similar definitions see Lindbeck (1995) and Posner and Rasmusen (1999).

social norms in tax compliance behavior. At the start of their experiment subjects face fixed values of the tax rate, the penalty rate and the probability of an audit. After several rounds subjects choose between two alternative levels of a single fiscal parameter at a time via secret majority voting, while the remaining two parameter levels are kept unchanged. In the next rounds subjects face parameter values of the voting outcome. The results show that the rejection of stricter sanctions on evasion by a group of taxpayers increases evasion in the post-vote rounds. The rejection sends a signal that evasion is more acceptable in the group and the social norm of compliance is weak, therefore individual taxpayers evade more in the post-vote rounds. When pre-vote communication is allowed, subjects vote for stricter enforcement and the post-vote compliance increases. The authors conclude that the group's statement on enforcement acts as a signal about the social norm of compliance for individual taxpayers who then act accordingly. Based on the analysis of a large survey data-set, Wenzel (2004) suggests that the social norm of compliance is effective only in a structured social field. Taxpayers are found to identify themselves with a social group and then internalize social norms that are attributed to this group.²⁷ Tax compliance behavior of others is found to be normative for a taxpayer when others are regarded as a reference group. Ostrom (2000) argues that social norms are more effective in a group with communication opportunities between its members. Onu and Oats (2016) analyze online interactions between web-designers regarding tax matters. The authors categorize interactions based on the information content of online discussions. Stating norms of compliance is identified as one of the interaction category. The authors suggest that the action of stating norms to generate compliance indicates the importance of social norms in tax compliance behavior. Casal and Mittone (2016) provide an experimental evidence on the effectiveness of non-monetary (dis)incentives in increasing tax compliance. In their experiment non-monetary (dis)incentives are generated by publicly announcing audited taxpayers' tax compliance behavior. The results show that a negative non-monetary incentive, such as publicizing tax evaders' identities, is more effective in increasing tax compliance than a positive non-monetary incentive, such as publicizing identities of fully compliant taxpayers. The authors argue that the negative non-monetary incentive should be more effective in a community with widespread compliance and the positive non-monetary incentive should be more effective in a community with widespread evasion.²⁸

²⁷This finding is in line with the theory of social identity, see e.g., Benjamin et al. (2010).

²⁸Some US states practice 'name and shame' programs in which the names of top debtors are publicly revealed, whereas some developing countries have programs in which the names of com-

The traditional models' failure in explaining empirically observed levels of compliance has motivated theorists to consider non-monetary incentives as additional factors of compliance. The analysis has been extended within EU framework by allowing an additive preference structure of the following form:

$$U(D, W, t, p, \lambda) = E[u(D, W, t, p, \lambda)] + S([W - D], n) \quad (1.1)$$

where $E[u(\cdot)]$ represents expected utility of an evasion lottery, when a taxpayer with the income level W reports the amount D for given levels of the tax rate, t , the penalty rate, λ , and the probability of an audit, p . Non-monetary incentives for compliance are captured by the term $S(\cdot)$, that is a function of one's own evaded income $[W - D]$ and the share of evaders in the society, n . For example, Gordon (1989) considers the following linear functional form of $S(\cdot)$:

$$S([W - D], n) = -[W - D][a + b[1 - n]] \quad (1.2)$$

where $a > 0$ is an individual-specific marginal 'private stigma' from evasion and $b[1 - n]$, with another individual-specific parameter $b > 0$, is referred to as the marginal 'social stigma' from evasion. A taxpayer who evades the amount of income $[W - D]$ suffers total private stigma of $a[W - D]$ and the social stigma of $b[1 - n][W - D]$, that is decreasing in the fraction of evaders in the society, n .

Traxler (2010) suggests a more general functional form of $S(\cdot)$, that captures non-monetary incentives for compliance:

$$S([W - D], n) = -\delta[W - D]f(n) \quad (1.3)$$

where $\delta > 0$ is an individual-specific 'degree of norm internalization' and the continuous function $f(n)$ captures the strength of the social norm of compliance in the society. $f(\cdot)$ is assumed to have the following properties, $0 < f(n) < \infty$ and $f'(n) \leq 0$ for $n \in [0, 1]$. Therefore, if the fraction of evaders is high, the social norm of compliance is weak and the marginal non-monetary cost of evasion is low for a taxpayer.

A similar approach is taken by Myles and Naylor (1996), who analyze a social custom of compliance, assuming that a fully compliant taxpayer derives strictly positive conformity payoff that is decreasing in the fraction of evaders in the society. If a taxpayer evades some income, he gets zero conformity payoff.

The literature that analyzes the interplay between economic incentives and so-
 pliant taxpayers are publicized (Luttmer and Singhal, 2014).

cial norms in the context of tax compliance (e.g., Gordon, 1989 and Traxler, 2010), can explain why some people never evade taxes. Such models predict higher compliance levels than the models that consider economic incentives only. Yet, there are several challenges these models fail to address. First, it is only the fraction of evaders, not the magnitude or extent of evasion, that signals the strength of the social norm of compliance in these models. For instance, if in one case fraction n of taxpayers evades half of their income (fraction $[1 - n]$ being fully compliant) and in another case, the same fraction n evades all their income, nevertheless the strength of social norms would be identical in the two cases. Therefore, the model should consider not only the fraction of evaders, but also the volume or extent of evasion as a measure for the strength of the social norm of compliance. Second, existing models either consider only social stigma and guilt from non-compliance with the norm (e.g., Traxler, 2010) or conformity payoff from compliance with the norm (e.g., Myles and Naylor, 1996), whereas evidence shows that guilt and esteem are both important components of compliance behavior (e.g., Casal and Mittone, 2016). Lastly, virtually all the tax compliance models using EU fail to correctly predict the tax rate-compliance relation. Empirical evidence shows that evasion increases in the tax rate (e.g. Clotfelter, 1983; Pudney et al., 2000), whereas theoretical models using EU either predict the inverse (e.g., Yitzhaki, 1974) or ambiguous relationship between compliance and the tax rate (See Andreoni et al., 1998; Sandmo, 2005 and Slemrod, 2007 for surveys).

This chapter suggests an alternative theoretical approach to the social norm of compliance and develops a model of tax compliance using prospect theory of Kahneman and Tversky (1979) and Tversky and Kahneman (1992). To the best of my knowledge, this is the first work that formalizes the social norm of compliance in the prospect theory framework.²⁹ The model builds upon the following main assumptions:

1. A taxpayer internalizes norm of compliance that is attributed to his reference income group (consistent with Wenzel, 2004).
2. A taxpayer cares about his performance relative to the average compliance level in his reference income group. Falling below the average declaration induces guilt that exceeds, in absolute value, esteem derived from higher income declaration of the equivalent magnitude relative to the average (consistent with Casal and Mittone, 2016).

²⁹Alm and Torgler (2011) discuss the relevance of prospect theory and argue that social norms might affect a taxpayer's reference point. Cullis et al. (2012) informally discuss the importance of prospect theory in explaining the effects of social norm on compliance.

3. A taxpayer treats his legal after-tax income as a reference point for economic outcomes (Dhami and al-Nowaihi, 2007) and regards the average compliance of his reference income-group as a reference point for societal outcomes.
4. Taxpayers have heterogeneous preferences in the sense that the relative weight given to the economic and the societal outcomes may differ for each taxpayer.

By considering a continuum of heterogeneous taxpayers, the model enables us to endogenously derive the equilibrium level of the average group compliance and the related strength of the social norm. Consistent with evidence, the model suggests that the equilibrium level of an average group compliance decreases in the tax rate and increases in the tax enforcement parameters - the penalty rate and the probability of an audit. Therefore, *ceteris paribus*, an increase in the tax rate weakens the norm of compliance, whereas the norm is stronger under the stricter tax enforcement regime.

The rest of the chapter is structured as follows. Section 2 presents the model. Section 3 considers the compliance problem of an individual taxpayer. Section 4 derives the equilibrium group behavior with heterogeneous taxpayers and Section 5 concludes.

2 The Model

An individual has exogenously given income level W , that is subject to tax. The flat tax rate $t \in (0, 1)$ is levied on the declared income $D \in [0, W]$. The tax authority carries out random income audits, and if the taxpayer is caught underreporting his income, he has to pay the evaded taxes and a penalty. The probability of an audit, $p \in (0, 1)$, is assumed to be exogenously given to the taxpayer and it is independent of the declared income. If the taxpayer is not audited, his after-tax income is given by the following:

$$Y_{NA} = W - tD \tag{2.1}$$

and in case of an audit, the disposable income of the taxpayer is:

$$Y_A = [1 - t]W - \lambda t[W - D] \tag{2.2}$$

where $\lambda > 0$ denotes the penalty rate and $\lambda t[W - D]$ is the total penalty that is proportional to the evaded taxes.

A taxpayer's preferences over the monetary and social outcomes are given by the following form:

$$U(Y, R, D, \bar{D}_W^b, \beta) = [1 - \beta]v(Y - R) + \beta u(D - \bar{D}_W^b) \quad (2.3)$$

The explanation of (2.3) is as follows. $v(\cdot)$ is the prospect theory value function defined over the difference between the after-tax income, Y , and the reference income level, R . Monetary (dis)incentives for compliance are captured by $v(\cdot)$ in the model. $u(\cdot)$ is another value function that embodies the taxpayer's societal incentives for compliance. The argument of $u(\cdot)$ is the difference between the taxpayer's declared income, D , and his belief about the average declaration in his reference income group, \bar{D}_W^b . The parameter $0 \leq \beta \leq 1$ captures the relative importance of societal outcomes in the preferences. For the sake of clear exposition, the value functions are assumed to be piecewise linear. The value function embodying monetary (dis)incentives for compliance is given by the following:

$$v(x) = \begin{cases} x, & \text{if } x \geq 0 \\ \theta x, & \text{if } x < 0 \end{cases} \quad (2.4)$$

where x is income relative to the reference income level. When $x \geq 0$, an individual is in the domain of gains, otherwise he is in the domain of losses. $\theta > 1$ is the loss aversion parameter, manifesting that the absolute value of disutility from loss is greater than utility from the equivalent gain.

The value function embodying societal incentives for compliance has the following form:

$$u(d) = \begin{cases} d, & \text{if } d \geq 0 \\ \gamma d, & \text{if } d < 0 \end{cases} \quad (2.5)$$

where d is the difference between a taxpayer's own declared income, D , and his perception of the average declaration in the reference income group, \bar{D}_W^b . The taxpayer experiences esteem if he declares higher income than his belief about the average declaration in his income group and suffers guilt if he falls below his belief about the average. $\gamma > 1$ is the guilt aversion parameter. Hence, falling below the average declaration induces sensation of guilt that exceeds, in absolute value, esteem derived from higher income declaration of the equivalent magnitude relative to the average. The guilt aversion formulation in the context of tax compliance is consistent with the recent experimental evidence. Casal and Mittone (2016) find

that a negative non-monetary incentive, such as publicizing tax evaders' identities, is more effective in increasing tax compliance than a positive non-monetary incentive, such as publicizing identities of fully compliant taxpayers. In light of a continuum of taxpayers, as it is specified below, on margin a taxpayer's declaration decision does not affect other taxpayers' utilities, therefore this paper abstracts from the psychological game theoretic considerations of guilt.³⁰

The suggested formulation of preferences captures the essence of the social norm of compliance. Consistent with empirical evidence (e.g., Wenzel, 2004), the social norm of compliance is effective if an individual identifies himself with a reference group to which the norm is attributed. Once identified, the positive effect of the social norm is mediated by internalization of the norm. Wenzel (2004) suggests that "people could consider their occupational group or their income group to be more important in the area of tax." Alm et al. (1999) write: "The stronger is the social norm, the more deviant the behavior of a non-compliant individual becomes, and the more loss the individual feels" (page 149). In line with these insights, higher is the average compliance in the reference income group and hence, beliefs about this average, \bar{D}_W^b , greater is the societal incentive to revise one's own declaration. Conversely, stronger is the social norm of compliance in the income group, ceteris paribus, lower is the overall evasion and thus, higher is the average declaration in the given group. The importance of the norm in individual compliance behavior is determined by the following two factors. First, exogenously given individual-specific parameter, β , that can be interpreted as the degree of norm internalization. Second, one's belief about the average income declaration in his income group.

It is assumed that a taxpayer's reference income is equal to his legal-after tax income (status-quo). Hence:

$$R = [1 - t]W \quad (2.6)$$

The specification of the reference income in (2.6) is adopted from Dhimi and al-Nowaihi (2007), who advocate the legal after-tax income as a reference income level in the prospect theory framework. The authors show that for all declaration levels, $D \in [0, W]$, a non-audited taxpayer is in the domain of gains and an audited taxpayer is in the domain of losses if and only if the legal after-tax income is the reference point, i.e., $R = [1 - t]W$. Adherence to this specification of the reference

³⁰In psychological game theoretic models an individual's utility depends, not only on monetary payoffs from actions, but also on his beliefs about other individual's actions (first order belief) and on his beliefs about other individual's beliefs (second order belief). An individual may experience guilt if he lets another player down, based on her second order belief. See e.g., Battigalli and Dufwenberg (2007, 2009) for modelling guilt in psychological game theoretic framework.

income is of decisive importance to predict the empirically correct compliance-tax rate relation.

A taxpayer, who considers underreporting his income because of pure monetary incentives, cares about the position of his after-tax income relative to the reference point. Using (2.1), (2.2), (2.6) and recalling that $D \in [0, W]$, the after-tax income of a non-audited taxpayer and the after-tax income of an audited taxpayer relative to the reference point are given by (2.7) and (2.8), respectively:

$$x_{na} = t[W - D] \geq 0 \quad (2.7)$$

$$x_a = -\lambda t[W - D] \leq 0 \quad (2.8)$$

Consistent with empirical evidence (e.g., Kahneman and Tversky, 1979; Tversky and Kahneman, 1992), a taxpayer overweights low probabilities and underweights high probabilities. Using a probability weighting function $\omega(\cdot)$, that is continuous and strictly increasing function from $[0, 1]$ onto $[0, 1]$ with $\omega(0) = 0$ and $\omega(1) = 1$, the weights given to the audit and non-audit probabilities are $\omega(p)$ and $\omega(1 - p)$, respectively.³¹

The model is closed by considering a continuum of taxpayers, with heterogeneous pretax income levels and individual-specific parameter values, β . Taxpayers are located on the unit square $\Omega(\beta, z) = [0, 1] \times [0, 1]$, where z is a locational label of an individual taxpayer. Pretax income is given by the density function $W(z)$. Apart from the parameter tuple (β, z) , taxpayers are identical. The loss aversion parameter, θ , and the guilt aversion parameter, γ , are the same for all individuals and the preferences of each taxpayer are represented by (2.3).

3 The Taxpayer's Compliance Problem

Consider a taxpayer who is located at the point (β, z) of the unit square Ω . Given his income level, $W(z)$, parameter values of p, t, λ, β and the probability weighting function $\omega(\cdot)$, the taxpayer chooses the optimal amount of income to declare, D . Using (2.3), the taxpayer maximizes the following:

$$V = [1 - \beta] \{ \omega(p)v(Y_A - R) + \omega(1 - p)v(Y_{NA} - R) \} + \beta u(D - \bar{D}_W^b) \quad (3.1)$$

³¹Here it is assumed that the probability weighting function for losses is the same as the one for gains, which need not be true in general.

From (2.1), (2.2), (2.6) and (3.1) we get:

$$V = [1 - \beta] \{ \omega(p)v(x_a) + \omega(1 - p)v(x_{na}) \} + \beta u(D - \bar{D}_W^b) \quad (3.2)$$

where $x_{na} \geq 0$ and $x_a \leq 0$ are given by (2.7) and (2.8), respectively.

The taxpayer's preferences consist of two domains - economic and social, which bear respective weights of $[1 - \beta]$ and β . The taxpayer is under the risk of audit, if he evades taxes. If the evasion gets detected, the taxpayer is in the domain of losses, $x_a \leq 0$, otherwise, he is in the domain of gains, $x_{na} \geq 0$. The decision weights of $\omega(p)$ and $\omega(1 - p)$ are assigned to the audit and non-audit outcomes, respectively.³² Hence, monetary (dis)incentives for compliance are captured by the term $\{ \omega(p)v(x_a) + \omega(1 - p)v(x_{na}) \}$. Societal incentives for compliance are captured by the value function $u(D - \bar{D}_W^b)$. In the social domain, the taxpayer compares his own declared amount, D , with his belief about the average declaration in his income group.

From (2.4), (2.7), (2.8) and (3.2) we obtain:

$$V = [1 - \beta] \{ -\omega(p)\theta\lambda t[W - D] + \omega(1 - p)t[W - D] \} + \beta u(D - \bar{D}_W^b) \quad (3.3)$$

Rearranging (3.3) results in:

$$V = [1 - \beta] \times t[W - D] \{ \omega(1 - p) - \omega(p)\theta\lambda \} + \beta u(D - \bar{D}_W^b) \quad (3.4)$$

Let $I = \{ \omega(1 - p) - \omega(p)\theta\lambda \}$. Note that the value of I decreases in the tax enforcement parameters, p (because $\omega(\cdot)$ is strictly increasing function) and λ . Therefore, stronger is the tax enforcement because of higher probability of an audit or higher penalty rate, lower is I . Hence, I represents the strength of the tax enforcement regime. (3.4) can be rewritten as:

$$V = [1 - \beta] \times t[W - D]I + \beta u(D - \bar{D}_W^b) \quad (3.5)$$

Note that, if $I \leq 0$, the taxpayer optimally declares all his income, W , $\forall \beta \in [0, 1]$. Assuming $I > 0$,³³ the taxpayer declares the amount of income $D \in [0, W]$, that maximizes (3.5).

Proposition 3.1 *Suppose $I > 0$. Then a taxpayer optimally declares $D^* = 0$ if $\beta <$*

³²For a two-outcome lottery, decision weights coincide with probability weights.

³³For the realistic parameter values, $0 < I < 1$. E.g., for the following parameter values, taken from Dhimi and al-Nowaihi (2007), $p = 0.03$, $\theta = 2.25$, $\lambda = 1$ and the probability weighting function $\omega(p) = e^{-(-\ln p)^{0.5}}$, $I \approx 0.49$.

$\frac{tI}{\gamma+tI}$, $D^* = \bar{D}_W^b$ if $\frac{tI}{\gamma+tI} < \beta < \frac{tI}{1+tI}$ and $D^* = W$ if $\beta > \frac{tI}{1+tI}$

Proof. Firstly consider the case $D \geq \bar{D}_W^b$. Then, using (2.5) and (3.5) we get:

$$V = [1 - \beta] \times t[W - D]I + \beta[D - \bar{D}_W^b] \quad (3.6)$$

Rearranging the right hand side of (3.6) gives:

$$V = D \{\beta - t[1 - \beta]I\} + t[1 - \beta]WI - \beta\bar{D}_W^b \quad (3.7)$$

For $D \geq \bar{D}_W^b$, the expression in (3.7) achieves its maximum at $D = \bar{D}_W^b$ if $\beta < \frac{tI}{1+tI}$ or at $D = W$ if $\beta > \frac{tI}{1+tI}$.

Next consider the case $D \leq \bar{D}_W^b$. Then, using (2.5) and (3.5) we have:

$$V = [1 - \beta] \times t[W - D]I + \beta\gamma[D - \bar{D}_W^b] \quad (3.8)$$

(3.8) can be written as:

$$V = D \{\beta\gamma - t[1 - \beta]I\} + t[1 - \beta]WI - \beta\gamma\bar{D}_W^b \quad (3.9)$$

For $D \leq \bar{D}_W^b$, the expression in (3.9) is maximized at $D = 0$ if $\beta < \frac{tI}{\gamma+tI}$ or at $D = \bar{D}_W^b$ if $\beta > \frac{tI}{\gamma+tI}$.

Given $\gamma > 1$, it follows that $\frac{tI}{\gamma+tI} < \frac{tI}{1+tI}$. For $\beta < \frac{tI}{\gamma+tI} < \frac{tI}{1+tI}$, it is optimal to declare \bar{D}_W^b under the first case, where $D \geq \bar{D}_W^b$, but 0 under the second case, where $D \leq \bar{D}_W^b$. Note that the option \bar{D}_W^b is also available in the second case, but not optimal to choose. Hence, $D^* = 0$ for $\beta < \frac{tI}{\gamma+tI} < \frac{tI}{1+tI}$.

For $\frac{tI}{\gamma+tI} < \beta < \frac{tI}{1+tI}$, it is optimal to declare \bar{D}_W^b under the both cases, thus $D^* = \bar{D}_W^b$.

And finally, for $\frac{tI}{\gamma+tI} < \frac{tI}{1+tI} < \beta$, we see that the optimal declaration amount under the second case is available but not optimal to choose under the first case, implying $D^* = W$. ■

A taxpayer with sufficiently low degree of norm internalization, $\beta < \frac{tI}{\gamma+tI}$, declares zero income and such behavior is driven by pure monetary incentives for evasion. A taxpayer with high enough degree of norm internalization, $\beta > \frac{tI}{1+tI}$, declares all income, W , and by doing so he avoids guilt if he believes that all the taxpayers in his reference income group are honest, $\bar{D}_W^b = W$, or derives esteem if $\bar{D}_W^b < W$. For the moderate values of β , the amount of declared income is solely determined by a taxpayer's belief about the average declaration in his income group. In this case, the taxpayer ensures that he declares enough to avoid

guilt, $D^* = \bar{D}_W^b$. Hence, on an aggregate level there are three types of taxpayers - unconditional evaders who neglect the social norm, unconditionally fully compliant taxpayers who neglect monetary incentives for evasion and conditionally compliant taxpayers who condition their compliance decision on the group average declaration. Therefore, the model is able to explain why some people never evade taxes even in the existence of strong monetary incentives for evasion.

4 Equilibrium Group Compliance and Social Norms

Now we are able to investigate the equilibrium tax compliance behavior of an income group of taxpayers. Beliefs of each taxpayer about the average reference group compliance are required to be correct at the equilibrium, i.e., $\bar{D}_W^b = \bar{D}_W$, where \bar{D}_W is the actual average declaration of the group. Recalling that the continuum of taxpayers are located on the unit square $\Omega(\beta, z)$, we have uniformly distributed β -s in each income group, $W(z)$. Then using *Proposition 3.1*, beliefs are correct if the following holds:

$$\bar{D}_W = \int_0^1 D^* d\beta = \int_{\beta_1}^{\beta_2} \bar{D}_W d\beta + \int_{\beta_2}^1 W d\beta \quad (4.1)$$

where, $\beta_1 = \frac{tI}{\gamma+tI}$ and $\beta_2 = \frac{tI}{1+tI}$.

At the equilibrium, β_1 share of the taxpayers with income level W declares zero income; $[\beta_2 - \beta_1]$ share of the taxpayers declares the average of the group, \bar{D}_W , and the remaining share, $[1 - \beta_2]$, declares all income, W . From (4.1) *Proposition 4.1* follows.

Proposition 4.1 *There exists a unique equilibrium $\bar{D}_W^b = \bar{D}_W = \frac{1-\beta_2}{\beta_1+1-\beta_2}W$, where $\beta_1 = \frac{tI}{\gamma+tI}$ and $\beta_2 = \frac{tI}{1+tI}$.*³⁴

Proof. From (4.1) we get:

$$\begin{aligned} \bar{D}_W &= [\beta_2 - \beta_1]\bar{D}_W + [1 - \beta_2]W \Rightarrow \\ \bar{D}_W &= \frac{1 - \beta_2}{\beta_1 + 1 - \beta_2}W \end{aligned} \quad (4.2)$$

³⁴For the general case, where β -s are distributed according to the cumulative distribution function $F(\beta)$ over the $[0, 1]$ interval, the equilibrium is $\bar{D}_W^b = \bar{D}_W = \frac{1-F(\beta_2)}{1-F(\beta_2)+F(\beta_1)}W$.

■

Note that the equilibrium value of the average declaration amount, \bar{D}_W , increases in the share of fully compliant taxpayers in the group, $[1 - \beta_2]$, and decreases in the share of the taxpayers who evade all income, β_1 . Therefore, higher is the share of fully compliant taxpayers in the group, stronger is the social norm of compliance and higher is the share of the taxpayers who evade all income, weaker is the social norm.

The compliance behavior of taxpayers is affected by the tax policy parameters - the tax rate, t , the probability of an audit, p , and the penalty rate λ . The equilibrium effects of these parameters are summarized in *Proposition 4.2*.

Proposition 4.2 *Equilibrium value of the average group declaration, \bar{D}_W , strictly decreases in the tax rate, t , but strictly increases in the probability of an audit, p , and the penalty rate λ .*

Proof. Substituting for $\beta_1 = \frac{tI}{\gamma+tI}$ and $\beta_2 = \frac{tI}{1+tI}$ in (4.2), we have:

$$\bar{D}_W = \frac{\frac{1}{1+tI}}{\frac{1}{1+tI} + \frac{tI}{\gamma+tI}} W = \frac{1}{1 + \frac{1+tI}{1+\frac{\gamma}{tI}}} W \quad (4.3)$$

Differentiation of (4.3) gives:

$$\frac{\partial \bar{D}_W}{\partial t} = -\frac{t^2 I^3 + 2\gamma t I^2 + \gamma I}{(t^2 I^2 + 2tI + \gamma)^2} W < 0 \quad (4.4)$$

$$\frac{\partial \bar{D}_W}{\partial I} = -\frac{t^3 I^2 + 2\gamma t^2 I + \gamma t}{(t^2 I^2 + 2tI + \gamma)^2} W < 0 \quad (4.5)$$

From (4.4), (4.5) and recalling that $I = \{\omega(1-p) - \omega(p)\theta\lambda\}$ is strictly decreasing in the tax enforcement parameters, p and λ , the proposition directly follows.

■

Proposition 4.2 suggests that, ceteris paribus, higher is the tax rate, lower is the average group compliance at the equilibrium. Therefore, an increase in the tax rate weakens the social norm of compliance. The channel through which the tax rate increase affects the equilibrium outcome is as follows. An increase in the tax rate strengthens the monetary incentive for evasion. From (3.5), we see that the economic return per unit of evaded income is equal to $[1 - \beta] \times tI$, that is larger for the higher tax rate, t . Therefore, the share of the taxpayers who evade all income, $\beta_1 = \frac{tI}{\gamma+tI}$, grows and the share of the fully compliant taxpayers, $[1 - \beta_2] = 1 - \frac{tI}{1+tI}$, diminishes. We also note that the share of the taxpayers,

$[\beta_2 - \beta_1]$, who declare income in accordance to their beliefs about the average declaration of the reference group, increases. The actual average declaration of the group declines and the taxpayers update their beliefs accordingly, so that at the new equilibrium with the higher tax rate the average amount of declared income is lower.

The prediction, that an increase in the tax rate lowers the equilibrium amount of the average group declaration, is in line with the evidence showing that evasion increases in the tax rate (e.g., Clotfelter, 1983; Pudney et al., 2000). An increase in the tax rate reduces the strength of the social norm of compliance. The sentiments expressed in the following quote from Lindbeck (1995) support this result. "There must also be a price on honesty, in the sense that habits and social norms that encourage such behavior may be undermined if honesty becomes sufficiently expensive because of high marginal tax rates" (page 484).

An increase in the probability of an audit, p , or the penalty rate, λ , has a positive effect on the average group compliance at the equilibrium, that is in agreement with intuition and evidence (see e.g., Slemrod, 2007). An increase in either p or λ (or in both simultaneously), reduces I and therefore, reduces the economic return per unit of evaded income, $[1 - \beta] \times tI$. Lower share of taxpayers finds it optimal to evade all income, i.e., the value of $\beta_1 = \frac{tI}{\gamma+tI}$ is smaller for smaller I . Higher share of taxpayers declares all income, as the value of $[1 - \beta_2]$ is higher for lower I . Those taxpayers who continue adhering to the social norm (and also those, who switched their decision from zero income declaration) and declare the amount they believe is the group average, adjust their beliefs upwards. As a result, at the new equilibrium with stronger tax enforcement (lower I) the average group compliance is higher.

The model predicts that the strength of the social norm of compliance increases in the strength of the tax enforcement. The near-absolute enforcement regime (high level of p or λ such that $I \rightarrow 0$), ensures the full compliance of each taxpayer, i.e., from (4.3) $\lim_{I \rightarrow 0} \bar{D}_W = W$, and establishes the absolute norm of compliance. At another extreme, because of the taxpayers who neglect monetary incentives and declare full income to derive the social esteem, the absence of the tax enforcement does not induce social norm of zero compliance, i.e., from (4.3) $\lim_{I \rightarrow 1} \bar{D}_W = \frac{1}{1 + \frac{1+t}{1+\frac{\gamma}{t}}} W > 0$.

The social norm at the group level is linked with the norm at the aggregate level. Integrating the right hand side of (4.3) using the distribution of income

$W(z)$, we get:

$$\bar{D} = \int_0^1 \frac{1}{1 + \frac{1+t}{1+\frac{\gamma}{t}}} W dz = \frac{1}{1 + \frac{1+t}{1+\frac{\gamma}{t}}} \bar{W} \quad (4.6)$$

where \bar{D} is the average social declaration and \bar{W} is the average social income.

The strength of the social norm of compliance at the aggregate level has the same determinants as the strength of the norm at the income group level. Therefore, the tax authority aiming at increasing the norm of compliance, either has to reduce the tax rate or stiffen the tax enforcement regime.

5 Concluding Remarks

The chapter suggests a way of modelling tax compliance behavior with endogenous social norms in the prospect theory framework. The model rests on the empirically supported assumptions that are new in the theoretical literature on social norms of compliance. First, in contrast to the existing models, it is the overall extent of evasion and not only the share of evaders that signals the strength of the social norm. Second, taxpayers identify themselves with a group of individuals with the same income levels and internalize the norms that are attributed to this group. Third, taxpayers are guilt averse in the social domain of their preferences.

The basic insight drawn from the model is that the tax policy parameters not only shape monetary (dis)incentives for compliance, but also determine the strength of the social norm of compliance at the equilibrium. *Ceteris paribus*, the model predicts that an increase in the tax rate weakens the norm of compliance and the social norm is stronger under the stricter tax enforcement regime. The model explains why some people never evade taxes, it also makes the empirically correct prediction of the tax rate effect on compliance.

The model considers exogenous distribution of individual-specific parameter values β and assumes that changes in the tax policy parameters do not affect the degree of norm internalization. Under more general set-up, this assumption should be loosened by allowing adjustment process in the distribution of β —s, the rationale being that the changed tax environment might affect the way individuals think of their tax obligations and affect the degree of norm internalization, at least in the long run. For instance, higher extrinsic incentives for compliance induced by stricter tax enforcement may crowd out intrinsic incentives for compliance (Luttmer and Singhal, 2014). Evolutionary game theoretic approach, e.g., gene-culture coevolution model of Gintis and Helbing (2015), is a promising chan-

nel to extend the analysis from the stationary distribution case into a dynamic, evolutionary case. This possible extension is left for the future research.

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