New Approaches to the Economics of Tax Evasion

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Abstract. The paper reviews recent models that have applied the techniques of behavioural economics to the analysis of the tax compliance choice of an individual taxpayer. The construction of these models is motivated by the perceived failure of the standard Allingham-Sandmo model to predict correctly the proportion of taxpayers who will evade and the effect of an increase in the tax rate upon the chosen level of evasion. Recent approaches have applied non-expected utility theory to the compliance decision and have addressed social interaction. The models we describe are able to match the observed extent of evasion and correctly predict the tax effect but do not have the parsimony nor precision of the Allingham-Sandmo model.

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1. Introduction
Tax evasion is the illegal concealment of a taxable activity. Measuring how much economic activity is concealed will always be difficult since those who engage in evasion have every motivation to conceal their activities. Even so, the estimates that are available from official sources and from academic researchers are in agreement that evasion is a significant activity. This emphasizes the importance of the understanding the decision process of a taxpayer when choosing whether to comply with tax law or to engage in evasion. A good theory of the compliance decision is essential for designing a tax structure that deters evasion.

The economic analysis of an individual taxpayer’s compliance decision can be traced back to the pioneering work of Allingham and Sandmo (1972). They modelled the taxpayer as facing a decision under risk with the extent of evasion chosen to maximize expected utility. The risk arises from the possibility that a random audit will be conducted by the tax authorities that discovers the evasion. Yitzhaki (1974) changed the model by using a different specification of the punishment for evasion that was more in line with practice, and this has since become the “standard” formulation of the compliance decision. The strength of the standard model is the clarity of its comparative statics predictions. The model predicts that the chosen level of evasion falls when either the penalty rate or the probability of being caught evading are increased. It also predicts that evasion increases with income when absolute risk aversion is decreasing. These results are in agreement with intuitive expectations and with empirical evidence. Unfortunately, there are two key dimensions in which the predictions of the model do not accord with data or intuition. Firstly, when confronted with values of the audit probability and the fine rate close to those observed in practice the model predicts that all taxpayers should engage in evasion. This is a consequence of the sufficient condition for evasion that obtains in the expected utility framework. For example, the estimated Arrow-Pratt measure of relative risk aversion for the United States is between one and two, but only a value of thirty would explain the observed compliance rate (Graetz and Wilde, 1985, Alm, McClelland, and Schulze, 1992). Secondly, the model predicts that the level of evasion will fall when the tax rate increases. This result is counter-intuitive but is a direct consequence of the fine being a multiple of the amount of tax which the taxpayer attempted to avoid paying. When the tax rate increases so does the total fine for a given amount of evasion, and this hits the taxpayer in the state in which they have the least income.

These results have caused the validity of the model to be questioned and have lead to an extensive search for a better model. The aim of this search is to construct a model of the compliance decision that remains grounded in economic theory while simultaneously correcting the imperfect predictions. The standard model is based on the expected utility theory of von Neumann and Morgernstern (1947). Recent research in behavioural economics has been successful in explaining a range of “anomalies” in observed choices that do not match the predictions of expected utility theory. One branch of behavioural economics has constructed models for choice with risk (or with uncertainty) that modify the axioms of expected utility theory. A second branch of behavioural economics addresses other anomalies by incorporating social interaction into the individual decision process. These branches of behavioural economics have been applied in the analysis of tax evasion. Non-expected utility and social interaction are not mutually exclusive and applications have frequently combined elements from both.

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1 The difference between risk and uncertainty is discussed in Section 3.2.
There is a growing number of papers contributing to this new literature on the compliance decision. The models now available have differences in assumptions and structure that sometimes hide the common components of the analysis. It therefore seems an appropriate time to take stock of this literature. By reviewing the recent results it is intended that an assessment can be obtained of what has been achieved, and whether the new approaches provide a significant advance over the standard model. In particular, the focus will be placed on isolating the features of the models that can resolve the incorrect predictions.

The analysis of the current range of non-expected utility model reaches two very clear conclusions. The first is that for reasonable parameter values these models can predict the correct level of evasion. This occurs because the models permit the subjective probability of audit (or “weighting” on the payoff when audited) to be greater than the objective probability. The second is that they do not generally correct the false prediction with respect to the direction of the tax effect. The non-expected utility models can reverse the tax effect when combined with other factors, such as a psychic cost of evasion or audit probabilities that depend upon announced income, but this is also true of expected utility. Eide (2002) has already made this observation for one particular model; what we argue is that it is true for all of the alternatives that have been proposed. This point is significant so it will be developed at length below (see the analysis of Section 4). A brief explanation is as follows. All the non-expected utility models are special cases of the Choquet Expected Utility (CEU) model (see Section 3 and Chateauneuf, 1994). The representation of CEU maintains a structure which is essentially a weighted sum of the payoff when evasion is successful and the payoff when the evader is caught. The tax rate does not enter into the determination of the weights, so its effect is felt through the effect upon the payoffs. Although there are differences in details (for example, through the introduction of a reference point in prospect theory), the tax rate enters the payoff function in a manner broadly similar to how it enters the standard model: typically, the payoff is dependent upon the product of the tax rate and the evasion level. As a consequence, the optimal choice of evasion level will generally be decreasing in the tax rate.

How, then, can the direction of the tax effect be reversed? The answer lies in ensuring that the level of evasion enters the payoff function separately from the tax rate. The literature has identified several ways in which this can be achieved. One simple possibility is to change the structure of the punishment for evasion. The limitation of this approach is that model then fails to represent the actual situation in many countries. An alternative is to make the probability of detection depend upon the level of income declared. This modification gives rise to alternative interpretations of a variable probability of detection. We discuss this further below. A third possibility is to introduce additional, non-monetary, elements into the decision problem that capture aspects of social interaction. The idea that the social environment affects the choices made by individuals has been an important theme of behavioural economics. Models with social interaction can predict the correct level of evasion and reverse the tax effect. However, these alternative models are not as parsimonious as the standard model nor do they make predictions that are as precise.

Section 2 introduces the individual compliance decision, describes the notation used throughout the paper, outlines the standard version of the Allingham-Sandmo model, and summarizes its predictions. Section 3 reviews a range of non-expected utility models of choice. Section 4 analyses the outcome of applying the non-expected utility models to the

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2 Although many countries can punish evasion by imprisonment (and some even have the death penalty), most cases are settled by the payment of a fine.
compliance decision. The effect of introducing social interaction is analyzed in Section 5. Section 6 offers some conclusions.

2. Tax Evasion
This section sets out the basic analytical framework for the compliance decision that is used throughout the paper. The standard form of the Allingham-Sandmo model is then analyzed. The shortcomings in the predictions of the model are identified and used to motivate the development of alternative models.

2.1 Compliance decision
The standard model of the compliance decision considers an individual taxpayer within a single-period setting. The taxpayer has a given amount of income that is not directly observed by the tax authority (including an observed component of income is straightforward) and must choose how much of this income to declare. The taxpayer is assumed to know the objective probability of an income declaration being audited. If the declaration is audited then the true level of income is revealed with certainty. The discovery of undeclared income results in the payment of tax on the undeclared income plus an additional fine.

The notation that is used throughout the paper is as follows. The actual level of income (unobserved) is $Y$, the level of income declared to the revenue service is $X$, and the amount of undeclared income is $E = Y - X$. The amount of tax paid on an income level $x$ ($x = X$ or $Y$) is $T = T(x)$ and the fine for evasion is $F = F(E)$. The fine for evasion may be dependent upon the tax structure. In the particular case of a linear tax and fine, $T(x) = tx$, and $F(E) = ftE$, where the tax rate, $t$, and the fine rate, $f$, satisfy $f > 0$, $t > 0$.

After the evasion decision is made one out of two potential states of the world is realized. In the state of the world in which evasion is successful the taxpayer is left with disposable income $Y^n$, where

$$ Y^n = Y - T(X). \tag{1} $$

The level of disposable income in the state of the world in which evasion is detected is denoted $Y^c$. This is given by

$$ Y^c = Y - T(Y) - F(E). \tag{2} $$

These two states of the world occur with objective probabilities $1 - p$ and $p$, respectively. These probabilities are determined by the audit activities of the revenue service. The non-expected utility models derive the subjective probabilities from the objective probabilities in a variety of ways which are discussed in detail later. Since the future state of the world is unknown the taxpayer's disposable income is a random variable. Let $\tilde{Y}$ denote the random level of disposable income prior to realization of the state of nature. When $E = 0$ it follows that $Y^n = Y^c = Y - T(Y)$. As a matter of convention the same notation is retained in this case even though the distribution of $\tilde{Y}$ is degenerate. The decision problem of the taxpayer is to choose the declaration $X$ (or, equivalently, the amount of evasion, $E$).
The payoff obtained from an outcome \( z \) is given by the payoff function \( v(z) \). It is assumed that \( v(z) \) is increasing in \( z \), so that \( v'(z) > 0 \) at those points where \( v(z) \) is differentiable. The models that follow differ with respect to assumptions about the payoff function and the nature of the outcome, \( z \), that enters the payoff function. The literature on choice theory finds it necessary to distinguish between risk and uncertainty. In a decision with \( \text{risk} \) there are known probabilities of the alternative outcomes. These probabilities may be objective or subjective. In contrast, in a decision with \( \text{uncertainty} \) there are no known probabilities. The analysis of choice requires different techniques in these two circumstances.

2.2 The standard model
The standard model is introduced as a baseline against which other models can be assessed. The model and its predictions are now described briefly. A detailed development can be found in Myles (1995).

It is assumed that the tax and fine are linear and that the taxpayer maximizes the expected value of utility from disposable income. The expectation is formed using the objective probabilities. Therefore, the outcomes are the income levels \( Y^c \) and \( Y^n \), and the payoff function \( v(\cdot) \) is a utility function \( U(\cdot) \) satisfying the standard assumptions \( U'' > 0 \) and \( U''' < 0 \).

The decision problem can be written as

\[
\max_{\{E\}} V = pU(Y[1 - t] - ftE) + [1 - p]U(Y[1 - t] + tE) \tag{3}
\]

The first- and second-order conditions for an interior optimum are

\[
-pfU'(Y^c) + [1 - p]U'(Y^n) = 0, \tag{4}
\]

and

\[
S = pf^2U''(Y^c) + [1 - p]U''(Y^n) < 0. \tag{5}
\]

A sufficient condition for tax evasion to take place is obtained by evaluating (4) at \( E = 0 \). Doing this shows that it is optimal to choose \( E > 0 \) if \( f < [1 - p]/p \). It is important to observe that this sufficient condition is independent of preferences, so if one taxpayer chooses to evade then all should evade. Moreover, with the value of \( f = 1 \) (which is fairly representative of international tax systems) the model predicts all taxpayers should evade if \( p < 0.5 \). Hence, a value of audit probability far in excess of what is observed is necessary to avoid all taxpayers choosing to conceal at least part of their incomes. The fact that the data on evasion (Andreoni et al. 1998, Slemrod and Yitzhaki 2002) shows that a large proportion actually choose to declare all income presents the first challenge to the model.

We now turn to the comparative statics of an interior optimum. The objective function is strictly concave so if there is an interior optimum it must be unique. To provide a concrete example before proceeding to the general case assume that utility is logarithmic, \( U(z) \equiv \ln(z) \). The decision problem is

\[
\max_{\{E\}} V = p\ln(Y[1 - t] - ftE) + [1 - p]\ln(Y[1 - t] + tE) \tag{6}
\]

An interior solution must satisfy
\[
- \frac{pf}{Y[1-t] - ftE} + \frac{1-p}{Y[1-t] + tE} = 0. \tag{7}
\]

This condition can be solved to give the level of evasion
\[
E = \frac{1}{t} \frac{Y[1-t][1 - p[1 + f]]}{f}. \tag{8}
\]

The level of evasion, \(E\), enters the objective function in (6) only through terms involving \(tE\) so the solution for \(E\) in (8) involves the term \(1/t\). This is a feature shared by many models. An increase in the tax rate reduces evasion since
\[
\frac{dE}{dt} = -\frac{1}{t^2} \frac{Y[1-t][1 - p[1 + f]]}{f} < 0. \tag{9}
\]

Returning to the general problem, the effect of an increase in the tax rate on the level of evasion is determined by
\[
\frac{dE}{dt} = -\frac{1}{S \frac{\partial^2 V}{\partial E \partial t}}. \tag{10}
\]

Using the Arrow-Pratt measure of absolute risk aversion
\[
R_A(I) = \frac{-U''(I)}{U'(I)}, \tag{11}
\]
we have
\[
\frac{\partial^2 V}{\partial E \partial t} = pfU'[Y^c] Y[R_A(Y^n) - R_A(Y^c)] - E[R_A(Y^n) + R_A(Y^c)] f \tag{12}
\]

If absolute risk aversion decreases as income increases then \(R_A(Y^n) < R_A(Y^c)\), so
\[
\frac{\partial^2 V}{\partial E \partial t} < 0, \tag{13}
\]

and the level of evasion will fall as the tax rate rises. This result is counter to intuition and contradicts much of the empirical evidence (Andreoni et al. 1998, Clotfelter, 1983).

In assessing the result in (13) it should be stressed that the assumption of absolute risk aversion decreasing with income cannot be regarded as universally acceptable. This leaves a degree of uncertainty over the conclusion that higher tax rates and higher income lead to greater tax evasion. In addition, the result is also sensitive to the precise form of the punishment for evasion. If the fine is determined as in Allingham and Sandmo (1972) by \(fE, f > t\), rather than \(ftE\), then the effect of the tax rate cannot be unambiguously signed even with decreasing absolute risk aversion. However, much of the literature on tax evasion has been developed on the presumption that the tax rate effect is negative.
3. Non-Expected Utility Theory

Expected utility theory follows as a consequence of a set of axioms governing preferences over lotteries (see, for example, Mas-Colell, Whinston and Green, 1995). The Allais paradox (Allais, 1953) provided a simple example for which violation of the axioms was commonplace. Further anomalies have since been identified and there is now considerable empirical and experimental evidence of choice behaviour that violates the axioms. The accumulation of this evidence has motivated the construction of alternative models of preferences that aim to provide better explanation of observed choices. The purpose of this section is to briefly review some of these alternatives. It begins by discussing models of choice under risk and then proceeds to models of choice under uncertainty.

3.1 Risk

The various models of choice with risk can be formulated using the following framework. Let \( X = \{x_1, \ldots, x_n\} \) be a set of \( n \) outcomes that partitions the set of states of the world, \( \Omega \), into mutually exclusive events. Hence, \( x_i \cap x_j = \emptyset \) if \( i \neq j \), and \( \cup_{i=1}^{n} x_i = \Omega \). A prospect, \( y \), is a pair of vectors \( \{(x_1, \ldots, x_n), (p_1, \ldots, p_n)\} \) where each \( x_i \in X \) and \( \sum p_i = 1 \). \( Y \) denotes the set of prospects. The outcomes are ordered so that \( x_n \succ x_{n-1} \ldots \succ x_1 \), where \( \succ \) denotes the relation “strictly preferred to”. The fineness of the partition (and hence the cardinality \( n \)) may differ between prospects. The prospect \( \{(x), (1)\} \) means that \( x \) is obtained with certainty.

The decision maker is endowed with a set of preferences over the set of prospects, \( Y \). Denote the preference relation “at least as good as” by \( \succeq \). A function \( V \) on \( Y \) represents the decision-maker’s preferences if

\[
V(y) \geq V(y') \iff y \succeq y'. \tag{15}
\]

A model of preferences can be viewed as a set of axioms that the preference order, \( \succeq \), over prospects must satisfy. These axioms determine the class of functions that can represent preferences for that model. We illustrate these observations by briefly describing several representations of preferences in this framework, and then proceed with a detailed discussion of some important models.

Chateauneuf (1994) provides a survey of how a range of models of preference representation under uncertainty fit with this general framework. The axioms of expected utility theory implies that preferences are represented by the function

\[
V(y) = \sum p_i U(x_i), \tag{16}
\]

where \( U(\cdot) \) is a utility function satisfying \( U'(\cdot) > 0 \) and \( U''(\cdot) \leq 0 \). Expected utility combines the objective probabilities with the utility of the outcome. The Allais paradox illustrates the shortcomings of expected utility theory compared to actual choice behaviour. Handa (1977) provides axioms that support the alternative representation

\[
V(y) = \sum w(p_i)x_i, \tag{17}
\]
with \( w(0) = 0 \). In this representation the objectives probabilities are transformed by a weighting function and utility is assumed to be linear in outcome. Kahneman and Tversky (1979) justify the representation of preferences

\[
V(y) = \sum w(p_i)v(x_i - R),
\]

(18)

where \( R \) is a reference point, so \( x_i - R \) is the “gain” (or “loss” if \( x_i - R < 0 \)) relative to the reference point, and the function \( v(x_i - R) \) can vary according to whether the gain is positive or negative. Karmarkar (1978) proposes the representation

\[
V(y) = \frac{\sum w(p_i)U(x_i)}{\sum w(p_i)},
\]

(19)

with

\[
w(p_i) = \frac{p^\alpha}{p^\alpha + (1 - p)^\alpha}, \quad 0 < \alpha \leq 1.
\]

(20)

In this formulation the utility function is combined with a precise form of transformation for the probabilities.

We have already mentioned that many choice anomalies have been observed that are inconsistent with expected utility theory. The alternatives models are not without their own problems. Quiggin (1981) notes that whenever \( w(p_i) \) is nonlinear the preferences may fail to satisfy the axiom of dominance which requires a dominant alternative to be valued higher. Kahneman and Tversky (1979) suggested “editing out” the dominated prospects, but Quiggin shows this leads to intransitivity of the preference order. We now consider some of the alternative models in more detail.

3.1.1 Rank Dependent Expected Utility Theory

Rank Dependent Expected Utility Theory (and the special case of Anticipated Utility) is characterized by the particular recursive manner in which the weights are generated from the objective probabilities. The ranking of alternatives is required so that the recursive process can be applied. Anticipated Utility was introduced by Quiggin (1981) which developed the analysis of Kahneman and Tversky (1979) and was formalized in Quiggin (1982). Quiggin and Wakker (1994) provided an axiomatic basis for Anticipated Utility and for the more general case of Rank Dependent Expected Utility.

Quiggin (1982) observed that the shortcoming of prior models of non-expected utility was the assumption that the decision maker distorted the probability of extreme outcomes but did not do the same to “intermediate” outcomes with the same probability. To correct this Quiggin proposed that the weighting for each outcome should be based, in principle, on all the individual probabilities. Doing this gives the objective function

\[
V = \sum w_i(p_1,.,.,p_n)U(x_i).
\]

(21)

It was argued that this alternative to expected utility theory, which Quiggin called Anticipated Utility, is more consistent with the evidence. The reason for making the decision weights depend on sums of probabilities is shown by observing that if the weights, \( w(\cdot) \), are based on individual probabilities the decision weights must satisfy \( w(1/n) = 1/n \). To see this, assume
they did not and that \( w(1/n) < 1/n \). Then, for any \( X \) and \( \varepsilon \) a non-negative random variable, it follows that for sufficiently small \( \varepsilon \)

\[
U(X) > \sum_{i=1}^{n} w(1/n) U(X + x_i + \varepsilon),
\]

(22)
even though \( X + x_i + \varepsilon \geq X \) with probability 1. To avoid this inconsistency the decision weights cannot imply \( w(1/n) < 1/n \).

A formalization of Anticipated Utility theory is undertaken in Quiggin (1982). The paper observes that the transitivity and dominance axioms of expected utility theory command virtually unanimous assent but in the Allais paradox, and other observed anomalies, it is the independence axiom that is violated. The Quiggin (1982) proposal is therefore to drop the independence axiom and, hence, introduce more flexible weighting schemes. Anticipated Utility is based on the assumption that \( w_i(p_i) = 0 \) if \( p_i = 0 \), and that \( w_i(1) = 1 \). Most importantly, it is also assumed that

\[
w_i((1/2), (1/2)) = 1/2.
\]

(23)
The key construction then follows. Given a weighting function \( w(p, 1 - p) \) for a two-outcome prospect, it is shown how this can extended to a three outcome prospect, and then extended recursively. To do this, for \( p \in [0, 1] \) define the function \( f(p) = w_1(p(1 - p)) \). Then the weights can be found using the recursion

\[
w_i(p) = f\left(\sum_{j=1}^{i} p_j\right) - f\left(\sum_{j=1}^{i-1} p_j\right),
\]

(24)
under the convention that \( \sum_{j=1}^{0} p_j = 0 \). It should be stressed here that the outcomes have to be ranked for this to apply. Quiggin and Wakker (1994) introduce the more general case of Rank Dependent Expected Utility which does not impose the condition in (23). For both cases the general representation of preferences is

\[
V = \sum_{i=1}^{n} f\left(\sum_{j=1}^{i} p_j\right) - f\left(\sum_{j=1}^{i-1} p_j\right) U(x_i),
\]

(25)
where \( f: [0, 1] \to [0, 1] \), is non-decreasing, and \( f(0) = 0, f(1) = 1 \). The representation in (25) can be expressed alternatively as

\[
V(X) = U(x_n) - \sum_{i=1}^{n} f\left(\sum_{j=i}^{n} p_j\right) U(x_i) - U(x_{i-1})
\]

(26)
Note that in the two-outcome case this just reduces to the standard formulation

\[
V(X) = f(p_1) U(x_1) + [1 - f(p_1)] U(x_2)
\]

(27)
Chateauneuf et al. (2005) provide the necessary and sufficient condition in the Rank Dependent Expected Utility framework for a decision maker to be averse to a monotone mean-preserving increase in risk. They adopt a variant of the Quiggin model where the decision function is a product of a utility function and a weighting function. The analysis is
based on the “greediness” of the utility function (an index of non-concavity) and the “pessimism” of the weighting function (how far it is below the diagonal).

Define the values

\[ G_U = \sup_{y \leq x} \frac{U'(x)}{U'(y)}, \]

and

\[ P_f = \inf_{0 < v < 1} \frac{(1 - f(v))}{(1 - v)} \frac{((f(v))/v)}. \]

For any function \( U \) it follows that \( G_U \geq 1 \). \( G_U = 1 \) if and only if \( U \) is concave. Chateauneuf et al. show that the decision maker is monotone risk averse if and only if \( P_f \geq G_U \), which is a joint restriction on utility and weighting functions. This construction provides a representation of preferences and a necessary condition for the decision maker to act rationally in the sense of being averse to risk. If they do not satisfy this condition then questions can be raised about their behaviour and the implications of any comparative statics results that arise from application of the preference representation.

3.1.2 Prospect Theory

In the Kahneman and Tversky (1979) version of Prospect Theory the decision maker “edits and evaluates” each of their prospects and chooses the one with the highest value. Consider a decision maker choosing between two prospects. One prospect occurs with probability \( p_1 \) and has outcome, measured relative to the reference point, \( R \), of \( y = I^+ - R \). The other prospect, which occurs with probability \( p_2 \), has outcome, measured relative to the reference point, of \( x = I^- - R \). The overall value of the edited prospect of the taxpayer is

\[ V = w_1(p_1)v(x) + w_2(p_2)v(y), \]

where \( w_i(p_i) \) is the decision weight. It is possible under the theory that \( w_i(p_i) \equiv p_i \). The value function, \( v(z) \), satisfies the assumptions

\[ v'(z) > 0, \]
\[ v''(z) \leq 0 \text{ for } z \geq 0. \]

The assumption in (32) is the statement of convexity in losses but concavity in gains. According to Eqn. (1) in Kahneman and Tversky (1979), under the assumption that \( w_i(p_i) \equiv p_i \), the value of the taxpayer's prospect is

\[ V = p_1v(x) + [1 - p_1]v(y) \]
\[ = v(y) + p_1[v(x) - v(y)] \]

Tversky and Kahneman (1992) provide the basis for a Cumulative Prospect Theory. This model is a response to the fact that their form of Prospect Theory does not satisfy stochastic dominance, so it is possible for more risky prospects to be valued higher than safer ones. Moving to a cumulative formulation based on Rank Dependent Expected Utility overcomes this deficiency. In this framework a prospect is a sequence of pairs \( \{x_i, A_i\} \) where
\( x_i \) is the outcome if \( A_i \) occurs, and if \( i > j \) then \( x_i > x_j \). The outcomes are labelled so that \( x_i \leq 0 \) for \( i = -m, \ldots, 0 \), and \( x_i > 0 \) for \( i = 1, \ldots, n \). \( f^+ \) is defined as the positive part, and \( f^- \) as the negative part. Cumulative Prospect Theory then has
\[
V(f) = V(f^+) + V(f^-),
\] (34)
where \( V(f^+) = \sum_{i=1}^{n} w_i^+ v(x_i) \) and \( V(f^-) = \sum_{i=-m}^{0} w_i^- v(x_i) \), and the decision weights are given by
\[
\begin{align*}
w_n^+ &= W^+(A_n), & w_{-m}^- &= W^-(A_{-m}), \\
w_i^+ &= W^+(A_i \cup \ldots \cup A_n) - W^+(A_{i+1} \cup \ldots \cup A_n), \\
w_i^- &= W^-(A_{-m} \cup \ldots \cup A_i) - W^-(A_{-m} \cup \ldots \cup A_{i-1}).
\end{align*}
\]
If there is a positive probability for each outcome \( x_i \) then the decision weights become
\[
\begin{align*}
w_n^+ &= W^+(p_n), & w_{-m}^- &= W^-(p_{-m}), \\
w_i^+ &= W^+(p_i + \ldots + p_n) - W^+(p_{i+1} + \ldots + p_n), \\
w_i^- &= W^-(p_{-m} + \ldots + p_i) - W^-(p_{-m} + \ldots + p_{i-1}).
\end{align*}
\] (35)
This reduces to the standard form of Prospect Theory if there are only two outcomes.

3.1.3 First Order and Second Order Risk Aversion
One of the failings of the standard model of compliance is the over-prediction of the proportion of taxpayers who will engage in non-compliance. The condition that delivers this conclusion is a direct consequence of the properties of the expected utility function: all indifference curves have the same gradient where they cross the sure-thing line. This gradient is determined entirely by the probability, \( p \), so is also the same for all taxpayers regardless of personal attitudes toward risk. Segal and Spivak (1990) investigate what is required to relax these conclusions by considering the behaviour of the risk premium for small gambles.

Consider a gamble \( \varepsilon \) with \( \varepsilon[\varepsilon] = 0 \), where \( \varepsilon[\cdot] \) is the expectations operator. The risk premium of the gamble \( r \varepsilon \) is denoted by \( \pi(r) \). The issue is the behaviour of the derivative of \( \pi(r) \) around \( r = 0 \). Pratt (1964) showed that in the expected utility framework
\[
\pi(r) \approx -\frac{r^2}{2} \frac{U''(x)}{U'(x)},
\] (36)
where \( x \) is the initial wealth. From this it can be seen that \( \frac{\partial \pi(r)}{\partial r}\big|_{r=0} = 0 \) but \( \frac{\partial^2 \pi(r)}{\partial r^2}\big|_{r=0} \neq 0 \) (provided \( U''(x) \neq 0 \)). Hence, the first derivative is zero but the second derivative is generally positive. This is called “risk aversion of order 2”. The implication is that the indifference curve has the same gradient as the fair odds line on the sure-thing line, so the certainty point will not be chosen except at an actuarially fair price.
The alternative scenario is to have “risk aversion of order 1”. In this case
\[ \frac{\partial \pi(r)}{\partial r} \bigg|_{r=0^+} \neq 0. \] (37)

If the risk premium is symmetric around \( r = 0 \) then
\[ \frac{\partial \pi(r)}{\partial r} \bigg|_{r=0^+} = -\frac{\partial \pi(r)}{\partial r} \bigg|_{r=0^-}. \] (38)
so the risk premium has to be kinked at \( r = 0 \). It is this condition that marks the difference between the two orders of risk aversion. The kink in the risk premium implies that the indifference curves are also kinked on the certainty line. This permits a point with certainty to be chosen even if the price is not actuarially fair.

The general expression for the gradient of the indifference curve on the certainty line is
\[ \lim_{r \to 0^+} \frac{rp/[1 - p] + \pi(r)}{r - \pi(r)} = \frac{-p/[1 - p] + \frac{\partial \pi(r)}{\partial r} \bigg|_{r=0^+}}{1 - \frac{\partial \pi(r)}{\partial r} \bigg|_{r=0^+}}, \] (39)
and in the other direction
\[ \lim_{r \to 0^-} \frac{rp/[1 - p] + \pi(r)}{r - \pi(r)} = \frac{-p/[1 - p] - \frac{\partial \pi(r)}{\partial r} \bigg|_{r=0^-}}{1 + \frac{\partial \pi(r)}{\partial r} \bigg|_{r=0^-}}. \] (40)
Contrasting (39) and (40) confirms that when there is risk aversion of order 1 the indifference curve is kinked on the sure-thing line.

Segal and Spivak (1990) demonstrate that risk aversion of order 1 arises (a) with expected utility if the utility function is not differentiable, or (b) if Rank Dependent Expected Utility applies with an Anticipated Utility function and either a strictly concave or a strictly convex distribution transformation.

3.1.4 Regret and disappointment
The Disappointment Theory of Loomes and Sugden (1986, 1987) asserts that the payoff is determined by a combination of the outcome resulting from a choice of action and the average outcome that could have occurred. Hence, if a bad outcome arises the payoff is reduced even further by additional “disappointment” when this poor outcome is contrasted to what might have been obtained. The disappointment gives greater motivation than expected utility theory for the decision-maker to avoid actions that potentially have particularly bad outcomes.

Consider an action \( a \) that leads to monetary payoff \( a(\omega) \) when state \( \omega \) occurs. The payoff from this action is given by
\[ V(a) = \delta[a(\omega)] + \delta[D(a(\omega) - \delta[a(\omega)])]. \] (41)
This is a particular risk-neutral form of Disappointment Theory. The disappointment function satisfies:

(i) \( D(0) = 0 \);
(ii) \( D \) is concave on \((-\infty, 0)\);
(iii) \( D \) is convex on \((0, \infty)\);
(iv) \( 0 < D'(x) < 1 \);
(v) \( -D(-x) \geq D(x) \);

Conditions (ii) and (iii) imply violation of independence axiom while (iv) ensures first-order stochastic dominance is satisfied. Under these conditions Disappointment Theory shares with Prospect Theory the assumption of concavity with respect to gains and convexity with respect to losses.

Regret Theory (Loomes and Sugden, 1982) has a similar structure. Let \( a \) and \( b \) be two risky actions. The representation of preferences is then defined by the condition

\[
a > b \iff \mathbb{E}[a(\omega) + R(a(\omega) - b(\omega))] > \mathbb{E}[b(\omega) + R(b(\omega) - a(\omega))].
\]  

(42)

Here \( R \) is the regret (or rejoicing) function which involves the comparison of what results from choosing \( a \) with what would have resulted from choosing \( b \). The regret function is assumed to be twice differentiable and increasing.

3.2 Uncertainty
A decision is made under uncertainty when there are no known objective probabilities. All probabilities are therefore subjective, and need not obey the usual axioms of probability theory. The aim of the literature on choice with uncertainty is to accommodate these assumptions within a formal framework.

3.2.1 Non-Additive Probabilities
Consider two sets \( A \) and \( B \). If \( A \) and \( B \) are disjoint, so \( A \cap B = \emptyset \), then a standard additive probability measure satisfies the additivity property

\[
p(A \cup B) = p(A) + p(B).
\]  

(42)

The basic problem encountered when moving to uncertainty is that a subjective assessment of probability need not satisfy additivity. A subjective probability measure that does not satisfy (42) is called non-additive. For example, a non-additive measure may have

\[
w(A \cup B) < w(A) + w(B).
\]  

(43)

The problem of integrating non-additive set functions is analyzed in Schmeidler (1986, 1989). Schmeidler assumes that the non-additive measure satisfies two conditions:

(i) Normalization: \( w(\emptyset) = 0 \), \( w(\Omega) = 1 \), where \( \Omega \) is the set of states;
(ii) Monotonicity: \( F \subseteq G \) implies \( w(F) \leq w(G) \).
Let \((\Phi_i)_{i=1}^k\) be a partition of \(\Omega\), \(\Phi_i^*\) an indicator function (so \(\Phi_i^*\) is equal to 1 on the set \(\Phi_i\)), and \(a = \sum_{i=1}^k \alpha_i \Phi_i\) a finite step function with \(\alpha_1 > \alpha_2 > ... > \alpha_k\). Let \(\alpha_{k+1} = 0\). The integral of \(a\) over \(\Omega\) is then defined by

\[
\int_{\Omega} a dw = \sum_{i=1}^k [\alpha_i - \alpha_{i+1}] w(\cup_{j=1}^i \Phi_j)
\]

(44)

This representation is extended to functions more general than the step function as follows. Let \(a\) be a real value, bounded function on \(\Omega\) and \(w\) a non-additive probability. Then

\[
\int_{\Omega} a dw = \int_{-\infty}^0 w(a \geq \alpha) - 1 d\alpha + \int_{0}^{\infty} w(a \geq \alpha) d\alpha.
\]

(45)

The presence of 1 in the first term of (45) after the equality represents \(w(\Omega)\). An axiomatic basis for this representation, and of some variants which are more restrictive, is given in Chateauneuf (1994).

3.2.2 Ambiguity

The subjective probabilities used above are known to the decision-maker even though they are not publicly known. Ambiguity refers to a situation in which the probabilities are unknown, even to the decision-maker, so it involves uncertainty about uncertainty. Ambiguity results from the uncertainty associated with knowing which distribution from a set of possible distributions is appropriate in a given situation. Ellsberg (1961) describes this distinction in terms of unambiguous versus ambiguous probabilities. Einhorn and Hogarth (1986) distinguish between “ignorance”, “ambiguity”, and “risk”, according to the degree to which alternative probability distributions can be ruled out. Hence, ambiguity is an intermediate state between ignorance (no probability distributions are ruled out) and risk (all probability distributions but one are ruled out). The amount of ambiguity is then an increasing function of the number of distributions that are not ruled out.

The motivation for considering ambiguity is to take into account the possibility that the information a decision maker has about some relevant uncertain event is vague or imprecise, and that this affects choice. Ambiguity aversion means that the decision-maker prefers to bet on unambiguous rather than on ambiguous events. Camerer and Weber (1992) define ambiguity more generally, referring to Fellner (1961) and Frisch and Baron (1988): “Ambiguity is uncertainty about probability, created by missing information that is relevant and could be known”. Ambiguity aversion in this case refers to the reluctance of people to take either side of a bet not only when they fear that others might have more information, but also when such fears are unfounded (Frisch and Baron, 1988).

Among the approaches to modelling ambiguity discussed in Camerer and Weber (1992), is the use of a second-order probability distribution, \(\Phi(p(x_i))\), over the probabilities \(p(x_i)\) (Marschak, 1975). Ambiguity can be expressed by second-order probability when the decision maker knows, or can assign, the probabilities to the probability distributions in the set of all possible distributions. The second-order probability view can be taken further by presuming subjective second-order probabilities of (first-order) probabilities that might also be subjective. An alternative way of modelling ambiguity is described in Einhorn and Hogarth (1986) as an anchoring-and-adjustment process. The anchor is an initial guess about the
probability, $p$. The judged probability is $S(p) = p + k$, where $k$ is the net effect of the mental adjustment process. The value of $k$ can depend on a range of factors. For example, if $k = f(1 - p) - fp^\beta$ then it depends on: (1) $p$ since $-p \leq k \leq 1 - p$; (2) $f \in [0,1]$, the amount of ambiguity ($f = 0$ when $p$ is known exactly; if $f = 1$ then all values of $p$ are possible); (3) $\beta \geq 0$, the relative weighting of probabilities $> p$ and $< p$ (the attitude to ambiguity). A value $\beta > 1$ means that probabilities higher than the anchor are weighted more than probabilities lower than the anchor.

An axiomatic approach to ambiguity was developed by Fishburn (1993). The fundamental property that distinguishes ambiguity from risk is submodularity, i.e. that $\alpha(A \cup B) \leq \alpha(A) + \alpha(B)$ if the sets $A$ and $B$ are disjoint. The rationale for this condition is that taking the union of $A$ and $B$ may reduce or cancel ambiguities associated with each separately, and will not introduce new sources of ambiguity in the combination that outweigh such reductions. More recently, an axiomatic approach that encompasses several generalizations of subjective expected utility theory was laid out by Ghirardato and Marinacci (2002).

Examples of preference representation for ambiguity include:

(1) Choquet expected utility (CEU)

$$V(f) = \int_S U(f(s))w ds,$$

where the integral is taken in the sense of Choquet. A subclass of the CEU ordering is subjective expected utility, a particular case in which $w$ is a probability measure.

(2) Maximin expected utility (MEU):

$$V(f) = \min_{P \in C} \int_S U(f(s))P(ds),$$

where $C$ is a compact and convex set of probability measures. Subjective expected utility is a particular case in which $C = \{P\}$ for some probability measure $P$. In this case the decision-maker evaluates the outcome with respect to the probability distribution that yields the lowest possible payoff. More generally, $\alpha$-MEU preferences assign some weight to the worst-case and best-case scenarios. For $\alpha \in [0, 1]$,

$$V(f) = \alpha \min_{P \in C} \int_S U(f(s))P(ds) + (1 - \alpha) \max_{P \in C} \int_S U(f(s))P(ds).$$

MEU (minimax) corresponds to $\alpha = 1$, and “maximax” has $\alpha = 0$.

4. Application to Tax Evasion

This section reviews the application of non-expected utility to the analysis of the individual tax compliance decision. The focus of the discussion will be upon the level of evasion predicted by each model and the direction of the tax rate effect.

3.1 Rank Dependent Expected Utility
Arcand and Graziosi (2005) analyze the tax evasion decision when the taxpayer has preferences determined by Rank Dependent Expected Utility. The key feature of Rank Dependent Expected Utility is that the objective probabilities are transformed using a weighting function. Hence, Arcand and Graziosi write the optimization as

$$\max_{\{e\}} V(E) = [1 - w_2(1 - p)]U(Y - tE) + w_2(1 - p)U(Y + tE),$$

where it is assumed that $w_2(0) = 0$ and $w_2(1) = 1$. In addition, $w_2(1 - p)$ is taken to be inverse s-shaped (concave, then convex). This has the effect of inflating low probabilities and deflating large probabilities. To contrast the level of evasion for this model with the level of evasion with choices determined by expected utility it is further assumed that:

(i) $w_2(1 - p) < 1 - p$;
(ii) $w_2(f/[1 + f]) < f/[1 + f]$.

Assumption (i) implies that $1 - w_2(1 - p) > p$, so the subjective probability of audit is inflated above the objective probability. Assumption (ii) requires that the penalty rate is high. The main result of the paper is the proof that under these assumptions the sufficient condition for evasion to take place is stricter with Rank Dependent Expected Utility than it is with expected utility. This is because of the overweighting of the probability of audit. A simulation analysis considers alternative weighting schemes for the probabilities but all produce similar results. What is important is that for some parameter values the level of evasion matches US data.

It should be noted that this formulation does not change the comparative static effect of a change in the tax rate, $t$. Given a probability, $p$, the change of variables $w_2(1 - p) \equiv 1 - q$, $1 - w_2(1 - p) \equiv q$ can be made, and the optimization becomes that of the standard but with $p$ replaced by $q$. The qualitative properties of the comparative statics are therefore unchanged.

### 3.2 Prospect theory

The basic idea of Prospect Theory is that there is a reference point relative to which gains or losses are assessed. In addition, the theory often assumes that the structure of the payoff function is different for gains and losses relative to the reference point, and that transformed probabilities are used by the decision maker. Since there is no natural reference point or functional form for the payoff, there is considerable flexibility within Prospect Theory for the representation of the choice problem. This flexibility explains why the applications of Prospect Theory to the compliance decision by Yaniv (1999), Bernasconi and Zanardi (2004), and al-Nowaihi and Dhami (2007) differ markedly in structure.

Using a payoff function that is convex in losses but concave in gains may have support in psychological evidence but when used in models with optimizing behavior it can create substantial analytical difficulties. The basic problem is that the objective function of the taxpayer will not be globally concave. Therefore, there is no guarantee of a unique maximum nor need a solution to the first-order condition for choice be a global maximum (it can be a local maximum with the global maximum in a corner, or even a minimum). It is this feature of Prospect Theory that gave rise to the “bang-bang” solution described in al-Nowaihi and Dhami: in some cases, a small change in underlying parameters can cause the taxpayer to leap from a corner solution with perfect compliance to a corner solution with no compliance.
These analytical issues can be illustrated by reviewing the model of Yaniv (1999) who analyzed the effect of an advance tax payment. In an expected utility framework an advance will have no effect upon the compliance decision. If, instead, prospect theory is employed the advance tax payment will have an effect if it determines the reference point from which gains and losses in different states of the world are measured. Denote the advance tax payment by $D$. Referring to Elffers and Hessing (1997), the income level $Y - D$ is suggested by Yaniv (1999) to be a natural reference point. From this reference point $D - tX$ is the gain if evasion is not detected, and $D - tX - ft[Y - X]$ is the loss if evasion is detected. This choice of a reference point results in the gain occurring with certainty, but part of the loss is random.

The objective function studied by Yaniv is

$$V = v(D - tX) + pv([-2D - tX - ft(Y - X)] - [D - tX])$$

This specification is justified by the assumption that when evaluating their prospects, the taxpayer segregates the certain outcome from the risk in the following way

$$V = v(Y^C) + [1 - p]v(Y^G) + pv(Y^L),$$

where $Y^C$ is the outcome received in both prospects, i.e. with certainty, $Y^G ≥ 0$ is the gain over the certain outcome in one of the prospects, that occurs with probability $1 - p$, and $Y^L ≤ 0$ is the loss from the certain outcome in the other prospect, that occurs with probability $p$. In this model, $Y^C = D - tX$, $Y^G = 0$, and $Y^L = -ft[Y - X] ≤ 0$ (so $Y^L = 0$ if the income is declared truthfully). To make the analyses concrete we consider the commonly used power function form for the payoff (Tversky and Kahneman, 1992)

$$v(z) = \begin{cases} 
z^\beta, & z ≥ 0, \\ -\gamma[-z]^\beta, & z < 0, \end{cases}$$

We treat the cases of the advance payment $D$ set above, and below, the true tax liability, $tY$, separately.

We first consider the case $D > tY$. Figure 1 adopts the “standard” parameterization of the value function ($\beta = 0.88$ and $\gamma = 2.25$), and Figure 2 a “more curved” parameterization ($\beta = 0.5$ and $\gamma = 4$). For both figures we employ the parameter values $Y = 1$, $t = 0.2$, $p = 0.1$, $f = 2$, and $D = 0.3$. The figures graph the value function (50) (solid line), as well as its two components, $v(D - tX)$ (dotted line) and $pv(-ft[Y - X])$ (dashed line). It can be seen immediately that because the value function is not globally concave, the first-order and the second-order conditions do not necessarily describe the solution of the maximization problem. In Figure 1 there is no point in the interior that satisfies the first-order condition whereas in Figures 2 the first-order condition is only satisfied at an interior minimum but the maximum is at the $X/Y = 1$ corner. In neither case will an analysis of the first-order condition provide a correct description of compliance behaviour.

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3 According to Eqn. (1) in Kahneman and Tversky (1979), the value of the taxpayer’s prospect should be $V^XT = v(D - tX) + p[v(D - tX - ft[Y - X]) - v(D - tX)]$. There is a difference between this formulation and the one in the text because Yaniv (1999) applies the probability weight to the value of the difference instead of to the difference in values. We choose to follow the Yaniv formulation to make our points.
We now turn to the case $D < tY$. Figures 3 and 4 correspond to the same two parameters of the value function as for Figure 2 but use $D = 0.1$ to ensure that $D < tY$ and higher values of $p$ and $f$. In Figure 3 the local maximum at $X/Y = 0.33$ is also the global maximum, whereas in Figure 4 the local maximum is at $X/Y = 0.47$, but the global maximum is at the corner with $X/Y = 1$. One can also see that in both cases the first-order condition has another solution which is the interior minimum.

The examples in Figures 1 – 4 make it clear that the assumptions of Prospect Theory about the payoff function – notably convexity in losses and concavity in gains – result in the need to exercise care when analyzing the compliance decision. In particular, the first-order condition for choice cannot simply be accepted and used as a basis for comparative statics analysis. Depending on parameter values the model can have corner solutions, local and global interior maxima, and even outcomes where the only solution to the first-order condition is an interior minimum. We now proceed to analyze the effect of choice of reference point, on the assumption that first-order condition does correctly describe a global maximum.

Tversky and Kahneman (1992) emphasize the role of gain/losses formulated relative to a reference point. As we have already observed Prospect Theory does not detail how this
reference point should be chosen which leaves a degree of freedom in modelling. The choice of reference point can be justified in different ways. For example, Yaniv (1999) argued for income after advance tax payment to be the reference point. This is using a situation that arises in the sequence of events being modelled to fix the reference point. An alternative form of justification for choice of reference point is used by al-Nowaihi and Dhami for the compliance decision without an advance. Their argument is that if the taxpayer evades and is not caught they should always be in the “gain” region while if they are caught they should always be in the “loss” region. The only reference point that guarantees this for any level of evasion is true income after tax, \( Y[1 - t] \). Hence, the reference point is fixed by appealing to a natural interpretation of gain and loss. Since the reference point is not fixed by the theory we consider it worthwhile to analyse the consequences of choosing different reference points in the Prospect Theory model defined by (30).

Denoting the reference point by \( R(E, t) \) we specify the objective function for the taxpayer as

\[
V = w_1(p)Y_c^c - R(E, t) + w_2(p)Y_n - R(E, t)
\]

\[
= w_1(p)v_c' + w_2(p)v_n'.
\]  

(53)

We are interested in the sign of \( dE/dt \) where \( E \) is the interior maximum of \( V \) on \((0, Y)\). The first-order condition is

\[
\frac{dV}{dE} = w_2(p)v_n'[t - R_E] - w_1(p)v_c'[ft + R_E] = 0,
\]  

(54)

and we assume the second-order condition is satisfied, so

\[
\frac{d^2V}{dE^2} = S < 0.
\]  

(55)

The effect of an increase in tax rate upon the level of evasion is derived from the total differential of (54) and is written as

\[
\frac{dE}{dt} = -\frac{F}{S},
\]  

(56)

where

\[
F = w_2(p)v_n'[1 - R_{Et} + w_1(p)v_c'[ft + R_{Et}]
\]

\[
- w_2(p)v_n'[t - R_E][Y - E + R_t] + w_1(p)v_c'[ft + R_E][Y + fE + R_t].
\]  

(57)

Since \(- S > 0\), the sign of \( dE/dt \) is determined by the sign of \( F \). We now consider several alternatives for the specification of the reference point. In every case it should be stressed that we are assuming that there is an interior optimum to which we can apply the comparative statics analysis.

Example 1: \( R = [1 - t]Y \)
In this case \( R_E = R_{Et} = R_{EE} = 0, R_t = -Y \), so \( F = tE \left[ w_2(p)v_n'' + w_1(p)v_c'' f^2 \right] \). Using these expressions gives
\[
\frac{dE}{dt} = - \frac{E}{t} < 0.
\]

This specification of Prospect Theory provides the entirely unambiguous conclusion that an increase in the tax rate reduces evasion. In this case the standard qualitative prediction holds.

**Example 2:** \( R = R(t) \) with \( R_t \neq 0 \).
In this case \( R_E = R_{Et} = R_{EE} = 0, R_t \neq 0 \) which is a generalization of Example 1. These give
\[
F = tE \left[ w_2(p)v_n'' + w_1(p)v_c'' f^2 \right] + [Y + R_t] \left[ w_1(p)v_c' f - w_2(p)v_n'' \right]
\]
For \( F \) to be positive requires
\[
E \left[ w_2(p)v_n'' + w_1(p)v_c'' f^2 \right] > [w_2(p)v_n'' - w_1(p)v_c'' f] (Y + R_t).
\]

(i) Either
\[
E > (Y + R_t) \frac{w_2(p)v_n'' - w_1(p)v_c'' f}{w_2(p)v_n'' + w_1(p)v_c'' f^2},
\]
if
\[
w_2(p)v_n'' + w_1(p)v_c'' f^2 > 0
\]
(This, in particular, requires \( Y + R_t > 0 \)).

(ii) Or
\[
E < (Y + R_t) \frac{w_2(p)v_n'' - w_1(p)v_c'' f}{w_2(p)v_n'' + w_1(p)v_c'' f^2} \quad \text{if} \quad w_2(p)v_n'' + w_1(p)v_c'' f^2 < 0
\]
(This, in particular, requires \( Y + R_t < 0 \)).

The latter condition means that if the reference point falls fast enough as the tax rate increases the tax effect may be reversed at low levels of evasion, provided the payoff from gains is sufficiently concave. The former condition means that the tax effect may be reversed at high levels of evasion provided the payoff from losses is sufficiently convex.

**Example 3:** \( R(E, t) = (1 - t)(Y - E) \).
In this case \( R_E = 1 - t, R_{Et} = 1, R_{EE} = 0, R_t = -Y + E \). These give the simplification
\[
F = \left[ 1 + f \right] w_1(p)v_c' \left[ \frac{v_c''}{v_c'} \right] \left[ \left[ 1 + f \right] - 1 \right].
\]
\( F \) will be positive if
\[
\frac{v_c''}{v_c'} [t(1 + f) - 1] > 1
\]
Thus requiring \( \frac{v_c''}{v_c'} > \frac{1}{t(1 + f) - 1} > 0 \) provided \( t > \frac{1}{1 + f} \).
In the Prospect Theory framework $v_e^c/v_e$ is the loss aversion and is positive if the payoff is convex and being caught evading places the taxpayer in the loss region. It is therefore a possibility that the tax effect can be reversed for this specification if the penalty rate is sufficiently high.

From these examples we conclude that some choices of the reference point can affect the direction of the tax effect in some situations, but none of the examples is compelling. Schepanski and Kelsey (1990) test the idea that shifting the reference should alter the choice that is made. This means that the way an experiment is presented or a choice is framed should have a bearing on the outcome if it can change the reference point. The paper reports on a literature that has found a weak framing effect, or no framing effect. This is partly counter to the claims of Kahneman and Tversky (1984). The basis of the experiment is that individuals find themselves in a loss, gain, or neutral position. Loss means an unexpected tax bill is due but they have the option of claiming a non-allowable deduction which will work as long as they are not audited. The gain is based partly on the refund of tax including a non-allowable deduction with the issue of whether the taxpayer should inform the tax authority that it has made a mistake. Neutral ones were just told the alternative payoffs that could occur (these were the same as in loss condition). The experiment is claimed to provide strong evidence of a framing effect. King and Sheffrin (2002) also provide a discussion of prospect theory and framing and a further experiment that tests the model.

3.3 Variable Probability of Audit

We showed in the previous section that the application of the Prospect Theory described in Section 3.1.2 to tax compliance results in an objective function that is not globally concave. This implies that an interior optimum is not guaranteed and that care must be exercised in applying comparative statics analysis. In this subsection we demonstrate how making the probability of audit dependent upon the level of income declared can produce a concave objective function in the Prospect Theory framework and can reverse the tax effect. This was a possibility suggested by Yaniv (1999) and explored by al-Nowaihi and Dhami (2007).

A general formulation that permits these points to be addressed can be given as follows. Let $v$ denote the value function and $R$ be the reference level of income. To simplify we assume that $R$ is independent of the tax rate and the level of evasion. The probability of audit is assumed to be a decreasing function of declared income, $p = p(X)$, with $p' < 0$. The objective of the taxpayer becomes

$$V = w_1(p(Y-E)v^c(Y^c - R) + w_2(1-p(Y-E))v^n(Y^n - R)$$

$$= w_1(p(Y-E)v^c(t,E) + w_2(1-p(Y-E))v^n(t,E).$$

(58)

The concavity of the objective function (58) is determined by the sign of

$$\frac{\partial^2 V}{\partial E^2} = w_1'' p' v^c + w_1' p' v^c - 2w_1' p' v^c_E + w_1 v^c_{EE}$$

$$+ w_2'' p' v^n - w_2' p' v^n + 2w_2' p' v^n_E + w_2 v^n_{EE}.\quad (59)$$

When $p$ is constant (59) reduces to
\[ \frac{\partial^2 V}{\partial E^2} = w_1 v_{EE}^1 + w_2 v_{EE}^2. \] (60)

The second-derivative in (60) has two terms with one being negative and the other positive. Concavity is therefore not guaranteed. In the case of variable \( p \) it can be seen from (59) that if \( w_1' > 0 \) and \( w_2' < 0 \) then \( p'' \) sufficiently negative will ensure concavity. Hence, some combinations of variable probability of detection and weighting function, for a given payoff function, will ensure concavity.

If we assume that there is an interior maximum, at which the second-order condition must be negative, then the variable probability can reverse the direction of the tax effect. This is one of the key contributions made by al-Nowaihi and Dhami. To show this for our objective function (58) denote the second-order condition by \( S \), so \( S < 0 \) and observe that the effect of an increase in the tax rate upon \( E \) is given by

\[ \frac{dE}{dt} = \frac{w_1' p' v_{E}^c - w_1 v_{E_t}^c - w_2' p' v_{E_t}^n - w_2 v_{E_t}^n}{S}. \] (61)

If the probability of audit is independent of \( E \) the terms \( w_1' p' v_{E}^c - w_2' p' v_{E_t}^n \) are absent and if \( -w_1 v_{E_t}^c - w_2 v_{E_t}^n > 0 \), as it usually is, then it follows that \( dE/dt < 0 \). With the variable probability there are two additional terms and these can reverse the tax effect if they are sufficiently negative.

Two examples are now used to illustrate these points. First, consider objective function (58) and let the reference point be the true after-tax income, \( R = Y [1 - t] \). The optimization problem with the Prospect Theory objective function,

\[ \max_{0 \leq X \leq Y} V = w_1 \{\min\{p(X) v(-f t[Y - X]) + w_2 (1 - p(X)) v(t[Y - X])\}. \] (62)

For simplicity we assume \( w_1(p(X)) = p(X) \) and adopt the “standard” functional form for \( v(\cdot) \) given in (52). For the example we use a variable probability of detection defined by

\[ p(X) = \alpha p_0^{X/Y}, \] (63)

with \( \alpha \) and \( p_0 \) between zero and one, so a taxpayer believes he will be audited and caught with probability \( \alpha \) if he declares zero taxable income and will be audited with probability \( \alpha p_0 \) if he reports true income. The graph below shows \( V \) for the “standard” calibration \( \beta = 0.88, \gamma = 2.25 \) using \( \alpha = 2/3 \) and \( p_0 = 0.01 \). It is clear that the variable probability ensures the objective function is now strictly concave.
We can also use this example to show the extent to which the perceived probability is increased. There are two parameters to choose for the subjective probability function. Table 1 reports pairs of values for $\alpha$ and $p_0$ that make it optimal for the taxpayer to report half of their true taxable income, $X = Y/2$. So, with the parameterization as in the second row, the taxpayer's perceived probability of audit is 52% if he reports zero taxable income, 1% if he reports truthfully, and 7.3% if he reports half of his true income. Hence, introducing a variable subjective probability results in plausible estimated values for the probability of audit. (With constant probability ($p_0 = 1$) the objective function in this example is strictly decreasing for any $\alpha \in (0, 1)$ and is maximized at $X = 0$.) These results show the significant effect that the variable probability has upon the outcome.

![Figure 5: Concavity and the variable probability of detection](image)

Table 1: Perceived audit probability

<table>
<thead>
<tr>
<th>$p_0$</th>
<th>$\alpha$</th>
<th>$p(Y/2)$</th>
<th>$p(Y)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.01</td>
<td>0.656</td>
<td>0.0656</td>
<td>0.00656</td>
</tr>
<tr>
<td>0.02</td>
<td>0.520</td>
<td>0.0736</td>
<td>0.0104</td>
</tr>
<tr>
<td>0.03</td>
<td>0.458</td>
<td>0.0793</td>
<td>0.0137</td>
</tr>
</tbody>
</table>

We now provide a second example to show that introducing varying probabilities in the formulation adopted in Yaniv (1999) can also reverse the direction of the tax effect in that model. The example employs a linear functional form for the subjective probability function:

$$p_L\left(\frac{X}{Y}\right) = \alpha \left[1 - \left(1 - p_0\right) \frac{X}{Y}\right].$$

In Figure 6 we show that the objective function with the linear probability is concave and has an interior maximum. Furthermore, a larger advance tax payment results in a larger declared taxable income. In both figures we used $\alpha = 0.9$, $p_0 = 0.01$, along with the parameterization for the power value function and the penalty rate used for Table 1.
In the situation depicted in the left-hand panel of Figure 10 the advance payment is set above the true tax liability ($D/Y = 0.35$). The taxpayer declares about 87% of their true taxable income and believes that they will be audited with probability 0.12 for the tax rate equal to 0.2 (solid line). When the tax rate increases to 0.3 (dashed line) the declared amount falls to 85% and the perceived probability of audit increases to 0.137. For the situation illustrated in the right-hand panel the advance payment is set below the true tax liability ($D/Y = 0.15$). When the tax rate is 0.2 (solid line), about 74% of the true taxable income is declared, and the perceived probability of audit is 0.236. Now an increase in the tax rate to 0.3 (dashed line) results in the sharp decline in the declared income: the maximum is at the kink point (50% is declared), and the perceived probability of audit is 0.45. Thus, the model predicts that evasion increases as the tax rate increases, and a slightly higher tax rate may result in a substantially higher evasion if the advance tax payment is set below the true tax liability.

Adopting a variable probability of detection can reverse the direction of the tax effect. Whether it does or not depends on the precise combination of weighting function, probability function, and payoff function. An interesting question is how we interpret the meaning of a probability that depends on the announcement of income. One possibility is that this reflects the operation of the subjective assessment of probabilities by the taxpayer. An alternative explanation, which is more objective in nature, is that it reflects a reduced form representation of the auditing process. This is the outcome that arises when the revenue service extracts a signal from the taxpayer’s declared income to determine the probability of audit (see Reinganum and Wilde, 1986).

### 4.3 Ambiguity

Snow and Warren (2005) apply the idea of ambiguity to the tax evasion decision. Ambiguity in their model means that there is a lack of precise knowledge of the audit probability so the taxpayer forms a probability distribution over possible audit probabilities. An increase in ambiguity means an increase in dispersion of this probability distribution. Snow and Warren show that an increase in uncertainty about the probability of being audited (meaning additional ambiguity) increases tax compliance for ambiguity-averse taxpayers but reduces compliance for ambiguity lovers. They also report that experimental evidence shows people are heterogeneous with respect to preferences over ambiguity. This implies that the sufficient condition for evasion to occur will differ across taxpayers.

The true probability of audit is $p$ but the taxpayer is ambiguous about this. The subjective probability is $\pi$ which is distributed according to the cumulative distribution
function \( F(\pi; a, p) \), where \( a \) is the measure of ambiguity. \( F(\pi; a, p) \) is the second-order probability distribution. An increase in ambiguity is a mean-preserving spread of \( F(\pi; a, p) \). It is assumed that \( \pi \) is an unbiased estimate of \( p \) so

\[
\int \pi dF = p \quad .
\]

(66)

Snow and Warren also assume that the perception of \( \pi \) is distorted into \( \phi(\pi, p) \). The objective function is then given by

\[
V = U(Y^n) - \int \phi dF[ U(Y^n) - U(Y^c) ] .
\]

(67)

Observe that if there is no ambiguity or distortion then \( \int \phi dF = p \) and the objective collapses to the standard expected utility form

\[
V = [1 - p]U(Y^n) + pU(Y^c)
\]

(68)

The functioning of the model can be demonstrated by considering the comparative statics with respect to true audit probability and the level of ambiguity. Assume that (i) an increase in \( p \) causes a first-order stochastic dominance shift in \( F(\pi; a, p) \), so \( F_p < 0 \); (ii) \( \phi(\pi, p) \) is monotonically increasing in \( \pi \); and (iii) the expected value of \( \phi_p \) is positive. Then the effect on an increase in \( p \) upon the payoff of the taxpayer is given by

\[
\frac{\partial V}{\partial p} = \left[ \int \phi_p dF + \int \phi dF_p \right] [U(Y^n) - U(Y^c)]
\]

\[
= \left[ \int \phi dF + \int \phi_p F_p d\pi \right] [U(Y^n) - U(Y^c)] < 0,
\]

(69)

using integration by parts. A similar analysis derives a result for an increase in ambiguity. An increase in ambiguity results in an increase in risk so

\[
\int_0^\tau F_a d\pi \geq 0,
\]

(70)

for all \( \tau \in [0,1] \). The effect of an increase in ambiguity is

\[
\frac{\partial V}{\partial a} = \left[ \int \phi dF_a \right] [U(Y^n) - U(Y^c)]
\]

\[
= \left[ \int \phi_{a\pi} F_a d\pi d\tau \right] [U(Y^n) - U(Y^c)] < 0.
\]

(71)

The second term follows from using integration by parts twice. Hence, an increase in ambiguity has no effect on expected utility if \( \phi_{a\pi} = 0 \). The taxpayer can be said to be ambiguity loving if \( \phi_{a\pi} < 0 \) because this ensures that \( \partial V / \partial x > 0 \). The converse holds if \( \phi_{a\pi} > 0 \), in which case the taxpayer is ambiguity averse.
This development allows the effect of ambiguity upon the declared level of income to be obtained. The necessary condition for an interior optimum is

$$\frac{\partial V}{\partial X} = U'(Y^n) - \left[ \int_0^1 \varphi dF \right] \left[ U'(Y^n) - U'(Y^c) [1 - f] \right]$$

(72)

The second-order condition must hold so the sign of $dX/da$ is the same as the sign of

$$\left[ -\int_0^1 \varphi \pi \int_0^1 \varphi dF d\pi d\tau \right] \left[ U'(Y^n) - U'(Y^c) [1 - f] \right]$$

(73)

Since $f > 1$ the sign of (73) is determined by the sign of the first term. Therefore, an increase in ambiguity increases compliance ($X$ rises) if the taxpayer is ambiguity averse. It can also be seen directly from (72) that since $\int_0^1 \varphi dF$ is independent of $t$, the tax rate only enters through

the standard channels of $Y^n$ and $Y^c$. Consequently, this presence of ambiguity does not reverse the direction of the tax effect.

The idea of higher or lower ambiguity is an interesting one for the tax compliance decision since it raises interesting policy questions about the likely effect of making auditing processes more or less transparent. The result derived shows that increasing ambiguity by making policy less transparent will increase compliance. The model will also yield a different necessary condition for evasion, so can predict higher levels of compliance than the standard model but it does not change the direction of the tax effect.

4.4 First-order and second-order inequality aversion
The ideas are applied to tax evasion by Bernasconi (1998). The paper adopts the Segal and Spivak (1990) description of orders of risk aversion to argue that a payoff function with first-order risk aversion can resolve the over-prediction of compliance by the expected utility theory.

Consider applying Rank Dependent Expected Utility theory to the evasion decision. Denote the prospect $(Y^n, Y^c)(1 - p, p)$. When $Y^n > Y^c$ the objective is

$$V = w(p)U(Y^c) + [1 - w(p)]U(Y^n),$$

(74)

so the gradient of the indifference curve as $Y^c \to Y^n$ from below is

$$-\frac{1 - w(p)}{w(p)}.$$

(75)

When $Y^n < Y^c$ the objective becomes

$$V = w(1 - p)U(Y^n) + [1 - w(1 - p)]U(Y^c),$$

(76)

and the gradient of the indifference curve as $Y^c \to Y^n$ from above is
The gradients in (75) and (77) will not, in general, be equal, which shows that Rank Dependent Expected Utility has risk aversion of order 1.

The sufficient condition for tax evasion to occur is derived from (75). Since this differs from the value of \(-p/[1-p]\) in the standard model, the sufficient condition for evasion to occur will also be changed. Bernasconi derives the probability of audit that triggers evasion for an individual taxpayer by using the Camerer and Ho (1994) probability weighting function

\[
w(p) = 1 - \frac{[1-p]^\gamma}{[p^\gamma + (1-p)^\gamma]^{1/\gamma}},
\]

with \(\gamma = 0.56\). Combining this weighting function with a standard CRRA utility function generates the probabilities displayed in Table 2. The table shows that the absolute value of the gradient of the indifference curve for Rank Dependent Expected Utility can be significantly less than for expected utility. The expected return from evasion therefore has to be much greater for evasion to occur.

<table>
<thead>
<tr>
<th>Audit probability, (p)</th>
<th>(-[1-p]/p)</th>
<th>(-[1-w(p)]/w(p))</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.01</td>
<td>99.0</td>
<td>7.4</td>
</tr>
<tr>
<td>0.02</td>
<td>49.0</td>
<td>5.0</td>
</tr>
<tr>
<td>0.03</td>
<td>32.3</td>
<td>3.9</td>
</tr>
<tr>
<td>0.05</td>
<td>19.0</td>
<td>2.9</td>
</tr>
<tr>
<td>0.09</td>
<td>10.1</td>
<td>2.1</td>
</tr>
</tbody>
</table>

Table 2: Gradient of indifference curves

4.5 Disappointment

The central feature of Disappointment is the comparison of the outcome achieved with outcomes that could have been achieved. When the realised outcome is poor the disappointment reduces the payoff and provides a disincentive to undertake risky actions. In the context of tax evasion this will, ceteris paribus, reduce the chosen level of evasion. We now consider whether the inclusion of disappointment modifies the sufficient condition for evasion or the tax effect.

The representation can be written

\[
V = \varepsilon[Y(E)] - \varepsilon[D(Y(E)) - \varepsilon[Y(E)]],
\]

where \(D(\ )\) is the disappointment function. From the definitions of \(Y^n\) and \(Y^c\) it follows that

\[
\varepsilon[Y(E)] = pY^c + [1-p]Y^n = Y[1-t] + [1-p-pf]tE.
\]

Employing this, (79) can be written

\[
-w(1-p)
\]

\[
1-w(1-p).
\]

(77)
From the objective in (80) it can be seen immediately that the sufficient condition for evasion to occur is that \(1 - p - pf > 0\), which is identical to that for the standard model. In addition, the objective is dependent upon \(tE\) so that the solution for \(E\) will involve a term in \(1/t\). Therefore the model does not provide a route to reversing the direction of the tax effect.

4.6 Summary
This section has considered the analysis of the tax compliance decision in a number of non-expected utility models. The primary conclusion is that these models are able to provide a sufficient condition for evasion to take place that differs from that of the standard Allingham-Sandmo model. Furthermore, under the realistic assumption that taxpayers over-weight the probability of detection these models are able to produce a stricter sufficient condition. This overcomes the problem of the standard model predicting that all taxpayers should evade given observed audit probabilities and fine rates. Furthermore, if the weighting function differs between taxpayers then the models can also justify the observation that only a proportion of taxpayers will choose to evade (contrasted to standard model in which all or none evade).

The predictions of the models for the direction of the tax effect are less successful. In any model in which the payoff depends upon the product of \(t\) and \(E\) the optimal choice of the taxpayer is a value of \(tE\). Hence, as \(t\) changes so does \(E\) to keep \(tE\) constant. This makes the optimal \(E\) involve the term \(1/t\) so as \(t\) increases this has the effect of causing \(E\) to fall. This conclusion can only be changed if the objective function has either \(t\) or \(E\) entering as a separate argument in a way that is sufficiently strong to dominate. Al-Nowaihi and Dhami (2007) showed that one way this can be achieved is to have a variable probability of detection. This gives an effect that is dependent upon \(E\) but not \(t\), so the tax effect can be reversed. This separation can also be achieved through the effects of social interaction which are described in the following section.

5. Social Interaction
The previous section has focussed on different models of non-expected utility that vary in the evaluation of the monetary payoffs. It has been shown that these models can improve the prediction on the degree of compliance, but generally will not reverse the tax effect unless coupled with additional modifications, such as a variable probability of audit. A second branch of behavioural economics considers the social environment in which choices are made. The models in this literature relax the assumption that each individual makes a private and isolated decision. Instead, they view individuals as involved into a range of social interactions that affect the payoffs from different choices. There is a wide variety of models and these incorporate a large number of different forms of interaction. We have attempted a categorization but it should be stressed that there are many overlaps between the different models.

5.1 The Cost of Evasion
There are a number of models of the evasion decision that include costs in addition to the fine if caught evading. These additional costs can be real financial costs such as the payment for avoidance services or the loss of return through using a hidden investment instrument. They can also be psychic costs that arise through the fear of detection or the shame of being exposed. We interpret these psychic costs as being a consequence of the social setting in
which the taxpayer operates, so are a result of the loss of social prestige or reputation. The experiments of Baldry (1986) suggest that such costs distinguish the evasion decision from a straightforward gamble. Costs can also arise in terms of the loss of a social custom utility when tax evasion is chosen. This class of models are discussed in the next subsection.

The approach adopted by Gordon (1989) to incorporate psychic costs into the evasion decision is to assume that utility is determined by the function

\[ U = U(Y) - \chi E. \]  

(82)

In this utility function \( \chi E \) is the additional psychic cost of undertaking an amount of evasion, \( E \). The parameter \( \chi \geq 0 \) measures the extent to which these psychic costs affect the individual taxpayer. There may be some taxpayers for whom \( \chi \) is close to zero; such taxpayers will exhibit behaviour very similar to that predicted by the standard model. Other taxpayers may have a high value of \( \chi \): they will be much more reluctant to evade tax. It is helpful to think of the value of \( \chi \) as being determined by a combination of the taxpayer’s attitude toward honest behaviour and the effects of the taxpayer’s social peer group.

When an evasion level \( E \) is chosen a gain \( tE \) is obtained if the evasion is undetected and a loss \( -t Ef \) is incurred if it is detected. The taxpayer can then be viewed as choosing a quantity \( tE \) of a random asset which has return \( r = 1 \) with probability \( 1 - p \) and return \( r = -f \) with probability \( p \). This allows disposable income to be defined as the random quantity

\[ \tilde{Y} = [1 - t]Y + \tilde{r} tE. \]  

(83)

With this notation individual maximization leads to the first-order condition for choice of \( E \)

\[ \mathcal{E}[U(\tilde{Y}) \tilde{r} E] - \chi = 0, \]  

(84)

where \( \mathcal{E}[\ ] \) is the expectations operator.

The level of evasion, \( E \), is positive when the marginal utility of evasion is greater than zero at \( E = 0 \). Hence, evasion occurs when \( V_0 - \chi > 0 \), where \( V_0 \equiv [1 - p - pf] U(Y[1 - t]) \). If \( \chi \) is greater than \( V_0 \) then all income will be declared. When the model is applied to a population of taxpayers with individual values of \( \chi \) the population will be separated into two parts: high-\( \chi \) taxpayers will declare all income whereas low-\( \chi \) taxpayers will evade. This is illustrated in Figure 7. It is tempting to label high-\( \chi \) taxpayers as “honest” but honesty is a relative concept in this model since all taxpayers with finite \( \chi \) will evade when the expected gain is sufficiently great. The effect of changes in the probability of detection, the fine, and income at the individual level are similar to those of the standard model described by (3). In contrast, the consequence of any change for the aggregate level of evasion (the sum of evasion across individual taxpayers) is composed of the change in the level of evasion by existing evaders (the “intensive” margin) and the change resulting from more or fewer taxpayers evading caused by the change in \( V_0 \) relative to \( \chi \) (the “extensive” margin). Since these effects work in the same direction, there is no change in the predicted effects on aggregate or individual evasion.
The effect of an increase in the tax rate upon the level of evasion is derived in Gordon (1989). With decreasing absolute risk aversion, Gordon shows that there exists some $\chi^* < V_0$ such that $\partial E / \partial t < 0$ if $\chi < \chi^*$ and $\partial E / \partial t > 0$ if $V_0 > \chi > \chi^*$. This is demonstrated by differentiating (84), to show that the effect of the tax change is

$$\frac{\partial E}{\partial t} = \frac{\varepsilon[U'(\tilde{Y})t][Y - \tilde{E}]}{\varepsilon[U'(\tilde{Y})t][Y - \tilde{E}]} - \frac{\chi}{t}.$$  \hspace{1cm} (85)

For $\chi = 0$, (85) reduces to the standard result which has already been shown to be negative. In the limit as $\chi$ tends to $V_0$ the derivative in (85) is positive since $E$ tends to 0 from a positive value. With decreasing absolute risk aversion the numerator is monotonic in $\chi$, so the sign of $\partial E / \partial t$ must change once as claimed. If there are taxpayers characterized by values of $\chi$ that fall in the relevant range then there will be some evaders who increase the extent of their evasion as the tax rate increases. In addition to this effect, an increase in $t$ also raises $V_0$, so that previously “honest” taxpayers will begin to evade. It is therefore possible, though not unambiguous, that the introduction of utility cost of evasion can generate a positive relation between the tax rate and the extent of evasion.

An alternative to the psychic cost is the “conscience parameter” of Eisenhauer (2006a, 2008). In this formulation of the compliance decision an individual recognizes that evading tax results in free-riding on the taxes paid by compliant taxpayers. This generates a sense of guilt for the tax evader. The guilt is represented by discounting the untaxed income by the moral equivalent of a tax rate. Thus, the utility function in the Eisenhauer model is

$$V = pU(Y[1 - t] - \kappa E) + [1 - p]U(Y[1 - t] + tE - \kappa E),$$  \hspace{1cm} (86)

where $\kappa$ is the “moral discount rate” of the taxpayer, or the “shadow price of morality”. The guilt interpretation implies that $\kappa > 0$. However, the model can also work with the assumption that $\kappa < 0$ which represents a taxpayer who derives pleasure from evading tax. If $\kappa > 0$ is sufficiently high ($\kappa > t[1 - p - pf]$) then it is optimal not to evade. The model implies that tax evasion increases with its expected financial gain but decreases when morality increases. However, the addition of guilt in this form has the effect of reducing the value of $dE/dt$, so moving the tax effect further in the wrong direction. Eisenhauer calibrated the model using recent empirical data from a transition economy (Moldova) and from several groups of self-employed U.S. taxpayers; both data sets involve aggregate data. The empirical results are unfavourable to the model: to generate the observed compliance rates $\kappa$ must be around 39%, i.e. guilt from under-reporting taxable income by one dollar is equivalent to the loss of 39 cents. This is high value for the guilt parameter since it exceeds the average value of observed tax rates.
Bayer (2006) provides an alternative structure for the cost of evasion (which can be interpreted as financial or psychic) that very directly addresses the tax effect. Bayer assumes that the taxpayers are risk-neutral (to simplify the analysis and permit an explicit solution to be derived) and that concealing income is costly. The marginal cost of evasion is taken to be proportional to the share of income not reported, so \( C'(E) = E/\xi \) where \( \xi \) represents individual evasion opportunities or attitudes. The total cost of evasion, \( C(E) \), has a constant component that captures the cost of acquiring information about evasion opportunities. The tax liability for income \( Y \) is \( T(Y) = \tau(Y)Y \), with \( \tau(Y) = tY + \alpha \), and the penalty is a linear function of the evaded tax.

Combining these assumptions shows that income if audited and caught evading is

\[
Y^C = Y - T(Y) - f[T(Y) - T(Y - E)] - C(E),
\]

and income if evasion is successful is

\[
Y^n = Y - T(Y - E) - C(E).
\]

Under the assumption of risk-neutrality the objective of the taxpayer can be written

\[
\max_{E} V = pY^C + [1 - p]Y^n.
\]

The first-order condition for the choice of the level of evasion is

\[
\frac{dV}{dE} = [1 - p]T'(Y - E) - pfT'(Y - E) - C'(E),
\]

which gives the necessary condition for some evasion to be undertaken

\[
1 - p - pf > 0.
\]

Using (87) and (88) the first-order condition can be solved to give the explicit solution for the level of evasion

\[
E = \frac{[1 - p - pf][2tY + \alpha]}{2t[1 - p - pf]+1/\xi Y}.
\]

Differentiating with respect to the tax rate \( t \) gives the effect of the tax rate upon evasion as

\[
\frac{\partial E}{\partial t} = \frac{2[1 - p - pf][1/\xi - \alpha[1 - p - pf]]}{[2t[1 - p - pf]+1/\xi Y]^2}.
\]

If evasion takes place then \( 1 - p - pf > 0 \) and \( Y > E \), so (92) implies that \( 1/\xi - \alpha[1 - p - pf] > 0 \). Hence, at any interior solution it must be the case that \( \partial E/\partial t > 0 \). The model predicts an increase in the tax rate, \( t \), (or in \( \alpha \)) must lead to more evasion.

Two comments on this analysis are in order. First, the result can be extended to general functional forms for the cost and tax function, so the specific functional forms are not
necessary. The assumption of linear expected utility and constant marginal cost are used to allow an explicit solution to be obtained for the level of evasion. Bayer (2006) provides necessary conditions on the cost function for the result to hold more generally. Second, by considering a population of individuals who are characterized by individual values of \( \xi \) it is possible to separate the population into evaders and non-evaders. This permits an analysis of the aggregate level of evasion via the intensive and extensive margins.

Although it does not fit exactly with our theme of social interaction, the work of Lee (2001) that provides an alternative interpretation of the cost of evasion is interesting and worth reporting. The assumption of the standard model is that the true income of a taxpayer is revealed after an audit by the revenue service. Lee assumes instead that the taxpayer can reduce the assessed income after audit by paying an additional cost. This cost could involve the reduced return obtained from using concealed investments or the cost of searching and arranging such investments. It could also represent the cost of professional advice for securing income in non-taxable forms, or the inconvenience of receiving income in such forms. In every case the cost can be interpreted as a form of self-insurance that reduces the loss resulting from an audit.

Let \( \Phi(a) \) represent the level of taxable income assessed by the revenue service after an audit when the taxpayer expends effort \( a \) at reducing liability. It is assumed that \( \Phi'(a) < 0 \) and \( \Phi''(a) > 0 \), so higher effort successfully reduces liability. When the declared level of income is \( X \) and effort \( a \) is made, the income level if not audited, \( Y^n \), and the income level if audited, \( Y^c \), are

\[
Y^n = Y - tX, \quad (94)
\]
\[
Y^c = Y - t\Phi(a) - ft[\Phi(a) - X]. \quad (95)
\]

The decision problem for the taxpayer is to choose the declaration and the effort level. Lee assumes that the marginal cost of effort is unity in terms of expected marginal utility of income. Hence, the choices solve

\[
\max_{(X, a)} V = pU(Y^c) + (1 - p)U(Y^n) - a. \quad (96)
\]

The first-order conditions describing an interior optimum are

\[
V_X = pU'(Y^c) f - (1 - p)U'(Y^n) = 0, \quad (97)
\]
\[
V_a = -pU'(Y^c) [1 + f t] \Phi' - 1 = 0. \quad (98)
\]

The effect of an increase in the tax rate on reported income can be written as

\[
\frac{dX}{dt} = \frac{V_{xa} V_{at} - V_{aa} V_{xt}}{V_{xx} V_{aa} - V_{xa}^2}. \quad (99)
\]

The denominator of (99) is positive since it is the second-order condition for the optimization. The numerator is given by
\[ V_{Xa}V_{at} - V_{aa}V_{Xt} = p[1 - p][1 + f]\left[Y''U''(Y'c)\Phi'' - U''(Y'c)\phi''\right] \\
+ p^2 f[1 + f][Y'U'(Y'c)\Phi' - \Phi\phi'] \tag{100} \]

The assumptions on \( \Phi \) imply that the first term on the right-hand side of (100) is negative. Hence, a sufficient condition for \( dX/dt < 0 \) is that \( \Phi'\Phi'' - \Phi\Phi''' \geq 0 \). The explanation for this result is that a higher tax rate increases the return from self-insurance. Since more self-insurance reduces the marginal cost of additional tax evasion the amount of income that is declared will fall.

The results that have been reviewed show that the introduction of additional costs into the compliance decision can alter the sufficient condition for evasion and reverse the tax effect. Furthermore, the introduction of individual-specific parameters into the extended representation of costs allows different taxpayers to make different choices. This permits the models to be in agreement with empirical and experimental evidence. The drawbacks, and these also apply to all the social interaction models that follow, are that there is now at least one unobserved parameter in the model and the predictions of the models are not as precise as those of the standard model.

5.3 Social Customs
One explanation for the existence of a psychic cost of evasion is the loss of social prestige that follows detection as a tax evader.\(^4\) The models that include a social custom in the decision framework make explicit the link between the psychic cost and the wider social environment. This permits a range of interesting phenomena to be modelled.

The psychic cost of Gordon (1989) can be interpreted as the payoff from a social norm which is exogenous to each taxpayer. It is more convincing, and more interesting, to assume that the additional cost is generated by explicit social interaction. This can be done by assuming that the cost is an increasing function of the proportion of taxpayers who do not evade. This formulation captures the fact that more social prestige will be lost the more out of step the taxpayer is with the remainder of society. This approach was developed by Myles and Naylor (1996) who showed that reputation effects can lead to multiple equilibria and epidemics of evasion.

Let the utility level for a taxpayer of income \( Y \) and facing the tax rate \( t \), who chooses not to evade, be given by

\[ V^{NE} = U(Y[1 - t]) + bR(1 - \mu) + c, \tag{101} \]

with \( b \geq 0 \) and \( c \geq 0 \). The additional utility from adhering to the social custom of honest tax payment is \( bR(1 - \mu) + c \), where \( \mu \) is the proportion of population evading tax and \( R > 0 \). The parameters \( b \) and \( c \) represent the attitude of the individual taxpayer toward the social custom and can be expected to be different across taxpayers. The effect of the social custom can be given two interpretations. One is that the utility, \( bR(1 - \mu) \), of conforming with the group of honest taxpayers and the utility, \( c \), obtained from following the social custom can be considered to be distinct entities. The distinction between the return to conformity and the return from following the social custom is adopted in Akerlof (1980) and has also been

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\(^4\) The Irish government publishes an annual list of tax evaders along with the amounts of unpaid tax. The UK government has discussed following suit. Major court cases are usually reported.
stressed in this context by Cowell (1990). Alternatively, the sum \( bR(1 - \mu) + c \) can represent a general function describing the effect of the social custom but with a linear form chosen for simplicity. It should be noted that the utility from adhering to the social custom is always derived from honest behaviour, even if the honest are in a minority.

When the decision to evade tax is taken, the resulting level of utility is

\[
V^E = \max_{X} \{ pU(Y[1 - t] - ft(Y - X)) + [1 - p]U(Y - tX) \}. \quad (102)
\]

The assumption used to write (102) is that the utility from following the social custom is lost when evasion is chosen. The declaration that maximizes (102) is denoted by \( X^* \) and the maximized level of utility by \( V^{E*} \). The optimal level of reported income must satisfy the first-order condition

\[
pfU'(Y[1 - t] - ft(Y - X^*)) - [1 - p]U'(Y - tX^*) = 0. \quad (103)
\]

From this condition it can be seen that for given \( Y \), the choice of \( X^* \), and hence the value of \( V^{E*} \), is independent of \( b \) and \( c \). Effectively, if evasion is chosen then the level is identical to that for the standard model. Hence, if an individual evades tax and deviates from the social custom the extent to which they evade does not depend on the importance attached to the social custom.

Whether an individual taxpayer evades depends upon the value of \( V^{NE} \) relative to \( V^{E*} \). Evasion will only take place if \( V^{E*} > V^{NE} \). The strict inequality captures the implicit assumption that the taxpayer prefers to follow the social custom if there is no utility loss from doing so. Writing this condition in detail, a taxpayer chooses to evade if

\[
pU(Y[1 - t] - ft(Y - X^*)) + [1 - p]U(Y - tX^*) > U(Y[1 - t]) + bR(1 - \mu) + c. \quad (104)
\]

The first point to note is that the model will generate no observations of taxpayers just evading a “little” tax. Taxpayers either do not evade or jump straight to evasion level \( E = Y - X^* \). The second point to note is that the model, in common with the psychic cost models, can have perfect compliance even when the expected financial gain from evasion is positive. This occurs when the gain from evasion is not sufficient to offset the loss from not following the social custom. The key point of the model is that the choice of whether to evade or not depends on the proportion of the population who are evading, \( \mu \). The choice is not made by the taxpayer in isolation but is the outcome of a process of social interaction. The determination of which taxpayers evade is made by finding a self-supporting proportion of evaders. That is, the equilibrium value of \( \mu \) has the property that precisely proportion \( \mu \) of taxpayers will find it optimal to evade in response to that value. Figure 8 depicts such an equilibrium.
A change in the tax rate has an effect at the intensive margin and the extensive margin. The effect at the intensive margin—a taxpayer declaring $X^* < Y$—is the same as for the standard model. The effect at the extensive margin depends on how the change in the tax rates affects the self-supporting value of $\mu$. It is through this process that the model can generate a range of interesting outcomes. For example, a small change in tax rate may cause a low-$\mu$ equilibrium to disappear so that the economy “jumps” to a high-$\mu$ equilibrium. Hence, an epidemic of evasion can occur in response to a minor change in the tax system.

The effect on the extensive margin can be found by taking given values of $Y$ and $t$ and evaluating the critical proportion of evaders required for a taxpayer with characteristics $\{b, c\}$ to evade. If there exists a value of $\mu^*$ satisfying

$$pU'(Y^c) + [1 - p]U'(Y^a) = U(Y^T) + bR(1 - \mu^*) + c,$$

where $Y^T = Y[1 - t]$, then, since the right-hand side is monotonically increasing in $\mu$, a taxpayer of parameters $\{b, c\}$ evades if $\mu > \mu^*$ and pays their full amount of tax if $\mu \leq \mu^*$. Now consider a taxpayer for whom there exists a value $\mu^*$ such that (105) is satisfied. The effect of an increase in the tax rate on the critical proportion, $\mu^*$, can be calculated as

$$\frac{d\mu^*}{dt} = \frac{pU'(Y^c)[1 - p]U'(Y^a) - U(Y^T)Y}{bR},$$

where the first-order condition for the choice has been used to simplify the expression. The effect of an increase in the tax rate on the critical proportion depends on the expected marginal utility from evasion compared to the marginal utility of correct declaration. This is not restricted by the model, so the effect may go in either direction. If $\frac{d\mu^*}{dt} < 0$ then an increase in the tax rate reduces the proportion of evaders required to encourage the (previously) marginal taxpayer to evade. The equilibrium number of evaders must therefore increase.
This model of a social custom emphasizes the importance of distinguishing between individual and aggregate effects of an increase in the tax rate. For each individual who is already evading it remains the case that an increase in the tax rate raises the level of income declared. However, an increase in the tax rate has the effect of increasing the proportion who evade. The net effect is determined by the resolution of these two. Consequently, aggregate data may show a positive relation between the tax rate and evasion even if the opposite is true at the individual level.

There have been several extensions of the social custom model some of which can achieve a reversal of the tax effect. These are now discussed. The basis of the extensions is that the payoff in a model of social customs and stigma can be given the general form

\[ V = \bar{E}[U(X)] - S(E_i, \mu), \]

where the cost of stigma or social custom loss is given by \( S(E_i, \mu) \). The models differ in the structure adopted for the loss function.

Kim (2003) employs a loss function of the form

\[ S(E_i, \mu) = p \Psi(E_i, 1 - \mu), \]

where \( \Psi(\cdot) \) is increasing in both arguments and convex in \( E_i \). The detection probability \( p \) appears here because it is assumed that the loss only occurs if the evader is caught. Kim assumes that the social cost is the same for all individuals so it does not allow for heterogeneity in moral attitudes. In this case it is other individual attributes, such as income, that result in individuals reaching different outcomes with respect to the evasion decision. This assumption is not necessary and could easily be relaxed.

Traxler (2010) adopts a special case of the Kim structure but introduces individual heterogeneity. The chosen form is

\[ S(E_i, \mu) = E_i \theta_i c(\mu), \]

where \( \theta_i \geq 0 \) is the individual-specific degree of norm internalization and \( c(\mu) \) is the strength of the norm for a given fraction of evaders. It is assumed that \( c'(\mu) \leq 0 \) for \( \mu \in [0,1) \) so that an increase in the proportion of taxpayer deviating from the norm lowers the social custom cost of evasion. With this functional form the first-order condition for an interior solution is

\[ -pftU'(\bar{Y}^c) + [1 - p]U'(\bar{Y}^{nc}) = \theta_i c(\mu). \]

If \( \theta_i = 0 \) the first-order condition collapses to (3) so the standard necessary condition for evasion to occur will apply. If \( \theta_i \) is sufficiently high then there will be no evasion. Evaluating (110) at \( X = Y \) gives the critical value of \( \theta_i \) that separates non-evaders from evaders:

\[ \hat{\theta}_{\mu} = \frac{[1 - p][1 + f]U'(1 - i)\bar{Y}}{c(\mu)}. \]
Hence, for given $\mu$, the choice of evasion behaviour is determined by

$$
\hat{E}_i = \begin{cases} 
0 & \text{for } \theta_i \geq \hat{\theta}(\mu), \\
E_i^* & \text{for } \theta_i < \hat{\theta}(\mu),
\end{cases}
$$

where $E_i^* = Y - X^*$, and $X^*$ is the solution to (103).

The effect of an increase in the tax rate can be found from (110) as

$$
\frac{\partial E_i^*}{\partial t} = \frac{1}{\varepsilon[U']} \left[ \frac{\theta_i c(\mu)}{t} \right] + \left[ p ft U'' \left( Y + f E_i^* \right) - [1 - p] U'' \left( Y + E_i^* \right) \right].
$$

When $\theta_i = 0$ this collapses to the standard result described in (10) and (12), so that $\partial E_i^*/\partial t < 0$. When $\theta_i$ satisfies

$$
\theta_i \geq \hat{\theta}(\mu) \equiv -\frac{t}{c(\mu)} \left[ p ft U'' \left( Y + f E_i^* \right) - [1 - p] U'' \left( Y + E_i^* \right) \right],
$$

then an increase in the tax rate raises the level of individual evasion. This is very similar to the result in Gordon (1989). What is different here is that the tax effect is dependent upon the extent of evasion in the population through $\mu$. A fall in the proportion of tax evaders reduces $\hat{\theta}(\mu)$ so a positive tax effect applies for a larger range of values of $\theta_i$.

A more complex version of social interaction is present in Fortin et al. (2007). Their model takes into account both social conformity effects, fairness effects, and correlated effects across taxpayers. The specification they adopt is given by

$$
S = E_i K(\bar{E}_{-i}, \bar{t}_{-i}, \bar{p}_{-i}, \eta).
$$

The social custom cost in this case depends on the average level of evasion, $\bar{E}_{-i}$, in the rest of the population. An increase in $\bar{E}_{-i}$ may reduce $K$ – meaning more “conformity” with other tax evaders – or increase $K$ which is “anti-conformity”. The cost is increasing in the average tax, $\bar{t}_{-i}$, and auditing rate, $\bar{p}_{-i}$, faced by others. These effects capture fairness motives. We say more about fairness in Section 5.4. The remaining parameter, $\eta$, is a vector of individual and group-specific characteristics that might affect the cost. The structure is tailored to an experimental study performed by Fortin et al., that assumes precise knowledge about the evasion behaviour of the other participants in a small, well-defined, group, rather than evasion in a large society. The experimental results provide evidence of fairness effects but reject social conformity. The specification could, however, be interpreted for a large population with the averages replaced by expectations.

For given values of the parameters $\{\bar{E}_{-i}, \bar{t}_{-i}, \bar{p}_{-i}, \eta\}$ the tax effect in this model will operate in the same way as in Traxler (2010). Hence, those for whom the individual characteristics make the value of $K(\bar{E}_{-i}, \bar{t}_{-i}, \bar{p}_{-i}, \eta)$ large will react to an increase in the tax
rate by increasing the level of evasion. In addition to this, there are also indirect effects arising from the terms \( \{ E_{-i}, \tilde{I}_{-i} \} \). The direction in which these operate will depend upon the assumptions made about the structure. If there is “anti-conformity” then an increase in \( E_{-i} \) increases \( K(\tilde{E}_{-i}, \tilde{I}_{-i}, \bar{p}_{-i}, \eta) \), and results in a larger proportion of the population exhibiting a positive tax effect - which reinforces the rise in \( E_{-i} \). This seems counter-intuitive but is a consequence of the positive tax effect being focussed on the set of taxpayers who are closest to being honest.

The introduction of psychic costs and of social norms is capable of explaining some of the empirically observed features of tax evasion which are not explained by the standard expected utility maximization hypothesis. It achieves this by modifying the form of preferences but the basic nature of the approach is unchanged. The obvious difficulty with these changes is that there is little to suggest precisely how social norms and utility costs of dishonesty should be formalized.

5.4 Perceptions of fairness

The tax compliance decision involves two dimensions of fairness. First, there is perceived trade-off between what is paid to the government in taxes and what it received from the government in public services. If the services received are viewed as limited in quantity or poor in quality then anything other than a demand for a low tax payment will be perceived as unfair. Second, there is the allocation of the tax payments across taxpayers. If some taxpayers are believed to pay little then a taxpayer asked to make a large payment will perceive the system to be unfair. The issue of horizontal equity as judged by individual taxpayers is relevant here, and vertical equity also plays a role. It is possible to view fairness as one aspect of the more general concept of “tax morale”. Certainly, when we discuss tax morale in the next section we will have cause to consider fairness again. A separate treatment of fairness is justified on the grounds that fairness in the sense we have described has been successfully formalized with interesting implications for the compliance decision and the tax effect.

The concept of fairness with respect to the public services obtained relative to tax payment has been analyzed by Cowell and Gordon (1988). In their model taxpayers derive utility from income and from a public good. An individual taxpayer can choose how much tax to evade but does not directly choose the quantity of public good which is determined by the tax rate and by the compliance decisions of the population of taxpayers. The key feature of the model is that a change in the tax rate has a non-negligible effect on public good supply and this indirectly affects the compliance decision. If the effect of the public good is sufficiently strong, and operates in the correct direction, then it can reverse the standard result for the tax effect.

A simplified version of the Cowell and Gordon (1988) model can be presented as follows. Let the taxpayer care about income and public good and write the expected utility function as

\[
V = pU(\tilde{Y}^c, G) + [1 - p]U(\bar{Y}^n, G).
\]

The taxpayer takes the quantity of public good, \( G \), as given when choosing the level of evasion. Under this assumption the first-order condition for the choice of evasion is
\[
\frac{dV}{dE} = -fpU_Y^C + [1 - p]U^n_Y = 0.
\] (117)

When the tax rate is increased public good supply will also change, and this effect must be incorporated into the analysis of the tax effect. The tax effect is therefore given by

\[
\frac{dE}{dt} = \frac{[1 - p]U^n_{YY}[Y - E] - p[U^n_Y + Y] + [1 - p]U^n_{YG} - fpU^C_{YG}}{S} \left( \frac{\partial G}{\partial t} \right),
\] (118)

where \( S < 0 \) is the second-order condition. The first two terms in the numerator are equivalent to the expression for the standard evasion model. The third term captures the public good effect. This is the product of the effect of additional public good upon the marginal utility of income and the effect of an increase in tax rate on public good supply. If the product of these terms is negative then they will offset the standard tax effect and will overturn it if strong enough.

The Cowell and Gordon analysis addresses the aspect of fairness concerning the services provided in return for payment of tax. The second aspect of fairness – the perceived fairness of the distribution of tax payments – has been added to the Cowell and Gordon model by Bordignon (1993). To make the extension Bordignon imposes a social norm upon behaviour, based on the concept of Kantian morality, under which each individual assesses their fair tax payment towards the provision of public goods. The calculation of the fair payment takes into account both the quantity of public good provided and the tax payments made by other taxpayers. This fair payment provides an upper bound on the extent of tax evasion since the taxpayer will not wish to pay less than the fair payment. To calculate the actual degree of tax evasion each taxpayer then determines a level of evasion from the expected utility maximization calculation and evades whichever is the smaller out of this quantity and the previously determined upper bound. This formulation is also able to provide a positive relation between the tax rate and evaded tax for some range of taxes since the tax rate plays a role in determining the upper bound on acceptable behaviour.

Two further contributions are worth describing. Falkinger (1988) analyzes the decision problem of an expected utility maximizing taxpayer who assesses the benefit obtained in exchange for the payment of tax. The analysis shows that evasion may decrease as the beneficial expenditure increases, but the result is not unambiguous. Falkinger (1995) presents arguments to explain a link between risk aversion and the perceived degree of fairness in the tax system. One aspect is the link between marginal utility and public good provision just described. A second aspect is that there is greater guilt from evasion when the system is perceived to be fair. Hence, the degree of fairness can be linked back as a determinant of the psychic cost discussed above.

5.5 **Tax morale**
We now discuss the concept of tax morale. Torgler and Schaltegger (2006) define tax morale as the intrinsic motivation to pay taxes or, following Schmölders (1960), as a set of attitudes regarding tax compliance. Tax morale includes the attitude towards paying taxes and contributing a fair share to the financing of public goods. The concept of tax morale is easy to grasp at an intuitive level, but it has proved harder to represent within a formal model of the compliance decision.
The literature has identified many dimensions of tax morale which are influenced by a range of factors. First, there is the cultural dimension. Included within culture are socio-demographic and socio-economic factors, as well as national pride and religious customs. Second, there is the institutional dimension which refers to the structure within which the government operates. Among the factors that are relevant in this dimension are the perception of inclusion in the democratic process, and the degree of trust in the institutions operating the tax system. These two factors combine to determine the level of acceptance of tax policy. It is this idea of acceptance that is at the heart of tax morale. The final dimension is the structure of the tax system, particularly its perceived degree of fairness, and the operation of the system. If the system is widely perceived as unfair then tax morale is reduced. Tax morale affects the compliance decision because the incentive to pay tax honestly is reduced if morale is low. Furthermore, changes in any of the dimensions of tax morale can lead to reduced compliance.

Frey and Feld (2002) apply “motivation crowding theory”, which addresses the undermining effect of rewards on intrinsic motivation, to tax evasion. External intervention undermines intrinsic motivation when it is perceived to be intrusive but raises intrinsic motivation when it is perceived to be supportive. Frey and Feld assume that external intervention in the form of rewards, commands, rules and regulations, and punishments negatively affect intrinsic motivation to pay tax. This implies that deterrence policies pursued by tax authorities can undermine individual willingness to comply with tax law. The individual cost of undertaking evasion rises when increased deterrence is applied by the tax authority and when the level of tax morale is higher. Increased deterrence will raise the level of tax evasion if tax morale is crowded out. Hence, a deterrence policy will only work if it is designed to avoid damage to tax morale.

Dell’Anno (2009) extended the model of Gordon (1989) to investigate how compliance is affected by tax morale and how tax morale is dependent on a taxpayer’s intrinsic attitudes to honesty and social stigma. Tax morale is separated into the effect of a “guilty conscience” and the effect of “public disgrace”. Both of these constitute a cost that reduces the utility of the taxpayer. The guilty conscience arises from the taxpayer anticipating guilt when under-reporting and escaping detection. The social stigma is caused by the taxpayer anticipating public shame when under-reporting. It is assumed that these attitudes are influenced by the taxpayer’s perception of the extent of tax evasion in the society and of the behaviour of the tax authority.

These ideas can be captured by assuming that the payoff function is given by

\[ V = pU(Y^c) + (1-p)U(Y^n) - \nu E - \phi p E. \] (119)

The psychic cost is \( \nu E \), where \( \nu \) is an individual honesty characteristic. The level of social stigma is determined by the perceived degree of fairness (\( \phi \)) and quality of relationship between taxpayer and tax authority (\( \rho \)). Anything that reduces perceived fairness, such as an increase in evasion, will reduce \( \phi \) and lower the social stigma cost of evasion. Similarly, the quality of relationship, \( \rho \), can be affected by the actions of the tax authority. This framework extends the basic psychic cost by making the cost dependent upon the social interaction between taxpayers, and between the taxpayer and the tax authority. For given values of the parameters determining psychic cost the analysis is essentially the same as in Gordon (1989). However, the tax effect can be very different once its effect upon the degree of fairness and the quality of relationship is taken into account. If an increase in tax rate reduces either, or
both, of $\rho$ and $\phi$ then this will provide a mechanism through which the direction of the tax effect can be reversed compared to the standard model.

Empirical research has analysed the determinants of tax morale and the effects of changes in tax morale. Torgler (2003) used Canadian data from the World Values Survey (WVS) to investigate the formation of tax morale. Tax morale was measured by the response to the statement “Cheating on tax if you have the chance” can always be justified, never be justified, or something in between, on a 10 point scale. Strong evidence was found that trust in government, pride, and religious conviction have systematic positive influences on tax morale even after controlling for age, income, education, gender, marital status, and employment status. Several studies have investigated how tax morale affects evasion. Weck (1983) found that there is a negative correlation between tax morale and the size of the shadow economy. Torgler (2001, 2005), Alm and Torgler (2006) and Alm et al. (2004) also found a strong correlation between tax morale and the size of shadow economy. For example, Alm and Torgler (2006) found that the variable “tax morale” can explain more than 20 percent of the total variance of the size of the shadow economy. Thus, the degree of tax morale has consequences for real behaviour. Moreover, it is not only the size of the shadow economy that is affected by tax morale. Using data from the US Taxpayer Opinion Survey which captured attitudes to the overstatement of deductions or expenses and of underreporting income, Torgler (2003) found that tax morale also significantly reduced tax evasion.

Frey and Torgler (2007) found a high correlation between perceived tax evasion and tax morale, as well as a strong positive correlation between institutional quality and tax morale, using survey data from 30 West and East European countries. Ashby et al. (2009) used a social identity framework to investigate how taxpayers perceived their occupational taxpaying culture, and how this perception influenced their self-reported tax compliance. Using questionnaire data from Australia, they found that occupational taxpaying culture is important in explaining attitudes towards the tax office and tax minimization. Laboratory experiments conducted by Torgler (2004) in Costa Rica and Switzerland replicated the structure of a voluntary income reporting and had a public good structure. The experiments were accompanied with a post-experiment questionnaire that allowed the measurement of tax morale. This showed that tax morale was an important determinant of tax compliance. Torgler (2002) provides a comprehensive survey of experimental work on tax morale.

There has been much empirical work on tax morale but the theoretical work in this area is relatively undeveloped. This is a consequence of the difficulties in formalizing the concept of morale in a precise way that is amenable to analysis. In some representations tax morale can appear similar to the social custom costs discussed above. In others, it can take a form very similar to the fairness models. Empirical evidence indicates that the tax morale is an important determinant of tax compliance decision, but the theoretical modelling so far has been less than convincing.

5.6 Summary
It should be clear from the discussion that the literature has analyzed a wide range of social interactions affecting taxpayer’s decision. The central point is that all the contributions emphasize the idea that the compliance decision is not taken in isolation but is made in the context of the social environment of the taxpayer. This extends the set of factors that the taxpayer has to take into account compared to the standard model of evasion. As a consequence, models that include social interaction are able to reverse the tax effect for appropriate choice of structure. A secondary point is that social interactions models involve
both intensive and extensive margins which impact upon the analysis of individual and aggregate evasion levels. However, it is clear that these benefits have to be set against the loss of precision of the predictions compared to those of the standard model.

6. Conclusions
The Allingham-Sandmo model of the individual tax compliance has formed the “standard” against which all later developments are judged. The general agreement in the literature is that the standard model produces two incorrect predictions. First, the sufficient condition for evasion to take place over-predicts the empirically-observed level of evasion. Second, the model predicts that the level of evasion will fall when the tax rate rises (a consequence of the fine for evasion being proportional to tax evaded). This result runs counter to “intuition” and is also in conflict with some of the empirical evidence. These shortcomings have lead to the development of a significant literature that reconsiders the compliance decision using ideas drawn from behavioural economics. This paper has surveyed these new contributions and assessed whether they perform any better than the standard model as an explanation of the compliance decision.

We have identified two classes of contribution in the behavioural economics literature. The first class modifies the Allingham-Sandmo model by using non-expected utility theory. Moving to non-expected utility permits a broader range of possibilities for the structure of preferences and removes some of the constraints imposed by expected utility theory. The second class of contributions alter the payoff structure to include a range of factors that broadly reflect “social interaction” between taxpayers. Together, these contributions provide a wide range of alternative models of the tax compliance decision.

The conclusion of this review is straightforward. The non-expected utility models can change the cut-off probability for evading and hence the proportion of evaders. This is a direct consequence of their use of weighting functions to replace the objective probabilities. The models can also change the amount of income declared relative to the standard model. The use of these weighting functions in place of the objective probabilities is not sufficient to reverse the tax effect if the payoff depends on the product of the tax rate and the amount of evasion. In order to have an impact upon the tax effect this structure has to be broken in some way. One possible way to do this is through the choice of the reference point in prospect theory. However, it should be stressed that the choice of the reference point must not be arbitrary but should instead have some relevance and meaning in the situation being analysed. A second route to a change in the tax effect is to assume that the probability of detection is dependent upon the declared income level. This is, in fact, an assumption that can be given a good justification in the context of the evasion decision.

The structure of the payoff function can also be changed by introducing considerations of social interaction. Among such elements we have discussed psychic costs, social customs and social norms, and tax morale. The actual predictions of the model with social interaction depend upon the precise structure that is adopted. Some variants can reverse the tax effect but others cannot. All are able to alter the sufficient condition for tax evasion to take place and can potentially make predictions consistent with practical observation. The concept of tax morale captures a broad ranges of ideas but has so far not received a compelling formalisation.
This new literature has incorporated many interesting elements into the tax evasion decision that are absent in the standard model of Allingham and Sandmo. The models are able to make predictions that fit better with the evidence. However, the gain in the potential to match the evidence has yet to offset the loss in precision relative to the standard model. The standard model is exemplary in its parsimony and clarity of prediction. To go beyond it some of the parsimony is lost. Each the alternative specifications is informative but which of them is useful will eventually be determined only by empirical testing.

References


