Rank Dependent Utility, Tax Evasion and Labor Supply

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Abstract

In the simple Allingham-Sandmo portfolio model of tax evasion an expected utility maximizer will cheat more than what is estimated in empirical studies. Two main types of explanation have been suggested as solutions to this puzzle: (1) Tax payers act according to some non-expected utility theory, and (2) Individual ethical norms and social stigma induce people not to cheat. In the present study we test two hypotheses within these broad explanations: (1) Tax payers are weighting subjective probabilities of being penalised according to the rank dependent utility theory, and (2) Tax payers' beliefs about social norms have an effect on their decision to evade taxes. Our model is characterized by a simultaneous determination of tax evasion and labour supply, including the effect on tax payers of a social norm of not cheating. Using Norwegian survey data our hypotheses are corroborated. Our estimates imply that if the objective probability of being penalized is, say 3 %, the weighted probability is about 23 %. Our study provides an independent confirmation of the rank dependent expected utility theory. The model explains data 53% better than pure random choices and predicts hours worked in the regular economy, among tax evaders as well non tax evaders, rather precisely. The model is an example of a two sector choice model and the results indicate that an overall wage increase may shift labor supply away from the irregular part of the economy towards the regular.

JEL-Code: C25, D12, D81, H26, J22.

Keywords: labor supply, tax evasion, rank dependent utility.

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1. **Introduction**

In the literature of tax evasion it has been considered a puzzle that people seem to cheat less than suggested by the expected utility theory. According to Allingham and Sandmo's (1972) portfolio choice approach to income tax evasion, a risk-averse tax payer, with a von Neumann-Morgenstern utility function, will under-report his income whenever the tax rate is greater than the expected penalty rate. Intuition as well as empirical evidence seems to contradict this conclusion. For the more common types of tax evasion the sanctions in many countries consist of fines less (or not much higher) than the amount evaded, whereas the probabilities of tax returns being audited are of the order of a few percent.[5] In general, expected utility maximizers would, therefore, be tax evaders, a result that is not supported by empirical evidence.[6]

One reason for the discrepancy might be that the tax payers' subjective probability of audit is considerably higher than the observed objective probability.[7] A related explanation is that people are weighting objective or subjective probabilities of sanctions. Another reason might be social norms producing shame and stigma. Our empirical study includes tests of these two. A third reason is lack of time and opportunities to work in the irregular part of the economy.

Although a number of models allow for weighting of probabilities, a phenomenon observed in many laboratory experiments, models based on simple weighting of probabilities violate stochastic dominance. In the RDEU model, initially developed by

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[5] Tax authorities are somewhat reluctant to supply information about the (low) values of probabilities of being audited and sanctioned. According to Marchese and Privileggi (1997), p. 400) the audit rate in Italy in 1991 and 1994 was about 1 per cent. In the US the audit rate decreased from 4.75 per cent in 1965 to 0.8 per cent in 1990, and increased to 1.9 per cent in 1995 (Feinstein 1998, p. 576) The penalty rate in the US is about 50 per cent of the tax evaded. Thus, in the early 1990ies, the expected value per dollar of evaded tax was almost equal to 0.99 dollar.

[6] See the review of Andreoni et al. (1998) for references and discussion. For any sensible value of the risk aversion parameter taxpayers should report either a small proportion of their income or none whatsoever (Feinstein 1999, p. 576). In spite of the apparent profitability of tax evasion, the comprehensive Taxpayer Compliance Measurement Program in the US found that about 40 per cent of the tax payers underpaid their taxes (Feinstein 1998, F361). Various studies of the underground economy conclude that in Western countries somewhere between 2 and 30 per cent of the BNP is not reported to the tax authorities. (Schneider and Enste 2000). Note that some authors report the *income* evaded and others the *tax* evaded, cf note 5. The difference is related to the difference between the model of Allingham and Sandmo (1972) and that of Yitzhaky (1974).

[7] This discrepancy is documented in a Slemrod's (1992) comprehensive survey of experimental and empirical literature on tax evasion.

Quiggin (1982), the linearity of probabilities of the EU model is replaced by a probability weighting function which assigns weights to the probabilities of the different states of nature. The weights themselves are functions of the rank of a given state of nature, where the rank is determined by the individual level of satisfaction obtained in the various states. Since in the RDEU model it is the *cumulative* distribution function that is transformed, stochastic dominance is assured (Quiggin 1982). The *cumulative* prospect theory of Tversky and Kahneman (1992) has also this property, and that model has the additional property of allowing for different weighting functions for losses and for gains, a property that has some attraction in studies of tax evasion. Perhaps less attractive in a study of tax evasion is the assumption in the cumulative prospect theory that only *changes* in wealth, and not its absolute value, matters.

The RDEU model is among the strongest contenders to the EU model (see e.g. Weber and Kirsner (1997)). Examining a number of empirical studies, Hey and Orme (1994) concludes that among a great number of utility functionals the RDEU function is found to be the best.[8] Empirical support for the RDEU model has been obtained by Lopes (1987, 1990), Cho, Luce, and von Winterfeldt (1994), and Chung, von Winterfeldt, and Luce (1994).[9]

A number of studies indicate that the weighting function in the RDEU model has the form of an inverted S-shaped curve. Empirical support for this shape is found i.a. in several choice studies.[10] A particular reason for employing the RDEU model is the theoretical study by Arcand and Rota Graziosi (2005) demonstrating that the RDEU model provides a compelling answer to the above mentioned puzzle of over-

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[8] Hey and Orme (1994, p. 1321) conclude their examination thus: "Expected utility theory (and its special case, risk neutrality) emerges from this analysis fairly intact. For possibly 39 % of the subjects … EU theory appears to fit no worse than any of the other models … For other 67 % of the subjects, one or more of the eight "top-level" functionals … fits significantly better in statistical terms, though often the economic significance is not all that great. Of the eight "top level" functionals it would appear that the two rank dependent functionals and the quadratic utility model emerge as the strongest contenders (with the Quiggin weighting functional having a models lead over its power weighting function rival)".

[9] See, however, discussions in Wakker et al. (1994), and Birnbaum et al. (1999) of various weaknesses of the RDEU model.

[10] "Empirical support for this specification comes from a wide range of studies. …Collectively, these studies show that models with s-shaped probability transformations offer significant predictive improvement over EUT and outperform other rivals." Starmer (2000, p. 359). For examples, see Camerer and Ho (1994), Tversky and Kahneman (1992), Wu and Gonzales (1996), Gonzales and Wu (1999), and, for a survey, Camerer (1995).

compliance.[11] The weight a person gives to the uncertainty of events may for several reasons differ from the objective probabilities. People may (i) form (deterministic) subjective probabilities, (ii) weigh objective probabilities, (iii) weigh subjective probabilities, or (iv), weigh probabilities due to ambiguity or uncertainty about subjective or objective probabilities. The present empirical study is based on subjective probabilities. The estimate of the parameter *a* below indicates that people transform these subjective probabilities. The study cannot, however, distinguish between a weighting of given subjective probabilities and a weighting caused by the uncertainty or vagueness of the objective probabilities. In studies of ambiguity, i.e. in studies where objective probabilities are absent, Gilboa (1987) and Schmeidler (1989) have (seemingly independently) come up with the RDEU model. In these studies, the decision weights are interpreted as non-additive subjective probabilities. In the standard RDEU model developed by Quiggin (1993) objective probabilities are assumed known. These probabilities are then transformed by non-additive decision weights. [12][13]

In recent years a growing number of studies have suggested that tax compliance depends on individual and social norms, and also that individual norms are influenced by social norms.[14]. By social norms are usually meant moral standards attributed to a social group or collective (Wenzel, 2004). Some authors rather emphasize the effect of social customs. There might be several reasons for a tendency to internalize social norms of tax compliance. One reason might be that people have a general wish of behaving according to society's rules, a conformity attitude. Tax law should be adhered to even if one disagrees with the specific rules (Henrich 2004). Another reason might be that people consider it right to act equally (ir)responibly as their fellow citizens, a reciprocity attitude (Rabin, 1998, and Falk and Fehr, 2002). Behavior will then be characterized by

[11] Dhami and al-Nowaihi (2007) demonstrates that the cumulative prospect theory of Tversky and Kahneman (1992) provides a satisfactory account of tax evasion, including an explanation of the Yitzhaki puzzle, than expected utility theory

[12] It is worth noticing that Allais in his 1953 article comes up with the RDEU model. Discussing the independent works of Quiggin (1982), Yaari (1987), and Segal (1987), he states in his Nobel prize lecture in 1988: "It is very significant that, starting from entirely different premises, all three authors have been led to a mathematical formulation that is analogous to my own".

[13] Some attempts to model this distinction appear in Fox and Tversky (1998), and Wu and Gonzales (1999). Kilka and Weber (2001) provide estimates of both probability judgements and probability transformations.

[14] Of course, the idea that individual norms of tax evasion might be influenced by social norms is not new, see e.g. Kelman (1958).

conditional cooperation (Frey and Torgler 2007). People will tend to comply only to the extent that other people comply.

Breaching ones' own individual norms might cause guilt, whereas breaching a social norm or custom might produce shame and stigma. Guilt and shame might produce "psychic costs" (Gordon 1989), and stigma might produce more direct costs reducing the utility of the tax payer. Several empirical studies corroborate these ideas. In their classical field experiment Schwartz and Orleans (1967) found that tax payers who were remined that compliance is a moral duty reduced evasion more than those who were informed that evasion might be sanctioned. Grasmick and Scott (1982) concluded that guilt had a stronger effect than stigma and legal punishment. A number of more recent studies indicate that internalized norms increase tax compliance (e.g. Hasseldine and Kaplan, 1992; Erhard and Feinstein, 1994; Reckers, Sanders and Roark, 1994).

In the social custom literature it is usually assumed that a person obtains utility by behaving in accordance with a social custom, a utility that is lost if tax evasion (of any amount) is undertaken. In addition, as Myles and Naylor (1996) assume, there is a conformity payoff that depends on the size of the conforming population.

It is not our purpose to distinguish between these various explanations of why social norms or customs might have an effect on the behavior of tax payers. Our goal is to carry out a simultaneous test of the deterrence hypothesis of an RDEU model of tax compliance (Bernasconi 1998, Eide 2003) and the hypothesis that an individual tax payer is influenced by his or her assessment of the social norm of tax compliance.

Our results indicate that people are exaggerating the probability of being sanctioned for tax evasion. In addition, they are overweighing this probability, possibly because of the uncertainty or ambiguity of the subjective (and objective) probability. We also find that tax evasion depends on individual tax payers' assessment of the social norm of tax compliance. Thus, stigma and overweighting of probabilities might explain the "tax evasion puzzle".[15]

We also allow for rational behavior in the form of utility maximization under budget constraints, together with random elements, to play a role in explaining labor supply

[15] Using various parameter estimates from other studies, Dhami and al-Nowaihi (2007) show that the "tax evasion puzzle" can be explained within a prospect theory framework.

when tax evasion is an option. It is left to the data to determine the importance of the different elements. In this respect we deviate from the approach to economic research hinted at in Elster (1989) where it seems that norms are alternatives to rational choice behavior rather than a supplement.

The empirical results imply that economic incentives matter with respect to the labor supply when working in the shadow economy is an option. The model explains data 53% better than if all choices had been made at pure random.

The labor supply elasticities imply that an overall wage increase may shift labor supply away from the irregular economy towards the regular economy. This also means that when there is a negative shock that hits employment and wages, labor supply may increase in the irregular part of the economy.

The paper is organized as follows. Section 2 presents the model. A labour supply model permitting people to evade tax or to be honest is estimated by use of data from a survey carried out by a Norwegian polling institute. In a first stage, a person is assumed to choose to be an evader or not. In a second stage, the person will decide on the number of working hours, given the decision of evading taxes or not. It should be noted that we employ a random utility framework. The reason why is that we do not observe all attributes of a choice that affect preferences. Hence our dependent variables will not be deterministic variables like hours of work, but probabilities of being a tax evader or not, and the probability of working certain hours. Our model is an example of a two sector choice model and to our knowledge this is the first attempt to analyse tax evasion based on a structural econometric model approach.

Sections 3 and 4 give the data and estimation results, respectively. Section 5 report labor supply elasticities and Section 6 concludes.

2. The model

2.1. Introduction

The purpose of our analysis is to estimate a labor supply model when tax evasion is an option. This implies that we are able to tests hypotheses with regards to how labor supply respond to changes in wages, exogenous income and tax rates. In our model we are able to present labor supply responses when tax evasion is an observed option. In this way we are able to control for something that otherwise is ignored when labor supply models are estimated. What otherwise has to be treated as unobserved heterogeneity in the choice sets are here included in the model. The model is an example of a two sector choice model where the two sectors are the regular and the irregular part of the economy.

We will assume that the individual decides in two stages. In the first stage he or she decides whether to be honest (H) or to be a tax evader (E). We will assume that the individual chooses the strategy that gives him, or her, the highest utility.

Tax evasion is a risky activity. There is a probability that a tax evader will be caught if taxes are evaded and we thus assume that the individual makes his or her tax evasion decision under uncertainty. As mentioned in the introduction we extend the approach of Allingham and Sandmo (1972) by allowing for the possibility that the individual deviates from the expected utility behavior by giving overweight to small probabilities that are related to undesirable events, see Kahneman and Tversky (1979).

In the second decision stage, the individual decides on how many hours to work, given the strategy of being honest or not. If he or she follows an evasion strategy, part of the wage income is not declared to the authorities. A tax evader may in part earn wage income that is declared to the tax authorities and in part wage income that is not declared. Thus, an individual who follows the evasion strategy may work in the regular as well as in the irregular part of the economy. A person following an honest strategy works of course only in the regular part of the economy.

There have been previous attempts to estimate tax evasion models based on micro data. In Lacroix and Fortin (1992) a quadratic utility function is applied together with budget constraints to generate labor supply functions for the regular and the irregular labor market. Agents are assumed to decide under uncertainty, given probabilities for being caught and fines if detected. The model is made stochastic by assuming that one of the parameter in the utility function is random. Labor supply functions are derived from applying a marginal criteria approach. The model is estimated on Canadian survey data.

Lemieux, Fortin and Frechette (1994) apply the same data set to estimate a similar labor supply model. Labor supply in the regular and irregular part of the economy is estimated, including the participation rate in tax evading activities. The utility function is assumed to be quasi-linear and separable in consumption and leisure. The model is made random by assuming that a parameter in the budget constraint is random. Again, labor supply functions are derived from applying a marginal criteria approach.

In contrast to the two previous contributions we assume a random utility model with extreme value distributed utilities. The specification of the deterministic part of the utility function is a Box-Cox transformation of consumption and leisure. This specification allows us to check whether the estimated utility function is quasi-concave for all individuals, which is not so easily done with polynomial forms. The Box-Cox utility function is rather flexible with linear and log-linear utility functions as special cases. Moreover, our specification of the budget constraints takes into account all details of the tax structure. The marginal tax rates are not uniformly increasing with income (Appendix 2) and hence, the budget set is non-convex. The latter implies that marginal criteria **cannot** be applied to generate labor supply decisions and in our model the agents are assumed to compare utilities across all alternatives when making their decisions. Moreover, because all details of the tax functions are accounted for, we are able to use the model, once estimated, to simulate the outcome of different tax structures. Finally, and in contrast to the previous work in this field, we allow for a weighting of the detection probability and we let perception of social norms play a role in explaining behavior.

Our model is a random utility model and with choice probabilities as the outcome of the model. These probabilities are input in the joint likelihood that gives the ex-ante joint probability of the observed choices made by the individuals in the sample. By maximizing this joint likelihood with respect to the unobserved parameters of the sample we let the observed choices has the highest chance to occur (maximum likelihood estimation). The theoretical model is the same as the empirical model and is an example of structural econometric modeling.

2.2 A two stage model.

To explain the model we start with the last decision stage, stage2. Here we model the choices, given the decision of the individual to be an evader or not.

Stage2. Given an honest strategy

Let

C_{iH} = after tax wage income when the individual follows an honest strategy (H) and h_{iH} = annual hours; i=1,2,,,n, where n is the number of categories of hours. When i=1, the individual does not work.

Let

W_H= hourly wage rate in the regular economy

R_{iH}=gross annual wage income=$W_H h_{iH}$

I=non-wage income

$T(R_{iH},I)$=taxes paid as a step-wise linear function of wage income and non-wage income.

Thus

$$(1) \quad C_{iH} = R_{iH} + I - T(R_{iH}, I) \ \ ; i = 1, 2, , , n$$

Let U_{iH} be the utility when the individual follows an honest strategy and works h_{iH} hours and let X be a vector of socio-demographic characteristics. Moreover, ε_{iH} is a random variable, assumed to be extreme value IID distributed with zero mean and a constant variance.

Thus

$$(2) \quad U_{iH} = u(C_{iH}, h_{iH}, X) + \varepsilon_i ; i = 1, 2, , , n$$

u(.) is the deterministic part of the utility function and ε_i is the random part. The random part may be known to the individual but not to the outside observer. The total utility, the sum of the random and the deterministic part, is an ordinal utility function.

Let S_H denote the expected value of the max of the utility function. As demonstrated in Ben-Akiva and Lerman (1985), S_H is given by

$$(3) \quad S_H = E[\max_{i=1,2,,,n} U_{iH}] = \mu_2 \ln \sum_{k=1}^{n} \exp(u_{kH} / \mu_2)$$

Unobserved heterogeneity in preferences is represented by a single constant μ_2. The more uncertain the preferences are, the larger this constant is. S_H can also be interpreted as the expected indirect utility function associated with the n (regular) alternatives

The probability of choosing h_{iH} hours, conditional on the honest strategy, is given by

$$(4) \quad P(h_{iH} \mid H) = P(U_{iH} = \max_{k=1,2,,,n} U_{kH}).$$

With ε_i being extreme value IID distributed it is well known that this optimal choice probability $P(h_{iH}|H)$ is a multinomial logit. This multinomial logit can be derived from taking the derivatives of the consumer surplus S_H with respect to the deterministic part of the utility function (see Anderson et al (1992), chapter 2, for this and other aspects of discrete choice models with random preferences):

$$(5) \quad P(h_{iH} \mid H) = \frac{\partial S_H}{\partial u_{iH}} = \frac{\exp(u_{iH} / \mu_2)}{\sum_{k=1}^{n} \exp(u_{kH} / \mu_2)}; i = 1, 2, , , n$$

We note that in (5) μ_2 appears only as a *scaling coefficient* of the deterministic part of the utility function. It will be absorbed in the parameters that are present in the deterministic part of the utility function. Hence, μ_2 is not identified from data.

Stage 2. Given a tax evading strategy

In order to derive the probabilities for hours supplied when a tax evading strategy is chosen we need some new notation.

Let

$C_{ijE,T}$ = after tax and penalty income when the individual is a tax evader and works h_{ij}= h_{iH}+h_{jE} annual hours, where h_{iH} is hours worked in the regular economy and h_{jE} is hours worked in the irregular economy. The subscript T indicates that the individual's tax evasion is detected and he or she has to pay a fine. The indices i= 1,2,,,n and j=1,2,,,n index hours of work alternatives in the regular and irregular economy, respectively.

$C_{ijE,NT}$= as above, but now tax evasion is not detected.

W_E= hourly wage rate in the black economy

R_{jE}= $W_E h_{jE}$

τ= the fine that the evader has to pay if detected.

Then

(6) $$C_{ij,E,T} = R_{iH} + R_{jE} + I - T(R_{iH} + R_{jE}, I) - \tau(R_{jE}); i, j = 1,2,,,n$$

(7) $$C_{ij,E,NT} = R_{iH} + R_{jE} + I - T(R_{iH}, I); i, j = 1,2,,,n$$

Let q denote the probability of detection (1≥q≥0) and let f(q) be a probability weighting function. As mentioned above this probability weighting function may allow for the possibility that individuals give overweight to small probabilities related to undesirable events. The specification used her implies a rank-dependent expected utility model, with the expected utility model as a special case, see Quiggin (1982, 1993).[16]

Thus

[16] The functional form implies an inflection point (i.e. where q=f(q)) at q=1/2 for 0<a<1. Prelec (1998, p. 504-506) discuss the function $w(p) = \exp(-(-\ln p)^{\alpha})$ [in our notation: $f(q) = \exp(-(-\ln q)^{\alpha}]$ which generates an inflection point at p=1/e = 0.37. Although Prelec argues that empirical data supports an inflection point in the vicinity of 0.37, we have, because of the reasons in support for the RDEU model, chosen specification (8) in the present study.

$$
(8)\quad \begin{cases} f(q) = 1 - \frac{1}{2}[1 + (1-q)^a - q^a];\ 1 \geq a \geq 0 \\ f(q) = \frac{1}{2} \text{ for } a = 0 \\ f(q) = q \text{ for } a = 1 \end{cases}
$$

The weighting function, f(q), is an inverted s-shaped curve for which the coefficient *a* determines the curvature. When *a* approaches 0, the curve approaches a step function for which f(q) = ½ for 0 < q < 1. When *a* approaches 1, the weighting function approaches the diagonal, that is f(q)=q.

The random utility function, given that the individual follows a tax evading strategy, denoted U_{ijE}, has two parts. (Remember that subscripts *i* and *j* denote the number of hours worked in the regular and in the irregular economy, respectively.) The first part is the deterministic part, which is the expected or rank dependent expected utility related to the lottery of taking part in tax evasion. The second part is the random term, random to the analyst and with the same distribution as the random term in (2). Thus,

$$
(9)\quad U_{ijE} = f(q)u(C_{ij,E,T}, h_{iH} + h_{jE}, X) + (1 - f(q))u(C_{ij,E,NT}, h_{iH} + h_{jE}, X) + \varepsilon_{ij}; i, j = 1, 2,,, n
$$

As above, let S_E be the expected value of the maximum of the expected random utility, that is

$$
(10)\quad S_E = E[\max_{i=1,2,,n; j=1,2,,n} U_{ijE}] = \mu_2 \ln \sum_{k=1}^{n} \sum_{r=1}^{n} \exp(u_{krE} / \mu_2)
$$

where now

$$
(11)\quad u_{ijE} = f(q)u(C_{ijE,T}, h_{iH} + h_{jE}, X) + (1 - f(q))u(C_{ijE,NT}, h_{iH} + h_{jE}, X)
$$

The probability of working h_{iH} in the regular economy and h_{iE} in the irregular economy, conditional on being a tax evader, is then given by:

$$(12)\quad P(h_{iH,}h_{jE} \mid E) = \frac{\partial S_E}{\partial u_{ijE}} = \frac{\exp(u_{ijE} / \mu_2)}{\sum_{k=1}^{n}\sum_{r=1}^{n}\exp(u_{rkE} / \mu_2)}; i, j = 1, 2, , , n$$

Stage 1. Choice of strategy, honest (H) or tax evader (E)

To select strategy in this first stage, the individual compares S_H and S_E. Because our model is a random utility model we have to derive the probabilities of the two strategies. As outlined in Ben Akiva (1973), Ben-Akiva and Lerman (1979,1985) the probability of choosing an optimal strategy can be evaluated by the expected indirect utility functions S_H and S_E.

Moreover, we assume that the agent, when deciding on evading taxes or not, pay attention to how **socially acceptable** the illegal act of evading tax is in society. To represent this in the model we will employ the individuals' perception of this issue as reported in our survey data. It is important to note that we do not introduce the norm variable as the only explanatory variable. We will also assume that the **opportunity** to evade taxes vary across different types of occupation. In principle we should have modeled the agents' choice of education and choice of sector in the regular economy, together with labor supply and tax evasion, but to do so would have required data beyond what we have access to. The justification for our approach is that the opportunity to evade taxes differs across occupations. For workers say, in the construction sector it is easier not to declare all income to the tax authorities than for those who work in the government sector. To reflect these possible differences in tax evasion opportunities we have introduced two dummy variables, one for those working in the construction sector and one for those working in the government sector.

Our motivation for doing this is that we have the hypothesis that social norms and the work place of the individuals affect the individual's propensity and possibility to evade taxes in addition to economic incentives like taxes and wages.

Let z be a **vector** of variables that includes perception of how socially acceptable tax evasion is and industry in which the individual works. Let g(z) denote a function that will be used to weight the expected indirect utility of tax evasion. Note that there are three variables in the z- vector and hence in the g-function. The empirical specification of the g-function is given below. For more details about weighting choice probabilities with opportunity densities we refer to Creedy and Kalb (2005) and Dagsvik and Strøm (2006).

Let P(H) denote the probability of pursuing an honest strategy. The probability of choosing the the tax evasion strategy, denoted P(E), equals
1-P(H).
Then

$$(13)\quad \begin{cases} P(H) = \dfrac{\exp(S_H/\mu_1)}{\exp(S_H/\mu_1) + g(z)\exp(S_E/\mu_1)} \\ P(E) = 1 - P(H) \end{cases}$$

where μ_1 is a positive constant. The g-function is attached to the part in the probability which contains the expected indirect utility that follows from the alternatives when the individual is a tax evader. It captures how norms and occupation may affect the choice probabilities of strategies (evasion or not). Following Dagsvik and Strøm (2006) we call this g-function the norm and opportunity density and it follows from eq. (13) that it can be interpreted as weighting the value of the tax evasion strategy in the choice probability.

The unconditional probabilities

The unconditional probabilities, which relates to the event that we observe, are denoted $P(h_{iH},H)$ and $P(h_{iH},h_{jE},E)$ and are given by

$$(14)\quad P(h_{iH}, H) = P(h_{iH} \mid H)P(H)$$

and

$$(15)\quad P(h_{iH}, h_{jE}, E) = P(h_{iH}, h_{jE} \mid E)P(E)$$

When $\mu_2/\mu_1 = 1$, the nested multinomial logit model (the two stage model outlined above) degenerates to a multinomial logit model, or

$$(16)\quad P(h_{iH},H)=\frac{\exp(u_{iH}/\mu_2)}{\sum_{k=1}^{n}\exp(u_{kH}/\mu_2)+g(z)\sum_{k=1}^{n}\sum_{r=1}^{n}\exp(u_{krE}/\mu_2)}$$

and

$$(17)\quad P(h_{iH},h_{jE},E)=\frac{g(z)\exp(u_{ijE}/\mu_2)}{\sum_{k=1}^{n}\exp(u_{kH}/\mu_2)+g(z)\sum_{k=1}^{n}\sum_{r=1}^{n}\exp(u_{krE}/\mu_2)}$$

The likelihood expression

Let N_H be the group of individuals in the sample who are observed to follow an honest strategy (they answer **no** to the question in the questionnaire of whether they have evaded taxes the last twelve months) and let N_E be the group of tax evaders in the sample. Let subscript s indicate an individual. The joint a priori probability of what we observe is then given by the likelihood L:

$$(18)\quad L=\prod_{s\in N_H}P_s(h_{iH},H)\prod_{s\in N_E}P_s(h_{iH},h_{jE},E)$$

The unknown parameters of model are then estimated by maximizing L with respect to these parameters.

Empirical specifications

Let $v(C,h,X)=u(C,h,X)/\mu_2$. This deterministic part of the utility function is assumed to be a Box-Cox transformation of disposable income and leisure. A justification for this functional form is given in Dagsvik and Strøm (2006).

$$(19)\quad v(C,h,X)=(\alpha_0)\frac{(C/100000)^{\lambda}-1}{\lambda}+(\beta_0+\beta_1X_1+\beta_2X_2)\frac{(8760-h)^{\gamma}-1}{\gamma},$$

where C is disposable household income. X_1 is age (in years) and X_2 is dummy, which equals 1 if the individual is a woman and zero otherwise. The coefficient μ_2 is absorbed in $(\alpha_0, \beta_0, \beta_1, \beta_2)$. The reason for hours of work in the utility function is that annual leisure in hours, defined as 8760-h, is assumed to have an impact on individual welfare.

In measuring C all details of the step-wise tax-functions are accounted for, see Appendix 2. The fine, if tax evasion is detected, is based on the perceived fines as reported by the respondents. The probability of detection, q, is also based on the individual's perception of detection probabilities as reported by the respondents. The wage rate used to calculate gross earnings equals the ordinary hourly wage rate reported by the respondent in the questionnaire. The same wage rate is used in the regular as well in the irregular economy. It is likely that the wage rate in the irregular part of the economy is less than the wage rate in the regular part, but we do not observe by how much for all participants in the sample. The model requires that all individuals know their potential wage rate in the irregular part of the economy, also those who did not participate. This is a consequence of assuming utility maximizing individuals who compare utilities in order to make their decisions. If we had estimated wage equations for working in the irregular economy, given the survey data, it might have introduced more biases in the model than simply using the reported wage in the regular part of the economy. One would also expect that **individual** wages in the regular and the irregular economy are strongly correlated.

Hours worked in the regular economy are observed in broad categories and we have used the midpoints (10, 25, 37.5, 50) per week and with 50 hours a week as a maximum. Hours worked in the irregular economy are reported as annual hours, and again in broad categories with midpoints (10, 25, 37, 75, 150, 250, 600) and with 600 as a maximum. In the data set none are observed with zero hours in the regular economy. Hence, we are not taking into account the decision not to participate in the regular labor market. If this should have been done, we would have needed information about non-working individuals. However, our sample is rather representative for the Norwegian labor market. Unemployment rates are low by international standards and the participation rate among married women is the highest in the world. If we had included the option of not working in the regular economy, without observing anyone doing so, there is a risk that we would have included some unobserved elements that could have biased our estimates. Of course, zero hours in the irregular labor market is an option in the model.

Feasible hours deviate somewhat from the model, the main difference being that they differ between the regular and the irregular part of economy. This way of treating feasible hours reflects that working in the irregular economy has the character of being side jobs.

The opportunity and norm density, the g-function, is supposed to be

(20) $g(z)=\exp(g_0+g_1z_1+g_2z_2+g_3z_3)$

The variables appearing in the z-vector are:

z_1 equals 1 if the respondent answers that he or she thinks that people in general accept tax evasion, and it equals zero otherwise, answer to Question 16 in the questionnaire, see Appendix 1.

z_2 equals 1 if the respondent works in the construction sector, otherwise equals zero,

z_3 equals 1 if the respondent works in the government sector, otherwise zero.

Our hypotheses are that z_1 may have a positive impact on the probability of being a tax evader. Moreover, we expect that z_2 may also have a positive impact on the probability. The reasons why individuals working in the construction sector may have a higher probability of being tax evader are in the first place that they have the skills that often are demanded by households when repairing and building houses, and in the second place this sector is typically organized with many small and also irregular firms. Finally, we expect that z_3 may have a negative impact on the probability of being a tax evader. In the first place individuals working in the public sector have qualifications that are not in so high demand when it comes to do what irregular workers normally do. In the second place it is not so easy to combine a regular full-time job with irregular jobs.

3. Data

The data we have used are taken from a survey done by a private Norwegian polling institute MMI in October 2003. The recruiting of participants was done by MMI over the telephone, asking the person in the household, above 15 years of age and who most recently celebrated his or her birthday, if he/she wanted to participate in a research study. The recruitment was conducted randomly in the Norwegian population. The individuals who said yes to participate got a questionnaire in anonymous envelopes and were asked to return them by mail. There was no possibility to link the telephone numbers to the returned envelops. Thus anonymity was ensured. Still it could be the case that the respondents underreport their tax evasion activities.

The answer percentage is fairly high, see Table 1 below. 86% said yes to receive a questionnaire in mail, and 73% of these individuals filled out the questionnaire and mailed it back, which implies that 63% (=0.86x0.73x100) of the persons initially contacted ended up participating in the survey. This is a very good response compared to response rates in other surveys, for instance in the consumer expenditure surveys of Statistics Norway.

Table 1. Response rates in the surveys. Norway. 2003.

Asked to participate, Number of individuals	1742
Agreed to participate,%	86
Of which answered,%	72
Returned the questionnaire, percentage of asked, %	63

A relevant question regarding the results is the one of possible systematic bias. A common experience with surveys is that people agreeing to participate might have better knowledge of and a higher interest in the subject in questions than the people refusing to participate. The participants might also have “an agenda” when answering. However, the 2-staged process of recruiting and filling out of questionnaires allows for some control of the possible bias, see Andresen et al (2005) for more details. In addition to drawing the recruiting areas randomly the results have afterwards been weighted as if everyone agreed to participate and filled out the questionnaire.

The survey contains information regarding relevant personal characteristics of the respondents, such as age and employment, economic variables such as income and taxes, and people's engagement in as well as attitudes towards non-reported income activities. The questions asked in the survey are presented in Appendix 1 as well as summary statistics. We note that 11.2 percent of the sample is tax evaders. The evaders work slightly more also in the regular economy than the non-evaders and pay also slightly more in taxes. The evaders are more inclined to think that evasion is socially acceptable, but it is interesting to note that a majority of the non-evaders also is of the same opinion. The evaders' perceptions of fines and detection probabilities are slightly below those of the non-evaders. The survey question that we employ in measuring participation in tax evasion activities is Question no 22: "During the last 12 months, have you received compensation for work that has not been reported or will not be reported to the tax authorities?" Alternatively the answer to question 17 could have been used: "Have you ever been engaged in non-reported income activities?" Given yes to Q22, the correlation between the two answers are 100%. If Q17 had been used the participation rate had been slightly higher, between 12 and 13 %. The reason for using the answer to Q22 is that this answer is related to the values of the economic variables that are reported by the respondents.

4. Estimates and predictions

The maximum likelihood estimates of the deterministic part of the utility function, and of the norm and opportunity density, are presented in Table 2. Note that the dependent variable is two dummies, whether to evade taxes or not (Stage 1 above) and hours of work (Stage 2). Because the utility function is random, the model is expressed in ex-ante choice probabilities of these variables and they enter the likelihood function in equation (18) above. In the table "Consumption" is disposable income in the different states as explained in equations (1), (6) and (7). "Leisure x age" is the interaction of log leisure and age and “Leisure x female” is the interaction between log leisure and a dummy equal to1 if the respondent is a woman.

It turned out that the best fit was with the deterministic part being a log-linear function of leisure, rather than a Box-Cox transformation of leisure. Note that when the exponent in the Box-Cox transformation of leisure goes to zero the functional form becomes log-linear in leisure. In the estimation μ_2/μ_1 was not significantly different from 1. We have thus estimated a multinomia1 logit model.

The estimates show that the marginal utility of disposable income is positive, but declining ($\lambda<1$). Marginal utility of leisure (or rather of not working outside home) is higher among women than among men, which cet.par. reduce the incentives among women to do illicit work.

The graph of the estimated weighting function,

$$f(q) = 1 - \frac{1}{2}(1 + (1-q)^{0.3567}) - q^{0.3567}$$

is presented in Figure 1.

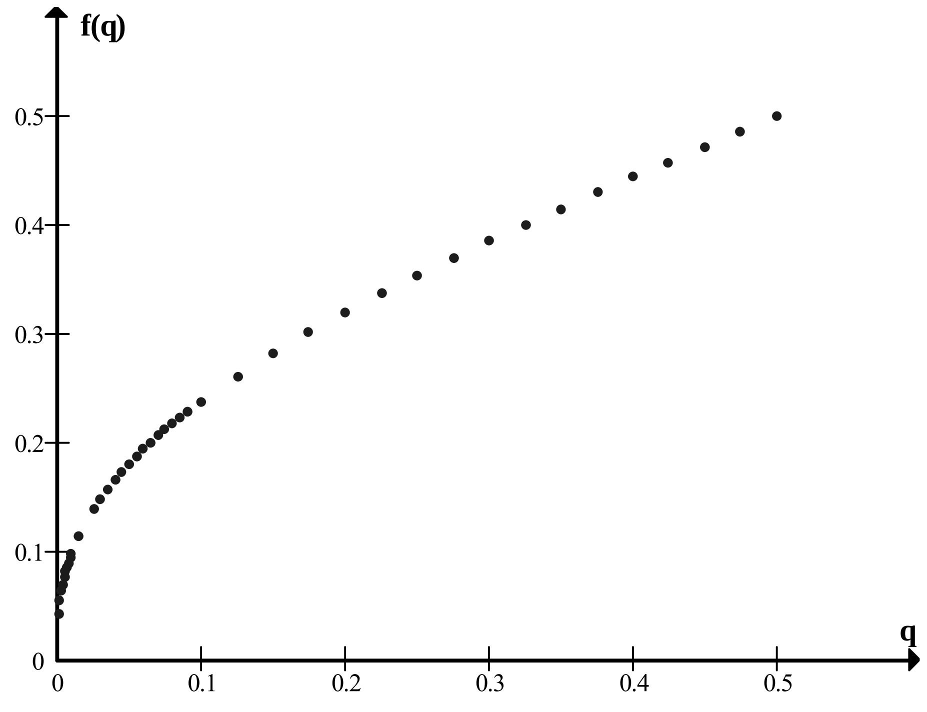

Figure 1.The estimated weighting function

Our hypothesis that the agents are overweighting detection probabilities is corroborated. Whereas the summary statistics show that the perceived detection probability is 0.10 for non-evaders and 0.07 for evaders, the estimate (a=0.3567) implies an average of the weighted probability of about 0.23. If the objective probability of being caught is about the same as in other countries (cf footnote 5 above), say 0.03, the perceived detection probability turns out to be about three times as high. With these estimates the puzzle of over-compliance is not that much of a puzzle. From Table 2 we note that the coefficient *a* is at the border of not being significant different from 0, which means that the perceived detection probabilities are not significant different from 0.5. The latter means that the individuals toss a coin when calculating the chances of being detected, which of course is a very high overweighting of detection probabilities. The expected utility model, EU, is a special case of our model. This occurs when a=1, which implies that f(q)=q, see equation (8). Thus, the EU model is strongly rejected.

The estimate of g_1 indicates that the more the agents think that tax evasion is accepted in the society, the more they evade. To work in the construction sector increases the probabilities of working in the irregular economy.

Table 2. Estimates of the utility function and the norm and opportunity density			
Parameters	Variables	Estimates	t-values
α	Consumption, constant	3.0176	7.9
λ	Consumption, exponent	0.7196	9.4
β_0	Leisure, constant	10.5402	3.5
β_1	Leisure x age	0.0261	0.5
β_2	Leisure x female	3.2374	2.9
a	Detection prob.	0.3567	1.8
g_0	Opportunity, constant	-4.8401	-16.8
g_1	Norm	0.9709	3.3
g_2	Construction sector	1.2029	3.2
g_3	Govt. sector	-0.6427	-0.8
No of observations	626		
Log-likelihood	-1068.74		
McFaddens rho	0.537		

Goodness of fit is defined as 1 minus the log-likelihood related to the estimates, relative to the log-likelihood when all alternatives have an equal chance to be chosen ("McFaddens rho"). Here McFaddens rho equals 0.537, which means that the empirical model explains data 53.7% better than if all choices had been made at pure random. Thus the economic incentives, norms and opportunities introduced in the model matter for the decisions made by the respondents.

In order to explain further how the model fits data we have predicted how well it predicts hours of work and tax revenues. This is an important test on the model since the main outcome of the model is labor supply. To predict labor supply outcomes and taxes paid we need the following new notation.

$$
\begin{aligned}
&(L_H \mid H) = 52\sum_{i=1}^{5} P(h_{iH} \mid H) h_{iH} \\
&(L_H \mid E) = 52\sum_{i=1}^{5}\sum_{i=1}^{8} P(h_{iH}, h_{jE} \mid E) h_{iH} \\
(21)\quad &(L_E \mid E) = \sum_{i=1}^{5}\sum_{i=1}^{8} P(h_{iH}, h_{jE} \mid E) h_{jE} \\
&L_H = P(H)(L_H \mid H) + P(E)(L_H \mid E) \\
&L_E = P(E)(L_E \mid E)
\end{aligned}
$$

Here

$(L_H|H)$:expected annual hours of work in the regular economy, given honest

$(L_H|E)$: expected annual hours of work in the regular economy, given evader

$(L_E|E)$: expected annual hours of work in the irregular economy, given evader

L_H: expected annual hours of work in the regular economy

L_E: expected annual hours of work in the irregular economy

52 are the number of weeks per year.

In addition we report the tax revenues in the different cases. T_H is the expected amount of taxes paid by the non-evaders, while $T_{H|E}$ is the expected amount of taxes paid the evaders. T is the expected amount of taxes paid in the total population, which, of course, lies between the two others.

Predictions and observed outcomes are given in Table 3. To predict the outcomes of the model we first predict the outcomes for each individual and then we aggregate. We observe that the model predicts the outcomes rather precisely. The model gives a rather remarkable good prediction of hours supplied in the regular part of the economy, in particular among the tax evaders. There is one exception: Hours worked in the irregular economy. A possible source of too high predictions of unregistered labor supply is that the observed hours of unregistered work may not be the hours supplied, since not all individuals are free to work unregistered as many hours as they want. For example, many of the respondents are employees who work in firms where it not so easy to combine irregular work with their main full time occupation, even if they had preferred to do so. Examples are individuals working in the government sector, in hospitals, in energy companies and supermarkets. An important aspect of structural models that deals with labor supply and taxation, here also with tax evaders included, is how well it predicts taxes paid. From Table 3 we observe that although the model predicts a somewhat lower amount paid by the tax evaders than observed, the prediction of taxes paid in the whole population is rather accurate.

Table 3. Observed and predicted outcomes

	Observered	**Predicted**
Shares of non-evaders P(H)	0.88782	0.88816
Shares of evaders, P(E)	0.11218	0.11184
Expected annual hours in the regular economy, given honest (L_H|H)	1733	1880
Expected annual hours in the regular economy, given dishonest (L_H|E)	1768	1730
Expected annual hours in the irregular economy, given dishonest (L_E|E)	79	300
Expected annual hours in the regular economy L_H	1736	1865
Expected annual hours in the irregular economy L_E	9	34
Annual taxes paid, given honest, T_H, NOK*	82 750	86 839
Annual taxes paid , given dishonest, $T_{H\|E}$, NOK	83 041	75 403
Annual taxes paid, T, NOK	82 782	85 642

*Sept 20, 2010, 1 Euro=7.9 NOK

5. Labor supply elasticities

In Table 4 we report the elasticity of labor supply aggregates (or weighted individual elasticities) with respect to wages rates. In the model feasible hours of work are 7 alternative hours per week in the regular economy and 7 alternatives per year in the irregular economy. Because preferences are random the choice of hours are represented through choice probabilities. Expected hours worked, as shown in eq. (21), is then the weighted sum of the feasible hours of work, weighted with the estimated probabilities. When wage rates change, these probabilities change. The probabilities depend on disposable income, as outlined in the model. This is the basis for calculating elasticities.

The within-sector elasticities are moderate, but the between-sector elasticities are sizable. We observe that an overall wage increase of 1 percent will increase supply of regular hours by 0.23 percent and reduce the supply of irregular hours by 0.41 percent. Thus we should expect that the size of the shadow economy is declining when real wages are increasing as they normally are during economic growth periods. This also implies that if real wages are declining say, due to a recession, we should expect that the shadow economy is growing. The impact of wages on choice probabilities are in part substitution effects and in part income effects.

Table 4. Labor supply elasticities

Variables	Intial predicted outcome	Elasticities wrt to wage levels		
		In regular economy	In irregular economy	Overall
Probability of…				
…honest strategy	0.89	0.11	-0.09	0.03
…evasion strategy	0.11	-0.91	0.70	-0.30
Annual expected hours:				
Regular hours, given honest				
Regular hours, given evasion	1880	0.25	0	0.25
Irregular, given evasion	1730	0.23	-0.19	0.06
	300	-0.72	0.60	-0.13
Annual hours:				
Regular	1865	0.26	-0.03	0.23
Irregular	34	-1.57	1.36	-0.41

6. Conclusion

A labour supply model in which the individuals have the option to evade taxes by working in the irregular economy is estimated on Norwegian survey data from October 2003. A growing number of studies indicate that people tend to overweigh low probabilities of losses. The possibility of being sanctioned for tax evasion might be an example of such losses, and we find that the hypothesis that people are overweighting subjective probabilities of being detected is corroborated. Tax payers' belief about social norms also has an effect on the tax evasion decision.

But economic incentives like wages and taxes are also found to play a role in explaining behaviour. The model can thus be used in policy simulations. An example is changes in tax rates and to find how these changes can reduce tax evasion and stimulate labor supply in the regular part of the economy.

The model predicts hours worked rather precisely both among the tax evaders and the non-evaders. The labor supply elasticities show that an overall wage increase in the society may shift labor supply away from the irregular economy and towards the regular economy. This also means that during recessions when real wages are declining one should expect that tax evading activities will increase.

The reported participation in the shadow economy the last 12 months gives a participation rate of around 11%. This together with irregular work being typically side jobs implies that the shadow economy in percent of GDP is substantially below estimates reported by Schneider (2007). For 2002-2003 he estimates the size of the Norwegian shadow economy in percent of GDP to 18.4 percent. This is a rather high estimate and puts the shadow economy above the oil and gas sector in Norway that year. His estimate is based on macroeconomic variables and in particular on money stocks and flows. The estimate also includes more shadow activities than otherwise legal work.

Our approach is based on microdata collected in surveys and it could well be that our estimates of tax evading activities is somewhat on the low side, while it seems that Schneider's estimates is on the high side. The purpose of our approach, however, is not to give a precise estimate of the shadow economy in percent of GDP, but to investigate labor supply behaviour when tax evasion is an option.

It is however true that the survey data implies that tax evading activities in Norway are minor. Findings that support this implication is given in Andresen et al (2005), where it is shown that the participation rate in the shadow economy in Norway has declined monotonically from 20 percent in 1980 to 11 percent in 2003. There is one exception. In 1988-1989 Norway went through a recession with increased unemployment and reductions in real wages. In 1989 the participation rate in shadow activities increased.

The reasons for the decline in shadow activities over the last 20-30 years are changes in the tax structure towards less progressive taxes, increase in real wages and income, more regular jobs and a substantial increase in the number of people working in the public sector. Moreover, since 1980 female participation in regular jobs outside home has increased to an extent that Norway now is number 1 in the world with respect to female labor market participation. Contini (1981) mentions higher female labor market participation as an important reason for less participation in the shadow economy among women.

These reasons for the gradually decline in tax evading activities over the last 20-30 years accords well with the findings in this paper.

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Appendix 1. The questionnaire.

Questions asked in the questionnaire

The respondents were asked to cross out answer-alternatives that vary across the questions. These alternatives are not shown here, but are available upon request.

Q.1. Gender
Q.2. Age
Q.3. Number of children living in the house
Q.4. Marital status
Q.5. Does your spouse have income generating work, and if so, how many hours?
Q.6. Education in years
Q.7. Occupational status (wage worker, self-employed, unemployed, retired, etc)
Q.8. Hours of work last week in the regular economy
Q.9. Hourly wage rate in main occupation
Q.10. Annual, net income (after tax) in main occupation
Q.11. Annual gross income in main occupation
Q.12 Occupation by industry
Q.13. Do you receive other income than wage income such as social security benefits/unemployment benefits/capital income?
Q.14.What is your tax rate for overtime work, the marginal tax rate in percent?
Q.15 How much tax do you pay in percent of your total annual gross income?
Q.16.What do you think is the attitude among people with respect to receive payment for work that is not reported to the tax authorities? Do you think it is accepted/accepted to some extent/not accepted/don't know
Q.17. Have you ever been engaged in non-reported income activities?
Q.18. If so, what kind of activities was it?
Q.19. If you had the opportunity to receive income without having to report it to the tax authorities, would you then accepted such income?
Q.20. If you don't report income to the tax authorities, how large do you think the

chance (percent) is that you would be caught?

Q.21. If you do not report income to the tax authorities, say NOK 20 000, and you are caught; you have to pay a penalty tax in addition to the regular tax on the nonreported income. How large do you think this penalty tax rate is (percent)?

Q.22. During the last 12 months, have you received compensation for work that has not been reported or will not be reported to the tax authorities?

Q.23. Approximately how many hours of non-reported work have you done during the last 12 months?

Q.24. At the last tax declaration; what was the total annual income from work and capital income that you did not report?

Table A, 1. Summary statistics: The whole sample, Norway 2003

Number of observations			626	
Number of non-evaders			556	
Number of evaders			70	
Share of women in the sample, percent			52	
Percentage that thinks that tax evasion is socially acceptable			53	
	Average	**StD**	**Min**	**Max**
Age, years	41	10	20	60
Hourly wage, NOK*	151	38	85	230
Gross annual wage income, NOK	294 581	119 268	48 100	598 000
Hours per week worked in the regular economy	37	10	10	50
Annual tax paid, NOK	82 782	53 069	5 694	231 146
Perceived fine, percent	19.5	13.6	0.7	37
Perceived detection probability	0.10	0.06	0.025	0.25

* September 20: 1Euro=NOK 7.9

Table A. 2. Summary statistics: Non-evaders, Norway 2003. Means

Age, years	41
Percentage women	54
Weekly hours in the regular economy	36
Hourly wage, NOK	151
Gross wage income, NOK	293 162
Annual tax, NOK	82 750
Perceived fine, percent	19.6
Perceived detection probability	0.10
Percentage that thinks that tax evasion is socially acceptable	51

Table A. 3. Summary statistics: Evaders, Norway 2003. Means.

Age, years	39
Percentage women	31
Weekly hours in the regular economy	39
Annual hours in the irregular economy	80
Hourly wage, NOK	151
Annual gross income from regular and irregular work, NOK	307 221
Annual tax, NOK	83 041
Perceived fine, percent	18.6
Perceived detection probability	0.07
Percentage that thinks that tax evasion is socially acceptable	74

Appendix 2.Tax function, Norway 2003

Income Y, NOK	Tax, NOK
0-23400	0
23400-33430	0.25Y-5750
33430-63400	0.078Y
63400-132500	0.358Y-17752
132500-190417	0.2908Y-8848
190417-340700	0.358Y-21664
340700-872000	0.493Y-67639
872000-	0.553Y-49959

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