The Elasticity of Taxable Income in the Netherlands

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Abstract

This research studies the elasticity of taxable (labour) income (ETI) in the Netherlands using the tax reform of 2001 as a natural experiment. We use instrumental variables to identify the ETI. The instrument we use for the endogenous marginal tax rate is the marginal tax rate that belongs to a synthetic income calculated using income before the reform as base and increasing this income with average income growth. We include base year income in our regressions to control for mean reversion. Under the preferred specification we find (uncompensated) income elasticities in the range of 0.08-0.10 for all individuals and in the range of 0.17-0.48 for high income earners. Furthermore, we find that elasticities for women are significantly higher than those for men.

Key words: elasticity-of-taxable-income, Netherlands

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1 Introduction

In this paper we study the elasticity of taxable (labour) income (ETI) with respect to marginal tax rates in the Netherlands, using a large tax return data set from Statistics Netherlands. This ETI tells us how strongly people respond to changes in their marginal tax rate and thus how tax revenue changes after a tax reform. Following the seminal contribution of Feldstein (1995), the recent public finance literature has focused on measuring the ETI, mostly for the United States of America. An introduction of taxes causes a discrepancy between individual benefits and social benefits of earning an income, which leads to inefficient behaviour by individuals. The more responsive people are (the higher the ETI), the higher the deadweight loss of an increase in taxes is. In this research we focus on wage earners. It is interesting to know how wage earners respond to changes in marginal tax rates, as most taxpayers fall in this category. The ETI we estimate gives an indication of the efficiency cost of taxation, as it includes all possible behavioural changes through which labour income can be adjusted, as hours worked, working effort and productivity, training, deductions and evasion. However, it does not include all possible behavioural changes which influence taxation, as we miss data on other types of income. There could be a shift in income from one tax base to another which leads to an overestimation of the distortions, as the income is then not out of the total tax base or it still adds to the economy.

We use the 2001 Dutch tax reform as a natural experiment in this study. This reform led to exogenous changes in marginal tax rates, making it possible to identify the impact of a change in the tax rate on behaviour. One of the key problems with estimating the relationship between tax rates and taxable income is that with a progressive tax system, a higher income leads to a lower net-of-tax rate as a higher bracket is reached, suggesting a negative relationship, while actually a higher net-of-tax rate could lead the person to choose a higher income. Therefore, if you estimate the relationship between the tax rate and income using a simple OLS regression, you find results that are biased by this reverse causality. We deal with this problem using instrumental variables (IV). The idea of IV is that a counterfactual income is constructed (what would a person's income be in absence of the tax reform) and marginal tax rates are calculated under the new tax system using the synthetic income. The counterfactual income is constructed by taking two lags of the actual income in 2001 and increasing this income with average wage growth. Furthermore, we account for mean reversion by including base year income and a number of control variables in our regressions. We also use a second method to control for exogenous income growth across the income distribution: income splines (Gelber, 2012). In all the regressions, we use robust standard errors, we weight the regressions by base year income and we exclude outliers. As the tax reform had a different impact for different income groups, there is a lot of variation in the marginal tax rates and the change in marginal tax rates, which can be used to find the ETI. Under the preferred specification we find uncompensated income elasticities in the range of 0.08-0.10 for all individuals and in the range of 0.17-0.48 for high income earners. The estimates using the second method are between 0.05-0.95, but we trust these estimates less than those of the first method. The estimates of the ETI that we found are in the range of the estimations of other recent literature (Gelber, 2012; Kleven and Schultz, 2012; Blomquist and Selin, 2010; Giertz, 2007). We also estimate the ETI for men and women separately and find that women have higher elasticities than men. As a sensitivity analysis, we check whether controlling for the change in the top rate of the VAT from 17% to 19% has an impact on the results. We find that it does not significantly change the estimated elasticities, as the impact of the change in VAT was similar for all individuals.

A previous study by the CPB (Bosch and Jongen, 2012), using the same data set as this study (1999-2005), estimated the response in weekly working hours to changes in net wages caused by the tax reform of 2001. They use the inverse Mills' ratio from a probit regression deal with selection in participation and add a number of control variables to the regressions. They find small responses ranging from zero for men in couples to 0.2 for single mothers. If we compare our study with this study, we find that total responses to taxes are larger than responses in labour hours.

There are many policy implications of this research. There have been studies searching for the optimal tax rates in the Netherlands, that have thus far used an average ETI found in recent international studies. Jacobs and Zoutman (2010) find that it does not pay to increase the top rate in the Netherlands (of 52%), as with a baseline uncompensated ETI of around 0.20, a compensated ETI of around 0.30 and a Pareto parameter of 3.25, the optimal tax rate would be 53%. Increasing the top rate above 53% would lower tax revenues. Therefore, we are already close to the top of the Laffer curve. Our research shows that the assumptions they have made concerning the ETI for the Netherlands for high income earners seem to be correct. It is more likely that the ETI is a bit higher than what they assumed than a bit lower, and in that case an increase of the top rate would be even less desirable.

Zoutman et al. (2011) analyze the optimal non-linear income tax for the Netherlands. Their findings suggest that in the current Dutch tax system the marginal top rate is too high, and marginal tax rates at the bottom of the income distribution are too low. To come to these results they have assumed an uncompensated elasticity of 0.25, and an average income effect of 0.10, leading to a compensated wage elasticity of 0.35. Our research shows that also this assumption is in the middle of the range of the estimates for the Netherlands and therefore seems to be correct.

The paper proceeds as follows: the theoretical framework and the related literature will be described in section 2. The Dutch tax reform will be discussed in section 3. Section 4 discusses the empirical model and section 5 describes the data. The empirical results will be presented in section 6 and conclusions and discussions can be found in section 7.

2 Theory and Related Literature

2.1 Theoretical Framework

A simple model that estimates the effect of taxes on earnings supply, looks as follows. Individuals maximize a utility function over consumption (c) and gross labour earnings (z): $(U(c, z; x))$, where x is a vector of household characteristics. First-order derivatives of the utility function are $u_c > 0$, $-u_z > 0$ and second-order derivatives are $u_{cc} < 0$, $-u_{zz} < 0$. The first-order derivative of u_z is negative as individuals dislike working (this model builds on a simple labour supply model). The household budget constraint is c = z - T(z). Solving the optimization problem gives the following first-order condition: $\frac{-u_z}{u_c} = 1 - T'(z)$. This FOC shows that increasing gross labour earnings with 1 increases consumption with 1 minus the marginal tax rate, at the optimum. If we assume that there are no income effects, then utility is given by the quasi-linear form $u = c - v(z; x)$ with $v_z > 0$, $v_{zz} > 0$. The first-order condition can then be written as $v_z(z; x) = 1 - T'(z)$. Differentiating this FOC yields:

$$\Delta v_z(z; x) = v_{zz}\Delta z + v_{zx}\Delta x = \Delta(1 - T'(z)) \tag{1}$$

This FOC implicitly defines an earnings supply function that is a function of the tax rate and the characteristics $z = z(T'(z), x)$, with $\frac{\Delta z}{\Delta T'} = \frac{-1}{v_{zz}} < 0$ and $\frac{\Delta z}{\Delta x} = \frac{-v_{zx}}{v_{zz}} \gtrless 0$, which depends on v_{zx} on which we have not made an assumption. From this earnings supply function, you can see the endogeneity problem: earnings depend on the marginal tax rate and the marginal tax rate depends on earnings. If we now write the differentiated FOC in relative changes, we get:

$$\frac{v_{zz}z}{v_z}\frac{\Delta z}{z} + \frac{v_{zx}x}{v_z}\frac{\Delta x}{x} = \frac{\Delta(1 - T'(z))}{(1 - T'(z))} \tag{2}$$

We can then write $\frac{\Delta z}{z} = \beta_1 \frac{\Delta(1-T'(z))}{(1-T')} + \beta_2 \frac{\Delta x}{x}$, where $\beta_1 \equiv (\frac{v_{zz}z}{v_z})^{-1}$ and $\beta_2 \equiv (\frac{-v_{zz}z}{v_{zx}x})^{-1}$. Writing this equation in logs, we find:

$$\Delta \ln z = \beta_1 \Delta \ln(1 - T'(z)) + \beta_2 \Delta \ln x \tag{3}$$

This equation is the basis for the regression equation. By adding a constant β_0 and an error term ε, we estimate the relation between z and $(1 - T'(z))$, controlling for x. β_1 gives the (biased) ETI.

$$\Delta \ln z = \beta_0 + \beta_1 \Delta \ln(1 - T'(z)) + \beta_2 \Delta \ln x + \varepsilon \tag{4}$$

In the simple model, people decide on an optimal consumption and gross labour income. Labour income can be influenced by work hours, and work effort (which would increase a person's productivity and wage) and also the effort necessary to find deductions or by evading taxes. Chetty (2009) studies evasion and avoidance and finds that this type of behaviour does not necessarily lead to an efficiency loss, as some of the costs are transfers to other agents. These transfers may be charitable contributions, for example.

As people are creatures of habit, it may be the case that even though there is a new optimal income after the tax change, they do not make changes because of transition costs or status quo bias. Kleven and Schultz (2012) find that optimization frictions indeed cause a difference in the ETI estimated for large and small tax reforms.

As the marginal tax rate changes the marginal benefit of earnings changes. This could lead to two effects: the substitution effect and the income effect. So far, we have assumed that the income effect is zero, but it is useful to explain both effects. The substitution effect is the effect that when relative prices of two goods change, individuals will substitute the good that is now more expensive with the less expensive good to increase their utility level. When taxes decrease, consumption becomes less expensive relative to leisure. Therefore, individuals will substitute leisure with consumption. People will thus work more and increase their income. The income effect is caused by a change in purchasing power. When the two goods that are considered are normal goods (you want to buy more of it when you have more money), an individual will consume more of both goods when his/her purchasing power is higher, as this will increase the utility level. When taxes decrease, an individual's purchasing power is higher and therefore both consumption and leisure will be increased. This effect leads to a decrease in income, as people will work less.

2.2 Related Literature

Recently, Saez et al. (2010) published a critical review of the literature estimating the elasticity of taxable income (ETI) with respect to marginal tax rates. They provide a theoretical framework and a large overview of research done both in the United States of America and in the rest of the world. They elaborate on whether the methods used are appropriate and whether the estimated ETI's are trustworthy or not. There are several discussions in this review worth mentioning here and also more recent literature will be briefly discussed. This selection of articles has been chosen because it shows how different authors came up with different methods to cope with the problems of endogeneity that exist when estimating the ETI. Not all of the methods that have been used are as good as others, so this overview shows what researchers have learned over the years working on this topic. The basic equation that researchers estimate is equation 4, in the previous subsection. The problem with this equation is that the coefficient we are interested in, β_1, is biased by reverse causality: the marginal tax rate also depends on income. The tax rate is therefore endogenous, which leads to problems. In order to find the effect of the marginal tax rate on income, different identification methods have to be used, such as difference-in-differences, instrumental variables and regression discontinuity. What these methods try to do, is to construct a design in which only one factor has changed: the marginal tax rate. Many researchers use a tax reform as natural experiment, as this gives exogenous variation in the tax rates, which is variation in the tax rates that is not caused by variation in income. Following, the different methods will be explained and estimates found in related research using these methods are provided.

One of the methods to overcome the endogeneity problem is difference-in-differences, where one group for which the marginal tax rate changed, is compared to a group for which the marginal tax rate did not change. With repeated cross-sectional data, the key assumption here is that there have not been any other factors than the marginal tax rate that have influenced a difference in income before and after the tax reform between the two groups that are compared. The income trends can therefore not be different across the income distribution in the period of the tax reform due to other factors than the tax reform. When using panel data, where we follow the same people over time, there are two problems to overcome: exogenous trends across the income distribution (just as with cross-sectional data) and mean reversion. Mean reversion is the phenomenon that people who are at the very top or bottom of the income distribution, because of very good or bad luck in one period, are very likely to reverse back to a more normal situation in the next period. If we compare the top 1% of the income distribution to the next 9% (Saez et al., 2010, page 24), it is thus likely that the people from the top will have a lower income in the next period regardless of the change in marginal tax rate. This leads to a biased estimate of the ETI. To overcome the problem of mean reversion it is important to use more than 2 years of data and to control for base year income. Also, many researchers excluded the individuals with an income below a certain cut-off from the panel, mostly 10.000 Euro or Dollar. In this way, mean reversion at the bottom of the income distribution no longer influences the results. For example, this excludes students who have a poorly paid part-time job while studying and a well paid full-time job when they are graduated.

Feldstein (1995) uses a dif-in-dif method, on a small sample, to estimate the ETI. He uses the TRA 86 (Tax Reform Act of 1986 in the U.S.) as natural experiment. He compares the percentage change in taxable income relative to adjusted 1985 income, to the change in the average net-of-tax rate in each group. He finds elasticities between 1 and 3. For example, Feldstein shows that if the middle income group experienced an increase in the net-of-tax rate of 12.2% and an increase of taxable income of 6.2%, while the high income group experienced an increase in the net-of-tax rate of 25.6% and an increase of taxable income of 21%, this suggests an ETI of

1.1 (21-6.2/25.6-12.2). The problem with this method is that the different income groups are not really comparable to each other, as there could be other factors influencing income in both groups in different ways, such as technological change that has a different impact on different income groups. The middle income group is therefore not a good counterfactual for the high income group, leading to biased estimates.

Auten and Carroll (1995) build on Feldstein's analysis of TRA 86, using a larger panel data set available within Treasury. They show that having a large sample influences the estimates and that the estimates are highly sensitive to decisions regarding whether observations are weighted by population or by income. The estimated elasticities are 1.09 for population-weighted taxable income and 0.60 for income-weighted taxable income, both substantially smaller than Feldstein's estimates. The difference between a population-weighted and an income-weighted specification is that with income-weighted specifications someone who earns twice as much as someone else, is weighted twice as much in the regressions, while in population-weighted specifications, every individual is weighted the same. The method of income-weighted specification is more appropriate, as changes in behaviour for high-income individuals also contribute more to the deadweight loss. In this research, we therefore also use income-weighting.

Moffitt and Wilhelm (1998) study an income concept close to AGI instead of taxable income. "Adjusted gross income (AGI) is total gross income minus specific reductions, while taxable income is adjusted gross income minus allowances for personal exemptions and itemized deductions" (Wikipedia). When using the approach of Feldstein (1995) to investigate behavioural responses to TRA 86, they find elasticities for AGI from 1.76-1.99. These estimates are similar to Feldstein's estimates for taxable income, but higher than his estimates for AGI. Using a different approach, instrumental variables, they find considerably lower estimates ranging from 0.35-0.97. The instruments they use are education level, occupation and the value of a household's house. The difference between estimates from Feldstein's method and IV shows that exogenous income growth across the income distribution is a problem in this period and biases the results for dif-in-dif. A problem with this research is that they have used only two years of observations, making results sensitive to mean reversion, both for dif-in-dif and IV. The problem with difference-in-differences is that it is in general hard to find a good comparison group and therefore results are biased.

A different method to cope with the endogeneity problem is instrumental variables. This method is used to clean up the correlation between the marginal tax rate and taxable income, to find the true effect of a change in the marginal tax rate on taxable income. The idea is to find a variable that is correlated with the marginal net-of-tax rate, but not with taxable income, except through the correlation between the marginal tax rate and taxable income. With IV, problems arise if the instrument that is chosen is still correlated with the error term, which is the case if it is correlated with taxable income in other ways. An instrument proposed by Auten and Carroll (1999) is the marginal net-of-tax rate that belongs to a synthetic income. This synthetic income is used as a counterfactual: to construct the income an individual would have if there would not have been a tax reform. In this way, synthetic marginal tax rates can be calculated, that are not endogenous (not chosen by the individuals as a response to the tax change). The synthetic income is constructed by taking a lagged value of income (before the tax reform) and increasing this income with average income growth (productivity increases, inflation, and economic prosperity).

An issue to take into account with IV is anticipation: when people adjust their income already in the years before the reform. If they would anticipate a lower tax rate in the next year, they would decrease their income now and then increase it even more in the next year. This would lead to an overestimation of the actual effect in the year of the tax reform if the base year is too close to the tax reform. It is thus better to use an earlier year as base year, so there will be no anticipation effects. However, the further we go back, the more difficult it will be to perfectly forecast the counterfactual income. There is a larger chance of an error and this error will also be larger in size. There is thus a trade-off in controlling for anticipation and the quality of forecasting the synthetic income.

Auten and Carroll (1999) use TRA 86 as a natural experiment and find an ETI of 0.55 using IV. Their instrument is constructed by increasing adjusted 1985 incomes with the CPI to 1989 levels. They add several non-tax factors as control variables for income inequality. They find different ETI's for different occupations: for example, 2.9 for investors and 1.63 for executives and managers. They have only used two years of data (1985 and 1989), making mean reversion a big problem, especially as tax rate changes are concentrated at the top during this tax reform, where we would expect mean reversion especially. This would mean that they have overestimated the ETI.

Gruber and Saez (2002) measure behavioural changes over three-year intervals, to investigate responses to both ERTA (Economic Recovery Tax Act of 1981 in the U.S.) and TRA 86. They incorporate both state and federal income changes and use an instrument similar to that from Auten and Carroll (1999): the change in the net-of-tax rate assuming that each individual's income grows at the rate of the overall nominal income growth. They also include an instrument to capture the income effect. They capture the income effect by adding the income shock in the regression $\log(z_2 - T_2(z_2))/(z_1 - T_1(z_1))$. As total tax depends on income, it is endogenous, and has to be instrumented. They do this by replacing $T_2(z_2)$ with T_p, where T_p is the tax liability a taxpayer would face if his real income had not changed from year 1 to year 2. The ETI estimate is 0.12 for broad income and 0.647 for taxable income. They do not find statistically significant differences between income groups. They estimate small income effects, implying that uncompensated and compensated ETI's are very similar.

Kleven and Schultz (2012) estimated the ETI for Denmark. They use panel tax return data over a long period (1980-2005) and a similar method to Gruber and Saez (2002). This long term data set makes it possible to control for different income trends for different income groups by directly adding income splines in the regressions. The idea of estimating a spline is to assign individuals to a place in the income distribution. Knots (cut-off points) are placed at the deciles for the 10-piece spline. The splines are used to estimate exogenous income growth across the income distribution, to control for a different income trend for different income groups that is not caused by the tax reform. They show that the Danish income distribution was relatively stable over the period they review, making skill-biased technological change less of a problem in the estimations. They find that elasticities of taxable labour income are small (0.05 for wage earners and 0.10 for the self-employed), capital income elasticities are 2-3 times larger than labour income elasticities, elasticities are increasing in income level and the ETI is larger when estimated for large tax reform changes than for small tax reform changes. They also estimate the income effect and conclude that it is small and that the compensated and uncompensated elasticities are not statistically different from each other.

Holmlund and Soderstrom (2008) estimated the ETI for Sweden, using panel data from 1991-2002. In this period two income tax reforms took place. They use changes in tax rates and changes in tax bracket thresholds to provide exogenous variations in tax rates to identify the ETI. They estimate dynamic income models in which they include a lagged change in marginal tax rate in their specification, to identify long term effects. They obtain significant long run elasticities for men (0.10-0.30) and elasticities around 0 for women.

Blomquist and Selin (2010) also estimated the ETI for Sweden, but using a different panel: the 1981 and 1991 waves from the Swedish Level of Living Survey. They perform a separate analysis for taxable income and hourly wage rates using an instrumental variable for the marginal tax rate. They propose a new kind of instrument that is not a function of base year income, but of income in 1986, in the middle of 1981-1991 which they use to calculate the year difference. They find estimates of the hourly wage rate elasticity in a range of 0.14-0.16 for men and 0.41-0.57 for women and an ETI between 0.19-0.21 for men and 0.96-1.44 for women. Contrary to other research, they find a significant income effect for men of -0.07, implying that the compensated ETI is about 5ppt higher than the uncompensated ETI.

A recent paper by Weber (2011) elaborated on what would be an appropriate instrument. She proposes to make the predicted tax rate instrument a function of the change in the marginal tax rate that belongs to a lag of ln(Yit-1) (=lagged before-tax-change-income), instead of a function of the change in the marginal tax rate that belongs to ln(Yit-1). She claims that this instrument is exogenous under assumptions concerning the degree of serial correlation in the error term. She controls for heterogeneous income trends at different ranges in the income distribution by using income splines. The estimated ETI is 1.046 in her preferred baseline (using 2, 3 and 4 lags of income) including only individuals with an income above $10.000.

Gelber (2012) examines the impact of the large Swedish tax reform of 1990-1991, by examining the income response of husbands and wives that face different changes in their marginal tax rate. He finds that if the tax rate of one of the two decreases, his/her income increases, and also the income of the partner increases. One of the specifications we use in this research is based on his specification: an instrumental variables method controlling for demographic variables and mean reversion with an income spline and instrumenting the net-of-tax rate using $ln(Y_{it-1})$. Gelber (2012) finds own uncompensated elasticities of 0.17 for husbands and 0.25 for wives. He finds a negative income effect, consistent with the idea that leisure is a normal good. He then calculates the compensated own elasticities, which are 0.25 for husbands and 0.49 for wives.

A third method to cope with the problem of endogeneity is regression discontinuity. This method makes use of certain cut-off points of income for which the marginal tax-rate jumps up or down, for example because of a certain tax credit. Because of these cut-off points, some people face a higher tax rate and some people face a lower tax rate, while they may be very similar in other aspects Slemrod (2010). By comparing the behaviour of individuals just in the 'treatment group' with individuals who are just out of it, you can find the causal effect of the marginal tax rate on income.

Saez (2009) uses data from 1960 to 2004 to analyze whether there is bunching of taxpayers at the kink points of the U.S. income tax schedule, caused by jumps in marginal tax rates. Bunching means that the density of taxpayers is higher around certain points than a normal distribution would suggest. This is caused by tax payers' responses to marginal tax rates. He finds clear evidence of bunching around the EITC (Earned Income Tax Credit) and he then uses this bunching to estimate a compensated ETI of 0.25, which is driven by responses among the self-employed as the estimated ETI is 0 for wage earners.

Different studies found different values of the ETI, pointing at two explanations that can also both be at play at the same time: either some of the estimations are biased, as argued by Carroll (1998) and Giertz (2007), or there is no universal value of the ETI (Slemrod and Kopczuk, 2002). Slemrod and Kopczuk (2002) have argued that it is very likely that the ETI depends not only on preferences, but also on factors that influence how easy it is for people to change their taxable income. For example, these could be the availability of tax deductions or the opportunities of tax evasion. These parameters could be heterogeneous among countries and periods.

It could also be that the ETI depends on how large the change in the tax rate was, therefore showing up large and positive for some tax reforms and small and insignificant for others (Kleven and Schultz, 2012). This effect could be due to adjustment costs, real and psychological, which causes people to only take action when the benefits are large enough.

3 The 2001 tax reform

In 2001, the Dutch tax system underwent a major change that influenced average and marginal tax rates for most Dutch citizens. Of particular interest to this study are the changes in marginal tax rates and the rise in indirect tax rates.

Table 1 shows the changes in marginal tax rates and bracket lengths over the period 1999-2005. From the table we see that the tax reform of 2001 reduced marginal tax rates for individuals with middle and higher incomes the most. Furthermore, marginal tax rates hardly changed over the period 1999-2000 and 2001-2005. Indeed, Figure 5 in the Appendix shows a histogram of changes in marginal tax rates for our dataset for 1999-2000, 2000-2001 and 2001-2002. We see that in 1999-2000 and 2001-2002 most individuals experience hardly any change in marginal tax rate (of course incomes and hence marginal tax rates do change for some individuals), whereas in 2001-2002 there is a clear second spike at -8%-points and also some smaller spikes of individuals that experience a (more modest) increase in marginal tax rates.

Table 1 also shows that in 2001 also the cut-off points of the different brackets changed. This leads to different changes in marginal tax rates across the income distribution. Table 2 shows the changes in marginal tax rates by income groups. There are three large income groups for which the change in marginal income tax is larger than 5% (6922-14870, 22234-46309, 48899-∞).

Next to the changes in marginal tax rates, the 2001 reform also introduced tax credits instead of tax allowances. Before 2001, taxable income was reduced by the general allowance, so the financial benefit depended on the marginal tax rate. After 2001, first taxes were calculated for a person's taxable income and then a the general tax credit was deducted from the amount of taxes, so after 2001 the financial benefit of the allowance/credit no longer depends on the marginal tax rate. Furthermore, 2001 saw the introduction of an earned income tax credit (for working individuals) which was more generous than its predecessor. This reduces marginal tax rates for individuals with incomes between 8,000 and 16,000 euro. Figure 6 in the Appendix shows the resulting changes in marginal tax rates by income for our dataset, taking into account all changes in the tax system between 2000 and 2001.

Table 1: Tax bracket rates and lenghts: 1999-2005

Year	1999	2000	2001	2002	2003	2004	2005
First bracket							
Rate (in %)	35.75	33.90	32.35	32.35	33.15	33.15	34.40
Top (in euro)	6,807	6,922	14,870	15,331	15,883	16,265	
Second bracket							
Rate (in %)	37.05	37.95	37.6	37.85	38.65	40.35	41.95
Top (in euro)	21,861	22,233	27,009	27,847	28,850	29,543	30,357
Third bracket							
Rate (in %)	50.00	50.00	42.00	42.00	42.00	42.00	42.00
Top (in euro)	48,080	48,898	46,309	47,745	49,464	50,652	51,762
Fourth bracket							
Rate (in %)	60.00	60.00	52.00	52.00	52.00	52.00	52.00
Top (in euro)	∞	∞	∞	∞	∞	∞	∞

Table 2: Changes in marginal tax rates by income groups

Income group	Bracket 2000	Rate 2000	Bracket 2001	Rate 2001	Diff. in %-points
<6,922	1	33.90	1	32.25	-1.65
6,923-14,870	2	37.95	1	32.25	-5.70
14,871-22,233	2	37.95	2	37.6	-0.35
22,234-27,009	3	50	2	37.6	-12.40
27,010-46,309	3	50	3	42	-8.00
46,310-48,898	3	50	4	52	+2.00
48,899-∞	4	60	4	52	-8.00

4 Empirical model

In this research we want to estimate the elasticity of taxable income (ETI). The simple OLS model, which follows from the theoretical model, looks as follows:

$$\Delta \ln(E_{it}) = \beta_0 + \beta_1 \Delta \ln(1 - T'_{it}(z)) + \beta_2 X_{i1999} + \varepsilon_{it} \tag{5}$$

In this regression, E_{it} stands for individual i's earned income in period t, $1-T'_{it}(z)$ is the net of tax rate of individual i in period t, X_{i1999} are individual characteristics in the base year such as age, gender and education level. This simple OLS is biased because the marginal tax rate is endogenous and therefore a different method is necessary. To overcome the problems of endogeneity, we use instrumental variables. Endogeneity arises when the variable of interest and the error term are correlated, which causes OLS to be biased. The IV approach involves finding a variable (an instrument) that is highly correlated with the (selection into) treatment but that is not correlated with unobserved characteristics that could affect outcomes. Due to the progressive tax system, people arrive in a higher tax bracket as they earn a higher income. This leads to a situation of reverse causality, in which not only the marginal tax rate influences taxable income, but also the taxable income influences the marginal tax rate. To overcome this problem, an instrument is needed, which captures the effect of the marginal tax rate on taxable income.

Our empirical methodology follows the approach outlined in Gruber and Saez (2002), Kleven and Schultz (2012) and Gelber (2012). In this method, so-called synthetic marginal tax rates are used as an instrument for actual marginal tax rates to estimate the causal effect of tax rates on taxable income. A counterfactual taxable income is constructed, which is a person's income after the tax reform in the absence of behavioural responses, and then the corresponding marginal tax rates are calculated. The net-of-tax rate is used in the regressions so that extra taxable income is linked to the net benefit of earning this extra income. We construct counterfactual taxable income by calculating average income growth for the sample over the relevant years and increasing individual income in 1999 for the first method (and income in 2000 for the second method), with this average growth. In this way, we account for the economic situation in these years. This is very important, as economic growth suffered a strong drop in 2001 which was not related to the tax reform of 2001. After estimating average growth in the sample, we compare this with individual growth and explain differences in income growth with differences in the change of the marginal tax rate. For all following regressions we use robust standard errors, income weighting and we exclude outliers (see Data section) from the sample. Using our instrument for the marginal tax rate, we get the following equation:

$$\Delta \ln(E_{it}) = \beta_0 + \beta_1 \Delta \ln(1 - \tau_{it}) + \beta_2 X_{i1999} + \varepsilon_{it} \quad (6)$$

Where $1 - \tau_{it}$ is the net-of-tax rate that is now no longer dependent on income in the period after the tax reform, as we assume that the synthetic income is not influenced by the tax reform: behaviour was not adjusted.

Next to instrumenting the marginal tax rate, it is important to control for exogenous changes in the income distribution. We add controls for personal characteristics: age, gender, education level, origin (native, Western immigrant or non-Western immigrant), and type of household (single, unmarried couple living together without children, unmarried couple living together with children, married couple without children, married couple with children and single parent). We control for base year income in two different ways: by including base year income as independent variable in the regressions and by including income splines in the log of base year income in the regressions. The equation including base year income looks as follows:

$$\Delta \ln(E_{it}) = \beta_0 + \beta_1 \Delta \ln(1 - \tau_{it}) + \beta_2 \ln(E_{i1999}) + \beta_3 X_{i1999} + \varepsilon_{it} \quad (7)$$

In this regression, E_{i1999} stands for individual i's earned income in the base year 1999. For this method, we estimated synthetic incomes using 1999 as base year and follow the idea of Weber (2011) that it is better to use an extra lag of income to estimate synthetic incomes. The results show that the effect of including income controls is important.

Next, we follow a different method, where we control for exogenous income growth. We do this by estimating splines in log base year income. The idea of estimating a spline is to assign individuals to a place in the income distribution. We estimate a 5-piece spline and a 10-piece spline, so we divide income groups in quintiles and deciles respectively. Knots (cut-off points) are placed at the quintiles for the 5-piece spline and at the deciles for the 10-piece spline. The splines are used to estimate exogenous income growth across the income distribution, to control for differences in income trends between different income groups that are not caused by the tax reform. For example Gruber and Saez (2002) include these splines directly in their 2SLS regressions to capture exogenous changes in the income distribution, such as skill-biased technological change or mean reversion. An issue with this method is that the coefficients of the splines could take up not only exogenous growth but also endogenous growth: growth caused by the tax reform. In this way the splines could 'soak up' the identification variation and can therefore only be used if the time frame of the data is long enough. In this study we only have a short period of data with one tax reform, so this could be problematic and therefore we need a different method to use the splines. This method is proposed by Gelber (2012). In this method we add an extra step to estimate the exogenous income growth. First, we link the knots of the spline to income growth in a period without a tax change and assume that the evolution of the income distribution in this period is exogenous and would be similar in the following years if there would not have been any tax changes. As we have a relatively short period before the tax reform, we have to use the data from 1999-2000 to estimate the evolution of the income distribution in a period without a tax reform. For this method, it is thus necessary to make the assumption that income in 2000 is exogenous, so we assume that there are no anticipation effects. As we make this assumption, we take 2000 as base year to estimate synthetic incomes.

The following regression was estimated to find the predicted exogenous income growth for the different income groups:

$$\Delta \ln(E_{it}) = \gamma_o + f \Delta \ln(E_{it-1}) \gamma_E + X_{it} \gamma + \nu_{it} \tag{8}$$

In this regression, f stands for the spline, γ_E gives a set of coefficients on the spline's knots and X_{it} stands for the same controls for personal characteristics as in the previous two regressions. The coefficients of the spline tell us about the evolution of income for different groups in the income distribution. A positive coefficient for the bottom 10%, could be an indication of mean reversion, as the lowest incomes reverse back to a more normal (permanent) income. A positive coefficient for the top 10% could be an indication of the people with the highest incomes benefitting from skilled biased technological change. The combined coefficients of the spline are next used to partial out the predicted exogenous income growth across the income distribution. This is important as it could be that the relative income share of high income earners would already increase, without the effect of lower marginal tax rates. Deducting the predicted exogenous income growth from actual income growth creates residual changes in the log of real income $\widetilde{\Delta}\ln(E_{it})$.

$$\widetilde{\Delta}\ln(E_{it}) = \Delta\ln(E_{it}) - f\Delta\ln(E_{it-1})\gamma_E \tag{9}$$

In this regression, $f\Delta\ln(E_{it-1})\gamma_E$ are the predicted values from equation 8. The residuals $\widetilde{\Delta}\ln(E_{it})$ represent remaining variation in the change in earned income, with the predicted effect of lagged income removed. Next, the residuals are related to the independent variables using 2SLS and the marginal tax rate belonging to the synthetic income as instrument:

$$\widetilde{\Delta}\ln(E_{it}) = \beta_0 + \beta_1\Delta\ln(1-\tau_{it}) + \beta_2 X_{it} + \varepsilon_{it} + \nu_{it} \tag{10}$$

In this regression, β_1 gives the effect of the net-of-tax rate on earned income: the estimated ETI, controlled for mean reversion, changes in income inequality, and personal characteristics.

5 Data

We use the Labour Market Panel (*Arbeidsmarktpanel*) 1999-2005 of Statistics Netherlands. This is a household panel dataset that contains administrative data on annual taxable labour income of all household members, administrative data on individual and household characteristics and the highest level of completed education (taken from the Labour Force Surveys 1995-2005). From this dataset we select individuals aged 25-54 that are working, earn more than 10 thousand euro in every year, have no income from some type of benefits (*e.g.* disabled, early retirement, unemployment), and do not change from being single to being part of a couple or vice versa. We select these individuals to limit problems of mean reversion and to remove big changes in income that should not be linked to the tax reform. Furthermore, we drop individuals whose marginal tax rate changes by more than 20 percentage points (outliers), which must be due to other factors than the reform and which observations would affect the estimates a lot. We also exclude individuals for which the education level is missing information, as this could be a very heterogeneous (though very small) group and not controlling for the education level could lead to a bias in the estimates. This leaves us with 120,183 individuals. Being this strict

Table 3: Descriptive statistics, 1999

	Mean	Standard deviation
Taxable labour income	30,683	14,596
Male	0.69	
Female	0.31	
Primary education (BO)	0.04	
Lower vocational training (VMBO)	0.15	
Higher vocational training (MBO, HAVO, VWO)	0.45	
Tertiary education (HBO, WO)	0.36	
Native	0.90	
Western immigrant	0.03	
Non-Western immigrant	0.07	
Single	0.12	
Single parent	0.02	
Unmarried couple without children	0.12	
Married couple without children	0.13	
Unmarried couple with children	0.04	
Married couple with children	0.57	
Net-of-tax rate	0.505	0.056
Observations	120,183	

Source: Labour Market Panel 1999-2005 (Statistics Netherlands).

with our data selection, we may underestimate the ETI, as we exclude people that leave or enter the labour market because of the tax reform. That the ETI may not apply for the lowest incomes is therefore a limitation of this study. Policy makers are usually most interested in the responses of the high incomes, so we think that it is most important to get a trustworthy estimate for this group.

Descriptive statistics of our selection are given in Table 3. Mean taxable income in 1999 is 30,683 euro. For individual and household characteristics we use the data for 1999. 69% of our sample are men. Most of the individuals have higher vocational training (45%) or tertiary education (36%), a small minority has only primary education (4%) and some more individuals have lower vocational training (15%). Regarding ethnicity, 90% is native Dutch, 3% is Western immigrant and 7% is Non-Western immigrant. When we look at household composition, most individuals are in a married couple with children (57%), the shares of singles, individuals in married and individuals in unmarried couples without children are all close to 12%, the shares of single parents and individuals in unmarried couples with children are small.

We use the sophisticated tax-benefit calculator MIMOS-2 of CPB to calculate marginal tax rates. This is a (non-behavioural) micro simulation model that contains a detailed programming of the tax-benefit system in the Netherlands for the period 1999-2005. We define taxes as the difference between gross income and net disposable income. Calculating the marginal tax rates takes considerable effort. First, we need to construct the variables from the *Arbeidsmarktpanel* which MIMOS-2 needs to calculate marginal tax rates. This includes, for example, data on the income of the partner of the individual, number of children and the sector in which the individual works. Second, MIMOS-2 needs gross income as input while we have taxable labour income. The differences between the two are employees' premiums. Hence, to calculate marginal tax rates we first need to convert our taxable labour income into gross income. These calculations were made by using formulas from Microtax of CPB. Microtax is an annually updated Excel file of CPB in which taxable incomes are calculated from gross incomes. Microtax, like MIMOS-2, distinguishes between three sectors: the private sector, the government and the health care sector. These sectors have different premiums that are in between gross income and taxable labour income. With Microtax we construct Excel sheets for the three sectors for all relevant years (1999-2005), in which we calculate a large set of combinations of gross income and taxable labour income, with a stepsize of 1000 euro. We then find gross income corresponding to a particular taxable labour income interpolating between these discrete points using Matlab. MIMOS-2 then uses these gross incomes to calculate the net incomes (by deducting employer's premiums, employees' premiums and direct taxes and health care fees). For a more detailed overview of the gross-net income calculation, see Table 4.

The method by which an individual's marginal tax rate is calculated is to increase his/her gross income by 3 percent and then calculate 1 minus the increase in nominal net income/the increase in gross income. Determining the increase in net income after an increase in gross income is complex however, due to the non-linearity of the tax system and several premiums that have to be taken into account (Zoutman et al., 2011).

We calculate synthetic gross incomes to construct the synthetic marginal tax

Table 4: Gross-net calculations

(I) Labour costs
(II)Employer's premiums
- Pension
- Unemployment
- Disability
- Sick leave
- Health care
(III) Gross wages (I-II)
(IV) Employees' premiums
- Pension
- Unemployment
(V) Taxable income (III-IV)
(VI) Direct taxes and health care
- Income taxes
- Health care
- Health care (nominal fee)
(VII) Net disposable income (V-VI)

Source: (Zoutman et al., 2011).

rates for 2001-2005 using average annual growth in taxable income over the whole period for our sample. We do this using 1999 or 2000 as the base year, depending on the empirical method used. The synthetic marginal tax rates are calculated using the synthetic marginal income and the tax system of the relevant year. We thus estimate the incomes as they would be in absence of the tax reform, but the marginal tax rates are calculated under the new tax system.

6 Empirical results

In this section we will show the results of the analysis. In Table 5 we show the results of the first method, using income in 1999 as base year for synthetic incomes. We estimated three regressions, all with instrumented marginal tax rates. First we estimate the most basic IV regression (see equation 6) and then we add controls for personal/household characteristics and in the third specification we add base year income as a control variable in the IV regressions (see equation 7). The first stage regressions, not shown here, are very strong (p=0.000 for the instrument), as for most individuals the marginal tax rate for synthetic income and real income are equal. The first requirement for the instrument (significant correlation with the variable of interest) is satisfied. The estimations of the ETI are given here for three time spans, from short term (1999-2001) to long term (1999-2005). The estimations are shown for the whole selection of individuals (income>10.000) and for the individuals with a high income (income>40.000). The difference between the regression without any controls and with controls for both personal characteristics and base year income is clear. The elasticities are significantly positive in the range of 0.08-0.10 for all individuals and in the range of 0.17-0.48 for high income earners, when controlled for base year income. The estimates show that the effects of the tax reform are larger in the long term than in the short term, signaling that it took time for people to adjust to the new tax system. In the appendix, Tables 11, 12 and 13 show the detailed second stage regressions of the third specification. The controls used in the regressions are highly significant and show that income growth decreases with age, increases with an individual's education level, is higher for males than for females, is higher for people in households with children (also for single parents), and is higher for immigrants than for natives. Base year income has a highly significant negative coefficient, thus controlling adequately for mean reversion at the top of the income distribution, which is important in this study as most variation in marginal tax rates is in the top. It could be the case that mean reversion at the top is higher during economic downturns (as in 2001) and that we also capture this effect when controlling for base year income.

Next the Gelber method was used. A 5-piece spline and a 10-piece spline in base year income were estimated for the whole sample and for the high income sample. The output for the estimation of the 5-piece spline is provided and explained here, the 10-piece spline is similar. Table 2 shows the cut-off points in log income at the quintiles.

Table 7 shows the regression output for regression 3, with income growth between 1999 and 2000 as dependent variable and the splines and control variables as independent variables. Relative to a constant of 1.5319, all 5 knots of the spline have a similar coefficient, which does not signal a difference in the income trends for different income groups in a period without a tax change. Figures 1,2 and 3 in the Appendix also show that the top (0.5% - 10%) of the income distribution was

Table 5: Estimates of the Elasticity of Taxable Income - base year 1999

		(All)			(>40,000)	
	(1)	(2)	(3)	(4)	(5)	(6)
Period	(99-01)	(99-03)	(99-05)	(99-01)	(99-03)	(99-05)
No controls	0.0201**	-0.0268**	-0.0012	0.0096	-0.0443	0.0855**
	(0.009)	(0.011)	(0.013)	(0.026)	(0.03)	(0.034)
With controls	-0.0044	-0.0569***	-0.0368***	-0.087	-0.0729**	0.0678**
	(0.009)	(0.01)	(0.012)	(0.025)	(0.029)	(0.033)
Controls and base year income	0.0873***	0.0907***	0.1001***	0.1716**	0.3542***	0.4805***
	(0.009)	(0.010)	(0.014)	(0.079)	(0.093)	(0.095)
Observations	120,183	119,569	110,152	20,018	20,013	19,838

Standard errors in parentheses, * denotes significant at 10% level, ** at 5% level and *** at 1% level.

very stable in the Netherlands for the years 1975-2000, and certainly compared to other countries. Table 10 in the Appendix shows that for the years 1989-2000 (net disposable) income shares for all the deciles of the income distribution have been relatively stable and therefore the income trends must be very similar.

Table 8 shows the second stage estimations of regression 10, linking the residual real income growth (real income growth minus exogenous income growth calculated with the splines) to the instrumented net-of-tax rate. This is done for exogenous growth both calculated with a 5-piece spline and a 10-piece spline. The estimated elasticities are all strongly significant and positive, in a range of 0.04-0.09 for all individuals and 0.15-0.19 for high incomes. To make these estimates comparable to the ones of the previous method, the coefficients have to be tripled for the period 00-03 and quintupled for the period 00-05, as we look here at the income growth per year and in the previous specification at total growth. The long run effects estimated by this method are thus larger than those found by the other method: 0.36-0.43 for all individuals and 0.77-0.95 for high income earners for the period 00-05. This is possibly due to the fact that 2000 is used here as base year. There could be anticipation effects, where people lower their income in 2000 by postponing income, and increase it a lot in 2001 under the lower tax rates, leading to an overestimation of the ETI .

Table 6: Estimation of a 5-Piece Spline

Knots	Knot 1	Knot 2	Knot 3	Knot 4
log(base year income)	9.8841	10.2121	10.3268	10.5346

Table 7: Estimation of Exogenous Changes in the Income Distribution

	Coefficient
Spline 1st quintile control	-0.1481***
	(0.004)
Spline 2nd quintile control	-0.0698***
	(0.007)
Spline 3rd quintile control	-0.0314***
	(0.007)
Spline 4th quintile control	-0.0262***
	(0.007)
Spline 5th quintile control	-0.0738***
	(0.003)
Constant	1.5319

Table 8: Estimates of the Elasticity of Taxable Income - Gelber method - base year 2000

		(All)			(>40,000)	
	(1)	(2)	(3)	(4)	(5)	(6)
Period	(00-01)	(00-03)	(00-05)	(00-01)	(00-03)	(00-05)
5-piece spline	0.0405***	0.0481***	0.0876***	0.1498***	0.1530***	0.1907***
	(0.007)	(0.004)	(0.003)	(0.017)	(0.008)	(0.007)
10-piece spline	0.0534***	0.0601***	0.0720***	0.1499***	0.1541***	0.1535***
	(0.007)	(0.004)	(0.003)	(0.017)	(0.008)	(0.009)
Observations	115,286	115,187	115,185	19,811	19,814	19,815

Standard errors in parentheses, * denotes significant at 10% level, ** at 5% level and *** at 1% level.

6.1 Sensitivity analysis

In this subsection we will provide sensitivity analysis. We will show the ETI for men and women separately and test whether the change in indirect taxes had an impact on the ETI. Table 14 in the Appendix shows the estimates of the ETI for men only in the first three specifications: no controls, with controls and with controls and base year income. The total sample size of men is around 80,000 and when only including men with an income above 40,000 euro we are left with around 18,700 men. The first two specifications (no controls, with controls) show negative and significant elasticities and the third specification (controls and base year income) shows positive elasticities, that are small (0-0.03) and mostly insignificant for the whole sample and large (0.15-0.46) and significant for the high incomes.

Table 15 in the Appendix shows the estimates of the same regressions for women only. The total sample for women is around 37,000 and when only including the high incomes, we are left with around 1,200 women. The results for women are very different from the results for men. The estimated elasticities are positive, large and significant for all specifications. For our preferred specification including base year income, elasticities are in the range of 0.30-0.33 for all women in the sample and between 0.41-0.93 for the high income earners. Looking at these elasticities for men and women separately and at the general elasticities, it seems as if the general results are driven mostly by the responses of women.

In Section 3 we discussed the fact that at the same time that direct taxes were lowered, indirect taxes were increased. This increase in indirect taxes affects prices and therefore inflation and consumption. To see whether controlling for this change in indirect taxes has an effect on the estimations of the ETI, we adjusted the inflation percentages used to calculate the real incomes and we adjusted the marginal tax rates to effective tax rates and use these in the regressions. The formula used to calculate the effective tax rate (τ'_{it}) is:

$$\tau'_{it} = 1 - \frac{1 - \tau_{it}}{1 + t_{it}} \tag{11}$$

We use an adjusted inflation series, where the CPI is adjusted for changes in indirect taxes such as VAT, subsidies and excise duties and a series of total indirect taxes as percentage of private consumption (t_{it}). Both series are provided by Statistics Netherlands. In Table 9 the results of the first 3 specifications are provided:

Table 9: Estimates of the Elasticity of Taxable Income - base year 1999 - correction for indirect taxes

		(All)			(>40,000)	
	(1)	(2)	(3)	(4)	(5)	(6)
Period	(99-01)	(99-03)	(99-05)	(99-01)	(99-03)	(99-05)
No controls	0.0163*	-0.0279***	0.0146	0.0091	-0.0443	0.0845**
	(0.009)	(0.011)	(0.013)	(0.026)	(0.030)	(0.034)
With controls	-0.0090	-0.0582***	-0.0262**	-0.0093	-0.0729**	0.0662**
	(0.009)	(0.010)	(0.013)	(0.025)	(0.029)	(0.033)
Controls and base year income	0.0820***	0.0901***	0.1120***	0.1707**	0.3542***	0.4794***
	(0.009)	(0.010)	(0.014)	(0.079)	(0.093)	(0.096)
Observations	120,183	119,569	110,152	20,018	20,013	19,838

Standard errors in parentheses, * denotes significant at 10% level, ** at 5% level and *** at 1% level.

no controls, with controls and with controls and base year income. The estimates of the ETI are in the range of 0.08-0.11 for all individuals and between 0.17-0.48 for high incomes. These estimates are very similar to the estimates of 0.08-0.10 and 0.17-0.48 without controlling for the change in indirect taxes. We have also used the Gelber method controlling for the change in indirect taxes. The results are shown in Table 18. Just as before, results are in the range of 0.04-0.09 for the whole sample and in the range of 0.15-0.19 for high income earners. Again the estimates have to be tripled for the period 00-03 and quintupled for the period 00-05. The reason why controlling for changes in indirect taxes has a very small influence on the ETI, is that the change in indirect taxes had a similar impact on the behaviour of all individuals in the sample. Therefore, the indirect taxes do not lead to extra variation in the marginal tax rate and thus do not show up in the ETI.

7 Discussion and concluding remarks

In this research we have estimated the elasticity of taxable income (ETI) with respect to marginal tax rates, using two slightly different methods. We calculated synthetic incomes using 1999 or 2000 as base year, depending on the method, and increasing individuals' base year income with average income growth. Actual and synthetic marginal tax rates were calculated using MIMOS-2 from CPB Netherlands. In our main regressions we control for exogenous income growth by including base-year income as control variable or by using an income spline in base-year income. The specification with base-year income as a control variable is our preferred specification, as this method allows us to cope with anticipation effects by choosing 1999 as base year instead of 2000. We believe that 1999 is a more trustworthy base-year for synthetic income than 2000. If income in 2000 has been affected by the tax reform in 2001, then the income growth from 1999 to 2000 that we call exogenous is actually endogenous. If we estimate exogenous income growth in an endogenous period, we lose identification variation as the splines pick up changes in the income distribution that are due to the tax reform. For a more trustworthy use of the Gelber method, we therefore need more years of observations before the tax reform, to be able to calculate exogenous income trends that are more arguably exogenous.

The income distribution for the Netherlands has been stable over a long period before the tax reform and therefore it is very likely that a changed income distribution after the tax reform is caused by the tax reform and not by causes as skill-biased technological change. Mean reversion remains a problem however, as the highest incomes (for which mean reversion is likely) were strongly affected by the tax reform. It is therefore important to control for base-year income and we show that this has a huge effect on the estimated elasticities compared to regressions that do not include an income control.

Under the preferred specification we find uncompensated income elasticities in the range of 0.08-0.10 for all individuals and in the range of 0.17-0.48 for high income earners. Most previous research (mentioned in the subsection Related Literature) shows that uncompensated and compensated income elasticities are not significantly different and therefore we assume that they are similar here.

For future research, it is an option to control for income effects by including the partner's income in the regressions as a proxy for endowment and to see whether this has an effect on the estimations. It is also an option to use a proxy for virtual income to estimate the income effect, as in (Gruber and Saez, 2002). To be able to do this, a richer data set is necessary, which includes information that allows for calculation of individuals' total taxes.

By estimating the regressions including only women or only men in our sample, we find that the results found are mainly driven by behavioural responses by women.

Elasticities for women are in the range of 0.30-0.33 for all women in our preferred specification including controls for personal characteristics and base-year income. For high income earners these elasticities are in the range of 0.41-0.93. Elasticities for men are significantly lower: between 0-0.03 for all men in our sample and between 0.15-0.46 for high income earners.

We also find that when controlling for the change in indirect tax rates, elasticities remain almost the same. This is likely due to the fact that the change in VAT had a similar effect on all individuals in the sample, leading to little extra variation in the marginal tax rate. A limitation of this study is the fact that we do not have data on personal tax deductibles and that we do not have data for the self-employed. Previous literature, such as Kleven and Schultz (2012) shows that elasticities of taxable income are higher for the self-employed than for employees, so it would be interesting to extend this research for the Netherlands including the self-employed.

A different data set available within CPB Netherlands, called IPO (Income Panel), would be a good follow-up data set as it includes data on the self-employed and on tax deductibles. Furthermore, IPO includes data on more years before the tax reform, making it possible to improve the control for exogenous income growth.

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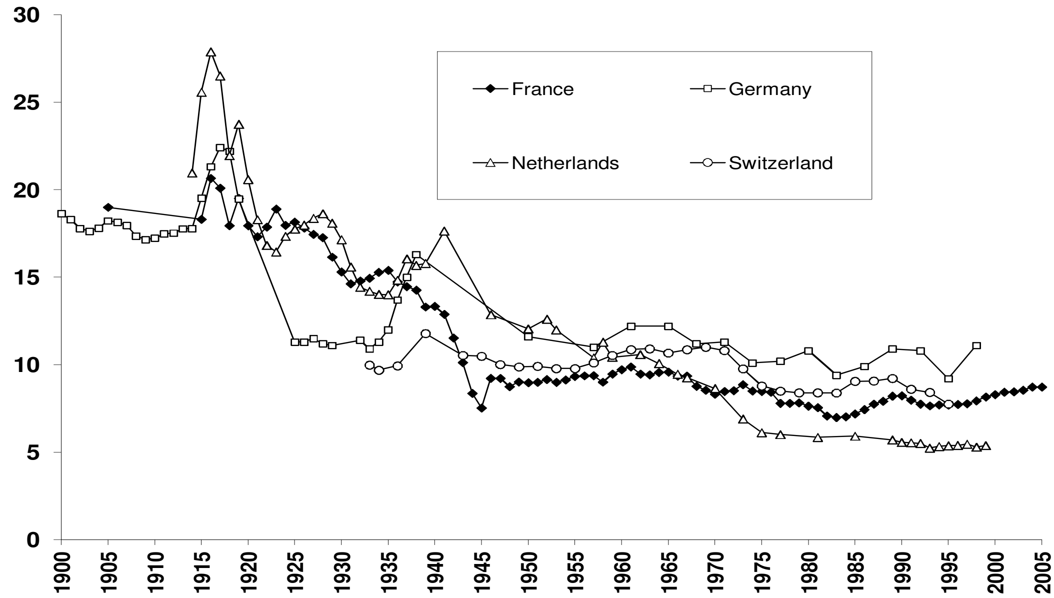
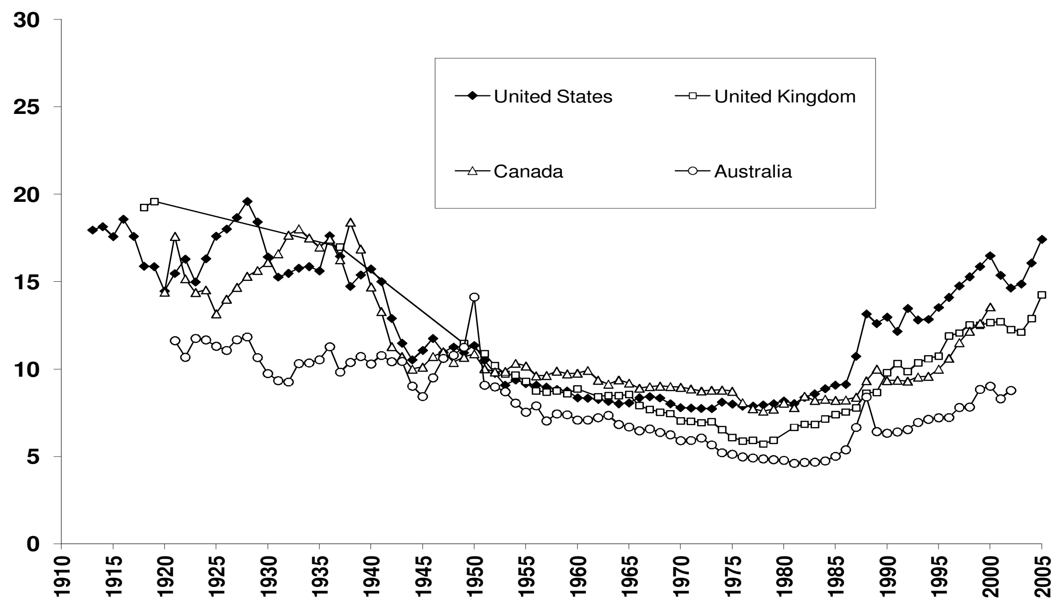
Figure 1: Top 1% income share Middle Europe (1900-2005)



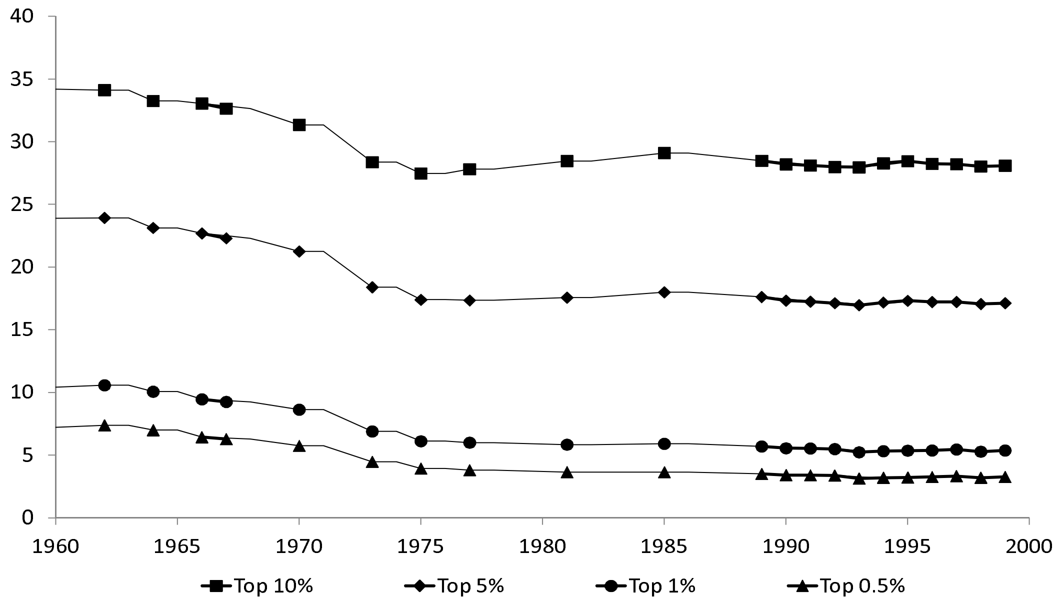
Source: The World Top Incomes Database.

Figure 2: Top 1% income share Anglo-Saxon countries (1910-2005)



Source: The World Top Incomes Database.

Figure 3: Top income shares in the Netherlands (1960-1999)



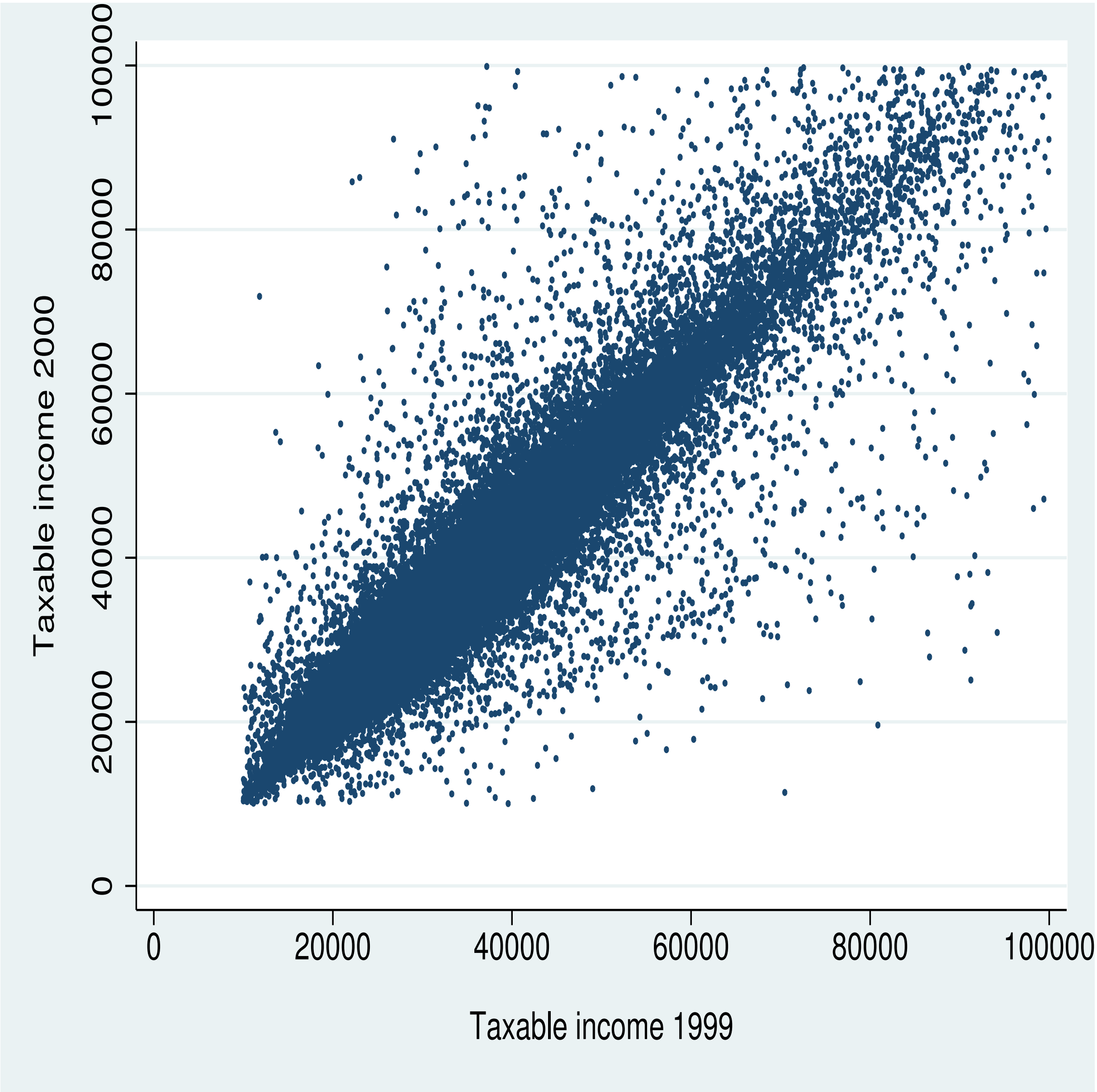
Source: The World Top Incomes Database.

Table 10: Disposable income shares of the deciles in the Netherlands

jaar	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
1989	2,67	4,82	6,04	7,08	8,13	9,37	10,85	12,66	15,37	23,59
1990	2,43	4,72	5,92	6,98	8,07	9,34	10,87	12,70	15,44	24,04
1991	1,98	5,15	5,88	6,93	8,05	9,35	10,91	12,76	15,52	23,87
1992	2,29	4,78	5,96	7,01	8,12	9,42	10,93	12,79	15,52	23,54
1993	1,85	5,03	5,95	7,00	8,14	9,45	11,00	12,89	15,64	23,36
1994	2,34	4,73	5,88	6,92	8,05	9,37	10,95	12,91	15,69	23,39
1995	2,48	4,72	5,86	6,89	8,01	9,32	10,91	12,88	15,67	23,51
1996	1,99	4,79	5,83	6,90	8,02	9,36	10,97	12,96	15,80	23,61
1997	1,93	4,89	5,88	6,94	8,05	9,37	10,98	12,95	15,72	23,49
1998	1,66	4,95	5,99	7,01	8,09	9,41	11,00	12,97	15,78	23,35
1999	1,52	4,84	5,96	7,00	8,06	9,40	11,02	13,03	15,85	23,47
2000	1,74	4,94	5,92	6,94	7,99	9,32	10,90	12,88	15,68	23,85

Source: http://emielafman.nl/inkomensverdeling.pdf

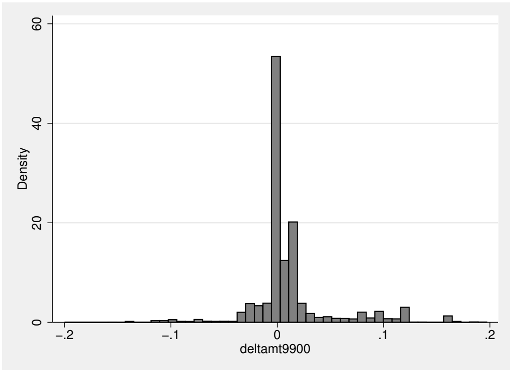
Figure 4: Income dynamics: 1999-2000



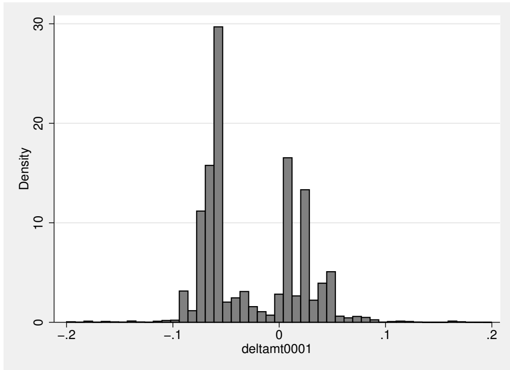
Source: Labour Market Panel 1999-2005 (Statistics Netherlands).

Figure 5: Changes in marginal tax rates

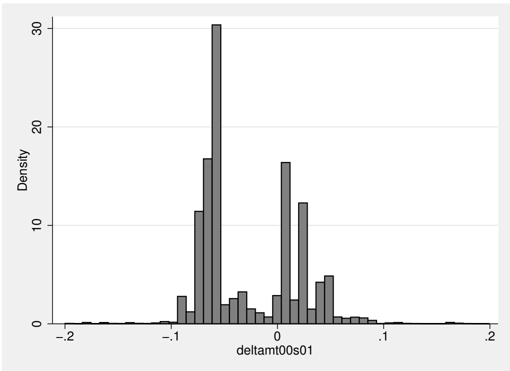
(a) 1999-2000



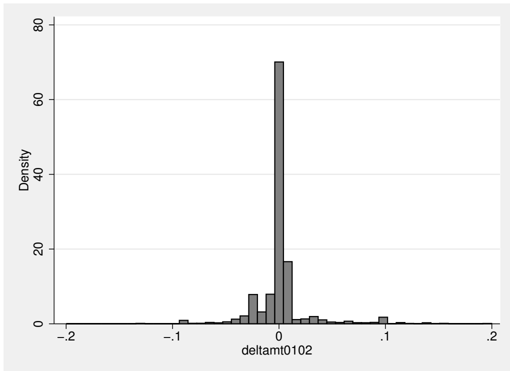
(b) 2000-2001



(c) 2000-2001 (synthetic)

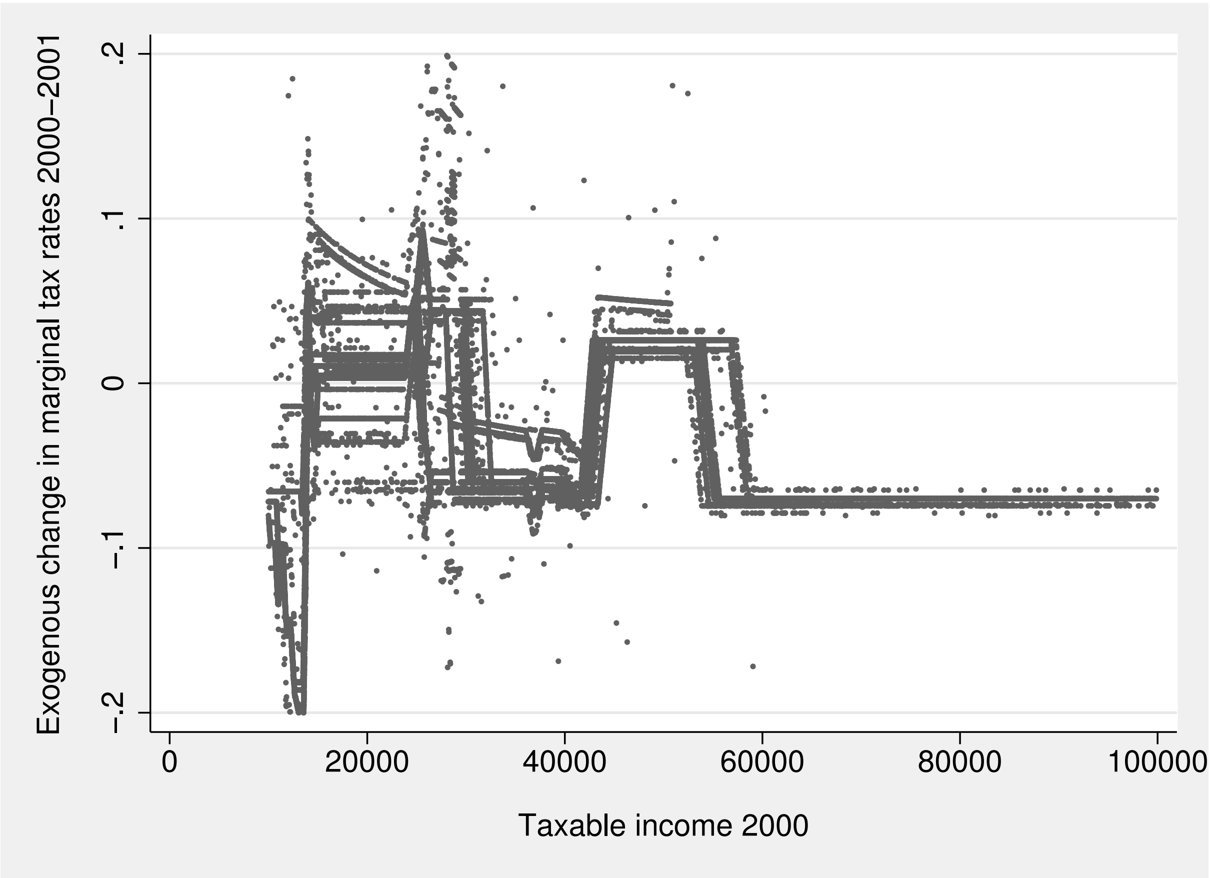


(d) 2001-2002



Source: Labour Market Panel (Statistics Netherlands) and own calculations.

Figure 6: Change in exogenous marginal tax rate 2000-2001 by income 2000



Source: Labour Market Panel 1999-2005 (Statistics Netherlands) and own calculations.

Table 11: Second stage regression - specification 2 - 1999-2001

$\Delta \ln(E_{it})$	Coefficient
Elasticity	0.0873***
	(0.009)
Base-year income	-0.0706***
	(0.008)
Age	-0.002***
	(0.000)
Lower secondary education	0.0144***
	(0.002)
Higher secondary education	0.0352***
	(0.003)
Tertiary education	0.0853***
	(0.004)
Female	-0.0463***
	(0.003)
Western immigrant	0.0083***
	(0.003)
Non-Western immigrant	0.0083***
	(0.002)
Couple living together, no kids	-0.0106***
	(0.002)
Married, no kids	-0.0187***
	(0.002)
Couple living together, with kids	0.005
	(0.004)
Married, with kids	0.0022
	(0.002)
Single parent	0.0319***
	(0.004)
Constant	0.8232***
	(0.0817)
Observations	120,183

Standard errors in parentheses, * denotes significant at 10% level, ** at 5% level and *** at 1% level.

Table 12: Second stage regression - specification 2 - 1999-2003

$\Delta \ln(E_{it})$	Coefficient
Elasticity	0.0907***
	(0.010)
Base-year income	-0.1107***
	(0.008)
Age	-0.0033***
	(0.000)
Lower secondary education	0.0188***
	(0.003)
Higher secondary education	0.0536***
	(0.003)
Tertiary education	0.1317***
	(0.004)
Female	-0.0687***
	(0.003)
Western immigrant	0.0108***
	(0.003)
Non-Western immigrant	0.0143***
	(0.003)
Couple living together, no kids	-0.0216***
	(0.003)
Married, no kids	-0.0195***
	(0.003)
Couple living together, with kids	0.0155***
	(0.004)
Married, with kids	0.0132***
	(0.002)
Single parent	0.0511***
	(0.005)
Constant	1.2921***
	(0.082)
Observations	119,569

Standard errors in parentheses, * denotes significant at 10% level, ** at 5% level and *** at 1% level.

Table 13: Second stage regression - specification 2 - 1999-2005

$\Delta \ln(E_{it})$	coefficient
Elasticity	0.1001***
	(0.014)
Base-year income	-0.0878***
	(0.010)
Age	-0.0061***
	(0.000)
Lower secondary education	0.0204***
	(0.003)
Higher secondary education	0.0590***
	(0.004)
Tertiary education	0.1568***
	(0.005)
Female	-0.0871***
	(0.003)
Western immigrant	0.0089**
	(0.005)
Non-Western immigrant	0.0200***
	(0.004)
Couple living together, no kids	-0.0235***
	(0.003)
Married, no kids	-0.0154***
	(0.003)
Couple living together, with kids	0.0333***
	(0.006)
Married, with kids	0.0226***
	(0.003)
Single parent	0.0795***
	(0.007)
Constant	1.171***
	(0.096)
Observations	110,152

Standard errors in parentheses, * denotes significant at 10% level, ** at 5% level and *** at 1% level.

Table 14: Estimates of the Elasticity of Taxable Income - base year 1999 - men only

		(All)			(>40,000)	
	(1)	(2)	(3)	(4)	(5)	(6)
Period	(99-01)	(99-03)	(99-05)	(99-01)	(99-03)	(99-05)
No controls	-0.0248**	-0.0828***	-0.0639***	-0.0065	-0.0649**	0.0640*
	(0.010)	(0.012)	(0.014)	(0.027)	(0.031)	(0.035)
With controls	-0.0408***	-0.1028***	-0.0500***	-0.0194	-0.0849**	0.0565*
	(0.009)	(0.011)	(0.014)	(0.026)	(0.029)	(0.034)
Controls and base-year income	0.0168	0.0044	0.0312*	0.1586*	0.3430***	0.4630***
	(0.009)	(0.013)	(0.016)	(0.083)	(0.097)	(0.099)
Observations	82,890	82,732	80,578	18,770	18,767	18,598

Standard errors in parentheses, * denotes significant at 10% level, ** at 5% level and *** at 1% level.

Table 15: Estimates of the Elasticity of Taxable Income - base year 1999 - women only

		(All)			(>40,000)	
	(1)	(2)	(3)	(4)	(5)	(6)
Period	(99-01)	(99-03)	(99-05)	(99-01)	(99-03)	(99-05)
No controls	0.1796***	0.1564***	0.0980***	0.3009***	0.3030***	0.4052***
	(0.019)	(0.021)	(0.027)	(0.100)	(0.109)	(0.123)
With controls	0.1856***	0.1548***	0.1072***	0.2223**	0.1955*	0.3519***
	(0.019)	(0.021)	(0.027)	(0.096)	(0.104)	(0.120)
Controls and base-year income	0.3379***	0.3083***	0.3054***	0.4117***	0.5655***	0.9265***
	(0.020)	(0.022)	(0.029)	(0.120)	(0.155)	(0.175)
Observations	37,293	36,837	29,574	1,248	1,246	1,240

Standard errors in parentheses, * denotes significant at 10% level, ** at 5% level and *** at 1% level.

Table 16: Estimates of the Elasticity of Taxable Income - base year 1999 - correction for indirect taxes - men only

	(All)			(>40,000)		
	(1)	(2)	(3)	(4)	(5)	(6)
Period	(99-01)	(99-03)	(99-05)	(99-01)	(99-03)	(99-05)
No controls	-0.0263**	-0.0843***	-0.0645***	-0.0071	-0.0649**	0.0627*
	(0.010)	(0.012)	(0.015)	(0.027)	(0.031)	(0.035)
With controls	-0.0425***	-0.1048***	-0.0503***	-0.0200	-0.0849***	0.0547
	(0.009)	(0.011)	(0.014)	(0.026)	(0.030)	(0.034)
Controls and base-year income	0.0146	0.0031	0.0309*	0.1577*	0.3430***	0.4616***
	(0.011)	(0.013)	(0.016)	(0.083)	(0.097)	(0.099)
Observations	82,914	82,549	80,318	18,771	18,767	18,505

Standard errors in parentheses, * denotes significant at 10% level, ** at 5% level and *** at 1% level.

Table 17: Estimates of the Elasticity of Taxable Income - base year 1999 - correction for indirect taxes - women only

	(All)			(>40,000)		
	(1)	(2)	(3)	(4)	(5)	(6)
Period	(99-01)	(99-03)	(99-05)	(99-01)	(99-03)	(99-05)
No controls	0.1597***	0.1545***	0.1707***	0.3009***	0.3030***	0.4052***
	(0.019)	(0.021)	(0.029)	(0.100)	(0.109)	(0.123)
With controls	0.1659***	0.1534***	0.1629***	0.2223**	0.1958***	0.3519***
	(0.019)	(0.022)	(0.029)	(0.096)	(0.104)	(0.120)
Controls and base-year income	0.3149***	0.3080***	0.3594***	0.4117***	0.5655***	0.9265***
	(0.020)	(0.022)	(0.031)	(0.120)	(0.155)	(0.175)
Observations	37,423	36,807	29,873	1,248	1,246	1,240

Standard errors in parentheses, * denotes significant at 10% level, ** at 5% level and *** at 1% level.

Table 18: Estimates of the Elasticity of Taxable Income - Gelber method - base year 2000 - correction for indirect taxes

	(All)			(>40,000)		
	(1)	(2)	(3)	(4)	(5)	(6)
Period	(00-01)	(00-03)	(00-05)	(00-01)	(00-03)	(00-05)
5-piece spline	0.0403***	0.0481***	0.0874***	0.1488***	0.1532***	0.1909***
	(0.007)	(0.004)	(0.003)	(0.017)	(0.008)	(0.007)
10-piece spline	0.0532***	0.0600***	0.0721***	0.1498***	0.1542***	0.1539***
	(0.007)	(0.004)	(0.003)	(0.017)	(0.008)	(0.008)
Observations	115,277	115,179	115,177	19,794	19,797	19,798

Standard errors in parentheses, * denotes significant at 10% level, ** at 5% level and *** at 1% level.