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## Empirical Evidence on the Effects of Marginal Tax Rates on Income – The German Case

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# Empirical Evidence on the Effects of Marginal Tax Rates on Income – the German Case

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February 2004

## Abstract

In 1990 the German personal income tax schedule underwent a major change. We interpret this reform as a ‘natural experiment’ and use a panel of individual income tax returns to analyze the response of income to changes in the individual tax rates. Our results suggest an average elasticity of taxable income with respect to the net-of-tax rate of around 0.4. Due to the detailed information the panel provides, we are not only able to distinguish between different levels of income but also between different types of income. We found very low elasticity estimates in the case of regular employment income, but values of up to 1.0 for business income and for high-income households.

*JEL classification:* H24,H31,J29

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# 1 Introduction

Assessing empirically the classical conflict between efficiency and redistribution requires the quantification of behavioral responses to incentives provided by existing tax systems. With regard to the personal income tax, the response of taxable income to changes in the individual net-of-tax rate (i.e. one minus the marginal tax rate) has recently gained considerable attention. The startling results obtained by Feldstein (1995) – that taxable income declared by U.S. households is extremely sensitive to changes in the individual net-of-tax rate – along with the implications of this results for optimal tax policy design (Feldstein 1999) lead to a series of subsequent investigations sometimes called ‘New Tax Responsiveness Literature’ (Goolsbee, 2000)<sup>1</sup>. Although the elasticity estimates found in recent studies are considerably lower than Feldstein’s (1995) results and vary considerably – the estimates range from negative values to values of well above 2.0, where, for the U.S., the most frequent elasticity estimate seems to be about 0.5 – they clearly confirm the empirical relevance of this issue for policy issues.

The present paper is a first German contribution to the ‘New Tax Responsiveness Literature’. We used the German tax reform of 1990 as a quasi-natural field experiment and observed the sensitivity of individual taxable income to changes in marginal tax rates to derive behavioral elasticity estimates. Some points are worth to be mentioned. First, compared to tax reforms which served as natural experiments in similar studies the German reform considered here provided some interesting, if not unique characteristics. Since most countries use a system of tax rate bands, a reduction of the tax rate in one band affects all households in this particular income bracket in the same way. As a consequence, the variation of one of the main variables which determine household behavior under taxation is rather limited. Due to the particular structure of the German income tax schedule (before and after the reform) in combination with the different tax treatment of singles and married couples, households with rather equal levels of income were affected by quite different changes in their marginal tax rates whereas, at the same time, households with quite different levels of income were hit by the same change of the tax price. Second, in many of the investigated reforms as, for example, the US Tax Reform Act of 1986 which underlied a whole series of studies (see, for example, Feldstein (1995), Auten/Carroll (1999), Moffitt/Wilhelm (2000)), the top maginal tax rates underwent the largest cuts. In this light the found elasticity estimates could be driven, to a large extend, by the reaction of high income households only. In the German tax reform the highest cuts of the marginal tax rates arose for mid range taxable income.

Furthermore, the data we used enabled us to replicate the tax assesment of

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<sup>1</sup>For a brief summary see, for example, Aarbu/Thorensen (2001) or, more recently, Gruber/Saez (2002).

every individual taxfiler. We were also in a position to carry out hypothetical tax assessments with all reform measures taken into account assuming unchanged (pre-reform) household behavior. In doing so we are able to distinguish between tax price effects and tax base, respectively income effects in a manner very similar to that used by Gruber/Saez (2002).

The paper proceeds as follows. In the next section we sketch the main features of the German tax reform. This section is followed by a short description of the data set underlying the estimation. The estimation equation is derived in section 4, followed by a discussion of the estimation strategy in section 5. Section 6 presents our estimation results. A short summary of the main results combined with some concluding remarks end the paper.

## 2 The German tax reform of 1990

The centerpiece of the 1990 tax reform was undoubtedly the replacement of the income tax schedule. Due to political concern about large disincentive effects, especially for mid-income earners, the pre-reform schedule which – in terms of marginal tax rates – increased concavely in taxable income was replaced by a linearly increasing schedule. The replacement also entailed a general reduction of the marginal tax rates. At the bottom of the scale tax rates were cut from 0.22 to 0.19, and from 0.56 to 0.53 at the top of the tax scale. Furthermore, the guaranteed minimum income was raised by roughly 850 DM to 5617 DM. Pre-reform and post-reform schedules are sketched in Figure 1.

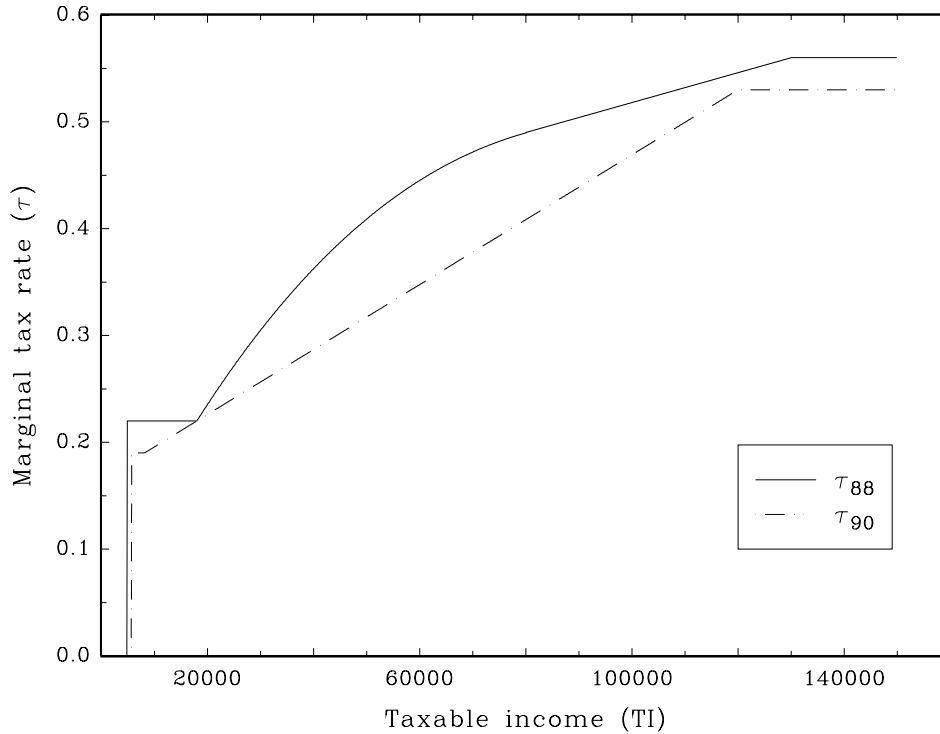
As can be seen quite clearly from Figure reffig:tarif different levels of taxable income were affected quite differently by the reduction of the marginal tax rates. The reduction of marginal tax rates translates into respective increases of the net-of-tax rates. The net-of-tax rate is defined as one minus the marginal tax rate and can be viewed as a measure for the incentives provided by the tax system to consume tax-favoured goods – that is, to declare less taxable income by resorting to activities which are deductible or excluded from the tax base. For any given level of taxable income the change in the net-of-tax rate caused by the reform can easily be depicted from Figure 1 as the vertical distance between  $\tau_{88}$  and  $\tau_{90}$ <sup>2</sup>. Due to the adjustment of the guaranteed minimum income taxfilers with a taxable income near the bottom of the tax schedule experienced the largest increase in their net-of-tax rate (about 28 percent). Beside this base effect, individuals with a taxable income of around 60000 DM benefited the most by the reform (with peak values of around 19 percent). As for individuals with very low or very high levels of taxable income the change in their net-of-tax rate amounted to only 4 or 7 percent, respectively. Within this respect the German tax reform differs from

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<sup>2</sup>Since  $(1 - \tau_{90}) - (1 - \tau_{88}) = \tau_{88} - \tau_{90}$ .



Figure 1: Marginal tax rates on taxable income before and after the reform.



most of the other tax reforms carried out in OECD-countries over the last two decades. In all these reforms the largest tax cuts applied to high-income households.

Simultaneously, a considerable number of other reform measures were introduced which primarily entailed only tax base effects. Among these were the abolition of the allowance for professional earnings, the abolition of the allowance for persons older than 64 years, the increase of the allowance for single parents and the increase of the allowance for professional expenses granted to non-itemizers, just to name a few<sup>3</sup>. As a consequence, not necessarily everybody gained by the reform. However, the reform was intended to reduce the tax burden and the vast majority of households actually experienced a tax relief. If one formally applies all reform measures on, for example, the 1989 data of our dataset in a static manner – i.e., without taking any behavioral changes into account – only 2 percent of all the taxfilers in the dataset would face a rising tax liability. Official estimates specified the total tax relief to amount to about 33 billion DM (BMF (1989)).

<sup>3</sup>The complete list comprises no less than 62 items. (BMF (1989))

### 3 The data

Our study is based on the income tax panel of the ‘Institut fuer Angewandte Wirtschaftsforschung’ (IAW). This panel dataset consists of consecutive individual and joint income tax assessments of 34555 households covering the period 1988-91. It constitutes a representative sample of all income tax cases of Baden-Wuerttemberg. With more than 150 entries for every single tax case the data is very detailed concerning tax relevant information. It even allows the detailed replication of the income tax assessment on the individual level. Additional demographic information, however, is rather limited due to confidentiality reasons. On the other hand, not only income from dependent work is recorded in the dataset, but other types of income as well. Hence, we can also investigate the responsiveness of households who run a business, receive property income, etc. Figure 2 shows the percentage share of taxfilers who report to have income of the listed types in 1988. Note that households declaring income from agriculture and fishery are excluded from the figure just as from the whole investigation, since these sectors are heavily regulated and the respective income also depends strongly on external factors such as subsidies, weather conditions, pests and the like. These circumstances make it hard, if not impossible, to extract those behavioral reactions which can be attributed to the tax reform.

Our investigation is based on the comparison of taxable income declared before (1988) and after (1990) the reform. Since the reform took place only in 1990 this time span may seem a bit short, specifically, if individuals respond slowly to tax changes<sup>4</sup>. On the other hand, in mid 1991 several special settlements were introduced into the German income tax law with the intention to speed up and to help financing the East German economic recovery<sup>5</sup>. These measures cannot be seen as an integral part of the 1990 reform which serves as the ‘natural experiment’ in our study. On the contrary, the general intention of the 1990 reform was mostly reversed by these measures. Comparing 1988 to 1991 outcomes would include the effects of this program and would thus interfere with the effects of the 1990 reform. Futhermore, the tax reform act of 1990 was passed in mid 88. Hence, the change in the income tax was well known in advance.

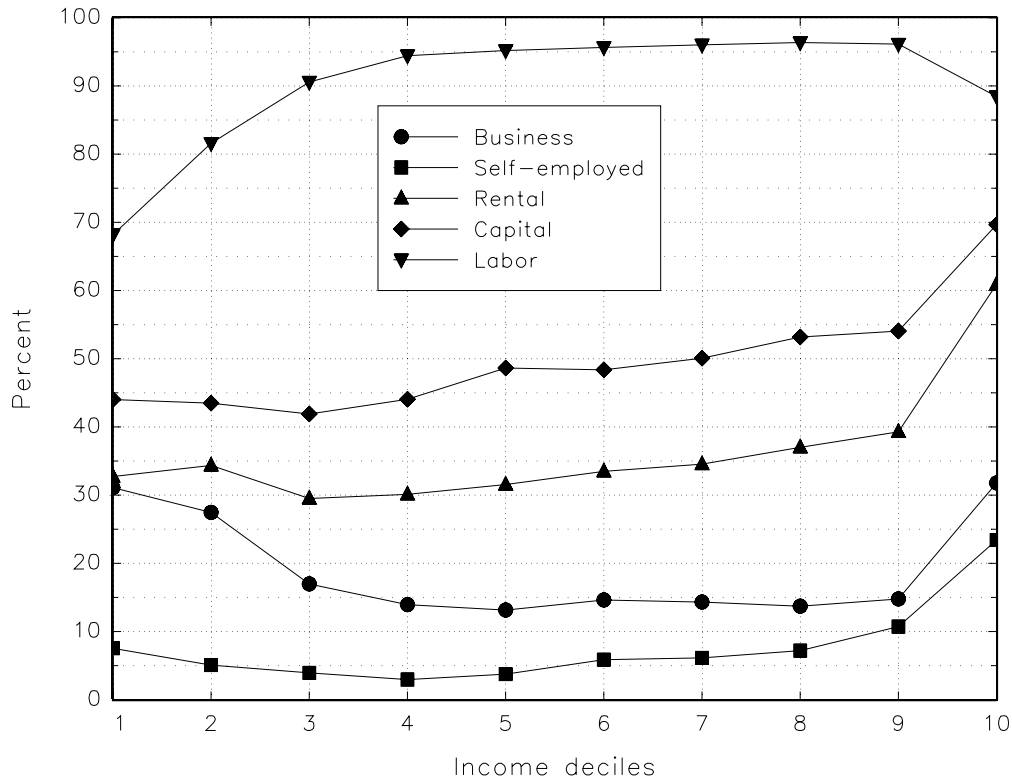
In order to avoid the inclusion of changes of the taxable income which we consider not to be directly attributable to the tax reform we excluded those cases from our investigation for which one of the following events applied:

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<sup>4</sup>See Goolsbee (2000) or Weiner (1997) for a further discussion of the time length considered.

<sup>5</sup>Among the introduced measures were, for example, a surcharge on the income tax commonly referred to as the ‘solidarity tax contribution’, subsidies and accelerated depreciation allowances for capital invested in East Germany.

Figure 2: Share of individuals who declare income of the respective type to total number of individuals (in percent) cut in deciles.



- the individual retired during the regarded period,
- the marital status of the individual changed,
- the number of children changed in unison with the labor force participation of the respective individual,
- the individual received social security benefits such as unemployment benefits or sick benefits.

This strategy is, of course, disputable. Especially concerning the first and the third item on the list above. Most studies exclude all retired individuals in general. In our case this seemed inappropriate. Clearly, if a person retired during the regarded period he, or she, probably experienced a significant cut in gross income, depending on the respective pension scheme. This effect is no behavioral response on the reform and should therefore be excluded. If, however, individuals retired before 1990 the respective data may well reflect a reaction on the reform. In particular, since about 85 percent of all retirees in the dataset report to have income from additional sources and also

pay income tax. However, as will be seen in section 6, we also performed estimations without any retirees included as well as estimations solely on retirees and found no significant difference in the results.

Concerning the third item, we excluded all households who conceived their first child during 1988-90 since we consider this to have a profound impact on household behavior. If the household already had children we excluded only those cases for which the number of children in the household increased and the secondary earner stopped working, or vice versa, the claimed number of allowances for children decreased and the secondary earner started to work. After the exclusion of the relevant cases 29705 tax files remained for the estimation.

In addition, we held capital income on a constant post-reform level (that of 1990). In other words, we neutralized any household reaction as far as the declaration of capital income is concerned. The reason for doing so is the introduction of a source tax on capital income in mid 1989 which was collected at the banking sector with the intention to reduce tax evasion. Although this source tax could be offset against the personal income tax liability it initiated a massive capital flight into foreign investment. As a result, the tax was already suspended at the end of 1989. Since the consequences of this short episode have no effect on the main independent variables, we are unable to separate household responses to this change of the type of tax collection from responses of capital income to the 1990 tax reform.

## 4 The estimation equation

As pointed out in section 2 the tax reform caused substitution as well as income effects. Therefore, we basically adopted the approach of Gruber/Saez (2002) with the difference that we estimated compensated price and income elasticities. Our starting point is the linearized form of the households budget equation in the consumption-income model:

$$(C) = Y - T(TI) = (1 - \tau)TI + R \quad (1)$$

where  $Y$  equals gross income,  $TI$  is taxable income, and  $T$ ,  $\tau$  and  $R$  are the income tax liability, the marginal tax rate and virtual income, respectively. Virtual income reflects the difference between gross income and taxable income on the one hand and the difference between  $T(TI)$  and  $\tau TI$  on the other. For any household a change in the income tax can thus be decomposed into a change of the relevant marginal tax rate  $\tau$  and a change of virtual income  $R$ . Since the former affects the relative price of tax preferred to ordinary consumption and the latter affects the household's income situation

the total reaction of taxable income  $TI(1 - \tau, R)$  is given by

$$dTI = \frac{\partial TI}{\partial(1 - \tau)} d(1 - \tau) + \frac{\partial TI}{\partial R} dR. \quad (2)$$

Decomposing  $\partial TI / \partial(1 - \tau)$  into substitution and income effect via the Slutsky-equation yields

$$dTI = \left( \frac{\partial TI}{\partial(1 - \tau)} \Big|_u + TI \frac{\partial TI}{\partial R} \right) d(1 - \tau) + \frac{\partial TI}{\partial R} dR. \quad (3)$$

The substitution or compensated price elasticity  $\epsilon^c$  and the income elasticity  $\epsilon^y$  are defined as

$$\epsilon^c := \frac{\partial TI}{\partial(1 - \tau)} \Big|_u \frac{(1 - \tau)}{TI} \quad \text{and} \quad \epsilon^y := \frac{\partial TI}{\partial R} \frac{R}{TI} \quad (4)$$

respectively. After rearranging the terms of equation (3) and substituting both definitions into (3) we obtain

$$\frac{dTI}{TI} = \epsilon^c \frac{d(1 - \tau)}{(1 - \tau)} + \epsilon^y \frac{d(1 - \tau)TI + dR}{R}. \quad (5)$$

From equation (1) can be seen that the initial impact of the tax change on the household's income situation is  $-dT = d(1 - \tau)TI + dR$ . As mentioned above, virtual income captures the difference between gross income and taxable income and the approximation error of the linearized tax schedule, i. e.:  $R = (Y - TI) + (\tau TI - T)$ . So we end up with

$$\frac{dTI}{TI} = \epsilon^c \frac{d(1 - \tau)}{(1 - \tau)} + \epsilon^y \frac{-dT}{(Y - TI) + (\tau TI - T)}. \quad (6)$$

All terms can be calculated readily from the given data, except for gross income  $Y$ . The latter is approximated by the income  $\tilde{Y}$  reported by the tax-filer before any allowances and deductions are being applied. Furthermore, following the majority of all studies in that field we used logarithmic approximations for the respective growth rates ( $dx/x \approx \log(x_{90}/x_{88})$  with  $x_{88}$  and  $x_{90}$  referring to the pre-reform and post-reform situation.).

The estimation equation has thus the form

$$\log \frac{TI_{90}}{TI_{88}} = \epsilon^c \log \frac{(1 - \tau_{90})}{(1 - \tau_{88})} + \epsilon^y \frac{T_{88} - T_{90}}{(\tilde{Y}_{88} - TI_{88}) + (\tau_{88} TI_{88} - T_{88})} + \log TI_{88} + X + \mu \quad (7)$$

where  $X$  is a set of additional, mostly dummy variables which will be described in the next section and  $\mu$  symbolizes the error term.

## 5 Estimation strategy

Three further aspects complicate the estimation. First, due to the functional relationship between taxable income and the marginal tax rate a straight-forward OLS regression on the basis of the actual 1988/90 tax rates and the respective levels of taxable income would be severely biased. As can be depicted from Figure 1, an increase in the growth rate of taxable income implies, up to a certain point, a decrease in the growth rate of  $(1 - \tau)$  and vice versa. Second, via the increase or cut of allowances the tax reform itself implied a change in the size of taxable income even if there were no behavioral responses. And third, the influence of inflation, business cycles and other external growth factors should be neutralized.

To account for these factors we proceeded as follows. We inflated the 1988 data to correspond to 1990 levels using nominal growth rates. For most of the items listed in the dataset we derived specific average growth rates directly from the dataset itself using the respective 1988 and 1989 figures. Otherwise, we used growth rates from official sources<sup>6</sup>. This procedure has its advantages but also its disadvantages. On the one hand, using previous year growth rates instead of longer run growth rates is susceptible to exceptional changes such as exogenous shocks, etc. On the other hand, specific growth rates are less crude since regional as well as structural factors are appropriately accounted for.

On the grounds of the adjusted 1988 data two tax assessments were carried out by the use of a previously developed simulation model<sup>7</sup>. One assessment was based on pre-reform tax rules and computed the taxable income levels  $TI_{88}^{pre}$ , the net-of-tax rates  $(1 - \tau_{88}^{pre})$  and the tax liabilities  $T_{88}^{pre}$ , the other was based on post-reform tax rules and computed  $TI_{88}^{post}$ ,  $(1 - \tau_{88}^{post})$  and  $T_{88}^{post}$  analogously.

Since  $TI_{88}^{post}$  is deprived from formal redefinitions of the tax base caused by the reform we used  $\log(TI_{90}/TI_{88}^{post})$  as dependent variable. Concerning the independent variables we specified two alternatives. In the first alternative we took  $\log((1 - \tau_{90})/(1 - \tau_{88}^{pre}))$  and  $(T_0^{pre} - T_{90})/((Y_0^{pre} - TI_0^{pre}) + (\tau_0^{pre} TI_0^{pre} - T_0^{pre}))$  as independent variables and used  $\log((1 - \tau_0^{post})/(1 - \tau_0^{pre}))$  and  $(T_0^{pre} - T_0^{post})/((Y_0^{pre} - TI_0^{pre}) + (\tau_0^{pre} TI_0^{pre} - T_0^{pre}))$  – i. e. the initial impact of the reform – as instruments to account for the interdependencies of tax rates and taxable income. In the other case we used  $\log((1 - \tau_0^{post})/(1 - \tau_0^{pre}))$  and  $(T_0^{pre} - T_0^{post})/((Y_0^{pre} - TI_0^{pre}) + (\tau_0^{pre} TI_0^{pre} - T_0^{pre}))$  directly as independent variables. The first specification entailed an IV-regression, the second specification was used for a median regression. We chose a median regres-

<sup>6</sup>For example, professional expenses were updated with the inflation rate listed in the Statistical Yearbook (StBa, 2000)

<sup>7</sup>The model applies the income tax code on the individual and joint taxfilers and computes all tax relevant information.

sion because the estimates are less influenced by outliers which are bound to occur in investigations of this type.

## 6 Estimation results

Before we turn to the estimation results, Table 1 lists the aggregate growth rates of taxable income by income deciles. Obviously, the growth rates of the lowest two deciles show the highest increase in taxable income. Very likely, this can be contributed to life-cycle and reversion-to-the-mean effects. Unfortunately we do not have any explicit information about the individuals age. However, the high concentration of singles in the lowest two deciles – 50-60 percent in the lower deciles compared to around 10-25 percent in higher ones – seems to support this interpretation.

Table 1: Taxable income per capita and average marginal tax rate in 1988, aggregate change of taxable income 1988-1990, in deciles. Individuals ranked by pre-reform taxable income (Number of Observations: 24345).

Decile number	Taxable income per capita	Aggregate growth rate of taxable income	Average marginal tax rate
1	8070	30.06	15.37
2	16403	17.68	21.42
3	24446	9.86	24.49
4	30661	5.19	26.94
5	36516	5.01	28.11
6	43441	4.00	29.49
7	51489	4.69	30.81
8	61073	2.87	33.00
9	76037	2.50	36.46
10	179676	5.37	46.04

On the other hand, the aggregate change of the net-of-tax rate is also comparably large, at least for the lowest income decile. This is, in part, a consequence of the raise of the guaranteed minimum income which generated the highest observed change in the net-of-tax rate. Furthermore, Figure 2 on page 5 reveals that the percentage of individuals reporting to have regular employment income is well below average, whereas the proportionate share of individuals reporting income from self-employment, business income or rental income is comparably large and declining for subsequent deciles<sup>8</sup>. If

<sup>8</sup>Note that old age pensioners were excluded from the data presented in Table 1 and in

promotion of the typically younger individuals, which usually leads to a considerable raise in their salary, were the only cause of the observed high growth rates, one would expect the share of individuals earning capital income or rental income to be quite low. However, this is not the case. Taking also into account that, according to the German tax law, the means to take influence on the tax base are more limited as far as income from regular employment is concerned than for other types of income – taxable rental income, for example, is in the majority of all cases a negative figure – there is also mild evidence that households in these groups have a stronger preference to avoid taxes. In this case, the comparably strong reaction of taxable income might also be caused by short run effects such as income shifting in time, at least to some extent.

Although it cannot be ruled out beforehand that highly "tax sensitive" households are concentrated in the lowest income deciles we restrict our regressions to households (or individuals) with a taxable income of 10000 DM or higher, due to the previous argumentation<sup>9</sup>. This sum amounts to approximately twice of the guaranteed minimum income in the base year.

## 6.1 All Households

The first series of regressions is performed on all relevant households or individuals regardless of the type of income they earn and regardless of the income level. Table 2 shows the estimation results of four different estimation specifications. Columns I and II refer to instrumental variable regressions which are most commonly applied. The instruments are chosen as explained in Section 4. The only difference between regressions I and II is that in II  $\ln y$  is included as control variable for reversion-to-the-mean effects.

It should be noted that, on the individual level, the observed proportionate change of taxable income ranges from  $-7.25$  to  $12.5$ . Obviously, an increase of taxable income by factor 12 is not (solely) contributable to the tax reform. However, imposing any limits on the growth rate of taxable income and thereby restricting the investigation to a certain range would inevitably be arbitrary. Instead, we contrast the iv-regressions to median regressions (columns III and IV), since the latter regression method puts less weight on outliers. Again, the difference between columns III and IV stems from the inclusion of a control for reversion-to-the-mean effects.

As table 2 shows, the inclusion of the control variable leads to higher estimates of the compensated substitution elasticity,  $\epsilon^c$ , in both types of re-

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Figure 2, because including them would distort the present view. In most of the regressions, however, the pensioners are included, since about 85 percent of them earn income from additional sources.

<sup>9</sup>Although this practice might be problematic it is commonly applied



Table 2: Elasticity estimates for alternative regression specifications (All regressions are unweighted, error probabilities are given in brackets).

	Two-Stage-Least-Square		Median regression	
	I	II	III	IV
$\epsilon^c$	0.025 (0.832)	0.581 (0.000)	0.246 (0.000)	0.379 (0.000)
$\epsilon^y$	0.032 (0.410)	-0.001 (0.909)	-0.650 0.000	-0.264 (0.000)
$\ln y$		-0.134 (0.000)		-0.099 (0.000)
Taxable income > 70000	-0.046 (0.000)	0.042 (0.000)	0.005 (0.108)	0.038 (0.000)
Joint filers	0.030 (0.005)	0.070 (0.000)	-0.012 (0.001)	0.025 (0.000)
Non dependent income	-0.009 (0.335)	-0.002 (0.772)	0.003 (0.299)	0.010 (0.000)
No. children	0.023 (0.000)	0.023 (0.000)	0.004 (0.000)	0.005 (0.000)
Single parent	-0.013 (0.499)	-0.023 (0.252)	-0.043 (0.000)	-0.036 (0.000)
Handicapped	-0.100 (0.000)	-0.114 (0.000)	-0.047 (0.000)	-0.048 (0.000)
Change in type of income	-0.279 (0.000)	-0.291 (0.000)	-0.061 (0.000)	-0.063 (0.000)
Older than 64	-0.072 (0.000)	-0.101 (0.000)	-0.065 (0.000)	-0.077 (0.000)
Intercept	0.018 (0.110)	1.372 (0.000)	0.123 (0.000)	1.102 (0.000)
Observations	28177	28177	28177	28177

gression. Although the impact is less dramatic in the case of the median regression (0.246 to 0.379). The iv-estimate of  $\epsilon^c$  is insignificant without controlling for mean reversion effects.

Income elasticity estimates range from  $-0.65$  to  $0.032$ . Both iv-estimates of  $\epsilon^y$  are comparably small and insignificant. Similar results lead Gruber/Saez (2002) to the conclusion that income effects do not matter. The median regression estimates, however, do not support this conclusion. Although adding the control for reversion-to-the mean reduces the estimate of  $\epsilon^y$  in absolute terms it is still highly significant and of considerable size ( $-0.264$ ). The negative sign of the coefficient supports the traditional view of the consumption-leisure-choice model that an (exogenous) increase in income leads to a reduction of taxable income<sup>10</sup>. The total reaction of the household on the tax reform thus depends on the relative magnitude of the income and price change by which the household is affected.

Table 2 also shows the estimation results for the set of additional explanatory variables – mainly dummy variables – we used for all estimations. Although we do not list them explicitly in subsequent tables. Based on the idea that wealthier households save more and consequently receive more income in later years we included a dummy for households with a taxable income of above 70 000 DM in the base year. As, for example, column IV indicates, the growth rate of taxable income of this group is indeed higher than for other households. However, if one takes the mechanism of the control for reversion-to-the-mean into account and looks at the estimates without the control included, the difference seems to be neglectable.

We also included a dummy variable for joint filing since the tax treatment of joint filers differs from that of individuals. At comparable levels of taxable income joint filers generally face a lower tax liability and also a lower marginal tax rate than individuals. Among other things this preferential tax treatment itself is a motive to opt for joint filing if income increases considerably and the estimated coefficient supports this view mildly. As the coefficient of the dummy for non dependent income shows there is no evidence that the taxable income of households who declare other types of income than regular employment income grows faster. In most cases the estimated coefficient is insignificant.

Perhaps more surprising is the estimation result for the impact of children. Due to the additional time constraint which parents face, one would expect the coefficient to have a negative sign. The parents' opportunities to improve on their working skills or even their effort at work might be reduced. However, this is only the case for single parents. Presumably, the time management within the household (or external resources) seems to prevent negative effects. The slightly positive estimations might be a mere statistical effect.

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<sup>10</sup>Although theoretically this must not necessarily be the case.

Since having children entails considerable allowances identical increases of income in absolute terms are related to a smaller base resulting in larger growth rates if the number of children is larger.

The coefficients of the other dummies show the expected sign. A change in the type of income occurs, for example, if the respective individual starts to operate a business or switches from regular employment to self-employment during the period under observation. Very likely, such changes come along with reduced income for a certain (start-up) period, in particular taxable income, if one takes tax breaks or the accumulation of reserves into account.

Both, handicapped individuals as well as individuals over 64 years of age are restricted in their job opportunities – although in quite different ways – which explains the negative coefficients. Note however, that the growth rate of taxable income of the latter group is probably influenced by the growth rate of statutory pension payments and by life-cycle effects. This may also affect the estimated tax responsiveness<sup>11</sup>. An additional regression performed solely on elderly individuals yields a tax-price elasticity of 0.394. If, on the other hand, one excludes this group from the observation set the estimated coefficients do not change considerably. The elasticities listed in table 2 fall from 0.379 to 0.361 ( $\epsilon^e$ ) and from  $-0.099$  to  $-0.113$  ( $\epsilon^y$ ).

## 6.2 Households Grouped by the Level of Income

The next table reports the estimation results for particular subgroups of households. In table 3 households are grouped by taxable income in the base year. In addition to the responsiveness of taxable income we also used broader income definitions for the dependent variable to gain some insights in the type of responsiveness.

The broadest income definition used is raw income. This term is equal to the income declared by the taxfilers before any deductions are made and is thus closest to gross income in an economical sense. Note, however, that in the case of non dependent income the determination of raw income is preceded by a profit and loss statement which gives the respective taxfilers more control over the size of raw income as well as over the timing of income. The second definition, let us call it total income, equals raw income net of deductible professional expenses and/or net of some basic variable and nonvariable allowances related to particular income types<sup>12</sup>. All other deductions are captured by taxable income.

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<sup>11</sup>Although the vast majority of individuals in the dataset who are above 64 obtain additional income from other sources than merely pension payments.

<sup>12</sup>According to 1988 tax rules 5 % of professional earnings are deductible from the tax base unless deductions do not exceed 1200 DM, regular employed non itemizers receive a fixed allowance of 564 DM for professional expenses.

Table 3: Elasticity estimates for specific ranges of taxable income and for specific definitions of income (Error probabilities are given in brackets).

Income range	Taxable income		Total income		Raw income		No. Obs.
	$\epsilon^c$	$\epsilon^y$	$\epsilon^c$	$\epsilon^y$	$\epsilon^c$	$\epsilon^y$	
<i>Iv estimates:</i>							
ı 35000	1.480 (0.008)	-1.770 (0.067)	0.519 (0.029)	-0.433 (0.044)	0.342 (0.128)	-0.003 (0.329)	9488
35000 - 70000	0.282 (0.045)	-0.367 (0.000)	0.639 (0.588)	-0.028 (0.833)	0.217 (0.844)	0.075 (0.494)	12122
ı 70000	1.042 (0.029)	0.008 (0.569)	0.882 (0.039)	-0.001 (0.892)	0.845 (0.026)	-0.001 (0.759)	6541
<i>Median regression estimates:</i>							
ı 35000	0.456 (0.000)	-0.859 (0.000)	0.134 (0.004)	-0.003 (0.947)	0.065 (0.088)	-0.237 (0.000)	9503
35000 - 70000	0.327 (0.000)	-0.445 (0.000)	0.278 (0.286)	0.077 (0.045)	0.207 (0.397)	0.020 (0.266)	12227
ı 70000	0.364 (0.000)	-0.226 (0.000)	0.208 (0.000)	-0.061 (0.000)	0.255 (0.001)	-0.192 (0.000)	6539

Note that although only the estimated elasticity values are listed in the table, the estimations were carried out with the full set of regression variables. Looking at table 3 the following tendencies can be observed. As before, iv-regressions produce considerably higher estimates for the substitution elasticities and (in absolute terms) lower income elasticity estimates, which are frequently insignificant. Second, the broader income is defined the smaller are the estimated substitution elasticities. This may in part be contributed to a statistical effect since the income variations are related to a larger base. And third, estimates of  $\epsilon^c$  are higher in the low and in the high income segment than for mid range income. It should be mentioned that despite the fact that we controll for reversion to the mean and life cycle effects, especially the estimates for the low income range may still be biased upwards due to a very pronounced impact of these effects within this group. However, if raw income is used as dependent variable the respective elasticity estimate is rather low. It amounts to 0.065 in the median regression case. Taking furthermore into account that within this group raw income is - in average - 1.6 times larger than taxable income, then the estimate would translate into an elasticity of taxable income of around 0.1 if variation of raw income were the only household reaction to the change of tax rates. Since we actually found an estimate of 0.456 for taxable income, there is again some evidence that households within this group are quite tax sensitive and that variation of raw income

seems not to be the dominant element of the household's responsiveness.

Only for households of the high income range the reform-induced increase of net-of-tax rates has a considerable and highly significant impact on raw income. The other groups seem to react mainly by adjusting tax privileged activities/consumption.

### 6.3 Grouping by types of income

There are basically two ways to investigate whether the tax responsiveness also depends on the type of income. The first alternative is to look exclusively at the variations of the type of income in question. This means that a broader income definition must be used since the majority of deductions or allowances are not directly contributable to a particular income source. Hence only a part of an individual's means to reduce the tax burden enter the investigation. Furthermore, an individual's total income is often comprised of various different income types and the responsiveness of the type of income in question may well be influenced by the total income situation and by the particular composition of total income<sup>13</sup>.

The second alternative leaves the focus on the taxable income of the individual or household. Here, households are grouped according to whether they receive a particular type of income or not. In contrast to the first alternative the grouping is exclusive, i. e. if a household is allocated to the business income group it will not occur in any other group even though most households of that group also earn income from regular employment<sup>14</sup>. This approach captures all legal means to reduce the tax burden. However, the observed reaction of taxable income may be partly stemming from other sources of income than the one in question. Since rental income is in very few cases the major source of income no separate group has been considered for this income type.

Both alternatives have their drawbacks but also allow for insights from different perspectives. The estimation results are given in tables 5 and 4. As before, only elasticity estimates are listed in the tables.

The upper half of Table 4 refers to estimates over the whole range of income ( $TI > 10000$ ). Not surprisingly, the income types allowing for a more 'creative' declaration of income also yield higher estimates for the compensated price elasticity  $\epsilon^c$  whereas the elasticity of the least flexible type of income within this respect – namely income from regular employment – is much lower (0.139). The estimate for rental income, however, should be treated with caution. As already mentioned, real property is a tax preferred asset

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<sup>13</sup>Think, for example, of the decision whether to invest in real property or hold purely financial assets, especially in the light of the different tax treatment of both types.

<sup>14</sup>Which in most cases means employment at their own firm.

Table 4: Elasticities for different types of raw income  $\tilde{Y}_i$  ( $\tilde{Y}_i > 0$ , median regression estimates)

	business	self-employed	rental	regular employed
<i>TI &gt; 10000</i>				
$\epsilon^c$	0.296 (0.059)	0.319 (0.275)	0.295 (0.007)	0.139 (0.000)
$\epsilon^y$	0.437 (0.000)	0.018 (0.010)	0.016 (0.478)	0.319 (0.000)
No. Obs.	4036	1619	3621	26083
<i>TI &gt; 100000</i>				
$\epsilon^c$	1.005 (0.043)	0.947 (0.018)	0.693 (0.523)	0.171 (0.085)
$\epsilon^y$	-0.002 (0.000)	0.019 (0.000)	-0.010 (0.801)	-0.084 (0.008)
No. Obs.	758	554	377	2062

and rental income is in 5137 out of 8758 relevant cases negative. Since, for obvious reasons, negative values are excluded from the regression, the estimate is based on only 40% of all taxfilers who declared to receive rental income. Furthermore, the observation period we chose for our investigation might be considered as too short to capture the full effect of the reform on this income type.

The lower half of Table 4 lists the estimation results for high income earners. More precisely, the regressions are restricted to households with at least 100000 DM of taxable income. With the exception of income from regular employment, the estimates of the compensated price elasticities are considerably higher for this group of households and income elasticities seem to be, in tendency, less important. The results suggest that high income earners tend to respond more pronounced with the adjustment of raw income to a change of the marginal tax rate than the average household. In the case of rental income, however, the variance of the error term rises sharply leading to a very poor level of significance (0.523). Since high tax rates provide a strong incentive to avoid taxes the high variance might again indicate that rental income adapts more slowly to a new situation while some households exploited their means to shift income in time. As far as income from regular employment is concerned only a slight increase of the estimated price elasticity can be observed. The rather low estimates seem to be in line with a

Table 5: Elasticities for households grouped by income type (median regression estimates)

	business	self-employed	regular employed
<i>TI &gt; 10000</i>			
$\epsilon^c$	0.595 (0.000)	-0.187 (0.177)	0.363 (0.000)
$\epsilon^y$	0.655 (0.000)	-0.306 (0.015)	-0.529 (0.000)
No. Obs.	5240	1917	16706
<i>TI &gt; 100000</i>			
$\epsilon^c$	0.999 (0.002)	0.647 (0.005)	0.615 (0.035)
$\epsilon^y$	0.145 (0.000)	0.041 (0.000)	-0.694 (0.000)
No. Obs.	908	517	1117

number of labor supply estimations<sup>15</sup>.

The results shown in Table 5 are based on the responsiveness of taxable income rather than raw income. In contrast to the results listed in Table 4 all means of a taxfiler to influence the tax base now leave their mark, except for pure substitution effects between different types of income. Consequently, this approach stresses the reaction of the individual (respectively the household) as deciding unit rather than the reaction of a particular income type. Note that the grouping of households is now exclusive although somewhat arbitrary<sup>16</sup>.

In general, the picture that can be drawn from Table 5 resembles that of Table 4. Again, the price elasticity estimates for high income households are distinctly higher than the average estimates obtained over the whole income range. The price elasticity estimate for regular employed - high income households (0.615) is now almost twice as high than the respective average estimate (0.363). Apparently, households earning mainly income from regular employment exploit predominantly other means to respond to tax rate changes than with the adjustment of their main source of income. In this context it should be noted that even in the case of regular employment the taxable income of a household typically comprises other types of income too.

<sup>15</sup>See, for example, Killingsworth (1983)

<sup>16</sup>All households declaring business income make up the first group, households who declare self-employed income and who are not already in the first group make up the second, etc.

For example, 33% of all households of this group also declare rental income and 39% declare capital income. For the high income group these figures rise to about 51% and 49%, respectively (in both cases the declared amount of rental income is, in aggregate, negative).

For similar reasons the average estimates listed in the upper half of Table 5 are in tendency higher than in the previous approach. Concerning the income elasticity estimates no obvious pattern can be found.

## 7 Summary and conclusions

We estimated the response of taxable income to changes in the marginal net-of-tax rate, where the German tax reform of 1990 served as a natural experiment. Since the reform combined a change of the income tax schedule with a number of modifications of specific deductions and allowances we followed the approach of Gruber/Saez (2002) to separate price-effects from income-effects. We found average elasticity estimates, based on all households, ranging from 0.38, in the case of a median regression approach, to 0.58, in the case of an IV-regression approach, most commonly used in this area. The significant discrepancy in the estimates of the two approaches is due to stronger responses in the low as well as in the high income section. Both have a stronger impact on the result of the iv-regression.

If we restrict the regression to specific ranges of income, we found higher estimates for the low as well as for the high income range. A greater sensitivity of high income households is not too surprising. Since the marginal tax rates are considerably higher for this group, they are very likely more tax-aware than other households. The high estimates for the low income range, on the other hand, could be due to life-cycle effects which cause an upward bias. However, if we use a broader income definition and compare the estimation results with the respective estimate for taxable income, life cycle effects do not seem to be the cause for this outcome. A second reason for these somewhat peculiar results could be the particular structure of the German tax schedule. At both edges of the schedule the marginal tax rates are constant over a certain range, whereas in between the tax rates are linearly increasing in income. Hence, an increase in taxable income leads inevitably to an increasing marginal tax rate for households with mid range income. As pointed out by Sillamaa (1999), household reactions might be dampened by this effect.

Concerning the responsiveness of different types of income we obtained estimates of around 0.3 for business, self-employed, and rental income and a value of 0.139 for labour income. The latter is surprisingly in line with respective estimates of labour-supply elasticities and does not change significantly if we restrict the regression to high income households only. The estimates



for other income types, however raise considerably to values of up to 1.005. On the one hand, these results confirm the intuitive notion that the extent to which the realization of income can be influenced by the taxpayer, e.g. via timing of income, plays a crucial role. On the other hand, the opportunities provided by the tax code are exploited more intensely by richer households. The estimated elasticities reflect both, behavioral patterns as well as institutional ones. Since the latter are usually modified by the investigated tax reform itself (in addition to a mere change of the tax schedule), one should be cautious with comparisons of elasticity estimates obtained from different studies as well as with straightforward applications of the results, e.g. when predicting the effects of planned tax reforms<sup>17</sup>. To take the narrowing or widening of the influence capabilities provided by the tax code more appropriately into account seems to be an interesting field for future research.

Nevertheless, the results we found suggest a considerable tax price response – especially, as far as income not stemming from regular employment and/or high income households are concerned – which should not be neglected in discussions of future income tax modifications.

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