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Abstract

This paper provides new empirical insights on the elasticity of taxable income for Germany. Using a rich panel of German income tax return data, the tax reforms of 2004 and 2005 are exploited implementing a new dynamic income model. Showing and discussing potential estimation problems of the most prominent model in the literature by Gruber and Saez (2002), this dynamic model delivers significant smaller estimates of the elasticity of taxable income. The overall estimate is 0.36 and robust against a number of sensitivity checks including non linear income controls. Elasticities differ between married and single assessed taxpayers with an elasticity of 0.17 for single and 0.44 for married taxpayers. These elasticities are similar to recent German results and considerablly smaller than recent results for the US from Weber(2014).

Keywords: Taxable income elasticity, dynamic panel data estimation, income tax return data, administrative data

JEL-Classification: C26, H21, H61

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1 Introduction

A series of major reforms, the so called *Agenda 2010*, introduced fundamental reforms on both the German labor market and to the German personal income taxation in the early 2000s. The reforms aimed to foster economic growth, reduce unemployment rates and lower the increasing federal debt. Former Chancellor Schröder recently called the reforms a cure for Germany formerly known as the "sick man Europe's" to become the "healthy woman" (see Hengst 2012). One of the reform's cornerstones were the *Hartz Reforms* which changed active labor market policy fundamentally.[1] Another key element were tax reforms which lowered marginal tax rates in several steps for the whole income distribution to increase work incentives and discourage tax evasion.

This reflects an international trend which saw tax rate reductions in a number of developed economies in the recent decades.[2] Moreover, results for the USA by Feldstein (1995) or Auten and Carroll (1998) suggested very elastic income responses to tax rate reductions, making tax reductions an attractive economic tool. Chancellor Schröder's federal government promised a boost in economic growth, employment and justice from the tax reductions. Moreover, the bulk of the reforms' revenue losses were expected to be self-financing.[3] However, a large body of subsequent literature suggests that income is not as elastic to tax rate changes as assumed (see Saez et al. 2012).

The elasticity of taxable income (ETI) has been established to measure income growth in response to changes of the net-of-tax rate, one minus the marginal tax rate. The ETI captures more dimensions of behavioral responses than labor supply elasticities.[4] It is the central fiscal policy parameter and of particular importance for predicting revenue changes from tax reforms (see Feldstein 1995, 1999). Moreover, the elasticity of taxable income allows to calculate deadweight losses of income taxation, if marginal costs of tax evasion and tax

[1] See for instance Caliendo & Steiner (2006) or Eichhorst & Zimmermann (2007) for an evaluation of the active employment policy implemented by the *Hartz Reforms*.

[2] For the period 2000-2010, see for instance Table II.1b, II. 2b and II.3b. of OECD (2010). The Table shows a reduction in average tax rates in a lot of OECD countries for selected positions in the income distribution between 2000 and 2010. See also Salanie (2003) page 5 and 6.

[3] See the coalitions agreement between the social party SPD and the green party Die Grünen in section III.

[4] However, note that the ETI is a local elasticity that measures income changes in response to the actual tax rate change. In contrast to the labor supply elasticity, the ETI does not include tax rate changes at other positions of the income distribution which might have an effect on the individual budget restriction. Unfortunately, German tax data do not comprise information about working hours and allows not to compute labor supply elasticities.

avoidance equal the marginal tax rate (see Feldstein 1999).[5] Feldstein's (1995) seminal paper was first to find taxable income elasticity exceeding 1, triggering a large body of literature estimating the size of the elasticity.[6] A very comprehensive overview of empirical results and econometric methodology is provided in Saez et al. (2012). The authors survey the most common estimation strategies, discuss possible drawbacks and identification issues. The majority of previous empirical results have focused on US tax reforms and the estimation of elasticity for the USA, with growing literature in Europe.[7] US results are within a wide range of values between 0.12 and 1 (see Saez et al. 2012), with recent results by Weber (2014) of an ETI of 0.86 for the US.

German findings tend towards a more moderate size: Gottfried and Witczak (2009) were first to adopt the most prominent model by Gruber and Saez (2002) using individual German income tax return data. Their preferred specification estimated an elasticity of taxable income for Germany of 0.6. Müller and Schmidt (2012) adopted the approach of Kopczuk (2005), an extension of Gruber and Saez (2002), and estimated an elasticity with similar results to Gottfried and Witczak (2009) and elasticities between 0.32 and 0.47.[8]

Estimating the elasticity of taxable income is challenging due to two reasons: applying valid instrumentation for the endogenous net-of-tax rate and using appropriate income controls accounting for income trends such as mean reversion.[9]

This paper contributes to the literature in two ways. First, it discusses Gruber and Saez's (2002) model which uses a flexible income control and base year income as source for the instrumentation of the net-of-tax rate. This model delivers consistent results if residuals do not show significant serial correlation. However, in the case of residuals in first differences or a misspecified model, this requirement could be violated and estimation results would be biased.[10]

Second, I propose an alternative model for the case that residuals show significant serial

[5]Chetty (2009) shows that in case that income sheltering has transfer and/or resource costs, the taxable income elasticity is not a sufficient statistic to calculate deadweight losses from income taxation.

[6]ETI above 1 is a necessary condition for self-financing tax reductions. See Creedy and Gemmell (2014) for thorough discussion and connection of the Laffer curve with values of the ETI.

[7]Saez et al. (2009) also discuss results for various European countries.

[8]One other study for Germany exists: Gottfried and Schellhorn (2004) analyzed the 1990 change in personal income tax schedule for taxpayers in Baden-Wuertemberg. They estimated an elasticity of taxable income of 0.4, but find also high values up to 1.0 when controlling for business income and high-income taxpayers.

[9]The net-of-tax rate is endogenous for a progressive income tax code and correlates negatively with taxable income.

[10]For instance, Gruber and Saez's (2002) model would be misspecified in case of an income process including an individual fixed effect.

correlation. That model is a special case of the dynamic model proposed by Holmlund and Söderström (2011) and uses higher lags of base year income as source for the instrumentation and lagged income growth as income control. Employing a recent and very rich German income tax panel data spanning the years 2001 to 2006, the German tax reforms of 2004 and 2005 are used to estimate the elasticity of taxable income. Tax cuts were implemented for the whole distribution of taxable income, with the highest cuts for the lowest tax rates and the top tax bracket. Applying Gruber and Saez's (2002) model suggests an elasticity of taxable income for Germany of 0.46, including non-linear income controls. Tests of serial residual correlation, however, raise doubt about the exogeneity of the instrumented net-of-tax rate and the income control.[11]

Results from the here proposed model suggest a rather modest size of the German elasticity of taxable income of 0.36 in the preferred specification. Results are robust against the exclusion of top incomes (0.36 vs. 0.36), the set of control variables (0.36 vs. 0.31) and the inclusion of non-linear income controls such as splines (0.36 vs 0.44).

Surprisingly, results from the preferred specification are remarkably similar to other recent estimates from Müller and Schmidt (2012). Müller and Schmidt's (2012) approach, however, differs from my empirical strategy, apart from the estimation model, in two other crucial aspects: (1) the authors employ weighted IV regressions and (2) use very strong selection criteria excluding lower incomes from the sample.[12] Replicating Müller and Schmidt's (2012) selection criteria significantly increases results for the elasticity to 0.56 and suggests that results might underlie a selection bias.

Elasticities are also estimated separately for married and single taxpayers, taking into account the heavy tax favoring of married taxpayers compared to single taxpayers by the German tax system. Married taxpayers can benefit from filing taxes together, which reduces average and marginal tax rates of the primary earner.[13] Moreover, married taxpayers might differ in other unobserved aspects from single taxpayers. Results promote the separate estimation with the elasticity of taxable income for married taxpayers of 0.44 and a significantly lower elasticity for single taxpayers with 0.17.

The remainder of this chapter is organized as follows: Section 2.2 briefly discusses the data and the data processing. Section 2.3 describes the German tax law and important recent

[11] A new specification of Gruber and Saez's (2002) model by Weber (2014), increases the elasticity to 0.70. However, tests also indicate systematic serial correlation.

[12] Taxpayers with base year income below 10,000 Euro are eliminated from their sample.

[13] Joint tax filing reduces the marginal tax rate of the primary earner if the average income of the married falls below the top tax bracket and the spouses have uneven high incomes.

reforms and section 2.4 sheds light on rational loss behavior as well as presents first results. The concluding section 2.5 reviews and interprets the major findings.

2 The German Income Tax System and Recent Reforms[14]

The German income tax schedule is directly progressive, i.e. marginal tax liability increases with taxable income. Income exceeding the basic tax allowance is divided into several brackets. Contrary to most other progressive tax systems, the German tax schedule increases quadratically with income and is not a step system. The German tax schedule substantially discriminates between single and married taxpayers.[15] Married taxpayers can opt for the splitting tax schedule to decrease their joint taxation and marginal tax rates.[16] The change of government in Germany in 1998 was associated with intensive discussions about tax and labor market reforms. The new red-green government agreed upon several reforms of income and corporate taxation starting in 1999. It was the biggest bundle of income tax reforms in Germany's history since World War II. Prior to the observation period, two major parts of that reform bundle were implemented. One was a reform affecting personal income taxation indirectly.[17] The other part of the reform was directly related to personal income taxation and reduced all marginal tax rates of the German tax schedule. Between 1999 and 2001 the bottom marginal tax rate was cut from 25.9% to 19.9%, whereas the top marginal tax rate was reduced by 4.5 percentage points from 53% to 48.5%. Marginal tax rates in between were reduced accordingly. The most prominent tax reform was announced and passed in 2000 and consisted of a further gradual reduction of personal income tax schedule, accompanied by a modest tax base broadening. Parallel to the income tax reform, the German government implemented the so called *Hartz Reforms* between 2003 and 2005. These reforms fundamen-

[14] The first half of this section is taken from an earlier joint work with Nima Massarrat-Mashhadi (2012) (see Massarrat-Mashhadi and Werdt (2012)).

[15] Steiner and Wrohlich (2008) provide evidence that joint taxation in Germany affects economic dimension such as work incentives and household welfare.

[16] Marginal tax rates for married taxpayers are determined as if one single taxpayer would earn the average taxpayers income. Accordingly, the tax burden is calculated as twice as much the single taxpayer with the average income would have to pay. Given the progressive schedule, married taxpayers with uneven distributed incomes can reduce their overall tax burden. Marginal tax rates for married taxpayers decrease until the average income is in the top bracket. O´Donoghue and Sutherland (1999) discuss how joint taxation affects work incentives of the secondary earner.

[17] It was a significant paradigmatic change in corporate taxation, taking place between 2000 and 2001. Its main attribute was the reduction of the corporate tax rate from 45% to 25% combined with simultaneous corporate tax base broadening. The reform of corporate taxation also included several adjustments regarding the income taxation.

tally changed institutional and legal framework of the labor market and the benefit system that might affect low wage earners.[18]

The tax reform combines several steps which lowered the income tax schedule in 2001, 2004 and 2005. Besides the reduction of all marginal tax rates, the basic tax allowance was slightly increased from 7,206 Euro in 2001 up to 7,664 Euro in 2005.

Figure 1 shows the linear increasing marginal tax rates with different slopes in the different brackets. The top marginal tax rate of 48.5% in 2001 (45% in 2004; 42% in 2005) begins at a taxable income of approximately 52000 Euro.

Figure 1: Marginal tax rates for an individually taxed taxpayer

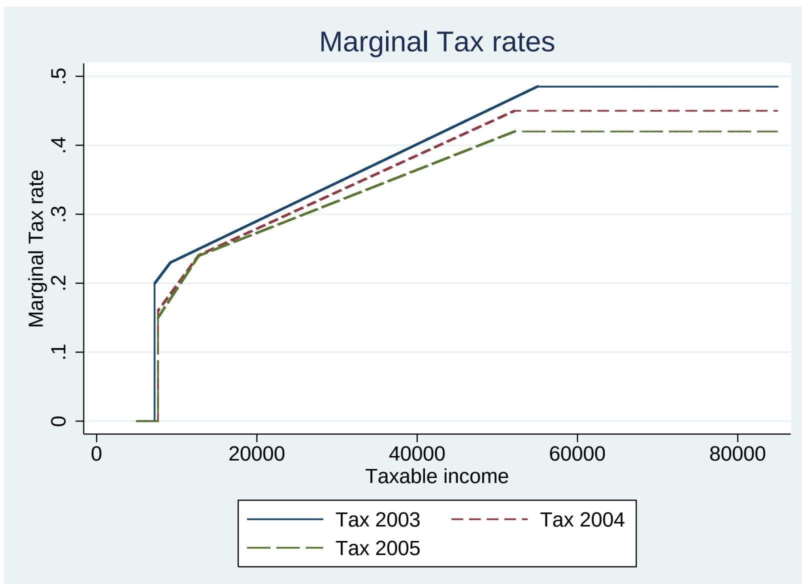
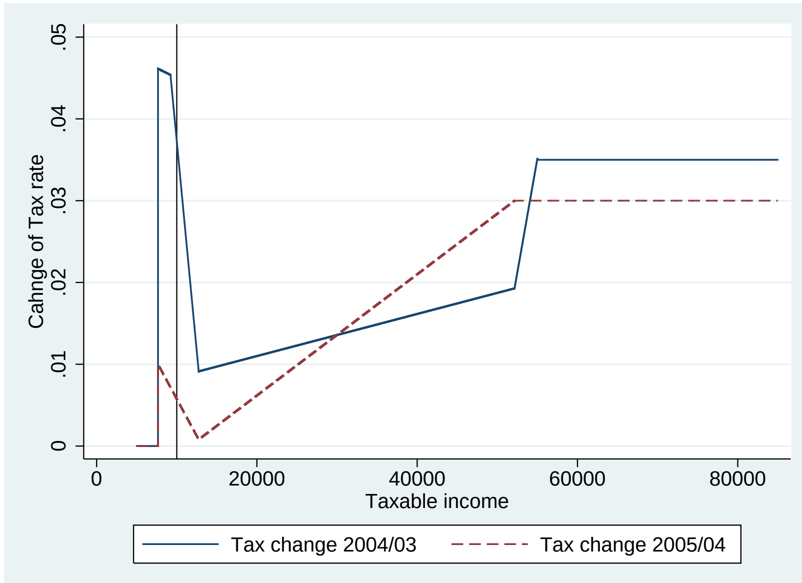


Figure 2 shows the tax rate changes in absolute values along the distribution of taxable income for taxable income exceeding the basic allowance in 2004. A small range of income just above the basic allowance experienced the biggest tax cuts up to 4.6 percentage points.[19] The second biggest tax cuts were conducted on the top tax bracket. The brackets in between experienced a lower, but increasing tax cut inducing substantial exogenous tax rate variation.

[18] Unfortunately, tax data do not allow to control for these changes.

[19] Results for the elasticity of taxable income are sensitive to the exclusion of taxpayers with less than 10,000 Euro taxable income. Estimates without those taxpayers increase the elasticities significantly.

Figure 2: Change of marginal tax rates for an individually taxed taxpayer



3 Data and Data Processing[20]

Relevant information generated in the process of taxation is documented in the income tax return: information on the household composition, declaration of income from different sources, granted deductions and exemptions, calculation of taxable income and personal income tax payment.[21] The German Federal Statistical Office collects the official income tax returns electronically as Income Tax Statistics, providing the basis for the German Taxpayer Panel. Individual taxpayers IDs are used to link annual cross section income tax returns over time to create the panel. It contains income tax returns of approximately 19 million observations in a balanced panel.[22] The panel is very representative for top and medium incomes and includes a high share of low incomes who are likely not to file a tax return in all six years of the data.[23] Unfortunately, German wage earners might be underrepresented, since they

[20]The first half of this section is taken from an earlier joint work with Nima Massarrat-Mashhadi (see Massarrat-Mashhadi and Werdt (2012)).

[21]German tax data only includes tax relevant information. Further demographic information like education, profession, parents income or wealth are not available.

[22]The German Taxpayer Panel does not include tax returns which are only available for a subset of years and are not consistently linkable. I assume that the probability of being included in the sample is random and uncorrelated with income and especially with income growth. This might be a strong assumption, however, confidential restrictions do not allow to match the data with other data to test this assumption.

[23]Jenderny (2014) compares the panel data with the cross sectional basis and shows that only incomes close to zero are low represented in the data.

were not forced to file tax return unless they have other additional incomes.[24] Taxpayers with demographic changes such as marriage or divorce are also only partially included.[25] In some cases, taxpayers that move from one state to another might also change their taxpayers ID and are not consistent linkable. Several socio-demographic characteristics of taxpayers, such as age, number of children, church membership and marital status are observable. A sample of 5% is drawn and made available for scientific purposes, based on four stratification criteria, i.e. federal state, assessment type, main type of income and total income. High incomes above 150,000 mean income are highly over-sampled and 85% of those are included in the 5% sample. The stratification procedure aims to optimize the sample with regard to standard errors of total income over time. Observation weights are generated accordingly.[26] The sample for the analysis consists of three one-year-pairs, pooling the years with the income growth from 2003 to 2004, 2004 to 2005 and 2005 to 2006.[27] Each pair consists of 928,993 taxpayers resulting in a balanced panel of 2,786,979 observations. Results are dawn from a sub-sample which excludes observations according to three categories: (1) observations which do not satisfy technical model requirements: models in the literature of taxable income elasticity are based on log-log specifications, accordingly negative incomes are not defined, which deletes 455,193 observations.[28] (2) Taxpayers that do not pay taxes in the base year $t-1$ and in year t, thus have marginal tax rates of zero, are excluded. That reduces the sample by 383,015 observations.[29] (3) Taxpayers with severe demographic changes such as marriage, divorce or one-time exceptional profits are also excluded, deleting 260,786 observations and leaving a sample of 1,690,685.[30] This exclusion is innocuous and results including these observations are virtually unchanged and not different from results without these observations.

[24]Cross sectional tax data from 2004 already includes all wage earners even when they did not file a tax report. Now, employers have to report wage income of their employees electronically to the tax authorities, but were not forced to in earlier years.

[25]This has two reasons: (1) only one person of the married couple keeps the individual taxpayer ID after marriage or divorce and is consistent linkable. In most cases, this is the primary earner. (2) sometimes the individual taxpayers IDs are newly created or changed and not consistently linkable.

[26]These weights allow to infer properties of the full balanced panel with the 19 million observations but are not designed to make projection for the whole German population.

[27]The data starts in 2001, the regression model in section 4.2 does not permit earlier year pairs.

[28]One way to avoid that selection mechanism would be the calculation of arc-elasticities instead. This, however, is not standard in the literature and I refrain from doing that.

[29]This is standard in the literature of taxable income and I assume that this exclusion is random and does not correlate with income growth. Moreover, results confirm that this selection is not crucial.

[30]Furthermore, a small group of taxpayers that are not fully taxable, because they do not live in Germany for instance are excluded.

4 Econometric Specification

This section discusses the model by Gruber and Saez (2002) and compares it to an alternative model introduced in this section.

4.1 Gruber and Saez

Gruber and Saez's (2002) model is a generalization of Auten and Carroll (1998). In this model the individual taxpayer's income growth rate $ln\left(\frac{y_{it}}{y_{it-1}}\right)$ is estimated by the growth rate of the net-of-tax rate $ln\left(\frac{1-\tau_{it}}{1-\tau_{it-1}}\right)$ with elasticity of taxable income β, demographic characteristics from the base year W_{it-1} to control for heterogeneity of taxpayers with coefficient vector γ,[31] base year income $ln(y_{it-1})$ with elasticity ρ_1 controlling for heterogeneous income trends and constant c.[32]

$$ln\left(\frac{y_{it}}{y_{it-1}}\right) = \beta ln\left(\frac{1-\tau_{it}}{1-\tau_{it-1}}\right) + \rho_1 ln(y_{it-1}) + \gamma W_{it-1} + c + \epsilon_{it} \tag{1}$$

ϵ_{it} is the individual residual in period t and assumed to be independent of the control variables W_{it-1} and $ln(y_{it-1})$ and uncorrelated over time. The literature widely recognizes that the net-of-tax rate is endogenous for a progressive tax schedule and 2SLS regressions are applied.[33] Gruber and Saez (2002) simulate an instrument based on the counterfactual growth rate of the net-of-tax rate which is strongly correlated with the endogenous variable.[34]
Note that Gruber and Saez's (2002) assumption of uncorrelated residual over time in equation (1) allows them to treat base year income y_{it-1} as exogenous and as source for the simulation of the counterfactual net-of-tax rate.[35] Appendix (7.1) presents a possible level equation of Gruber and Saez's (2002) model that satisfies that assumption. However, the assumption

[31] See Table A.1 for a depiction of the control variables.

[32] Gruber and Saez (2002) modify this model by using 10 piece-wise linear splines of base year income instead base year income.

[33] See Saez et al. (2012) for an interpretation of the endogeneity problem and different potential solutions.

[34] This is done by deriving a counterfactual income for year t by inflating the individual base year income y_{it-1} and computing tax rates using the tax schedule of year t. To avoid that taxpayers with the same taxable income in the base year have the same counterfactual growth rate, incomes and taxable deductions are inflated by different growth rates. Income is inflated by using the GDP growth rate and individual deductions are inflated by using the consumer price index.

[35] See Gruber and Saez (2002), page 10 ff. with a detailed discussion of the potential endogeneity of base year income. Gruber and Saez argue that using an appropriate functional form of base year income solves all endogeneity problems and also controls for mean reversion. Growth rates of the inflation rate and the GDP are obtained from the German federal statistical office and can be downloaded at `https://www.destatis.de/DE/ZahlenFakten/GesamtwirtschaftUmwelt/VGR/Inlandsprodukt/Inlandsprodukt.html`.

of uncorrelated residuals over time is potentially violated in two cases: (1) if equation (1) is nevertheless in first differences and so are residuals which then follow a moving average process of at least order one. Moreover, this also implies that base year income systematically correlates with the residuals and would be endogenous. Weber (2014) shows in great detail that the endogeneity of base year in equation (1) is inevitable if it follows from first differences and cannot be avoided using instruments based on the base year, regardless of additional functional forms of the base year income controls.[36] (2) if income follows an individual fixed effect but equation (1) is not in first difference, the fixed effect would be embedded in the residuals which would then have significant serial correlation and high correlation with base year income.

4.2 An alternative approach

To introduce the alternative model, equation (2) presents the level equation of individual income y_{it} for period t. Income follows an individual fixed effect i, its own lag, base year income y_{it-1} with elasticity ρ_2, the net-of-tax rate $1 - \tau_{it}$ with elasticity β, a linear time trend t with coefficient c and current demographic characters W_{it} with a vector of coefficients γ_1. To allow for a dynamic influence of demographic characteristics, income also follows W_{it} interacted with the time trend t and coefficient vector γ_2.[37]

$$ln(y_{it}) = i + \beta ln(1 - \tau_{it}) + \rho_2 ln(y_{it-1}) + \gamma_1 W_{it} + t \cdot (c + \gamma_2 W_{it}) + \epsilon_{it}{}^{38} \tag{2}$$

ϵ_{it} is the individual residual in period t and assumed to be independent of the control variables in W_{it} and $ln(y_{it-1})$ and uncorrelated over time.

Taking first differences eliminates the individual fixed effect and the estimation model becomes:

$$ln\left(\frac{y_{it}}{y_{it-1}}\right) = \beta ln\left(\frac{1-\tau_{it}}{1-\tau_{it-1}}\right) + \rho_2 ln\left(\frac{y_{it-1}}{y_{it-2}}\right) + (\gamma_1 + t\gamma_2)\Delta W_{it} + c + \gamma_2 W_{it-1} + \Delta\epsilon_{it} \tag{3}$$

[36] To overcome this, Weber (2014) proposes the usage of higher lags of base year income as source for the instruments. Weber's (2014) specification includes income controls from the first and second lag of base year income.

[37] Including a dynamic influence of demographic characteristics controls for heterogeneous income growth and increases comparability between the alternative model and the Gruber and Saez's 2002 model from equation (1).

[38] This model is a special case of the model of Holmlund and Söderström (2011) if γ_2 is zero. Their model also includes the lagged net-of-tax rate and the demographic control variables from period t and period $t-1$.

Now, the growth rate of the net-of-tax rate and the lagged income growth correlate systematically with ϵ_{it-1} and are endogenous.

Equation (3) estimates income growth in several aspects differently than Gruber and Saez's (2002) equation (1) does. First, equation (3) depends on the endogenous lagged income growth instead of the assumed exogenous base year income. Second, residuals in equation (3) follow a moving average process of order one instead of residuals assumed to be only from period t. Third, due to the endogeneity of base year income, a higher lag of base year income is used as sources for the counterfactual income and as instrument.[39]

5 Results

Note: the data I use is not a random draw, but a 5% stratified sample (see section 3 for a description). To control for the non-random properties of the data, results in this section are estimated with the stratification criteria as control variables.[40] Results are computed on a constant definition of taxable income, based on the tax law from 2001.[41] This section presents results according to the modeling section, starting with results for Gruber and Saez's (2002) model from equation (1) presented in Table 2. Subsequently follow results for the alternative model from equation (3) presented in Table 3 including an extensive sensitivity analysis of the model in Table 4.

In Table 1, some mean values and standard deviations (in brackets) of the sample are presented. The table is divided into two panels, the left panel shows average values for the sample without weighting factors, the right panel presents average values for weighted observations. Taxable income is very high in the unweighted sample with an average of 141,706 Euro and weighted clearly smaller with an average of 43,854, which reflects the strong over-sampling

[39] Instruments for the net-of-tax growth rate are computed analog to the procedure by Gruber and Saez (2002) introduced in the previous subsection. Source for the counterfactual net-of-growth rates are the lagged individual base year income y_{it-2} and the second lag of base year income y_{it-3}. The instruments for the lagged income growth is the lag of individual base year income y_{it-2} and the second lag of income growth $ln\left(\frac{y_{it-2}}{y_{it-3}}\right)$.

[40] See Solon et al. (2013) for an extensive discussion about estimating causal effects in non random sample and an evaluation of the usage of sample weights.

[41] All changes of the definition of taxable income between 2002 and 2006 are corrected as long as the data allows for a consistent correction. This includes annual child allowances which were increased from 2556 Euro per year and child to 2904 Euro per year and child, allowed expenses for non-itemizing employees which were reduced from 1044 Euro to 920 Euro, allowances for single parents which were cut from 2871 Euro to 1308 Euro and capital gain exemptions which were reduced from 1550 Euro to 1370 Euro per year. I assume that these changes only induce mechanical reactions and do not affect the measured elasticity of taxable income.

of the high taxpayers. Average values for the income growth, average tax rate the net-of-tax rates are also smaller for the weighted observations. The average age of the taxpayer is 47, 61% are married, 2.4% of taxpayers have newborn children and 0.4% change their residency from one federal state to another.

Table 1: Descriptive Statistics

	Unweighted	Weighted
	Mean (Std. Deviation) (1)	Mean (Std. Deviation) (2)
Taxable income	141706	43854
	(948274)	(204818)
Average tax rate	.365	.311
	(.088)	(.069)
Income growth	.035	.015
	(.397)	(.247)
Net-of-Tax Rate	.023	.012
	(.063)	(.049)
Counterfactual Net-of-Tax Rate Based on y_{it-1}	.022	.010
	(.029)	(.019)
Counterfactual Net-of-Tax Rate Based on y_{it-2}	.019	.010
	(.031)	(.020)
Counterfactual Net-of-Tax Rate Based on y_{it-3}	.022	.009
	(.030)	(.022)
	Demographic control variables	
Age	49.98	46.82
	(41.75)	(32.98)
Married Dummy	.67	.61
	(.473)	(.489)
New Child Dummy	.023	.024
	(.163)	(.162)
Change of State Dummy	.024	.004
	.058	(.066)
Number of observations	1,690,685	37,100,000

Source: Own computation based on German Taxpayer Panel 2001-2006.

5.1 Regression results

Results in Table 2 are from 2SLS regression and serve as comparison results based on Gruber and Saez‘s (2002) model from equation (1). All models include further control variables for the stratification criteria (strat. controls) and demographic variables (demo. controls).[42] Table 2 consists of five columns, with the first three columns reproducing Gruber and Saez's (2002) model with base year income as income control and as source for the counterfactual net-of-tax rate. As argued in the previous section, base year income is likely to be endogenous, thus column (4) and (5) use lagged base year income as source for the counterfactual net-of-tax rate and lagged base year income as control.[43] Column (1) estimates the equation with 2SLS without income control, column (2) and (4) use the log of income control and column (3) and (5) use 10 piece linear splines of the income control. Results for OLS are presented in Table A.3 of Appendix 7.4.2. The estimated ETI is very sensitive to the inclusion of the income controls. Results in column (1) are without income control and the estimated ETI is negative and large with -0.77. Including base year income as control variable increases the ETI significantly to 1.23 in column (2) and using 10 linear splines of base year income reduces the ETI to 0.46 in column (3).[44] Using lagged base year income and according instruments in column (4) results in an ETI of 0.91 and using splines also reduces the ETI significantly to 0.70 in column (5).

[42] Demographic control variables are age, age squared, young and old dummies, taxpayer moving the federal state (Bundesland), taxpayer with newborn children, two earner taxpayers, handy-capped taxpayers, single parents taxpayers, and retired taxpayers. Variables controlling for the stratification are income from the first year of the data and dummies for joint tax filing and for tax code related main income source. Additionally all regressions include time dummies. See Table A.1 for a detailed description.

[43] These specifications are also conducted in Weber (2014).

[44] This is not unusual in the literature. Gruber and Saez 2002 obtain an ETI -0.462 without income control, of 0.611 with log of base year income and an ETI 0.4 with splines. Müller (2012) and Schmidt estimate for Germany an ETI of -0.189 without income control, 0.99 with the lagged income growth rate and the log of the lag of base year, and 0.32 with splines.

Table 2: Results for estimating the ETI from equation (1)

	Instruments based on $t-1$			Instruments based on $t-2$ and $t-3$	
	(1)	(2)	(3)	(4)	(5)
$ln\left(\frac{1-\tau_{it}}{1-\tau_{it-1}}\right)$	-0.748***	1.237***	0.460***	0.909***	0.701***
	(0.01)	(0.02)	(0.02)	(0.03)	(0.03)
$ln\left(y_{it-1}\right)$		-0.145***	10 Piece		
		(0.00)	-Spline		
$ln\left(y_{it-2}\right)$				-0.041***	10 Piece
				(0.00)	-Spline
D new child	-0.002	0.002	-0.002	-0.003	-0.004
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
D change of state	0.082***	0.087***	0.083***	0.102***	0.093***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
D marriage	0.031***	0.100***	0.080***	0.057***	0.055***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Income 2001	-0.000	0.000***	0.000***	0.000***	0.000*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Strat. controls	Yes	Yes	Yes	Yes	Yes
Age controls	Yes	Yes	Yes	Yes	Yes
Demo. controls	Yes	Yes	Yes	Yes	Yes
	Tests of weak Instruments				
First stage F-Statistic	262353	43299	38988	20087	16959
Partial R^2	.134	.071	.065	.038	.032
	Test of Moving Average				
Arellano-Bond test, order 1	-265	-187	-93	-107	-105
(p value)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Arellano-Bond test, order 2	-20	31	-11	-3.07	-5.33
(p value)	(0.000)	(0.000)	(0.000)	(0.002)	(0.000)
Number of Observations	1690685	1690685	1690685	1690685	1690685

Notes: * p<0.05, ** p<0.01, *** p<0.001. All regressions include a constant and year dummies. Sample control variable are dummy variables for main income source and dummy controls for the level of income in 2001. Age control variables are the taxpayers age, age squared, a dummy for taxpayers over 55 and a dummy for taxpayers younger than 21 in 2001. Demographic control variables are dummy variables for single parents, handicapped taxpayers, two earner taxpayers, retired taxpayers and non-taxable income. Partial R^2 is the partial R-squared for the growth rate of the net-of-tax rate, see Shea (1997) and Godfrey (1999) for a description. The Arellano-Bond tests for first-order and second-order of moving average is asymptotically N(0,1) distributed.
Source:Own computation based on German Taxpayer Panel 2001-2006.

Results of the F-statistic and the partial R^2 confirm that instruments in the first stage are strong in all regressions and the weak instrument problem is not a threat. The F-statistics are very high with values above 10,000 in all specifications and the partial R^2 is high in all columns but (5).[45] However, the Arellano-Bond tests of moving average reject the null

[45]The F-statistic and the partial R^2 are the two most common used criteria for assessing the instrumental

hypothesis of no serial correlation for the first and for the second order. The Arellano-Bond test is asymptotic standard normal N(0,1) distributed, test values exceed critical values at all significance levels and p values are 0 in all specifications.[46] This confirms, for the German case, that neither base year income nor lagged base year income are exogenous and valid income controls for a model of type equation (1). Moreover, these results indicate that standard tests of instrumental validity such as the Sargan Test (1958) are potentially misleading if instruments are based on lagged dependent variables.[47]

Table 3 reports 2SLS regression results for the regression model in equation (3). Column (1) shows results for a restricted income growth model, setting the influence of lagged income to zero $\rho_2 = 0$[48], column (2) allows ρ_2 to differ from zero and is the benchmark result that follows directly from equation (3). Column (3) is a sensitivity check estimating equation (3) only with a subset of control variables, column (4) adds a selection control following Heckman (1979) using W_{it-1} and indicator variables from the first year of the panel as exclusion restrictions, columns (5) and (6) are a reproduction of the benchmark equation but without taxpayers with the highest 1% incomes in (5) and without taxpayers with base year income below 10,000 Euro in (6). The ETI in the restricted specification in column (1) is relatively small with 0.03 and insignificant but positive. First stage results suggest that the 2SLS estimation is not likely to suffer from a weak instrument problem and instruments for the net-of-tax rate are strongly correlated, confirmed by the partial R^2 of 0.065 and the F-statistic of 59,230.

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strength in single endogenous models. Critical values of the F-test statistic are around 20 depending on the size and power of the test, see Stock and Yogo (2002) for a derivation of critical test values. However, the F-statistic can be misleading in large samples. The F-statistic measures the reduction in the sum of squared residuals (RSS) when adding the instruments and increasing the number of explanatory variables. With increasing sample size, this statistic could become significantly different from zero even for weak instruments. In contrast, the partial R^2 is independent of sample size and measures the additional explained variance of the instruments on the endogenous variable, see Shea (1996) and Godfrey (1999) for an introduction to the measure.

[46] See Arellano and Bond (1991) for an introduction of the test.

[47] Weber (2014) proposes the use of the Sargan Test to test for endogeneity of the instrument based on base year. However, the Sargan Test is conditional on the validity of the other instruments, which would be problematic if the other instruments are based on higher lags of base year income and residuals have a high persistence in the residual autocorrelation structure.

[48] This specification corresponds to a level equation of income independently of lagged income and equals the benchmark model from Weber (2014).

Table 3: Results for estimating the ETI from equation (3)

	(1)	(2)	(3)	(4)	(5)	(6)
$ln\left(\frac{1-\tau_{it}}{1-\tau_{it-1}}\right)$	0.032	0.364***	0.307***	0.340***	0.362***	0.561***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
$ln\left(\frac{y_{it-1}}{y_{it-2}}\right)$		0.117***	0.116***	0.088***	0.121***	0.076***
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
D new child	0.014***	-0.003	0.016***	0.015***	-0.003	-0.002
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
D change of state	0.122***	0.091***	0.109***	0.105***	0.091***	0.060***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
D marriage	-0.001*	0.039***	0.003***	0.003***	0.040***	0.042***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Income 2001	-0.000**	-0.000	-0.000	-0.000	-0.000***	0.000
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
λ				0.026***		
				(0.00)		
Strat. controls	Yes	Yes	Yes	Yes	Yes	Yes
Age controls	Yes	Yes	Yes	Yes	Yes	Yes
Demo. controls	Yes	Yes			Yes	Yes
	Tests of weak Instruments					
First stage F-Statistic	59230	18890	19088	19700	18367	20418
Partial R_1^2	.065	.055	.056	.057	.053	.059
Partial R_2^2		.154	.147	.084	.164	.173
	Tests of Moving Average					
Arellano-Bond test, order 1	-223	-165	-159	-126	-166	-155
(p-value)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Arellano-Bond test, order 2	-15	-0.93	2.65	-0.360	-0.379	-4.67
(p-value)	(0.000)	(0.353)	(0.008)	(0.69)	(0.718)	(0.000)
Number of Observations	1690685	1690685	1690685	1690685	1668493	1616385

Notes: * p<0.05, ** p<0.01, *** p<0.001. All regressions include a constant and year dummies. Sample control variable are dummy variables for main income source and dummy variables for the level of income in 2001. Age control variables are the taxpayers age, age squared, a dummy for taxpayers over 55 and a dummy for taxpayers younger than 21 in 2001. Age control variables in 1, 2, 5 and 6 are the full set with the taxpayers age, age squared, a dummy for taxpayers over 55 and a dummy for taxpayers younger than 21 in 2001. The first difference of those control variables are included in 3 and 4. Demographic control variables are dummy variables for single parents, handicapped taxpayers, two earner taxpayers, retired taxpayers and non-taxable income. λ denotes the inverse Mills ratio from the Heckman sample selection model. The first stage F-Statistic is the Cragg-Donald Wald F statistic with critical values of 11.04 for 5% relative IV bias and 16.87 for 10% IV size, source Stock and Yogo (2005). Partial R_1^2 is the partial R-squared for the growth rate of the net-of-tax rate, Partial R_2^2 is the partial R-squared for the lagged income growth, see Shea (1997) and Godfrey (1999) for a description. The Arellano-Bond tests for first-order and second-order of moving average is asymptotically N(0,1) distributed.
Source:Own computation based on German Taxpayer Panel 2001-2006.

However estimates from this restricted model in column (1) have to be viewed with caution. The Arellano-Bond tests of moving average reveal significant negative first- and negative second-order autocorrelation in the residuals. This implies potential model misspecification which could be induced by restricting the influence of lagged income zero.

Including lagged income growth in column (2) increases the estimated ETI to 0.36, with a positive and significant coefficient of the lagged income growth with 0.12. Note that equation (3) contains more than one endogenous variable once lagged income growth is included, increasing the number of endogenous variables to two. In the case of multiple endogenous variables both Shea's partial R^2 and the standard F-statistic can be problematic when assessing the instrumental validity.[49] The Cragg-Donald F-test can be used in the case of multiple endogenous variables to test if the instruments strongly correlate with the endogenous variables.[50] Checking nevertheless first stage statistics, show high partial R^2s of 0.055 and 0.154 and a large F-statistic with 18,890. Table A.2 presents further descriptive results for the instrumented net-of-tax rate and compares them to descriptive results for the net-of-tax rate. The first order moving average test is significant and negative, but the second order with a p-value of 0.35 is insignificant at any conventional significance levels.[51]

Column (3) is a robustness check restricting lagged demographic variables of equation (3) to zero by setting $\gamma_2 = 0$. Thus, now control variables are only included in first differences.[52] Column (3) shows that demographic control variables have little influence on the measured ETI and the lagged income growth. Both are only slightly smaller with an ETI of 0.31 and lagged income elasticity of 0.12. First stage results change only little with partial R^2s of 0.056 and 0.146 and the F-statistic of 19,080.

As described in section (3), results are based on a selective sub-sample of taxpayers. Arguably the most crucial selection is that only taxpayers with taxable income exceeding the basic allowance in base year $t-1$ and year t are included. This serves two purposes: it excludes taxpayers with marginal tax rates equal zero in t or $t-1$ and it excludes taxpayers with potential high mean reversion unrelated to the tax reform. However, that non-random

[49]Valid IV estimation needs at least as many instruments as endogenous variables. However, both the F-statistic and the partial R^2 are estimated for joint validity of all instruments and will have high test values once at least one of the instruments is strong, even when the other is not.

[50]The Cragg-Donald F-test is equal to the F-test in the case of one endogenous variable. The test uses canonical correlations, testing the smallest canonical correlation between the set of instruments and the set of endogenous variables.

[51]This is consistent with residuals uncorrelated over time in the level equation (2).

[52]However, most models in the literature of the elasticity of taxable income use demographic variables to control for the heterogeneity between different types of taxpayers. Excluding the demographics reduces the comparability to Gruber and Saez's (2002) model in equation (1). See Table A.1 for a description of all control variables.

selection might bias the estimation result of the elasticity.
Column (4) demonstrates the effect of controlling for the non-random selection by including the inverse Mills ratio λ from a Heckman selection control estimation.[53] The inverse Mills ratio is small but significant with an estimate of 0.03. However, including the selection control does not have a statistically significant effect on the estimated ETI with 0.34. That estimate is not different from the estimated ETI in column (2) with 0.36 and the elasticity in column (3) with 0.31. Hence, I assume that results are not source to a selection bias and the alternative model from equation (3) in column (2) is consistently estimated for the German case.
Bach et al. (2009) document that top incomes in Germany had dramatic income increase by partially more than 50% between 2001 and 2005. Moreover, there is a large literature estimating income responses to taxation only for the top incomes (see Saez et al. 2102). This is motivated by two aspects of taxpayers with high incomes: (1) a special interest in the responses of the group of taxpayers paying the most taxes[54], (2) taxpayers at the top might substantially differ from the remaining taxpayers which might be hard to control in this type of model. To control for the influence of top incomes in an easy way, results in column (5) are estimated on a sub-sample that excludes taxpayers who belong to the top 1% of taxable income which excludes 22,192 observations. Results are not sensitive to this selection and are virtually unchanged with an ETI of 0.36 and the lagged income growth of 0.12.[55]
Most studies of the elasticity of taxable income literature exclude the lowest incomes from their sample.[56]
As a robustness check in column (6), I employ a strong selection on lower incomes and

[53]See Heckman (1978) for an introduction to the model. To compute the selection control λ, the selection equation needs so employ valid and strong exclusion restrictions. I use the demographic control variables also excluded in column (3) as exclusion restrictions in column (4). Furthermore I produce indicator variables from the first year of the panel: (1) Indicator for the number of different income sources, (2) the variance of the incomes between the income sources and (3) an indicator for negative incomes are used as exclusion restrictions.

[54]Note that the German income tax schedule arrives at the top marginal tax rate at a taxable income of approximately 52,000 Euro. The top 10% of incomes in Germany, however, have already an average annual income of 83,400 Euro between 1992 and 2001 (see Bach et al. 2009). Calculating an ETI just for top incomes in Germany with my data would suffer from very low variation and most incomes would face the same tax rate change and the ETI would simply be a constant.

[55]Excluding only taxpayers with top 0.1% of taxable income gives even more similar results.

[56]This has two reasons. One reason is that mean reversion is supposed to be strongest at the lower end of the income distribution. Another reason is that most recent tax reforms lowered the tax rate for the top incomes but kept tax rates for the lower and middle part of the distribution constant. Dropping the lowest part of the sample, serves then comparability between the treatment and the control group in the sense of a difference-in-difference estimation.

exclude taxpayers with base year income below 10,000 Euro. This reduces the number of observations by 74,300 to 1,616,385.[57] Results for the ETI and the lagged income growth change significantly: the ETI is now 0.56 and the lagged income growth decreases to 0.08. This raises some doubt about appropriateness of this strong selection and suggests that this result is driven by selection bias.

This strong selection is copied from another recent study for Germany by Müller and Schmidt (2012). Their results are remarkably similar to my benchmark results with an ETI of 0.32. However, when applying their selection criteria, my results differ severely. Müller and Schmidt (2012) differ from this study in four other aspects: (1) the authors employ the specification by Kopczuk (2005), an approach based on the Gruber and Saez (2002) model. Thus, their results might suffer from serial correlation, which the authors also acknowledge but do not provide test results to support their model. (2) The authors estimate the model on the popular three years lag basis, which however potentially induces serial correlation of a higher order. (3) Following Gruber and Saez (2002), the authors only report weighted regression results.[58]

Comparing my results for Germany with results from the US is challenging due to the wide range of results, with values between 0.12 and 1 (see Saez et al. 2012).

A recent study by Weber (2014) estimates high values of ETI for the US with an approach similar to my model.[59] Weber's baseline result for the elasticity of taxable income is 0.86, thus more than twice the size of the German ETI. This could be related to the fact that the German welfare state is generally more redistributive than the US welfare state. It would be interesting to compare US results to the German results for an income elasticity to a joint measure of taxes, transfers and social security contributions. Transfers and social securities are especially high at the lower end of the German income distribution, including transfer withdrawal rates of 80 and 90%, with implicit marginal tax rates near one. Such an income elasticity would have a pronounced relevance on the governmental budget and extents the picture from tax revenue to tax-transfer revenue.[60]

The following Table 4 presents 2SLS result for further sensitivity checks of the benchmark

[57] Despite including a potential selection bias with this exclusion of the lowest taxpayers, this also excludes the group of taxpayers with the highest tax rate changes, see Figure 2.

[58] This might produce inconsistent results when one tries to estimate causal effects, see Solon et al. (2012) for an extensive discussion about weighting factors in regressions.

[59] Section 7.2 in the Appendix presents Weber's (2014) model and results from column (1) correspond to Weber's baseline model.

[60] See a similar approach by Bartels (2013) computing long-term participation tax rates for Germany and their influence on work incentives.

result from the alternative model of equation (3) in two dimensions, one is the usage of a non-linear income control with 10 linear piece splines, the second is the separation of the elasticity of taxable income for married and for single taxpayers. Column (1) of Table 4 is a reproduction of column (2) of Table 3 and is the benchmark result with an elasticity of taxable income of 0.36. Column (2) uses a non-linear function of the lagged income growth with a 10 piecewise linear splines.[61] Gruber and Saez (2002) were the first in the literature of taxable income elasticity to use splines as non-linear income control and its usage has become popular in most papers.[62] The ETI in column (2), including the non-linear income splines, is 0.44 with high standard errors of 0.06 and is not statistically different from the benchmark elasticity with 0.36. However, using splines on lagged income growth in the alternative model of equation (3) increases the number of endogenous variables to 11.[63] First stage statistics raise concern about a weak instrument problem which questions the liability of results in column (2): the F-statistic has a value of 1 which is very low for 11 endogenous variables and 1,690,685 observations.

[61]Break points and distribution of the splines are based on the lagged income growth using the Stata command *mkspline*.

[62]See for instance Weber (2014), Heim (2009), Kopczuk (2005) and Giertz (2007) using 10 piecewise linear splines of income controls in their estimations.

[63]Instruments for the 10 splines are the 10 linear splines of the second lagged income growth.

Table 4: Sensitivity results for estimating the ETI from equation (3)

	(1)	(2)	(3)	(4)	(5)
$ln\left(\frac{1-\tau_{it}}{1-\tau_{it-1}}\right)$	0.364***	0.441***			
	(0.02)	(0.06)			
$ln\left(\frac{1-\tau_{it}}{1-\tau_{it-1}}\right)_{single}$			0.170***	0.166***	0.408***
			(0.03)	(0.03)	(0.03)
$ln\left(\frac{1-\tau_{it}}{1-\tau_{it-1}}\right)_{married}$			0.442***	0.439***	0.619***
			(0.03)	(0.02)	(0.03)
$ln\left(\frac{y_{it-1}}{y_{it-2}}\right)$	0.117***	10 Piece	0.114***	0.119***	0.074***
	(0.00)	-Spline	(0.00)	(0.00)	(0.00)
D new child	-0.003	0.009	-0.003	-0.003	-0.002
	(0.00)	(0.02)	(0.00)	(0.00)	(0.00)
D change of state	0.091***	0.157***	0.088***	0.087***	0.058***
	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)
D marriage	0.039***	0.033***	0.033***	0.034***	0.037***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Income 2001	-0.000	0.000	-0.000	-0.000***	0.000
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Strat controls	Yes	Yes	Yes	Yes	Yes
Age controls	Yes	Yes	Yes	Yes	Yes
Demo. controls	Yes	Yes	Yes	Yes	Yes
	Tests of weak Instruments				
First stage F-Statistic	18890	1.01	11960	11587	12897
Partial R_1^2	0.055				
Partial R_{11}^2			0.07	0.068	0.074
Partial R_{12}^2			0.082	0.080	0.086
Partial R_2^2	0.154		0.150	0.161	0.170
	Tests of Moving Average				
Arellano-Bond test, order 1	-165	-14	-162	-163	-153
(p-value)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Arellano-Bond test, order 2	-0.93	1.92	-1.10	-0.536	-4.82
(p-value)	(0.353)	(0.054)	(0.273)	(0.592)	(0.000)
Number of Observations	1690685	1690685	1690685	1668493	1616385

Notes: * $p<0.05$, ** $p<0.01$, *** $p<0.001$. All regressions include a constant and year dummies. Sample control variable are dummy variables for main income source and dummy variables for the level of income in 2001. Age control variables are the taxpayers age, age squared, a dummy for taxpayers over 55 and a dummy for taxpayers younger than 21 in 2001. Age control variables are the taxpayers age, age squared, a dummy for taxpayers over 55 and a dummy for taxpayers younger than 21 in 2001. Demographic control variables are dummy variables for single parents, handicapped taxpayers, two earner taxpayers, retired taxpayers and non-taxable income. The first stage F-Statistic is the Cragg-Donald Wald F statistic with critical values of see Stock and Yogo (2005). Partial R_1^2 is the partial R-squared for the growth rate of the net-of-tax rate. Partial R_{11}^2 is the partial R-squared for the growth rate of the net-of-tax rate for single taxpayers, Partial R_{11}^2 is the partial R-squared for the growth rate of married taxpayers. Partial R_2^2 is the partial R-squared for the lagged income growth, see Shea (1997) and Godfrey (1999) for a description.
For sake of brevity, no partial R-squared for specification (2) and (3) are reported as the number of endogenous variables increases to 6, respectively 11. The Arellano-Bond tests for first-order and second-order of moving average is asymptotically N(0,1) distributed.
Source:Own computation based on German Taxpayer Panel 2001-2006.

The German tax law discriminates heavily between married and single taxpayers. Married taxpayers can opt for the splitting tax schedule to decrease their joint taxation and marginal tax rates. Results in columns (3), (4) and (5) interact the marriage dummy with the growth rate of the net-of-tax rate to allow different elasticities for single and married taxpayers. Separating elasticities is common practice in micro-econometric analysis, for instance, in the labor supply elasticity literature.[64] Column (3) is the interaction for the whole sample with 1,690,685 observations and shows that the ETI for single taxpayers is 0.17 and significantly smaller than the ETI for married taxpayers with 0.44. The ETI of married taxpayers exceeds the elasticity of single taxpayers by 0.27, which supports separate estimations. This reflects the higher tax-planing potential of married taxpayers and could be related to the opportunity of inter-personal transfers and different utility functions of the married. The coefficients of the control variables and the lagged income growth are virtually unchanged. First stage statistics are high with a F-statistic of 11960 and partial R^2s above 5%.[65] Column (4) and (5) are results from the selective samples and serve as comparison to the results from column (3). Results in column (4) show that the separated elasticities of married and single taxpayers are not sensitive to the exclusion of the top 1% taxable income. The elasticity for the married is 0.44 and the elasticity for single taxpayers is 0.17. Results are not statistically different from the results of the full sample in (3) and first stage statistics indicate strong instruments. Column (5) shows the reproduction of the selection of column (6) from Table 3 for the separation of the ETI for married and single taxpayers by deleting taxpayers with taxable income below the 10,000 Euro in the base year $t-1$. The ETIs are again significantly higher than in the benchmark results in column (3) with an elasticity of 0.62 for married taxpayers and an elasticity of 0.41 for single taxpayers. These estimates confirm the evidence for selection bias that is caused by the the income cut off at the lower end of the income distribution.

6 Conclusion

This paper provides new insights for the elasticity of taxable income for Germany. Results are based on a rich and unique German panel data for six straight years from 2001 to 2006. That data over-samples high incomes and comprises two major reforms in 2004 and 2005

[64] Bargain et. al (2012) provide a survey of recent labor supply elasticities for 17 European countries and the US. The estimation and results of labor supply elasticities are divided for single and couple households.

[65] The number of endogenous variables increases to three through the interaction with the marriage dummy, all instruments for the growth rate of net-of-tax are interacted accordingly.

that were part of a bundle of reforms, the so called *Agenda 2010*. The tax reforms induced substantial exogenous variation on personal income taxation along the whole income distribution. Marginal and average tax rates were lowered for the whole income distribution, with biggest reductions at the lower and top end of the tax bracket.

The elasticity of taxable income is of particular interest for assessing tax revenue changes from tax reforms. The current paper proposes an alternative model to measure the elasticity of taxable income which avoids potential pitfalls of models from the literature. Beginning with an introduction of the most prominent model in the literature by Gruber and Saez (2002) in equation (1), the paper argues that results from this model might be biased in the case of residuals with significant serial correlation. For the case that Gruber and Saez' (2002) model suffers from serial correlation, an alternative model, that delivers un-biased estimates, is introduced in equation (3).

The Gruber and Saez (2002) model from equation (1) estimates an ETI of 0.46 for Germany. However, tests of residuals suggest significant serial correlation in equation (1) and the estimates suffer from a remaining endogeneity problem. Estimating the alternative model from equation (3) suggests an ETI of 0.36 for Germany. Tests of residual serial correlation show that results are consistent and do not suffer from a weak instrument problem. Results for the ETI are very robust against a number of sensitivity checks: excluding the top 1% taxable incomes, the amount of control variables and non-linear income controls.

My result for the ETI of 0.36 is remarkably similar to results from a recent study by Müller and Schmidt (2012). Which is surprising, since Müller and Schmidt (2012) differ in various important aspects from my study. However, when I reproduce their sample selection, my result for the ETI increases significantly to 0.56. This questions the validity of that selection and supports the presence of a selection bias in their results. Accounting for the heavy tax favoring of married taxpayers compared to single taxpayers, the elasticity of taxable income is also estimated separately for both types of taxpayers. Married taxpayers have a larger ETI of 0.44 than single taxpayers with 0.17. The difference of the ETI between the married and single is robust against the exclusion of the top 1% taxable incomes or exclusion of low taxable incomes.

The ETI for Germany with 0.36 is significantly lower than recent results for the USA from Weber (2014). Employing a model similar the alternative model from equation (3), Weber finds an ETI of 0.86 which exceeds my result by 0.5.

This paper provides reactions to the change of taxation for an income concept that is defined by the tax code. Employing the same model for a more general income concept like some gross income concept would be fruitful and add another perspective of behavioral responses to taxation for future research. Moreover, this is common practice in the literature, for instance, Gruber and Saez (2002) find an insignificant elasticity of broad income to changes in taxation.

Another aspect of future research would be the inclusion of transfer withdrawal rates. The German welfare state is very redistributive and provides significant income insurance. This induces very high transfer withdrawal rates for low incomes of 80 and 90% and implicit marginal tax rates near one. An elasticity of taxable and transfer income would be worthwhile to estimate and compare it to the elasticity of taxable income. Unfortunately, German tax data are not as representative for lower incomes than they are for top incomes and do not allow to derive the full household context necessary to compute transfers. Survey panel data like the SOEP are very representative at the lower end of the income distribution and allow to include the household context of taxpayers.[66] This comes with the price of of low representativity of top incomes. Matching both data sources would be an obvious instrument to capture the entire German income distribution. Confidentiality restrictions, however, do not allow to combine the data and use it as one. Furthermore, in 2006/07, the marginal top tax rate was increase again to 45%, while the remaining tax schedule was unchanged. Employing model (3) on data for the years until 2007 would be an interesting and important result since taxpayers with top incomes contribute the most tax revenue in Germany.

7 Appendix

7.1 The Level Equation of Gruber and Saez (2002)

An underlying level equation to Gruber and Saez's (2002) model, in which residuals are not serial correlated, can look like:

$$ln(y_{it}) = \beta ln\left(\frac{1-\tau_{it}}{1-\tau_{it-1}}\right) + (1+\rho_1)ln\left(y_{it-1}\right) + \gamma W_{it-1} + c + \epsilon_{it} \tag{4}$$

Since residuals are not in first difference and do not follow a moving average process, base year income is exogenous and a valid control and valid source for the instrument. However, note two things about this model: first, income follows its own lag with coefficient $(1+\rho_1)$

[66]A promising opportunity of the SOEP would be usage of the tax and transfer simulation model STSM provided by DIW, see Steiner et al. (2012) for a documentation of the STSM.

and second, the elasticity of taxable income, β, depends on the growth rate of the net-of-tax rate rather than on the net-of tax rate.[67]

7.2 Weber's (2014) model

A recent model by Weber (2014) is based on the decomposition of individual income of period t y_{it} into a permanent μ_i, transitory η_{it} and an income component that depends on the net-of-tax rate $(1-\tau_{it})$ with elasticity β:

$$ln(y_{it}) = \beta ln(1-\tau_{it}) + ln(\mu_i) + ln(\eta_{it}) \tag{5}$$

Taking first differences, assuming that permanent income is time invariant, delivers the following estimation model:

$$ln\left(\frac{y_{it}}{y_{it-1}}\right) = \beta ln\left(\frac{1-\tau_{it}}{1-\tau_{it-1}}\right) + \Delta ln(\eta_{it}) \tag{6}$$

Weber (2014) estimates this equation also with additional control variables including lagged base year income, or splines of lagged base year income. Weber (2014) discusses the serial correlation of the transitory income in great detail and tests instrumental validity with the help of over-identifying restrictions. Since base year income y_{it-1} systematically correlates with the $\Delta ln(\eta_{it})$, it is endogenous and is not a valid instrument. Weber (2014) uses the Sargan Test (1958) to show the endogeneity of instruments created from base year income. Over-identifying restrictions are drawn from instruments based on higher lags of base year income. However, this is potentially problematic if higher lags of base year income also correlate with $\Delta ln(\eta_{it})$. This would be the case if, for instance, transitory income follows a moving average of order one. Then the first difference of transitory income also systematically correlates with the lag of base year income y_{it-2} through η_{it-2}:

$$\Delta ln\left(\eta_{it}\right) = \theta_1 ln\left(\frac{\eta_{it-1}}{\eta_{it-2}}\right) + ln\left(\frac{\varsigma_{it}}{\varsigma_{it-1}}\right)$$

with θ_1 as the coefficient of persistence of the transitory income and ς_{it} and ς_{it-1} as uncorrelated innovations. Once θ_1 is of considerable size, also other higher lags of base year income would correlate with the residuals and be endogenous.

[67] Gruber and Saez (2002) derive the elasticity of taxable income from a consumption model and result to an estimation question quite different from this.

A simple way to avoid this endogeneity problem is by using the lagged income growth as further control variable in equation (6):

$$ln\left(\frac{y_{it}}{y_{it-1}}\right) = \rho ln\left(\frac{y_{it-1}}{y_{it-2}}\right) + \beta ln\left(\frac{1-\tau_{it}}{1-\tau_{it-1}}\right) + \Delta ln(\eta_{it})$$

In case there was no tax reform in the year between lagged base year and base year, lagged income growth $ln\left(\frac{y_{it-1}}{y_{it-2}}\right)$ corresponds to $ln\left(\frac{\eta_{it-1}}{\eta_{it-2}}\right)$ and lagged base year income y_{it-2} is not endogenous anymore and a valid instrument. This specification corresponds to my alternative model from equation (3).[68]

7.3 Control variables

A detailed description of construction of the sample is available upon request.[69]

7.4 More Results

7.4.1 Descriptive Results for the Instrumentation

Table A.2 shows results for the instrumentation of the net-of-tax rate in the alternative model (3). The descriptive results for the whole sample in the top block show that the instrumentation results to a significantly smaller variance in the instrumented net-of-tax rate than in the initial true net-of-tax rate. The middle block, however, shows that the variation of the net-of-tax rate and its instrumented version is much similar, once the top 1% and the lowest 1% of the net-of-tax rate are excluded. Furthermore, excluding the top 5% an lowest 5% of the net-of-tax rate in the lowest block shows that the instrumentation produces a similar variation of the instrumented net-of-tax rate then the true net-of-tax rate, and deviations in the top block are mainly driven from outliers.

[68] This special case of Weber's (2014) model differs from equation (3) regarding the control variables, which however could easily be adjusted.

[69] Business activity includes taxable income from agriculture and forestry, from unincorporated business enterprise and from self-employed activities.

Table A.1: Coding and Construction of control variables

D new child	Taxpayer has a new child between base year $t-1$ and year t	Dummy (1 = yes; 0 =no)
D change of state	Taxpayer moves from one federal state to another between base year $t-1$ and year t	Dummy (1 = yes; 0 =no)
	Stratification controls	
D marriage	Taxpayer is a married couple	Dummy (1 = yes; 0 =no)
Income 2001	Taxpayers gross income in 2001	In level
D_1 main income	Dependent employment is main income source	Dummy (1 = yes; 0 =no)
D_2 main income	Income from business activity is main income source	Dummy (1 = yes; 0 =no)
D_3 main income	Income from others is main income source	Dummy (1 = yes; 0 =no)
D_1 income 2001	Gross income in 2001 is lower 150000	Dummy (1 = yes; 0 =no)
D_2 income 2001	Gross income in 2001 is between 150000 and 1000000	Dummy (1 = yes; 0 =no)
D_3 income 2001	Gross income in 2001 is higher than 1000000	Dummy (1 = yes; 0 =no)
	Age controls	
D age	Taxpayers age	In level
D age^2	Taxpayers age squared	In level
D old	Taxpayer older than 55 in 2001	Dummy (1 = yes; 0 =no)
D young	Taxpayer younger than 21 in 2001	Dummy (1 = yes; 0 =no)
	Demographic controls	
D handicapped	Taxpayers with allowance for disability	Dummy (1 = yes; 0 =no)
D retired	Taxpayer who is retired	Dummy (1 = yes; 0 =no)
D prog	Taxpayer with non-taxable income with influence on the marginal tax rate	Dummy (1 = yes; 0 =no)
D two earner	Married taxpayers with two earner	Dummy (1 = yes; 0 =no)
D single parent	Single taxpayer with children	Dummy (1 = yes; 0 =no)
	Further controls	
Constant		
Year dummy		Dummies for 2003 and 2004

Table A.2: Instrumentation based on alternative model (3)

		Growth rate of Net-of-tax rate	Growth rate of Instrumented Net-of-tax rate
All	Mean	.023	.023
	Std	.063	.028
	N	1690685	1690685
p(99)< and >P(1)	Mean	.023	.023
	Std	.049	.028
	N	1656871	1656871
p(95)< and >P(5)	Mean	.023	.023
	Std	.035	.028
	N	1521616	1521616

Source: Own computation based on German Taxpayer Panel 2001-2006.

7.4.2 Results from OLS

Table A.3: Comparing OLS with 2SLS

	(1)	(2)	(3)	(4)
	OLS		2SLS	
$ln\left(\frac{1-\tau_{it}}{1-\tau_{it-1}}\right)$	-4.668***	-4.655***	0.307***	0.364***
	(0.00)	(0.00)	(0.02)	(0.029
$ln\left(\frac{y_{it-1}}{y_{it-2}}\right)$	-0.076***	-0.080***	0.116***	0.117***
	(0.00)	(0.00)	(0.00)	0.00)
D new child	0.009***	0.008***	0.016***	-0.003
	(0.00)	(0.00)	(0.00)	(0.00)
D change of state	0.010**	0.008*	0.109***	0.091***
	(0.00)	(0.00)	(0.01)	(0.01)
D marriage	-0.004***	0.011***	0.003***	0.039***
	(0.00)	(0.00)	(0.00)	(0.00)
Income 2001	0.000***	0.000***	-0.000	-0.000
	(0.00)	(0.00)	(0.00)	(0.00)
Strat. controls	Yes	Yes	Yes	Yes
Age controls	Yes	Yes	Yes	Yes
Demo. controls		Yes		Yes
	Tests of weak Instruments			
First stage F-Statistic			19088	18890
Partial R_1^2			.056	.0548
Partial R_2^2			.147	.154
	Tests of Moving Average			
Arellano-Bond test, order 1			-159	-164.6
(p-value)			(0.000)	(0.000)
Arellano-Bond test, order 2			2.65	-0.929
(p-value)			(0.008)	(0.353)
Number of Observations	1690685	1690685	1690685	1690685

Notes: * $p<0.05$, ** $p<0.01$, *** $p<0.001$. All regressions include a constant and year dummies. Sample control variable are dummy variables for main income source and dummy variables for the level of income in 2001. Age control variables are the taxpayers age, age squared, a dummy for taxpayers over 55 and a dummy for taxpayers younger than 21 in 2001. Age control variables are the taxpayers age, age squared, a dummy for taxpayers over 55 and a dummy for taxpayers younger than 21 in 2001. Demographic control variables are dummy variables for single parents, handicapped taxpayers, two earner taxpayers, retired taxpayers and non-taxable income. λ denotes the inverse Mills ratio from the Heckman sample selection model. The first stage F-Statistic is the Cragg-Donald Wald F statistic with critical values of 11.04 for 5% relative IV bias and 16.87 for 10% IV size, source Stock and Yogo (2005). Partial R_1^2 is the partial R-squared for the growth rate of the net-of-tax rate, Partial R_2^2 is the partial R-squared for the lagged income growth, see Shea (1997) and Godfrey (1999) for a description. The Arellano-Bond tests for first-order and second-order of moving average is asymptotically N(0,1) distributed.
Source:Own computation based on German Taxpayer Panel 2001-2006.

Table A.3 presents results from OLS and reproduces results from 2SLS. Column (1) and (2) are OLS results for the elasticity of taxable income, column (3) and (4) reproduces results from the alternative model from equation (3) from Table 3. Comparing results for the elasticity of taxable income reveals the strong differences of the estimates: OLS results are very large negative with -4.67 and -4.66, depending on the amount of control variables. Hausman-Wu Tests (not reported) strongly indicate that the net-of-tax rate is endogenous and the OLS estimates are different from 2SLS results. The large negative correlation is as expected and is offspring to the progressive tax schedule which decreases the net-of-tax rate for increasing income.

Results for the lagged income growth are also very different for OLS in column (1) and (2) with -0.08 from 2SLS with 0.12.

7.4.3 Results with restricted sets of control variables

Results in Table A.4 of equation (3) are with very restricted sets of control variables. The left block in column (1), (2) and (3) shows results without lagged income growth $ln\left(\frac{y_{it-1}}{y_{it-2}}\right)$. Results show very small ETI in all specification with a small but significant ETI of 0.06 in the most restrictive specification without control variables in column (1). Including control variables in column (2) and (3) results to an insignificant ETI of 0.032 in column (2) and a significant ETI of 0.06 in column (3). All results without lagged income growth need to be viewed with caution. Results for the tests of serial correlation cannot reject a moving average of at least order 2 which raises questions about the exogeneity of the employed instruments.[70]

The right block of Table A.4 shows results for equation (3) including lagged income growth without control variables in column (4), with reduced amount of control variables in column (5) and with the full set of control variable corresponding to the full model from equation (3) in column (6). Estimates for the ETI are positive in all specifications and increase with increasing extent of control variables. First stage statistics are high in all specifications, especially in column (4) with an ETI of 0.22. Including control variables from first differences and stratification control in column (5) presents a higher ETI of 0.31. Including all control variables in column (6) deliver an ETI of 0.36 with residuals that have no serial correlation of order 2 which corresponds to uncorrelated residuals in the level equation of the model in equation (2).

[70] Instruments are counterfactual net-of-tax growth rates based on lagged base year income and the second lag of base year income. If those lags of base year income are still significantly correlated with the residuals, estimates of the ETI are biased. My data comprise only six years and do not allow to include higher lags of base year income for computation of additional and alternative counterfactual net-of-tax rates.

Table A.4: Results for variation of controls

	(1)	(2)	(3)	(4)	(5)	(6)
$ln\left(\frac{1-\tau_{it}}{1-\tau_{it-1}}\right)$	0.058***	0.032	0.062**	0.219***	0.307***	0.364***
	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.02)
$ln\left(\frac{y_{it-1}}{y_{it-2}}\right)$				0.105***	0.116***	0.117***
				(0.00)	(0.00)	0.00)
D new child		0.014***	-0.004*		0.016***	-0.003
		(0.00)	(0.00)		(0.00)	(0.00)
D change of state		0.122***	0.099***		0.109***	0.091***
		(0.01)	(0.01)		(0.01)	(0.01)
D marriage		-0.001*	0.035***		0.003***	0.039***
		(0.00)	(0.00)		(0.00)	(0.00)
Income 2001		-0.000**	-0.000		-0.000	-0.000
		(0.00)	(0.00)		(0.00)	(0.00)
Strat. controls		Yes	Yes		Yes	Yes
Age controls		Yes	Yes		Yes	Yes
Demo. controls			Yes			Yes
	Tests of weak Instruments					
First stage F-Statistic	192433	59230	57553	43517	19088	18890
Partial R_1^2	.185	.065	.063	.164	.056	.0548
Partial R_2^2				.136	.147	.154
	Tests of Moving Average					
Arellano-Bond test, order 1	-250	-223	-227	-171	-159	-164.6
(p-value)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Arellano-Bond test, order 2	-14	-15	-21	2.59	2.65	-0.929
(p-value)	(0.000)	(0.000)	(0.000)	(0.009)	(0.008)	(0.353)
Number of Observations	1690685	1690685	1690685	1690685	1690685	1690685

Notes: * p<0.05, ** p<0.01, *** p<0.001. All regressions include a constant and year dummies. Sample control variable are dummy variables for main income source and dummy variables for the level of income in 2001. Age control variables are the taxpayers age, age squared, a dummy for taxpayers over 55 and a dummy for taxpayers younger than 21 in 2001. Age control variables are the taxpayers age, age squared, a dummy for taxpayers over 55 and a dummy for taxpayers younger than 21 in 2001. Demographic control variables are dummy variables for single parents, handicapped taxpayers, two earner taxpayers, retired taxpayers and non-taxable income. λ denotes the inverse Mills ratio from the Heckman sample selection model. The first stage F-Statistic is the Cragg-Donald Wald F statistic with critical values of 11.04 for 5% relative IV bias and 16.87 for 10% IV size, source Stock and Yogo (2005). Partial R_1^2 is the partial R-squared for the growth rate of the net-of-tax rate, Partial R_2^2 is the partial R-squared for the lagged income growth, see Shea (1997) and Godfrey (1999) for a description. The Arellano-Bond tests for first-order and second-order of moving average is asymptotically N(0,1) distributed.
Source:Own computation based on German Taxpayer Panel 2001-2006.

7.4.4 Including Taxpayers with Demographic Changes

Table A.5: Results including taxpayers with demographic changes

	(1)	(2)
$ln\left(\frac{1-\tau_{it}}{1-\tau_{it-1}}\right)$	0.381***	0.328***
	(0.02)	(0.03)
$ln\left(\frac{y_{it-1}}{y_{it-2}}\right)$	0.119***	0.090***
	(0.00)	(0.00)
D new child	-0.010***	-0.009***
	(0.00)	(0.00)
D change of state	0.086***	0.087***
	(0.01)	(0.01)
D marriage	0.038***	0.036***
	(0.00)	(0.00)
Income 2001	-0.000	-0.000
	(0.00)	(0.00)
λ		0.003
		(0.00)
Strat. controls	Yes	Yes
Age controls	Yes	Yes
Demo. controls	Yes	Yes
	Tests of weak Instruments	
First stage F-Statistic	19572	32811
Partial R_1^2	0.152	0.072
Partial R_2^2	0.049	0.042
	Tests of Moving Average	
Arellano-Bond test, order 1	-174	-128.5
(p-value)	(0.000)	(0.000)
Arellano-Bond test, order 2	1.791	-3.41
(p-value)	(0.073)	(0.001)
Number of Observations	1951471	1951471

Notes: * p<0.05, ** p<0.01, *** p<0.001. All regressions include a constant and year dummies. Sample control variable are dummy variables for main income source and dummy variables for the level of income in 2001. Age control variables are the taxpayers age, age squared, a dummy for taxpayers over 55 and a dummy for taxpayers younger than 21 in 2001. Age control variables are the taxpayers age, age squared, a dummy for taxpayers over 55 and a dummy for taxpayers younger than 21 in 2001. Demographic control variables are dummy variables for single parents, handicapped taxpayers, two earner taxpayers, retired taxpayers and non-taxable income. λ denotes the inverse Mills ratio from the Heckman sample selection model. The first stage F-Statistic is the Cragg-Donald Wald F statistic with critical values of 11.04 for 5% relative IV bias and 16.87 for 10% IV size, source Stock and Yogo (2005). Partial R_1^2 is the partial R-squared for the growth rate of the net-of-tax rate, Partial R_2^2 is the partial R-squared for the lagged income growth, see Shea (1997) and Godfrey (1999) for a description. The Arellano-Bond tests for first-order and second-order of moving average is asymptotically N(0,1) distributed.
Source:Own computation based on German Taxpayer Panel 2001-2006.

Table A.5 presents results of equation (3) including taxpayers that have severe demographic changes such as marriage, divorce or one-time exceptional profits which increases the sample to 1,951,471 observations. Column (1) shows 2SLS results for the full model of equation (3) with an ETI of 0.38 which is statistically not different from the benchmark result from Table 3 with an ETI of 0.36. Results in column (2) are based on the 1951471 observations and include a selection control following Heckman (1979) λ.[71]

These results imply that the employed observation selection does not induce a selection bias.

[71]Exclusion restrictions for the estimation of the selection control are obtained from the first year of the panel data. (1) Indicator for the number of different income sources, (2) the variance of the incomes between the income sources and (3) an indicator for negative incomes are used as exclusion restrictions.

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