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# What drives tax refund maximization from inter-temporal loss usage? Evidence from the German Taxpayer Panel

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# What drives tax refund maximization from inter-temporal loss usage? Evidence from the German Taxpayer Panel*

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**Abstract**

This paper investigates the inter-temporal loss usage of tax units in Germany. Tax units that experience a loss in a year can offset that loss with positive income from adjacent year to receive a tax refund. Similar to companies, tax units can employ losses as carry-back in the year before the loss or as carry-forward in the year following the loss. The tax code does not force a particular loss usage but provides tax units with freedom to allocate the losses between carry-back and carry-forward. Choosing an individual appropriate allocation of carry-back and carry-forward creates a maximal tax refund. Inter-temporal loss usage is a special case of tax avoidance: tax units receive a tax refund from loss usage as carry-forward (carry-back) but forfeit the alternative refund from carry-back (carry-forward). Estimations show that the probability of maximizing the tax refund highly depends on the difference of the tax rates from the loss adjacent years. An increase of 10 percentage points of the tax rate difference increases the probability of tax refund maximization by 24.5%. This confirms that tax avoidance is strong in case of significant tax incentives.

**Keywords:** Losses, tax planing, taxpayer panel, administrative data

**JEL-Classification:** H24; H63; D14

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# 1 Introduction

The usage of losses is widely recognized as a tax planning tool to reduce tax burden.[1] The German income tax code provides substantial insurance against negative incomes in two ways: (1) negative incomes from one income source can be offset against positive incomes from other income sources from the same year. (2) if the negative incomes exceed positive incomes from the same year, those negative incomes, hence called losses, can be offset against positive incomes from the adjacent years. Incomes from renting and leasing are a prominent example of loss offsetting within a year in Germany and recent results suggest a negative correlation between total income and income from renting and leasing.[2] Losses from business income are the main source for inter-temporal loss usage, which plays a considerable role in the federal German budget and reduces the tax revenue 1.2% annually.[3] Tax units are free to chose the allocation[4] of the losses as a carry-back to the year before the loss or as a carry-forward to the year following the loss in the income and tax declaration.[5] This paper calculates if tax units use a tax refund maximizing allocation of losses and estimates what drives that maximizing allocation. Using micro-simulation methods show that only 59% of tax units choose an allocation that maximizes their tax refund from losses, which are hence called refund maximizer. The share of the refund maximizer increases between 8% to 15% when tax units are allowed to have small deviations from the tax refund maximizing loss allocation.

The recent release of administrative micro panel-data from 2001 to 2006 on income tax returns, supplied by the German Federal Statistical Office, opens new possibilities to investigate the inter-temporal loss usage. During that period, the biggest German tax reform in recent history was implemented. The reform lowered tax rates between 2003 and 2005 in two steps and increased incentives to use losses as

[1] See for instance Bach et al. (2009) who disregard losses from renting and leasing exceeding 5000 Euros for the calculation of individual economic income.

[2] See Müller (2006) for more details on the size and distribution of losses from renting and leasing.

[3] See Bach and Buslei (2009) for an extensive depiction of the influence of losses on the tax budget.

[4] There is a limit on the carry-back for a single tax unit of 500,000 Euros. Carry-forwards are unrestricted until 1,000,000 Euros, and losses exceeding that amount can be still used with 60%. Unused losses can be only carry-forwarded but do not expire and must be used once income in the subsequent years is positive.

[5] Tax units are able to delay their income declaration to the end of the following year when the tax unit has knowledge of the incomes from both adjacent years. The declaration asks the tax unit whether she wants to restrict the amount of carry-back and if so by how much. If a tax unit does not report anything, losses will be carried back.

carry-backs.[6]

Literature on losses can be divided into two branches, individual loss usage and companies loss usage. A milestone in the literature on company losses is the paper by Auerbach and Poterba (1987). Their results suggest that companies losses play a key role for profit strategy and in tax planning. Dwenger (2008) shows for Germany how potential restrictions on inter-temporal loss usage of companies could substantially increase tax revenue.[7]

So far, there is only little empirical evidence on the individual loss usage for Germany. Müller (2006) describes contemporary loss offsetting between 1989 and 2001 with five cross sections of tax income returns. He finds a negative correlation between total income and the two main loss sources, income from renting and leasing, and business income. While more than 40% of the aggregated losses from renting and leasing are held by the 10% richest tax units, about 70% of the business losses are obtained by the lowest 10% of the income distribution.[8] Another example by Bach and Buslei (2009) relies on microsimulation for assessing the impact of losses on effective tax rates on income sources. They compute effective tax rates with and without loss usage and find that effective tax rates significantly increase for most types of incomes when losses are included. Moreover, they show how the loss offsetting regulations decrease tax revenue by 1.2% annually. Lang et. al (1997) find that tax revenue in 1983 is reduced by 33.6% of total tax revenue due to legal and illegal tax avoidance. Estimated effective marginal and average tax rates are as much as sixteen percentage points lower than legislated tax rates and mainly come from tax avoidance through under-reporting of interest income and deductions from real estate.[9]

Inter-temporal loss usage possesses integral features of tax avoidance that allows to complement Lang et al.'s (2013) results: loss usage creates a tax refund in the used year, but costs a reduced tax refund from loss usage in alternative years. This is in line with Slemrod's (2001) model of tax avoidance which derives tax avoidance as a

[6]The tax rate in the year the loss is used determines the tax refund. Assuming income from adjacent years being equal and a tax reform lowering tax rates in future years, one would expect tax units to use more losses as carry-back to maximize tax refund.

[7]While only a small share of companies would be affected from the restriction, tax revenue would increase over 1 billion Euros.

[8]Wegener (2014) confirms that the two main individual loss sources are renting and leasing, and business income, and finds that the majority of losses are contemporary offset with positive incomes. This is especially true for losses from renting and leasing where 96% of all losses are contemporary offsets. About 84% of losses from business income are contemporary offset.

[9]Bach et al. (2013) remark that those numbers are based on survey data that do not include the richest two percent of German tax units, and do not allow to draw conclusions about taxation of the top.

function of the income tax and avoidance costs. Slemrod (1995, 2001) shows that tax avoidance is individually optimal when marginal costs of avoidance equal its individual benefit. Furthermore, inter-temporal loss usage contains features of tax avoidance such as tax planning, renaming or re-timing activities aiming to reduce tax liability.

This chapter contributes to the literature on tax avoidance and individual loss usage with a special case of tax avoidance for Germany. To the best of my knowledge, it is the first paper to measure tax avoidance in the special context of inter-temporal loss usage. Incentives for tax avoidance depend on the individual income and the associated tax refund. The particular inter-temporal loss offset feature of the German income tax code can be used to maximize the inter-temporal tax refund by choosing the right allocation of carry-back and carry-forward.

Applying the popular Probit model shows that tax refund maximization highly depends on the difference between the tax rates from the loss adjacent years. A tax rate difference of 10 percentage points between the years prior to the loss and subsequent to the loss increases the probability of refund maximization by 24.5 percentage points.[10] This is in line with the result from Alstadsaeter and Jacob (2012) who find that tax incentives have a particular high impact on tax avoidance.[11] The results for the tax rate difference are robust against the inclusion of control variables for incomes and losses. Somewhat surprising are results that tax consultants do not have a significant influence on the probability of refund maximization. By contrast, the size of the loss can have an impact on the probability of refund maximization.[12]

This chapter proceeds as follows: Section 4.2 describes the German tax system, recent tax reforms and the mechanics of loss usage. Section 4.3 presents some descriptive results and Section 4.4 shows regression results and section 4.5 concludes.

[10] Using 10 percentage points is a conservative number for the tax rate difference. Tax units with losses in a year have high income variance and accordingly high tax rate variance. Tax refund maximizer have a high mean of tax rate difference with 20.6 percentage points.

[11] Alstadsaeter and Jacob (2012) classify tax avoidance into three categories: incentive, access and awareness. Using a regression discontinuity design to investigate income shifting from personal income to corporation income induced by the Swedish capital taxation reform 2006, the authors find that tax minimization activities increase significantly with increasing tax rates and awareness of the tax code.

[12] Losses increase the probability of tax refund maximizing in the benchmark specification but reduce the probability in alternative specifications.

# 2 The German Income Tax System and Reforms

The German income tax schedule is progressive, taxable income above the basic allowance is divided into three brackets with increasing marginal tax rates within the two lower brackets and a constant marginal tax rate in the top bracket. Moreover, it discriminates substantially between single and married tax units.[13]

Further, the German tax code allows tax units to delay their income declaration until the end of the subsequent year. Thus, tax units are able to know their taxable incomes from the years surrounding a loss before they have to choose a loss allocation.[14] The German Income Tax code allows several tax reliefs on total income reducing the basis for the taxable income. Losses from other years need to be used primarily before other reliefs can be employed. However, only if total income is negative, tax units can use their negative income as a loss in other years. A negative taxable income or a taxable income below the basic allowance is not sufficient to claim inter-temporal loss usage.[15] Once tax units declare a loss, they can either use the loss as a carry-back in the year prior to the loss, or as carry-forward in the year(s) after the loss. The income declaration asks to limit the amount of carry-back. If the tax unit does not choose an amount, the loss will be carried back until total income from the prior year is either zero or the losses are all carried back. Losses which are not used as carry-back need to be used as carry-forward once the total income from the subsequent year is positive.[16] Unfortunately, the data do not allow to use losses from earlier years than 2004 due to other reforms on the loss offset law.[17]

Marginal tax rates from the loss adjacent years determine the tax refund from the loss usage. The most prominent income tax reform in recent German history had an impact on marginal tax rates and was passed in 2000. The reform consisted of

[13]Married taxpayers can opt for the splitting tax schedule to decrease their joint taxation and marginal tax rates. Marginal tax rates for married couples 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.

[14]The data deliver detailed information on the usage of losses. I.e. it is possible to identify the amount of carry-back and carry-forward. Furthermore, it is possible to determine the income source with the loss.

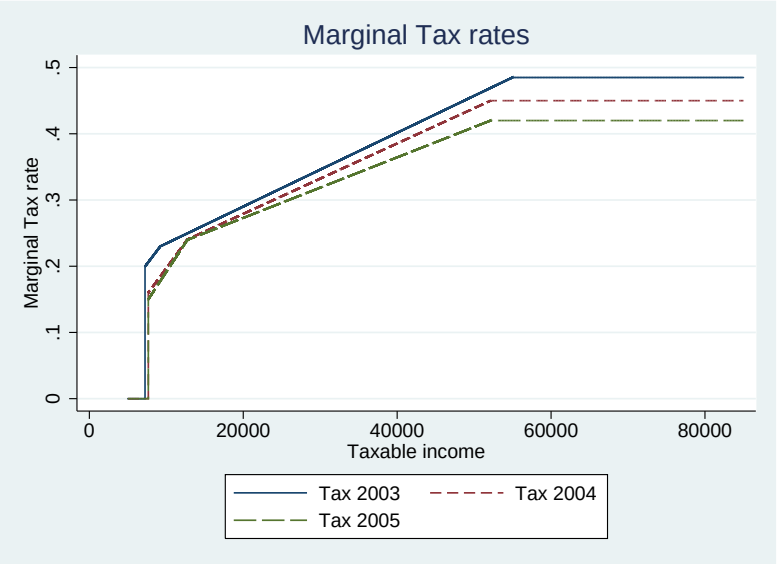
[15]Note that other tax reliefs lose their tax saving potential, once used losses reduce total income below the basic allowance in the employed year.

[16]However, there are restrictions on the maximum amount of loss usage. Carry-back cannot exceed 500,000 Euros (1,000,000 Euros) for single (married) tax units. Carry-forward is unrestricted until 1,000,000 Euro (2,000,000 Euro) for single (married) tax units, and restricted to 60% for losses exceeding 1,000,000 Euro (2,000,000 Euro). Remaining losses can be used in the following years.

[17]The usage of losses between 2001 and 2003 was primarily restricted to usage within income sources. A complex deduction system also allowed to offset a limited amount of high losses with positive incomes from other sources. However, the data is not providing conclusive identification to connect losses and their usage in other years.

a gradual reduction of the personal income tax schedule, accompanied by modest tax base broadening and combined several steps which lowered the whole income tax schedule from 2003 to 2004 and from 2004 to 2005.[18] Figure 1 demonstrates the effect of the reform on marginal tax rates for an individually taxed tax unit.

**Figure 1:** Marginal tax rates for an individually tax unit




Note that the tax reform decreased the tax refund from carry-forward and increased incentives for loss usage as carry-back. Equation (1) illustrates an example of incentives for loss usage for the first loss Euro. $\Delta\tau$ is the difference of tax refund when the loss is used as a carry-back or as a carry-forward. $\tau_{t-1}(Z_{t-1})$ ($\tau_{t+1}(Z_{t-1})$) denotes the marginal tax rate from the year prior to (following) the loss and $Z_{t-1}$ ($Z_{t+1}$) is taxable income from the year prior to (following) the loss.

$$\Delta\tau = |\tau_{t-1}(Z_{t-1}) - \tau_{t+1}(Z_{t+1})| \tag{1}$$

The refund is maximized when losses are used in the year with the higher marginal tax rate. Thus, tax units that are not able to increase their tax refund from a reallocation of loss usage can be defined as tax refund maximizer.[19] Maximizing the tax refund from a considerable loss implies that the marginal tax rates from the

[18] Besides the reduction of all marginal tax rates, the basic tax allowance was slightly increased from 7,206 Euro in 2003 to 7,664 Euro in 2005.

[19] Alternatively, one can allow tax units to differ from this strict definition of tax refund. One alternative definition allows tax units to deviate with up to 200 Euros from their maximal tax refund, another definition allows tax units to deviate up to 5% of losses weighted by average income. In addition another definition tax units can deviate up to 2% of the potential maximum of tax refund.

adjacent years are equal after loss usage.[20] Thus maximizing the tax refund from losses underlies the same optimization process than tax avoidance does: individual tax avoidance is maximal when marginal avoidance costs equal the marginal tax saving. To avoid an endogeneity problem when estimating the probability of tax refund maximization, only the tax rate difference of the first loss Euro is used in the further analysis.[21]

# 3 Descriptive Results

This section displays some descriptive results of German tax units with losses. Starting with simple descriptive results, the section continues with an analysis of the distribution of refund maximizers and the distribution of deviating losses from the refund maximizing allocation. Subsequently, the section shows at which positions of the income distribution tax units with losses are, and finishes with more detailed descriptive statistics.

Simple descriptive results are presented in Table 1. The Table contains the tax rate difference $\Delta\tau$ for tax refund maximizer and for non-maximizer, the loss and the adjacent incomes $Z_{t-1}$ and $Z_{t+1}$. Table 1 shows that $\Delta\tau$ is 58% higher for refund maximizer than for non-maximizer. Losses and incomes $Z_{t-1}$ and $Z_{t+1}$ are high on average with very high variation. Moreover the mean-median ratio shows that incomes and losses are highly skewed with mean-median ratios exceeding 3. The size of the individual maximal tax refund is a combination of the loss and the corresponding tax rates from the adjacent years. Accordingly, one would expect that incentives to maximize the refund show positive correlation with increasing adjacent incomes and with increasing size of the loss. Further, one would expect that the probability of refund maximization particularly correlates with a combination of losses and adjacent income: the loss income ratio.

[20] This is true unless the refund is maximized by using losses only in one year. That could be in the case of a small loss or comparable high income in one year and comparable low income in the other year.

[21] In the case that the tax refund is maximal through loss usage with both carry-forward and carry-back, the tax rate differences for the last Euro is zero.

**Table 1:** Descriptive statistics for selected variables

| | Mean | Median | Mean-Median Ratio | Std. | N. Obs. |
|---|---|---|---|---|---|
| $\Delta\tau$, RM | .208 | .207 | 1.005 | .13 | 5227 |
| $\Delta\tau$, NRM | .132 | .084 | 1.57 | .12 | 3604 |
| Losses | -111871 | -16388 | 6.83 | 479753 | 8831 |
| $Z_{t-1}$ | 126940 | 33909 | 3.74 | 550264 | 8831 |
| $Z_{t+1}$ | 136334 | 28984 | 4.70 | 560245 | 8831 |

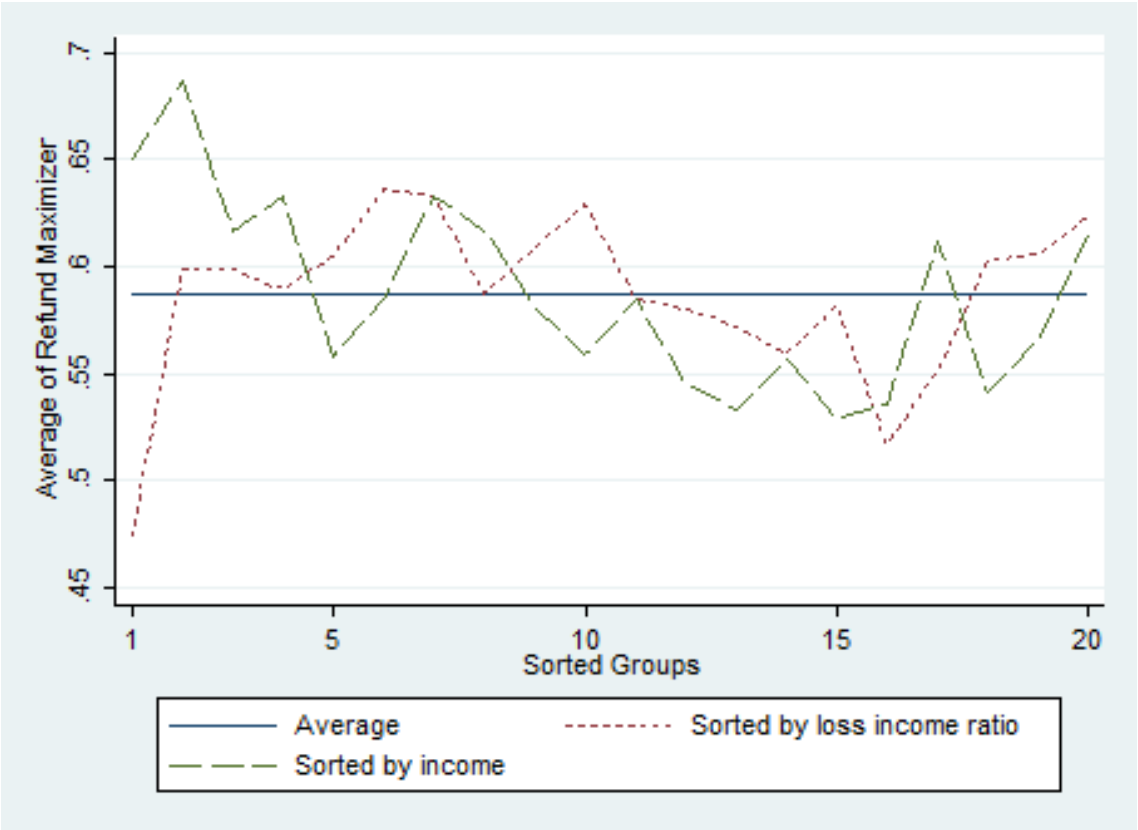
*Notes:* RM denotes tax units that maximize the tax refund, NRM denotes tax units that do not maximize the tax refund. $Z_{t-1}$ denotes the total income from the year prior to the loss, $Z_{t+1}$ denotes total income from the year subsequent to the loss, N. Obs. is the number of observations with losses from either 2004 or 2005 with incomes in the adjacent years exceeding the basic allowance.

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

Figure 2 illustrates shares of tax units that maximize their tax refund. Tax units are sorted into 20 equally sized groups and average shares of refund maximizer are computed for every group. The long dashed line presents the groups average shares sorted by increasing income from adjacent years, the dashed line presents the groups average shares sorted by the increasing ratio of losses to income from adjacent years, using that loss income ratio as an indicator for the relevance of the losses to the tax units. The solid line is the overall average share of tax refund maximizer with 59%. The figure displays that there is no clear pattern for refund maximization with either increasing income or increasing loss income ratio. Shares of refund maximizer differ only little per group from the overall mean. Only the lowest two groups of the income sorted tax units have substantially higher refund maximization rates and only the lowest group of the losses weighted by income has a substantially lower rate of maximization rate.[22] The message of Figure 2, though, is limited to the correlation between shares of tax refund maximizer and two variables: income and the loss income ratio. However, the figure is not able to reveal the magnitude of the deviations from the refund maximizing loss allocations.

[22]Sorting tax units by losses looks very similar to the sorting by income.

**Figure 2:** Distribution of shares of refund maximizer




To complement Figure 2, Figure 3 depicts how much tax units deviate from the refund maximizing loss allocation. Average shares of deviating losses are computed and ordered into 20 equally sized groups and sorted by adjacent income (solid line) or the losses income ratio (dotted line). Sorting tax units according to income shows a very robust share of deviating losses for all 20 groups. Sorting according to the loss income ratio however, highlights a strong decline for deviating loss from an increasing ratio.[23]

[23] Appendix (7.2) shows very similar results for further tax refunds weighted by the losses in Figure 5.

**Figure 3:** Share of deviating losses

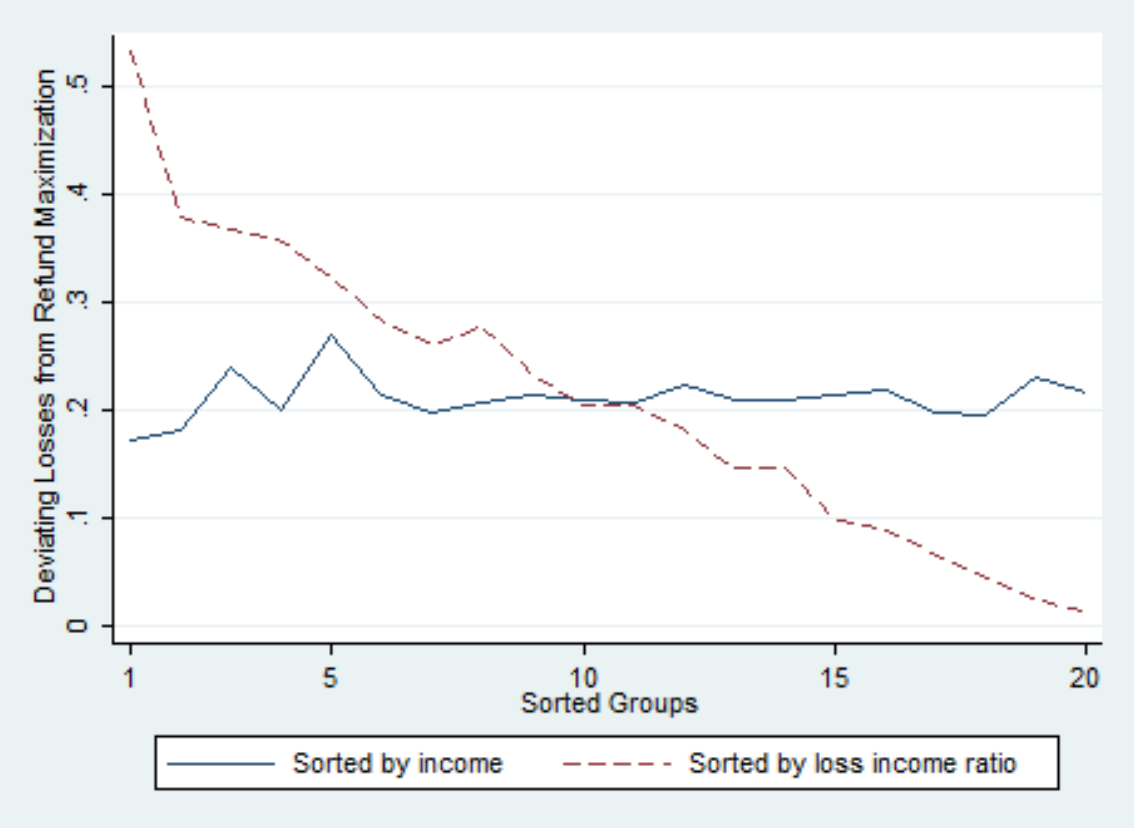



Figure 2 and Figure 3 provide three insights. (1) Adjacent income neither drives the probability of refund maximization nor deviating losses from the refund maximizing loss allocation. (2) The loss income ratio does not drive the probability of refund maximization but shows strong correlation to the deviating losses. (3) With increasing loss income ratio, i.e. relevance of losses to the tax units, deviating losses from refund maximization decrease.

Figure 4 shows that inter-temporal loss usage is not concentrated on one section of the income distribution and matters to the whole income distribution. However, the size of the losses along the distribution increase exponentially with the income decile.[24] The solid blue line in Figure 4 is the relative share of all tax units with losses in the decile. The dotted red line is the average loss in a decile divided by overall average loss.[25] Figure 2 shows that the majority of tax units with losses are located in the second and third decile. Losses below the sixth decile are small

[24]The position in the income distribution is defined on the average income in all years but the year of the loss and expressed with 10 deciles.

[25]The average loss is the mean loss of all tax units with losses.

compared to the average loss, but increase exponentially with the deciles. Losses are highest in the top decile and about 23 times higher than the average loss.

**Figure 4:** Distribution of losses

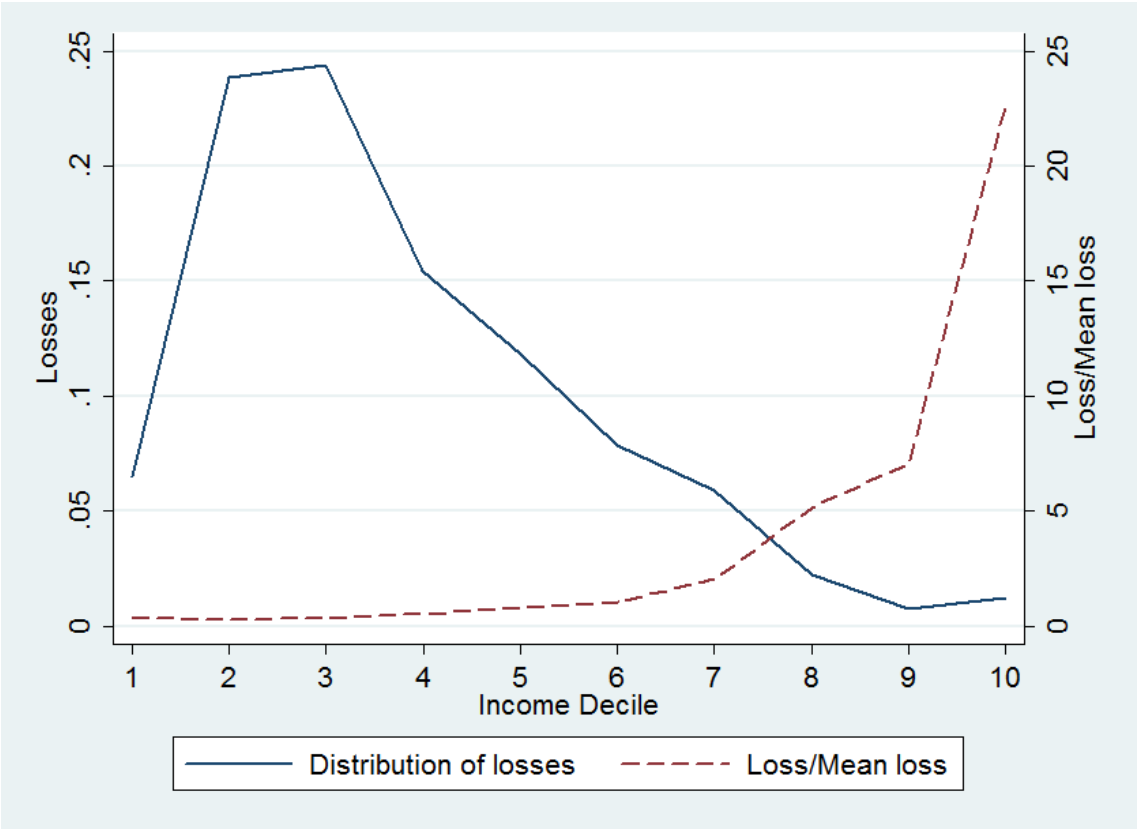



Table 2 continues with descriptive results that is better able to show incentives for the loss usage as carry-forward or carry-back. Even if the tax reform, depicted in Figure 1 lowered the tax refund from carry-forward for losses from 2004 or 2005, a refund from carry-forward could still be higher than from carry-back, depending on the tax units income distribution. Table 2 illustrates incentives for particular loss usage by sorting tax units with different income distributions into different groups. The left panel shows descriptive results for tax units with higher income in the year prior to the loss than following the loss ($Z_{t-1}>Z_{t+1}$), the right panel shows descriptive results for tax units with higher incomes in the year following the loss ($Z_{t-1}<Z_{t+1}$). In both panels are tax units separated into refund maximizing (RM) and non-maximizing (NRM) observations. Table 2 confirms for both panels that refund maximizing tax units have higher averages of tax rate differences than non-maximizing tax units. There are two further points about the descriptive results for

the tax rate differences worth noting. First, the gap between the tax rate differences between refund maximizing and non-maximizing is particularly huge in the right panel with higher income in the following year. Second, due to the tax reform that lowered tax rates in years following the loss, tax units that do not maximize the tax refund would have a 17.4 percentage points higher tax refund from using the first loss Euro as carry-back than from carry-forward.

**Table 2:** Mean and standard deviation sorted after adjacent incomes

| | $Z_{t-1} > Z_{t+1}$ | | $Z_{t-1} < Z_{t+1}$ | |
|---|---|---|---|---|
| | NRM | RM | NRM | RM |
| $\Delta\tau$ | .174 | .22 | .072 | .197 |
| | (.12) | (.13) | (.07) | (.12) |
| | Carry-Forward | | | |
| $\frac{Forward}{Z_{t+1}}$ | .518 | .20 | .389 | .398 |
| | (.41) | (.38) | (.40) | (.37) |
| $\frac{Forward}{Losses}$ | .618 | .077 | .549 | .781 |
| | (.42) | (.20) | (.44) | (.34) |
| $\frac{Forward}{Used\ Losses}$ | .884 | .128 | .676 | .900 |
| | (.32) | (.27) | (.46) | (.27) |
| | Carry-Back | | | |
| $\frac{Back}{Z_{t-1}}$ | .065 | .291 | .147 | .082 |
| | (.20) | (.29) | (.28) | (.23) |
| $\frac{Back}{Losses}$ | .113 | .810 | .316 | .09 |
| | (.31) | (.34) | (.45) | (.26) |
| $\frac{Back}{Used\ Losses}$ | .116 | .872 | .324 | .10 |
| | (.32) | (.27) | (.46) | (.27 ) |
| Number of Observation | 2136 | 2515 | 1468 | 2712 |

*Notes:* RM denotes tax units that maximize the tax refund, NRM denotes tax units that do not maximize the tax refund. $Z_{t-1}$ is total income from the year prior to the loss, $Z_{t+1}$ income from the year following the loss. Observations are taxpayers with losses from either 2004 or 2005 and with incomes exceeding the basic allowance in the adjacent years.

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

Table 2 also displays the distribution of loss usage in greater detail. Three ratios show different aspects of loss usage: the first ratio compares carry-forward (carry-back) to income of the following year (income of the prior year), the second carry-forward (carry-back) to the total losses and the third carry-forward (carry-back) to all used losses.[26]

The three measures confirm that non-maximizing tax units do not use their losses according to their income and tax rate distribution. The sub-group of non-maximizing

[26]Total losses can exceed the used losses if total losses are bigger than the adjacent income.

tax units with higher incomes in the year prior to the loss, use only 12% of carry-back of their used losses while using 62% of total losses as carry-forward. Those tax units use excessive carry-forward even when the refund from carry-back would be higher.[27] This is particularly interesting since the German income tax code would automatically assign losses as carry-back if not chosen differently by the tax unit. Also, carry-backs offer other potential advantages: the tax refund is one year earlier than a refund from the subsequent year and higher tax rates in the year prior to the loss offer higher tax refunds. In contrast, tax refund maximizing tax units with higher income in the year prior to the loss use 87% of their used losses as carry-back and only 8% of total losses as carry-forward. Non-maximizing loss users in the right panel have a low average of tax rate difference and use excessive carry-back. However, differences between refund maximizing and non-maximizing tax units are not as striking for tax units with higher incomes in the year following the loss. Refund maximizing tax units use 90% of their losses as carry-forward, while non-maximizing tax units only 68%. However note that differences between groups are not statistically significant in this descriptive analysis.

# 4 Regression Analysis

This section presents results from the regression analysis. Section 4.1 starts with results from the Probit model in Table 3. Results are based on a strong criterion for tax refund maximization: every tax unit that could have an increased tax refund from an alternative loss allocation is denoted as non-maximizing. A sensitivity analysis, relaxing this strong requirement on refund maximization is presented in in Table 4.

All results from Table 3 and Table 4 are drawn from a selective sub-sample with tax units that face a decision of their loss usage between carry-back and carry-forward.[28] This induces a potential selection problem and section 4.2 presents results in Table 5 based Probit model which controls for the selective nature of the data following Heckman (1979).

[27] About 60% of all tax units use only carry-forward, 29% use only carry-back and only 11% use both carry-back and carry-forward.

[28] Only tax units with income above the basic allowance in the years adjacent to the loss can reduce tax burden in both years with the usage of carry-back or carry-forward.

## 4.1 Probit model

The Probit model estimates the tax refund maximizing loss usage $y_i$ of tax unit $i$ equaling 1 if the tax unit maximizes the tax refund, and 0 if not. The model includes a constant, the individual difference of the tax rates $\Delta\tau_i$ and two types of control variables $X_i$ and $Z_i$. $\Delta\tau_i$ is allowed to have a non-linear relationship, measured by $\alpha_1$ and $\alpha_2$, $X_i$ contains characteristics of the tax unit which could have an influence on loss usage, measured by column vector $\beta_1$ and $Z_i$ includes the adjacent incomes and the absolute value of the loss in logs, measured by column vector $\beta_2$.[29] To control for the influence of the variables contained in $Z_i$, regressions are also performed using only a subset of the controls of $Z_i$. $u_i$ is the error term and is assumed to follow the standard normal distribution.[30] Since tax units can file the income report at the end of the year following the loss, I assume that all incomes from loss adjacent years and the loss are exogenous to usage of the loss.[31]

$$y_i = c + \alpha_1\Delta\tau_i + \alpha_2(\Delta\tau_i)^2 + \beta_1' X_i + \beta_2' Z_i + u_i \tag{2}$$

Column I of Table 3 shows marginal effects for the Probit model of equation(2) without controls for adjacent income and loss. The tax rate difference has a significant, high and concave effect on the likelihood of tax refund maximization. Higher tax rate differences have a strong impact on the probability of tax refund maximization. A tax rate difference of 10 percentage points increases the probability of tax refund maximization by 20.8 percentage points. Most of the control variables including the tax consultant dummy are insignificant, which is surprising.[32]
Tax units with higher incomes are likely to have a higher variation in income, and be able to profit from experience with tax minimizing strategies.

[29] Table A.4 in the appendix describes the control variables in greater detail.

[30] To check that assumption, results for the Logit model, assuming a standard logistic error distribution and the linear probability model, assuming a uniform distribution, are presented in the appendix.

[31] This is equivalent to assuming that tax units do not produce a loss in a year on purpose.

[32] The data provide information about expenses for conducting the income report. Tax units that exceed a lower threshold of expenses are assumed to have a tax consultant. However, results are robust against any probability level.

**Table 3:** Probit model with different specification

| | I | II | III | IV |
|---|---|---|---|---|
| $\Delta\tau$ | 2.378*** | 2.382*** | 2.426*** | 2.459*** |
| | (0.122) | (0.123) | (0.126) | (0.126) |
| $\Delta\tau^2$ | -3.033*** | -3.045*** | -2.448*** | -2.509*** |
| | (0.286) | (0.288) | (0.294) | (0.294) |
| $ln(Z_{t-1})$ | | | -0.057*** | -0.049*** |
| | | | (0.005) | (0.005) |
| $ln(Z_{t+1})$ | | | 0.074*** | 0.080*** |
| | | | (0.004) | (0.004) |
| ln(loss) | | 0.064*** | | 0.087*** |
| | | (0.016) | | (0.016) |
| $\ln(\text{loss})^2$ | | -0.003*** | | -0.005*** |
| | | (0.001) | | (0.001) |
| D tax consultant | 0.015 | 0.011 | 0.010 | 0.007 |
| | (0.011) | (0.011) | (0.010) | (0.010) |
| D business | -0.037* | -0.030* | -0.028 | -0.023 |
| | (0.015) | (0.015) | (0.015) | (0.015) |
| D business, high | 0.038** | 0.021 | 0.010 | 0.007 |
| | (0.013) | (0.014) | (0.013) | (0.014) |
| D rent | 0.009 | 0.008 | 0.013 | 0.010 |
| | (0.015) | (0.015) | (0.015) | (0.015) |
| D rent, high | 0.005 | -0.006 | -0.008 | -0.013 |
| | (0.015) | (0.015) | (0.015) | (0.015) |
| D year | -0.022* | -0.023* | -0.021* | -0.021 |
| | (0.010) | (0.010) | (0.010) | (0.010) |
| D prior losses | -0.045*** | -0.046*** | -0.059*** | -0.057*** |
| | (0.012) | (0.012) | (0.012) | (0.012) |
| Pseudo-$R^2$ | .090 | .091 | .126 | .128 |
| Number of Observations | 8831 | 8831 | 8831 | 8831 |
| Share of RM | .592 | .592 | .592 | .592 |

*Notes:* Regressions also include a constant, a marriage dummy and a dummy for losses bigger than income from adjacent years. Asterisks denote the respective significance level at 95% (*), 99% (**), and 99.9% (***). $ln(Z_{t-1})$ is the logarithm of the total income from the year prior to the loss, $ln(Z_{t+1})$ is accordingly the income from the year following the loss. Share of RM is the relative share of refund maximizing tax units.

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

Also, tax units with higher losses might substantially differ from tax units with lower losses but could have the same tax rate difference. For instance, they could have more resources at their disposal to plan their income declaration, have higher education or experience the loss with a different background.

To control for influence of potential heterogeneity between tax units with the same tax rate difference, results in column III and IV include the losses and column II

and IV include the adjacent incomes. Adding the losses in column II has no effect on the coefficients of the tax rate differences. However, the probability of tax refund maximization increases with increasing losses, also with a concave effect.
Including incomes from the adjacent years in column III leaves the marginal effects of the tax rates virtually unchanged. The marginal effect of income from the year before the loss is negative, the marginal effect from income from the year following the loss is positive. This is connected to the tendency of a large group of tax units to use losses preferably in the following than the prior year.
Adding both the incomes and losses in column IV does not affect the tax rate difference significantly, but slightly increases its effect. Now, a 10 percentage point tax rate difference increases the probability of tax refund maximization by 22 percentage points.
First robustness checks are performed in Table 4 which presents a variation in the criterion of of tax refund maximization. Column I is a reproduction of column IV of Table 3 and is based on the strong refund maximization criterion.
To control for this strong requirement of refund maximization, three alternative definitions are applied and compared to the benchmark results from column I. Results in column II are produced based on the first alternative refund maximization definition: tax units can deviate up to 200 Euros of tax refund from the strong criterion. This criteria does not penalize minor deviations from strict refund maximization.[33] This increases the share of refund maximizing tax units by 7.6 percentage points. The second alternative in column III allows tax units to deviate up to 5% of the loss income ratio. This is my preferred specification because it allows relative small deviations from the strong criterion and redefines only tax units with their majored of losses used for refund maximization.
This is my preferred specification because it allows relative small deviations from the strong criterion and redefines only tax units that use their majority of losses for refund maximization.[34] Compared to the benchmark, the share of refund maximizer increases by 11.5 percentage points. Column IV shows results based on the third alternative: tax units can deviate up to 2% of the potential maximum of tax refund, which increases the share by 14.8 percentage points to 74%.

[33]Note that this criteria changes the sorting of the tax units asymmetrically and is likely to redefine non-maximizing tax units with small losses more often into the refund maximization category than tax units with bigger losses.

[34]Noe, that this alternative does not assign tax units with small losses automatically to the tax refund maximizing category.

**Table 4:** Probit for different criteria of refund maximization

| | I | II | III | IV |
|---|---|---|---|---|
| | No Deviation allowed | 200 Euro Deviation | Loss weighted Deviation(5%) | Tax-Refund weighted Deviation(2%) |
| $\Delta\tau$ | 2.459*** | 2.155*** | 1.801*** | 1.633*** |
| | 0.126 | 0.120 | 0.120 | 0.115 |
| $\Delta\tau^2$ | -2.509*** | -2.525*** | -1.436*** | -1.509*** |
| | 0.294 | 0.278 | 0.284 | 0.269 |
| $ln(Z_{t-1})$ | -0.049*** | -0.052*** | -0.014** | -0.023*** |
| | 0.005 | 0.005 | 0.005 | 0.005 |
| $ln(Z_{t+1})$ | 0.080*** | 0.040*** | 0.064*** | 0.049*** |
| | 0.004 | 0.004 | 0.004 | 0.004 |
| ln(loss) | 0.087*** | -0.201*** | -0.219*** | -0.301*** |
| | 0.016 | 0.020 | 0.021 | 0.023 |
| $\ln(\text{loss})^2$ | -0.005*** | 0.009*** | 0.008*** | 0.012*** |
| | 0.001 | 0.001 | 0.001 | 0.001 |
| D tax consultant | 0.007 | 0.005 | 0.012 | 0.014 |
| | 0.010 | 0.010 | 0.010 | 0.009 |
| D business | -0.023 | -0.038** | -0.059*** | -0.052*** |
| | 0.015 | 0.015 | 0.014 | 0.014 |
| D business, high | 0.007 | 0.028* | 0.042** | 0.053*** |
| | 0.014 | 0.013 | 0.013 | 0.013 |
| D rent | 0.010 | 0.011 | 0.002 | 0.004 |
| | 0.015 | 0.014 | 0.014 | 0.013 |
| D rent, high | -0.013 | 0.007 | 0.003 | 0.013 |
| | 0.015 | 0.014 | 0.014 | 0.013 |
| D year | -0.021* | 0.003 | 0.007 | 0.011 |
| | 0.010 | 0.009 | 0.009 | 0.009 |
| D prior losses | -0.057*** | -0.048*** | -0.029** | -0.029** |
| | 0.012 | 0.011 | 0.011 | 0.010 |
| Pseudo-$R^2$ | .128 | .14 | .128 | .123 |
| Number of Observations | 8831 | 8831 | 8831 | 8831 |
| Share of RM | .592 | .668 | .707 | .740 |

*Notes:* Regressions also include a constant, a marriage dummy and a dummy for losses bigger than income from adjacent years. Asterisks denote the respective significance level at 95% (*), 99% (**), and 99.9% (***). $ln(Z_{t-1})$ is the logarithm of the total income from the year prior to the loss, $ln(Z_{t+1})$ is accordingly the income from the year following the loss. Share of RM is the relative share of refund maximizing tax units.

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

A tax rate difference of 10 percentage points increases the likelihood of refund maximization by 19 percentage points in column II, by 16.6 percentage points in column III and by 14.8 percentage points in column IV. However, while the marginal effect of the tax rate difference decreases, it remains significant and has a high influence on the likelihood of refund maximization.

Results for the tax rate difference suggest that the increasing share of refund maximizer reduces the differences between the refund maximizer and the non refund maximizing tax units. Changing the definition of refund maximization induces only one noticeable difference for the control variables with the coefficients for the loss. The coefficient changes from 0.09 in column I to -0.20 in column II and remains that high and negative for the alternative specifications in column III and IV. This indicates that tax units with smaller losses change disproportionally more from the non-maximizing to the refund maximizing group. Moreover, this implies the surprising result that following column II to IV, the higher the loss of the tax unit, the lower the probability of refund maximization.

## 4.2 Probit model including a selection control

Results so far can be driven by a potential selection bias through non-random selection which would not allow to interpret the marginal effects as causal effects.[35] To control for the selection, results in Table 5 are based on the Probit model including a Heckman (1978) selection control.[36]

Results in Table 5 are produced analogously to results in Table 4 with varying refund maximization criteria. The selection parameter, the inverse Mills ratio $\lambda$ is significant for all specifications with little variation between the optimality definitions and a mean of 0.1Again, most marginal effects of the control variables are not sensitive to the criterion of refund maximization. A 10 percentage point tax rate difference in my favored specification in column III increases the probability of refund maximization by 24.5 percentage points. The effect of the loss is negative for all specifications but the benchmark criteria, with smaller marginal effects (in absolute value) in column II to IV. Results from these estimations confirm that tax incentives determine loss usage. High tax incentives increase the likelihood of refund maximization, thus driving tax avoidance.

[35]Results from Table 3 and Table 4 are based on a heavy selective sample: only tax units with losses and adjacent incomes exceeding the basic allowance have the necessary loss usage circumstances.

[36]The exclusion restriction for the Heckit is the number of children, age of the tax units and information about losses from earlier years.

**Table 5:** Probit model including selection control for different criteria of refund maximization

| | I | II | III | IV |
|---|---|---|---|---|
| | No Deviation allowed | 200 Euro Deviation | Loss weighted Deviation(5%) | Tax-Refund weighted Deviation(2%) |
| $\Delta\tau$ | 3.100*** | 2.930*** | 2.800*** | 2.617*** |
| | (0.201) | (0.194) | (0.192) | (0.186) |
| $\Delta\tau^2$ | -3.858*** | -4.155*** | -3.536*** | -3.577*** |
| | (0.444) | (0.426) | (0.426) | (0.410) |
| $ln(Z_{t-1})$ | -0.029*** | -0.028*** | 0.016* | 0.006 |
| | (0.007) | (0.007) | (0.007) | (0.007) |
| $ln(Z_{t+1})$ | 0.098*** | 0.061*** | 0.091*** | 0.076*** |
| | (0.006) | (0.006) | (0.006) | (0.006) |
| ln(loss) | 0.173*** | -0.105*** | -0.098** | -0.185*** |
| | (0.027) | (0.028) | (0.028) | (0.029) |
| $\ln(\text{loss})^2$ | -0.010*** | 0.004* | 0.001 | 0.005*** |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| D tax consultant | 0.003 | 0.000 | 0.006 | 0.008 |
| | (0.011) | (0.010) | (0.010) | (0.009) |
| D business | -0.015 | -0.029* | -0.048** | -0.041** |
| | (0.015) | (0.015) | (0.014) | (0.014) |
| D business, high | -0.001 | 0.019 | 0.031* | 0.042** |
| | (0.014) | (0.014) | (0.013) | (0.013) |
| D rent | 0.015 | 0.017 | 0.010 | 0.012 |
| | (0.015) | (0.014) | (0.014) | (0.013) |
| D rent, high | -0.018 | 0.001 | -0.003 | 0.007 |
| | (0.015) | (0.014) | (0.014) | (0.013) |
| D year | -0.036*** | -0.015 | -0.016 | -0.012 |
| | (0.011) | (0.010) | (0.010) | (0.009) |
| D prior losses | -0.084*** | -0.081*** | -0.072*** | -0.070*** |
| | (0.014) | (0.013) | (0.013) | (0.012) |
| $\lambda$ | 0.112*** | 0.138*** | 0.176*** | 0.175*** |
| | (0.028) | (0.028) | (0.027) | (0.026) |
| $N_1$ | 8831 | 8831 | 8831 | 8831 |
| $N_2$ | 1849155 | 1849155 | 1849155 | 1849155 |
| Share of RM | .592 | .668 | .707 | .740 |

*Notes:* Regressions also include a constant, a marriage dummy and a dummy for losses bigger than income from adjacent years. Asterisks denote the respective significance level at 95% (*), 99% (**), and 99.9% (***). $log(Z_{t-1})$ is the logarithm of the total income from the year prior to the loss, $log(Z_{t+1})$ is accordingly the income from the year following the loss. $\lambda$ denotes the inverse Mills ratio from Heckmans sample selection model. $N_1$ is the number of observations used in the second stage of the model, $N_2$ the number of observations that are not included in the second stage of the model but in the first stage of the Heckman model. Share of RM is the relative share of refund maximizing tax units.

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

Moreover, tax units with low tax rate differences do not use losses to maximize tax refunds because incentives are not high enough.

# 5 Conclusion

This paper uses a substantial insurance component of the German income tax code to study opportunities of tax avoidance. German tax units with severe income shocks who experience a loss in a year can offset that loss with positive incomes from adjacent years. Tax avoidance is maximized if the offset losses are used according to tax rates from the loss adjacent years.

The paper uses a unique German tax return panel data that comprise six straight years, from 2001 to 2006, and three different tax rate schedules. That data connects exhaustive individual information about incomes, socio-demographic characteristics and losses. Moreover, it allows to connect the losses from one year with its usage in the surrounding years. Micro simulation provides tax rates and the computation of the potential tax refund from the loss usage, and the computation of the refund maximizing loss usage. The progressive German tax schedule and two steps of a recent income tax reform provide strong exogenous variation of tax refund and promote to use losses in the year before the loss.

Results show that only about 59% of tax units maximize their tax refund. Non-refund maximizing tax units belong mainly to two groups: tax units with low increase of tax refund from an alternative loss allocation, or tax units that prefer future tax refund over current tax refund.[37] However, the share of 59% refund maximization is based on a strong criterion for tax refund maximization: the tax unit needs to use all losses according the refund maximization loss allocation. Relaxing that somewhat strong criterion by allowing minor deviations increases the share up to 67% or 74% depending on the deviation concept.

To investigate determinants that drive tax refund maximization, this chapter further employs the Probit model to estimate determinants of the probability of tax refund maximization. The preferred model includes several socio-demographic control variables, incomes from loss adjacent years and the loss. Further, the model includes the variable of interest, the tax rate difference from the loss adjacent years. That variable illustrates the difference of the tax refund potential from the loss adjacent years. Results from sensitivity analysis show that the marginal effects of the tax rate difference is robust against the inclusion of incomes from adjacent years and the loss. Further, results imply that tax consultants have no significant positive impact on the probability of tax refund maximization. Main results are drawn from the

[37] That is particular interesting since the German income tax code would automatically assign losses as carry-back if not chosen differently by the tax unit. Moreover, carry-backs offer other potential advantages: the tax refund is one year earlier than a refund from the subsequent year and higher tax rates in the year prior to the loss offer higher tax refunds.

Probit model including a selection control following Heckman (1978). That selection control counteracts the selective nature of the estimation sample: only tax units that experience an aggregated loss in one year and have incomes above the basic allowance in the loss adjacent years have incentives for inter-temporal loss usage. The first requirement is an obvious necessity for studying inter-temporal loss usage, the second requirement ensures that the tax units have incentives for loss usage in both years and need to decide where to use it. In order to control for the selective nature of the estimation sample and to interpret marginal effects as partial effects, the Heckman model includes a selection control from a first step estimation. Indeed results from the Heckman model confirm the necessity of the selection control.
Results from the preferred model are obtained for four different definitions of tax refund maximization. Most reasonable results are obtained from allowing minor deviations of 200 Euro from the strong criterion. Estimations suggest that a tax rate difference of 10 percentage points increases the probability of tax refund maximization by 24.5 percentage points.
That result is robust for alternative definitions of tax refund maximization including relative deviations from the strong criterion. Estimation results from the strong criterion however propose a stronger impact from the tax rate difference. A 10 percentage points tax rate difference increases then the probability of tax refund maximization by 27.1 percentage points.
Results from this chapter suggest that tax avoidance is especially large when tax incentives have a considerable size. Further, that tax incentives of small size are less likely to induce tax units to maximize their tax refund and to exercise tax avoidance. This result is in line with Lang et. al (1997) who find that tax avoidance in Germany increases with increasing tax rates and is of significant size and confirms theoretical results that tax avoidance is very responsive to taxation (Slemrod 1995, 2001). Moreover, results imply that tax avoidance is non-constant, increases with tax rates and is stronger than income reactions to taxation.[38] Following Chetty (2009), this provides further evidence that the elasticity of taxable income is inappropriate for welfare analysis of income taxation.

[38]See Chapter 2 for estimations of the taxable income to tax rate changes.

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# 7 Appendix

## 7.1 Data and data processing[39]

Relevant information generated in the process of taxation is documented in the income tax return: information on the family situation, declaration of income from different sources, granted deductions and exemptions, calculation of taxable income, and personal income tax payment. The German Federal Statistical Office collects the official income tax returns electronically as Income Tax Statistics, providing the basis for a balanced panel, the German Taxpayer Panel. Individual taxpayer's IDs are used to link annual cross section income tax returns over time to create the panel. However, this procedure might be problematic. In cases of marriage, divorce or moving to another federal state, individual tax ID will be given up, created new or changed. Additionally, German wage earners are not forced to file a tax return unless they have other sources of income. Moreover, the incentive for wage earners of filing a tax return depends on the expectation of a possible tax refund. The German Taxpayer Panel does not include tax returns which are only available for a subset of years and not consistently linkable. It contains income tax returns of approximately 19 million observations out of possible 31 million taxpayers included in the Income Tax Statistics. Several socio-economic characteristics of taxpayers such as age, number of children, church membership and marital status are observable. Tax units with losses are very likely to file income reports since they have a potential tax saving ability. Furthermore, tax units with atypical income structure need to file a tax report anyway.

On basis of five stratification criteria, i.e. federal state, assessment type, main type of income, level of total income and variation of the total income, a 5% sample is drawn and made available for scientific purposes. The stratification procedure aims to optimize the sample with regard to standard errors of total income over time. Observation weights are generated accordingly. Tax units with high positive income are highly over-sampled in our sample. However, losses of tax units are not over sampled and I assume that they are only randomly drawn and are representative for tax units with losses in Germany.

[39] The first half of this section is taken from an earlier working paper with Nima Massarrat-Mashhadi (see Massarrat-Mashhadi (2012)).

## 7.2 Further Descriptive Statistics

**Figure 5:** Distribution of further tax refunds

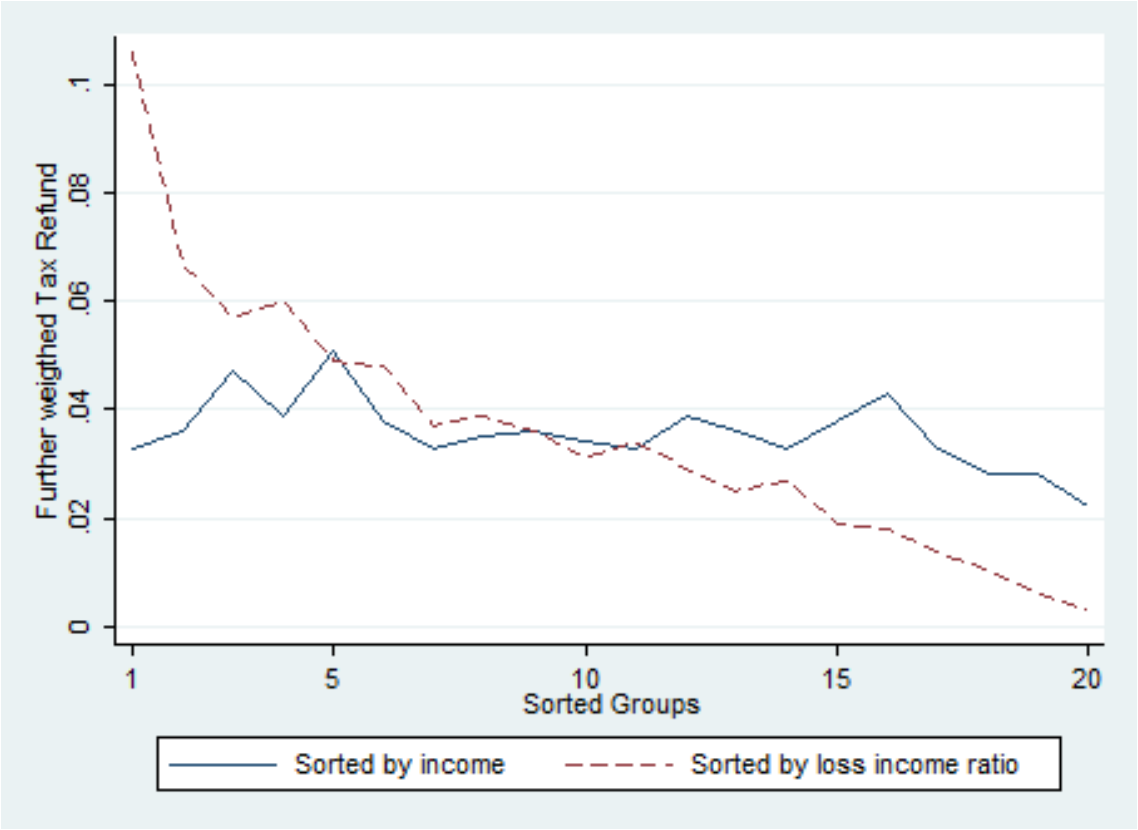


Figure 5 is a reproduction of Figure 3 and shows the ratio of further tax refunds to the size of the loss if tax units would have used all losses according to refund maximizing. Average shares of the ratio are computed and ordered into 20 equally sized groups and sorted by adjacent income (solid line) or the losses income ratio (dotted line). The ratio can be understood as a weighted result of the deviating losses: deviating losses are weighted by the individual tax rates and the loss. If tax rates are different along the sorting, the average shares of the refund ratio should show a varying pattern. Sorting tax units according to income shows a robust share of refund ratio for all 20 groups. Sorting according to the loss income ratio, however, highlights a strong decline for refund ratio for increasing loss income ratio. These patterns are very similar to the patterns in Figure 3 which suggests that further refund follows a similar distribution to the deviating losses.

## 7.3 Results from the Logit model

Results in Table A.1 and Table A.2 show marginal effects from the Logit model for different criteria of redund maximization. Table A.1 shows results for the model without the selection control from the two step Heckman approach, and Table A.2 including the selection control.
All in all, marginal effects from the Logit model resemble the marginal effects from the Probit model remarkably well. The marginal effects of the tax rate difference in Table A.2 have the same size and are not statistically different from the marginal effects from the Probit model in Table 4. Results in Table A.2 also resemble results from the Probit model in Table 5 remarkably well and are statistically not distinguishable.

**Table A.1:** Logit for different criteria of refund maximization

| | I | II | III | IV |
|---|---|---|---|---|
| | No Deviation allowed | 200 Euro Deviation | Loss weighted Deviation(5%) | Tax-Refund weighted Deviation(2%) |
| $\Delta\tau$ | 2.442*** | 2.133*** | 1.775*** | 1.627*** |
| | (0.126) | (0.119) | (0.120) | (0.115) |
| $\Delta\tau^2$ | -2.457*** | -2.478*** | -1.324*** | -1.463*** |
| | (0.300) | (0.281) | (0.297) | (0.277) |
| $ln(Z_{t-1})$ | -0.048*** | -0.048*** | -0.012** | -0.020*** |
| | (0.005) | (0.005) | (0.005) | (0.005) |
| $ln(Z_{t+1})$ | 0.082*** | 0.040*** | 0.064*** | 0.048*** |
| | (0.004) | (0.004) | (0.004) | (0.004) |
| ln(loss) | 0.089*** | -0.204*** | -0.223*** | -0.308*** |
| | (0.016) | (0.020) | (0.022) | (0.024) |
| $\ln(\text{loss})^2$ | -0.005*** | 0.009*** | 0.008*** | 0.012*** |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| D tax consultant | 0.007 | 0.005 | 0.011 | 0.014 |
| | (0.010) | (0.010) | (0.010) | (0.009) |
| D business | -0.023 | -0.038** | -0.060*** | -0.054*** |
| | (0.015) | (0.015) | (0.014) | (0.014) |
| D business, high | 0.008 | 0.027* | 0.041** | 0.051*** |
| | (0.014) | (0.013) | (0.013) | (0.012) |
| D rent | 0.010 | 0.011 | 0.001 | 0.003 |
| | (0.015) | (0.014) | (0.014) | (0.013) |
| D rent, high | -0.013 | 0.006 | 0.003 | 0.013 |
| | (0.015) | (0.014) | (0.014) | (0.013) |
| D year | -0.022* | 0.002 | 0.006 | 0.010 |
| | (0.010) | (0.010) | (0.009) | (0.009) |
| D prior losses | -0.056*** | -0.047*** | -0.028** | -0.028** |
| | (0.012) | (0.011) | (0.011) | (0.010) |
| Pseudo-$R^2$ | .127 | .139 | .128 | .122 |
| Number of Observations | 8831 | 8831 | 8831 | 8831 |
| Share of RM | .592 | .668 | .707 | .740 |

*Notes:* Regression includes a constant, a marriage dummy and a dummy for losses bigger than income from adjacent years. Asterisks denote the respective significance level at 95% (*), 99% (**), and 99.9% (***). $ln(Z_{t-1})$ is the logarithm of the total income from the year prior to the loss, $ln(Z_{t+1})$ is accordingly the income from the year following the loss. Share of RM is the relative share of refund maximizing tax units.

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

**Table A.2:** Logit model including selection control for different criteria of refund maximization

| | I | II | III | IV |
|---|---|---|---|---|
| | No Deviation allowed | 200 Euro Deviation | Loss weighted Deviation(5%) | Tax-Refund weighted Deviation(2%) |
| $\Delta\tau$ | 3.051*** | 2.905*** | 2.767*** | 2.607*** |
| | (0.202) | (0.196) | (0.195) | (0.189) |
| $\Delta\tau^2$ | -3.744*** | -4.103*** | -3.418*** | -3.529*** |
| | (0.449) | (0.432) | (0.441) | (0.422) |
| $ln(Z_{t-1})$ | -0.029*** | -0.025*** | 0.018** | 0.009 |
| | (0.007) | (0.007) | (0.007) | (0.007) |
| $ln(Z_{t+1})$ | 0.099*** | 0.061*** | 0.091*** | 0.074*** |
| | (0.006) | (0.006) | (0.006) | (0.006) |
| ln(loss) | 0.171*** | -0.109*** | -0.103 *** | -0.194*** |
| | (0.027) | (0.028) | (0.029) | (0.030) |
| $\ln(\text{loss})^2$ | -0.010*** | 0.004* | 0.001 | 0.006*** |
| | (0.001) | (0.002) | (0.002) | (0.002) |
| D tax consultant | 0.003 | 0.001 | 0.005 | 0.008 |
| | (0.011) | (0.010) | (0.010) | (0.009) |
| D business | -0.015 | -0.029 | -0.048** | -0.043** |
| | (0.015) | (0.015) | (0.014) | (0.014) |
| D business, high | 0.000 | 0.018 | 0.030* | 0.041** |
| | (0.014) | (0.014) | (0.013) | (0.013) |
| D rent | 0.015 | 0.017 | 0.008 | 0.010*** |
| | (0.015) | (0.014) | (0.014) | (0.013) |
| D rent, high | -0.018 | 0.001 | -0.003 | 0.007 |
| | (0.015) | (0.014) | (0.014) | (0.013) |
| D year | -0.037*** | -0.016 | -0.018 | -0.012 |
| | (0.011) | (0.010) | (0.010) | (0.009) |
| D prior losses | -0.082*** | -0.080*** | -0.070*** | -0.069*** |
| | (0.014) | (0.013) | (0.012) | (0.012) |
| $\lambda$ | 0.108*** | 0.138*** | 0.176*** | 0.174*** |
| | (0.028) | (0.028) | (0.028) | (0.027) |
| $N_1$ | 8831 | 8831 | 8831 | 8831 |
| $N_2$ | 1849155 | 1849155 | 1849155 | 1849155 |
| Share of RM | .592 | .668 | .707 | .740 |

*Notes:* Regressions also include a constant, a marriage dummy and a dummy for losses bigger than income from adjacent years. Asterisks denote the respective significance level at 95% (*), 99% (**), and 99.9% (***). $log(Z_{t-1})$ is the logarithm of the total income from the year prior to the loss, $log(Z_{t+1})$ is accordingly the income from the year following the loss. $\lambda$ denotes the inverse Mills ratio from Heckmans sample selection model. $N_1$ is the number of observations used in the second stage of the model, $N_2$ the number of observations that are not included in the second stage of the model but in the first stage of the Heckman model. Share of RM is the relative share of refund maximizing tax units.

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

## 7.4 Results from the linear probability model

**Table A.3:** Probit model including selection control for different criteria of refund maximization

| | I | II | III | IV |
|---|---|---|---|---|
| | No Deviation allowed | 200 Euro Deviation | Loss weighted Deviation(5%) | Tax-Refund weighted Deviation(2%) |
| $\Delta\tau$ | 3.349*** | 3.051*** | 2.971*** | 2.639*** |
| | (0.21) | (0.20) | (0.19) | (0.19) |
| $\Delta\tau^2$ | -4.489*** | -4.428*** | -4.046*** | -3.719*** |
| | (0.45) | (0.43) | (0.42) | (0.40) |
| $ln(Z_{t-1})$ | -0.019** | -0.021** | 0.022*** | 0.010 |
| | (0.01) | (0.01) | (0.01) | (0.01) |
| $ln(Z_{t+1})$ | 0.091*** | 0.051*** | 0.080*** | 0.062*** |
| | (0.01) | (0.01) | (0.01) | (0.01) |
| ln(loss) | 0.173*** | -0.054* | -0.008 | -0.037 |
| | (0.03) | (0.03) | (0.03) | (0.02) |
| $\ln(\text{loss})^2$ | -0.010*** | 0.001 | -0.003* | -0.001 |
| | (0.00) | (0.00) | (0.00) | (0.00) |
| D tax consultant | 0.004 | -0.000 | 0.003 | 0.006 |
| | (0.01) | (0.01) | (0.01) | (0.01) |
| D business | -0.014 | -0.024 | -0.038** | -0.026 |
| | (0.02) | (0.01) | (0.01) | (0.01) |
| D business, high | 0.001 | 0.014 | 0.023 | 0.029* |
| | (0.01) | (0.01) | (0.01) | (0.01) |
| D rent | 0.014 | 0.014 | 0.006 | 0.008 |
| | (0.01) | (0.01) | (0.01) | (0.01) |
| D rent, high | -0.016 | -0.004 | -0.011 | -0.005 |
| | (0.02) | (0.01) | (0.01) | (0.01) |
| D year | -0.040*** | -0.016 | -0.017 | -0.010 |
| | (0.01) | (0.01) | (0.01) | (0.01) |
| D prior losses | -0.082*** | -0.075*** | -0.062*** | -0.058*** |
| | (0.01) | (0.01) | (0.01) | (0.01) |
| $\lambda$ | 0.105*** | 0.112*** | 0.139*** | 0.125*** |
| | (0.03) | (0.03) | (0.03) | (0.03) |
| $N_1$ | 8831 | 8831 | 8831 | 8831 |
| $N_2$ | 1849155 | 1849155 | 1849155 | 1849155 |
| Share of RM | .592 | .668 | .707 | .740 |

*Notes:* Regressions also include a constant, a marriage dummy and a dummy for losses bigger than income from adjacent years. Asterisks denote the respective significance level at 95% (*), 99% (**), and 99.9% (***). $log(Z_{t-1})$ is the logarithm of the total income from the year prior to the loss, $log(Z_{t+1})$ is accordingly the income from the year following the loss. $\lambda$ denotes the inverse Mills ratio from Heckmans sample selection model. $N_1$ is the number of observations used in the linear probability model, $N_2$ the number of observations that are not included in the linear probability model but in the first stage of the Heckman model. Share of RM is the relative share of refund maximizing tax units.

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

Results for the Probit model are very similar to the results from the linear probability model in Table A.3. A 10 percent tax rate difference for the benchmark specification for the linear probability model increases the probability of refund maximization by 29 percentage points. Allowing for minor deviations from refund maximization delivered for the 10 percent tax rate difference effects of 26.1 in column II, 25.7 in column III and 22.7 in column IV. These effects are slightly higher than the marginal effects from the Probit model which estimates from a 10 percent tax rate difference an increase in the probability of refund maximization by 27.1 percentage points in the benchmark specification in column I, by 25.1 in column II, by 24.5 in column III and by 22.5 in column IV.

**Table A.4:** Dependent variables and covariates

| Variable | Description | Coding/construction |
|---|---|---|
| y | Tax refund maximization variable | Dummy (1=yes; 0=else) |
| $\Delta\tau$ | Difference between first loss Euro tax rates in prior or following year | Absolute value of difference |
| | Variables included in $X_i$ | |
| $log(Z_{t-1})$ | Taxable income of year prior to the loss | Log total income |
| $log(Z_{t+1})$ | Taxable income of year following the loss | Log total income |
| log of loss | Amount of loss in absolute value | Log of the loss |
| | Variables included in $Z_i$ | |
| D tax consult. | Taxpayer has expenses for tax consultant | Dummy (1=yes; 0=else) |
| D business, high | Taxpayer has loss from business more than -10000 | Dummy (1=yes; 0=else) |
| D rent | Taxpayer has loss from rent and lease up till -10000 | Dummy (1=yes; 0=else) |
| D rent, high | Taxpayer has loss from rent and lease more than -10000 | Dummy (1=yes; 0=else) |
| D business | Taxpayer has loss from business up till -10000 | Dummy (1=yes; 0=else) |
| D year | Year of the loss | Dummy (1=2005; 0=2004) |
| D prior losses | Taxpayer had losses in earlier years of the panel | Dummy (1=yes; 0=else) |

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