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Intertemporal Income Shifting Around a Large Tax Cut: The Case of Depreciations

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Abstract

A corporate tax rate cut provides an incentive for corporations to shift taxable income from years before the tax rate cut to post-reform years. Our study analyzes whether depreciations and write-offs are used to achieve intertemporal income shifting. Using a panel of German manufacturing firms, we test in a difference-in-differences setting whether firms reacted to the announced 2008 corporate tax rate cut of 10 percentage points by accumulating depreciation expenses in the pre-reform year. Our results suggest that depreciation expenses in 2007 are on average about 2.5% higher than in the other observation years. Our analysis also sheds light on heterogeneity in intertemporal income shifting across firms. We provide evidence for a weaker reaction of loss firms resulting from a lower tax incentive. By contrast, we find stronger intertemporal income shifting of large firms and especially firms with a relatively high share of new investments in the capital stock. While the first result is consistent with a higher cost-efficiency of tax planning of large firms, the second finding suggests that investments in the current year provide more discretion for (tax-induced) earnings management.

Keywords

Tax planning; Intertemporal income shifting; Tax avoidance opportunity; Depreciations; Write-offs

JEL Classifications

H25 · M41

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Intertemporal Income shifting around a Large Tax Cut: The Case of Depreciations and Write-Offs

1. Introduction

The accounting literature provides robust evidence that foreseeable changes in corporate income tax rates lead to strategies of intertemporal shifting of taxable income (in the following intertemporal income shifting) of firms to save tax payments. Scholes et al. (1992) exploit a large corporate income tax cut through the U.S. Tax Reform Act (TRA) 1986 and find that firms shift profits from high-tax years to low-tax years. Existing studies in this field (e.g., Boynton et al. 1992; Manzon 1992; Scholes et al. 1992; Guenther 1994, Maydew 1997; Sundvik 2017) rely on financial accounting data and therefore address the question if tax incentives of firms result in tax-induced earnings management strategies respectively conforming tax planning that also affect the financial accounts. However, these studies are not able to identify non-conforming tax avoidance strategies that might shift taxable income without affecting book income.

In our paper, we analyze a large tax cut in the German corporate income tax rate. As part of the German Business Tax Reform 2008 (in the following BTR 2008), the German parliament decided a reduction of the German corporate income tax rate from 25% to 15%. Considering further changes of the German BTR 2008, this lead to a reduction of the marginal tax rate of German corporations between 7.8 to 10.2 percentage points from 2007 to 2008 and created a strong incentive to shift taxable income from the year 2007 to the following periods like 2008 and 2009. Shifting €1 of taxable income resulted in a permanent tax saving of about €0.08 to €0.10. The reform passed the German legislation process in July 2007. Thus, there was sufficient time for German investors to anticipate the tax rate cut and to adjust tax avoidance strategies.

We focus on the question if and to what extent the BTR 2008 affected the accumulation in depreciations for tax accounting purposes in the year 2007. In spite of detailed regulations in the German income tax code and the depreciation tables (German: *AfA-tabellen*) of the German fiscal administration regarding amortization periods and depreciation methods, depreciations are a business expense that may provide discretion for intertemporal income shifting. As we have access to a business survey encompassing information on tax accounting depreciations, we are not only able to identify conforming tax avoidance strategies, but also to account for non-conforming tax avoidance resulting in different depreciations in the tax and financial accounts. In addition, we focus on

depreciations and write-offs as one channel if intertemporal income shifting and address the heterogeneity of shifting across different firm types.

Using a difference-in-differences identification strategy with partnerships and sole proprietorships as control group, we find robust and significant empirical evidence for an abnormal increase of about 2.5% in depreciation expenses in the year 2007. While this outcome might be a lower-bound estimate,[3] it nevertheless suggests that, even in case of a strong intertemporal shifting incentive resulting from the BTR 2008, the impact of intertemporal income shifting on aggregate depreciations in 2007 was not excessively high. This might be due to limited shifting opportunities.

Analyzing heterogeneity in shifting activity across firms we can show that (1) loss firms are less active in intertemporal shifting of income via depreciations; (2) large firms with a presumably higher cost-efficiency of tax planning are more active in intertemporal income shifiting; (3) there is a very high abnormal increase of about 26.2% in depreciation volume in 2007 for firms with a high ratio of new investments in their capital stock. The third finding confirms the expectation that shifting opportunity via depreciations is much higher for new investments compared to investments of earliers years, where amortization periods and depreciation schedules have already been set. We do not find empirical support that shifting activity is significantly related to the excessive use of debt finance (as measure for financial reporting costs, see Guenther 1994). In part, this might be due to the fact that we also consider non-conforming tax avoidance strategies and not only conforming tax-induxed earnings management with high financial reporting costs.

Our heterogeneity tests also provide an explanation for the relatively small aggregate estimated effect on depreciation volume in 2007. Thus, relevant shifting opportunity was only available for depreciations on new investments, while opportunities for additional depreciations and write-offs on the older investments seem to have been very small. In addition, not all firms had incentives for intertemporal shifting of income (loss firms) and costs of tax planning reduce the incentive for the accumulation of depreciation expenses in 2007.

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[3] We cannot fully rule out that some of the non-corporate firms in our control group also had an incentive to shift income from 2007 to 2008. This is for two reasons. First, changes in the local business tax and the personal income tax rate on business earnings generated heterogenous tax incentives for that group of firms, which might add "white noise" to our regression results. Second, corporations may act as partners of partnerships and influence their tax avoidance strategy. However, that should only affect the policy of partnerships in case of large holdings of corporate partners. Due to data limitations, we are not able to identify the owners and parent firms of the businesses in our sample.

We contribute to the literature in several ways. First, while the existing literature on tax-induced earnings management and intertemporal income shifting is almost exclusively focused on the U.S. (an exception is Sundvik 2017 analzing intertemporal income shifting in Sweden), we provide significant evidence that such activities are also relevant for German and European corporations. This is relevant, as the opportunities for intertemporal income shifting via depreciations and write-offs depend on tax-system charactistics and should therefore largely differ between countries. Thus, the external validity of U.S. evidence should be debatable and quantitative estimates cannot be simply extrapolated to other countries.

Second and different from existing research, we provide evidence for conforming and non-conforming strategies of intertemporal income shifting since we rely on tax accounting information. However, the estimated impact of the large tax rate cut on aggregate depreciation volume seems to be relatively small. While our evidence should be taken as a lower bound estimate, our findings nevertheless suggest that shifting opportunity might be limited in case of depreciation expenses, and here especially in case of depreciations and write-offs for old investments. That should also hold nowadays, as current German tax law does not allow any more for the declining balance sheet method. A further implication of that finding is that worries about negative consequences of the very high book-tax conformity in Germany in 2007[4] on the informativeness of German GAAP (e.g., Evers et al. 2016) might be not that relevant for average depreciations and write-offs. Even if we might underestimate the true impact of BTR 2008 on depreciation volumes, it seems unlikely that the very high tax cut of BTR 2008 excessively affected average depreciation volume in the financial accounts. However, our findings also suggest that the loss of informativeness might be higher for certain types of firms (especially for firms with large current investments). Note that our calculations rely on tax accounting information and consider both conforming and non-conforming tax avoidance strategies. Therefore, the impact on the financial accounts should have been smaller than the estimated effect on the tax accounts.

Finally, we extend the existing literature on the heterogeneity of shifting activities. Previous studies suggest stronger intertemporal income shifting of tax-aggressive firms (Lopez et al. 1998; Andries et al. 2017), less shifting of firms with low marginal tax rates

[4] In 2009, the German legislator reduced the degree of book-tax conformity in the German tax code by the introduction of the so-called Balance Sheet Modernisation Act (German: *Bilanzrechtsmodernisierungsgesetz*).

and shifting incentives (Boynton et al. 1992; Manzon 1992), less intertemporal income shifting of firms with high financial reporting costs (Guenther 1994; Cloyd et al. 1996; Kosi and Valentincic 2013) and more intertemporal shifting of private firms with typically lower financial reporting costs than public firms (Burgstahler 2006; Lin et al. 2014).

While the literature provides evidence that intertemporal income shifting is related to marginal tax rates (Boynton et al. 1992; Manzon 1992), we are not aware of evidence for loss firms. We extend the existing literature and can show that loss firms are less active in intertemporal income shifting compared to profitable firms. Second and more innovative, we are the first to address the issue of shifting opportunity and to show empirically that firms with presumably higher shifting opportunities (measured by a high share of current investments in their capital stocks) react stronger to shifting incentives. While this finding may be partially due to the existence of the declining balance method in the German tax rules in 2007, such rules might also be relevant for other tax systems. Furthermore, by showing that large firms are more active in intertemporal shifing of income, we contribute to the literature on the relationship of firm size and tax avoidance (e.g. Zimmerman, 1983; Rego 2003; Richardson and Lanis 2007). Our finding suggests that large firms are more cost-efficient and therefore more active in tax avoidance practices than small firms.

The paper is organized as follows. Section 2 describes the institutional background. We develop our hypotheses in Section 3, and describe the empirical identification strategy and our data in Section 4. We discuss our empirical findings and the robustness tests in Section 5. Section 6 concludes.

2. The German business tax reform 2008

We investigate intertemporal income shifting of corporations by analyzing depreciations for tax purposes before the German BTR 2008. The German tax system for corporations encompasses two main taxes on income: the corporate income tax including a so-called solidarity tax surcharge of 5.5% on the corporate income tax payment and the German local business tax. The local business tax has a basic rate of 3.5%, which is multiplied with a local tax multiplier of typically 2 to 4.9 in the observation period, [5] resulting in local business tax rates of 7.00% to 17.15%.

[5] There also existed higher local business tax multipliers for some small municipalities. For example, Dierfeld had and still has a multiplier of 9 in 2008.

The BTR 2008 introduced major changes in German taxation of companies, including a reduction of the corporate income tax rate from 25% to 15% and adjustments of the German local business tax being relevant for corporations but also for partnerships and individual business taxpayers. Including the solidarity tax surcharge, the reform reduced the effective corporate income tax rate from 26.38% to 15.83% (25% respectively 15% multiplied by 1.055). In addition, BTR 2008 reduced the basic local business tax rate from 5% to 3.5% and abolished the tax deductibility of the local business tax from taxable profit.[6] In the year 2008, local business tax rates typically ranged from 7.00% (local business tax multiplier of 2) to 17.15% (local business tax multiplier of 4.9). Accounting for the higher basic rate of 5% and the tax deductibility of the local business tax from its own tax base, historical tax rates before 2008 were slightly higher (9.09% for a tax multiplier of 2 and 19.68% for a local business tax multiplier of 4.9). The local business tax base is a modified firm profit. The most important modification is the nondeductibility of a fraction of interests, leases, and rents paid (before 2008 only nondeductibility of a fraction of interests for long-term debt). To avoid double taxation, there are also exemptions for distributed profits and dividends.

The main objective of the BTR 2008 was to enhance Germany's attractiveness for business investment. Allover, the BTR 2008 resulted in a reduction of the aggregate business tax rate for corporations (corporate income tax including solidarity tax surcharge and the local business tax) on corporate income. If we assume a local business tax multiplier of 4, the aggregate tax rate was reduced by 8.8 percentage points from 39.3% to 29.8%. Due to the abolishment of the deductibility of the local business tax, the overall reduction of the tax burden depended on the local business tax multiplier with a higher reduction for small tax multipliers. However, corresponding differences were relatively small (10.2 percentage points reduction for a tax multiplier of 2 and 7.8 percentage points for a tax multiplier of 4.9).

While the reform as itself did not change standard rates of the personal income tax,[7] the BTR 2008 also affected the aggregate tax burden of partnerships and sole proprietorships. A main reason were the changes regarding the German local business tax. In contrast to

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[6] Before 2008, the German local business tax payments therefore reduced the tax base of the (corporate and/or personal) income tax and its own tax base.

[7] BTR 2008 introduced reduced personal income tax rates for nondistributed business earnings (German: *Thesaurierungsbegünstigung*) and capital earnings (German: *Abgeltungsteuer)*. The details of these special tax rate regimes go beyond the scope of our analysis. The reduced personal income tax rate for nondistributed business earnings typically results in consequential tax payments in future periods and is therefore regarded as non-benefitial for most partnerships and sole proprietorships.

German corporations, individual taxpayers can credit local business tax payments against their personal income tax (local business tax credit). As the BTR 2008 abolished the deductibility of the German local business tax from taxable profit, BTR 2008 also increased and adjusted the local business tax credit. Additional tax incentives for individual business taxpayers resulted from the introduction of a higher personal income tax rate of 45% for taxpayers with a personal income above 250,000 € (so-called "Reichensteuer") in 2007. On the one hand, this tax reform might have generated an incentive for some individual taxpayers and partnerships to accumulate depreciations in 2007 and thereafter as maximum marginal tax rates increased. On the other hand, Section 32c of the German income tax code effectively delayed the introduction of the 45% tax rate for German taxpayers with business income by one year. As a result, there should also have been an incentive for some German individual taxpayers and partnerships to accumulate business expenses and depreciations in 2008 and thereafter.

Combining the effects of lower local business taxes and potentially higher personal income tax rates for individual business taxpayers from 2007 to 2008, we calculated effective tax rates for different combinations of incomes and local business tax multipliers and find a high variation of tax incentives for individual taxpayers and partnerships. Thus, while the marginal tax rate on business income decreased from 2007 to 2008 for some individual taxpayers by zero to about five percentage points (taxpayers with low personal income and high tax multipliers), it increased for other taxpayers to a similar extent (taypayers with high personal income exceeding 250,000 € and low tax multipliers). Concluding, the BTR 2008 strongly reduced the combined tax rate of German corporations but generated heterogeneous tax effects for German individual business taxpayers and partnerships.

To offset revenue losses from lower tax rates, the BTR 2008 further encompassed a number tax law changes broadening the German income tax base for businesses. These included an extension of the German thin-capitalization tax rules and an adaption of non-deductible business expenses for the German local business tax (e.g., part of the leasing expenses). Most relevant for our analysis, BTR 2008 abolished the declining-balance method for tax accounting purposes that allowed degressive depreciations with a maximum rate of 25% for movable assets like machines and cars before 2008. In addition, one of the reform's main goals was to reduce the incentives of multinational companies to shift profits abroad. Along with the tax rate cut, the reform introduced stricter transfer

pricing regulations broadening the corporate tax base. These rules should not be relevant for our analysis and are therefore not discussed in detail.

3. Theory and hypotheses

3.1 Intertemporal income shifting

Our study analyzes whether corporations accumulate depreciation expenses in the year before a corporate tax cut to shift taxable profits to post-reform years. The rationale is simple: We assume that a corporation tries to minimize its tax burden across years. If the corporation anticipates a change in the applicable tax rate, it is favorable to subject taxable profits to the lower rate. In case of the German BTR 2008, there was an economically significant reduction of the aggregate business tax rate for corporations in the years after 2007 ranging from 7.8 percentage points to 10.2 percentage points. As the reform had been announced during the year 2007, this created a strong incentive to shift earnings from corporations to the following years (e.g. by delaying sales contracts) and to bring forward business expenses from 2008 to 2007.

We expect that corporations had a strong incentive to accumulate depreciations in 2007. However, such a behavior is only feasible if firms have at least some discretion in their depreciation methods for tax accounting. German tax accounting regulations for depreciations are relatively strict and set clear legal constraints. For example, the straight-line method is regarded as standard method, depreciation tables (German: *AfA-Tabellen*) of the German fiscal administration define amortization periods for a myriad of assets and industries, amortization periods for buildings are defined by the German income tax code, and tax-relevant write-offs (German: *Teilwertabschreibung*) are only possible in case of an enduring reduction of the asset value.

Nevertheless, German tax accounting regulations for depreciations and write-offs also provide discretion for intertemporal income shifting. For example, taxpayers may deviate from amortization periods in depreciation tables, if they can prove a more accelerated loss of asset value (e.g., cars with a very high road performance). In case of movable fixed assets, businesses could choose the declining-balance method instead of the straight-line method until the year 2007 for new assets. In case of movable assets with an asset value below 410 € (without VAT), firms could decide for an immediate write-off in the acquisition year. Furthermore, there exist special depreciation regimes like a bonus depreciation for SME firms and accelerated depreciation schemes for historical buildings and buildings in redevelopment areas. Regarding write-offs and amortizations, the

German income tax code requires a long-term reduction in asset value (measured in market prices). However, in practice there is discretion about "true" asset values as well as about the question if a reduction in asset values will be "long-term".

An interesting feature of the German tax accounting regulations especially before the German balance sheet reform 2009 (German: *Bilanzrechtsmodernisierungsgesetz 2009*) is a high degree of book-tax conformity. Thus, in principle German tax depreciations should be in line with book depreciations. However, in practice there was a wide range for differences of tax and book depreciations even before the balance sheet reform 2009. Most relevant, businesses have free choice to define their amortization periods and depreciation methods in their financial accounts as long as they can be justified by rational commercial assessment. By contrast, there exist strict regulations for amortization periods and depreciation methods in the tax accounts as aforementioned. Regarding write-offs, the German GAAP demand a write-off for current assets in case of any reduction of asset value, while the German tax accounting rules only allow for a write-of in case of an enduring loss in asset value. In addition, immediate write-offs for small-value assets in the tax accounts did not have to be considered in the financial accounts.

Concluding, we expect a strong incentive of the German BTR 2008 for German corporations to accumulate tax depreciations in the year 2007 and sufficient opportunity to do so. In spite of a generally high degree of book-tax-conformity in 2007, there was also room for non-conforming tax avoidance strategies that accelerated tax depreciations without affecting book income. Thus, while acculmulated tax depreciations might have been related to financial reporting costs resulting from a tax-driven reduction of book income in 2007, this should not be the case under all circumstances. We expect abnormally high depreciation expenses in 2007 for corporate taxpayers.

H1: Corporations accumulate tax depreciations in 2007 resulting in abnormally high depreciations during that year.

3.2 Heterogeneity in tax avoidance incentives

The incentives of intertemporal income shifting are heterogeneous across firms. Following the literature, we focus on two aspects. First, findings of Manzon (1992), Scholes et al. (1992) and Maydew (1997) suggest that loss firms have a smaller incentive to accumulate business expenses for intertemporal income shifing. The rational of that consideration is simple. It is only advantageous for a company to accumulate tax-deductible depreciation expenses in one year if this reduces taxable profits and avoids tax

payments. For corporations without positive taxable profits in the year prior to the tax rate cut, there is no incentive to reduce tax payments through higher depreciations (Manzon 1992). Thus, accumulating depreciations will not help much to save tax payments for loss firms. As we do not have access to detailed data on tax loss carryforwards, we focus on corporations with current ongoing losses and hypothesize:

H2a: Corporations with current losses accumulate less tax depreciations in 2007 than corporations with current profits.

Incentives for intertemporal income shifting may also be heterogeneous for different leverage levels. Profits may act as a signal to creditors of companies with high third-party loans. Considering that reported net income and taxable income of German firms were closely related due to book-tax conformity in 2007, shifting income away from 2007 into future periods may also have affected book income resulting in financial reporting costs for high-leverage companies, for example if such a strategy led to a violation of covenants. Following Guenther (1994), we expect that leverage reduces the willingness to engage in intertemporal income shifting. Due to data limitations, we proxy high-leverage firms as firms with abnormally high interest expenses.

H2b: Corporations with abnormally high interest expenses accumulate tax depreciations in 2007 to a smaller degree.

3.3 Heterogeneity in income shifting opportunity and shifting costs

We further address the heterogeneity of intertemporal shifting opportunity considering depreciations on new investments in 2007 compared to depreciations on old investments from earlier years. In case of old investments, taxpayers already specified amortization periods and depreciation methods in earlier years. Thus, to accelerate depreciations, the taypayer has to provide arguments for changes in amortization periods and depreciation methods, which is typically hard to justify in practice. In addition, taxpayers may argue in favor of a long-term reduction in asset value and write off the asset value of old investments. However, resulting from the jurisdiction of the German Fiscal Supreme Court (German: *Bundesfinanzhof*), such opportunities are clearly limited. In case of depreciable fixed assets, the fair value test of the German Fiscal Supreme Court requires an effective reduction in book value of about 50% (e.g., Bundesfinanzhof 2006). In case of hidden reserves resulting from an increase in asset prices (e.g., buildings), the required reduction in asset values would have been even higher.

By contrast, German tax law provided more opportunity to accumulate depreciations for investments in new assets, as amortization periods and depreciation methods had not already been pre-determined in earlier periods. Considering movable fixed assets until 2007, taxpayers could choose the declining balance method, which typically accelerated depreciations. In addition, there was an opportunity of a full write-off for movable assets with a low aquisiation cost for each single asset (below 410 € excluding VAT), and special depreciation schemes for investments of small and medium firms and investments in historical buildings and buildings in redevelopment areas. Considering these aspects, we expect a higher opportunity to accumulate depreciation expense for firms with a relatively high share of new investments in their capital stock. We hypothesize:

H3a: Corporations with a high ratio of new investments to their capital stock accumulate tax depreciations in 2007 to a higher degree.

We further address the relationship of firm size and intertemporal income shifting. Existing research on the relationship of firm size and tax avoidance practices has provided contradictory evidence (Zimmerman 1983; Rego 2003; Richardson and Lanis 2007). Corresponding to the political-cost hypothesis (Zimmerman 1983), large firms have higher political costs of aggressive tax avoidance strategies, which may include aspects like audit risks, lobbyism, and reputational costs of aggressive tax planning. However, as documented by research on tax compliance and planning costs (Eichfelder and Vaillancourt 2014), there exist enormous economies of scale in tax compliance and tax planning processes. Thus, large firms are more cost-effective in promoting tax avoidance practices, as the marginal costs of tax planning decrease in the volume of such activities. In line with that argument, Rego (2003) and Richardson and Lanis (2007) find a positive relationship between measures of tax avoidance and firm size. In addition, Knittel (2007) finds low take-up rates of small U.S. companies (with high compliance costs) for the 2002 and the 2004 U.S. bonus depreciation. Eichfelder and Schneider (2014) provide further evidence that large German firms with relatively low tax compliance costs reacted to a stronger degree on investment tax incentives of a German bonus depreciation program for the reconstruction of Eastern Germany in the 1990s.

Overall, the literature provides strong evidence for the planning-cost hypothesis, while the political cost hypothesis should be most relevant for a comparison of very large firms to other large firms (thus, both with low marginal planning costs). Our data set primarily consists of private companies of the German industrial sector with a relatively small size (minimum size of 20 employees). Therefore, we expect that the planning-cost hypothesis

is more relevant in our case and hypothesize a negative relationship of business size (measured by turnover) and the accumulation of depreciation expenses in 2007.

H3b: Large corporations accumulate tax depreciations in 2007 to a higher degree.

4. Empirical strategy and data

4.1 Identification strategy

We rely on a difference-in-differences identification strategy, comparing depreciation expenses of German corporations with German partnerships and sole proprietorships around the corporate tax cut in 2008. The tax cut in the German corporate income tax from 25% to 15% was only relevant for German corporations. In sum with further changes of the German local business tax, BTR 2008 reduced the aggregate burden of German corporations by about 7.8 to 10.2 percentage points. By contrast, individual partners of German partnerships and sole prorietorships remained unaffected by the reduction of the German corporate income tax rate and therefore faced a much smaller and more heterogenous incentive for intertemporal income shifting from 2007 to 2008, depending on their personal income tax rate and the local business tax rate (see also Section 2). Therefore, we regard partnerships and sole proprietorships as an appropriate control group to identify the strong economic incentive for intertemporal income shifting resulting from the reduction of the German corporate income tax rate by the end of 2007. We estimate the following regression equation to test our hypothesis H1:

$$Depr_{i,t} = \alpha_0 + \beta_1\, Corp_i \times 2007_t + \beta_2\, Capital\ Stock_{i,t-1} + \beta_3\, Investment_{i,t} + \gamma\, Controls_{i,t} + Firm_i + Year_t + \epsilon_{i,t} \quad (1)$$

The dependent variable is the logarithm of depreciations for tax purposes $Depr_{i,t}$ of firm i in year t. The independent variable of interest is the interaction term between $Corp_i$ and 2007. The dummy variable $Corp_i$ has a value of one if a firm is a corporation and zero otherwise. The dummy variable 2007_t has a value of one for the year 2007 before the tax rate cut ($2007 = 1$ if $t = 2007$). Using the interaction term, we measure how the temporal difference in depreciation expenses between 2007 and the other sample years of corporations relates to the temporal difference of depreciatons of partnerships and larger sole proprietorships with a minimum of 20 employees. We expect an abnormal increase in the depreciations of corporations in 2007 captured by $Corp_i \times 2007_t$.

Depreciations largely depend on the book value of fixed assets, which depends on investment activities and depreciations in earlier periods. We account for that by

including a measure for the beginning-of-the-year capital stock $CapitalStock_{i,t-1}$, acknowledging that companies with higher depreciable fixed assets have higher depreciation expenses. We provide a detailed explanation on the calculation of $CapitalStock_{i,t-1}$ in Section 4.2. In addition, current investments also have a positive impact on depreciations. We include the logarithm of current net investments ($Investment_{i,t}$). We define net investments as gross investments minus disinvestments in fixed assets and add one to avoid undefined logarithmic values. By including $Investment_{i,t}$, we control for potential changes in the investment activities of firms (e.g., a shifting of investments between both periods) that could result from the BTR 2008. Thus, we ensure that our findings result from intertemporal income shifting and not from intertemporal shifting of investments.

We add a number of control variables including the marginal business tax rate of firm *i* $Tax\ Rate_{i,t}$, the ratio of Ebitda (earnings before interest, tax, depreciation and amortization) to turnover of *i* $Ebitda\ per\ Turnover_{i,t}$, the number of German establishments of an entity $Plants_{i,t}$, and the logarithm of interest expense $Interest_{i,t}$. To account for potential income shifting in the year 2008, we further add an interaction term $Corp_i \times 2008_t$, which corresponds to $Corp_i \times 2007_t$, but accounts for the year 2008.

We further add year fixed effects that control for general shocks and trends like the business cycle. Firm fixed effects $Firm_i$ account for time-invariant firm-specific characteristics (e.g, the influence of the legal form of the company, which does not change during the observation period). Thus, the variable $Corp_i$ does not have to be included in the regression separately. Time-invariant industry effects are also absorbed by $Firm_i$.

A benefit of our difference-in-differences strategy is that it implicitly accounts for other regulations of the BTR 2008 reform package affecting both the treatment group and the control group (e.g., changes in the local business tax, abolishment of the declining balance method for movable fixed assets, introduction of stricter thin-capitalization rules). In addition, it also accounts for major economic trends and shocks (e.g. the financial crisis 2007/2008) affecting both groups. In robustness checks, we further use propensity score weighting to make our control group more similar to our treatment group. Corresponding regression results are almost identical to our baseline regressions.

We should mention that our identification strategy also has a number of weak points. First, due to changes in personal income tax rates and local business tax rates, tax incentives for partnerships and sole proprietorships may also have changed during the years 2007 and 2008, though to a much lesser degree than for corporations. While

corresponding tax incentive changes for partnerships and sole proprietorships were heterogenous, corresponding effects should typically be "white noise" and affect the error term. Second, our data lacks of information about proprietors of the analyzed businesses. As a result, partnerships could also have corporations as partners with similar incentives for intertemporal income shifting as the corporations in our treatment group. In these cases the "corporate partners" of a partnership could influence the tax avoidance strategy of the partnership with the target of shifting income from 2007 to 2008. Concluding, we cannot rule out that incentives for intertemporal income shifting also affected partnership entitites that we are using as a control group. Therefore, our quantative estimates on the impact of the tax cut on depreciations should be interpreted with due caution.

In further tests, we analyze the heterogeneity of tax effects within the treatment group. We focus on depreciations of German corporations in the year 2007 considering four aspects: (a) loss corporations, (b) high-leverage corporations, (c) high-investment corporations, and (d) large corporations. In all these tests, we generally use only the remaining corporations as baseline/control groups and do not include partnerships. Thus, the baseline groups of our heterogeneity tests differ from each other as well as from the control group of our main specification (partnerships and sole proprietorships). Apart from the tested properties, the group of interest and the baseline group in our heterogeneity tests face the same tax incentives resulting from BTR 2008, which allows us an identification of the impact of heterogeneity properties (e.g., high leverage). Note that the heterogeneity properties can vary over time, which allows us to keep all observations of corporations in our sample.[8] We estimate the following regression equation (2) for out tests on H2a to H3b:

$$Depr_{i,t} = \alpha_0 + \beta_1 H_{i,t} \times 2007_t + \beta_2 H_{i,t} + \beta_3 Capital\ Stock_{i,t-1} + \beta_4 Investment_{i,t} + \gamma Controls_{i,t} + \alpha_i + \alpha_t + \epsilon_{i,t} \quad (2)$$

$H_{i,t}$ is a dummy variable for a certain heterogeneity property, which is calculated for each year separately.Thus, $H_{i,t}$ is not captured by our firm fixed effects. For our tests on H2a, $H_{i,t}$ takes a value of one in case of a loss in the current year (*Loss*$_{i,t}$, e.i. a negative sum of sales revenue plus goods on own account minus production costs and other cost categories). Testing H2b, $H_{i,t}$ represents a dummy variable for firms with high interest expenses (*High Interest*$_{i,t}$). *High Interest*$_{i,t}$ has a value of one if the interest-to-sales-ratio

[8] In a classical difference-in-difference approach, we would focus on the value of $H_{i,t}$ in 2007. In this case, we would lose all observations of corporations without survey information in 2007.

of firm *i* in year *t* lies in the the upper quartile of the interest-to-sales ratios over all corporations. Testing H3a, $H_{i,t}$ represents a dummy with a value of one for firms with high gross investments in the current year (*High Investment*$_{i,t}$). *High Investment*$_{i,t}$ is equal to one if the investment-to-capital ratio (investment in movable fixed assets) of firm *i* in year *t* lies in the the upper quartile. Testing H3b, $H_{i,t}$ stands for a dummy with a value of one if the average turnover over the current year *t* and the last year *t–1* of firm *i* falls in the upper quartile (*High Size*$_{i,t}$).

Controlling for $H_{i,t}$, we identify reactions of heterogenous firm types by the interaction term $H_{i,t} \times 2007_t$. Again, we further account for $Capital\ Stock_{i,t-1}$, $Investment_{i,t}$, the other $Controls_{i,t}$, and firm and year fixed effects. We provide a detailed documentation of all regression variables in Table 1.

[Table 1 about here]

4.2 Data

We rely on data from the AFiD panel for the manufacturing and mining industries[9] (German: *Amtliche Firmendaten in Deutschland im Verarbeitenden Gewerbe, Bergbau und Gewinnung von Steinen und Erden*) representing about one quarter of the gross value added of the German economy (Destatis, 2015). As depreciable fixed assets are an important factor in these industries, we have an optimal data source for analyzing depreciation effects. While we have access on data from 1995 to 2008, we only rely on data from 2003 to 2008 to avoid statistical problems that would be related to the German tax reforms of the years 1999 to 2002. The AFiD panel comprises several mandatory business surveys conducted by the German Federal Statistical Office (German: *Statistisches Bundesamt*) that can be accessed by remote-data processing. A more detailed documentation of the data is provided by Malchin and Voshage (2009).

We use information from two surveys of AFiD. (1) The Cost Structure Survey (German: *Kostenstrukturerhebung*) provides information on sales revenue, earnings and a detailed

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[9] Data source: "RDC of the Federal Statistical Office and the Statistical Offices of the Länder, AFiD panel for the manufacturing and mining industries, 1995-2008"; see also http://www.forschungsdatenzentrum.de/bestand/afid-panel_industriebetriebe/index.asp. Original titles of the detailed statistics (in German language) are: *AFiD-Panel Industrieunternehmen*, (information on the firm level) consisting of the *Kostenstrukturerhebung im Bereich Verarbeitendes Gewerbe, Bergbau und Gewinnung von Steinen und Erden* (Cost Structure Survey) and *AFiD-Panel Industriebetriebe* (information on the establishment level), consisting of the *Jahresergebnisse des Monatsberichtes für Betriebe im Verarbeitenden Gewerbe, Bergbau und Gewinnung von Steinen und Erden* (Monthly Report), and the *Betriebsdatensätze der Investitionserhebung im Verarbeitenden Gewerbe, Bergbau und Gewinnung von Steinen und Erden* (Investment Survey on the permanent establishment level). We hereafter refer to these surveys as *AFid panel for the manufacturing and mining industries*.

list of business expenses (including depreciations for tax purposes) on the level of the single firm entity (unsolidated data). Thus, the information of the Cost Structure Survey is similar to the profit assessment in the annual accounts and provides information on loss firms. Apart from a few positions, the Cost Structure Survey does not provide balance sheet information on capital stock or the accumulated value of provisions. (2) The Investment Survey (German: *Investitionserhebung*) gives detailed information on investments in different asset types (e.g., land, buildings, and movable fixed assets) on the establishment level. We aggregate that information on the level of the single entity firm. While the Investment Survey consists of an almost full sample of German plants in the manufacturing and mining industries with at least 20 employees, the Cost Structure Survey is based on a 50% random sample. Thus, our analysis is based on unconsolidated data of a 50% sample of all firms with at least 20 employees in the manufacturing and mining sector.

For our analysis, AFiD has a number of major benefits. First, while the existing literature is limited to depreciations in financial accounts (e.g. Boynton et al. 1992; Scholes et al. 1992; Guenther 1994; Lopez et al. 1998; Maydew 1997, Andries et al. 2017; Sundvik 2017), AFiD provides information on depreciations for tax accounting purposes. In spite of the relatively high level of book-tax conformity in Germany in 2007, there were major differences between depreciation regulations for financial accounting and tax accounting. Most relevant, amortization periods and legitimate depreciation methods are clearly defined for each asset type in the German income tax code and the depreciation tables of the German fiscal administration, while German GAAP only require that amortization periods and depreciation methods fit well with the expectations of an educated and rational businessman. Thus, there is much more leeway in financial accounting and the question arises if the standards of tax accounting leave firms sufficient opportunity for intertemporal income shifting. Second, AFiD provides detailed information on investments in real estate fixed assets and movable fixed assets that can be used for our tests on H3a and H3b. An third benefit stems from the high coverage of the AFiD data considering a 50% sample of all firms in the manufacturing and mining sector with at least 20 employees. As the surveys are mandatory, missing or incomplete information is a minor issue. Thus, AFiD gives a comprehensive picture not only for public firms but also for small and medium-sized firms.

A disadvantage of the data is that it does not provide information on firm ownership or holding structures. Thus, we obtain data for one entity but not for subsidiaries, parent

companies or owners of that entity. Therefore, we are not able to distinguish partnerships with solely individual partners from partnerships with corporate partners. Further, the data are restricted to the manufacturing mining sector, and they provide information only on gross investment but not on the capital stock.

We extract information on depreciation expenses for tax purposes from the cost structure survey. As the depreciations are, according to our expectations, strongly skewed, we use the natural logarithm of depreciations for tax purposes $Depr_{i,t}$ as the dependent variable. Average depreciations and write-offs for the full sample amount to €2.73m between 2003 and 2008. The values for the arithmetic average and the median confirm a strongly left-skewed distribution of depreciations.

As documented by Equations (1) and (2), we control for the value of depreciable fixed assets by including the natural logarithm of the beginning-of-the-year capital stock in the regression ($CapitalStock_{i,t-1}$). While AFiD includes detailed information on depreciations and investments in fixed assets, it does not provide the book value of the capital stock. Following Eichfelder and Schneider (2014), we calculate the capital stock by using the time series of depreciations and investments on the firm level since the year 1995 in two steps. 1) As a start value, we gross up the depreciation expenses of each year resulting from buildings and equipment. We assume that the average amortization period for movable fixed assets is seven years (Devereux et al. 2009), while the average amortization period for buildings is 35.66 years in 2008.[10] We allocate depreciations to equipment and buildings using information from the Investment Survey on the average composition of investments among different firm types and industries and assuming a constant investment activity of firms. For example, if 20% of investments are building investments, we assume that 20% of the capital stock consist of buildings. Then we extrapolate the current value of the capital stock by multiplying depreciations from equipment and buildings with half of the corresponding amortization periods (7 years for equipment and 35.66 years for buildings). In doing so, we implicitly assume that on average half of depreciations has already been used in earlier periods (= half of the amortization period) has already been passed on average for the sum of fixed assets. As we intend to calculate the capital stock at the beginning of the year, we subtract half of the current year's investments, assuming that investments are linearly distributed over the

[10] This amortization period is a weighted average of periods for different types of business buildings (including buildings with amortization periods of 25 years, 33 years, 40 years and 50 years). We also account for the fact that amortization periods for certain types of buildings changed over time. Eichfelder and Schneider (2014) provide a more detailed explanation.

entire year and are depreciated on a pro-rata-temporis basis. 2) We use the start value of step 1) as well as information on depreciation and investments over the whole time series to calculate book values of capital stocks at the beginning of each period. Starting in 1996, we define the book value of the capital stock at the beginning of *t* as the start value of the capital stock in *t–1* plus investments *t–1* and minus depreciations in *t–1*. Thus, we use the path-dependency of capital stocks and our time series information to calculate accurate book values of capital stocks. As our final sample exclusively relies on the years 2003 to 2008, this approach should ensure a high quality of our calculated book values of capital stocks. We further consider in our regressions the logarithm of current years investments ($Investment_{i,t}$), which is gross investments in fixed assets minus desinvestments in fixed assets (plus one to avoid undefined logarithmic values).

We observe an average capital stock of €26.73m for the full sample between 2003 and 2008. The average capital stock for corporations is €31.58m, compared to €18.03m for partnerships and sole proprietorships. Comparing arithmetic average and median suggests a left-skewed distribution. Therefore, we use the natural logarithm of the capital stock as a control variable.

[Insert Table 2 about here]

Table 2 reports descriptive statistics for our dependent variable and our main explanatory variables for the aggregate sample (panel A), corporations (panel B) and partnerships and sole proprietorships (panel C). Similar to the capital stock, average depreciations are higher for corporations than for partnerships and sole proprietorships (€3.30m compared to €1.71m). The same holds for Ebitda (€11.00m to 5.55m), turnover (€115.73m to €51.15m), and interest expense (€0.97m to €0.48m), while the average number of plants does not differ significantly between both groups. Overall, the average size of the corporations in our sample significantly exceeds the average size of the partnerships and sole proprietorships. However, this is not necessarily a problem for our identification strategy as time-invariant differences among firms are captured by firm-fixed effects and other control variables.

Differences in the calculated business tax rates of both groups mainly result from the assumptions of our calculation approach. We generally assume that individual taxpayers (including partnerships and their partners) fall under the German tax system for individual taxpayers (personal income tax including solidarity tax surcharge plus local business tax including a local business tax credit) and consider in these cases the maximum personal income tax rate of the respective year. By contrast, the business tax rate of corporate

taxpayers only considers the tax burden on accumulated profits (corporate income tax including solidarity tax surcharge plus local business tax) but not the tax burden on profit distributions, which depends on the type of shareholder (e.g., individual shareholder, corporate shareholder). Our calculations cleary reveal a strong reduction of *TaxRate* for the corporation subsample. The limited increase in *TaxRate* for the subsample of partnerships and sole proprietorships is mainly a consequence of the increase in the maximum marginal income tax rate from 42% to 45% from 2007 to 2008, which we generally assume for calculated business tax rates for partnerships and sole proprietorships. However, as our data does not provide sufficient information to account for variation in personal income tax rates among individual taxpayers, this should be interpreted with caution.

Overall, our panel consists of 85,666 firm-year observations, with 55.297 observations from corporations and 30.369 observations from partnerships and single entity firms. Therefore, approximately two thirds of firms are incorporated. While this ratio is quite constant over the period 2003 to 2007, we observe a slightly higher number of corporations in 2008.

5. Results

5.1 Intertemporal income shifting

We estimate Equation (1) to test our first hypothesis and present results in Table 3. In Column (1), we regress depreciations on the interaction of $Corp$ and the dummy variable for the year 2007 with *CapitalStock* and *Investment* as controls. Column (2) additionally includes the interaction of $Corp$ and the dummy variable for the year 2008, Column (3) the business tax rate *TaxRate* and Columns (4) to (6) additional regression controls *Ebitda per turnover*, *Interest*, and *Plants*. In all regressions, we account for firm and year fixed effects. As documented by adjusted R squared, the firm and year fixed effects, the interaction term of *Corp* and *2007*, *CapitalStock*, and *Investment* explain by far most variation in the data. In fact, these parameters alone account for 95.4% of the variation in the dependent variable, while adding further variables only adds additional 0.2% of explanatory power as measured by adjusted R squared.

[Insert Table 3 about here]

The estimated coefficient of the interaction term $Corp \times 2007$ is positive, significant ($p < 0.01$) and quantatively robust over all specifications. The size of the estimated

coefficient ranges just slightly from 0.0237 in Column (3) to 0.0265 in Column (5). Due to the logarithmic specification of the dependent variable, our results are to be interpreted as semi-elasticities. Thus, we have to recalculate estimated dummy variable coefficients to obtain the impact on depreciations. As shown by Kennedy (1981), the percentage change can be approximated by $\exp\left(\hat{\beta}_i - \frac{1}{2} \cdot Var\left(\hat{\beta}_i\right)\right) - 1$, with the estimated regression coefficient $\hat{\beta}_i$ and the variance $Var\left(\hat{\beta}_i\right)$ resulting in an estimated change from 2.4% to 2.7%, and 2.5% if we consider all regression controls as in Column (6). Regarding Column (6) as best estimate and supporting H1, BTR 2008 increased depreciations by 2.5% in 2007.

Coefficients for $Corp \times 2008$ are never significantly different from zero. In 2008, corporations do not have a tax incentive for an accumulation of depreciation expenses. As the tax rate remained stable thereafter, there is also no clear tax incentive to reduce depreciations. As expected, coefficients of $Capital\ Stock$ and *Investment* are positive and significant ($p < 0.01$). Thus, depreciations increase in the book values of depreciable capital stocks and investments. We find positive coefficients for *Ebitda per turnover*, *Interest*, and *Plants*, suggesting that high-yield firms, high-debt firms and firms with multiple plants have on average higher depreciation expenses. For *TaxRate*, we find no significant regression coefficient. This might result from low variation or measurement error in this (calculated) control variable.

We can put the size of our effect into perspective of the federal corporate income tax statistics in 2010. The overall taxable income for corporations in 2010 amounts to €169.7bn. Statistics of the Deutsche Bundesbank on representative balance sheet information of German firms (Deutsche Bundesbank, 2014, Sheet 1) report for the average German corporation in 2010 a depreciation-to-revenues ratio of 2.9%, a net profit-to-revenues ratio of 3.0%, and an income taxes-to-revenues ratio of 0.9% (adding up to a taxable income-to-revenues ratio of 3.9%). Thus, our estimated value of 2.5% would translate into an amount of shifted income of approximately €3.1bn ($= 2.5\% \cdot \frac{€169.7bn}{3.9\%} \cdot 2.9\%$). Consequently, the corporate income tax revenue around the tax cut could be reduced by up to 0.8% of the 2010 corporate income tax if income is shifted to a period with a 10 percentage points lower tax rate ($= \frac{€3.1bn \cdot 10\%}{\frac{€169.7bn}{3.9\%} \cdot 0.9\%}$).

One obvious issue of a DiD approach is whether the pre-treatment common trends assumption holds. We document the common trend visually. We chose an approach based

on Autor (2003) and Pischke (2007). It is comparable to introducing pseudo reforms. But instead of measuring the effect of one pseudo reform per regression, we measure the conditional difference between corporations and the control group for every year in a single regression:

$$Depr_{i,t} = \alpha_0 + \mathbf{\beta_1}\, Corp_i \times 2004_t + \mathbf{\beta_2}\, Corp_i \times 2005_t + \mathbf{\beta_3}\, Corp_i \times 2006_t + \beta_4\, Corp_i \times 2007_t + \beta_5\, Corp_i \times 2008_t + \beta_6\, Capital\ Stock_{i,t} + \gamma\, Controls_{i,t} + \alpha_i + \alpha_t + \epsilon_{i,t} \quad (3)$$

In this setting, the common trend assumption is consistent with the difference in our dependent variable (β_1, β_2, β_3) not being significant in the pre treatment periods. The resulting graph is:

[Insert Figure 1 about here]

The difference in the conditional dependent variable is not significant on the 5% level in the years 2004-2006. There may be an announcement effect in 2006 that would be consistent with our story (but biases against our results for 2007), but this effect is not significant on the 5% level. All in all, we conclude that the common trend assumption is justified in our setting.

5.2 Heterogeneity in the depreciation activity of corporations

For our heterogeneity tests, we rely on Equation (2). We refer to the heterogeneity of corporations with certain characteristics compared to all other corporations. Thus, while firms in the treatment and control group are corporations affected by BTR 2008, our identification strategy focuses on the four addressed heterogeneity items. We document results in Table 4.

[Insert Table 4 about here]

In Column (1), we test heterogeneity regarding loss firms. Adjusting for the Kennedy (1981) formula, we find significantly lower depreciation volumes of 9.8% of firms with a loss in 2007 (negative coefficient of -0.103 of $Loss \times 2007$). Thus, corporations with smaller tax incentives reacted to a much smaller degree to the BTR 2008. As the coefficient for $HighDebt \times 2007$ in Column (2) is not significant, we cannot provide valid evidence for H2b suggesting a weaker reaction of firms with high interest expenses and likewise high financial reporting costs. In part, this might be due to the fact that we do not only observe conforming tax-induced earnings management (as in Guenther, 1994), but also non-conforming tax avoidance. In line with H3a, the regression coefficient

of $HighInvestment \times 2007$ in Column (3) suggests that firms with a high investment activity in 2007 had a very high abnormal increase in depreciation volume of about 25.6% compared to other corporations without abnormally high investments in 2007. Note that this finding is not driven by the mechanical relationship of current investments and depreciations as our regression model controls for the volume of current investments as well as for the dummy variable $HighInvestment$. Our findings suggest that new investments provide much more opportunity for intertemporal income shifting via depreciations. The main reason is that firms choose amortization periods and depreciation methods in the first year of depreciation. In 2007, firms had the opportunity to select the declining belance method for movable assets as well as a full write-off for long-term assets with a low asset value. In addition, in spite of the depreciation tables used for tax purposes, firms may argue in favor of shorter amortization periods, could depreciate movable assets with respect to their economic use (e.g., cars with a high road performance) and could also consider special depreciation regimes for tax purposes (e.g., for historical buildings). Fourth, we find evidence supporting the hypothesis that large firms are more active in intertemporal income shifting, as they are more cost-efficient in tax planning (planning-cost hypothesis H3b). Compared to other corporations, large corporations accumulate about 6.1% higher depreciation expenses. Again we control for purely mechanical effects by our regression controls (e.g., *CapitalStock*, *Investment*).

Overall, our heterogeneity tests provide statistically significant and economically strong evidence for the hypotheses H2a, H3a, and H3b. That holds especially for the higher opportunity of new investments in fixed assets to provide discretion of depreciation activity. By contrast, we are not able to confirm the findings of Guenther (1994) suggesting a weaker reaction of high-debt firms on intertemporal income shifting around a large tax cut.

5.3 Robustness tests

Finally, we address the robustness of our findings. We concentrate on our main specifications in Section 5.1 considering three issues: (1) length of the observation period, (2) analysis of pseudo tax reforms, and (3) the use of propensity-score weighting to make treatment group and control group more similar to each other.

The observation period from 2003 to 2008 covers predominantly years prior to the financial crisis. However, we might capture the beginning of the crisis in Germany in the year 2008. While the difference-in-differences approach principally eliminates influences of the business cycle, there nevertheless might be divergent effects on the treatment and

control group. As a robustness check, we limit the observation period to the years 2003 until 2007, rerun our baseline best estimate from Table 3, Column (6) and display results in Table 5, Column (1). The estimated coefficient of the variable of interest, the interaction term between the dummy $Corp$ and the year dummy for 2007, is still significantly positive and the size of the estimated effect of about 2.5% (see Kennedy 1981) is (without rounding almost) identical to our baseline best estimate (2.5%). Thus, our finding is robust regarding a shorter observation period.

[Insert Table 5 about here]

According to our hypotheses, 2007 is the only year in the observation period that provides a tax incentive to accumulate depreciation expenses and therefore shift profits to the following periods with a lower tax rate for corporations. We conduct a robustness test establishing pseudo-tax cuts to confirm that our approach does not ignore other effects that may cause a similar accumulation of depreciation expenses in the other years. We rerun our baseline specification from Table 3, Column (6), for every interaction term of $Corp$ and the years from 2003 until 2008 (except 2007) to analyze if there is a significant difference in depreciation expenses between corporations and non-corporate firms compared to the rest of the observation period in any year.

Table 5, Columns (2) to (6), displays the results. The estimated coefficients of the interaction terms imitating pseudo-tax reforms are not significant in any specification. That is, depreciation expenses of corporations only abnormally increase in 2007, but in no other year. We are thus confident that the effect on depreciations is due to the tax incentive for intertemporal income shifting resulting from the BTR 2008, since other effects that influence expenses should also occur in other observation years.

As a third robustness test, we use propensity score weighting to make the treatment group and the control group more similar to each other. Propensity score weighting is a statistical method to generate pre-matched samples without throwing away or losing observations. Therefore, it accounts for the fact that our treatment group in the baseline sample is larger than our control group (55,297 compared to 30,369 observations). Different from next-neighbour matching, propensity score weighting in principle accounts for all observation units, but overweights (underweights) firms of the control group that are more (less) similar to the treatment group (for more detail see Guo and Fraser 2015, 239–254). Therefore, propensity score weighting is largely analogous to Kernel matching estimators that also keep all matched observations but consider different weights (Caliendo and Kopeinig 2008).

In technical terms, our approach is as follows. We perform a logit regression with treatment status as dependent variable and average values over the years 2003 to 2005 (pre-treatment period) of the following matching characteristics as explanatory variables: legal form, industry, number of domestic establishments, turnover, wage payments, gross investments in fixed assets, and costs of goods sold. Using the results of this regression, we calculate propensity scores and take the inverse of the propensity scores as inverse probability weights (see also inverse probability of treatment weights, Guo and Fraser 2015, 242–245). Thus, we drop observations of firms that are not included in our sample during the relevant matching period (2003 throughout 2005), as we are not able to calculate matching weights for these firms. This includes foundations in later periods as well as sampling changes over time.

Finally, we perform a weighted ordinary least squares regression (OLS) regression as documented by Equation (1) using the inverse probabilities as regression weights. Apart from weighting, the regression approach corresponds to Table 3 and Table 6 documents the results. The regression coefficient of the interaction term $Corp \times 2007$ is positive and significantly different from zero in all specifications. Compared to our baseline specification (Table 3) and our best estimate (2.5%), we find a somewhat smaller increase of depreciation expenses in 2007 of about 2.1%. Concluding, our findings are fairly robust with regard to the selected control group and do hold if we make our control group more comparable to our treatment group via propensity score weighting.

[Insert Table 6 about here]

6. Conclusion

In our paper, we analyze if and to what extent German corporations reacted to a large cut of the corporate income tax as part of the German BTR 2008 by interemporal income shifting via depreciations and write-offs. The tax rate reduction provided a strong incentive to accumulate depreciation expenses in the pre-reform high-tax year 2007. We use a difference-in-differences approach to identify abnormal depreciation expenses of corporations with partnerships and sole proprietorships as control group. Using tax accounting data from an official survey raised by the German Federal Statistical Office for the German manufacturing and mining industries, we find that corporations increased depreciation expenses in 2007 by about 2.5%, which translates into lower corporate tax revenues of approximately 0.8%. The results are qualitatively and quantitatively robust to a battery of tests and cross checks. One explanation for the relatively moderate effect

of BTR 2008 on depreciations in 2007 is that firms should also be active in intertemporal income shifting in other periods with the general target of accelerating depreciation expenses. Thus, we are only able to identify the additional effect resulting from the tax rate incentive of the BTR 2008. In addition, due to the strict tax regulations on depreciation, there might be a limited ability of firms to additionally accelerate depreciations in 2007 in order to benefit from the BTR 2008.

We further analyze whether incentives for intertemporal income shifting are heterogeneous across corporations. We find that loss firms with smaller shifting incentives are less active in intertemporal income shifting. For high-interest firms with presumably high financial reporting costs, we find a negative regression coefficient, which is statistically not significant. Thus, while our findings are consistent with Guenther (1994), we cannot provide significant evidence. We find a stronger accumulation of depreciation expenses in 2007 for large firms with a likewise higher cost-efficiency of tax planning, and especially for firms with high volumes of new investments. The last finding suggests that especially new investments provide opportunity for intertemporal income shifting via depreciations as amortization periods and depreciation methods are not determined yet. By contrast, it seems to be extremely hard for firms to adjust amortization periods and depreciation methods (including write-offs) for investments of earlier periods.

The partnerships and sole proprietorships in our control group may also face (heterogenous) incentives for earnings management and intertemporal income shifting. Such heterogeneity might bring in white noise in the regression equation. In addition, our data does not provide information on shareholders, parent companies and partners of our sample firms. Thus, we cannot rule out the opportunity that some partners of the partnerships in our control group were corporations and therefore faced similar shifting incentives than the firms in our treatment group. Considering both aspects, our regression estimates for $Corp \times 2007_{i,t}$ might be regarded as a lower bound estimate for overall shifting activity and only identifies additional shifting resulting from the drop in the German corporate income tax rate from 25% to 15%. Nevertheless, considering the heterogeneity of tax incentives for partnerships and the small number of corporate partners, it seems unlikely that the true impact of BTR 2008 excessively exceeds our best estimate of about 2.5%.

A potential limitation is our focus on German businesses in the manufacturing and mining industries with at least 20 employees. Thus, it may be debatable to what extent of our

findings hold for other countries, industries and very small firms. Considering bonus depreciations for small firms in the German income tax code (Section 7g), it seems likely that very small German firms have more discretion in depreciation policies and therefore reacted more strongly to the incentives of the BTR 2008.

Finally, one might discuss the comparability of our treatment group and our control group. However, considering the robustness of our findings in the tests with matched samples, we regard that as a minor issue. Overall, our results provide robust evidence that firms react to a tax incentive for intertemporal income shifting by adjusting their depreciations and write-offs. As suggested by our heterogeneity tests, such firm reactions are widely restricted by a lack of discretion in depreciations and write-offs, shifting incentives (e.g., loss firms), and the tax planning costs and risks of intertemporal shifting of income.

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Tables

Table 1: Definiton of regression variables

Variable		Definition
$Depr_{i,t}$		Logarithm of tax-deductible depreciations of tangible fixed assets of company *i* in year *t*.
$CapitalStock_{i,t-1}$		Logarithm of the book value of capital stock of company *i* at the beginning of the year. For a detailed explanation of the calculation of $CapitalStock_{i,t-1}$ see
$Investment_{i,t}$		Logarithm of gross investments in fixed assets minus disinvestments in fixed assets of company *i* in year *t*, + 1 (in order to allow ln($Investment_{i,t}$) for $Investment_{i,t} = 0$)
$TaxRate_{i,t}$		Total marginal business tax rate of company *i* in year *t* including corporate income tax (corporations), personal income tax (partnerships and sole proprietorships), local business tax, and solidarity tax surcharge. For partnerships and sole proprietorships, we also consider the local business tax credit.
Ebitda per Turnover$_{i,t}$		Earnings before interest, tax, depreciation and amortization, scaled by Turnover (including variation of half-finished and finished products) of company *i* for year *t*.
$Interest_{i,t}$		Logarithm of interest on borrowed capital of company *i* in year *t*.
$Plants_{i,t}$		Number of domestic establishments of company *i* in year *t*.
$Corp_i$		Dummy variable which equals 1 if the company *i* is incorporated.
$2003_t, \ldots, 2008_t$		Dummy variable for the respective years 2003 to 2008.
$H_{i,t}$	$Loss_{i,t}$	Dummy variable which equals 1 if a firm's Ebitda in year *t* is zero or negative.
	$HighDebt_{i,t}$	Dummy variable which equals 1 if the ratio of interest per turnover of company *i* in year *t* falls in the upper quartile.
	$HighInvestment_{i,t}$	Dummy variable which equals 1 if the ratio of investments in movable fixed assets per capital stock of company *i* in year *t* falls in the upper quartile.
	$HighSize_{i,t}$	Dummy variable which equals 1 if the average turnover for two periodes (current and last year) of company *i* in year *t* falls in the upper quartile.

Table 2: Descriptive Statistics

Panel A: full sample

Variable	N	Mean	Std. Dev.	Median	first percentile	99th percentile
Depr (1000 euro)	85,666	2,734	33,584	324	4	31,897
CapitalStock (1000 euro)	85,666	23,635	198,678	3,410	40	292,773
Investment	85,666	2,786	31,278	237	0	34,440
TaxRate	84,036	0.4012	0.0613	0.3899	0.2668	0.5189
Ebitda (1000 euro)	85,666	8,702	149,115	977	-7,545	98,852
Interest (1000 euro)	85,666	792	11,612	74	0	8,423
Plants	85,666	1.38	2.29	1.00	1.00	7.00
Turnover (1000 euro)	85,666	91.163	975,758	13,651	1,002	1,024,573
Panel B: subsample for corporations						
Depr (1000 euro)	55,297	3,278	41,292	312	4	39,734
CapitalStock (1000 euro)	55,297	27,849	242,831	3,233	33	360,968
Investment	55,297	3,348	38,318	232	0	40,023
TaxRate	54,100	0.3636	0.0396	0.3761	0.2632	0.4119
$TaxRate_{2007}$	8,513	0.3795	0.0128	0.3779	0.3542	0.4063
$TaxRate_{2008}$	10,615	0.2889	0.0172	0.2863	0.2562	0.3228
Ebitda (1000 euro)	55,297	10,386	180,174	897	-9,343	121,006
Interest (1000 euro)	55,297	959	14,301	65	0	9,845
Plants	55,297	1.40	2.55	1.00	1.00	7.00
Turnover (1000 euro)	55,297	112,925	1,208,360	13,401	1,075	1,291.587
Panel C: subsample for partnerships and sole proprietorships						
Depr (1000 euro)	30,369	1,743	8,688	349	7	20,432
CapitalStock (1000 euro)	30,369	15,960	62,341	3,729	61	192,726
Investment	30,369	1,765	9,202	243	0	22,865
TaxRate	29,936	0.4691	0.0234	0.4676	0.4332	0.5239
$TaxRate_{2007}$	4,731	0.4509	0.0111	0.4488	0.4307	0.4722
$TaxRate_{2008}$	5,095	0.4741	0.0091	0.4687	0.4674	0.4989
Ebitda (1000 euro)	30,369	5,635	59,988	1,120	-4,641	67,616
Interest (1000 euro)	30,369	490	2,794	92	0	6,312
Plants	30,369	1.36	1.71	1.00	1.00	6.00
Turnover (1000 euro)	30,369	51,538	157,002	14,201	914	629.633

This table reports summary statistics for our variables of main interest. It shows the average values of the variables from 2003 to 2008 as well as the tax rates for the years 2007 and 2008 separately. Due to the fact that we use confidential data, we are not allowed to report minimum or maximum values. Therefore, we report the first and the 99th percentile as approximated values for minimum and maximum. All values are price-adjusted with the price index for industrial production (base year 2005). Panel A encompasses the whole sample, whereas panel B refers to corporations (treatment group) and Panel C to partnerships and sole proprietorships (control group).

Table 3: Shifting of Depreciation Expenses around the 2008 Corporate Tax Cut

Variable	(1)	(2)	(3)	(4)	(5)	(6)
Corp×2007	0.0259***	0.0258**	0.0237**	0.0265***	0.0265***	0.0245**
	(0.00929)	(0.00963)	(0.00946)	(0.00925)	(0.00958)	(0.00941)
Corp×2008		-0.000136	-0.000774		-0.000363	-0.00185
		(0.0140)	(0.0243)		(0.0138)	(0.0240)
CapitalStock	0.374***	0.374***	0.375***	0.367***	0.367***	0.367***
	(0.0282)	(0.0282)	(0.0294)	(0.0277)	(0.0277)	(0.0289)
Investment	0.0179***	0.0179***	0.0184***	0.0173***	0.0173***	0.0177***
	(0.00115)	(0.00115)	(0.00117)	(0.00114)	(0.00114)	(0.00116)
TaxRate			0.0188			0.0105
			(0.184)			(0.181)
Ebitda per Turnover				0.318***	0.318***	0.357***
				(0.0401)	(0.0401)	(0.0385)
Interest				0.0166***	0.0166***	0.0165***
				(0.00165)	(0.00165)	(0.00170)
Plants				0.0270***	0.0270***	0.0281***
				(0.00704)	(0.00704)	(0.00787)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Sample	Full	Full	Full	Full	Full	Full
Observations	85,666	85,666	84,036	85,666	85,666	84,036
Within R^2	0.0958	0.0958	0.0960	0.105	0.105	0.106
Adjusted R^2	0.954	0.954	0.955	0.955	0.955	0.956

Dependent variable is the natural logarithm of depreciation expenses (depr). Corp×2007 and Corp×2008 refer to the interaction („×") of the respective variables. We control for the natural logarithm of the capital stock in all specifications. The variables are defined in Table 1. All results are based on the full sample. Estimations are performed by ordinary least squares (OLS) and include firm and year fixed effects (FE). Heteroscedasticity-robust standard errors, which have been clustered at the firm level, are documented in parentheses. ***, **, and * refer to significant results on the 1%, 5%, and 10% level. Within R^2 is obtained by the Stata command xtreg, whereas we used the areg command for calculating the adjusted R^2.

Table 4: Heterogeneity in Shifting Incentives and Opportunities

Variable	(1)	(2)	(3)	(4)
Loss×2007	-0.103***			
	(0.0224)			
Loss	0.0249**			
	(0.0105)			
HighDebt×2007		-0.00702		
		(0.0104)		
HighDebt		0.0876***		
		(0.0104)		
HightInvestment×2007			0.228***	
			(0.0135)	
HightInvestment			-0.00103	
			(0.00849)	
HighSize×2007				0.0596***
				(0.0120)
HighSize				0.117***
				(0.0141)
CapitalStock	0.352***	0.349***	0.346***	0.334***
	(0.0357)	(0.0355)	(0.0364)	(0.0351)
Investment	0.0183***	0.0184***	0.0159***	0.0181***
	(0.00141)	(0.00141)	(0.00145)	(0.00149)
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
Sample	Corp	Corp	Corp	Corp
Observations	54,100	54,100	54,100	52,020
Within R^2	0.104	0.107	0.114	0.103
Adjusted R^2	0.958	0.958	0.958	0.958

Dependent variable is the natural logarithm of depreciation expenses (depr). Loss×2007, HighDebt×2007, HightInvestment×2007 and HighSize×2007 refer to the interaction („×") of the respective variables. We control for the natural logarithm of the capital stock in all specifications. Further controls (Controls) are *TaxRate*, *Ebitda per turnover*, *Interest* and *Plants*. The variables are defined in Table 1. All results are based on the corporation subsample. Estimations are performed by ordinary least squares (OLS) and include firm and year fixed effects (FE). Heteroscedasticity-robust standard errors, which have been clustered at the firm level, are documented in parentheses. ***, **, and * refer to significant results on the 1%, 5%, and 10% level. Within R^2 is obtained by the Stata command xtreg, whereas we used the areg command for calculating the adjusted R^2.

Table 5: Robustness Tests: Limitation of Observation Period, Pseudo-Tax Cut Analysis

Variable	(1)	(2)	(3)	(4)	(5)	(6)
Corp×2003		-0.00630				
		(0.00898)				
Corp×2004			-0.00762			
			(0.00702)			
Corp×2005				-0.00465		
				(0.00715)		
Corp×2006					0.00113	
					(0.00662)	
Corp×2007	0.0250***					
	(0.00956)					
Corp×2008						0.000856
						(0.0242)
CapitalStock	0.368***	0.367***	0.367***	0.367***	0.367***	0.367***
	(0.0331)	(0.0289)	(0.0289)	(0.0289)	(0.0289)	(0.0289)
Investment	0.0162***	0.0177***	0.0177***	0.0177***	0.0177***	0.0177***
	(0.00114)	(0.00116)	(0.00116)	(0.00116)	(0.00116)	(0.00116)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Sample	Without 2008	Full	Full	Full	Full	Full
Observations	68,326	84,036	84,036	84,036	84,036	84,036
Within R^2	0.0984	0.105	0.105	0.105	0.105	0.105
Adjusted R^2	0.957	0.956	0.956	0.956	0.956	0.956

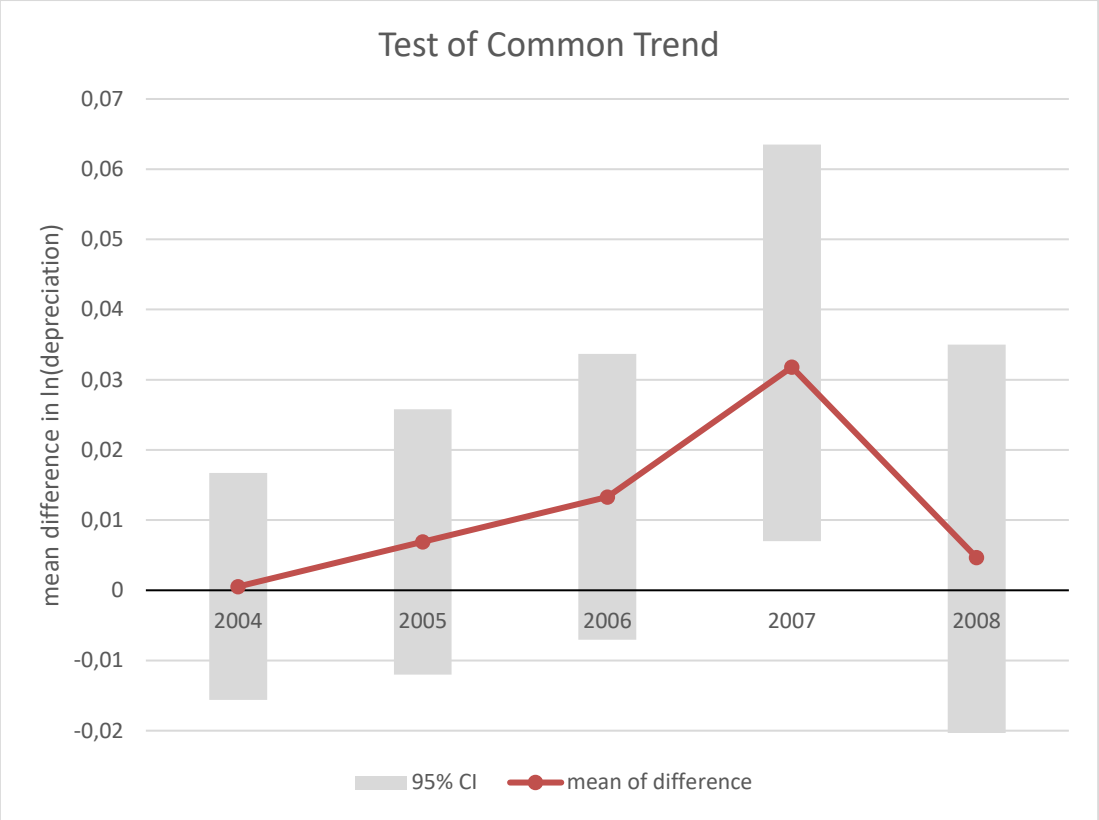
Dependent variable is the natural logarithm of depreciation expenses (depr). Corp×2003 through Corp×2008 refer to the interaction („×") of the respective variables. We control for the natural logarithm of the capital stock in all specifications. Further controls (Controls) are *TaxRate*, *Ebitda per turnover*, *Interest* and *Plants*. The variables are defined in Table 1. All results are based on the full sample. Estimations are performed by ordinary least squares (OLS) and include firm and year fixed effects (FE). Heteroscedasticity-robust standard errors, which have been clustered at the firm level, are documented in parentheses. ***, **, and * refer to significant results on the 1%, 5%, and 10% level. Within R^2 is obtained by the Stata command xtreg, whereas we used the areg command for calculating the adjusted R^2.

Table 6: Robustness tests: Baseline specification in a matched sample

Variable	(1)	(2)	(3)	(4)	(5)	(6)
Corp×2007	0.0207**	0.0206**	0.0204**	0.0213**	0.0213**	0.0213**
	(0.00928)	(0.00961)	(0.00956)	(0.00924)	(0.00956)	(0.00950)
Corp×2008		-0.000379	-0.0148		-0.000671	-0.0156
		(0.0147)	(0.0259)		(0.0146)	(0.0256)
CapitalStock	0.365***	0.365***	0.367***	0.358***	0.358***	0.359***
	(0.0287)	(0.0287)	(0.0301)	(0.0282)	(0.0282)	(0.0296)
Investment	0.0184***	0.0184***	0.0188***	0.0177***	0.0177***	0.0180***
	(0.00130)	(0.00130)	(0.00133)	(0.00130)	(0.00130)	(0.00132)
TaxRate			-0.110			-0.116
			(0.202)			(0.199)
Ebitda per Turnover				0.361***	0.361***	0.388***
				(0.0432)	(0.0432)	(0.0428)
Interest				0.0167***	0.0167***	0.0167***
				(0.00173)	(0.00173)	(0.00179)
Plants				0.0244***	0.0244***	0.0251***
				(0.00717)	(0.00717)	(0.00778)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Sample	Matched	Matched	Matched	Matched	Matched	Matched
Observations	69,826	69,826	68,452	69,826	69,826	68,452
Within R^2	0.0926	0.0926	0.0920	0.102	0.102	0.102
Adjusted R^2	0.955	0.955	0.956	0.955	0.955	0.956

Dependent variable is the natural logarithm of depreciation expenses (depr). Corp×2007 and Corp×2008 refer to the interaction („×") of the respective variables. We control for the natural logarithm of the capital stock in all specifications. The variables are defined in Table 1. All results are based on the pre-matched full sample. Estimations are performed by weighted ordinary least squares (OLS) and include firm and year fixed effects (FE) with inverse propensity scores as weights. Heteroscedasticity-robust standard errors, which have been clustered at the firm level, are documented in parentheses. ***, **, and * refer to significant results on the 1%, 5%, and 10% level. Within R^2 is obtained by the Stata command xtreg, whereas we used the areg command for calculating the adjusted R^2.

Figure 1: Visual Test of the Common Trend Assumption



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