Arbeitskreis Quantitative Steuerlehre
Quantitative Research in Taxation – Discussion Papers

Sebastian Eichfelder, Jonas Knaisch, Kerstin Schneider

How Does Bonus Depreciation Affect Real Investment?
Effect Size, Asset Structure, and Tax Planning

arqus Discussion Paper No. 278
June 2023

www.arqus.info
ISSN 1861-8944

How Does Bonus Depreciation Affect Real Investment?
Effect Size, Asset Structure, and Tax Planning

Sebastian Eichfelder* Jonas Knaisch†

Kerstin Schneider‡

June 22, 2023

Abstract

We analyze how tax incentives (bonus depreciation) affect real investment choices of firms by exploiting an exogenous variation in regional tax regulation in former East Germany (*Development Area Law*, DAL). Our rich administrative panel data for the universe of German manufacturing firms at the establishment level allow us not only to identify an aggregate effect, but also to identify which types of investment (equipment, buildings, land) are are most affected (asset structure). Our baseline results suggest that the DAL increased real gross investment by 16.0% to 19.9%. This aggregate effect is primarily driven by additional investments in buildings (76.6% to 92.3%) and land (108.0% to 121.3%) investments, which have the longest regular depreciation periods in absence of bonus depreciation. The impact on equipment investment is significantly smaller (7.3% to 10.5%). Hence, firms did not only increase their real investment, but also adjusted their asset structure in response to the tax incentive. Addressing firm heterogeneity, we observe a stronger response for firms with more than one business establishment and large firms, thereby providing evidence of tax planning opportunities (multi-establishment firms) and relatively low tax planning costs (large firms) enhancing the effect of bonus depreciation on investment. There is only week evidence of financial reporting costs (accounting incentives) moderating the tax induced effect on firms' real investment choices.

JEL classification codes: G11; H25; H32; M41

Keywords: business taxation, user cost of capital, tax elasticity, real investment

*Email: sebastian.eichfelder@ovgu.de; Otto-von-Guericke-Universität Magdeburg.

†Email: jonas.knaisch@ovgu.de; Otto-von-Guericke-Universität Magdeburg.

‡Email: ; Universität Wuppertal.

1 Introduction

Policymakers frequently use bonus depreciation to promote investment and foster economic growth. Examples include the 2017 US tax reform, the Dutch bonus depreciation from 2009 to 2011 (Wielhouwer and Wiersma 2017), and the US bonus depreciation from 2008 to 2010. Many OECD countries have frequently used bonus depreciation for countercyclical fiscal policy (Maffini et al. 2019). Our paper addresses the questions (1) whether and to what extent such tax incentive programs affect real investment decisions of firms, (2) how these incentives alter a firm's asset structure, and (3) which firm types react the most. In doing so, we follow several calls for additional research. Hanlon and Heitzman (2010) call for more research on real effects of accounting and tax incentives. Zwick and Mahon (2017) ask for more research regarding the heterogeneity of firm responses. Finally, Jacob (2022) sees a research gap in the relationship of tax effects on investment decisions and tax avoidance opportunities.

While most prior studies find positive investment effects from bonus depreciation, the effectiveness of such programs is still under debate (see the discussion in Ohrn 2017; Wielhouwer and Wiersma 2017).[1] Most important, there is a high range of elasticity estimates (4 to 14) regarding the effectiveness of such programs. In addition, it is unclear whether studies using accounting data are able to fully identify *real* investment responses or could be affected by accounting incentives (e.g., conforming tax avoidance, see Edgerton 2012; Badertscher et al. 2019) and tax avoidance behavior. Furthermore, while Zwick and Mahon (2017) document that average effects can mask large heterogeneity in investment responses to bonus depreciation programs, there is only a small number of papers that investigate this issue (Edgerton 2010; Wielhouwer and Wiersma 2017; Zwick and Mahon 2017).Edgerton (2012) argues that the effectiveness of investment tax incentives depends on accounting incentives. He hypothesizes that programs that provide tax benefits and also increase book income (e.g., investment tax credits) might have a stronger effect on investment activity than programs that do not have a positive effect on book income (e.g., bonus depreciation). We are not aware on any current research that discusses the link between accounting incentives, tax avoidance opportunities and the effectiveness of

[1] On the one hand, there is evidence of a positive effect of bonus depreciation on investment (House and Shapiro 2008; Edgerton 2012; Maffini et al. 2019; Zwick and Mahon 2017; Wielhouwer and Wiersma 2017; Ohrn 2019). On the other hand, Cohen and Cummins (2006), Dauchy and Martínez (2008), Hulse and Livingstone (2010), and Edgerton (2011) do not find corresponding evidence.

investment tax incentives.

We use an exogenous variation in a German bonus depreciation program (Development Area Law, DAL) to address these important questions. The first target is to identify and quantify the average treatment effect on real investment activity of treated German establishments by a difference-in-differences (DiD) estimation strategy. A main benefit of our data is that we can observe real investment data in a mandatory survey of the German Federal Statistical Office at the establishment level that will not be affected by accounting choices like earnings management or conforming tax avoidance. We consider subsidized establishments in Eastern German states as the treatment group and non-subsidized establishments in the West states as the control group and compare investments in the DAL treatment period (1995–1998) with investments in the period after expiration of the DAL (1999–2008). In 1995, the first year in our sample, the vast majority of establishments in the Eastern states were owned by West German firms and had access to the same technologies.[2] Thus, we expect West German establishments to be an appropriate control group.[3] Our baseline estimates suggest a treatment effect on investment at the extensive margin (investment probability) of 3.8 percent to 4.4 percent and at the intensive margin (conditional investment volume) of 11.7 percent to 14.8 percent, suggesting an aggregate effect of 16.0 percent to 19.9 percent. If we also consider a wide range of additional robustness checks, the effect size ranges from 10.5 percent (for a balanced panel of establishments over the whole observation period) to 34.8 percent (for a mixed panel of firms with establishments in both parts of Germany). Hence, our results point to bonus depreciation programs having substantial effects on real investment activity.

Going beyond identifying an aggregate effect, we investigate two dimensions of heterogeneity: capital types and firm characteristics. From a theoretical perspective, bonus depreciation becomes more valuable for investment goods with long regular depreciation

[2]The main privatization strategy of the *Treuhand* Agency (THA) at the end of the German Democratic Republic was to find an experienced and established West German or international firm, while management-buy-outs were a secondary alternative (Paqué 2009, p. 47f.). As the fraction of international investors was only about 6 percent, experienced firms in the former West were by far the most relevant investor group (BvS, 2003, p. 58).

[3]Note that our approach does not require identical economic conditions in both parts of Germany, since we control for the district-level economic situation. We also account for differences in cross-sectional characteristics by establishment fixed effects and other control variables. In robustness checks, we rely on firm panels with establishments in both parts of Germany and propensity score matching to increase the similarity of control and treatment groups. Our analyses provide compelling evidence for common trends in the investment activity of both groups in the post-DAL period – our reference point.

benefits (e.g., buildings). While existing empirical research often relies on that assumption (e.g., Desai and Goolsbee 2004; Edgerton 2010; Zwick and Mahon 2017), corresponding evidence is still missing. We find that the investment response for assets with long regular depreciation periods like building investments (76.6 percent 92.3 percent) and land investments (108.0 percent to 121.3 percent) by far exceeds the investment response of equipment investments (7.3 percent to 10.5 percent). This finding is robust for a wide range of tests and underlines that investment tax incentives do not only affect investment volumes but also the firms' asset structure.

Regarding firm heterogeneity, we expect that the effectiveness of bonus depreciation increases in opportunities for subsidy shopping, i.e. tax planning, and decreases in tax planning costs (e.g., Jacob 2022). Due to economics of scale in tax avoidance (Hundsdoerfer and Jacob 2019), tax planning costs should decrease in firm size, thereby increasing the effectiveness of bonus depreciation for large firms. Our analysis provides robust evidence that multi-establishment firms and large firms react more strongly to the bonus depreciation. We also address the relevance of accounting incentives for the effectiveness of bonus depreciation. Due to special accounting regulations, the use of the German bonus depreciation in the tax return required an equal depreciation deduction in the financial accounts ("reversed" book-tax conformity). As a consequence, the reform produced financial reporting costs by impairing the information content of financial accounts and by forcing firms to under-report their earnings. While we hypothesize that firms with higher financial reporting costs should show a weaker investment response in line with Edgerton (2012), we do not find such evidence. Thus, accounting incentives to not seem to play an important role for the effectiveness of bonus depreciation programs.

Our paper contributes to the literature in a number of ways. First, we contribute to the literature on the effectiveness of bonus depreciation programs (e.g., Desai and Goolsbee 2004; Edgerton 2010; Zwick and Mahon 2017). While Eichfelder, Jacob and Schneider (2023) use the same policy variation to analyze the effect of the German bonus deprecation on the quality of investments, our focus is on identifying the impact of the program on the quantity of real investments. A benefit for our study is that we rely on an exogenous policy variation identified at the establishment level (different from most studies which identify policy variation at the industry level) and have access on high quality data from the German Federal Statistical Office on real investments. Thus, our analysis will remain unaffected by tax avoidance and earnings management activities that could bias accounting data (e.g., Badertscher et al. 2019; Eichfelder, Jacob, Kalbitz and Wentland 2023. Our estimates suggest an elasticity of the user-cost of capital to the German bonus depreciation program ranging from 4 to 5 for our baseline estimates and from 2.7 to 8.1 if we consider additional robustness checks. This elasticity is moderate if we compare it to existing evidence on bonus depreciation programs (elasticity range of 6 to 14, see House and Shapiro 2008;Maffini et al. 2019) but high if we compare it to investment elasticities with regard to tax *rates* (elasticity range of 0.2 to 1, see Auerbach and Hassett 1992;Chirinko et al. 1999; Bond and Xing 2015; Melo-Becarra et al. 2021 with further references).

Second, as we have access to detailed administrative data regarding investment types at the establishment level (e.g., Desai and Goolsbee 2004; Edgerton 2010; Zwick and Mahon 2017), we are the first to estimate the impact of bonus depreciation on asset structures. While most studies use the industry level variation in tax benefits for different assets to identify the investment reactions of firms, empirical evidence of a stronger investment response for assets with long standard depreciation periods is still missing.

Third, we contribute to the scarce literature on how different firm types react to bonus depreciation incentives (Edgerton 2010; Zwick and Mahon 2017; Wielhouwer and Wiersma 2017). We follow the advice of Jacob (2022) and are the first to analyze the relationship of investment tax incentives, planning costs and tax avoidance opportunities. We find that large firms with lower tax planning costs reacted considerably stronger to the tax policy. This is consistent with evidence from Knittel (2007) and Kitchen and Knittel (2011) on lower take-up rates of bonus depreciation by small firms in the United States.[4] We also find a stronger investment reaction of multi-establishment firms with higher opportunities for subsidy shopping. By contrast, we do not find evidence that accounting incentives and conforming tax avoidance (e.g., Edgerton 2012; Badertscher et al. 2019; Eichfelder, Jacob, Kalbitz and Wentland 2023 play a relevant role for the effectiveness of bonus depreciation programs.

The remainder of the paper is structured as follows. Section 2 describes the German

[4]Our findings are not necessarily a contradiction to Zwick and Mahon (2017), since the definition of firm size in our analysis significantly differs from their paper. Zwick and Mahon (2017) interpret their finding of a larger investment response of smaller firms as evidence that liquidity constraints increase the effectiveness of investment tax incentive programs.

investment tax incentives and corresponding accounting regulations. Section 3 introduces the theoretical framework and derives the hypotheses. We describe the identification strategy and data in Section 4. Section 5 presents the results, while Section 6 concludes.

2 Institutional Background and Development Area Law (DAL)

Generally, the German tax system is similar to many other countries' corporate tax systems. Corporate profits are subject to corporate income tax, local business tax, and to dividend taxes upon distribution.[5] The German tax code defines the tax base, including depreciation schemes applicable to all firms in Germany. In 1991, the German federal government enacted the Development Area Law (DAL) bonus depreciation program to foster business investment in the five Eastern states (Brandenburg, Mecklenburg-West Pomerania, Saxony, Saxony-Anhalt, and Thuringia) and Berlin. In addition to DAL, firms could also apply for tax-exempt grants from the Investment Subsidy Law (German: *Investitionszulagengesetz*, expired in 2013, hereafter ISL) and taxable grants of the Joint Task Program "Enhancement of Regional Economic Structure", which supports investments in underdeveloped German areas (German: *Gemeinschaftsaufgabe "Verbesserung der regionalen Wirtschaftsstruktur"*, still ongoing, hereafter JTP). The DAL was among the most costly subsidies of the 1990s and the only program that included bonus depreciations. In 1996, the DAL ranked first among all German tax incentive programs.

The DAL allowed firms to depreciate 50% of eligible investments immediately, while the remaining 50% of book value were depreciated over the useful asset life.[6] The bonus depreciation could be easily claimed in the filing of the regular tax return and was not restricted to specific branches or business types.[7] It was available for all movable assets (except for aircrafts) and for structures (including the modernization of buildings). We exploit the expiration of the DAL in December 1998, which we interpret as an increase in

[5] From 1999 to 2001, there were major reforms of the German tax system affecting corporate taxation (with a large reduction of the German corporate income tax burden) and dividend taxation (with a large reduction of the dividend tax). As the reform affected corporations in both parts of Germany in a similar way, our DiD design effectively accounts for such endogeneity concerns.

[6] As an alternative, bonus depreciation could have been freely allocated over the first five years following the investment if no other special depreciation schemes had been used.

[7] In contrast to the DAL, JTP and ISL required a formal application, resulting in higher compliance costs. The assessment base of both programs was smaller and funding criteria were more rigid. Before 1999, ISL grants were restricted to new movable assets, with some exceptions (no low-value assets, cars, or aircraft). After 1999, ISL grants were expanded to new structures, but only in the case of so-called "initial" investments, including the foundation or extension of an establishment, major modifications of products and production methods, and the acquisition of a business that would otherwise have been liquidated. In case of the JTP, fundable investments included movable and intangible assets. Different from DAL and ISL, there was no legal entitlement for JTP grants. Thus, the success of applications and funding rates depended on the individual decisions of administrative authorities.

the user costs of capital.

An interesting aspect for our analysis is the accounting treatment of the DAL bonus depreciation. Before the German Accounting Law Modernisation Act from 2008 (German: *Bilanzrechtsmodernisierungsgesetz*), the German GAAP had a special form of book-tax conformity that required a consideration of special tax treatments in financial accounts (so-called "reversed" book-tax conformity). Therefore, if a firm wanted to save taxes by using bonus depreciation in the tax accounts, it also had to report lower book income. For example, if a firm wanted to deduct a bonus depreciation of € 1 million from taxable profit, the earnings in the financial reports of the same year were also reduced by a depreciation of € 1 million. Hence, the use of bonus depreciation resulted in potential misinformation in the financial reports and corresponding financial reporting costs.[8]

Table 1 summarizes the most relevant features of the programs in place. Note that the key changes occurred for bonus depreciation (DAL) and the DAL was the only program comprising such tax incentives.

[Table 1 about here]

Figure 1 shows the aggregate value of DAL ISL, and JTP subsidies by their present value (for computational details see Online Appendix A) from 1995 to 2008. Aggregate subsidy volumes (DAL, ISL, and JTP) as well as DAL subsidies dropped significantly around the DAL expiration in 1998/1999, while the sum of ISL and JTP subsidies remained stable over time. The small DAL subsidies after 1998 resulted from delayed bonus depreciations. Taken together, Figure 1 documents a strong and permanent decline in aggregate tax incentives for investments in Eastern establishments due to the expiration of the DAL program.

[Figure 1 about here]

[8] In contrast to that, direct and tax-exempt ISL subsidies were regarded as tax-exempt income in the financial accounts that increased earnings. JTP grants could be either reported as taxable earnings or as a reduction of acquisition costs in their financial reports. This resulted either in higher income in the current year (by higher earnings) and/or in future periods (by lower depreciations). Therefore, while DAL bonus depreciation had a negative effect on current earnings, ISL and JTP subsidies had either a neutral or a positive effect on the income of the current year.

3 Theoretical Framework and Hypotheses

The seminal work of Hall and Jorgenson (1967) presents the general framework for the impact of tax policy on business investments. According to their model, taxes and tax incentives have an impact on the user cost of capital. Abstracting from adjustment costs, the user cost of capital is (e.g. Cohen et al. 2002; Devereux and Griffith 2003)

$$C_t = \varphi_t \cdot T_t \cdot [\rho_t + \delta_t - E(\Delta\varphi_t/\varphi_t)], \tag{1}$$

with φ_t representing the price level, ρ_t the after-tax cost of funds, and δ_t the physical rate of depreciation at time t. $E(\Delta\varphi_t/\varphi_t)$ describes expected changes in the price of capital goods. Therefore, $\delta_t - E(\Delta\varphi_t/\varphi_t)$ is the expected net rate of depreciation (Auerbach 1983). The tax term is defined as

$$T_t = \frac{(1 - \tau_t \cdot Z_t - s_t)}{(1 - \tau_t)}, \tag{2}$$

where τ_t is the tax rate on profits, s_t is the rate of direct subsidies (in our case ISL and JTP benefits), and Z_t is the present value of depreciation allowances per € invested (in our case the sum of regular depreciation benefits plus bonus depreciation benefits).

Considering the strong decline in aggregate subsidy volumes in 1998 as documented by Figure 1, we conclude that the expiration of the DAL increased the average user costs of capital of treated establishments and hypothesize abnormally high investments in these establishments during the DAL treatment period.

H1: *DAL increased real investment in treated establishments.*

Further, we address the heterogeneity of the investment response. As documented by Eq. 1, the user costs of capital decrease in depreciation benefits $\tau_t \cdot Z_t$. In case of an immediate write-off (bonus depreciation), the value of the depreciation benefits is equal to τ_t as Z_t is one for $t = 0$ (see also Cohen et al. 2002). Therefore, bonus depreciation becomes more valuable if regular depreciation benefits are small. For $t \to \infty$ the present value of depreciations Z_t converges to zero, which is the case for assets with very long depreciation periods like unbuilt ground or structures. Therefore, we expect a stronger impact of the bonus depreciation program on assets with long depreciation periods like building and land investments.

H2: *DAL had a stronger effect on investment goods with long standard depreciation periods (buildings and land).*

We further analyze how firm characteristics are related to the effectiveness of the DAL bonus depreciation program. First, we account for the fact that tax avoidance and tax planning is a costly activity that also depends on opportunity. The literature on tax complexity and compliance costs clearly documents that the marginal costs of tax planning and compliance decrease with firm size (Gunz et al. 1995; Richardson and Lanis 2007). The combined planning and compliance costs as a fraction of sales revenue can be 10 times or even 100 times larger for small firms than for large firms (Eichfelder and Vaillancourt 2014). Therefore, larger firms tend to spend more resources on tax planning and the optimization of tax benefits. In line with that argument, Knittel (2007) and Kitchen and Knittel (2011) observe low take-up rates of bonus depreciations and accelerated depreciations by small US businesses.

The literature on profit shifting and tax avoidance further documents that business groups with international subunits relocate patents, earnings or costs with the target to generate tax benefits (e.g., Dharmapala 2014; De Simone et al. 2017; Hundsdoerfer and Jacob 2019). In similar terms, we might expect that firms with more than one establishment have more opportunities to adjust their investment strategy in order to benefit from bonus depreciation ("subsidy shopping"). Both arguments suggest:

H3a: *The DAL had a stronger effect on investments of firms with low planning costs (large firms) and on investments of firms with more opportunities for subsidy shopping (multi-establishment firms).*

An interesting institutional aspect of the German DAL regime is its accounting treatment. As documented in Section 2, the use of the bonus depreciation in the tax return required an equal depreciation deduction in the financial accounts ("reversed" book-tax conformity). As a consequence, while bonus depreciation provided cash tax benefits, it also produced financial reporting costs by impairing the information content of financial accounts and by forcing firms to underreport their earnings. Edgerton (2012) hypothesizes that firms do not only consider tax benefits but also financial reporting incentives of investment tax benefits in their investment decisions (see also Aarbu and MacKie-Mason 2003; Klemm 2010). Therefore, we expect that the investment response to the DAL is partially offset by the financial reporting costs induced by "reversed" book-tax conformity.

We use two proxies for these costs. First, due to accountability and the capital maintenance principle,[9] corporations likely face higher financial reporting costs. Second, we expect that owner-managed firms have smaller financial reporting costs, since they are less affected by agency problems.

H3b: *The DAL had a stronger effect on firms with low financial reporting costs (non-corporate firms and owner-managed firms).*

4 Identification Strategy and Data

4.1 Identification Strategy

We interpret the expiration of the DAL as a natural experiment. Since establishments in the Western German states were not subsidized, we use them as a control group and identify the DAL effect by difference-in-differences (DiD) estimation. An important advantage of our identification strategy is that the DAL bonus depreciation applied to almost all types of investments in the Eastern states. It was not necessary to apply for DAL or to actively "self-select" into the DAL program. Hence, self-selection should be of minor concern (see e.g., Wielhouwer and Wiersma 2017 for related problems). To control for potential self-selection by founding an establishment in a treatment area, we also perform a robustness check in Section 5.3 for a balanced panel of establishments that existed at the beginning of our observation period (1995).

A main prerequisite for DiD estimation is the common trends assumption.[10] We discuss potential concerns regarding this assumption in Subsection 4.4. Most importantly,

[9]In Germany, limited liability companies and other corporate firms are only allowed to distribute their (retained) book income after taxes as a dividend. In addition, such corporate firms are typically less closely held than partnerships and sole proprietorships, thereby increasing agency problems and related financial reporting costs. We therefore expect a weaker investment response of corporations.

[10]Another relevant but often neglected prerequisite is the stable unit of treatment assumption (SUTVA). SUTVA implies that treatment affects the treatment group but not the control group. A potential concern in our case might be that investments could have been redirected from the West to the East in order to obtain higher bonus depreciation. However, considering the dominance of the Western German economy and the limited size of the economy in the Eastern part of Germany, this should be a minor problem. In spite of the bonus depreciation from 1995 to 1998, only about 14.5% of the investments in our data were conducted in East Germany. Thus, even if some of these investments were shifted from the West, this could have had only a minor impact on the investment activity of our control group (i.e., the establishments in the Western states).

graphical analysis in this subsection provides compelling evidence of a common trend after the expiration of the DAL bonus depreciation as well as a structural break after the expiration of the program.

We account for potential differences between establishments in both parts of Germany in several ways. First, we control for time-invariant differences by establishment fixed effects, α_i. Second, we capture differences in capital stock, productivity, and general economic conditions in the region (e.g. unemployment rates, GDP per capita) by a set of control variables, X_{it}. Third, to account for economic shocks, we also include year fixed effects, γ_t, and industry-year fixed effects, θ_{it}. Fourth, in robustness checks in Section 5.3 and additional analyses in Section 5.5 we perform tests for a sample of firms with establishments in both parts of Germany and also apply propensity score matching to make our control group more similar to our treatment group. Fifth, we provide estimates for a wide array of additional specifications with robust results. Our baseline model can be written as

$$I_{it} = \beta_0 + \beta_1 \cdot DiD_{it} + \phi \cdot X_{it} + \alpha_i + \gamma_t + \theta_{it} + \epsilon_{it}. \tag{3}$$

We use two alternative dependent variables, I_{it} , for aggregate gross investments at the extensive and intensive margins of establishment i at time t (H1). We measure I_{it} using either a dummy variable indicating whether a firm has invested or not (extensive margin) or the logarithm of (positive) investment volume (intensive margin). In additional analyses (Subsection 5.2), we also consider investment measures for different asset types (H2). Similar to Zwick and Mahon (2017), we rely on the logarithm of investment to measure investment at the intensive margin, which allows us to interpret coefficients as elasticity estimates.[11]

The variable of interest in Eq. (3) is DiD_{it}, which is the interaction term of a dummy variable for establishments in East Germany and a dummy for the DAL treatment period. Therefore, DiD_{it} has a value of one if establishment i is located in an Eastern state and the observation is before 1999. We identify the average treatment effect by β_1. Since year and establishment fixed effects are included, the dummy variables $East_i$ and $Before99_t$ are redundant. At the establishment level, our vector of controls, X_{it}, includes the logarithm

[11] In an unreported robustness check, we also use investments scaled by capital stock as an alternative dependent variable with consistent results.

of the capital stock from the preceding period, K_{it-1}, as a proxy for capital endowment. We proxy the investment potential using the ratio of revenue to K_{it-1}. This ratio also serves as a measure for capital constraints, since revenue is positively correlated with cash flows as a common proxy for capital constraints (Hadlock and Pierce 2010). Controlling for economic conditions at the district level, we consider the unemployment rate, the logarithm of the price-adjusted GDP per capita, and the logarithm of the population in a district.

To test hypotheses H3a and H3b, we add triple difference interaction terms to Eq. (3). These terms interact the indicator DiD_{it} with the following dummy variables for firm characteristics: $Large_{it}$ is a dummy with a value of one for large firms with at least 250 employees; $Group_{it}$ is a dummy with a value of one for multi-establishment firms with more than one establishment; $Owner_{it}$ is a dummy with a value of one for firms with an active business owner in the management of the firm; $Corp_{it}$ is a dummy with a value of one for corporate firms with limited liability. We obtain:

$$\begin{aligned} I_{it} = \beta_0 &+ \beta_1 \cdot DiD_{it} \\ &+ \beta_2 \cdot DiDLarge_{it} + \beta_3 \cdot DiDGroup_{it} + \beta_4 \cdot DiDOwner_{it} + \beta_5 \cdot DiDCorp_{it} \\ &+ \beta_6 \cdot Large_{it} + \beta_7 \cdot Group_{it} + \beta_8 \cdot Owner_{it} + \beta_9 \cdot Corp_{it} \\ &+ \phi \cdot X_{it} + \alpha_i + \gamma_t + \theta_{it} + \epsilon_{it}. \end{aligned} \tag{4}$$

In Eq. (4), β_1 captures the average DAL effect, while β_2, β_3, β_4, and β_5 capture the additional effects from large, multi-establishment, owner-managed and corporate firms. Thus, the overall effect for firms with all characteristics is the aggregate effect of all coefficients β_1 to β_5.

4.2 Data

Our analysis uses the German AFID panel (German: *Amtliche Firmendaten in Deutschland*) for the manufacturing and mining industries from 1995–2008, which includes a number of mandatory business surveys conducted by the German Federal Statistical Office.[12] The main surveys used in this analysis are the Investment Survey and the Monthly

[12]The data can only be accessed by remote data processing (Malchin and Voshage 2009).

Report for the manufacturing and mining industries.[13] Both surveys are a census of the universe of business establishments in these sectors with at least 20 staff members, including managers and working business owners and provide information at the establishment level. We also collect data at the district level (GDP per capita, population, unemployment rate) from RegioStat[14] to control for regional economic conditions. Hence, we have a comprehensive panel of establishments covering the period between 1995 and 2008.

Compared to firm panels from Compustat or AMADEUS, AFiD has clear advantages for our analysis. First, unlike accounting data, the Investment Survey provides information at the most granular level of identification, the business establishment. This is crucial for our analysis, since we need corresponding data for a clear identification of DAL-treated investments. Note that establishments in the East typically belong to Western firms.

Second, as AFiD is a mandatory business survey for the universe of establishments in the German manufacturing sector, non-response, self-selection or a potential lack of representativeness, which are common problems in accounting research, are not challenges for our analysis. In addition, the very detailed information in our data allow us to disentangle investment responses for different types of assets, namely equipment, buildings and land, which is typically not possible by the use of accounting and aggregate data.

Lastly, our measures for business investment will not be affected by depreciation policies, earnings management or conforming tax avoidance (see for example Dobbins et al. 2018; Badertscher et al. 2019; Eichfelder, Jacob, Kalbitz and Wentland 2023), while we have data on investment flows instead of stocks. These conditions make it feasible to investigate the effect of bonus depreciation on *real* investment activity.

A potential disadvantage is that our data is restricted to the manufacturing sector, which, however, is a very relevant part of the German economy. In addition, since there is no financial reporting at the establishment level, the data does not provide explicit information on capital stocks. Therefore, extending the approach of Wagner (2010), we estimate the capital stock at the establishment level using information from the Cost

[13]In German: *Investitionserhebung bei Betrieben des Verarbeitenden Gewerbes sowie der Gewinnung von Steinen und Erden; Monatsbericht bei Betrieben des Verarbeitenden Gewerbes sowie der Gewinnung von Steinen und Erden.*

[14]See also `https://www.regionalstatistik.de/genesis/online/logon`.

Structure Survey[15] (for computational details see Appendix B).

The raw data comprises 691,822 establishment-year observations. Due to the special status of the Berlin area, we omit the 13,394 observations located in Berlin. We also drop 21,019 observations of mining companies. Finally, we drop 113,324 observations with incomplete information on our primary variables of interest (e.g. resulting from business restructurings or restructurings at the county level). After these adjustments, our sample comprises 544,085 observations over 14 years.[16]

We price-adjust the data on investments, sales, and capital stocks. Since the German Federal Statistical Office does not report regional producer price indices, we use the German Producer Price Index for the manufacturing industry (Bofinger et al. 2011). Building prices, however, depend on local economic conditions. Since a regional subsidy like bonus depreciation can affect regional prices (Goolsbee 1998; House and Shapiro 2008), we use state-level building price indices for the manufacturing industry to control for price differences of building investments (see also Appendix C).

4.3 Descriptive Statistics

We report descriptive statistics of our sample in Table 2. On average, price-adjusted gross investments in the control (West) group (€ 1,140.45 thousand) slightly exceed the values in the treatment (East) group (€ 1,021.27 thousand). While average equipment investment and land investment per establishment are slightly larger in the control group, average building investment is somewhat larger in the treatment group. The percentage of establishments with positive gross investments is quite high and almost identical in the treatment group (85.68 percent) and the control group (86.64 percent). Establishments in the East have a higher probability of investing in buildings and land (28.40 percent and 5.11 percent, respectively) compared to Western establishments (19.59 percent and 3.00, respectively). This is in line with our expectation that the DAL especially promoted investments in assets with long depreciation periods. Western establishments have larger revenues and larger capital stocks than Eastern establishments. This is in line with representative balance sheet data provided by the German Central Bank (Bank 2012),

[15] German: *Kostenstrukturerhebung*

[16] Note that due to M&A and other forms of restructuring, a single establishment may be owned by more than one firm over the time period studied.

according to which the ratio of revenue to capital stock of Eastern German firms is smaller than in the West. Unemployment rates in Eastern German districts are higher and GDP-per-capita ratios are smaller than in Western districts.[17]

[Table 2 about here]

4.4 Common Trends Assumption

The key assumption critical to our identification strategy is the common trends assumption. Apart from the treatment effect, the trends of the two samples (the treatment group and the control group) should not differ from each other. In our study, we examine the expiration of a bonus depreciation regime. We interpret the DAL's expiration as a policy change that *increases* the user cost of capital of investments in Eastern establishments, relative to Western establishments. Consistent with standard DiD estimation, we expect a common trend of investment activity in both parts of Germany after the change in the user costs. Before the DAL's expiration, H1 suggests a positive treatment effect on the volume of investments in Eastern establishments.

A potential concern regarding the common trends assumption might be general differences in development or business cycles of the establishments in both parts of Germany. Note that our analysis does not require a common trend of both parts of Germany but rather a common trend of the investment activity of establishments in the manufacturing sector in both parts of Germany. As mentioned before, establishments in the former East in the middle of the 1990s were typically owned by Western German firms. Thus, they competed in the same market, had typically the same owner, and access to the same technologies as their Western counterparts.

In order to provide evidence on common trends, we compare the investments for the treatment and control groups for the years shortly before and after the annulation of the DAL program (period from 1995 to 2004) graphically. Since we are only interested in differences in trends for both groups and not in differences in means, we de-mean all the variables with their average value in the period after 1999 and subtract the mean

[17] We also use propensity score matching as a robustness check to make the control and treatment groups more comparable. Appendix D provides details on the matching process, while Table D.2 contains results of estimating the baseline Eq. (3) with the matched sample. The results remain qualitatively and quantitatively unchanged.

of the logarithm of investments from the post-DAL period. Hence, we calculate yearly deviations from the "normal" average investment activity from 1999 to 2004. Figure 2 shows the average price-adjusted and de-meaned gross investments for the treatment and control groups. Prior to 1999, the treated establishments have an abnormally high level of investment, as one would expect due to the bonus depreciation regime. In addition, we find some graphical evidence that the investment reaction to the DAL expiration took about one year to converge to the normal level in 2000. This is not unexpected, since delays in building projects and construction works are a common problem. Thus, even if firms intended to reduce their investment activity after the DAL expiration, this reaction to the tax-driven increase in the user costs of capital was likely to take some time.

[Figure 2 about here]

5 Results

5.1 Average Treatment Effects

Our analysis starts with estimating the baseline model in Eq. (3) for gross investments at the extensive and intensive margins. For investments at the extensive (intensive) margin, the dependent variable is a dummy variable with a value of one for establishments having non-zero gross investment (the natural logarithm of price-adjusted gross investment). When modelling investments at the intensive margin, we only consider observations with positive investments, thus reducing the number of observations. Our final sample includes 544,085 observations of 68,289 establishments for investments at the extensive margin and 470,548 observations of 63,733 establishments for investments at the intensive margin.

Since we are not interested in predicting investments, but rather explaining them, we rely on a linear probability model to investigate the extensive margin. The benefit of this model type is that we can interpret the regression coefficients as percentage point changes in the conditional average probability to invest. In the robustness checks (see Table 5), we also calculate logit regressions that confirm our baseline analyses. As our main variables of interest are dummy variables and the dependent variable in the intensive margin models is the logarithm of investment, our regression coefficients are roughly equal to the DAL-induced relative changes of the investment activity. To get an unbiased estimate of the relative change, we apply the formula of Kennedy et al. (1981) and calculate the relative change as $exp\left[\hat{\beta}_i - \frac{1}{2} \cdot Var(\hat{\beta}_i)\right] - 1$.

Table 3 presents the regression results. Models (1) to (4) refer to investment at the extensive margin, while the models (5) to (8) contain results for the intensive margin. In the first specifications, we only use establishment fixed effects and year fixed effects to account for a potential over-control bias. In the other specifications, we gradually add industry-year fixed effects, district controls and establishment controls. Our preferred specifications are the fully specified models (4) and (8). We cluster heteroscedasticity-robust standard errors at the firm level, since investment decisions are made by the firm rather than the establishment.[18]

[Table 3 about here]

The coefficient on DiD is positive and statistically significant in all models. Thus, we find robust empirical support for H1 suggesting that the DAL bonus depreciation increased investment activity either by new investment projects or by an anticipation of investment projects. In our preferred specification in Column (4), we estimate a treatment effect on the probability to invest of 3.23 percentage points. Compared to the average probability to invest in Eastern establishments (85.08 percent, Table 2), this implies an increase of gross investments at the extensive margin by 3.8 percent (= 0.0323/0.8568). Without any controls in Column (1), we find a slightly larger effect size on investment at the extensive margin of 4.4 percent (= 0.0378/0.8508). The average increase in investment at the intensive margin can be calculated by applying the Kennedy et al. (1981) formula to the coefficient estimates in Columns (5) to (8). For the full model in Column (8), we find an increase of 11.7 percent [$0.117 = exp\,(0.111 - 1/2 \cdot 0.0199) - 1$] and for the reduced model in Column (5) an increase of 14.8 percent [$0.148 = exp\,(0.138 - 1/2 \cdot 0.0195) - 1$]. Thus, the DAL increased the conditional volume of investment by about 11 to 15 percent. Combining both estimates, we calculate an aggregate increase in real gross investments in the manufacturing sector ranging from 16.0 percent ($= 1.1038 \times 1.117$) to 19.9 percent ($= 1.1038 \times 1.148$).

[18] In unreported robustness checks, we also calculate bootstrapped standard errors that are very close to the standard errors reported here. We report R squared as well as the adjusted R squared. Both R-squared measures account for the explanatory power of the establishment fixed effects.

5.2 Asset Structure

In the models (1) to (6) of Table 4, we perform similar analyses as in Table 3, but use equipment investments, building investments and land investments at the extensive and intensive margins as dependent variables (H2). In these models, we use the specification with all control variables of Eq. (3). In Appendix F, we also perform alternative regressions without control variables and obtain qualitatively and quantitatively robust results. Our evidence provides strong empirical support for H2 suggesting a stronger impact of the DAL on investment goods with long regular depreciation periods. Furthermore, we only find relatively moderate effects for equipment investments that can be depreciated over a small number of periods (Devereux et al. 2009 assume an average period of 7 years for such investment goods) and also by the declining balance method that reduces the disadvantage of the regular depreciation scheme in relation to bonus depreciation.

[Table 4 about here]

Using similar calculations as in Section 5.1. (i.e., comparisons with Table 2 and the Kennedy et al. 1981 formula), the coefficients in Table 4 translate into an abnormal increase in equipment investment at the extensive margin of 3.8 percent and 3.4 percent at the intensive margin, resulting in an aggregate effect on equipment of 7.3 percent. This relatively moderate effect is contrasted by an abnormal increase in building investment at the extensive margin of 28.6 percent and at the intensive margin of 37.3 percent, resulting in an aggregate increase in building investment activity by 76.6 percent. Land investment increased at the extensive margin by 37.6 percent and at the intensive margin by 51.2 percent, which implies an overall increase in land investment of 108.0 percent. While these large investment responses do not allow for definitive statements whether the DAL bonus depreciation resulted in additional investment projects or rather a temporal anticipation of investment activity for that type of capital goods, we can provide clear evidence that the DAL bonus depreciation did not only increase aggregate gross investment but also affected the asset structure and resulted in a large growth of investments in structures and land.

This is also underlined by Column (7) of Table 4, where the building and land investment share (i.e., the ratio of building and land investment to total investment) is the dependent variable. The fraction of building and land investments increased by 3.8

percentage points. Compared to an average building and land investment share of 15.9 percent (own calculations using Table 2), this implies a relative increase in the fraction of building and land investment activity by 23.8 percent.[19]

5.3 Robustness Checks

To confirm the robustness of our main findings, Table 6 reports additional estimates for gross investment (Columns 1-2), equipment investment (Columns 3-4), building investment (Columns 5-6), and land investment (Columns 7-8) when performing 4 alternative specifications. A potential concern might be that the DAL bonus depreciation program did not only affect investment activities of existing firms, but also resulted in the foundation of new establishments in East Germany or the relocation of establishments from the West to the East. In this case, our estimates in Section 5.1 would also capture location decision of establishments, which could result in an overestimation of the pure investment response. Therefore, we perform an additional test that restricts our sample to establishments that existed in 1995 in both parts of Germany. While this reduces our observation number to 241,147, it does not largely affect our results. Indeed, we still find statistically significant investment responses for gross investments at the extensive margin and for all investment types. If we use the investment responses of the different asset classes (equipment, buildings, land) to calculate an aggregate investment response,[20] we find an increase in gross investment activity of 10.5 percent, which is somewhat smaller than our baseline estimate of 16.0 percent. Thus, part of the investment response might fall on additional investments as a consequence of the DAL program.

Another concern might be that our treatment and control group might differ from each other with regard to technology access. To account for that issue, we restrict our analysis to a sample of Western German firms with establishments in both parts of Germany (i.e., at least one establishment in the East and one establishment in the West). We

[19]Goolsbee (1998) argues that investment tax incentives increase asset prices, which dampens their impact on real investment. For our purposes, this should not be a problem, since we deflate the value of building investment at the intensive margin in all specifications by a regional building price index. In additional analyses, we only find weak evidence for a relevant impact of the DAL on building prices (see Appendix C).

[20]We calculate the investment response for each asset class and then weight each of theses responses with the average fraction of investments in the asset type to overall investments. In doing so, we only consider statistically significant coefficients.

also add parent fixed effects to account for the fact that specific establishments belong to the same firm. This approach ensures that Western and Eastern establishments belong to the same firms, have access to the same technologies and are widely similar to each other. In Panel B, we reestimate Eq. (3) for this largely reduced panel with only 38,350 observations. Again, we find significant investment responses for gross investments, equipment investments and building investments. For land investments, the coefficient estimates are positive but not significantly different from zero, which is likely due to the low number of observations with positive land investments (only 1,075 firm-year observations). If we use the investment responses of the different asset classes (equipment, buildings, land) to calculate an aggregate investment response, we find an increase in gross investment activity of 32.5 percent, which is larger than our baseline estimate. This has two implications. First, potential differences in technology access between the treatment and control group in our baseline analysis should not result in an overestimation, but could rather bias our baseline estimate downwards. Second, firms with establishments in both parts of Germany could react more strongly due to subsidy shopping opportunities. In Appendix D.4, we document the robustness of this finding by adding parent-year fixed effects to the specification in Panel B. An addition, we also show that our baseline results are qualitatively and quantitatively robust to an alternative control group based on a pre-matched control group.

[Table 5 about here]

In Panel C and Panel D, we account for two potential technical concerns. In Panel C, we cluster standard errors at the industry-year level and not at the firm level. This does not significantly affect our results. In Panel D, we perform logistic regressions instead of linear probability models for the extensive margin analysis. In these logistic models, we still find statistically significant evidence that the DAL program increased real investment activity for gross investments, equipment, buildings and land. Overall, Table 5 documents strong robustness of our baseline regression results.

5.4 Tax Planning and Accounting Incentives

For the firm heterogeneity tests (H3a and H3b), Similar to the last section, we account for all control variables. A challenge for our analysis is that information on legal structure

(*Corp* dummy) and the activity of the firm's business owner (*Owner* dummy) relies on the Cost Structure Survey. Different from the Investment Survey, the Cost Structure Survey is not provided for the universe of German manufacturing firms but only for a sample of typically larger firms. This provides us with two alternative approaches. First, we can restrict our heterogeneity tests to this smaller sample of 243,919 observations of 45,381 establishments. However, a disadvantage of this approach is that this smaller sample might not be representative for the universe of all establishments. Second, we can perform the analysis for the full sample, while setting the value of the dummy variables *Owner* and *Corp* to one only for firms that provide the corresponding information. A disadvantage of this approach is that it increases white noise in our data, since a value of zero for *Corp* could either mean that the firm is not a corporation or that such information is not available. To account for both challenges, we perform both approaches and report results in Table 5. In this table, we also perform additional tests with a reduced number of triple difference interaction terms in the regressions.

[Table 6 about here]

Most notably, we find evidence for H3a that expects a stronger investment reaction for multi-establishment firms due to opportunities for subsidy shopping, as indicated by the positive and statistically significant interaction term *DiDLarge* at the intensive margin. Thus, firms with more than one establishment had a stronger investment reaction compared to single-establishment firms. We find an additional DAL-driven increase in investment activity for large firms ranging from 19.6 percent (full sample) to 29.0 percent (restricted sample).[21]

Regarding multi-establishment firms, we find evidence for a significantly higher investment response in most specifications. While we find a statistically significant effect on investment at the extensive margin for the full sample in Model (4), we obtain a statistically significant increase on investment at the intensive margin in Models (5) and (7). Overall, our evidence suggests that large firms and also firms with multiple establishments reacted more strongly to the investment incentives of the German DAL program. In line

[21] These aggregate effects result from an insignificant effect on investment at the extensive margin and a statistically significant effect on investment at the intensive margin from 19.6 percent (full sample) to 29.0 percent (restricted sample).

with H3a, this suggests that lower costs of tax planning or higher opportunity for subsidy shopping are positively associated with the effectiveness of investment tax incentives.

By contrast, Table 5 does not provide empirical support for H3b. Overall, there is only one specification with an statistically significant and abnormally high investment response of owner-managed firms in model (3). For *DiDCorp* we find an abnormally high investment response for the full sample at the extensive margin (model 3), but an abnormally low investment response for investment at the intensive margin (model 7). Thus, the overall evidence is mixed and the results regarding H3b are inconclusive.

5.5 Additional Tests and Analyses

As documented in detail by our Appendices D.1 to D.5, we perform the following additional tests and analyses. In D.1, we analyze the effect of the German DAL on building prices. Different from Goolsbee (1998), we find only weak pricing effects. Even if we allocate the full change in building price indices to the DAL, the DAL-induced increase in building prices is only 4.4 percent compared to an increase in real investment activity in buildings of 76.6 percent and in land of 108.0 percent.

To alleviate concerns regarding the appropriateness of our control group, we use propensity score matching to increase the similarity of the treatment and control group and re-estimate the regression Eq. (3) with the matched sample. We report results in Table D.2 in Appendix D.2 that qualitatively and quantitatively confirm our baseline evidence. In Table D.2, we find a range for the aggregate DAL effect on investment activity of 15.2 percent to 18.4 percent, which is very close to our baseline range of 16.0 percent ot 19.9 percent.

In Appendix D.3, we investigate whether firms anticipated the expiration of the DAL and therefore simply shifted investment decisions from the future into the DAL period. As shown in Table D.3, there is no evidence of a negative investment effect right after the DAL expired. Put differently, there was no abnormal decrease of investments in Eastern establishments compared to the control establishments after the DAL period. This indicates that the main results are not driven by anticipation effects.

In Appendix D.4, we show that our results are robust to several alternative control variable settings and thus are not driven by our control variable specifications. In Table D.4, we report the results for different investment types (equipment, buildings, land) without regression control variables and industry-year fixed effects. In Table D.5, we account for a potential concern of endogenous regression controls and report results for gross investments and the investment types if we use once-lagged control variables. In Table D.6, we further include EBITDA per capital (as a measure of cash flow), interest per capital (as a measure of debt ratios), and the legal form of the firm (as a measure of financing opportunities), since one might argue that revenue per capital stock is not sufficient to control for capital constraints. This information is not available for all observations, causing our sample size to shrink by more than 50 percent. In Table D.6, we re-estimate our test for a panel of Western firms with establishments in both parts of Germany, but further add parent-year fixed effects. By doing so, we identify the DAL treatment effect at the level of the establishment holding firm-years constant. Thus, for each firm, we compare investment responses between Western and Eastern establishments of the same firm. Average treatment effects remain very similar to Panel B of Table 5.

Lastly, considering the partially mixed evidence on firm heterogeneity in Table 6, we re-estimate this table in Appendix D.5 for different types of investment goods in the Tables D.8 (equipment), D.9 (building) and D.10 (land). These additional tests confirm our main findings of Table 6. Most relevant, we find abnormally high investment responses for large firms and multi-establishment firms in line with H3a. By contrast, we do not find consistent evidence for owner-managed firms and corporations.

6 Conclusion

Using high-quality data of the German Federal Statistical Office at the establishment level, we exploit a bonus depreciation regime (Development Area Law, DAL) for establishments in the Eastern part of Germany to analyze whether, to what extent, and how such tax regimes affect *real* investment activity. We find strong empirical evidence that the DAL increased real investment activity by 15 to 20 percent. This moderate average effect masks a large heterogeneity in investment responses. With regard to asset types, we find an aggregate investment response of about 7 to 10 percent for equipment, 75 to 90 percent for buildings and 108 to 120 percent for land investments. These findings suggest that firms rationally react to investment tax incentives, and at least temporarily adjust their asset structure in order to optimize tax benefits. We further provide evidence that large firms and firms with more than one establishment have a higher investment response.

We also discuss potential limitations of our study. First, as our sample is limited to the manufacturing industry of Germany, results may not be representative to empirical settings in other industries and countries. Second, the observed policy variation took place at a time where German business tax rates were higher than today. Thus, bonus depreciation programs might be less effective if tax rates are lower. Nevertheless, our elasticity estimates are rather at the lower bound of other studies that analyze more recent bonus depreciation regimes. Therefore, our paper underlines the finding of several empirical studies that bonus depreciation seems to be a very effective strategy to increase investment activity, and that real investments are affected. That holds especially for asset classes with long regular depreciation periods.

A policy implication of our paper is that bonus depreciation regimes will be more effective if standard depreciation periods are long. Thus, reducing standard depreciation periods in the long run might promote investment activity, but also will make temporal and anti-cyclical investment tax incentive programs less effective. A second policy implication is that large firms and firms with more opportunities for subsidy shopping receive higher benefits from investment tax incentive programs. Thus, governments should be careful and restrict subsidies that are given to such firms as investment tax incentives might reduce average investment quality (Eichfelder, Jacob and Schneider 2023) and could harm competition between small and large firms. Lastly, accounting incentives, as highlighted by Edgerton (2012), do not seem to play a major role for the effectiveness of bonus depreciation policies.

Figures and Tables

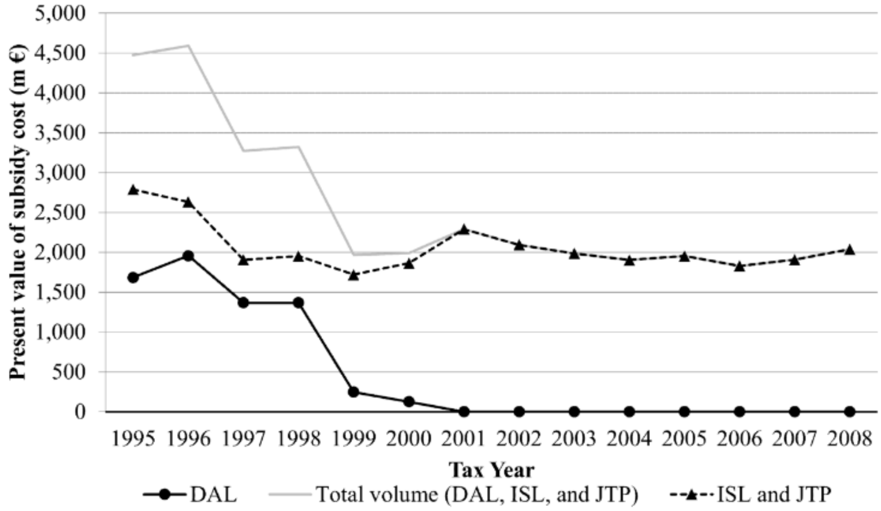

Figure 1: Subsidy volume of DAL, ISL, and JTP

Note: TThis figures plots the present value volumes of subsidy costs for the DAL program and the sum of the DAL and ISL programs, based on German government reports on subsidies (Deutscher Bundestag, Drucksache 12/1525, Drucksache 13/2230, Drucksache 14/1500, Drucksache 15/1635, Drucksache 16/6275). For the calculations, see Online Appendix A.

(a) De-Meaned investments East and West

(b) Investment levels East and West

Figure 2: De-meaned investment and investment levels before and after treatment

Notes: Panel (a) plots the de-meaned value of the logarithm of gross investments in the manufacturing sector for the treatment group (East German establishments) and the control group (West German establishments). The figure highlights the trend in the investment activity of both groups in the DAL period (1995–1998) and following years. Panel (b) does the same for investment levels.

Table 1: Regional investment subsidies for establishments in Eastern Germany, 1995–2008

	DAL	**ISL**	**JTP**
Validity period	Until December 31, 1998	Whole observation period	Whole observation period
Subsidy form	Bonus depreciation	Direct and tax-exempt subsidy	Direct and taxable grant
General rates	50% (1995–1996), 40% (1997–1998)	5% (1995–1998),c 10% (1999), 12.5% (since 2000)	Maximum rates (actual grants depend on authority decision and overall funding level): 35% (1995–1996); 28–35% (1997–2006); 30% (since 2007)
Increased rates	NA	+ 5% (Small and medium-sized enterprises, SME, 1995–1998), twice the general rate for initial equipment investment (SME, since 1999); + 2.5% (border areas, since 2001)	Additional maximum rates for small and medium-sized enterprises: +15% (1995–2006); +10–20% (since 2007)
Special regional regulations	NA	Berlin: reduced validity periods (West Berlin) and reduced rates under certain conditions	Maximum rates and detailed regulations depend on the regional area; reduced rates for Berlin area (since 2000)
Assessment base	Movable assets (excluding aircraft), immovable assets, modernization of buildings	New and movable assets (excluding low-grade assets, aircraft, cars), new and immovable assets (since 1999), restriction to initial investments (since 1999)	Movable assets and intangible assets; fundable investments depend on minimum investment volumes, employment effects, and authority decisions
Formal requirements	Tax return with legal entitlement	Formal application with legal entitlement	Formal application without legal entitlement

Notes: This table summarises the 3 major subsidies that were in place during the sample period 1995-2008. The last amendment of the law (ISL 2010) had run out by the end of 2013. The investment subsidy rate is up to 8% until the end of 1996 for investments that started before July 1994.

Table 2: Descriptive Statistics by Region

	Full Sample (N=544,085)			**West Germany (N=456,913)**			**East Germany (N=87,172)**		
Variable	Mean	SD	P50	Mean	SD	P50	Mean	SD	P50
Real investments (thousands €)									
Gross investment	1,121.36	10,947.59	111.28	1,140.45	11,243.91	113.46	1,021.27	9,239.69	99.70
Equipment investment	983.56	10,041.45	100.00	1,007.27	10,338.92	103.54	859.32	8,308.80	82.51
Building investment	129.97	1,498.17	0.00	125.07	1,384.05	0.00	155.65	1,949.36	0.00
Land investment	7.83	271.95	0.00	8.12	293.23	0.00	6.30	104.41	0.00
Fraction of establishments with positive investments (%)									
Gross investment	86.48	34.19	100.00	86.64	34.02	100.00	85.68	35.03	100.00
Equipment investment	86.10	34.59	100.00	86.28	34.40	100.00	85.15	35.56	100.00
Building investment	21.00	40.73	0.00	19.59	39.69	0.00	28.40	45.09	0.00
Land investment	3.34	17.97	0.00	3.00	17.07	0.00	5.11	22.02	0.00
Control variables									
Capital stock (thousands €)	5,104.99	39,896.66	1,375.64	5,200.81	41,021.10	1,354.22	4,602.75	33,384.80	1,488.71
Revenue (millions €)	29.90	296.16	5.77	32.84	321.33	6.25	14.48	77.32	3.87
Revenue per capital (%)	174.60	45,913.49	4.24	205.06	50,099.93	4.56	14.97	1,084.40	2.60
GDP per capita (thousands €)	25.01	9.72	23.07	26.49	9.76	24.03	17.27	4.33	16.21
Population (thousands)	273.86	239.69	202.20	297.87	251.63	241.77	148.02	88.55	130.30
Unemployment rate (%)	10.52	4.57	9.20	9.01	2.92	8.50	18.43	3.32	18.40

Notes: Descriptive statistics of the main variables (see Section 4) for the AFiD panel of establishments in the manufacturing sector in Germany 1995-2008; Panel A contains the full sample, while Panel B shows Western establishments (control group), and Panel C depicts Eastern establishments (treatment group). All investment and regional variables are price-adjusted using the German Producer Price Index. Building investments are price-adjusted using building price indices from the German states (see Appendix C).

Table 3: Gross investment at the extensive and intensive margin

Variables	Extensive margin				Intensive margin			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
DiD	**0.0378*****	**0.0356*****	**0.0320*****	**0.0323*****	**0.1380*****	**0.1190*****	**0.1070*****	**0.1110*****
	(0.0034)	**(0.0034)**	**(0.0036)**	**(0.0036)**	**(0.0195)**	**(0.0192)**	**(0.0201)**	**(0.0199)**
Capital stock				0.0088***				0.1310***
				(0.0001)				(0.0050)
Revenue per capital				-0.0302*				0.3230*
				(0.0181)				(0.1720)
Unemployment rate			-0.0021***	-0.0020***			-0.0131***	-0.0116***
			(0.0006)	(0.0006)			(0.0033)	(0.0033)
GDP per capita			-0.0077	-0.0091			0.1740***	0.1530**
			(0.0092)	(0.0092)			(0.0630)	(0.0625)
Population			-0.0164**	-0.0158**			-0.0157	-0.0099
			(0.0074)	(0.0074)			(0.0397)	(0.0393)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry–year FE	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Observations	544,085	544,085	544,085	544,085	470,548	470,548	470,548	470,548
Establishments	68,289	68,289	68,289	68,289	63,733	63,733	63,733	63,733
R-squared	0.472	0.472	0.472	0.473	0.702	0.704	0.704	0.705
Adjusted R-squared	0.396	0.396	0.397	0.397	0.655	0.657	0.657	0.658

Notes: OLS regressions with establishment fixed effects and clustered standard errors at the firm level (in parentheses). In models (1)-(4), the dependent variable is a dummy variable with a value of one for an establishment i with positive gross investments in t (extensive margin). In models (5)-(8), the dependent variable is the logarithm of positive gross investments of establishment i in t (intensive margin). DiD is an interaction term of a dummy variable for establishments in Eastern German states and a dummy variable for the DAL treatment period (1995–1998). Capital stock is the logarithm of the capital stock of establishment i and Revenue per capital is the ratio of sales revenue to the capital stock. Unemployment rate is the unemployment rate of the district of establishment i in t in percentage points. GDP per capita (Population) is the logarithm of the gross domestic product per capita (the number of inhabitants) of this district. ***, **, and * indicate significance levels of 0.01, 0.05, and 0.1, respectively.

Table 4: Investment goods at the extensive and intensive margin

Variables	Equipment		Buildings		Land		Buildings and land share
	Extensive	Intensive	Extensive	Intensive	Extensive	Intensive	Intensive
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
DiD	**0.0322*** **	**0.0336***	**0.0813*** **	**0.3180*** **	**0.0192*** **	**0.4350** **	**0.0377*** **
	(0.0037)	**(0.0189)**	**(0.0054)**	**(0.0498)**	**(0.0027)**	**(0.2080)**	**(0.0028)**
Capital stock	0.0088***	0.1380***	0.0112***	-0.0846***	0.0012***	-0.0242	-0.0023***
	(0.0009)	(0.0049)	(0.0009)	(0.0148)	(0.0004)	(0.0626)	(0.0005)
Revenue per capital	-0.0303*	0.3470**	0.0044	-0.3760***	0.0001	7.3590	-0.0126***
	(0.0181)	(0.1660)	(0.0074)	(0.0337)	(0.0001)	(67.200)	(0.0035)
Unemployment rate	-0.0019***	-0.0104***	-0.0006	-0.0396***	-0.0004	-0.0274	-0.0001*
	(0.0006)	(0.0032)	(0.0008)	(0.0095)	(0.0004)	(0.0417)	(0.0004)
GDP per capita	-0.0097	0.1520**	-0.0201*	0.2560*	-0.0078	0.1610	-0.00461
	(0.0094)	(0.0606)	(0.0119)	(0.1490)	(0.0053)	(0.6200)	(0.0062)
Population	-0.0175**	-0.0010	-0.0094	0.0359	-0.0039	-0.3070	0.0028
	(0.0052)	(0.0264)	(0.0030)	(0.0895)	(0.0264)	(0.2900)	(0.0035)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry–year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	544,085	468,458	544,085	114,285	544,085	18,175	470,228
Establishments	68,289	63,616	68,289	30,828	68,289	9,716	63,640
R-squared	0.471	0.711	0.450	0.489	0.274	0.623	0.288
Adjusted R-squared	0.394	0.666	0.371	0.298	0.170	0.170	0.176

Notes: OLS regressions with establishment fixed effects and clustered standard errors at the firm level (in parentheses). For equipment (building, land) investment at the extensive margin in Model (1) (3, 5), the dependent variable is a dummy variable with a value of one for an establishment i with positive equipment (building, land) investments in t. For equipment (building, land) investment at the intensive margin in Model (2) (4, 6), the dependent variable is the logarithm of positive equipment (building, land) investments of establishment i in t. In Model (7), the dependent variable is the natural logarithm of the ratio of building plus land investments to total investments. DiD is an interaction term of a dummy variable for establishments in Eastern German states and a dummy variable for the DAL treatment period (1995–1998). Capital stock is the logarithm of the capital stock of establishment i and Revenue per capital is the ratio of sales revenue to the capital stock. Unemployment rate is the unemployment rate of the district of establishment i in t in percentage points. GDP per capita (Population) is the logarithm of the gross domestic product per capita (the number of inhabitants) of this district. ***, **, and * indicate significance levels of 0.01, 0.05, and 0.1, respectively.

Table 5: Robustness Checks

Investment type	Gross investment		Equipment		Buildings		Land	
Investment margin	Extensive	Intensive	Extensive	Intensive	Extensive	Intensive	Extensive	Intensive
Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Balanced panel								
DiD	**0.0210*** **	**0.0334**	**0.0215*** **	**-0.0213**	**0.0478*** **	**0.254*** **	**0.0212*** **	**0.4810* **
	(0.0043)	**(0.0253)**	**(0.0044)**	**(0.0240)**	**(0.0075)**	**(0.0627)**	**(0.0040)**	**(0.2580)**
Observations	241,147	219,744	241,147	218,899	241,147	63,744	241,147	10,396
Establishments	24,336	24,079	24,336	24,069	24,336	15,487	24,336	5,375
R-squared	0.446	0.696	0.442	0.704	0.463	0.474	0.290	0.616
Adjusted R-squared	0.383	0.658	0.379	0.668	0.402	0.303	0.210	0.181
All models include establishment and country controls, establishment fixed effects, year fixed effects and industry-year fixed effects.								
Panel B: Mixed groups with parent fixed effects								
DiD	**0.0127**	**0.3180*** **	**0.0101**	**0.2300*** **	**0.0711*** **	**0.3140* **	**0.0125**	**0.5660**
	(0.0144)	**(0.0892)**	**(0.0144)**	**(0.0881)**	**(0.0169)**	**(0.1790)**	**(0.0087)**	**(0.7240)**
Observations	38,259	31,389	38,259	31,188	38,259	8,898	38,259	1,075
Establishments	7,308	5,996	7,308	5,995	7,308	2,627	7,308	561
R-squared	0.503	0.811	0.505	0.815	0.533	0.517	0.382	0.521
Adjusted R-squared	0.405	0.771	0.408	0.776	0.442	0.359	0.262	0.146
All models include establishment and country controls, establishment, year, parent, and industry-year fixed effects.								
Panel C: Standard errors clustered at industry-year-level								
DiD	**0.0323*** **	**0.1110** **	**0.0322*** **	**0.0336**	**0.0813*** **	**0.318*** **	**0.0192*** **	**0.4350** **
	(0.0042)	**(0.0437)**	**(0.0042)**	**(0.0428)**	**(0.0060)**	**(0.0443)**	**(0.0023)**	**(0.1710)**
Observations	544,805	470,548	544,805	468,458	544,805	114,285	544,805	18,175
Establishments	68,289	63,733	68,289	63,616	68,289	30,828	68,289	9,716
R-squared	0.473	0.705	0.471	0.711	0.450	0.489	0.274	0.623
Adjusted R-squared	0.397	0.658	0.394	0.666	0.371	0.298	0.170	0.170
All models include establishment and country controls, establishment fixed effects, year fixed effects and industry-year fixed effects.								
Panel D: Logistic models								
DiD	**0.3170*** **		**0.2890*** **		**0.4960*** **		**0.3400*** **	
	(0.0350)		**(0.0342)**		**(0.0239)**		**(0.0410)**	
Observations	544,805		544,805		544,805		544,805	
Establishments	68,289		68,289		68,289		68,289	
Log likelihood	-167,820		-171,565		-212,211		-66,652	
All models include establishment and country controls, establishment fixed effects, year fixed effects and industry-year fixed effects.								

Notes:

Table 6: Firm heterogeneity: gross investment at the extensive and intensive margin

Variables	Extensive margin				Intensive margin			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
DiD	0.0284***	0.0294***	0.0264***	0.0108	0.0587***	0.2240**	0.0601***	0.1040
	(0.0039)	(0.0113)	(0.0044)	(0.0120)	(0.0212)	(0.0891)	(0.0233)	(0.0917)
DiD Large	**-0.0152**		**-0.0164**	**0.0091**	**0.1780*** **		**0.1810*** **	**0.2580*** **
	(0.0101)		**(0.0103)**	**(0.0124)**	**(0.0577)**		**(0.0585)**	**(0.0774)**
DiD Group	**0.0177**		**0.0154**	**0.0314** **	**0.1330** **		**0.1130* **	**0.1010**
	(0.0108)		**(0.0109)**	**(0.0152)**	**(0.0588)**		**(0.0585)**	**(0.0891)**
DiD Owner		**-0.0067**	**0.0332** **	**-0.0058**		**0.1450**	**0.0569**	**0.1620**
		(0.0198)	**(0.0155)**	**(0.0199)**		**(0.135)**	**(0.0993)**	**(0.134)**
DiD Corp		**0.0007**	**0.0231** **	**0.0058**		**-0.1510**	**-0.1440* **	**-0.1140**
		(0.0124)	**(0.0105)**	**(0.0126)**		**(0.0941)**	**(0.0734)**	**(0.0938)**
Large	0.0053		-0.0073	-0.0312***	0.3380***		0.3050***	0.3710***
	(0.0049)		(0.0050)	(0.0063)	(0.0264)		(0.0276)	(0.0358)
Group	-0.0332***		-0.0339***	-0.0334***	-0.1750***		-0.1750***	-0.2210***
	(0.0045)		(0.0045)	(0.0057)	(0.0227)		(0.0227)	(0.0322)
Owner		-0.0165**	-0.0134***	-0.0191**		0.1330***	0.1360***	0.1270***
		(0.0078)	(0.0059)	(0.0079)		(0.0454)	(0.0409)	(0.0459)
Corp		-0.0123*	0.0061	-0.0134**		0.1110***	0.1340***	0.1050***
		(0.0068)	(0.0044)	(0.0068)		(0.0406)	(0.0344)	(0.0406)
Establishment controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
District controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry–year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	544,085	243,919	544,085	243,919	470,548	219,323	470,548	219,323
Establishments	68,289	45,381	68,289	45,381	63,733	42,895	63,733	42,895
R-squared	0.474	0.543	0.475	0.544	0.705	0.778	0.779	0.779
Adjusted R-squared	0.398	0.438	0.399	0.439	0.659	0.724	0.725	0.725

Notes: OLS regressions with establishment fixed effects and clustered standard errors at the firm level (in parentheses). In models (1)-(4), the dependent variable is a dummy variable with a value of one for an establishment i with positive gross investments in t (extensive margin). In models (5)-(8), the dependent variable is the logarithm of positive gross investments of establishment i in t (intensive margin). DiD is an interaction term of a dummy variable for establishments in the Eastern German states and a dummy variable for the DAL treatment period (1995–1998). DiD Large is an interaction term of a dummy variable for firms with at least 250 staff members (Large) and DiD. DiD Group is an interaction term of a dummy variable for firms with more than one establishment (Group) and DiD. DiD Owner-Managed is an interaction term of a dummy variable for firms that are managed by an owner (Owner-managed) and DiD. DiD Corporation is an interaction term of a dummy variable for corporations with limited liability (Corporation) and DiD. All models include the full control variable setting, as well as year and industry-year fixed effects. ***, **, and * indicate significance levels of 0.01, 0.05, and 0.1, respectively.

References

Aarbu, K. O. and MacKie-Mason, J. K. (2003). Explaining underutilization of tax depreciation deductions: Empirical evidence from norway, *International Tax and Public Finance* **10**(3): 229–257.

Auerbach, A. J. (1983). Taxation, corporate financial policy and the cost of capital, *Journal of Economic Literature* **21**(3): 905–940.

Auerbach, A. J. and Hassett, K. (1992). Tax policy and business fixed investment in the united states, *Journal of public Economics* **47**(2): 141–170.

Badertscher, B., Katz, S. P., Rego, S. and Wilson, R. J. (2019). Conforming tax avoidance and capital market pressure, *The Accounting Review* **94**: 1–30.

Bank, G. F. (2012). Verhältniskennzahlen aus jahresabschlüssen deutscher unternehmen von 1996 bis 2008–statistische sonderveröffentlichung 6 [proportional indicators from annual accounts of german firms in 1996 to 2008– statistical special publication 6], *URL: http://www.bundesbank.de/Navigation/DE/Statistiken/Unternehmen_und_private_Haushalte/Unternehmensabschluesse/Tabellen/tabellen.html* .

Bofinger, P., Feld, L. P., Franz, W., Schmidt, C. M. and Weder di Mauro, B. (2011). Verantwortung für europa wahrnehmen. jahresgutachten 2011/12, *Technical report*, Jahresgutachten.

Bond, S. and Xing, J. (2015). Corporate taxation and capital accumulation: Evidence from sectoral panel data for 14 oecd countries, *Journal of Public Economics* **130**: 15–31.

Botosan, C. A., Plumlee, M. A. and Wen, H. (2011). The relation between expected returns, realized returns, and firm risk characteristics, *Contemporary Accounting Research* **28**(4): 1085–1122.

Caliendo, M. and Kopeinig, S. (2008). Some practical guidance for the implementation of propensity score matching, *Journal of economic surveys* **22**(1): 31–72.

Chirinko, R. S., Fazzari, S. M. and Meyer, A. P. (1999). How responsive is business capital formation to its user cost?: An exploration with micro data, *Journal of public economics* **74**(1): 53–80.

Cohen, D. S. and Cummins, J. G. (2006). A retrospective evaluation of the effects of temporary partial expensing.

Cohen, D. S., Hansen, D.-P. and Hassett, K. A. (2002). The effects of temporary partial expensing on investment incentives in the united states, *National Tax Journal* **55**(3): 457–466.

Dauchy, E. P. and Martínez, C. (2008). Corporate tax minimization and the effectiveness of investment tax incentives, *Proceedings of the 100th Annual Conference on Taxation*, JSTOR.

De Simone, L., Klassen, K. J. and Seidman, J. K. (2017). Unprofitable affiliates and income shifting behavior, *The Accounting Review* **92**(3): 113–136.

Desai, M. A. and Goolsbee, A. (2004). Investment, overhang, and tax policy, *Brookings Papers on Economic Activity* **2004**(2): 285–355.

Devereux, M. P., Elschner, C., Endres, D. and Spengel, C. (2009). Effective tax levels using the devereux/griffith method, *Project for the EU Commission* .

Devereux, M. P. and Griffith, R. (2003). Evaluating tax policy for location decisions, *International tax and public finance* **10**(2): 107–126.

Dharmapala, D. (2014). What do we know about base erosion and profit shifting? a review of the empirical literature, *Fiscal Studies* **35**(4): 421–448.

Dobbins, L., Eichfelder, S., Hechtner, F. and Hundsdoerfer, J. (2018). Intertemporal income shifting around a large tax cut: The case of depreciations, *Schmalenbach Business Review* **70**(4): 313–340.

Edgerton, J. (2010). Investment incentives and corporate tax asymmetries, *Journal of Public Economics* **94**(11-12): 936–952.

Edgerton, J. (2011). The effects of taxation on business investment: New evidence from used equipment, *Federal Reserve Board of Governors, Mimeo, January* .

Edgerton, J. (2012). Investment, accounting, and the salience of the corporate income tax, *Technical report*, National Bureau of Economic Research.

Eichfelder, S., Jacob, M., Kalbitz, N. and Wentland, K. (2023). How do statutory rates alter conforming tax avoidance?, *Available at SSRN 3523388* .

Eichfelder, S., Jacob, M. and Schneider, K. (2023). Do tax incentives affect investment quality, *Journal of Corporate Finance* (80): 102403.

Eichfelder, S. and Vaillancourt, F. (2014). Tax compliance costs: A review of cost burdens and cost structures, *Hacienda Pública Española/Review of Public Economics* (210): 111–148.

Goolsbee, A. (1998). Investment tax incentives, prices, and the supply of capital goods, *The Quarterly Journal of Economics* **113**(1): 121–148.

Gunz, S., Macnaughton, A. and Wensley, K. (1995). Measuring the compliance cost of tax expenditures: The case of research and development incentives, *Can. Tax J.* **43**: 2008.

Hadlock, C. J. and Pierce, J. R. (2010). New evidence on measuring financial constraints: Moving beyond the kz index, *The review of financial studies* **23**(5): 1909–1940.

Hall, R. E. and Jorgenson, D. W. (1967). Tax policy and investment behaviour, *American Economic Review* **57**(3): 391–414.

Hanlon, M. and Heitzman, S. (2010). A review of tax research, *Journal of accounting and Economics* **50**(2-3): 127–178.

House, C. L. and Shapiro, M. D. (2008). Temporary investment tax incentives: Theory with evidence from bonus depreciation, *American Economic Review* **98**(3): 737–68.

Hulse, D. S. and Livingstone, J. R. (2010). Incentive effects of bonus depreciation, *Journal of Accounting and Public Policy* **29**(6): 578–603.

Hundsdoerfer, J. and Jacob, M. (2019). Conforming tax planning and firms' cost behavior, *Available at SSRN 3430726* .

Jacob, M. (2022). Real effects of corporate taxation: A review, *European Accounting Review* **31**(1): 269–296.

Kennedy, P. E. et al. (1981). Estimation with correctly interpreted dummy variables in semilogarithmic equations [the interpretation of dummy variables in semilogarithmic equations], *American Economic Review* **71**(4): 801–801.

Kitchen, J. and Knittel, M. (2011). Business use of special provisions for accelerated depreciation: Section 179 expensing and bonus depreciation, 2002-2009, *Available at SSRN 2789660* .

Klemm, A. (2010). Causes, benefits, and risks of business tax incentives, *International Tax and Public Finance* **17**(3): 315–336.

Knittel, M. (2007). Corporate response to accelerated tax depreciation: Bonus depreciation for tax years 2002-2004, *Office of Tax Analysis Papers* **98**.

Maffini, G., Xing, J. and Devereux, M. P. (2019). The impact of investment incentives: evidence from uk corporation tax returns, *American Economic Journal: Economic Policy* **11**(3): 361–89.

Malchin, A. and Voshage, R. (2009). Official firm data for germany, *Journal of Contextual Economics* **129**(3): 501.

Melo-Becarra, L. A., Mahecha, J. and Ramos-Ferrero, J. E. (2021). Corporate taxation and investment: Evidence from a context of frequent tax reforms, *Hacienda Pública Española/Review of Public Economics* (237): 3–31.

Ohrn, E. (2017). Do investors value tax investment incentives? evidence from bonus depreciation and the fiscal cliff, *Technical report*, Working Paper, Grinnell College.

Ohrn, E. (2019). The effect of tax incentives on us manufacturing: Evidence from state accelerated depreciation policies, *Journal of Public Economics* **180**: 104084.

Paqué, K.-H. (2009). *Die Bilanz: eine wirtschaftliche Analyse der deutschen Einheit*, Hanser Verlag.

Richardson, G. and Lanis, R. (2007). Determinants of the variability in corporate effective tax rates and tax reform: Evidence from australia, *Journal of accounting and public policy* **26**(6): 689–704.

Wagner, J. (2010). Estimated capital stock values for german manufacturing enterprises covered by the cost structure surveys, *Technical report*, Working Paper Series in Economics.

Wielhouwer, J. L. and Wiersma, E. (2017). Investment decisions and depreciation choices under a discretionary tax depreciation rule, *European Accounting Review* **26**(3): 603–627.

Zwick, E. and Mahon, J. (2017). Tax policy and heterogeneous investment behavior, *American Economic Review* **107**(1): 217–48.

Appendices

A Present Value of DAL Benefits

A.1 Calculation of DAL Present Value

We calculate the DAL present value as the sum of the tax savings from bonus depreciation during the first year plus the present value of remaining depreciations in the future, and minus the present value of the 'fastest' alternative depreciation scheme without bonus depreciation. Since we calculate the DAL benefit from the perspective of a given period t, we do not account for changes in taxes and the after-tax cost of funds in future periods (e.g., for the reduction of corporate income tax rates resulting from the German tax reform 1999/2000/2001). Taking into account that German tax rates declined after 1998, we calculate a lower-bound estimate of the ex-post DAL benefit, because the value of depreciation benefits increases with the tax rate. We also do not account for the possibility of future tax losses that would reduce the present value of future tax depreciation.[1] We assume that the DAL bonus depreciation is fully utilised in the first year and the investment is executed in the middle of the year. The present value of DAL benefits is then equal to

$$PV_t = \tau_t \cdot \Phi_t \cdot \left[\beta_t + (1 - \beta_t) \cdot \sum_{t+x}^{t+X} \frac{\delta reg_{t+x}}{(1 + \rho_{\tau t})^{x-1}} - \sum_{t+x}^{t+X} \frac{\delta alt_{t+x}}{(1 + \rho_{\tau t})^{x-1}} \right], \tag{A.1}$$

where Φ_t denotes the total sum of DAL-funded depreciations in the Eastern German states in a given year t, τ_t the average tax rate in t, $\rho_{\tau t}$ the after-tax cost of funds in t, and x is an index for following depreciation years. The bonus depreciation rate of a given period (ranging from 40 percent to 50 percent) is denoted β_t. Thus, $(1 - \beta_t)$ is the remaining book value that has to be depreciated by the regular scheme. The parameters $0 \leq \delta reg_{t+x} \leq 1$ and $0 \leq \delta alt_{t+x} \leq 1$ describe the allocation of depreciations under the regular scheme and the alternative scheme, respectively.

German tax instalments are affected by depreciation allowances. In line with Cohen et al. (2002), we therefore reduce the number of discounting periods x by one. Subsidy reports of the German Federal Government (German Federal Government, 1995–1999; German Federal Ministry of Finance, 2001–2010) do not report the total amount of depre-

[1] In case of a tax loss, the remaining depreciation volume does not result in a reduction of the tax burden (the tax payment is zero anyway), but increases the loss carryforward. Thus, future losses might decrease the present value of the remaining depreciation volume.

ciations Φ_t, but only the amount of tax losses resulting from bonus depreciation $\tau_t \cdot \Phi_t \cdot \beta_t$. We use this information to calculate $\tau_t \cdot \Phi_t$.

A.2 After-Tax Coft of Funds

An important aspect affecting the present value of depreciation allowances is the after-tax cost of funds. Using the definition of weighted average costs of capital (WACC) (Hulse and Livingstone, 2010; Frank and Shen, 2016), after-tax costs of funds in a given period t can be written as

$$\rho_{\tau t} = \rho_{dt} \cdot d \cdot (1 - \tau_{t^*}) + \rho_{et} \cdot (1 - d). \tag{A.2}$$

In Eq. A.2, ρ_{dt} denotes the pre-tax cost of debt capital at time t, ρ_{et} the cost of equity capital, and d the – for simplicity, this is a constant – fraction of debt capital. The tax deductibility of interest payments at the firm level is included in the tax rate τ_{t^*}, thereby accounting for the limited tax-deductibility of interests for long-term debt with regard to the German local business tax (German: *Gewerbesteuer*).

To approximate the cost of debt capital ρ_{dt} for a given year t, we use average long-term interest rates published by the German Central Bank (German: *Deutsche Bundesbank*).[2] This can be justified by the fact that investments are generally financed by equity and long-term debt, while short-term debt is more relevant for operational business. The average interest rate between 1995 and 2008 was 6.07 percent. The average fraction of debt capital is taken from representative balance sheet statistics of the manufacturing industry, which are also provided by the German Central Bank (2001–2012). In line with Hulse and Livingstone (2010), we focus on the ratio of long-term debt to equity. Therefore, we assume that short-term debt and accruals result from operational business and do not affect the after-tax cost of funds of long-term business investment. We do not observe strong changes in d during our sample period. Therefore, we use a fixed average value of $d = 0.3439$.

In contrast to the cost of long-term debt, the cost of equity is not published by the

[2]Since the definitions of reported interest rates of the German Central Bank change over time, we rely on a number of different proxies for the cost of debt capital. For 1997 to 2002, we use average interest rates for business credits ranging from € 500,000 to € 5 million (BBK01.SU0509). For 2003 and thereafter, we use interest rates for credits to corporations exceeding € 1 million and a duration of more than 5 years (BBK01.SUD129). For the period from 1991 to 1996, we use floating long term mortgage interest rates (BBK01.SU0049) as business interest rates are not available. We use 'overlapping' periods with more than one possible proxy of interest rates to adjust all interest rates to a consistent definition over the whole period, using interest rates from 1997 to 2002 as our reference point (BBK01.SU0509).

German Central Bank. While there are a number of proxies for ρ_{et}, there is no generally accepted definition of this variable. Botosan et al. (2011) describe 10 alternative proxies with a positive and significant correlation with future realised returns; we rely on the mean of these 10 proxies for equity cost as reported by Botosan et al. (2011). It should be noted that the values of ρ_{et} are based on U.S. data instead of German data. However, this should not be a severe problem, as Hail and Leuz (2006) do not find evidence for strong differences in the equity cost of capital in both countries. Nevertheless, we re-weight the equity cost by the corresponding differences reported in Hail and Leuz (2006) and obtain an average cost of 11.0 percent. To obtain average values per year, we relate this value to the average cost of long-term debt and obtain a ratio of 1.814. Thus, average ρ_{et} can be approximated by $\rho_{dt} \cdot 1.814$. This is very close to the relationship between ρ_{et} and ρ_{dt} of 1.8 as assumed by Hulse and Livingstone (2010).

The tax rate τ_{t^*} is a weighted effective tax rate with respect to the deduction of interest expenses of business establishments in Eastern Germany. To calculate τ_{t^*}, we account for the distribution between profits generated by corporations (taxed at corporate income tax rates) and by self-employed businesses and partnerships (taxed at personal income tax rates). The fraction of profits generated by corporations is approximated by the corresponding distribution of revenue as documented in the VAT statistics of the German Federal Statistical Office. To calculate the effective tax rate of corporations (partnerships), we use the corporate income tax rate (the maximum marginal personal income tax rate) for accumulated business profits of a given year. We further consider the solidarity tax surcharge (German: *Solidaritätszuschlag*) and the average local business tax rate (German: *Gewerbesteuer*) of the Eastern German states. We account for the fact that local business tax payments were deductible from taxable income until 2007. In addition, we account for the local business tax credit for partnerships (German: *Gewerbesteueranrechnung*) and the add-backs of long-term debt for the German local business tax (German: *Hinzurechnungen*).

A.3 Depreciation Regulations

To calculate the parameters $0 \leq \delta reg_{t+x} \leq 1$ and $0 \leq \delta alt_{t+x} \leq 1$ in Eq. A.1, we rely on the depreciation regulations of the German income tax code for different asset classes as well as the distribution of real investments between buildings and equipment for a given year (see Tables 2.1, 3.1 and 4.1 in German Federal Statistical Office, 2010).

In the 1990s, new buildings were generally depreciated over a period of 25 years. For investments after 2000, these depreciation periods for new business buildings were increased to 33.3 years. For the modernisation (extension, improvement) of old buildings, longer depreciation periods of 40 and 50 years (depending on the construction date of the building) were in force. We use the average fraction of new buildings as reported in the German building statistics of the corresponding period to construct weights for old and new buildings. For modernisations, we assume that one half of investments are depreciated over 40 and the other half over 50 years.[3]

Furthermore, we account for declining depreciation schemes for new buildings and modernisations as documented in § 7 Section 5 of the German income tax code. These alternative depreciation schemes were available if (1) the new building was constructed (or an old building was modernised) with a building application before January 1994 or January 1995, respectively, or (2) the building was purchased before January 1994 or January 1995, respectively. As buildings are constructed after the building application has been submitted, we assume that declining depreciation schemes are available for two years after the expiration date (100 percent in the first year after the abolition and 50 percent in the second year).

There is no data on average tax depreciation periods for equipment investment in Germany. Therefore, we assume an average depreciation period of seven years as documented by Devereux et al. (2009). In the 1990s, the depreciation rate of the declining balance method for movable assets was 30 percent. Hence, we assume that all equipment investments use the declining balance method, as long as corresponding depreciations are 'higher' than the alternative linear depreciations. Note that the declining balance method was not available if the bonus depreciation was utilised. Therefore, the consideration of these programs reduces the relative benefit of bonus depreciation to some extent.

B Calculation of Capital Stocks

Our calculation is based on Wagner (2010), who uses depreciation values for tax purposes reported in the Cost Structure Survey, information on the composition of investments from the Investment Survey and average depreciation periods for different asset classes (buildings and equipment) to compute capital stocks. Our method extends this approach in a number of ways and can be described by

$$K_{i,t-1} = \left(D_{it} \cdot \left(\alpha_{it}^{E} \cdot P_{t}^{E} + \alpha_{it}^{B} \cdot P_{t}^{B}\right) - I_{it}^{N}\right) \cdot \frac{1}{2}, \tag{B.1}$$

where $K_{i,t-1}$ is the capital stock at the end of the previous period (or beginning

[3]We rely on the number of constructed non-residential buildings in the former East (new buildings versus modernisations during the period from 1993 to 1999, which was relevant for the Development Area Law).

of the current period) of the firm i, D_{it} is the depreciation of i in t, α_{it}^{E} is the fraction of equipment investment of a given year, α_{it}^{B} the fraction of building investment in that year, and P_t^E $\left(P_t^B\right)$ the average depreciation period for equipment (building) investment in Germany in t.

Multiplying the sum of depreciations with the average depreciation period yields the investment value at the beginning of the operating period. To account for depreciations after the beginning of the operating period of an asset, we divide this value by two. Therefore, we assume that the average operating period has expired by a factor of 50% for each asset. This implies further that price-adjusted depreciations are approximately evenly distributed over time. Note that investments in t have a positive effect on D_{it}. If investments are executed in the middle of the year, D_{it} should rather be a measure of the capital stock in the middle of the period instead of the beginning of the period. To account for that aspect, we deduct 50% of net investments I_{it}^{N} (defined as gross investment minus disinvestment) of firm i in time t.

The depreciation period P_t^E for equipment is assumed to be 7 years (see Devereux et al. 2009). For new buildings, the regular periods are 25 years (for old buildings 40 to 50 years). For simplicity, we do not account for declining depreciation schemes for buildings. This can be justified by the fact that declining schemes increase the present values of depreciation allowances, but not the average depreciation over the depreciation period. The composition of different asset classes is estimated by the distribution of investments α_{it}^{E} and α_{it}^{B} of the manufacturing industry in our data, with $\alpha_{it}^{E} + \alpha_{it}^{B} = 1$. To account for measurement error, we calculate average values for α_{it}^{E} and α_{it}^{B} by year, industry, business size (large firms compared to small firms with up to 250 staff members) and region (Eastern versus Western Germany).

The tax depreciation period for new buildings increased to 33.3 years in 2001, while depreciation periods for modernization remained unchanged. The increased depreciation period is only relevant for new installments. Thus, considering economic growth and declining depreciation schemes of preceding periods, we assume a declining adaptation process of the average depreciation period per firm over 25 years with $D_{2000+x} = D_{2000} + \Delta \cdot \sqrt{\frac{x}{25}}$, where D_{2000} denotes the average depreciation period in 2000 (29 years on average for old and new buildings), x the number of years after 2000 and the increase in the average depreciation period resulting from the reform. This yields an average depreciation period for buildings of 35.66 years in 2008.

The computation of capital stock may be affected by measurement error in D_t. This is especially a problem for a high variation of tax depreciations over time, implying a fluctuating capital stock. To account for that, we rely on estimated capital stocks of future periods to obtain a more consistent estimate of the capital stock of preceding periods. Hence, we define the capital stock of the preceding period as the capital stock of the following period plus investments and minus depreciations and disinvestments in t. In addition to fixed assets, and extending Wagner (2010), we consider leased investments as increasing the effective capital-in-kind. We rely on data from the Investment Survey to compute the ratio of leased assets to fixed assets by year, industry, business size and region (Western versus Eastern Germany). The value of fixed assets of each firm is multiplied by one plus the computed ratio.

A drawback of our data is that depreciation volumes of the Cost Structure Survey are only available at the firm level. Therefore, we allocate depreciations to the establishment. We compute the ratio of the capital stock to the number of staff members by year, industry, business size (large firms compared to small firms with up to 250 staff members) and region (establishments in the West and establishments in the East). Using these ratios, we allocate the firms' capital stock to the establishments.

C Calculation of the relative tax burden and elasticities

C.1 Effective Net-of-Tax Rate

The effective net-of-tax rate of investments in Eastern German establishments can be written as

$$NETR_t = \frac{1 - \tau_t^W \cdot Z_t^W - s_t^W}{1 - \tau_t^E \cdot Z_t^E - s_t^E} \cdot \frac{1 - \tau_t^E}{1 - \tau_t^W}, \tag{C.1}$$

where τ_t^E, Z_t^E, s_t^E (τ_t^W, Z_t^W, s_t^W) denote the tax rate on profits, the present value of depreciations per € invested, and the effective ISL subsidy rate for East (West) Germany in a given period, respectively. As introduced in Appendix A, τ_t^E and τ_t^W are based on weighted tax rates of partnerships and corporations including taxes on income, the solidarity tax surcharge, and the local business tax. To calculate τ_t^E (τ_t^W), we use average local business tax multipliers (German: Hebesätze) for the East (West) German states. Z_t^E and Z_t^W are calculated as in Appendix A. The after-tax costs of funds of Appendix A.2 are used to compute discounted values of depreciation allowances.

We account for the fact that applications for ISL subsidies are generally related to investments of the preceding year. Therefore, the effective subsidy rate s_t^E is defined as the nominal ISL rate discounted by one period. As shown in Table 1, the ISL rate for equipment investment of large firms was 5% (small firms 10%) from 1995 to 1998, 10%

(small firms 20%) in 1999, and 12.5% (small firms 25%) thereafter. Regarding building investment, funding rates were zero before 1999 and 10% (12.5%) for initial investments in 1999 (after 1999). In this case, there were no increased rates for firms with no more than 250 staff members. There was also a higher subsidy rate of 8% for equipment investments of all firms before 1997 if investments had been initiated before June 1994. We assume that this is relevant for 50% of investments in 1995 and 0% thereafter. Correspondingly, we assume that the increase of funding rates in 2000 (from 10.0% to 12.5%) was relevant for 50% of businesses in that period and for 100% thereafter. Note that s_t^W is zero, as ISL subsidies were restricted to investments in the Eastern states. In addition, there was a funding gap for investments initiated before August 25, 1997 and completed after December 31, 1998. For simplicity, we do not consider this aspect in our calculations. This can be justified by the fact that this funding gap was not expected by owners and managers.

C.2 Calculation of Investment Elasticities

Following Zwick and Mahon (2017), we calculate investment elasticities with respect to the net of the effective tax rate $1 - \tau_\epsilon$ (in the following NETR), respectively the reciprocal of the tax term of the user cost of capital. For the calculation of the effective tax rate, we rely on the same assumptions as for the calculation of the relative tax burdens Appendix C.1) Consistent with our regression approach, we focus on the relative tax benefit of establishments in eastern Germany. Thus, we rule out any other tax law changes affecting establishments in both parts of Germany equally. We define the additional relative tax incentive of eastern German establishments during the treatment period as the difference between the average relative NETR in the treatment period and the average relative NETR in the post-treatment period. Thus, the change in the relative tax incentive of Eastern German establishments is

$$\Delta NETR = \overline{NETR}_{TREAT} - \overline{NETR}_{POST}, \tag{C.2}$$

with $NETR_t = \frac{1-\tau_t^W \cdot Z_t^W - s_t^W}{1-\tau_t^E \cdot Z_t^E - s_t^E} \cdot \frac{1-\tau_t^E}{1-\tau_t^W}$. We calculate $\Delta NETR$ for large and small firms for three classes of buildings and equipment: 1a) initial building investment, 1b) new buildings (no initial investment), 1c) modernisation of buildings (no initial investment), 2a) initial equipment investment, 2b) non-initial equipment investment, and 2c) non-fundable equipment investment. To calculate the aggregate average $\Delta NETR$ for small and large firms, we make assumptions about the average distribution of these six different types of investments. Note that there are no official statistics on initial investments according to ISL or the fundability of assets.

As extensions of an establishment are considered as initial investment according to ISL, the majority of building constructions should be initial investments. Hence, in case of the aggregate volume of building investments, we assume that the majority (55%) are initial investments. Corresponding to the German building statistics, about 20% of building investments are modernizations. We regard the remainder (25% of building investments) as constructions, but not as initial investments (e.g. extensions of buildings, major enhancements of buildings). In case of equipment investments, we assume that the majority (55%) are replacement investments and are therefore not considered as initial investments. This is consistent with the empirical observation that the increased funding rates of the ISL 1999 did not result in a significant increase in aggregate ISL subsidy payments. As most equipment in the manufacturing sector was fundable (e.g. machines), we assume that non-fundable equipment is only 1/5 of the remaining equipment investments. Thus, the remainder (4/5) falls on fundable initial equipment investments.

D Additional Robustness Tests and Analyses

D.1 DAL and Building Prices

Goolsbee (1998) finds evidence that investment tax incentives increase asset prices, which dampens their impact on real investment. While studies on bonus depreciation do not provide support for such pricing effects (House and Shapiro 2008; Edgerton 2011; Zwick and Mahon 2017), we account for that by deflating building investment at the intensive margin by a regional building price index. Corresponding price indices are provided by the statistical offices of ten major federal German states. The state of Berlin has been excluded from our data. For the remaining five states (Bremen, Hamburg, Mecklenburg-West Pomerania, Rhineland-Palatinate, and Schleswig-Holstein), we rely on average building price indices for the Western and the Eastern German states. These average price indices are calculated using the average of existing GDP-weighted price indices for states in the former West (Baden-Württemberg, Bavaria, Hessen, Lower Saxony, North Rhine-Westphalia and Saarland) and in the former East (Brandenburg, Saxony, Saxony-Anhalt and Thuringia). Using building price indices from states in the East and the West, we calculate weighted building price indices for both parts of Germany and report the results in Table D.1.

We find only weak pricing effects. Using 2005 as reference year, the building price index in Eastern Germany in the treatment period (1995–1998) exceeds the index for Western Germany by 3.0 percentage points on average, while it is slightly lower than the Western German index in the post-treatment period (1.2 percentage points). Even

Table D.1: Building price indices: manufactoring sector

Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
East	97.9	98.1	97.3	96.3	95.0	94.7	94.1	94.3	95.3	97.8	100.0	102.5	110.4	114.6
West	93.9	94.2	93.9	94.5	94.7	95.9	96.7	96.9	97.2	98.4	100.0	102.3	109.6	113.6

Notes: Weighted average building price indices for the manufacturing sector in the eastern and western German states. We calculate the indices from GDP-weighted price indices in the manufacturing sector as reported by the Statistical State Offices for the western German federal states (Baden-Württemberg, Bavaria, Hessen, Lower Saxony, North Rhine-Westphalia and Saarland) and the eastern states (Brandenburg, Saxony, Saxony-Anhalt and Thuringia). Due to the specific economic and legal conditions in Berlin, we do not account for price developments in that area. There are no corresponding price indices available for Bremen, Hamburg, Mecklenburg-West Pomerania, Rhineland-Palatinate or Schleswig-Holstein.

if one were to assume that this change in the difference of the building price indices is exclusively the result of the DAL, this suggests a DAL treatment effect of 4.2 percentage points (estimated by the difference in the differences of 3.0 and minus 1.2) or 4.4 percent of the building price level in 1999. This is minor if compared to our estimated average response for real building investments of 83 percent that we calculate in Subsection 5.2.

D.2 Propensity Score Matching

To ensure the comparability and similarity of our treatment group and control group, we use propensity score matching (Caliendo and Kopeinig 2008). Relying on one-to-one matching with replacement and the base year 1999, we generate a pre-matched control group that is similar to our treatment group. We match on the following variables: investment activity (as measured by the logarithm of building investment and the logarithm of equipment investment; both increased by one to avoid undefined values), establishment size and economic activity (as measured by the logarithm of sales revenue and the logarithm of the number of employees), industry, firm type (single establishment firm, multi-establishment firm, multinational firm, establishment of a foreign firm), and the type of goods produced (input goods, investment goods, durables, commodities). We do not use the capital stock as a matching characteristic, as this variable has been constructed using the information on investments (for the calculation of the capital stock see Appendix B). We select 1999 as our base year for matching but also consider outcome values from future periods (2000–2008) for our time-variant matching variables to account for the common trends assumption. To ensure a minimum common support, we drop establishments with propensity scores that are higher than the maximum (and lower than the minimum) propensity score in our control group. We end up with a final sample of 89,734 observations from 7,406 establishments.

Table D.2 depicts the results from performing the baseline model (Table 3) for the matched sample. The coefficient estimates are in line with Table 3 qualitatively and quantitatively.

Table D.2: Gross investment at the extensive and intensive margin–Matched Sample

Variables	Extensive margin				Intensive margin			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
DiD	0.0213***	0.0207***	0.0180***	0.0181***	0.1450***	0.1450***	0.1210***	0.1210***
	(0.0049)	(0.0049)	(0.0052)	(0.0052)	(0.0303)	(0.0299)	(0.0312)	(0.0309)
Capital stock				0.0048**				0.1230***
				(0.0019)				(0.0106)
Revenue per capital				-0.0162***				101.9
				(0.0011)				(86.66)
Unemployment rate			-0.0011	-0.0011			-0.0159***	-0.0148***
			(0.0001)	(0.0001)			(0.0055)	(0.0055)
GDP per capita			-0.0215	-0.0230			0.0866	0.0470
			(0.0166)	(0.0166)			(0.1010)	(0.0997)
Population			-0.0152	-0.0145			0.0496	0.0636
			(0.0105)	(0.0105)			(0.0680)	(0.0673)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry–year FE	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Observations	89,734	89,734	89,734	89,734	81,777	81,777	81,777	81,777
Establishments	7,406	7,406	7,406	7,406	7,375	7,375	7,375	7,375
R-squared	0.371	0.373	0.373	0.374	0.669	0.673	0.673	0.675
Adjusted R-squared	0.314	0.315	0.315	0.316	0.636	0.640	0.640	0.641

Notes: OLS regressions with establishment fixed effects and clustered standard errors at the establishment level (in parentheses). In models (1)-(4), the dependent variable is a dummy variable with a value of one for an establishment i with positive gross investments in t (extensive margin). In models (5)-(8), the dependent variable is the logarithm of positive gross investments of establishment i in t (intensive margin). DiD is an interaction term of a dummy variable for establishments in Eastern German states and a dummy variable for the DAL treatment period (1995–1998). Capital stock is the logarithm of capital stock of establishment i and Revenue per capital is the ratio of sales revenue to the capital stock. Unemployment rate is the unemployment rate of the district of establishment i in t in percentage points. GDP per capita (Population) is the logarithm of the gross domestic product per capita (the number of inhabitants) of this district. ***, **, and * indicate significance levels of 0.01, 0.05, and 0.1, respectively.

D.3 Investment Loopholes and Delays

As the DAL bonus depreciation provided a temporal enhancement in depreciation opportunities and the expiration of the program might have been a foreseeable event for firms, a potential reaction of firms could have been a temporal anticipation of investments that would have been executed otherwise in future periods. Thus, firms might anticipate investments from the period after the expiration (after 1998) of the program into the subsidy period (before 1998). If this is the case, it could lead to abnormal reduction of investment activity in treated Eastern establishments compared to control establishments in Western Germany. Therefore, we perform an additional test, considering not only the overall treatment effect in the period before the expiration (baseline model) but also a treatment effect in the post-DAL year 1999. We estimate the following model:

$$I_{it} = \beta_0 + \beta_1 \cdot DiD_{it} + \beta_2 \cdot PostDiD_{it} + \phi \cdot X_{it} + \alpha_i + \gamma_t + \theta_{it} + \epsilon_{it}. \tag{D.1}$$

In this model, $PostDiD_{it}$ is an interaction term of the post-DAL year 1999 and a dummy variable with a value of one for establishments in Eastern German states. As documented by Table D.3, and opposite from expectations regarding an investment hole, we still find a positive regression coefficient for $PostDiD_{it}$. Thus and in line with our graphical evidence in Figure 2, we still find evidence for slightly higher investment activity in Eastern establishments in the post-DAL year 1999. An explanation for our finding is the presence of temporal delays of investments that were initially intended to be executed within the DAL period. Considering that DAL-driven investment were especially relevant for buildings and project delays are a common problem in the building industry, it should not be surprising that not all DAL-related projects were finished in time before the funding period ended. Notwithstanding, Table D.3 does not provide evidence that investment projects were anticipated from the past-DAL period to maximise tax benefits before the DAL period ended.

Table D.3: Tests for post–DAL investment effects

Variables	Extensive margin				Intensive margin			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
DiD	**0.0407*** **	**0.0383*** **	**0.0351*** **	**0.0356*** **	**0.1450*** **	**0.1240*** **	**0.1130*** **	**0.1210*** **
	(0.0036)	**(0.0036)**	**(0.0039)**	**(0.0039)**	**(0.0206)**	**(0.0204)**	**(0.0216)**	**(0.0213)**
Post DiD	**0.0184*** **	**0.0174*** **	**0.0163*** **	**0.0173*** **	**0.0405* **	**0.0347**	**0.0337**	**0.0505** **
	(0.0043)	**(0.0043)**	**(0.0044)**	**(0.0044)**	**(0.0218)**	**(0.0218)**	**(0.0221)**	**(0.0220)**
Capital stock				0.0089***				0.1310***
				(0.0009)				(0.0050)
Revenue per capital				-0.0302*				0.3230*
				(0.0181)				(0.171)
Unemployment rate			-0.0019***	-0.0018***			-0.0127***	-0.0111***
			(0.0006)	(0.0006)			(0.0033)	(0.0033)
GDP per capita			-0.0052	-0.0064			0.1800***	0.1610**
			(0.0093)	(0.0093)			(0.0633)	(0.0628)
Population			-0.0174**	-0.0170**			-0.0180	-0.0132
			(0.0074)	(0.0074)			(0.0397)	(0.0393)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry–year FE	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Observations	544,085	544,085	544,085	544,085	470,548	470,548	470,548	470,548
Establishments	68,289	68,289	68,289	68,289	63,733	63,733	63,733	63,733
R-squared	0.472	0.472	0.472	0.473	0.702	0.704	0.704	
Adjusted R-squared	0.396	0.397	0.397	0.397	0.655	0.657	0.657	

Notes: OLS regressions with establishment fixed effects and clustered standard errors at the establishment level (in parentheses). In models (1)-(4), the dependent variable is a dummy variable with a value of one for an establishment i with positive gross investments in t (extensive margin). In models (5)-(8), the dependent variable is the logarithm of positive gross investments of establishment i in t (intensive margin). DiD is an interaction term of a dummy variable for establishments in Eastern German states and a dummy variable for the DAL treatment period (1995–1998). Post DiD is an interaction term of a dummy variable for establishments in Eastern German states and a dummy variable for the post DAL year 1999. Capital stock is the logarithm of capital stock of establishment i and Revenue per capital is the ratio of sales revenue to the capital stock. Unemployment rate is the unemployment rate of the district of establishment i in t in percentage points. GDP per capita (Population) is the logarithm of the gross domestic product per capita (the number of inhabitants) of this district. ***, **, and * indicate significance levels of 0.01, 0.05, and 0.1, respectively.

D.4 Alternative Control Variable Settings

The following tables report regression results for four alternative control variable settings to control if our results are driven by control variable choices. In Table 4, we investigate investment types including the full set of control variables. Table D.4 reports the same analysis without controls and industry-year fixed effects, similar to the simplest baseline analyses for gross investment (Table 3). The results confirm our baseline findings in Table 4. Like in table 3, we obtain quantitatively larger effects if we do not include regression controls and industry-year fixed effects. We find an increase of 10.5 percent (baseline 7.3 percent) for equipment, of 92.9 percent (baseline 76.6 percent) for building investment and of 121.3 percent (108.0 percent) for land investment.

A potential concern might be that our regression controls are endogenous with investment as dependent variable. Therefore, we estimate an alternative specification with once-lagged regression control variable and report results in Table D.5. As the choice of lagged controls reduces our observation period, the number of firm-year observation decreases to 468,549. If we use the investment responses of the different asset classes (equipment, buildings, land) to calculate an aggregate investment response (similar to Table 5), we obtain an overall investment response of 15.0 percent, which is very close to our baseline estimate.

Another concern might be an omitted varialbe bias. Therefore, we perform a robustness check that adds additional control variables at the level of the firm. These include the legal form of the company (corporation or pass-through entity), interest expenses per capital stock as a measure for liquidity and capital constraints and operating income (EBITDA) per capital stock as a measure for profitability. These variables are provided by the Cost Structure Survey and therefore only available for less than 50 percent of our sample. We report results in Table D.5. Using the investment responses of the different asset classes (equipment, buildings, land) to calculate an aggregate investment response (similar to Table 5), we obtain an overall investment response of 14.5 percent, which is very close to our baseline estimate.

Finally, we extend the robustness check of Panel B in Table 5 by adding parent-year fixed effects. In doing so, we control for year parent-year combination and thus use only the variation at the firm level to identify the DAL effect. Hence, holding firm-year combinations constant, we compare investment activities of Eastern and Western establishments of the same firm, to estimate the DAL effect. Our results confirm the evidence in Panel B of Table 5. Using the investment responses of the different asset classes (equipment, buildings, land) to calculate an aggregate investment response, we obtain an overall investment response of 34.9 percent, which is close to Table 5.

Table D.4: Investment types without controls

Variables	Equipment		Buildings		Land		Buildings and land share
	Extensive	Intensive	Extensive	Intensive	Extensive	Intensive	Intensive
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
DiD	**0.0375***	**0.0573***	**0.0867***	**0.3910***	**0.0215***	**0.4630**	**0.0404***
	(0.0035)	**(0.0185)**	**(0.0052)**	**(0.0466)**	**(0.0026)**	**(0.1990)**	**(0.0027)**
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry–year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	544,085	468,458	544,085	114,285	544,085	18,175	470,228
Establishments	68,289	63,616	68,289	30,828	68,289	9,716	63,640
R-squared	0.470	0.708	0.449	0.485	0.273	0.614	0.287
Adjusted R-squared	0.393	0.662	0.370	0.295	0.169	0.168	0.176

Notes: OLS regressions with establishment fixed effects and clustered standard errors at the firm level (in parentheses). For equipment (building, land) investment at the extensive margin in Model (1) (3, 5), the dependent variable is a dummy variable with a value of one for an establishment i with positive equipment (building, land) investments in t. For equipment (building, land) investment at the intensive margin in Model (2) (4, 6), the dependent variable is the logarithm of positive equipment (building, land) investments of establishment i in t. In Model (7), the dependent variable is the natural logarithm of the ratio of building plus land investments to total investments. DiD is an interaction term of a dummy variable for establishments in Eastern German states and a dummy variable for the DAL treatment period (1995–1998). ***, **, and * indicate significance levels of 0.01, 0.05, and 0.1, respectively.

Table D.5: Lagged control variables

Investment type	Gross investment		Equipment		Buildings		Land	
Investment margin	Extensive	Intensive	Extensive	Intensive	Extensive	Intensive	Extensive	Intensive
Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
DiD	**0.0330*** **	**0.0880*** **	**0.0329*** **	**0.0184**	**0.0764*** **	**0.3130*** **	**0.0211*** **	**0.3850* **
	(0.0037)	**(0.0206)**	**(0.0038)**	**(0.0196)**	**(0.0057)**	**(0.0524)**	**(0.0030)**	**(0.2320)**
Establishment controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
County controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry–year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	468,549	407,241	468,549	405,481	468,549	97,531	468,549	15,522
Establishments	63,628	58,068	63,628	57,817	63,628	26,309	63,628	8,528
R-squared	0.490	0.716	0.488	0.722	0.462	0.506	0.286	0.641
Adjusted R-squared	0.412	0.668	0.409	0.675	0.380	0.309	0.176	0.183

Notes: OLS regressions with establishment fixed effects and clustered standard errors at the establishment level (in parentheses). ***, **, and * indicate significance levels of 0.01, 0.05, and 0.1, respectively.

Table D.6: Reduced sample and firm controls

Investment type	Gross investment		Equipment		Buildings		Land	
Investment margin	Extensive	Intensive	Extensive	Intensive	Extensive	Intensive	Extensive	Intensive
Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
DiD	**0.0250*** **	**0.1000*** **	**0.0266*** **	**0.0339**	**0.0816*** **	**0.2970*** **	**0.0167*** **	**0.6300* **
	(0.0061)	**(0.0374)**	**(0.0044)**	**(0.0360)**	**(0.0111)**	**(0.0877)**	**(0.0064)**	**(0.3800)**
Establishment controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry–year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	192,232	175,188	192,232	174,596	192,232	54,255	192,232	8,941
Establishments	42,879	39,077	42,879	38,946	42,879	??	42,879	5,001
R-squared	0.568	0.798	0.568	0.802	0.551	0.561	0.372	0.642
Adjusted R-squared	0.448	0.740	0.448	0.745	0.428	0.348	0.198	0.164

Notes: OLS regressions with establishment fixed effects and clustered standard errors at the establishment level (in parentheses). ***, **, and * indicate significance levels of 0.01, 0.05, and 0.1, respectively.

Table D.7: Mixed firms with parent–year fixed effects

Investment type	Gross investment		Equipment		Buildings		Land	
Investment margin	Extensive	Intensive	Extensive	Intensive	Extensive	Intensive	Extensive	Intensive
Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
DiD	**0.0182**	**0.3830*** **	**0.0159**	**0.3130*** **	**0.0769*** **	**0.2990**	**0.0171** **	**0.9610**
	(0.0123)	**(0.0846)**	**(0.0124)**	**(0.0835)**	**(0.0155)**	**(0.2520)**	**(0.0084)**	**(0.8560)**
Establishment controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
County controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry–year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	37,508	29,584	37,508	29,336	37,508	6,631	37,508	492
Establishments	7,165	5,651	7,165	5,654	7,165	2,153	7,165	334
R-squared	0.490	0.716	0.488	0.722	0.462	0.506	0.286	0.641
Adjusted R-squared	0.412	0.668	0.409	0.675	0.380	0.309	0.176	0.183

Notes: OLS regressions with establishment fixed effects and clustered standard errors at the establishment level (in parentheses). ***, **, and * indicate significance levels of 0.01, 0.05, and 0.1, respectively.

D.5 Firm Heterogeneity and Asset Structure

In Tables D.8, D.9, and D.10, we report regression results using triple difference specifications as in Table 5, but using equipment (Table D.8), building (Table D.9), and land (Table D.10) investments at the extensive and intensive margins as dependent variable.

Table D.8: Firm heterogeneity for equipment investment

Margin	Extensive		Intensive	
Sample	Full	Reduced	Full	Reduced
	(1)	(2)	(3)	(4)
DiD	0.0260***	0.0207*	-0.0199	0.0589
	(0.00451)	(0.0122)	(0.0220)	(0.0887)
DiD Large	-0.0182*	0.0062	0.1880***	0.2470***
	(0.0103)	(0.0125)	(0.0559)	(0.0746)
DiD Group	0.0152	0.0309**	0.1030*	0.0602
	(0.0109)	(0.0152)	(0.0572)	(0.0871)
DiD Owner	0.0292*	-0.0119	0.0494	0.1410
	(0.0159)	(0.0204)	(0.0952)	(0.1290)
DiD Corp	0.0185*	-0.0015	-0.1310*	-0.1180
	(0.0108)	(0.0127)	(0.0706)	(0.0906)
Firm type controls	Yes	Yes	Yes	Yes
Establishment controls	Yes	Yes	Yes	Yes
County controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Industry–year FE	Yes	Yes	Yes	Yes
Observations	544,085	243,919	468,458	218,491
Establishments	68,289	45,381	63,616	42,835
R-squared	0.473	0.542	0.712	0.785
Adjusted R-squared	0.397	0.436	0.667	0.732

Notes: OLS regressions with establishment, year, and industry-year fixed effects. Standard errors are clustered at the establishment level (in parentheses). Models (1) and (3) (2 and 4) refer to the extensive (intensive) margin of equipment investments, while columns (1) and (2) depict the restricted sample (only containing observations that have non-missing information on Owner-managed and Corporation), and columns (3) and (4) use the full sample. DiD is an interaction term of a dummy variable for establishments in the Eastern German states and a dummy variable for the DAL treatment period (1995–1998). DiD Large is an interaction term of a dummy variable for firms with at least 250 staff members (Large) and DiD. DiD Group is an interaction term of a dummy variable for firms with more than one establishment (Group) and DiD. DiD Owner-Managed is an interaction term of a dummy variable for firms that are managed by an owner (Owner-Managed) and DiD. DiD Corporation is an interaction term of a dummy variable for corporations with limited liability (Corporation) and DiD. ***, **, and * indicate significance levels of 0.01, 0.05, and 0.1, respectively.

As seen in Table D.8, results for equipment are widely in line with Table 5. We find some evidence for a stronger increase in investment activity for multi-establishment firms with the opportunity for subsidy shopping as well as strong evidence for a positive aggregate response for large firms with at least 250 employees that is primarily driven by the large increase of investments at the intensive margin for this type of firms. Hence, Table

D.8 provides clear additional support for H3a. For owner-managed firms, the evidence is relatively weak. The coefficients of DiD Owner and DiD Corporation mostly have the expected signs but are only marginally statistically significant for the full sample models.

Table D.9: Firm heterogeneity for building investment

Margin	Extensive		Intensive	
Sample	Full	Reduced	Full	Reduced
	(1)	(2)	(3)	(4)
DiD	0.0792***	0.0444	0.2740***	-0.0315
	(0.0066)	(0.0276)	(0.0652)	(0.222)
DiD Large	0.0035	0.0283	0.4070***	0.5740***
	(0.0157)	(0.0205)	(0.1280)	(0.1620)
DiD Group	0.0058	0.0286	-0.0698	-0.1180
	(0.0129)	(0.0203)	(0.1310)	(0.1730)
DiD Owner	0.0564**	0.0510	0.2290	0.3140
	(0.0279)	(0.0381)	(0.2280)	(0.3170)
DiD Corp	0.0087	0.0101	0.1950	0.2210
	(0.0208)	(0.0276)	(0.1690)	(0.2190)
Firm type controls	Yes	Yes	Yes	Yes
Establishment controls	Yes	Yes	Yes	Yes
County controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Industry–year FE	Yes	Yes	Yes	Yes
Observations	544,085	243,918	114,285	66,783
Establishments	68,289	45,381	30,828	19,964
R-squared	0.451	0.529	0.490	0.539
Adjusted R-squared	0.372	0.420	0.300	0.339

Notes: OLS regressions with establishment, year, and industry-year fixed effects. Standard errors are clustered at the establishment level (in parentheses). Models (1) and (3) (2 and 4) refer to the extensive (intensive) margin of equipment investments, while columns (1) and (2) depict the restricted sample (only containing observations that have non-missing information on Owner-managed and Corporation), and columns (3) and (4) use the full sample. DiD is an interaction term of a dummy variable for establishments in the Eastern German states and a dummy variable for the DAL treatment period (1995–1998). DiD Large is an interaction term of a dummy variable for firms with at least 250 staff members (Large) and DiD. DiD Group is an interaction term of a dummy variable for firms with more than one establishment (Group) and DiD. DiD Owner-Managed is an interaction term of a dummy variable for firms that are managed by an owner (Owner-Managed) and DiD. DiD Corporation is an interaction term of a dummy variable for corporations with limited liability (Corporation) and DiD. ***, **, and * indicate significance levels of 0.01, 0.05, and 0.1, respectively.

For building investments, the results in Table D.9 are somewhat different from the results for aggregate investments in Table 5. Most notably, we do not find significant effects for DiD Group but likewise a very strong and positive effect for DiD Large at the intensive margin. Thus, especially investments with a very large investment response (buildings) seem to be abnormally high for large firms with low tax planning costs. This is in line with H3a and documents that large firms use bonus depreciation to a higher extent than their smaller counterparts. For land investment (Table D.10), there are no statistically significant triple difference interaction terms, which might be partially due to smaller observation numbers.

Table D.10: Firm heterogeneity for land investment

Margin	Extensive		Intensive	
Sample	Full	Reduced	Full	Reduced
	(1)	(2)	(3)	(4)
DiD	0.0199***	0.0332**	0.3060	0.1960
	(0.0033)	(0.0163)	(0.2670)	(0.8390)
DiD Large	-0.0150	-0.0149	0.9050	0.6090
	(0.0092)	(0.0133)	(0.5880)	(0.7240)
DiD Group	-0.0008	-0.0089	-0.0608	0.3780
	(0.00675)	(0.0121)	(0.5760)	(0.8070)
DiD Owner	0.0119	0.0109	0.3630	0.5210
	(0.0171)	(0.0230)	(0.7450)	(0.9740)
DiD Corp	-0.00863	-0.0149	-0.3300	-0.1110
	(0.0127)	(0.0165)	(0.6240)	(0.8530)
Firm type controls	Yes	Yes	Yes	Yes
Establishment controls	Yes	Yes	Yes	Yes
County controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Industry–year FE	Yes	Yes	Yes	Yes
Observations	544,085	243,919	18,175	10,737
Establishments	68,289	45,381	9,716	5,855
R-squared	0.275	0.346	0.626	0.640
Adjusted R-squared	0.170	0.196	0.170	0.166

Notes: OLS regressions with establishment, year, and industry-year fixed effects. Standard errors are clustered at the establishment level (in parentheses). Models (1) and (3) (2 and 4) refer to the extensive (intensive) margin of equipment investments, while columns (1) and (2) depict the restricted sample (only containing observations that have non-missing information on Owner-managed and Corporation), and columns (3) and (4) use the full sample. DiD is an interaction term of a dummy variable for establishments in the Eastern German states and a dummy variable for the DAL treatment period (1995–1998). DiD Large is an interaction term of a dummy variable for firms with at least 250 staff members (Large) and DiD. DiD Group is an interaction term of a dummy variable for firms with more than one establishment (Group) and DiD. DiD Owner-Managed is an interaction term of a dummy variable for firms that are managed by an owner (Owner-Managed) and DiD. DiD Corporation is an interaction term of a dummy variable for corporations with limited liability (Corporation) and DiD. ***, **, and * indicate significance levels of 0.01, 0.05, and 0.1, respectively.

Impressum:
Arbeitskreis Quantitative Steuerlehre, arqus, e.V.
Vorstand: Prof. Dr. Ralf Maiterth (Vorsitzender),
Prof. Dr. Kay Blaufus, Prof. Dr. Dr. Andreas Löffler
Sitz des Vereins: Berlin

Herausgeber: Kay Blaufus, Jochen Hundsdoerfer, Martin Jacob, Dirk Kiesewetter, Rolf J. König, Lutz Kruschwitz, Andreas Löffler, Ralf Maiterth, Heiko Müller, Jens Müller, Rainer Niemann, Deborah Schanz, Sebastian Schanz, Caren Sureth-Sloane, Corinna Treisch

Kontaktadresse:
Prof. Dr. Dr. h.c. Dr. h.c. Caren Sureth-Sloane,
Universität Paderborn, Fakultät für Wirtschaftswissenschaften,
Warburger Str. 100, 33098 Paderborn,
www.arqus.info, Email: info@arqus.info

ISSN 1861-8944