Essays on the Investment and Tax Revenue Effects of Tax Loss Offset Provisions

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1. Introduction

"Investment is the fundamental source of firm value and economic growth."[1] In principle, investments can be defined as cash spendings for the purpose of generating future income (e.g., Schneider, 1992). Characteristics of investments are the general long-term orientation, the future orientation and the risk for profitability and liquidity (e.g., Hölscher, 2010). The types of corporate investment are manifold. Essentially, investments comprise the procurement of tangible and intangible fixed assets, the purchase of financial assets and the disposition and production of inventories. Financial investments also include the purchase of shares in other firms.

Firms decide on investments based on the expected future cash flows. From an economic perspective, an investment should be realized if a positive net present value can be expected. Taxes would not have to be considered in the firm's decision process if they would not lead to decision distortions. Since existing tax systems are not decision-neutral, a rational decisionmaker includes tax payments in his decision calculus when choosing between tax-relevant investments, since taxes on the one hand reduce the financial outcome of the alternatives, but on the other hand they can also influence the rank order of different investment projects and thus trigger decision effects (e.g., Scheffler, 2020). It is not sufficient to only use the statutory tax rate in order to determine the effective tax burden of an investment project. Instead, it is additionally of importance to consider aspects of the tax base. Due to the real effects of tax regulations on corporate investment decisions, legislators should have an interest in creating competitive tax systems that incentivize investment and, if possible, do not make investment disadvantageous through taxes. Nevertheless, from a macroeconomic perspective, the fiscal purpose of taxes in terms of financing governmental spendings must also be considered.

Against this background, the treatment of losses compared to profits is asymmetrical in all countries of the European Union.[2] While profits are typically taxed in the year of occurrence, firms running a loss do not, in principle, receive an immediate refund. Instead, losses have to be used in previous (loss carryback) or subsequent (loss carryforward) periods. Although offsetting a loss against previous profits results in liquidity, the possibility to carry losses back is only permitted in a few countries and usually allowed to a limited extent in terms of time and amount. With regard to loss carryforwards, firms only receive tax savings in the future at the

[1] Hanlon and Heitzman, 2010, p. 147.
[2] The exception is Estonia, which applies a distribution tax system.

time a profit is generated and offset against accumulated losses. In addition to the time lag in loss utilization, it is also possible that the loss offset is restricted by so called minimum taxation regulations, since a portion of the profits is taxed even if they would be sufficient for offsetting. Furthermore, losses may expire unused because countries limit the offset of tax loss carryforwards in time. All in all, the asymmetric tax loss treatment reduces the after-tax net present value of investments and distorts corporate investment decisions.

Recent legislative changes provide anecdotical evidence that loss offset provisions are used to influence the investment behavior of firms. For example, the German legislators passed the Coronavirus Tax Assistance Act in 2020 "to support the economic recovery of businesses and to create incentives for investment"[3]. In this context, the possibility of carrying losses back was extended to provide firms with additional liquidity for investments. However, these law changes require a connection between the offsetting of losses and firms' investment.

This effect of asymmetric taxation on investment decisions has been subject of theoretical and empirical studies. Auerbach (1986) shows that, in principle, a lack of loss offset lowers investment. However, if the firm has incurred or expects to incur losses that have to be offset against profits from future investments, this may have a positive investment effect as firms try to use up their loss carryforwards. Consequently, investment decisions depend on firms' current and future tax status (e.g., Dreßler and Overesch, 2013; Auerbach and Poterba, 1987). Additionally, the less restrictive treatment of losses due to a loss carryback, and thus an immediate refund, leads to an increase in firms' investment (e.g., Dobridge, 2021; Bethmann et al., 2018). In contrast, the effect of loss carryforwards on corporate investment has not yet been convincingly corroborated in an empirical manner (e.g., Dreßler and Overesch, 2013). However, it is essential to comprehensively understand this relationship as tax policies shape investment (e.g., Gallemore et al., 2021) and the debate on an appropriate tax treatment of losses is ongoing (e.g., Zwick, 2021; Bethmann et al., 2018).

Therefore, my first study *(Asymmetric Tax Loss Treatment and Corporate Investment Behavior: an Empirical Investigation using Simulated Marginal Tax Rates)* contributes to the question whether and how losses and loss carryforwards affect corporate investment. I examine whether losses and their offsetting probability are an influencing factor in firms' investment decisions, whether the tax rate factor predominates the loss offset factor and whether losses have opposing effects on investment. Using a large European firm-level dataset over the period

[3] See https://www.bundesfinanzministerium.de/Content/EN/Standardartikel/Topics/Public-Finances/Articles/2020-06-04-fiscal-package.html, last accessed: July 19, 2022.

2003 to 2019, I determine simulated marginal tax rates which reflect the firm's future earnings expectations by forecasting income and include the effect of the tax rate, tax losses and tax loss offset provisions. This firm-specific tax burden measure is defined as the change in taxes payable resulting from earning an additional unit of taxable income in the current period (e.g., Graham and Kim, 2009a) and has the advantage that it captures the firm's current tax status considering the future development. I document that losses and their offsetting probability have a significant effect on firms' investment behavior and verify that tax loss carryforwards have contrary effects – they increase investment from a tax perspective in order to achieve tax benefits resulting from offsetting accumulated losses (e.g., Auerbach, 1986) and reduce investment from an economic perspective because of a lack of financial sources for further investment (e.g., Dreßler and Overesch, 2013). An important contribution of this study is that increasing loss compensation leads to an increase in corporate investment and that restricting loss carryforwards inhibits investment.

In addition to the time and amount restrictions on the offsetting of loss carryforwards, most European countries have additional rules that apply when firms invest in shares of other corporations. These so-called anti-tax loss trafficking rules usually become effective when there is a certain percentage change in the ownership of a corporation, the firm fundamentally changes its activity, or a combination of both. As a result, the accumulated tax losses of the acquired target firm expire if the acquisition meets the requirements. Consequently, a devaluation of the target's loss carryforwards and thus of an acquirable asset occurs from the perspective of the acquirer. To the best of my knowledge, there is only the study of Steffens (2015) which examines the effect of anti-tax loss trafficking rules on investment decisions. He investigates the question whether loss transfer restrictions affect firm entries and exits and could further not confirm that the restrictions are effective in achieving the intended aim. Therefore, it is an open empirical question whether investments of acquirers are affected by anti-tax loss trafficking rules.

Against this background, the second study of this thesis *(Anti-Tax Loss Trafficking Rules and the Acquisition of Loss-Carrying Firms)* aims to answer the question whether acquisitions of loss-carrying firms are reduced due to these restrictions and whether the design of anti-tax loss trafficking rules affects the quantity of acquiring loss targets. Using a dataset of acquisitions of European target firms, I show a significant negative effect for the strictness of anti-tax loss trafficking rules on the acquisition rate and number of acquisitions of loss-carrying firms, indicating that the stricter the anti-tax loss trafficking rules the lower the acquisitions of loss targets. The results provide insights that the design of anti-tax loss trafficking rules affects

acquirers' investment decisions because they alter the acquisition characteristics and hence the attractiveness of targets with loss carryforwards.

The two aforementioned studies contribute to the literature on the effect of tax loss offset provisions on corporate investment behavior and provide empirical evidence that restrictive loss offset rules generally reduce corporate investment. Against this background, unrestricted loss offset regulations should be adopted as far as possible in order to not inhibit investment. A way to reform loss offsetting in Europe would be abandoning minimum taxation. The abolishment would allow firms to offset their losses without amount restrictions as soon as they generate profits. This would lead to a faster offsetting of loss carryforwards and return to fully taxable status. However, a reform of loss offsetting requires a forgoing of tax revenues from the perspective of legislators. Therefore, the aim of the third study *(How expensive is the Abolition of Minimum Taxation in Europe? An Estimation of Tax Revenue Consequences)* is to estimate the tax revenue consequences which result from an abolition of minimum taxation in Europe. I find that countries would have to forego 0.44 to 3 percent of their tax revenues. This relative reform effect is equivalent to 5.784 billion Euro for Germany in absolute terms.

All in all, this thesis pursues the aim to enhance the understanding of the interaction of tax loss offset provisions and corporate investment behavior and to assess possible reform effects. The underlying data in all three studies covers private firms, which has three advantages: First, the availability of unconsolidated financial accounting data and thus the possibility to draw firm-level decisions. Second, private firm investment is substantially more than public firms and thus relevant for overall growth in macroeconomic terms (e.g., Asker et al. 2015). Third, the effects of taxation on the behavior of private firms have been rather neglected in previous empirical research (e.g., Hanlon and Heitzman, 2010).

This thesis is structured as follows (see Figure 1.1). Chapter 2 to Chapter 4 present the three studies. The final Chapter 5 concludes.

Figure 1.1: Structure of the thesis

Chapter 1: Introduction	• Context and structure of the thesis		Pages 1-5
Chapter 2: Asymmetric Tax Loss Treatment and Corporate Investment Behavior: an Empirical Investigation using Simulated Marginal Tax Rates			Pages 6-55
Do losses and their offsetting possibility have an effect on firms' investment behavior, and if so, in which direction does this effect go?	• Losses and their offsetting probability have a significant effect on firms' investment behavior • tax loss carryforwards have contrary effects – they increase investment from a tax perspective and reduce investment from an economic perspective	• Auerbach, 1986 • Dreßler and Overesch, 2013 • Graham and Kim, 2009a	
Chapter 3: Anti-Tax Loss Trafficking Rules and the Acquisition of Loss-Carrying Firms			Pages 56-110
Do anti-tax loss trafficking rules have an effect on the acquisition activity of acquirers?	• The stricter the anti-tax loss trafficking rules, the lower the acquisition rate and number of acquisitions of loss-carrying firms	• Auerbach and Reishus, 1987 • Steffens, 2015	
Chapter 4: How expensive is the Abolition of Minimum Taxation in Europe? An Estimation of Tax Revenue Consequences			Pages 111-134
How much tax revenues would European countries have to forego in case of an abolition of minimum taxation?	• Countries would have to forego 0.44 to 3 percent of their tax revenues that would result without a loss offset reform. • The absolute reform effect for Germany is quantified to a revenue deficit of 5.784 billion Euro.	• Oestreicher et al., 2014 • Oestreicher et al., 2012	
Chapter 5: Conclusion	• Summary of the results and contributions • Main limitations • Future research		Pages 135-138

2. Asymmetric Tax Loss Treatment and Corporate Investment Behavior: an Empirical Investigation using Simulated Marginal Tax Rates

Rebecca Hoehl[4]

Working Paper[5]

Abstract:

In almost all tax systems, governments do not participate in losses in the same way as in profits due to an asymmetric treatment of losses. Thus, the timing discrepancy of loss emergence and loss utilization affects the net present value of investments. Using firm-specific simulated marginal tax rates, I provide evidence that managers consider losses and their offset probability in their investment decisions and show that increasing loss compensation leads to an increase in corporate investment. Furthermore, I verify that tax loss carryforwards have contrary effects – a positive effect from a tax perspective and a negative effect from an economic perspective. Moreover, the results suggest that a restrictive limitation of tax loss offset with respect to loss carryforwards inhibits investment.

Keywords: Corporate Taxation, Tax Loss Treatment, Simulated Marginal Tax Rates, Corporate Investments

JEL Classification: G31 · H25 · H32

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[5] First version: July 2016 (previous title: "Corporate tax asymmetries, investment behavior and the marginal tax rate", co-authored with Lisa Hillmann). This version: January 2022.

2.I. Introduction

The link between corporate investment and taxes is obvious – tax payments affect the net present value of investment projects and thus investment decisions. Therefore, governments can influence the level of corporate investment through their tax policies. Since investment is a major source for economic growth, it is important to understand how taxes and tax base elements affect investment decisions (e.g., Hanlon and Heitzman, 2010). Both theoretically and empirically, it is unambiguous that the corporate statutory tax rate has a negative effect on corporate investment (e.g., Jacob, 2022). One of the aspects of the tax system that is considered to have a relevant impact on investment is the treatment of losses. In almost all tax systems, governments do not participate in losses in the same way as in profits due to an asymmetric treatment of losses. While profits are typically taxed in the year of occurrence, firms running a loss do not, in principle, receive an immediate refund. Instead, losses have to be used in previous (loss carryback) or subsequent (loss carryforward) periods. While offsetting a loss against previous profits results in liquidity, a company only receives tax savings in the future at the time a profit is generated and offset against the accumulated loss carryforwards. In addition to the time lag in loss utilization, it is also possible that losses expire unused as countries have limited loss carryforward provisions. All in all, the asymmetric tax loss treatment affects the net present value of investments, and should therefore have an effect on firms' investment decisions.

The connection between tax losses and corporate investment is subject of various studies. In principle, a lack of loss offset lowers investment (e.g., Auerbach, 1986). However, if the firm has incurred or expects to incur losses that have to be offset against profits from future investments, this may have a positive investment effect as firms try to use up their loss carryforwards. Consequently, managers should consider firms' current and future tax status when making investment decisions (e.g., Dreßler and Overesch, 2013; Auerbach and Poterba, 1987). The special nature of loss carrybacks is investigated in two recent studies which examine the less restrictive treatment of losses on corporate investment. The resulting immediate refund of a loss carryback and thus liquidity leads to an increase in firms' investment (e.g., Dobridge, 2021; Bethmann et al., 2018). In contrast, the effect of loss carryforwards on investment has not yet been convincingly corroborated. Empirical evidence only confirms that firms with high loss probabilities which operate in countries with very restrictive loss carryforward limitations reduce their investments (e.g., Dreßler and Overesch, 2013). However, it is essential to comprehensively understand this relationship as tax policies shape investment (e.g., Gallemore et al., 2021) and the debate on an appropriate tax treatment of losses is ongoing (e.g., Zwick,

2021; Bethmann et al., 2018). Therefore, this study contributes to a deeper understanding of the effect of losses and loss offset possibilities on firms' investment decisions.[6] First, I address the question of whether losses and their offsetting probability are an influencing factor in firms' investment decisions. Second, I examine whether the tax rate factor predominates compared to the loss offset factor. Third, I separate the loss effect and investigate if losses have opposing effects on investment.

I use a sample of over 340,000 firms from 25 European countries over the period 2003 to 2019 and determine firm-specific expectations regarding the emergence and utilization of losses using simulated marginal tax rates (MTR) to examine the effect of the tax rate, tax losses and tax loss treatments on corporate investment. This tax burden measure considers the firm's historical trend when forecasting the taxable income taking account for country-specific loss offsetting rules including loss carryback, loss carryforward and minimum taxation regulations. Moreover, marginal tax rates offer the advantage of more accurately reflecting the effects of the firm-specific probability and offset possibilities of losses compared to separate effects in the form of indicator variables (e.g., Graham, 2003). A further advantage of simulated marginal tax rates based on unconsolidated financial statements is that they correlate more strongly with firms' actual tax statuses than marginal tax rates from consolidated accounting data (e.g., Bause, 2018). Due to the long time horizon of my dataset, it is possible to determine marginal tax rates for a total of 17 years.

The results of my multiple linear regression with fixed effects provide three main insights. First, I provide empirical evidence that losses and their offsetting probability have a significant effect on firms' investment behavior, confirming the assumption that firms consider their firm-specific expectations about the emergence and use of losses when making investment decisions (e.g., Langenmayr and Lester, 2018; Auerbach and Poterba, 1987). Second, I show that the tax rate effect is the predominant decision factor of the corporate tax system. This aspect is important because quantifying the magnitude of the impact informs policymakers about the strength of the investment response. Third, I verify that tax loss carryforwards have contrary effects – they increase investment from a tax perspective in order to achieve tax benefits resulting from offsetting loss carryforwards (e.g., Auerbach, 1986) and reduce investment from an economic perspective because of a lack of financial sources for further investment (e.g., Dreßler and Overesch, 2013). In addition, various cross-sectional tests deepen the

[6] I examine investment decisions of firms based on the level of capital expenditures. I do not pursue the question of where to locate investments.

understanding of the effects and identify heterogeneity in the investment response. I show that firms with repetitive losses and firms with financial constraints especially suffer from financing hurdles. Furthermore, firms that have only a short loss offset opportunity due to a limited loss carryforward have little incentives to increase their investments from a tax perspective compared to firms with long-term loss offset objectives, as achieving tax savings is more difficult due to the restrictive loss offset. Moreover, firms invest particularly in tangible assets and labor in order to achieve profits in the following periods that can be offset against accumulated losses and refrain from long-term amortization assets like intangibles.

Thus, the paper contributes to two strands of literature: examining the effect of asymmetric tax loss treatment on corporate investment and expanding the literature on the use of simulated marginal tax rates. First, my findings provide a deeper understanding of the effect of losses, in particular carryforwards, and loss offset possibilities on firms' investment decisions. Second, I comply with the requirement that firm-specific expectations about their tax status need to be considered in investment decisions by incorporating marginal tax rates (e.g., Langenmayr and Lester, 2018; Graham, 2003; Auerbach and Poterba, 1987). Third, I enhance the use of marginal tax rates in empirical studies and contribute to the question whether the consideration of marginal tax rates improves the empirical performance (e.g., Ramb, 2007). Overall, my results are relevant for policymakers because they show that loss compensation is very important for encouraging corporate investment and that a restrictive limitation of tax loss offset with respect to loss carryforwards inhibits investment. Against this background, a less restrictive tax loss treatment without a minimum taxation is recommended to enhance investment.

The paper is structured as follows. Section 2.II contains a literature review, theoretical considerations and the development of the hypotheses. In Section 2.III, I present the underlying sample, describe the determination of simulated marginal tax rates and demonstrate the estimation approach. Section 2.IV presents my regression results with cross-sectional findings and discusses the robustness. Section 2.V contains concluding remarks.

2.II. Literature, Theory and Hypotheses Development

2.II.I Literature Review

The essential source of firm value and economic growth is investment (e.g., Hanlon and Heitzman, 2010). Consequently, it is essential to understand whether and how determinants influence corporate investment decisions. Since the basic rule for investment decisions is to invest as long as the net present value of a project is positive, it is important to investigate what influences the marginal benefits and costs of an investment. States participate in the

performance of firms by levying corporate income taxes. From a firm's perspective, taxes payable represent expenses that reduce the cash flows of investments. Thus, taxes directly affect the net present value of investments and are therefore an important determinant (e.g., Scholes et al., 2015).

To examine the effect of taxes on investment decisions there are basically two main theoretical approaches, the neoclassical investment theory (e.g., Jorgenson, 1963; Hall and Jorgenson, 1967; Auerbach, 1983) and the Q-theory (e.g., Tobin, 1969). The neoclassical investment theory assumes that the aim of a firm is an optimal capital stock at any time in order to maximize its present value whereby the present value of the firm is defined as the present value of discounted net receipts after taxes. In this model, corporate taxes increase and allowances for depreciation and investment tax credits reduce the cost of investment (e.g., Hanlon and Heitzman, 2010). In contrast, the Q-theory assumes that a firm invests as long as the ratio between the company's market value and the cost of capital (average q) is larger than one. Since Q is a decreasing function of the corporate tax rate (e.g., Kubota et al., 2013), an increase in the statutory tax rate is associated with a decrease in firm's investment. These theoretical considerations have been the basis for a large number of empirical studies examining the effects of corporate taxation on investment. Besides the empirical evidence that the corporate statutory tax rate has a negative effect on corporate investment (e.g., Ohrn, 2019; Dobbins and Jacob, 2016; De Mooij and Ederveen, 2003), there are several strands on how different taxes and tax base items affect firms' investment decisions. In addition to different deduction methods in form of depreciations (e.g., Wielhouwer and Wiersma, 2017; House and Shapiro, 2008) and other tax incentives (e.g., Lester, 2019; Ohrn, 2018; Zhang et al., 2018; Zwick and Mahon, 2017; Klemm and Van Parys, 2012; Chirinko and Wilson, 2008), the impact of consumption taxes (e.g., Jacob et al., 2019), repatriation taxes (e.g., Amberger et al., 2021), dividend taxation (e.g., Yagan, 2015) and changes in the taxation system (e.g., Liu, 2020) were examined. For a comprehensive overview, see Jacob (2022), who provides a review of the empirical tax literature on the real effects of corporate taxation, particularly focusing on corporate investment.

Studies are also focusing on the effects of tax losses and asymmetric tax loss treatment. In almost all tax systems, profits are typically taxed in the year of occurrence, while a firm running a loss does not, in principle, receive an immediate refund. Instead, losses can only be used in previous (loss carryback) or subsequent (loss carryforward) profit periods to net the positive with the previous negative income. While offsetting a loss against previous profits results in liquidity, a company only receives tax savings in the future at the time a profit is generated and offset against the accumulated loss carryforwards. In addition to the not negligible time lag in

loss utilization, it is possible that losses carried forward may expire as countries have limited loss carryforward provisions (e.g., Cooper and Knittel, 2010; Cooper and Knittel, 2006; Altshuler and Auerbach, 1990; Mintz, 1988). Therefore, the government does not participate in losses in the same way as in profits. Since investments usually involve the possibility of a loss, firms must weigh the advantage of greater returns against disadvantages of possible losses in their investment decisions (e.g., Domar and Musgrave, 1944). In theory, a symmetric tax system should be aimed at, since investment decisions are not distorted then. Nevertheless, more restrictive loss offset regulations might be preferred by policymakers in order to achieve, on the one hand, even and more predictable corporate tax revenues (e.g., Goncharov and Jacob, 2014). On the other hand, due to asymmetric tax loss treatment, firms with below normal return rates should not be encouraged (e.g., Auerbach, 1986), since various studies show that the asymmetric treatment of tax losses alters corporate risk taking (e.g., Langenmayr and Lester, 2018; Ljungqvist et al., 2017; Eisdorfer, 2008; Domar and Musgrave, 1944). Firms' risk taking is positively related to the length of tax loss offset periods because less restrictive tax loss carryforward provisions shift some risk to the government (e.g., Langenmayr and Lester, 2018; Ljungqvist et al., 2017). In addition, the tax rate has a positive effect on risk-taking for firms that expect to use losses while the effect is weakly negative for firms expecting a loss expiration (e.g., Langenmayr and Lester, 2018). Thus, the impact on risk taking depends on the extent of loss offset prospects. Another issue that depends on the taxable status of a firm is the impact of tax incentives for investment. The effectiveness of depreciations in non-taxable firms due to tax losses is reduced compared to the situation in which firms are fully taxable (e.g., Edgerton, 2010). Hence, the asymmetric treatment also affects firms' income-shifting behavior, as firms seek to maximize the use of and tax savings from tax loss carryforwards (e.g., Gamm et al., 2018; De Simone et al., 2017; Erickson et al., 2013; Albring et al., 2011; Maydew, 1997). However, tax planning could also result in reduced tax benefits of losses (e.g., Dyreng et al., 2018).

Furthermore, an additional strand of literature studies the effect of tax losses and tax loss offset rules on the level of investment since tax losses affect the corporate tax base. Auerbach (1986) analyzes the effect of asymmetric tax loss treatment on investment and shows analytically and through simulation that although a lack of loss offset lowers investments in principle, but low-return firms with a high loss probability and loss carryforwards, respectively, may increase their investments to use up their carryforwards. Moreover, the time difference between loss emergence and utilization is not likely to have homogeneous effects on different firms and asset types. Investment decisions depend on a firm's current and future tax status (e.g., Auerbach and

Poterba, 1987). Devereux (1989) found a negative impact of corporate taxation on investment using the cost of capital, accounting for tax asymmetries. Using tax-adjusted Q and user cost investment regressions, a further study could not confirm the assumption that considering tax asymmetries improve the empirical performance noticeably (Devereux et al., 1994). Dreßler and Overesch (2013) empirically investigate the impact of intertemporal loss offset provisions on corporate investment behavior. Using dummy variables, indicating whether a country allows for a carryback or has a limited loss carryforward period, they could only observe that investments are reduced if subsidiaries in high loss probability industries could only use their potential loss carryforward in the next five years. They also provide an initial insight that firms consider existing loss carryforwards in their investment decisions by using an indicator variable. A subsequent study of Orihara (2015) examines the effect of tax loss carryforwards on either leverage or investment using tax return data. The impact on investment could not be proven statistically significant due to a weak identification strategy. In contrast, two other studies focus on impact of loss carrybacks in particular. Bethmann et al. (2018) find that less asymmetric treatment of losses through a less restrictive grant of refunds in the form of loss carrybacks increases investment of loss firms, however, especially in firms that tend to make risky overinvestments. Dobridge (2021) observes that tax refunds do not necessarily improve firms' financial conditions and that firms use, depending also on macroeconomic circumstances, tax refunds differently, including investments, extension of cash holdings (e.g., Heitzman and Lester, 2022) or reduction of long-term debt.

Overall, the effect of existing losses and loss offset restrictions on corporate investment has not yet been encompassing proven empirically. Nevertheless, understanding this relation is indispensable as tax policies shape investment (e.g., Gallemore et al., 2021) and the debate on an appropriate tax treatment of losses is ongoing (e.g., Zwick, 2021; Bethmann et al., 2018). Studies have demonstrated that firm-specific expectations about the emergence and use of losses need to be considered in investment decisions (e.g., Langenmayr and Lester, 2018; Auerbach, 1986). In particular, empirical evidence is lacking, first, whether loss carryforwards and their offsetting possibilities have a significant impact on corporate investment decisions, second, which factor of the corporate tax system predominates and, third, which of the two possible loss effects prevails. On the one hand, firms with accumulated tax losses may increase their investments in order to use their losses and receive tax benefits as soon as possible since losses decay in value over time and may expire unused (e.g., Auerbach, 1986). On the other hand, firms with loss carryforwards face higher hurdles in finding financing sources for future investments, as past losses may indicate that the firm's business model is not promising (e.g.,

Dreßler and Overesch, 2013). Thus, a negative effect on investment is also possible. This is exactly where this study takes up. Using simulated marginal tax rates enables a separation of the different effects (e.g., Gamm et al., 2018; Koch, 2014a).

The marginal tax rate is defined as the change in taxes payable resulting from earning an additional unit of taxable income in the current period (e.g., Shevlin, 1990). In principle, the use of the 'true' marginal tax rate would be the best representation to measure the effect of the firm-specific tax burden (e.g., Scholes et al., 2015; MacKie-Mason, 1990).[7] Since it is not possible to determine the 'true' marginal tax rate, various simulation approaches have been developed in the literature;[8] the methods are valid since the simulated MTR is highly correlated with the rate derived from tax return data (e.g., Graham and Mills, 2008; Plesko, 2003). The simulated marginal tax rate can be interpreted as the firm managers' expectations considering a firm-specific drift and volatility of income based on the historical firm performance (e.g., Graham, 1996b). Due to the possibility of tax losses and their offsetting, the marginal tax rate ranges between zero (non-taxable status of the firm) and the statutory tax rate.

Prior research finds that the MTR is correlated with capital structure decisions of firms (e.g., Koch, 2014a; Hartmann-Wendels et al., 2012; Alworth and Arachi, 2001; Graham et al., 1998; Graham, 1996a). Studies using simulated marginal tax rates to analyze corporate profit shifting (e.g., Gamm et al., 2018) and investment behavior (e.g., Edgerton, 2010; Ramb, 2007; Arachi and Biagi, 2005) are still rare. Arachi and Biagi (2005) use marginal tax rates based on Graham's method (1996a) to improve the measurement of the cost of capital when estimating the elasticity of the investment rate. The consideration of the MTR does not enhance the empirical performance. With an own measure for the taxable status and considering carrybacks and minimum tax, Edgerton (2010) examines the impact of tax incentives in form of bonus depreciations for investments. Contrary to the expectations, implications of changes in taxable status are relatively modest while firms are more responsive to tax incentives for investment when their cash flows are high. Ramb (2007) investigates the direct effect of Graham's (1996a) marginal tax rates on firm's cost of capital and provides evidence that an increase in the marginal tax rate entails an average decrease in the propensity to invest. All in all, empirical evidence on the effect of tax loss asymmetries on firm's investment behavior, particularly with

[7] Graham (1996b) examines how well proxies anticipate firms' future tax status and concludes that the simulated marginal tax rate is the preferred MTR proxy, followed by the statutory tax rate, a taxable income dummy, and a trichotomous variable (Shevlin, 1990).

[8] Random walk approach (e.g., Graham et al., 1998; Graham, 1996a; Shevlin, 1990; Shevlin, 1987), non-parametric bin approach (e.g., Blouin et al., 2010), first-order autoregressive approach (Graham and Kim, 2009a).

regard to the impact of loss utilization in the future due to loss carryforwards, is still insufficient. Therefore, I use simulated firm-specific marginal tax rates based on the method of Graham and Kim (2009a)[9], considering country-specific regulations on loss carrybacks, loss carryforwards and minimum taxation, to examine the effects of the asymmetric tax loss treatment on corporate investment.

The paper contributes to two strands of literature: examining the effect of asymmetric tax loss treatment on corporate investment and expanding the literature on the use of simulated marginal tax rates. First, I examine whether losses, and in particular carryforwards, and their offsetting possibilities have an impact on corporate investment decisions (e.g., Dreßler and Overesch, 2013). I further provide insights that the statutory tax rate has a greater impact on the investment level than losses. I explore whether the delay in loss offsetting due to the asymmetric tax loss treatment increases or reduces investment. Second, I comply with the requirement that firm-specific expectations about the emergence and use of losses need to be considered in investment decisions (e.g., Langenmayr and Lester, 2018; Auerbach and Poterba, 1987). Graham (2003) ascertains that the effects of the probability and offset possibilities of losses should be captured directly in analyses by incorporating marginal tax rates, rather than including these factors as separate variables. Third, I enhance the use of marginal tax rates in empirical studies and pursue the question whether the consideration of the MTR improves the empirical performance. I calculate a proxy for managers' expectations due to forecasting the future stream of taxable income on the basis of the past record of earnings. My analysis relates to the study of Ramb (2007). I expand his findings by using the investment level of firms as the dependent variable instead of the cost of capital, deepening the understanding of loss compensation, separating the effects of losses and using an advanced simulation approach to determine the firm-specific marginal tax rates.

2.II.II Theoretical Considerations and Derivation of Hypotheses

The hypotheses explored in this paper are based on theoretical considerations and previous findings in the literature. On the one hand, Appendix 2.B illustrates an extension of the neoclassical investment theory (e.g., Auerbach, 1983; Hall and Jorgenson, 1967; Jorgenson, 1963) considering the possibility to offset tax losses. From the optimality conditions for the present value of the firm follows that an increase in the statutory tax rate leads to a reduction of the capital stock (see 2.B.17 in Appendix 2.B) to meet the optimum condition further on. The

[9] Koch (2014b) examines the forecasting performance of the different simulation approaches and concludes that simulating taxable income with the AR(1)-approach provides marginal tax rates with the smallest measurement errors (see Bause (2018) for a broader discussion).

first-order condition for the tax loss compensation is positive, indicating that an increase in offsetting losses leads to an increase of the capital stock (see 2.B.18 in Appendix 2.B). On the other hand, Jacob (2022) uses a model developed by Dyreng et al. (2020) to understand the role of taxes in investment decisions. Their framework, which examines how tax incidence and tax avoidance interact, is also based on a function for firms' after-tax profit. Besides the factors, capital K and labor L, they also include tax avoidance A:

$$\Pi(K, L, A) = [1 - (\tau - A)](\rho F(K, L) - wL - \eta rK) - (1 - \eta)rK - C(A) \qquad (2.1)$$

It is assumed that firms aim to maximize their after-tax profits. All three factors are accompanied with costs for the firm. Wages w are fully tax deductible, but the tax deductibility of capital investment is restricted to $\eta \in [0, 1]$. The restriction parameter η is not necessarily equivalent to the cost of capital investment, but also captures any tax-induced investment distortions (e.g. limited loss offset rules). Parameter τ represents the statutory tax rate on pre-tax income. Irrelevant for this study are the implications of A, representing the reduction of the tax rate due to tax avoidance (see Dyreng et al., 2020).

The partial deviation with respect to the capital investment K shows that the optimal investment level depends on the statutory tax rate τ, if the tax deductibility η is restricted (< 1), illustrating that higher corporate tax rates reduce capital investment. The first-order condition also outlines that tax policies regarding the tax base affect corporate investment decisions when the proportion of deductibility η is altered. If policy makers decrease the deductibility of investment expenses, corporate investment decreases. Therefore, restrictive loss offset rules have a negative effect on the investment level as the tax deductibility decreases. In contrast, allowing for a loss carryback increases the deductibility of investment costs (higher η), which increases investment (see Jacob, 2022).

Taking the theoretical considerations and existing studies on the effect of tax losses and tax loss treatment together, firm-specific expectations about the emergence and use of losses are considered by firms when making investment decisions (e.g., Langenmayr and Lester, 2018; Auerbach and Poterba, 1987). Thus, I state the following hypothesis:

H1: Losses and their offsetting probability have a significant effect on firms' investment behavior.

In a survey, Graham et al. (2017) ask tax executives which tax rates their firms use when making investment decisions. The responses indicate that most firms initially decide on the statutory tax rate. In addition, the above theoretical considerations also show that the tax rate affects the

net income due to a proportional cut τ of the profits before tax, while the tax loss offset is only a part of the tax base determination. Therefore, I state my second hypothesis as follows:

H2: The statutory tax rate has a greater impact on the investment level than losses.

In principle, losses and loss carryforwards can have both positive and negative effects on investment. On the one hand, accumulated tax losses can incentivize firms' decision makers to increase investment in order to utilize losses and obtain tax benefits, as losses decay in value over time and may expire unused (e.g., Auerbach, 1986). On the other hand, a negative effect on investment is also possible. Firms with loss carryforwards may face funding restrictions for future investments, as past losses may indicate that the firm's business model is not promising (e.g., Dreßler and Overesch, 2013). It is possible to examine these two effects by means of using simulated marginal tax rates. However, it remains an open empirical question which of the effects prevail.

H3: Tax loss carryforwards increase investments from a tax perspective and reduce investments from an economic perspective.

2.III. Empirical Identification

2.III.I Data and Sample Selection

This study is based on firm-level data from Amadeus, a database containing accounting information from unconsolidated financial statements of European private firms, provided by Bureau van Dijk. Since private sector investment is an important part of the economy (e.g., Asker et al., 2015), it is important to understand the role of tax base elements in shaping investments (e.g., Jacob, 2022). Therefore, this data enables me to examine the effect of tax loss offsetting on private firm's investment behavior. By merging four different updates of Amadeus (125, February 2005; 172, January 2009; 262, July 2016 and 318, March 2021), it is possible to overcome the often-mentioned limitation of Amadeus' short available time horizon (e.g., Bethmann et al., 2018). However, due to changing identifiers, I can only obtain a data history for 927,769 corporations. Thereupon, I exclude firms in the financial and utility sectors because it can be assumed that the investment intensity of firms in these sectors appears less important for their business models. I require fixed assets and sales to be at least € 50,000 to exclude very small firms from the analysis, as such fast-growing firms could bias my investment measure (e.g., Bethmann et al., 2018). Furthermore, I eliminate observations with negative values for total assets, cash and age. The resulting sample represents the initial dataset for determining simulated marginal tax rates. Due to high data requirements for the

determination of MTRs (see Section 2.III.II), the final sample for the analysis comprises 2,226,392 firm-year observations of 340,486 firms from 25 European countries over the period 2003 to 2019.[10] The sample selection process is summarized in Table 2.10 (Appendix 2.A). In this sample, 283,454 (thereof 204,843 in a no-carryback country) firm-year observations have a prior year's negative pre-tax income which has to be offset against previous or future income. Furthermore, considering that MTR and STR differs in 1,098,970 observations, it suggests that most losses are not used immediately after their occurrence to offset against profits through carrybacks and carryforwards, and therefore firms need to check their firm-specific loss offset opportunities when planning their investments.

Information on the statutory corporate tax rate and tax loss treatment regulations is collected from the European Tax Handbooks (IBFD, 2003-2019) and the EY Tax Guides (EY, 2003-2019). I add country-year-level information from the World Bank.

2.III.II Determination of Simulated Marginal Tax Rates

I use simulated marginal tax rates to show that investment decisions are affected by tax considerations. This tax burden measure is based on a forecast of future firm development where forecasted earnings are translated into tax payments considering the asymmetric tax treatment of profits and losses. Discounting the results for each simulation year constitutes the present value of expected future tax payments. The simulated marginal tax rate of year t is defined as an increase in the present value of expected tax payments as a result of earning an additional unit of taxable income in the current year (e.g., Graham, 1996a; Shevlin, 1990).

Three alternative concepts for measuring the tax burden with regard to forecasted earnings have emerged in the literature: the random walk model (RW-model, e.g., Graham, 1996a; Shevlin, 1990; Shevlin, 1987), the autoregressive approach (AR(1)-model, e.g., Graham and Kim, 2009a) and the non-parametric approach (NP-model, e.g., Blouin et al., 2010). For my purposes, I refer to the autoregressive approach (AR(1)-model) proposed by Graham and Kim (2009a) because the NP-model and RW-model overestimate loss situations, while the AR(1)-model reflects the realized earnings most suitable (e.g., Koch, 2014b). It allows for mean-reversion of earnings compared to the RW-model that understates the volatility of forecasted future earnings. Instead of forecasting indirectly obtained consolidated estimates of taxable income, I simulate unconsolidated pre-tax income and apply country-year-specific tax regulations on it. I estimate the marginal tax rates on unconsolidated data for three reasons: first, almost

[10] The distribution of firms across the European countries can be found in Table 2.12 (Appendix 2.A). Due to insufficient data coverage, marginal tax rates could not be determined for firms in Cyprus and Lithuania. Estonia is not considered because of its distribution tax system.

exclusively unconsolidated data is available in Amadeus; second, simulated marginal tax rates based on unconsolidated financial statements correlate more strongly with firms' actual tax statuses than marginal tax rates from consolidated accounting data (e.g., Bause, 2018) and third, measurement errors can be assumed due to the assumption that groups are taxed with their entire income at the parent company level. In addition to the data selection process described in Section 2.III.I, I follow Graham and Kim (2009a) and exclude firm-years with total assets less than € 1 million for the purpose of the MTR determination due to possible biases or outliers (e.g., Fama and French, 2000). Furthermore, the firm's return on asset must be available at least in the year before the forecast and each observation of return on assets has to be $ROA_{i,t} \leq |2|$ to remain in the sample.

The simulation procedure uses separate forecasting algorithms for return on assets (ROA) and total assets (TA). To simulate the return on assets of firm i in year t based on a firm-specific estimate, I use a first-order autoregressive (AR(1)) process:

$$ROA_{i,t} = \mu_i + \rho_i \cdot ROA_{i,t-1} + \varepsilon_{i,t}, \qquad \varepsilon_{i,t} \sim N(0, {\sigma_i}^2), \tag{2.2}$$

where $ROA_{i,t-1}$ is based on earnings before taxes ($EBT_{i,t-1}$) scaled by the beginning total assets of year t-1 ($TA_{i,t-2}$), μ_i is the drift parameter, ρ_i is the first-order autoregressive parameter, $\varepsilon_{i,t}$ and σ_i represent random shocks and the volatility of shocks, respectively. This approach requires at least five firm-year observations due to the lag in total assets to estimate the three relevant simulation parameters properly. To address the strong data requirements, I cluster firm-year observations from firms that have less than four historical return on assets but at least three historical pre-tax incomes.[11] The bins are used to re-estimate eq. (2.2) to obtain bin-specific returns on assets using a system GMM estimator developed by Blundell and Bond (1998). If the firm-specific AR(1)-parameters are unsuitable (at least one criteria is met: $|\rho_i| \geq 1, \sigma_i > 1$ and $\left|\frac{\mu_i}{1-\rho_i}\right| > 0.6$), the parameters are replaced by the bin-specific estimates.

The forward projection of total assets of firm i in year t is based on a clean-surplus-approach considering a firm-specific dividend distribution rate:

$$TA_{i,t-1} = TA_{i,t-2} + EBT_{i,t-1} \cdot \left(1 - \tau_{i,t-1}\right) - D_{i,t-1}\,. \tag{2.3}$$

[11] I first divide the firms with insufficient observations for the firm-specific forecasting algorithm into six income groups based on their mean return on assets (two groups for negative and four groups for positive ROA observations). In a second step, I further subdivide them according to their industry classification.

where $TA_{i,t-1}$ is total assets in the beginning of year t, $TA_{i,t-2}$ is the initial inventory of total assets in year t-1, $EBT_{i,t-1}$ represents the earnings before taxes in year t-1, $\tau_{i,t-1}$corresponds to the top country-specific statutory tax rate in year t-1 and $D_{i,t-1}$ reflects the firm-specific amount of profit distributed in year t-1. It implies that total assets at the beginning of year t are the sum of total assets at the beginning of year t-1 and after-tax earnings less dividends paid out in year t-1. Profit distributions are estimated by multiplying an estimated firm-specific payout ratio by taxable income. For positive income forecasts, I estimate the payout ratio for each firm year by dividing dividends from the previous year by after-tax earnings in the same year. Since I cannot obtain dividends in Amadeus, I use the difference of profit/loss after tax and the change in other shareholder funds as an approximation. For firms having negative after-tax results in the previous year, I divide the dividends by 0.06 × total assets to estimate the payout ratio. I adjust payout ratios which are less than zero to zero and greater than one to one. In cases of negative income forecasts, I assume the same amount of dividends as in the previous year.

The product of both terms (2.2) and (2.3) results in the forecast of earnings before taxes ($EBT_{i,t}$), determined by the simulated return on assets $ROA_{i,t}$ and total assets at the beginning of year t ($TA_{i,t-1}$):

$$EBT_{i,t} = ROA_{i,t} \cdot TA_{i,t-1} \tag{2.4}$$

In consideration of the country-specific tax loss treatment[12] and the firm-specific loss offsetting, I calculate the taxable income for ten future years.[13] In this context, I take advantage of the long time horizon of the data (earliest starting point: financial year 1994) and determine the current amount of tax loss carryforwards up to the starting point of the simulation, taking into account all loss offsetting rules including loss carryback, loss carryforward and minimum taxation regulations applicable in the past. The taxable income after tax loss offsetting is multiplied with the top statutory tax rate. The remaining tax payments are discounted with a rate of six percent and yield in the present value of expected future tax payments. The simulated marginal tax rate corresponds to the difference in present values of current and expected future taxes associated with earning one additional unit of income in year t. To include uncertainty about future income, the simulation procedure is repeated two hundred times.

[12] The tax loss offset regulations across the European countries can be found in Table 2.15 (Appendix 2.A).

[13] The non-consideration of tax exemption for dividend income, if it affects my results at all, should lead to an understatement of the effects of tax loss offset provisions since the tax base for inter-period tax loss offset may be estimated unreasonably high.

2.III.III Identification Strategy

In order to analyze the effect of the tax rate, tax losses and tax loss treatments on investment of European firms, I use a multiple linear regression with fixed effects[14], applying the ordinary least squares (OLS) method for estimating the parameters:

$$Investment_{i,t} = \beta_0 + \beta_1 \cdot Tax_{j/i,t} + \gamma \cdot X_{i,t} + \delta \cdot C_{j,t} + \beta_i + \beta_m + \beta_t + \varepsilon_{i,t} \qquad (2.5)$$

where $Investment_{i,t}$ is the change in fixed assets before depreciation relative to the prior year's total assets (e.g., Liu, 2020; Bethmann et al., 2018; Asker et al., 2015). In contrast to the stock of fixed assets (e.g., Dreßler and Overesch, 2013; Becker et al., 2012), this measure reflects gross investment and takes into account otherwise existing possible effects of depreciations and amortizations.[15] $Tax_{j/i,t}$ represents different tax variables used. First, I use $STR_{j,t}$, the country-specific top statutory tax rate, to provide evidence that higher corporate tax rates reduce corporate investment (e.g., Dobridge, 2021; Dreßler and Overesch, 2013). Second, I use simulated marginal tax rates $MTR_{i,t}$ to account for the firm-specific tax burden in year t, since the MTR corresponds to the additional tax amount that results from earning an additional unit of income after accounting for the consequences of offsetting tax losses, and therefore represents the firm's current and future tax status. Firms that suffer tax losses today or have loss carryforwards may deduct their losses from profits of previous or future periods, respectively. As long as the additional income is fully offset against losses or loss carryforwards, the MTR is zero and the firm tax-exempt. In contrast, the MTR is equal to the STR when the firm is fully taxable. Including STR and MTR in the regression allows for the estimation of the loss compensation effect, since the tax rate effect is filtered through STR.

Since simulated marginal tax rates may also reflect loss characteristics other than tax considerations (e.g., lack of financing sources for investments, see Auerbach, 1986), I capture these non-tax but economic determinants by introducing the variable $Ratio\ MTR_{i,t}$ ($\frac{STR_{j,t}-MTR_{i,t}}{STR_{j,t}}$) into the model (e.g., Koch, 2014a). The ratio can take the value of zero if the firm has no tax benefits resulting from tax losses and is therefore taxable at the statutory tax rate (MTR=STR). The variable is one for firms having tax losses and are therefore tax exempt (MTR=0). Since an increase of this variable reflects an increase in losses, I expect

[14] My fixed effects estimation eliminates the unobserved heterogeneity by taking the mean-difference. Another possibility is the use of a first-difference estimator which is preferred in general because it is often a more efficient estimator (e.g., Cameron and Trivedi, 2010). Therefore, I show that the variables of main interest change just slightly when re-estimating equation (5) by taking first differences (see Table 2.19 (Appendix 2.A)).

[15] My results are robust to using net investment (change in fixed assets after depreciation relative to the prior year's total assets, e.g., Amberger et al., 2021) as the dependent variable (see Table 2.17 (Appendix 2.A)).

a decrease in investment due to, e.g., increasing financing problems from an economic perspective. To separate the tax rate effect from the firm-specific tax status resulting from current tax losses and intertemporal loss-offset opportunities (e.g., Gamm et al., 2018), I further include $\Delta\, MTR_{i,t}$ $(MTR_{i,t} - STR_{j,t})$. If managers take the tax status of their firm into account and therefore the tax loss treatment when making decisions, a lower MTR compared to the STR will increase investments (see Graham, 1996a). That means that more losses incite investment from a tax perspective. Since the variable ranges between minus STR (MTR=0) and zero (MTR=STR) and therefore an increase in Δ MTR goes in hand with a decrease in losses, I expect a negative coefficient for this variable, which induces a decrease in investment from a tax perspective.

With respect to time-varying firm characteristics, I include a vector $X_{i,t}$ of firm-level investment determinants (firm size, capital intensity, cash, sales growth and long-term debt). All firm-level variables except for size are winsorized at the 1 percent and 99 percent levels. Furthermore, $C_{j,t}$ consists of macroeconomic variables that may affect firms' investment (GDP, GDP per capita, regulatory quality, voice and accountability, government effectiveness, control of corruption and inflation). Finally, I include firm (β_i), industry (β_m) and year (β_t) fixed effects to control for unobserved firm characteristics enabling the identification of differences within a firm regarding investment and heterogeneous industry and time shocks, respectively (e.g., Wooldridge, 2010). Descriptive statistics of the variables used are displayed in Table 2.13 (Appendix 2.A).

2.IV. Results

2.IV.I Baseline regression

Table 2.1 presents the regression results from equation (2.5). First, I follow up on previous studies and estimate the effect of the corporate statutory tax rate on firms' investment (column (1)). In line with prior empirical results and the deviation from the theoretical framework, I find a negative and significant effect for the statutory tax rate (column (1)). The corresponding investment decrease amounts to 22.3 percent of total assets. This magnitude is comparable to results from existing estimates (e.g., Jacob, 2022, Dreßler and Overesch, 2013). I also find evidence that larger firms have lower investment levels than small growing firms. High levels of fixed assets are negatively related to investments, while high sales lead to higher investment (e.g., Bethmann et al., 2018). Column (2) integrates the firm-specific marginal tax rates to test my hypothesis 1. The marginal tax rate represents the firm's current and future tax status (e.g., Auerbach and Poterba, 1987) and can therefore be interpreted as the firm managers'

expectations considering a firm-specific drift and volatility of income based on the historical performance (e.g., Graham, 1996b). Due to the calculation of the MTR, this variable basically considers the tax rate, the firm's expected performance and the firm-specific offsetting of losses taking into account country-specific offset restrictions (limited loss carryforward, possible loss carryback, minimum taxation). Thus, if losses have no effect on investment, the coefficient of the MTR variable in column (2) should not be significant. In column (3), I examine my hypothesis 2 by estimating the tax rate and tax loss effect through the MTR variable, while separating the economic effect of losses through the ratio variable. In this setting, the MTR represents the firm‘s tax status. A comparison of the MTR coefficient with the coefficient of the STR in column (2) allows for an assessment of the superiority of the tax rate effect over the loss effect. The investigation of hypothesis 3 follows in column (4) by including the statutory tax rate and two measures for the tax loss and economic loss effect.

Table 2.1: Baseline results

	(1)	(2)	(3)	(4)
Dependent variable	Investment	Investment	Investment	Investment
STR	-0.223***	-0.288***		-0.287***
	(0.081)	(0.086)		(0.079)
MTR		0.078***	-0.287***	
		(0.008)	(0.038)	
Δ MTR				-0.287***
				(0.025)
Ratio MTR			-0.113***	-0.113***
			(0.013)	(0.007)
Firm Size	-0.156***	-0.158***	-0.160***	-0.160***
	(0.007)	(0.007)	(0.007)	(0.007)
Capital Intensity	-0.410***	-0.407***	-0.406***	-0.406***
	(0.009)	(0.009)	(0.009)	(0.009)
Cash	-0.012	-0.016	-0.017	-0.017
	(0.031)	(0.031)	(0.031)	(0.031)
Sales Growth	0.054***	0.056***	0.056***	0.056***
	(0.005)	(0.005)	(0.005)	(0.005)
LT Debt	0.278***	0.278***	0.278***	0.278***
	(0.004)	(0.004)	(0.004)	(0.004)
GDP	0.011	0.008	0.011	0.011
	(0.017)	(0.018)	(0.018)	(0.017)
GDP pC	0.091***	0.092***	0.091***	0.091***
	(0.021)	(0.019)	(0.019)	(0.021)
Control of Corruption	0.018***	0.017***	0.018***	0.018***
	(0.006)	(0.006)	(0.004)	(0.006)
Government Effectiveness	-0.023***	-0.023***	-0.023***	-0.023***
	(0.007)	(0.007)	(0.007)	(0.007)
Inflation	0.002**	0.002**	0.002***	0.002**
	(0.001)	(0.001)	(0.001)	(0.001)

Regulatory Quality	0.024**	0.024**	0.024**	0.024**
	(0.010)	(0.010)	(0.009)	(0.010)
Voice & Accountability	-0.046***	-0.047***	-0.050***	-0.050***
	(0.006)	(0.006)	(0.008)	(0.006)
Observations	2,226,392	2,226,392	2,226,392	2,226,392
Adj. R^2	0.1728	0.1728	0.1729	0.1729
Firm FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes

Notes: This table reports the baseline regression results. The dependent variable is the change in fixed assets before depreciation relative to the prior year's total assets (Investment). The variables of particular interest are STR (column (1)), STR and MTR (column (2)), MTR and Ratio MTR (column (3)) and STR, Δ MTR and Ratio MTR (column (4)). All variables are defined in Table 2.11 (Appendix 2.A). All regressions include firm-, industry- and year-fixed effects. Robust standard errors (clustered at the firm-level) are provided in parentheses. Stars behind the coefficients indicate the significance level, *** 1%, ** 5%, * 10%.

In column (2), the tax rate effect is separated by the variable STR from the marginal tax rate, which includes this effect in principle. Thus, the MTR represents the loss effect and depicts the offsetting of losses. Two conclusions can be drawn. First, the relation between the loss compensation and investment derived from the theoretical considerations is corroborated since a higher compensation of losses, expressed by a higher marginal tax rate ($\lim_{loss \to 0} MTR = STR$), results in an increase in investment. A particular advantage of the firm-specific marginal tax rate is that the performance of the firm is integrated. Thus, I comply with the requirement that firm-specific expectations about the emergence and use of losses need to be considered in corporate decisions (e.g., Langenmayr and Lester, 2018; Auerbach and Poterba, 1987). Second, my first hypothesis can be confirmed, as the loss effect is significant. This provides empirical evidence that firms take their future expectations regarding a possible loss carryforward offset into account when deciding about investments.

Specification (3) includes the marginal tax rate and the ratio of the statutory and marginal tax rate as explanatory variables to examine whether the statutory tax rate or the tax loss offset expectations prevails in investment decisions. Since the ratio variable represents the economic non-tax effects of losses, the MTR variable measures the effect of the tax rate and loss compensation. An increase in the MTR corresponds to a reduction of losses and thus to a convergence to a fully taxable status on the statutory tax rate level. The sign of the coefficient shows which of the two effects prevail: on the one hand, an increase in the tax loss compensation is linked to an increase in investment (see Section 2.II.II and Appendix 2.B). On the other hand, an increase of the tax rate leads to reduced investments. The result in column (3) is consistent with my second hypothesis and provides a negative and significant coefficient for the MTR, indicating that the tax rate effect is prevailing. Furthermore, the economic loss effect is in line with the expectations that firms with losses face higher financing hurdles for

further investments. Since an increase of the ratio goes in hand with an increase in losses, the negative coefficient provides evidence for a reduction in the investment level from a non-tax perspective (e.g., Dreßler and Overesch, 2013; Auerbach, 1986).

Hypothesis 3 is investigated in column (4). In this specification, I include the statutory tax rate to separate this effect on firms' investment. In addition, I use Δ MTR and Ratio MTR to separate the tax effect and the economic effect of losses. While the literature predicts a positive investment effect of losses from a tax perspective due to tax savings, a negative effect is expected from a non-tax perspective because of financing problems. In line with my predictions, the results provide the following insights: first, an increase in the tax rate (STR) leads to a decrease in investment; second, since losses represent tax savings, a decrease of losses (Δ MTR ↑) leads to a decrease in investment because less losses need to be offset with future investment income. Conversely, this means that existing losses lead to increasing investments to gain tax savings. Third, firms' investment level is reduced by an increase of losses (Ratio MTR ↑) from a non-tax perspective. Fourth, when comparing the coefficients of the loss effects, it can be assumed that the tax rate effect prevails.

All in all, I have to agree with the previous findings in the literature. The inclusion of tax asymmetries and the consideration of firm-specific expectations about the emergence and utilization of losses does not improve the performance of the estimation model (e.g., Arachi and Biagi, 2005; Devereux et al., 1994).

2.IV.II Cross-sectional variation

In the following, I expand the findings with various cross-sectional tests. At first, I examine the intensity of the different effects depending on firm characteristics, since the current loss treatment represents a trade-off between not supporting undesirable activity and encouraging investment in almost all countries (e.g., Dobridge, 2021; Bethmann et al., 2018; Auerbach, 1986). Due to the fact that a firm running a loss does not, in principle, receive an immediate refund but has to use its losses in subsequent profit periods, a loss carryforward merely represents tax savings in the future. In the lack of positive income, losses can accumulate and even expire unused due to time-limited loss carryforward provisions. Therefore, restrictive loss compensation rules penalize especially firms with runs of losses (e.g., Auerbach, 1986). Derived from this consideration, the loss compensation will be challenging for these "Bad performers" (firms, reporting a loss in more than half of the observations)[16]. As a result, capital

[16] The threshold corresponds to the 90 percent percentile of the loss ratio (loss observations divided by all income observations per firm).

providers may lose confidence in the business model and reduce their financing activities. This poses major challenges for the firm, as sources of financing for new investments decline. Therefore, I especially expect a negative and significant effect for the economic loss effect. In addition, loss firms are generally more likely to face financial distress relative to profitable firms (e.g., Altman, 2013) since investments of distressed firms are expected to generate less value during times of high uncertainty (e.g., Eisdorfer, 2008). Thus, I expect a stronger loss compensation effect for these firms compared to non-distressed firms since the offset of losses generates tax benefits and thus creates new liquidity. Nevertheless, distressed firms may also face greater financing problems than their counterparts.

Table 2.2: Split on firms' performance history and financial distress

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable	Investment			Investment		
STR × Indicator = 0	-0.311***		-0.303***	-0.290***		-0.271***
	(0.089)		(0.081)	(0.023)		(0.022)
STR × Indicator = 1	0.106		0.096	-0.276***		-0.275***
	(0.069)		(0.074)	(0.022)		(0.022)
MTR × Indicator = 0	0.070***	-0.306***		0.088***	-0.262***	
	(0.009)	(0.040)		(0.019)	(0.018)	
MTR × Indicator = 1	0.123***	-0.002		0.070***	-0.266***	
	(0.013)	(0.052)		(0.004)	(0.016)	
Δ MTR × Indicator = 0			-0.291***			-0.207***
			(0.028)			(0.068)
Δ MTR × Indicator = 1			-0.071			-0.264***
			(0.061)			(0.020)
Ratio MTR × Ind. = 0		-0.117***	-0.112***		-0.108***	-0.092***
		(0.014)	(0.007)		(0.006)	(0.018)
Ratio MTR × Ind. = 1		-0.042***	-0.060***		-0.105***	-0.104***
		(0.015)	(0.017)		(0.005)	(0.006)
Observations	2,226,320	2,226,320	2,226,320	1,713,051	1,713,051	1,713,051
Adj. R^2	0.1729	0.1729	0.1729	0.0542	0.0543	0.0543
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table reports cross-sectional regression results. The dependent variable is the change in fixed assets before depreciation relative to the prior year's total assets (Investment). The variables of particular interest are interactions with STR and MTR (column (1) and (4)), MTR and Ratio MTR (column (2) and (5)) and STR, Δ MTR and Ratio MTR (column (3) and (6)). In columns (1)-(3), the tax variables are interacted with an indicator variable "Bad Performer" representing the firms' loss performance, which equals one (zero) if the firm reports a loss (measured by operating profit/loss) in more (less or equal) than half of the observations. In columns (4)-(6), the tax variables are interacted with an indicator variable "Distress" representing the firms' financial distress, which equals one (zero) if the firm has an Altman z-score below (above) the 75th percentile in the prior year. All variables are defined in Table 2.11 (Appendix 2.A). All regressions include firm-level and country-level control variables and firm-, industry- and year-fixed effects. Robust standard errors (clustered at the firm-level) are provided in parentheses. Stars behind the coefficients indicate the significance level, *** 1%, ** 5%, * 10%.

Table 2.2 presents the regression results. In columns (1) to (3), the tax variables are interacted with an indicator variable "Bad performer" representing the firms' loss performance, which equals one (zero) if the firm reports a loss (measured by operating profit/loss) in more (less or equal) than half of the observations. The results provide the following insights for firms with a high frequency of loss observations: First, "Bad performers" are not sensitive to tax rate changes (see the insignificant tax rate effect in column (1) and (3)). Second, the focus of these firms is on their losses. It can be stated that, compared to their counterparts with less loss observations, a higher loss compensation provides a greater incentive to invest (column (1)). Third, the problem of such "Bad performer" firms becomes apparent in columns (2) and (3). When differentiating between the tax effect and the non-tax but economic effect, only the economic effect is significant and negative, indicating that those firms face financing hurdles. Therefore, the tax benefits are irrelevant since a tax loss offset is not possible due to a lack of funding further investments. In columns (4) to (6), I distinguish between the investment responses of distressed versus non-distressed firms by including an indicator variable. The variable equals one (zero) if the firm has an Altman z-score (e.g., Altman, 2013) below (above) the 75th percentile in the prior year. The results do not support my assumption that the importance of the loss compensation effect is greater for distressed firms (column (1)), but the separation of the effects show that losses gain more importance for such firms, especially from a tax perspective but also from an economic perspective (column (3)). This finding is in line with the assumption, that financially distressed firms try to use dormant tax savings.

The above conducted sample split (Table 2.2, columns (1) to (3)) focuses on firm performance. Since the marginal tax rate considers the managers' expectations about future taxable income (performance) and country-specific regulations on the statutory tax rate, loss carrybacks, loss carryforwards and minimum taxation, I further examine two effects of the tax rate system. First, I exclude observations in countries which allow for a loss carryback (Table 2.3, columns (1) to (3)). Loss carrybacks result in an immediate refund if the firm has previous positive tax income. An extension of the loss carryback period could increase the marginal tax rate of loss firms (e.g., Graham and Kim, 2009b). Previous literature has provided evidence that less asymmetric treatment of losses through a grant of refunds in the form of loss carrybacks increases investment of loss firms (e.g., Dobridge, 2021; Bethmann et al., 2018). Therefore, especially the tax loss effect could be biased by those observations. Due to the exclusion of those observations, I provide evidence that the tax compensation and tax loss effect is still persistent. Second, I examine how a short loss carryforward period affects firms' investment behavior (Table 2.3, Columns (4) to (6)). Firms operating in a country where a loss carryforward is

limited to five or less years are obliged to use losses very quickly. At best, they generate profits immediately right after the loss year. Two outcomes are possible: on the one hand, firms may react stronger than firms in countries with less restricted or unlimited loss carryforward, as they try everything to achieve their tax savings from loss carryforwards. On the other hand, a lower reaction is possible because managers already notice in their planning horizon that a firm will offset its losses in any case or that it will be impossible to use the large amount of tax loss carryforwards in this short time period. Accordingly, an adjustment of the investment plan is not necessary.

Table 2.3: Results without carryback observations and split on loss carryforward limit

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable	Investment			Investment		
STR	-0.369***		-0.360***	-0.325***		-0.321***
	(0.022)		(0.022)	(0.089)		(0.080)
MTR	0.094***	-0.315***		0.094***	-0.310***	
	(0.003)	(0.017)		(0.009)	(0.039)	
Δ MTR			-0.285***			-0.478***
			(0.021)			(0.044)
Ratio MTR		-0.123***	-0.114***		-0.125***	-0.176***
		(0.005)	(0.006)		(0.014)	(0.012)
STR × LCF Short				-0.221***		-0.295***
				(0.080)		(0.078)
MTR × LCF Short				0.010*	-0.284***	
				(0.006)	(0.038)	
Δ MTR × LCF Short						-0.101***
						(0.022)
Ratio MTR × LCF Short					-0.090***	-0.036***
					(0.011)	(0.007)
Observations	1,596,363	1,596,363	1,596,363	2,226,392	2,226,392	2,226,392
Adj. R^2	0.2189	0.2191	0.2191	0.1728	0.1729	0.1729
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table reports regression results for a restricted sample and cross-sectional regression results. The dependent variable is the change in fixed assets before depreciation relative to the prior year's total assets (Investment). The variables of particular interest are STR and MTR (column (1) and (4)), MTR and Ratio MTR (column (2) and (5)) and STR, Δ MTR and Ratio MTR (column (3) and (6)) and their interactions. In columns (1)-(3), the sample is restricted to only loss carryforward countries. In columns (4)-(6), the tax variables are interacted with Short LCF, indicating that the loss carryforward is (not) restricted to less or equal than five years in the respective country and year. All variables are defined in Table 2.11 (Appendix 2.A). All regressions include firm-level and country-level control variables and firm-, industry- and year-fixed effects. Robust standard errors (clustered at the firm-level) are provided in parentheses. Stars behind the coefficients indicate the significance level, *** 1%, ** 5%, * 10%.

Table 2.3 reports the results for the restricted sample without loss carryback observations (columns (1) to (3)) and for a split on a short loss carryforward period (columns (4) to (6)).

First, the results are robust to the exclusion of loss carryback countries. Second, the coefficients are larger compared to my baseline results (Table 2.1), suggesting that the investment response increases when an immediate refund is not possible. Thus, achieving tax benefits only depends on the firm's future performance. The results for the investigation with regard to a short loss carryforward support the prediction that firms having a short loss offset possibility increase their investments significantly less than firms with long-term loss offset objectives. Since the tax rate has roughly the same coefficient estimate, the divergent reaction with regard to losses becomes clear in column (6).

In the following specifications, I examine the investment effect in more detail and use different dependent variables to explore the impact of tax losses and tax loss offset to various asset types. I re-estimate equation (2.5) (see Section 2.III.III) using tangible investment, intangible investment and labor investment as dependent variables. In line with previous literature, I expect investment responses mainly for asset types that promise cash flows soon. Since intangible assets require a longer amortization time, a small effect is assumed (e.g., Bethmann et al., 2018; Paunov, 2012; Guellec and Wunsch-Vincent, 2009; Auerbach and Poterba, 1987). The results are presented in Table 2.4. They confirm the assumption that firms invest more in tangible assets and labor in order to achieve profits in the following periods that can be offset against accumulated losses and refrain from long-term amortization assets like intangibles.

Table 2.4: Types of investment

Dependent variable	(1) Tangible Investment	(2) Tangible Investment	(3) Tangible Investment	(4) Intangible Investment	(5) Intangible Investment	(6) Intangible Investment	(7) Labor Investment	(8) Labor Investment	(9) Labor Investment
STR	-0.308***		-0.296***	-0.017***		-0.018***	-0.185***		-0.200***
	(0.027)		(0.028)	(0.004)		(0.003)	(0.026)		(0.027)
MTR	0.064***	-0.240***		0.007***	-0.024***		0.027***	-0.195***	
	(0.002)	(0.019)		(0.001)	(0.003)		(0.002)	(0.017)	
Δ MTR			-0.181***			-0.030***			-0.191***
			(0.014)			(0.006)			(0.013)
Ratio MTR		-0.094***	-0.076***		-0.010***	-0.011***		-0.069***	-0.068***
		(0.006)	(0.004)		(0.001)	(0.002)		(0.005)	(0.004)
Observations	2,225,064	2,225,064	2,225,064	2,217,846	2,217,846	2,217,846	2,026,455	2,026,455	2,026,455
Adj. R^2	0.0896	0.0898	0.0899	0.3194	0.3194	0.3194	0.6467	0.6468	0.6468
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table reports regression results for different dependent variables. In columns (1)-(3), the dependent variable is the change in tangible fixed assets before (weighted average) depreciation relative to the prior year's total assets (Tangible Investment). In columns (4)-(6), the dependent variable is the change in intangible fixed assets before (weighted average) depreciation relative to the prior year's total assets (Intangible Investment). In columns (7)-(9), the dependent variable is Labor Investment, defined as cost of employees relative to the prior year's total assets. The variables of particular interest are STR and MTR (column (1), (4) and (7)), MTR and Ratio MTR (column (2), (5) and (8)) and STR, Δ MTR and Ratio MTR (column (3), (6) and (9)). All variables are defined in Table 2.11 (Appendix 2.A). All regressions include firm-level and country-level control variables and firm-, industry- and year-fixed effects. Robust standard errors (clustered at the firm-level) are provided in parentheses. Stars behind the coefficients indicate the significance level, *** 1%, ** 5%, * 10%.

Overall, my results reveal important findings. First, firms consider their tax status which is dependent of losses and their offset probability when making investment decisions. Second, as expected, the statutory tax rate is the predominant tax factor. Nevertheless, firm-specific tax loss compensation has been shown to have a positive effect on investment. Third, I show that losses have different effects on the firms' investment level. On the one hand, firms try to use their tax loss carryforwards in advance to achieve tax savings. Thus, increasing tax losses increase investment from a tax perspective. On the other hand, firms with tax losses could have financing problems. Therefore, an increase in losses leads to a decrease in investment from a non-tax perspective. In summary, my results are relevant for policymakers because they show that loss compensation is very important for encouraging corporate investment and that a restrictive limitation on tax loss offset restriction with respect to loss carryforwards inhibits investment. Against this background, a less restrictive tax loss treatment without a minimum taxation is recommended to enhance investment, even if firms' risk taking is positively related to the length of tax loss offset periods (e.g., Langenmayr and Lester, 2018; Ljungqvist et al., 2017). Nevertheless, loosening the regulations may not support undesirable activities of firms because the cross-sectional test for "Bad performers" suggests that tax benefits are irrelevant for those firms since a tax loss offset is not possible due to a lack of funding further investments.

2.IV.III Robustness checks

This section documents the robustness of my results. First, my results are robust to using alternative firm-level and country-level control variables that additionally account for the firm's age and labor intensity as well as macroeconomic factors like unemployment and population growth. Also, replacing the variables GDP and GDP per capita with growth rates does not affect the results (see Table 2.16 (Appendix 2.A)). Second, I address the concern that countries with lots of observations[17], namely Italy, France and Spain, cause or dominate my results. Therefore, I exclude those countries in further robustness checks.[18] In order to show that my results are not biased by the economic and financial crisis which presented a negative shock for the investment stock, I exclude the years 2008 and 2009 in a further analysis. The results of Table 2.5 and Table 2.6 are almost unaffected in their magnitude and significance, suggesting that neither selected countries nor the financial crisis trigger my results.

[17] See Table 2.12 (Appendix 2.A) for an overview of the distribution of observations across the countries.

[18] In a further robustness check, I exclude observations from Sweden (see Table 2.18 (Appendix 2.A)) since Swedish firms can create a tax allocation reserve that allows them to defer taxable income for a maximum of six years. This option can ensure a refund like a loss carryback.

Table 2.5: Regression results without observations in Spain and France

	(1)	(2)	(3)	(4)	(5)	(6)
Dep. variable	Investment	Investment	Investment	Investment	Investment	Investment
STR	-0.350***		-0.343***	-0.348***		-0.337***
	(0.052)		(0.055)	(0.046)		(0.049)
MTR	0.069***	-0.279***		0.075***	-0.291***	
	(0.006)	(0.037)		(0.006)	(0.034)	
Δ MTR			-0.221***			-0.244***
			(0.032)			(0.030)
Ratio MTR		-0.104***	-0.087***		-0.109***	-0.096***
		(0.011)	(0.010)		(0.010)	(0.009)
Observations	950,535	950,535	950,535	1,184,717	1,184,717	1,184,717
Adj. R^2	0.0829	0.0830	0.0830	0.0950	0.0950	0.0950
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table reports regression results for restricted samples. The dependent variable is the change in fixed assets before depreciation relative to the prior year's total assets (Investment). In columns (1)-(3), observations in Spain are excluded. In columns (4)-(6), the sample does not include French firms. The variables of particular interest are STR and MTR (column (1) and (4)), MTR and Ratio MTR (column (2) and (5)) and STR, Δ MTR and Ratio MTR (column (3) and (6)). All variables are defined in Table 2.11 (Appendix 2.A). All regressions include firm-level and country-level control variables and firm-, industry- and year-fixed effects. Robust standard errors (clustered at the firm-level) are provided in parentheses. Stars behind the coefficients indicate the significance level, *** 1%, ** 5%, * 10%.

Table 2.6: Regression results without observations in Italy and financial crisis years

	(1)	(2)	(3)	(4)	(5)	(6)
Dep. variable	Investment	Investment	Investment	Investment	Investment	Investment
STR	-0.333***		-0.287***	-0.244***		-0.245***
	(0.072)		(0.077)	(0.041)		(0.044)
MTR	0.096***	-0.223***		0.058***	-0.239***	
	(0.011)	(0.052)		(0.006)	(0.031)	
Δ MTR			-0.154***			-0.233***
			(0.041)			(0.031)
Ratio MTR		-0.090***	-0.071***		-0.089***	-0.088***
		(0.014)	(0.011)		(0.009)	(0.009)
Observations	705,561	705,561	705,561	1,101,070	1,101,070	1,101,070
Adj. R^2	0.0213	0.0214	0.0214	0.1044	0.1045	0.1045
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table reports regression results for restricted samples. The dependent variable is the change in fixed assets before depreciation relative to the prior year's total assets (Investment). In columns (1)-(3), observations in Italy are excluded. In columns (4)-(6), the years 2008 and 2009 are not considered due to the financial crisis. The variables of particular interest are STR and MTR (column (1) and (4)), MTR and Ratio MTR (column (2) and (5)) and STR, Δ MTR and Ratio MTR (column (3) and (6)). All variables are defined in Table 2.11 (Appendix 2.A). All regressions include firm-level and country-level control variables and firm-, industry- and year-fixed effects. Robust standard errors (clustered at the firm-level) are provided in parentheses. Stars behind the coefficients indicate the significance level, *** 1%, ** 5%, * 10%.

A potential concern of my sample relates to intragroup and intertemporal loss shifting, as documented by e.g., Gamm et al. (2018) and Maydew (1997), respectively. To address the first issue, I re-estimate equation (2.5) (see Section 2.III.III) on a sample which only includes standalone firms. Those firms have no possibility to shift profits to loss firms in order to achieve tax savings and reduce the overall tax burden of the tax group. Furthermore, benefits from group taxation are also not achievable. Table 2.7 shows the robustness of my main results using only standalone firms.

Table 2.7: Regression results for standalone firms

Dependent variable	(1) Investment	(2) Investment	(3) Investment
STR	-0.456***		-0.463***
	(0.030)		(0.031)
Lag MTR	0.093***	-0.383***	
	(0.006)	(0.029)	
Lag Δ MTR			-0.311***
			(0.039)
Lag Ratio MTR		-0.146***	-0.125***
		(0.009)	(0.012)
Observations	480,053	480,053	480,053
Adj. R^2	0.2197	0.2201	0.2202
Controls	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes

Notes: This table reports regression results for a restricted sample. The dependent variable is the change in fixed assets before depreciation relative to the prior year's total assets (Investment). The sample considers only standalone firms. The variables of particular interest are STR and MTR (column (1)), MTR and Ratio MTR (column (2)) and STR, Δ MTR and Ratio MTR (column (3)). All variables are defined in Table 2.11 (Appendix 2.A). All regressions include firm-level and country-level control variables and firm-, industry- and year-fixed effects. Robust standard errors (clustered at the firm-level) are provided in parentheses. Stars behind the coefficients indicate the significance level, *** 1%, ** 5%, * 10%.

The significance and direction of the effects stay unaffected. Only the coefficients are slightly higher, indicating that firms in tax groups use partly the channel of group profit allocation so that the investment effect is slightly mitigated. I cannot completely rule out that the second aspect has an effect on my results. Maydew (1997) shows that firms do intertemporal income shifting with loss carrybacks since they can decide when losses are used and thus maximize their tax benefits. However, three arguments contradict this consideration. First, the results of my robustness test, in which I exclude observations from loss carryback countries, are robust (Table 2.3). Second, the determination of the MTR follows a pessimistic approach with regard to this argument because a loss carryback is used if possible. A firm thus has, if any, lower loss carryforwards which can be offset with the additional unit of income and therefore a marginal

tax rate which is equal or greater compared to an income-shifting marginal tax rate. This argues against finding an effect. Third, the design of the tax system in future years is not transparent to firm managers, so rationally it does not seem to make much sense to defer losses for a later offset when there is an opportunity to take advantage of tax benefits earlier. This aspect is also supported by the fact that loss values decline over time.

In a further robustness check, I address the challenge that the firm's tax status is a result of preceding investment decisions. In contrast to studies examining financing decisions with pre-financing marginal tax rates (e.g., Graham et al., 1998), I am unable to determine pre-investment marginal tax rates. Graham (2003) notes that the simulated tax rates capture the influence of profitability on the corporate MTR by construction. I encounter this problem by applying the approach of MacKie-Mason (1990) and use the lagged marginal tax rate to explain the current-period investment response (e.g., Graham, 2003; Graham et al., 1998; Graham, 1996a). Table 2.8 shows the results using a lag of the simulated marginal tax rate. The direction of the effects as well as the significance remain unchanged. Only the coefficients in column (2) are slightly lower. However, I cannot rule out the possibility that difficulties in determining firms' taxable status are responsible for the barely improved empirical performance.

Table 2.8: Lag MTR

Dependent variable	(1) Investment	(2) Investment	(3) Investment
STR	-0.306***		-0.299***
	(0.042)		(0.044)
Lag MTR	0.074***	-0.112***	
	(0.004)	(0.032)	
Lag Δ MTR			-0.263***
			(0.024)
Lag Ratio MTR		-0.058***	-0.104***
		(0.010)	(0.007)
Observations	1,753,064	1,753,064	1,753,064
Adj. R^2	0.0601	0.0600	0.0601
Controls	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes

Notes: This table reports regression results with lagged variables. The dependent variable is the change in fixed assets before depreciation relative to the prior year's total assets (Investment). The variables of particular interest are STR and Lag MTR (column (1)), Lag MTR and Lag Ratio MTR (column (2)) and STR, Lag Δ MTR and Lag Ratio MTR (column (3)). All variables are defined in Table 2.11 (Appendix 2.A). All regressions include firm-level and country-level control variables and firm-, industry- and year-fixed effects. Robust standard errors (clustered at the firm-level) are provided in parentheses. Stars behind the coefficients indicate the significance level, *** 1%, ** 5%, * 10%.

Finally, I do not consider time-delayed effects of investment in my baseline regression (see, e.g., Auerbach and Hines, 1986). Incorporating the lag of investment in my fixed effects regression equation (2.5) would lead to a dynamic panel bias because the first step is to subtract the individual's mean value of the dependent and every independent variable from the respective variable when calculating the within estimator of a fixed effects model. Subtracting the mean of the lagged dependent variable creates a correlation with the error term which distorts the estimation (see Nickell, 1981). One mechanism to include the effect of the lagged investment is the use of instrumental variables. Therefore, I use the Anderson-Hsiao estimator which creates instruments for the lagged dependent variable from the second and third lag of investment (see Anderson and Hsiao, 1982). The applied dynamic estimation procedure is the two-stage instrumental variables approach (IV 2SLS) which leads to the following model:

$$Investment_{i,t} = \beta_0 + \beta_1 \cdot Investment_{i,t-1} + \beta_2 \cdot Tax_{j/i,t} + \gamma \cdot X_{i,t} + \delta \cdot C_{j,t} + \beta_i + \beta_m + \beta_t + \varepsilon_{i,t} \quad (2.6)$$

The results of the instrumental variables approach are reported in Table 2.9 and show the p-value of the F-test of excluded instruments at the first stage of the regression and the p-value of Sargan-Hansen-overidentification test which check for the validity of the instruments applied. The instruments have to be independent from the error term $\varepsilon_{i,t}$ but correlated with the lagged dependent variable $Investment_{i,t-1}$. Thus, I follow Anderson and Hsiao (1982) and instrument the lag dependent variable with deeper lags of the dependent variable. Table 2.9 provides the following insights: first, my results also hold in the dynamic approach. Second, the firm's previous investment has a positive and significant effect on current investments (e.g., Dreßler and Overesch, 2013). The test statistics confirm that the F-test of excluded instruments at the first stage is highly significant which means that my instruments are relevant. Furthermore, the Sargan-Hansen-test of overidentifying restrictions shows that my instruments are exogenous to the error term.

Table 2.9: Results for the dynamic model

Dependent variable	(1) Investment	(2) Investment	(3) Investment
$Investment_{t-1}$	0.236***	0.236***	0.236***
	(0.008)	(0.008)	(0.008)
STR	-0.246***		-0.254***
	(0.031)		(0.032)
MTR	0.058***	-0.263***	
	(0.006)	(0.026)	
Δ MTR			-0.275***
			(0.034)
Ratio MTR		-0.099***	-0.103***
		(0.008)	(0.010)
Observations	1,118,347	1,118,347	1,118,347
1st stage F-test	0.0000	0.0000	0.0000
Sargan-Hansen-test	0.2639	0.2707	0.2704
Controls	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes

Notes: This table reports regression results for the instrumental variable approach (IV 2SLS). The dependent variable is the change in fixed assets before depreciation relative to the prior year's total assets (Investment). The variables of particular interest are STR and MTR (column (1)), MTR and Ratio MTR (column (2)) and STR, Δ MTR and Ratio MTR (column (3)) and the lag of the dependent variable, $Investment_{t-1}$, which is instrumented with the 2nd and 3rd lag of the dependent variable. All variables are defined in Table 2.11 (Appendix 2.A). All regressions include firm-level and country-level control variables and firm-, industry- and year-fixed effects. Robust standard errors (clustered at the firm-level) are provided in parentheses. Stars behind the coefficients indicate the significance level, *** 1%, ** 5%, * 10%.

2.V. Conclusion

This paper examines the effect of losses and their offsetting probability considering the asymmetric tax loss treatment on corporate investment. I document that losses and their offsetting probability have a significant effect on firms' investment behavior and therefore confirm the assumption that firms consider their firm-specific expectations about the emergence and use of losses when making investment decisions (e.g., Langenmayr and Lester, 2018; Auerbach and Poterba, 1987). The results suggest that losses matter, but that the tax rate effect is the predominant decision factor of the corporate tax system. Nevertheless, I find a significant and positive effect for the tax loss compensation on firms' investment. In a further separation of the loss effect, I verify that tax loss carryforwards have contrary effects – they increase investment from a tax perspective in order to achieve tax benefits resulting from offsetting accumulated losses (e.g., Auerbach, 1986) and reduce investment from an economic perspective because of a lack of financial sources for further investment (e.g., Dreßler and Overesch, 2013). Within the scope of cross-sectional tests, I document that firms having only a short loss offset opportunity due to a limited loss carryforward have little incentive to increase

their investments from a tax perspective compared to firms with long-term loss offset objectives, as achieving tax savings is more difficult due to the restrictive loss offset.

An important contribution of my paper is the empirical evidence that losses and loss offset matters in investment decisions. I show that increasing loss compensation leads to an increase in corporate investment and that restricting loss carryforwards inhibits investment. Therefore, my findings are relevant for policymakers because they show that loss compensation is very important to encourage corporate investment. Based on the results, it is recommended to enact regulations that are as unrestrictive as possible so as not to discourage investment. In particular, an unlimited loss carryforward and no minimum taxation are recommended to enhance investment. On the one hand, such a regulation would not penalize firms due to expiring losses. On the other hand, it would not support misallocations, as an extension of loss carryback does (e.g., Dobridge, 2021; Bethmann et al., 2018). Even if firms' risk taking is positively related to the length of tax loss offset periods (e.g., Langenmayr and Lester, 2018; Ljungqvist et al., 2017), loosening the rules may not support undesirable activities of underperforming firms, as tax benefits are almost irrelevant for those firms since a tax loss offset is not possible due to a lack of funding further investments. However, this regulatory change would reduce future tax revenues. Determining the financial consequences is a point for future research.

2.VI. Appendix

Appendix 2.A

Table 2.10: Sample selection process

Selection criteria		Number of firms
Composition of Amadeus updates 125 (February 2005), 172 (January 2009), 262 (July 2016), 318 (March 2021)		927,769
Excluding:		
(1)	firms without unconsolidated data	(1,411)
(2)	firms without NACE code or financial and utility firms (NACE 35-39, 64-66)	(7,404)
(3)	very small firms	(120,757)
(4)	data plausibility requirements	(72)
(5)	data requirements for MTR determination not fulfilled	(364,081)
(6)	missing regression variables or singleton observations	(93,558)
	Number of firms	340,486
	Number of observations	2,226,392

Notes: This table provides details on the sample selection process. Based on four different updates of the Amadeus database (125, 172, 262 and 318), I match the firm-year observations to receive a long data horizon. Due to weekly changes in the identifiers, a total of 927,769 firms could be connected. I exclude firms without unconsolidated financial information (1). I eliminate firms from the financial and utility sector and firms without an industry categorization (2). I further exclude very small firms with fixed assets and sales lower than € 50,000 since the investments of such small, partially fast-growing firms could skew my investment measure (e.g., Bethmann et al., 2018) (3). I eliminate firms with negative values for total assets, cash and age (4). Due to the data requirements to determine the MTR (see Section 2.III.II), further firms cannot be considered (5). Finally, firms cannot be included because of lacked variables for the regression or singleton observations (6). This selection process results in 2,226,392 firm-year observations of 340,486 unique firms from 25 European countries over the period 2003 to 2019.

Table 2.11: Variable definition

Variable	Definition
Dependent variables	
Investment	Change in fixed assets before depreciation relative to the prior year's total assets
Intangible Investment	Change in intangible fixed assets before (weighted average) depreciation relative to the prior year's total assets
Tangible Investment	Change in tangible fixed assets before (weighted average) depreciation relative to the prior year's total assets
Labor Investment	Cost of employees relative to the prior year's total assets
Net Investment	Change in fixed assets after depreciation relative to the prior year's total assets
Tax variables	
STR♦	Statutory tax rate
MTR	Firm-specific simulated marginal tax rate
Δ MTR	Firm-specific difference between the simulated marginal tax rate and the statutory tax rate (MTR – STR)
Ratio MTR	Firm-specific ratio of the difference between the statutory tax rate and the simulated marginal tax rate relative to the statutory tax rate (STR-MTR/STR)
Short LCF	Indicator variable, equal to one if the loss carryforward is restricted to less or equal than five years in the respective country and year
Firm-level variables	
Firm Size	Natural logarithm of the prior year's total assets
Capital Intensity	Prior year's fixed assets relative to the prior year's total assets, winsorized at 1 percent and 99 percent
Cash	Cash and cash equivalents relative to the prior year's total assets, winsorized at 1 percent and 99 percent
Sales Growth	Annual percentage change in operating revenue turnover, winsorized at 1 percent and 99 percent
LT Debt	Long-term debt relative to the prior year's sum of non-current and current liabilities, winsorized at 1 percent and 99 percent
Labor Intensity	Number of employees relative to the prior year's total assets, winsorized at 1 percent and 99 percent
Age	Natural logarithm of the age of a firm, measured as the difference between t and the year of incorporation
Bad Performer	Indicator variable, equal to one if the firm reports a loss in more than half of the observations (measured by operating profit/loss)
Distress	Indicator variable, equal to one if the firm has an Altman z-score[19] below the 75th percentile in the prior year
Country-level variables	
GDP♠	Natural logarithm of GDP in current U.S. dollars

[19] Modified Altman z-score: $0.717 \times \frac{current\ assets - current\ liabilities}{total\ assets} + 3.107 \times \frac{operating\ profit/loss}{total\ assets} + 0.42 \times \frac{total\ equity}{total\ assets - total\ equity} + 0.998 \times \frac{sales}{total\ assets}$. X_2 of the formula cannot be considered because retained earnings are not available (see Altman, 2013).

GDP pC♠	Natural logarithm of GDP per capita in constant 2010 U.S. dollars
Control of Corruption♣	Indicator for the extent to which public power is exercised for private gain
Government Effectiveness♣	Indicator for quality of public services, of the civil service and the degree of its independence from political pressures, of the policy formulation and implementation and the credibility of the government's commitment to such policies
Inflation♠	Inflation measured by the annual growth rate of the GDP implicit deflator
Regulatory Quality♣	Indicator for the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development.
Voice & Accountability♣	Indicator for the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media
GDP growth♠	Annual percentage growth rate of GDP at market prices based on constant local currency
GDP pC growth♠	Annual percentage growth rate of GDP per capita based on constant local currency
Population Growth♠	Annual population growth rate for year t is the exponential rate of growth of midyear population from year t-1 to t, expressed as a percentage
Unemployment♠	Unemployment refers to the share of the labor force that is without work but available for and seeking employment

Notes: This table reports the variable definitions. Sources: ♦ IBFD and EY, 2003 – 2019; ♠ World Development Indicators, World Bank 2021; ♣ Worldwide Governance Indicators, World Bank 2021.

Table 2.12: Country statistics and the distribution of the simulated marginal tax rates

Country	N	Percent	Cum.		MTR Mean	MTR Min	MTR Max
AT	16,439	0.738	0.738		0.1984	0	0.2500
BE	88,208	3.962	4.700		0.2757	0	0.3399
BG	36,601	1.644	6.344		0.0860	0	0.2350
CZ	19,491	0.875	7.219		0.1607	0	0.3099
DE	73,513	3.302	10.521		0.2427	0	0.3841
DK	634	0.028	10.549		0.1877	0	0.2350
ES	454,481	20.413	30.962		0.2516	0	0.3500
FI	33,766	1.517	32.479		0.1742	0	0.2900
FR	466,938	20.973	53.452		0.2857	0	0.3543
GB	87,847	3.946	57.398		0.2000	0	0.3000
GR	53,433	2.400	59.798		0.1711	0	0.3500
HR	8,845	0.397	60.195		0.1456	0	0.2000
HU	6,851	0.308	60.503		0.0853	0	0.1900
IE	837	0.038	60.541		0.1040	0	0.1250
IT	732,229	32.889	93.430		0.2445	0	0.3825
LU	2,058	0.092	93.522		0.2304	0	0.3038
LV	167	0.008	93.530		0.1360	0	0.1900
MT	19	0.001	93.531		0.3238	0.0013	0.3500
NL	894	0.040	93.571		0.2606	0	0.3450
PL	22,893	1.028	94.599		0.1564	0	0.2700
PT	45,779	2.056	96.655		0.2321	0	0.3300
RO	5,384	0.242	96.897		0.1235	0	0.2124
SE	27,280	1.225	98.122		0.1791	0	0.2800
SI	18,895	0.849	98.971		0.1511	0	0.2000
SK	22,910	1.029	100.000		0.1565	0	0.2500
Total	2,226,392	100.00					

Notes: This table provides an overview over the number of firms in the sample and the distribution of the simulated marginal tax rates per European country.

Table 2.13: Descriptive statistics

Variable	N	Mean	Std. Dev.	Min	Max
Dependent variables					
Investment	2,226,392	0.0584	0.6705	-1.1843	807.6481
Intangible Investment	2,219,242	0.0055	0.1385	-0.9970	172.7207
Tangible Investment	2,225,175	0.0413	0.2209	-1.6721	210.6994
Labor Investment	2,029,855	0.2676	0.3752	0.0000	224.1354
Net Investment	1,820,864	0.0178	0.3608	-0.9854	315.1302
Tax variables					
STR	2,226,392	0.2965	0.0540	0.0900	0.3841
MTR	2,226,392	0.2426	0.1148	0	0.3841
Δ MTR	2,226,392	-0.0539	0.1049	-0.3841	0
Ratio MTR	2,226,392	0.1832	0.3505	0	1
Firm control variables					
Firm Size	2,226,392	8.6563	1.2865	6.9078	19.0781
Capital Intensity	2,226,392	0.4402	0.2900	0.0186	0.9871
Cash	2,226,392	0.1132	0.1518	0.0000	0.7346
Sales Growth	2,226,392	0.0401	0.2253	-0.5765	1.1499
LT Debt	2,226,392	0.1902	0.2617	0	1.1194
Labor Intensity	1,972,242	0.0080	0.0091	0.0001	0.0566
Age	1,297,336	3.1353	0.6250	0	6.7044
Country control variables					
GDP	2,226,392	27.9344	0.9410	22.9245	29.0082
GDP pC	2,226,392	10.4471	0.2942	8.4853	11.6260
Control of Corruption	2,226,392	0.8327	0.6500	-0.2959	2.4650
Government Effectiveness	2,226,392	0.9958	0.5083	-0.3290	2.2611
Inflation	2,226,392	1.3966	1.0716	-9.7275	20.0716
Regulatory Quality	2,226,392	1.0538	0.3251	0.1484	2.0474
Voice & Accountability	2,226,392	1.1114	0.2054	0.2201	1.7836
GDP growth	2,226,392	1.1000	2.0424	-14.2597	25.1625
GDP pC growth	2,226,392	0.7517	2.0781	-12.8324	23.9855
Population Growth	2,226,392	0.3458	0.5426	-2.0813	3.4920
Unemployment	2,226,392	10.7304	4.9419	2.0100	27.4700

Notes: This table presents descriptive statistics of all variables used over the period 2003 to 2019. All variables are defined in Table 2.11 (Appendix 2.A).

Table 2.14: Top statutory tax rates in the sample countries

Country	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
AT	34.00	34.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
BE	33.99	33.99	33.99	33.99	33.99	33.99	33.99	33.99	33.99	33.99	33.99	33.99	33.99	33.99	33.99	29.58	29.58
BG	23.50	19.50	15.00	15.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
CZ	31.00	28.00	26.00	24.00	24.00	21.00	20.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00
DE	38.31	38.34	38.36	38.41	38.36	29.41	29.37	29.48	29.55	29.58	29.65	29.72	29.79	29.83	29.90	29.90	29.93
DK	30.00	30.00	28.00	28.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	24.50	23.50	22.00	22.00	22.00	22.00
ES	35.00	35.00	35.00	35.00	32.50	30.00	30.00	30.00	30.00	30.00	30.00	30.00	28.00	25.00	25.00	25.00	25.00
FI	29.00	29.00	26.00	26.00	26.00	26.00	26.00	26.00	26.00	24.50	24.50	20.00	20.00	20.00	20.00	20.00	20.00
FR	35.43	35.43	34.93	34.43	34.43	34.43	34.43	34.43	34.43	34.43	34.43	34.43	34.43	34.43	34.43	34.43	32.02
GB	30.00	30.00	30.00	30.00	30.00	28.00	28.00	28.00	26.00	24.00	23.00	21.00	20.00	20.00	19.00	19.00	19.00
GR	35.00	35.00	32.00	29.00	25.00	25.00	25.00	24.00	20.00	20.00	26.00	26.00	29.00	29.00	29.00	29.00	28.00
HR	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	18.00	18.00	18.00
HU	18.00	16.00	16.00	16.00	20.00	20.00	20.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	9.00	9.00	9.00
IE	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50	12.50
IT	38.25	37.25	37.25	37.25	37.25	31.40	31.40	31.40	31.40	31.40	31.40	31.40	31.40	31.40	27.90	27.90	27.90
LU	30.38	30.38	30.38	29.63	29.63	29.63	28.59	28.59	28.83	28.83	29.22	29.22	29.22	29.22	27.08	26.01	26.01
LV	19.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
MT	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00	35.00
NL	34.50	34.50	31.50	29.60	25.50	25.50	25.50	25.50	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00	25.00
PL	27.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00
PT	33.00	27.50	27.50	27.50	26.50	26.50	26.50	26.50	29.00	31.50	31.50	31.50	29.50	29.50	29.50	31.50	31.50
RO	25.00	25.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00
SE	28.00	28.00	28.00	28.00	28.00	28.00	26.30	26.30	26.30	26.30	22.00	22.00	22.00	22.00	22.00	22.00	21.40
SI	25.00	25.00	25.00	25.00	23.00	22.00	21.00	20.00	20.00	20.00	17.00	17.00	17.00	17.00	19.00	19.00	19.00
SK	25.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	19.00	23.00	22.00	22.00	22.00	21.00	21.00	21.00

Notes: This table provides an overview of the top statutory tax rates (in percent) in the European countries for the years 2003 to 2019. **Source:** IBFD and EY, 2003 – 2019.

Table 2.15: Tax loss treatment rules in the sample countries

Country	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
AT	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞
BE	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞
BG	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
CZ	7	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
DE	∞[1]	∞[1]	∞[1]	∞[1]	∞[1]	∞[1]	∞[1]	∞[1]	∞[1]	∞[1]	∞[1]	∞[1]	∞[1]	∞[1]	∞[1]	∞[1]	∞[1]
DK	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞
ES	15	15	15	15	15	15	15	15	15	18	18	18	∞	∞	∞	∞	∞
FI	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
FR	5[3]	∞[3]	∞[3]	∞[3]	∞[3]	∞[3]	∞[3]	∞[3]	∞[1]	∞[1]	∞[1]	∞[1]	∞[1]	∞[1]	∞[1]	∞[1]	∞[1]
GB	∞[1]	∞[1]	∞[1]	∞[1]	∞[1]	∞[1]	∞[1]	∞[1]	∞[1]	∞[1]	∞[1]	∞[1]	∞[1]	∞[1]	∞[1]	∞[1]	∞[1]
GR	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
HR	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
HU	5	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	5	5	5	5	5
IE	∞[1]	∞[1]	∞[1]	∞[1]	∞[1]	∞[1]	∞[1]	∞[1]	∞[1]	∞[1]	∞[1]	∞[1]	∞[1]	∞[1]	∞[1]	∞[1]	∞[1]
IT	5	5	5	5	5	5	5	5	∞	∞	∞	∞	∞	∞	∞	∞	∞
LU	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	17	17	17
LV	5	5	5	5	8	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞		
MT	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞
NL	∞	∞	∞	∞	9[1]	9[1]	9[1]	9[1]	9[1]	9[1]	9[1]	9[1]	9[1]	9[1]	9[1]	9[1]	6[1]
PL	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
PT	6	6	6	6	6	6	6	4	4	5	5	12	12	12	5	5	5
RO	5	5	5	5	5	5	7	7	7	7	7	7	7	7	7	7	7
SE	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞
SI	5	5	5	5	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞
SK	5	5	5	5	5	5	5	7	7	7	7	4	4	4	4	4	4

Notes: This table provides an overview of loss carryforward and loss carryback provisions in the European countries for the years 2003 to 2019. If a loss carryforward is restricted in time, the number corresponds to the length of the loss carryforward period. The superscript number reports the number of years of a loss carryback, if possible. The box around the year reflects a minimum taxation. **Source:** IBFD and EY, 2003 – 2019.

Table 2.16: Robustness of regression results using different control variables

Dependent variable	(1) Investment	(2) Investment	(3) Investment	(4) Investment	(5) Investment	(6) Investment	(7) Investment	(8) Investment	(9) Investment
STR	-0.354***		-0.345***	-0.291***		-0.290***	-0.279***		-0.275***
	(0.046)		(0.049)	(0.088)		(0.081)	(0.086)		(0.079)
MTR	0.074***	-0.296***		0.078***	-0.288***		0.079***	-0.279***	
	(0.006)	(0.033)		(0.008)	(0.038)		(0.008)	(0.039)	
Δ MTR			-0.246***			-0.287***			-0.284***
			(0.030)			(0.025)			(0.025)
Ratio MTR		-0.111***	-0.096***		-0.113***	-0.113***		-0.111***	-0.112***
		(0.010)	(0.009)		(0.013)	(0.007)		(0.014)	(0.007)
Firm Size	-0.142***	-0.144***	-0.144***	-0.159***	-0.160***	-0.160***	-0.158***	-0.160***	-0.160***
	(0.009)	(0.009)	(0.009)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Capital Intensity	-0.435***	-0.435***	-0.435***	-0.407***	-0.406***	-0.406***	-0.408***	-0.408***	-0.408***
	(0.012)	(0.012)	(0.012)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
Cash	-0.038***	-0.040***	-0.040***	-0.017	-0.018	-0.018	-0.018	-0.019	-0.019
	(0.011)	(0.011)	(0.011)	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)	(0.031)
Sales Growth	0.047***	0.047***	0.047***	0.056***	0.056***	0.056***	0.056***	0.056***	0.056***
	(0.003)	(0.003)	(0.003)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
LT Debt	0.318***	0.318***	0.318***	0.278***	0.277***	0.277***	0.277***	0.277***	0.277***
	(0.007)	(0.007)	(0.007)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
GDP	0.045**	0.059***	0.049**	0.002	0.005	0.004			
	(0.020)	(0.020)	(0.020)	(0.018)	(0.016)	(0.018)			
GDP pC	0.021	0.007	0.018	0.083***	0.083***	0.083***			
	(0.024)	(0.022)	(0.024)	(0.020)	(0.019)	(0.020)			
Control of Corruption	0.018***	0.017***	0.020***	0.017***	0.018***	0.018***	0.013**	0.015***	0.015***
	(0.006)	(0.005)	(0.006)	(0.006)	(0.003)	(0.006)	(0.006)	(0.004)	(0.006)
Government Effectiveness	0.013***	0.014***	0.014***	-0.019***	-0.018**	-0.018***	-0.023***	-0.023***	-0.023***
	(0.005)	(0.005)	(0.005)	(0.007)	(0.008)	(0.007)	(0.007)	(0.008)	(0.007)
Inflation	0.003***	0.002***	0.003***	-0.000	-0.000	-0.000	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)

Regulatory Quality	0.014	0.016	0.014	0.016*	0.016*	0.016	0.030***	0.030***	0.030***
	(0.014)	(0.013)	(0.014)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
Voice & Accountability	-0.048***	-0.051***	-0.051***	-0.053***	-0.056***	-0.056***	-0.056***	-0.058***	-0.058***
	(0.011)	(0.011)	(0.011)	(0.007)	(0.008)	(0.007)	(0.007)	(0.008)	(0.007)
Age	0.012**	0.012**	0.012**						
	(0.006)	(0.006)	(0.006)						
Labor Intensity	4.167***	4.120***	4.122***						
	(0.756)	(0.757)	(0.757)						
Population Growth				0.007***	0.007***	0.007***			
				(0.003)	(0.003)	(0.003)			
Unemployment				-0.000	-0.000	-0.000			
				(0.000)	(0.000)	(0.000)			
GDP Growth							0.009***	0.009***	0.009***
							(0.002)	(0.002)	(0.002)
GDPpC Growth							-0.009***	-0.009***	-0.009***
							(0.002)	(0.002)	(0.002)
Observations	1,193,354	1,193,354	1,193,354	2,226,392	2,226,392	2,226,392	2,226,392	2,226,392	2,226,392
Adj. R^2	0.0951	0.0952	0.0952	0.1728	0.1729	0.1729	0.1728	0.1729	0.1729
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table reports regression results with further control variables. The dependent variable is the change in fixed assets before depreciation relative to the prior year's total assets (Investment). Columns (1)-(3) control for further firm characteristics (age and labor intensity). In columns (4)-(6), country-level controls are added for the population growth and the country-specific unemployment. In columns (7)-(9), the growth rates of GDP and GDP pC are used instead of GDP and GDP pC. The variables of particular interest are STR and MTR (column (1), (4) and (7)), MTR and Ratio MTR (column (2), (5) and (8)) and STR, Δ MTR and Ratio MTR (column (3), (6) and (9)). All variables are defined in Table 2.11 (Appendix 2.A). All regressions include firm-, industry- and year-fixed effects. Robust standard errors (clustered at the firm-level) are provided in parentheses. Stars behind the coefficients indicate the significance level, *** 1%, ** 5%, * 10%.

Table 2.17: Regression results on net investment

Dependent variable	(1) Net Investment	(2) Net Investment	(3) Net Investment
STR	-0.285***		-0.274***
	(0.020)		(0.021)
MTR	0.071***	-0.247***	
	(0.004)	(0.016)	
Δ MTR			-0.218***
			(0.021)
Ratio MTR		-0.098***	-0.090***
		(0.005)	(0.007)
Observations	1,753,064	1,753,064	1,753,064
Adj. R^2	0.0483	0.0484	0.0484
Controls	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes

Notes: This table reports regression results for a the dependent variable "Net Investment" which is defined as the change in fixed assets after depreciation relative to the prior year's total assets (Net Investment). The variables of particular interest are STR and MTR (column (1)), MTR and Ratio MTR (column (2)) and STR, Δ MTR and Ratio MTR (column (3)). All variables are defined in Table 2.11 (Appendix 2.A). All regressions include firm-level and country-level control variables and firm-, industry- and year-fixed effects. Robust standard errors (clustered at the firm-level) are provided in parentheses. Stars behind the coefficients indicate the significance level, *** 1%, ** 5%, * 10%.

Table 2.18: Regression results without observations in Sweden

Dependent variable	(1) Investment	(2) Investment	(3) Investment
STR	-0.285***		-0.285***
	(0.086)		(0.079)
MTR	0.077***	-0.288***	
	(0.008)	(0.038)	
Δ MTR			-0.293***
			(0.025)
Ratio MTR		-0.114***	-0.115***
		(0.013)	(0.007)
Observations	2,199,112	2,199,112	2,199,112
Adj. R^2	0.1750	0.1751	0.1751
Controls	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes

Notes: This table reports regression results for a restricted sample. The dependent variable is the change in fixed assets before depreciation relative to the prior year's total assets (Investment). In columns (1)-(3), observations in Sweden are excluded. The variables of particular interest are STR and MTR (column (1)), MTR and Ratio MTR (column (2)) and STR, Δ MTR and Ratio MTR (column (3)). All variables are defined in Table 2.11 (Appendix 2.A). All regressions include firm-level and country-level control variables and firm-, industry- and year-fixed effects. Robust standard errors (clustered at the firm-level) are provided in parentheses. Stars behind the coefficients indicate the significance level, *** 1%, ** 5%, * 10%.

Table 2.19: Baseline regression using the first-difference estimator

Dependent variable	(1) Investment	(2) Investment	(3) Investment	(4) Investment
STR	-0.442***	-0.476***		-0.457***
	(0.029)	(0.030)		(0.031)
MTR		0.043***	-0.222***	
		(0.006)	(0.025)	
Δ MTR				-0.065**
				(0.029)
Ratio MTR			-0.081***	-0.034***
			(0.008)	(0.009)
Firm Size	-0.796***	-0.797***	-0.797***	-0.797***
	(0.053)	(0.053)	(0.053)	(0.053)
Capital Intensity	-1.485***	-1.484***	-1.484***	-1.484***
	(0.043)	(0.043)	(0.043)	(0.043)
Cash	-0.199***	-0.200***	-0.200***	-0.200***
	(0.022)	(0.022)	(0.022)	(0.022)
Sales Growth	0.016***	0.016***	0.016***	0.016***
	(0.002)	(0.002)	(0.002)	(0.002)
LT Debt	0.226***	0.226***	0.226***	0.226***
	(0.009)	(0.009)	(0.009)	(0.009)
GDP	0.513***	0.514***	0.529***	0.514***
	(0.042)	(0.042)	(0.042)	(0.042)
GDP pC	-0.088**	-0.094**	-0.116***	-0.100***
	(0.038)	(0.038)	(0.038)	(0.038)
Control of Corruption	-0.025***	-0.025***	-0.024***	-0.025***
	(0.004)	(0.004)	(0.004)	(0.004)
Government Effectiveness	-0.005	-0.005	-0.005	-0.005
	(0.004)	(0.004)	(0.004)	(0.004)
Inflation	-0.001	-0.001	-0.001**	-0.001
	(0.000)	(0.000)	(0.000)	(0.000)
Regulatory Quality	-0.003	-0.003	0.005	-0.003
	(0.006)	(0.006)	(0.006)	(0.006)
Voice & Accountability	-0.093***	-0.093***	-0.094***	-0.093***
	(0.008)	(0.008)	(0.008)	(0.008)
Observations	1,710,740	1,710,740	1,710,740	1,710,740
Firm FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes

Notes: This table reports the regression results using first differences instead of mean differences. The dependent variable is the change in fixed assets before depreciation relative to the prior year's total assets (Investment). The variables of particular interest are STR (column (1)), STR and MTR (column (2)), MTR and Ratio MTR (column (3)) and STR, Δ MTR and Ratio MTR (column (4)). All variables are defined in Table 2.11 (Appendix 2.A). All regressions include firm-, industry- and year-fixed effects. Robust standard errors (clustered at the firm-level) are provided in parentheses. Stars behind the coefficients indicate the significance level, *** 1%, ** 5%, * 10%.

Appendix 2.B

The theoretical analysis of tax effects on investment decisions of firms can be based on the neoclassical investment theory extended by tax effects (e.g., Auerbach, 1983; Hall and Jorgenson, 1967; Jorgenson, 1963) and enlarged by the possibility to offset tax losses.

The aim of the firm is an optimal capital stock at any time to maximise the present value of the firm. The present value of the firm W is defined as the present value of discounted net receipts after taxes $NR(t)$ which represent future cash flows to the shareholders where i is the rate of time discount.

$$W = \int_0^\infty NR(t)e^{-it}dt \tag{2.B.1}$$

For simplification purposes, it can be assumed that the firm has two production factors, labour $L(t)$and capital $K(t)$, which are compensated with the factor prices $w(t)$ and $r(t)$. Furthermore, the firm acquires investment units $I(t)$ at the price $p_I(t)$ which are considered in the capital stock $K(t)$. The firm considers all prices as given to focus on the production plans and avoid the inclusion of consumption decisions. In consideration of a general concave production function $F[K(t), L(t)]$ $(F' > 0, F'' < 0)$ and the corresponding output price $p_Q(t)$, the profit before taxes of the firm $R(t)$ at time t can be expressed as

$$R(t) = p_Q(t)F[K(t), L(t)] - w(t)L(t) - r(t)K(t). \tag{2.B.2}$$

Taking taxes into account requires an integration of tax depreciation of investment units as well as tax losses from previous periods which can be compensated. The net receipts at time t are determined as

$$NR(t) = [1 - \tau(t)]R(t) + \tau(t)l(t)R(t) + \tau(t)\int_{-\infty}^{t} p_I(s)I(s)D(t-s)ds \tag{2.B.3}$$

where s is the point of time an investment unit was acquired. The reduction of the tax base caused by tax depreciation after acquiring a unit of an investment good is represented by $p_I(s)D(t-s)$. Under the assumption that tax losses carried forward exist from the previous period t-1, a compensation of these tax losses at time t is possible as a proportion of the profit before taxes $l(t)R(t)$. This tax loss compensation leads to tax savings. Considering tax influencing factors leads to the following present value of the firm:

$$W = \int_0^\infty [(1 - \tau_t)R_t - (1 - \tau Z)p_I I + \tau_t l_t R_t]e^{-it}dt \tag{2.B.4}$$

where $Z = \int_0^\infty D_t e^{-it} dt$ represents the present value of tax depreciation of a new unit of an investment good. Since capital is subject to economic depreciation δ, the capital stock at time t corresponds to $K(t) = \int_0^t I_s e^{-\delta(t-s)} ds$. When calculating the differential regarding t, the transition equation is received:

$$\dot{K}(t) = I(t) - \delta K(t). \tag{2.B.5}$$

The following derivations are based on Chiang (1992). The maximum principle is used for the dynamic optimization and presents a dynamic generalisation of the static Lagrange method. The Hamiltonian function in present values serves as a tool to solve the optimisation problem:

$$H = [(1-\tau)R - (1-\tau Z)pI + \tau lR] + \mu[I(t) - \delta K(t)]. \tag{2.B.6}$$

The following conditions are necessary for the optimum:

$$\frac{\partial H}{\partial L} = 0 \tag{2.B.7}$$

$$\frac{\partial H}{\partial I} = 0 \tag{2.B.8}$$

$$\dot{K}(t) = \frac{\partial H}{\partial \mu} \tag{2.B.9}$$

$$\dot{\mu} = -\frac{\partial H}{\partial K} + i\mu \tag{2.B.10}$$

$$\lim_{t\to\infty} K(t) e^{-it} \mu(t) = 0 \tag{2.B.11}$$

Condition (2.B.11) presents the transversality condition which needs to be fulfilled because the capital stock $K(t)$ is subject to a non-negative condition. In consideration of the stated condition the following is applied in the optimum case[20]:

$$\frac{\partial H}{\partial L} = (1-\tau)\left[p_Q(t) F_L(t) - w(t)\right] + \tau l[p_Q F_L(t) - w(t)] = 0 \tag{2.B.12}$$

$$\frac{\partial H}{\partial I} = -(1-\tau Z)p_I + \mu = 0 \tag{2.B.13}$$

$$\dot{\mu} = -\left[(1-\tau)p_Q F_K(t) + \tau l p_Q F_K\right] + \delta\mu + i\mu \tag{2.B.14}$$

From equation (2.B.12) results the optimality condition for the optimal labour input. The marginal return of an additional unit of labour equals the marginal costs of an additional unit of labour: $p_Q(t)F_L(t) - w(t)$. By equation (2.B.13) follows $\mu = (1-\tau Z)p_I$ and therefore $\dot{\mu} = 0$. Under this assumption the optimality condition for the capital input is a result of the equations (2.B.13) and (2.B.14):

$$(1 - \tau + \tau l)p_Q F_K(t) = (i + \delta)(1 - \tau Z)p_I \tag{2.B.15}$$

The interpretation of the equation (2.B.15) is similar to the optimality condition of the labour input. The marginal return of an additional unit of capital equals the marginal costs of an

[20] Solutions like K(t) = 0 = L(t) are excluded from the optimum condition.

additional unit of capital. By solving equation (2.B.15) for $F_K(t)$, the optimality condition can be received. Therefore, the maximization of the present value (2.B.4) under the condition (2.B.5) requires in the optimum condition that the marginal product of capital equals the user cost of capital:

$$F_K(t) = C(t) \equiv (\delta + i)\frac{p_I}{p_Q}\frac{1 - \tau Z}{1 - \tau(1 - l)} \ . \tag{2.B.16}$$

The term $C(t)$ determines the user cost of capital which not only represents the cost of capital but also the cost of taxation. The influence of the tax rate and tax loss compensation on the choice of the capital stock can be determined based on the partial derivation of equation (2.B.16):

$$\frac{\partial C(t)}{\partial \tau} = (\delta + i)\frac{p_I}{p_Q}\frac{1 - Z - l}{\left(1 - \tau(1 - l)\right)^2} \ . \tag{2.B.17}$$

Based on the partial derivation with respect to the statutory tax rate, it can be concluded that an increase of the statutory tax rate leads to an increase of the user capital costs which implies a reduction of the capital stock to meet the optimum condition further on if $1 - Z - l > 0$.

$$\frac{\partial C(t)}{\partial l} = -(\delta + i)\frac{p_I}{p_Q}\frac{1 - \tau Z}{\left(1 - \tau(1 - l)\right)^2} \ . \tag{2.B.18}$$

Based on the partial derivation with respect to the proportion of the profit before taxes which can be used to compensate the loss carried forward, it can be concluded that an increase of the tax loss compensation leads to a decrease of the user capital costs which implies an increase of the capital stock. Despite of the fact that my model just involves one period of the tax loss compensation it can be seen that tax loss compensation presents an investment incentive. That means that existing losses stimulate increasing investments in order to use tax losses that are carried forward (e.g., Auerbach, 1986).

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3. Anti-Tax Loss Trafficking Rules and the Acquisition of Loss-Carrying Firms

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Working Paper[22]

Abstract:

In cases of mergers and acquisitions, anti-tax loss trafficking rules aim to prevent loss trafficking between firms and may result in the expiration of the target's accumulated tax loss carryforwards. The denial of future tax benefits creates an increasing marginal price differential in acquisition negotiations and reduces successful completions of acquisitions. I am the first providing empirical evidence that specific tax loss treatment rules affect acquisitions of loss-carrying firms. Using European acquisitions from 2011 to 2017, my findings show that the stricter the anti-tax loss trafficking rules, the lower the relative rate and the absolute number of acquisitions of targets with tax loss carryforwards.

Keywords: Corporate Taxation, Tax Loss Treatment, Loss Transfer, Mergers and Acquisitions

JEL Classification: G34 · H25 · L22

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3.I. Introduction

In Europe, the volume of acquisitions increased from 591.24 billion US dollars in 2011 to 1,007.99 billion US dollars in 2017[23], and the motives for acquisitions are manifold. However, they are always associated with an increase in benefits, regardless of the type of benefit. Basically, acquisitions are used to drive a firm's growth, enter markets or acquire know-how. Therefore, in the screening process and valuation phase, it is necessary to evaluate the characteristics and features of target firms that create value for the acquirer. One potential asset that can be acquired is a loss carryforward of the target firm resulting from asymmetric tax loss treatment (e.g., Erickson et al., 2019; Haw et al., 1987). Instead of an immediate tax refund, losses have to be offset against profits of previous (loss carryback) or subsequent (loss carryforward) periods. Loss carryforwards thus represent future tax savings, which are realized at the time the firm generates a profit. These potential future tax savings are also attractive to corporate acquirers looking to reduce their overall tax burden in the future. Previous studies provide empirical evidence that the target's tax loss carryforwards can be a potential driver for acquisitions (e.g., Sureth-Sloane and Vollert, 2012; Hayn, 1989; Auerbach and Reishus, 1988; Auerbach and Reishus, 1987) and are relevant in price negotiations (e.g., Chiang et al., 2014; Sarkar, 2014; Henning et al., 2000; Amir and Sougiannis, 1999; Plummer and Robinson, 1990; Moore and Pruitt, 1987).

But, in addition to time restrictions on the use of loss carryforwards, there are also special rules in cases of acquisitions, so called anti-tax loss trafficking rules. With these provisions, the legislators aim to prevent purely tax-motivated acquisitions without economic justification which are aimed solely at exploiting loss carryforwards (e.g., Nijhawan, 2015). In most European countries, these country-specific regulations usually apply when there is a certain percentage change in the ownership of a corporation, the firm fundamentally changes its activity, or a combination of both. If an acquisition meets the requirements, this results in the expiration of the target's accumulated tax losses. Consequently, a devaluation of the target's loss carryforwards and thus of an acquirable asset occurs from the perspective of the acquirer. Therefore, it is an open empirical question whether acquisitions of loss-carrying firms are reduced due to these restrictions and whether the design of anti-tax loss trafficking rules affects the quantity of acquiring loss targets. Using a European cross-country setting, I examine this research gap.

[23] See https://www.statista.com/statistics/408938/value-of-european-merger-and-acquisition-deals/, last accessed: July 19, 2022.

Studies on the effect of anti-tax loss trafficking rules are still rare. Steffens (2015) examines the effect of loss transfer restrictions on firm entries and exits and cannot confirm that such regulations reduce business start-ups, but finds that they favor market exits. Moreover, his tests on the effectiveness of the restrictions remain without significant results. Bührle and Spengel (2020) provide an overview of the design and development of these restrictions in the EU28 and develop a categorization depending on the strictness of the anti-tax loss trafficking rules. In a subsequent study, Bührle (2021) examines whether venture capital investors reduce funding to start-ups in response to anti-tax loss trafficking rules. She finds that the stricter the regulations, the less venture capital start-ups receive. Overall, the knowledge of the impact of anti-tax loss trafficking rules on different aspects of acquisitions is still rare.

In the event of an acquisition, it depends on the country-specific anti-tax loss trafficking rule whether the target can offset its accumulated tax loss carryforwards after the acquisition or whether the losses expire unused. Furthermore, the restriction determines if the acquirer will benefit from the loss carryforwards as an asset in terms of future tax savings. In cases of expiration, this creates a higher marginal price differential and may cause the acquisition to fail (e.g., Jacob and Pasedag, 2010). As a consequence, the design of anti-tax loss trafficking rules can be decisive to whether an acquisition is economically valuable for the acquirer and whether it should proceed. Against this background, I examine whether the stricter the anti-tax loss trafficking rules, the lower the acquisition rate and number of acquisitions of loss-carrying firms. Furthermore, I analyze whether tightening (relaxing) the anti-tax loss trafficking rule leads to a decrease (increase) in the acquisition rate and number of acquisitions of loss-carrying firms.

In order to study the effect of anti-tax loss trafficking rules on acquisition activity, I use a panel data set of acquisitions of European target firms, linked to financial accounting information and aggregated at the country-level. To investigate my hypotheses, I employ a linear and a pseudo Poisson regression, respectively. I support my findings with additional country cases, using a difference-in-differences (DiD) approach.

My results show a significant negative effect for the strictness of anti-tax loss trafficking rules on the acquisition rate and number of acquisitions of loss-carrying firms, indicating that the stricter the anti-tax loss trafficking rules the lower the acquisitions of loss targets. When separating the effect, the findings on tightening the regulation suggest a reduced acquisition rate in targets with loss carryforwards, but the results are not as robust. In contrast, the results for relaxing the restrictions indicate a positive significant impact in particular on the number of

acquisitions of loss-carrying firms. There is only some evidence for the effect on the relative relation between loss acquisitions and all acquisitions in a country. Overall, the analyses provide evidence that the design of anti-tax loss trafficking rules affects acquisitions of targets with loss carryforwards.

My paper contributes to several strands of literature. First, I add to the literature on the determinants of acquisitions and especially for the acquisition decision in loss-carrying firms. According to previous literature, I provide further evidence that tax loss carryforwards are relevant in acquisition decisions and have a value for the potential acquirer (e.g., Erickson et al., 2019; Chiang et al., 2014; Sarkar, 2014; Sureth-Sloane and Vollert, 2012; Erickson and Wang, 2007; Henning et al., 2000; Amir and Sougiannis, 1999; Plummer and Robinson, 1990; Hayn, 1989; Auerbach and Reishus, 1988; Auerbach and Reishus, 1987; Haw et al., 1987; Moore and Pruitt, 1987). Second, I shed light on the impact of tax loss treatment rules. So far, the literature has particularly focused on time restrictions on offsetting loss carryforwards and the relevance of loss carrybacks (e.g., Bethmann et al., 2018; Langenmayr and Lester, 2018; Ljungqvist et al., 2017; Dreßler and Overesch, 2013) and suggests that asymmetric loss offset provisions matter. I am the first providing empirical evidence that specific restrictions are also relevant for acquisition decisions. Nevertheless, a deeper understanding of the effect of anti-tax loss trafficking rules on acquisitions is still necessary (e.g., Bührle, 2021; Steffens, 2015).

Moreover, my results are also relevant for policymakers. I contribute to the ongoing debate on tax loss offset restrictions and provide insights that the design of anti-tax loss trafficking rules affects the attractiveness and therefore the acquisition of targets with loss carryforwards. Against this background, legislators should enact regulations that are as precise and targeted as possible, that apply exclusively to the intended purpose and do not penalize acquisitions that are less tax-motivated in order to pave the way for potentially profitable firms to recover. This can lead to an increase in economic efficiency and remove possible obstacles.

The paper is structured as follows. Section 3.II encompasses a literature review and the development of the hypotheses. In Section 3.III, I explain my research design and data. Section 3.IV presents my estimation results and discusses possible related concerns. Section 3.V contains concluding remarks.

3.II. Literature Review and Hypotheses Development

The reasons for acquisitions are manifold. In particular, there is almost never just one motive that is decisive, but a variety of motives. It is therefore generally difficult to get a clear picture

of the acquisition motivation (e.g., Nguyen et al., 2012; Palepu, 1986). However, acquisitions are basically used to drive a firm's growth, open up new markets or acquire know-how. In general, acquisitions occur when the value that can be generated through the acquisition of the target firm is positive for the acquiring firm (e.g., Jensen and Ruback, 1983). Both in the screening process and in the subsequent valuation of the target firm as part of the transaction phase, various determinants affect the acquisition's benefits and therefore the decision to acquire. In addition to geographical, macroeconomic and other factors (e.g., Erel et al., 2012), the earnings situation of the target is a particularly relevant factor influencing the value of an acquisition (e.g., Tunyi, 2021; Brar et al., 2009; Martynova et al., 2007; Weir and Laing, 2003; Belkaoui, 1978; Stevens, 1973; Singh, 1971). The reasons for acquiring profitable firms are obvious. It is assumed that previous success will continue in the future (e.g., Ali et al., 2016; Agrawal and Jaffe, 2003). But not only profitable firms are involved in acquisitions. Theory also justifies acquisitions of targets with negative performance. Firms can fall into financial distress because of inefficient management, among other reasons. According to the inefficient management hypothesis, firms with negative earnings situations can be all the more attractive to potential acquirers the greater the deviation in performance between the actual state with inefficient management and the potential state it could be achieved with more efficient management (e.g., Kozlowski and Puleo, 2021; Martin and McConnell, 1991; Manne, 1965). Consequently, the acquisition probability of a firm increases with good performance on the one hand, but also with increasingly negative performance or financial constraints on the other (e.g., Erel et al., 2015; Khatami et al., 2015; Liao, 2014; Bergström et al., 2005).

Furthermore, taxes are potentially important in acquisition decisions (e.g., Hanlon and Heitzmann, 2010; Shackelford and Shevlin, 2001). They play a role in the selection process of target firms (e.g., Arulampalam et al., 2019; Feld et al., 2016; Hebous et al., 2011; Bertrand et al., 2007), in structuring acquisitions (e.g., Harendt, 2018; Scheuering, 2014; Huizinga and Voget, 2009; Dhaliwal et al., 2005; Ayers et al., 2004; Erickson, 1998) and in determining acquisition prices (e.g., Mescall and Klassen, 2018; von Hagen and Pönnighaus, 2018; Chow et al., 2016; Huizinga et al., 2012; Ayers et al., 2003; Erickson and Wang, 2000). However, they also affect the acquisition activity (e.g., Amberger and Robinson, 2021; Bloin et al., 2021; Todtenhaupt et al., 2020; von Hagen and Prettl, 2020; Ohrn and Seegert, 2019; Ayers et al., 2007; Collins et al., 1995; Scholes and Wolfson, 1990), create new tax planning opportunities (e.g., Belz et al., 2017; von Hagen and Harendt, 2017) and influence the post-transaction performance (e.g., Todtenhaupt and Voget, 2021). One aspect of the tax system that may also have an effect on acquisitions is the special treatment of tax losses.

While profits are taxed immediately in the year in which the profit occurs, losses are treated asymmetrically for tax purposes in most European countries.[24] Instead of an immediate tax refund, losses have to be offset against the profits of the previous (loss carryback) or subsequent (loss carryforward) periods. While offsetting the loss against previous profits results in liquidity, a firm only receives tax savings in the future at the time a profit is generated and simultaneously offset against the accumulated loss carryforwards. Therefore, at the time of loss offset, the firm faces a reduced tax rate.

In M&A processes, these potential future tax savings due to tax loss carryforwards are also attractive to corporate acquirers looking to reduce their overall tax burden in the future. In particular, unprofitable firms with large accumulated tax losses can be acquired by profitable firms to offset the otherwise worthless or sinking losses. Since corporations are taxable independently of their shareholders, loss relief is achieved after an acquisition, for example, by transferring income-generating assets from the acquirer to the target in order to use their income to offset unused losses and reduce the overall tax burden of the group. However, the losses can also be used by the target after efficiency has been improved by new management in the course of the acquisition. Therefore, tax loss carryforwards are valuable assets (e.g., Erickson et al., 2019). In purchase price negotiations, loss carryforwards are priced into the marginal prices of the vendor and the acquirer. While the vendor wants to be compensated for the sale of tax savings, the acquirer is willing to pay a certain value for its future tax savings generated by the loss carryforwards (e.g., Erickson and Wang, 2007; Haw et al., 1987). Early studies confirm that the transfer of unused tax losses can be an important potential tax-related driver of acquisitions (e.g., Sureth-Sloane and Vollert, 2012; Hayn, 1989; Auerbach and Reishus, 1988; Auerbach and Reishus, 1987), while other studies suggest that accumulated loss carryforwards affect stock prices to price in the potential future value of the loss (e.g., Sarkar, 2014; Henning et al., 2000; Amir and Sougiannis, 1999; Plummer and Robinson, 1990; Moore and Pruitt, 1987). Relevant for pricing the target is also the duration how long it will take the acquirer to use the loss carryforwards (e.g., Chiang et al., 2014).

However, the ability to utilize losses depends not only on the future performance of the target but also on country-specific loss offset regulations. Due to time limitations for carrying forward a loss in some European countries, it is possible that losses carried forward may expire. Studies show that firms have different loss utilization rates and are exposed to different cycles and

[24] An exception is Estonia, where a distribution tax system prevails. Therefore, tax loss restrictions are irrelevant. Latvia also changed its tax system in 2018 so that corporate income tax is payable at the time of profit distribution.

concentrations of loss carryforwards (e.g., Cooper and Knittel, 2010; Cooper and Knittel, 2006). In addition, the asymmetric treatment of profits and losses introduces distortions in corporate decisions (e.g., Poitevin, 2002; Auerbach, 1986). Recent studies provide evidence that less asymmetric tax loss rules in the form of loss carrybacks increase investment (e.g., Dobridge, 2021; Bethmann et al., 2018; Langenmayr and Lester, 2018; Ljungqvist et al., 2017; Dreßler and Overesch, 2013). In line with these findings, Jacob (2022) shows in a theoretical framework that the greater the tax deductibility restriction due to limited loss offset rules, the lower corporate investment because the cost of capital increases.

But, in addition to the time restrictions on offsetting loss carryforwards, there are further restrictions if there is a change of ownership or business activity in most European countries to prevent loss trafficking between firms in cases of mergers and acquisitions.[25] These country-specific anti-tax loss trafficking rules usually apply when there is a certain percentage change in the ownership of a corporation, the firm fundamentally changes its activity, or a combination of both. If an acquisition meets the requirements, this results in the expiration of the target's accumulated tax loss carryforwards. With these provisions, the legislators aim to prevent purely tax-motivated acquisitions without economic justification[26], whereby, apart from exceptions, takeovers whose motivation is not tax-related are also covered (e.g., Nijhawan, 2015). Independent of its aim, the valuation of the target's loss carryforwards and thus of the entire target is affected by such loss offset restrictions. While the tax situation for the vendor does not change because its future tax savings are not altered by the regulation without a sale, the acquirer is not willing to pay for the accumulated losses, as they do not reflect any future tax savings. The marginal price difference is thus increased due to the anti-tax loss trafficking rules and should have a negative impact on the acquisition decision (e.g., Jacob and Pasedag, 2010). Furthermore, Jacob (2022) applies his findings from the theoretical framework to M&A decisions and posits that greater deductibility of investment costs increases capital investment. Vice versa, more restrictive anti-tax loss trafficking rules should lead to a decrease in acquisition activity. Anecdotally, it seems that some firms make acquisitions to obtain tax benefits where possible. For example, when the Internal Revenue Service unexpectedly repealed some of the U.S. loss limitation rules for financial institutions during the financial

[25] An overview of the various regulations across the European countries can be found in Table 3.16 (Appendix).
[26] See, e.g., OECD, 2011.

crisis, there was increased competition for targets with loss carryforwards. One of the popular examples is the acquisition of Wachovia.[27]

Anti-tax loss trafficking rules have been the focus of a few recent investigations. Steffens (2015) investigated whether the introduction of an anti-tax loss trafficking rule has a negative effect on firm entries and a positive effect on firm exits. He could not confirm his hypothesis that such regulations reduce business start-ups, but that they favor market exits. Moreover, his tests on the effectiveness of the restrictions remained without significant results. Bührle and Spengel (2020) provided an overview of the design and development of these restrictions in the EU28 countries and discussed, how these regulations affect start-ups. They also developed a categorization depending on the strictness of anti-tax loss trafficking rules. In a subsequent study, Bührle (2021) examined whether venture capital investors reduce funding to start-ups in response to anti-tax loss trafficking rules. She found that the stricter the regulations, the less venture capital start-ups receive. Consequently, such restrictions reduce the ability of start-ups to decrease their funding constraints. Overall, the knowledge of the impact of anti-tax loss trafficking rules on different aspects of acquisitions is still rare. Therefore, the aim of this paper is to investigate whether anti-tax loss trafficking rules have an effect on acquisitions of loss-carrying firms since empirical evidence is still lacking.

Taking the above considerations into account, the acquirer purchases not only the assets and liabilities of the target but also possible synergy effects, efficiency enhancement potentials and future tax consequences. A target's tax loss carryforward is generally a valuable asset that is considered in price negotiations. Accordingly, in the event of an acquisition, it depends on the country-specific anti-tax loss trafficking rule whether the target can offset its accumulated tax loss carryforwards after the acquisition or whether the losses expire unused. The regulation determines whether the acquirer will benefit from the loss carryforwards as an asset in terms of future tax savings. In the case of loss expiry, on the one hand the unused tax losses are completely useless for the target itself, and on the other hand the losses lose their value for the acquirer. This creates a higher marginal price differential and may cause the acquisition to fail (e.g., Jacob and Pasedag, 2010). As a consequence, the design of anti-tax loss trafficking rules can be decisive to whether an acquisition is economically valuable for the acquirer and whether

[27] In September 2008, Citigroup Inc. agreed to acquire Wachovia for about 2 billion dollars. Just days later, Wells Fargo & Co. announced an agreement to acquire Wachovia for about 15 billion dollars. Wells Fargos's increased offer was likely adjusted due to a recent change in the tax law that eased restrictions on offsetting losses. See, https://www.crowell.com/NewsEvents/AlertsNewsletters/all/Tax-Notice-Drives-Wachovia-Takeover-Turmoil, last accessed: July 19, 2022.

it should proceed. Based on these considerations and in line with the derivations from the theoretical framework proposed by Jacob (2022), I pose the following hypotheses:

H1a: The stricter the anti-tax loss trafficking rules, the lower the acquisition rate of loss-carrying firms.

H1b: The stricter the anti-tax loss trafficking rules, the lower the number of acquisitions of loss-carrying firms.

Regulations that provide a loss forfeiture when a certain threshold of change in ownership is exceeded lead to faster non-recognition of loss utilization compared to rules that rely on a change in business activity or even on the cumulative criterion of a change in ownership and business activity. Against this background, a change in regulations should also have an impact on the acquisition rate and the number of acquisitions of loss-carrying firms.

H2a: Tightening (relaxing) the anti-tax loss trafficking rule leads to a decrease (increase) in the acquisition rate of loss-carrying firms.

H2b: Tightening (relaxing) the anti-tax loss trafficking rule leads to a decrease (increase) in the number of acquisitions of loss-carrying firms.

3.III. Empirical Identification

3.III.I Data and Sample Selection

In order to study the effect of anti-tax loss trafficking rules on acquisition activity, I combine data on corporate acquisitions with financial accounting information of target firms and information on tax loss treatment. Historical data is suitable for this analysis, since the expectation about the development of the target is generated on the historical earnings situation before the acquisition. The main data for my analysis stems from the database Zephyr, compiled by Bureau van Dijk (BvD). Zephyr contains information of worldwide M&A activities with detailed characteristics for each deal.[28] I use the update version 30 (November 2017) and restrict the dataset to completed acquisitions of European targets (see Table 3.12 in the Appendix for a detailed overview of the sample selection process) in advance to merge this deal information with another dataset of BvD, Amadeus. Amadeus provides firm-level accounting information (esp. balance sheets and income statements) for private firms in Europe. I use the update version 317 (February 2021) of Amadeus to complement my dataset with information on financial

[28] Erel et al. (2015) notes that Zephyr's coverage of private M&A acquisitions is superior compared to alternative databases. For a detailed insight in Zephyr's data quality, see Bollaert and Delanghe (2015).

statements. Since the online version of Amadeus only covers the last ten fiscal years and I need at least one historical observation to account for tax losses, the deal completion period is limited from 2011 to 2017. Furthermore, I restrict the sample to corporations to ensure that the post-acquisition anti-tax loss trafficking rules apply to the target. For the same reason, only acquisitions with an acquired stake of at least 75 percent are considered. The final sample comprises 14,267 acquisitions of 14,544 target firms in 26 European countries.[29]

Information on the corporate income tax rate, general loss offset rules and anti-tax loss trafficking regulations originate from the European Tax Handbooks (IBFD, 2011-2017) and the EY Tax Guides (EY, 2011-2017). The strictness measure of the anti-tax loss trafficking rules corresponds, with minor deviations, to the index developed by Bührle and Spengel (2020).

Table 3.1: Categories of anti-tax loss trafficking rules

Category	Description
Category 0	No explicit anti-loss trafficking rule
Category 1	Denial of loss transfer after change in ownership and activity (cumulative requirement)
Category 2	Denial of loss transfer after change in activity
Category 3	Denial of loss transfer after change in ownership
Category 4	Denial of loss transfer after change in ownership or activity (fulfilment of one criterion sufficient)

Notes: Categories on the strictness of anti-tax loss trafficking rules. **Source:** Bührle and Spengel, 2020.

Bührle and Spengel (2020) divided loss transfer restrictions into five categories based on their strictness (see Table 3.1). While losses of targets in countries with no specific anti-tax loss trafficking rules can still be offset against future profits after acquisitions and thus loss carryforwards represent an asset of future tax savings for acquirers (category 0), losses are mostly lost in target countries with category 4 regulations, as a change of ownership or activity is sufficient to meet the requirements for loss expiry. If the acquirer intends to maintain the target's activity, the loss carryforwards of the target are still eligible for offset in countries with regulations in category 1 and 2. A change of ownership alone is considered harmless in these

[29] The distribution of deals across the European countries can be found in Table 3.14. Due to insufficient observations, Cyprus cannot be included in the analysis. As mentioned above, Estonia is not considered because of its distribution tax system. As a result, only 26 European countries are in the sample.

countries. In countries with category 3 rules, the loss carryforward depends solely on a change in ownership.[30]

Figure 3.1 and Figure 3.2 compares the statuses of the anti-tax loss trafficking rules in 2011 and 2017. A trend emerges that loss carryforwards do not already disappear with a change in ownership, but that the activity must also change. Two countries tightened their restrictions by introducing a regulation during the sample period (Greece and Hungary), while two countries relaxed their rules (Germany and Spain). Moreover, there is no country that prohibits the use of target's tax loss carryforwards after a change in ownership or activity (a single criterion would suffice, Category 4).

Figure 3.1: Overview of anti-tax loss trafficking rules in Europe in 2011

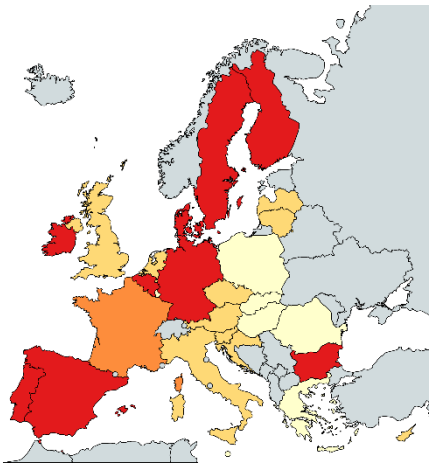
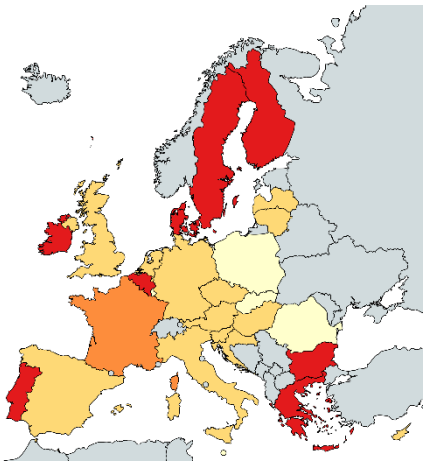


Figure 3.2: Overview of anti-tax loss trafficking rules in Europe in 2017



Notes: These figures provide an overview over the anti-tax loss trafficking rules in the EU28 countries for the years 2011 (Figure 3.1) and 2017 (Figure 3.2). Countries with no explicit rule (category 0) are light yellow colored. The color of category 1-countries is dark yellow. Orange is the color signaling that the country has a rule which belongs to category 2. Red corresponds to countries with restrictions of category 3.

Macroeconomic controls were obtained from the World Bank's World Development Indicators Database. Aggregated governance indicators stem from the World Bank's Worldwide Governance Indicators. A full list of variables used in the analysis is presented in Table 3.13 in the Appendix.

3.III.II Identification Strategy

To examine whether the strictness (hypotheses 1a and 1b) and tightening or relaxing (hypotheses 2a and 2b) of anti-tax loss trafficking rules affect the acquisition of loss-carrying

[30] Anti-tax loss trafficking rules apply irrespective of the actual aim and objective of the acquisition and presuppose that the acquisition is tax-motivated. It is up to the acquirer to prove otherwise. Nonetheless, only some European countries have exemption provisions that allow proof to the contrary. Therefore, the retroactively applicable rules are not considered in this analysis.

firms, I use two different panel estimation approaches for the target firm data described above, which I aggregated at the country level. I apply each model with fixed effects to control for unobserved time-constant heterogeneity (e.g., Wooldridge, 2010). Standard errors are clustered at the country level.

$$Y_{i,t} = \beta_0 + \beta_1 X_{i,t} + \gamma C_{i,t} + \alpha_i + \alpha_t + \varepsilon_{i,t} \quad (3.1)$$

The dependent variable $Y_{i,t}$ is on the one hand the country-specific loss ratio (*loss ratio*, hypothesis 1a and 2a) and on the other hand the country-specific number of loss acquisitions (*loss acquisitions*, hypothesis 1b and 2b). The *loss ratio* is determined as the quotient of the number of all loss acquisitions in a given country i in a given year t divided by the number of all acquisitions in a given country i in a given year t: $Loss\ ratio_{i,t} = \frac{Loss\ acquisitions_{i,t}}{All\ acquisitions_{i,t}}$ (see Steffens, 2015)[31]. An acquisition counts as a loss acquisition if the firm has a loss carryforward in the period of the transaction. Accordingly, there must be at least a loss in the year prior to the acquisition. In the main analyses, a loss is measured by negative earnings before taxes (EBT). For this dependent variable, I obtain my estimates with a linear regression using ordinary least squares (OLS). The second dependent variable, *loss acquisitions*, corresponds to the number of all loss acquisitions in a given country i in a given year t.[32] As above, a loss is measured by negative earnings before taxes for the year prior to the acquisition. I estimate the effect of anti-tax loss trafficking rules on the number of loss acquisitions using a non-linear pseudo Poisson regression design with a maximum-likelihood estimator (PPML, e.g., Motta, 2019).

The variable of main interest is $X_{i,t}$, which corresponds to *Index* to test hypotheses 1a and 1b and to *Tight* or *Relax* to address the intendent thesis of hypotheses 2a and 2b. *Index* reflects the categorial variable on the strictness of the anti-tax loss trafficking rules (see Bührle, 2021; Bührle and Spengel, 2020; Section 3.III.I, Table 3.1 and Table 3.16 (Appendix)). The variable *Tight* is an indicator variable that equals one if there is a tightening of anti-tax loss trafficking rules in the given country and year compared to 2011. Otherwise, the variable takes the value zero. Correspondingly, the indicator variable *Relax* is coded. The variable *Relax* equals one if the anti-tax loss trafficking rule has been relaxed in the given country and year compared to 2011, and zero otherwise.

[31] The distribution of the loss ratios across the European countries can be found in Table 3.17 (Appendix).
[32] The distribution of the number of loss acquisitions across the European countries can be found in Table 3.18 (Appendix).

Furthermore, I use a set of control variables $C_{i,t}$ that is consistent with previous literature examining the determinants of M&A activity (e.g., Todtenhaupt et al., 2020). I include annual *GDP growth* and the logarithm of *GDP* to account for the macroeconomic conditions and changes in the target country (e.g., Erel et al., 2012; Rossi and Volpin, 2004). Following Di Giovanni (2005), who found that financial conditions are important for M&A investment flows, I consider *credit*, which measures the amount of credit granted to firms. I control for the top statutory tax rate (*STR*), as higher tax rates reduce the probability that corporations are subject of an acquisition (e.g., Arulampalam et al., 2019). Other controls include *inflation*, the size of the *service sector* and the *trade* ratio. Rossi and Volpin (2004) found that the volume of M&A activity is positively associated with accounting standards and shareholder protection. Therefore, I add *Corruption* and *RuleLaw*, an index for confidence in and compliance with rules, respectively. I account for the fact that decision makers make decisions based on completed, historical rather than on current periods by lagging the macroeconomic variables by one year (e.g., Todtenhaupt et al., 2020). Furthermore, I include country and year fixed effects to control for general time trends in acquisition activity and time-invariant unobservable differences in country characteristics. Because of the fixed effects, countries without a change in the strictness of anti-tax loss trafficking rules serve as a control group (see Todtenhaupt et al., 2020; Cao et al., 2019; Dessaint et al., 2017 for a comparable approach in the context of M&As). Descriptive statistics of the main variables are displayed in Table 3.2.

Table 3.2: Summary statistics

	Obs.	Mean	Std. Dev.	Min	Max
Index	172	1.494	1.157	0	3
Tight	172	0.058	0.235	0	1
Relax	172	0.029	0.169	0	1
GDP	172	26.305	1.487	22.970	28.960
Growth	172	1.791	3.087	-9.133	25.163
Credit	172	85.589	35.780	28.128	185.359
STR	172	0.229	0.064	0.090	0.380
Trade	172	4.684	0.482	3.951	5.973
Inflation	172	1.345	1.558	-1.736	6.091
Service Sector	172	63.368	6.652	42.963	79.332
Corruption	172	0.963	0.802	-0.267	2.313
RuleLaw	172	1.113	0.628	-0.112	2.100

Notes: This table provides summary statistics for the variables in the main analysis. An overview of the summary statistics of all variables used can be found in Table 3.19 (Appendix). All variables are defined in Table 3.13 (Appendix).

In order to get a differentiated picture on the effect of anti-tax loss trafficking rules beyond the cross-country results, I estimate the effect of each country-specific change on the loss ratio and number of loss acquisitions using a difference-in-differences (DiD) approach:

$$Y_{i,t} = \beta_0 + \beta_1 Post_t \times Treatment_i + \gamma C_{i,t} + \alpha_i + \alpha_t + \varepsilon_{i,t} \quad (3.2)$$

The dependent variable $Y_{i,t}$ and the control variables $C_{i,t}$ correspond to the variables of the linear regression and count model. Instead of using the categorial variable *Index*, I include the interaction term *Post* × *Treatment*. The indicator variable *Post* is equal to one for years in which there was a change in the strictness of the anti-tax loss trafficking rule compared to 2011, and zero for years before the reform. To focus on each individual change in form of a country case, *Treatment* equals one for the country of interest and zero for all other countries. Therefore, countries without a change in the strictness of their anti-tax loss trafficking rules serve as the control group. Excluded from the control group are those countries that have a reform in the sample period. The coefficient β_1 for the interaction term represents the effect of the change in legislation on the ratio and number of acquisitions of loss-carrying firms. I also include country and year fixed effects to control for country-specific time-invariant and time-variant heterogeneity. However, I only explore three of four reforms because the reform in Hungary cannot be specifically examined with the underlying data, as the regulation applies from 2012 onward and thus only the year immediately before the reform is available in the sample, which serves as a benchmark.

3.IV. Empirical Results

3.IV.I Index

In my first set of analyses, I examine whether the strictness of anti-tax loss trafficking rules affects the acquisition rate (hypothesis 1a) or the number of acquisitions of loss-carrying firms (hypothesis 1b). To test these hypotheses, I use the categorial variable *Index* (see Section 3.III.II) to account for the differences in the design of the restrictions. I expect a negative effect for this variable to show that the stricter the rule the lower the acquisition rate and number of acquisitions of loss-carrying firms.

First, I use the *loss ratio* to determine whether the relative proportion of acquisitions of loss-carrying firms is decreasing in relation to all acquisitions. To address the problem of identifying loss-carrying firms, I use a total of three different definitions for losses. Unfortunately, due to the limited time horizon of the dataset, it is not possible to approximate the level of the target's loss carryforwards over multiple periods. Therefore, I assume that the target firm has a loss

carryforward in the deal year if it has negative earnings before taxes at least in the pre-deal-year (*LossRatio*$_{EBT}$, column (1)).[33] In column (2), I require that the target's earnings before taxes be negative in the pre-deal- and deal-year to be considered as a loss acquisition (*LossRatio*$_{2Years}$), while the dependent variable in column (3) requires a total loss in the two periods (*LossRatio*$_{Sum}$).

Table 3.3: Effect of strictness categorization on loss ratio

	(1)	(2)	(3)
Dependent variable	LossRatio $_{EBT}$	LossRatio $_{2Years}$	LossRatio $_{Sum}$
Index	-0.122*	-0.114*	-0.132**
	(0.061)	(0.065)	(0.053)
GDP	0.336	0.062	-0.723**
	(0.391)	(0.231)	(0.320)
Growth	-0.001	-0.000	0.005
	(0.007)	(0.006)	(0.005)
Credit	0.004*	0.002	0.002
	(0.002)	(0.001)	(0.002)
STR	-0.092	0.376	0.501
	(0.548)	(0.599)	(0.742)
Trade	-0.121	-0.584	-0.173
	(0.575)	(0.448)	(0.428)
Inflation	-0.030	-0.023	-0.022
	(0.022)	(0.018)	(0.017)
Service Sector	-0.014	-0.010	-0.018**
	(0.011)	(0.009)	(0.007)
Corruption	0.185	0.209	0.461***
	(0.139)	(0.135)	(0.149)
RuleLaw	-0.241	-0.166	0.091
	(0.192)	(0.214)	(0.205)
Observations	172	170	170
Number of Countries	26	26	26
Adjusted R-squared	0.066	0.059	0.093
Country FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes

Notes: Estimation with OLS. The dependent variable is the number of loss acquisitions per country and year divided by the number of all acquisitions per country and year. In column (1) a loss acquisition is measured by negative earnings before taxes in the pre-deal-year, in column (2) a loss acquisition is measured by negative earnings before taxes in the pre-deal- and deal-year and in column (3) a loss acquisition is measured by a negative sum of earnings before taxes of the pre-deal- and deal-year. The main variable of interest is Index (see Table 3.1). All variables are defined in Table 3.13 (Appendix). All regressions include country- and year-fixed effects. Robust standard errors (clustered at the country-level) are provided in parentheses. Stars behind the coefficients indicate the significance level, *** 1%, ** 5%, * 10%.

Overall, the findings in Table 3.3 show a negative effect for *Index*, i.e., the stricter the anti-tax loss trafficking rules the lower the acquisition rate of loss-carrying firms. A change in the

[33] This assumption is based on the fact that a loss carryforward is necessary in almost all cases, since, on the one hand, a loss carryback is only permitted in a few European countries (see Table 3.15) and, on the other hand, requires a positive result in the previous period.

restriction to the next higher category leads to a decrease in the acquisition rate of about 12 percentage points, implying a decrease in the acquisitions of loss-carrying firms relative to all acquisitions. The effect is independent of the definition of loss acquisitions. In line with previous literature, the macroeconomic controls are predominantly not significant because they play only a moderating role (e.g., Erel et al., 2012; Brar et al., 2009; Rossi and Volpin, 2004). Nevertheless, the insignificance does not mean that there are no effects, but a systematic variation could not be proven. Rather, the characteristics of the acquirer and target are crucial in acquisition decisions (e.g., Nguyen et al., 2012; Palepu, 1986).

Table 3.4: Effect of strictness categorization on loss ratio – different dependent variables

Dependent variable	(1) LossRatio $_{EBIT}$	(2) LossRatio $_{PL}$	(3) LossRatio $_{EBT100\%}$	(4) LossRatio $_{EBT<75\%}$
Index	-0.120*	-0.113*	-0.119*	0.023
	(0.059)	(0.065)	(0.063)	(0.037)
Observations	172	172	171	168
Number of Countries	26	26	26	26
Adjusted R-squared	0.051	0.043	0.068	0.066
Country FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes

Notes: Estimation with OLS. The dependent variable is the number of loss acquisitions per country and year divided by the number of all acquisitions per country and year. In column (1) a loss acquisition is measured by negative earnings before interest and taxes in the pre-deal-year, in column (2) a loss acquisition is measured by a loss per period in the pre-deal-year and in column (3) and (4) a loss acquisition is measured by negative earnings before taxes in the pre-deal-year, but the sample only includes 100% acquisitions (column (3)) and acquisitions with an acquired stake of less than 75 percent (column (4)). The main variable of interest is Index (see Table 3.1). All variables are defined in Table 3.13 (Appendix). All regressions include control variables and country- and year-fixed effects. Robust standard errors (clustered at the country-level) are provided in parentheses. Stars behind the coefficients indicate the significance level, *** 1%, ** 5%, * 10%.

To prove that the effect is independent of whether the loss is measured by earnings before taxes, I use different dependent variables in further regressions. In column (1) of Table 3.4, the *loss ratio* is determined as the quotient of the number of loss acquisitions measured by negative earnings before interest and taxes in the year prior to the acquisition divided by the number of all acquisitions per country and year ($LossRatio_{EBIT}$). This measure also takes account for possible interest limitations since interest limitation rules may not allow all interest expenses to be deducted from the tax base in order to restrict excessive debt financing. The dependent variable of column (2) is the *loss ratio*, assuming a loss acquisition if the target has a loss for period ($LossRatio_{PL}$). In column (3), I check whether the narrowing of the sample with respect to the assumed acquisition stake threshold has an impact on the effect. Therefore, I only consider acquisitions with an acquired stake of 100 percent to ensure that the loss is almost certainly forfeited under the anti-tax loss trafficking rules ($LossRatio_{EBT\ 100\%}$). Consequently,

the sample is reduced to 13,242 acquisitions of 13,523 target firms. Furthermore, to check that the acquisition ratio of loss acquisitions below the 75 percent threshold is not affected, the dependent variable in column (4) is $LossRatio_{EBT\ <75\%}$, which includes only acquisitions with an acquired stake of less than 75 percent.[34] Table 3.4 reports the results for variations of the dependent variable. The effect and the size of the effect hold for all specifications, suggesting that the strictness of anti-tax loss trafficking rules has a negative effect on the relative acquisition rate of loss-carrying firms, consistent with my hypothesis 1a. As expected, the coefficient of the loss ratio, which only considers acquisitions below an acquisition stake of 75 percent, is insignificant. Further robustness checks can be found in the Appendix.[35]

Since the loss ratio expresses a relative proportion of acquisitions of loss-carrying firms to all acquisitions in a country and thus considers the fact that not only the number of acquisitions of loss firms but also the total number of acquisitions may change, the following analyses will shed light on the change in the absolute number of acquisitions of loss-carrying firms. I test hypothesis 1b using a Poisson model with the number of acquisitions of loss-carrying firms (*Loss-Acq*) as the dependent variable. The Poisson model is appropriate, since the dependent variable does not have an excessive number of zeros (zero-inflated) and is not over-dispersed (see Wooldridge, 2010). Following the above procedure, the loss acquisitions in column (1) of Table 3.5 are measured against earnings before taxes in the year prior to the acquisition ($Loss\text{-}Acq_{EBT}$). In column (2) and (3), the classification of a loss acquisition depends on the performance in the pre-deal- and deal-year. In column (2), there must be a loss in both years ($Loss\text{-}Acq_{2Years}$), while in column (3), the sum of the two years' earnings has to be negative ($Loss\text{-}Acq_{Sum}$).

The findings of Table 3.5 confirm the assumption that the strictness of anti-tax loss trafficking rules has indeed a negative effect on acquisitions of loss-carrying firms. A change in the restriction to the next higher category leads to a reduction in the number of loss target acquisitions by about 20 percent ($e^{-0.224} - 1 = -0.201$, column (1)). The significance and magnitude of the coefficient estimates are almost independent of the definition of loss acquisitions. Moreover, the results suggest that acquisitions of loss-carrying firms increase when trading increases and more financial resources (e.g., loans, credits) are available to finance acquisitions. In addition, the contrasting effects of corruption and rule compliance

[34] The sample comprises 7,402 acquisitions of 5,337 target firms.
[35] See Table 3.20 (Appendix) for further robustness tests.

complement each other and indicate that the number of loss target acquisitions decreases as governance quality increases, suggesting that the losses cannot be used in a roundabout way and will be effectively useless.

Table 3.5: Effect of strictness categorization on number of loss acquisitions

	(1)	(2)	(3)
Dependent variable	Loss-Acq $_{EBT}$	Loss-Acq $_{2Years}$	Loss-Acq $_{Sum}$
Index	-0.224**	-0.217**	-0.267***
	(0.104)	(0.102)	(0.095)
GDP	2.303	2.511	1.680
	(1.772)	(1.897)	(1.956)
Growth	0.055	0.051	0.065*
	(0.036)	(0.033)	(0.038)
Credit	0.014**	0.014**	0.013**
	(0.006)	(0.006)	(0.006)
STR	-7.782	-6.566	-6.259
	(5.353)	(5.442)	(5.572)
Trade	6.506**	6.329**	6.701**
	(3.106)	(3.098)	(3.147)
Inflation	0.096	0.129	0.130
	(0.114)	(0.104)	(0.106)
Service Sector	0.160	0.152	0.186
	(0.128)	(0.113)	(0.131)
Corruption	1.688***	1.513***	1.816***
	(0.528)	(0.548)	(0.518)
RuleLaw	-2.945***	-2.953***	-2.681***
	(0.778)	(0.770)	(0.908)
Observations	171	170	170
Number of Countries	26	26	26
Pseudo LL	-526.12	-388.60	-523.44
Country FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes

Notes: Estimation with PPML. The dependent variable is the number of loss acquisitions per country and year. In column (1) a loss acquisition is measured by negative earnings before taxes in the pre-deal-year, in column (2) a loss acquisition is measured by negative earnings before taxes in the pre-deal- and deal-year and in column (3) a loss acquisition is measured by a negative sum of earnings before taxes of the pre-deal- and deal-year. The main variable of interest is Index (see Table 3.1). All variables are defined in Table 3.13 (Appendix). All regressions include country- and year-fixed effects. Robust standard errors (clustered at the country-level) are provided in parentheses. Stars behind the coefficients indicate the significance level, *** 1%, ** 5%, * 10%.

Table 3.6 provides results of further regressions with different dependent variables and sample selections. Column (1) measures a loss by negative earnings before interest and taxes in the year prior to the acquisition (*Loss-Acq*$_{EBIT}$). The dependent variable in column (2) is the number of acquisitions of target firms that report a loss for period in the pre-deal year (*Loss-Acq*$_{PL}$). In column (3) and (4), a loss acquisition is classified at the negative earnings before taxes in the year prior to the acquisition (*Loss-Acq*$_{EBT}$), but the sample is restricted to acquisitions with an acquired stake of 100 percent (column (3), *Loss-Acq*$_{EBT\ 100\%}$) on the one hand and to acquisitions

with a change in ownership of less than 75 percent on the other (column (4), *Loss-Acq*$_{EBT<75\%}$). Overall, the results reveal that the number of acquisitions of loss-carrying firms is lower the stricter the anti-tax loss treatment rule, regardless of the loss measure and sample selection.[36] In contrast to the results with the loss ratio as the dependent variable (Table 3.4, column (4)), the statistically significant effect in column (4) of Table 3.6 shows that acquisitions below the threshold are also affected, which could be possible due to some lower country-specific thresholds (e.g., the threshold in Germany is a 50 percent change in ownership). An explanation why no effect was found for the ratio may be that the number of total acquisitions in the loss ratio seems to change in a similar proportion as the loss acquisitions.

Table 3.6: Effect of strictness categorization on number of loss acquisitions – different dependent variables

	(1)	(2)	(3)	(4)
Dependent variable	Loss-Acq $_{EBIT}$	Loss-Acq $_{PL}$	Loss-Acq $_{EBT100\%}$	Loss-Acq $_{EBT<75\%}$
Index	-0.262**	-0.226*	-0.204*	-0.226**
	(0.110)	(0.119)	(0.113)	(0.101)
Observations	171	171	171	168
Number of Countries	26	26	26	26
Pseudo LL	-522.24	-528.67	-484.53	-434.07
Country FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes

Notes: Estimation with PPML. The dependent variable is the number of loss acquisitions per country and year. In column (1) a loss acquisition is measured by negative earnings before interest and taxes in the pre-deal-year, in column (2) a loss acquisition is measured by a loss per period in the pre-deal-year and in column (3) and (4) a loss acquisition is measured by negative earnings before taxes in the pre-deal-year, but the sample only includes 100% acquisitions (column (3)) and acquisitions with an acquired stake of less than 75 percent (column (4)). The main variable of interest is Index (see Table 3.1). All variables are defined in Table 3.13 (Appendix). All regressions include control variables and country- and year-fixed effects. Robust standard errors (clustered at the country-level) are provided in parentheses. Stars behind the coefficients indicate the significance level, *** 1%, ** 5%, * 10%.

In sum, the results from my analyses confirm that the stricter the anti-tax loss trafficking rules the lower the acquisition rate and the number of acquisitions of loss-carrying firms, consistent with my hypotheses 1a and 1b.

3.IV.II Tightening

Further on, I separate the overall effect measured by *Index* and examine which effect is related to the tightening of anti-tax loss trafficking rules. I expect a negative effect in this case, as a tighter regulation will lead to a more frequent disallowance of loss utilization after an acquisition, so that the target's loss carryforward will become increasingly worthless for the

[36] See also Table 3.20 (Appendix) for further robustness tests.

acquirer. Consequently, the acquisition of a loss-carrying firm may become less attractive. I use the aforementioned dependent variables and the indicator variable *Tight* to test one part of my hypotheses 2a and 2b. The variable *Tight* takes the value of one in years when the country has a stricter anti-tax loss trafficking rule compared to 2011, and zero otherwise. Table 3.7 reports OLS regression results for the effect on the *loss ratio*.

Table 3.7: Effect of tightening the restriction on the loss ratio

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable	LossRatio $_{EBT}$	LossRatio $_{2Years}$	LossRatio $_{Sum}$	LossRatio $_{EBIT}$	LossRatio $_{PL}$	LossRatio $_{EBT\ 100\%}$
Tight	-0.504*	-0.513*	-0.379	-0.486*	-0.499	-0.464
	(0.289)	(0.269)	(0.316)	(0.247)	(0.295)	(0.311)
Observations	172	170	170	172	172	171
Number of Countries	26	26	26	26	26	26
Adjusted R-squared	0.078	0.085	0.070	0.060	0.061	0.072
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Estimation with OLS. The dependent variable is the number of loss acquisitions per country and year divided by the number of all acquisitions per country and year. In column (1) a loss acquisition is measured by negative earnings before taxes in the pre-deal-year, in column (2) a loss acquisition is measured by negative earnings before taxes in the pre-deal- and deal-year and in column (3) a loss acquisition is measured by a negative sum of earnings before taxes of the pre-deal- and deal-year. In column (4) a loss acquisition is measured by negative earnings before interest and taxes in the pre-deal-year, in column (5) a loss acquisition is measured by a loss per period in the pre-deal-year and in column (6) a loss acquisition is measured by negative earnings before taxes in the pre-deal-year, but the sample only includes 100% acquisitions. The main variable of interest is Tight. All variables are defined in Table 3.13 (Appendix). All regressions include control variables and country- and year-fixed effects. Robust standard errors (clustered at the country-level) are provided in parentheses. Stars behind the coefficients indicate the significance level, *** 1%, ** 5%, * 10%.

The findings of Table 3.7 provide the following insights. The estimated effect is negative and significant for the main dependent variable ($LossRatio_{EBT}$, column (1)), revealing that tightening the restriction leads to a decrease in the acquisition rate of about 50 percentage points. Compared to the effect obtained with the categorial variable (Table 3.3), this result seems large, but the indicator variable considers only the change in the regulation and not the relation of strictness. But, the statistical significance and magnitude of the coefficient estimates vary across the different specifications. Therefore, the effect is not as robust, which is also illustrated by further tests in the Appendix.[37]

[37] See Table 3.21 (Appendix) for further robustness tests.

Table 3.8: Effect of tightening the restriction on the number of loss acquisitions

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable	Loss-Acq $_{EBT}$	Loss-Acq $_{2Years}$	Loss-Acq $_{Sum}$	Loss-Acq $_{EBIT}$	Loss-Acq $_{PL}$	Loss-Acq $_{EBT\ 100\%}$
Tight	-0.213	-0.147	0.125	-0.190	-0.086	-0.035
	(0.428)	(0.463)	(0.436)	(0.407)	(0.465)	(0.454)
Observations	171	170	170	171	171	170
Number of Countries	26	26	26	26	26	26
Pseudo LL	-530.54	-391.19	-530.22	-528.03	-533.17	-486.72
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Estimation with PPML. The dependent variable is the number of loss acquisitions per country and year. In column (1) a loss acquisition is measured by negative earnings before taxes in the pre-deal-year, in column (2) a loss acquisition is measured by negative earnings before taxes in the pre-deal- and deal-year and in column (3) a loss acquisition is measured by a negative sum of earnings before taxes of the pre-deal- and deal-year. In column (4) a loss acquisition is measured by negative earnings before interest and taxes in the pre-deal-year, in column (5) a loss acquisition is measured by a loss per period in the pre-deal-year and in column (6) a loss acquisition is measured by negative earnings before taxes in the pre-deal-year, but the sample only includes 100% acquisitions. The main variable of interest is Tight. All variables are defined in Table 3.13 (Appendix). All regressions include control variables and country- and year-fixed effects. Robust standard errors (clustered at the country-level) are provided in parentheses. Stars behind the coefficients indicate the significance level, *** 1%, ** 5%, * 10%.

Table 3.8 reports the results for the Poisson regressions on the number of acquisitions of loss-carrying firms (*Loss-Acq*). Contrary to expectations, the tightening of the anti-tax loss trafficking rules has no significant effect across all specifications.[38] Unfortunately, there are only two countries in my sample period that have tightened their regulations. Both, Hungary and Greece had no explicit regulation in 2011. While Hungary introduced a special rule based on a change in ownership and activity (category 1), Greece decided to deny the loss utilization already in case of a change in ownership (category 3). Accordingly, loss acquisitions in Hungary may only be slightly affected by the introduction of an anti-tax loss trafficking rule if at all, as the target's loss carryforwards can be used as long as the previous activity is continued after the acquisition. Therefore, a possible explanation for the insignificance of the effect could be that the attractiveness of acquiring targets with loss carryforwards has not decreased sufficiently.

[38] More regressions on the number of acquisitions of loss-carrying firms can be found in Table 3.21 (Appendix).

Overall, my findings in this Section on the negative effect of tightening the regulation on the acquisition rate and number of acquisitions of loss-carrying firms cannot convincingly confirm my first part of hypotheses 2a und 2b. Another aspect contributing to the weakness of my results is the low variance of the independent variable.

3.IV.III Relaxing

In the next step, I examine whether the acquisition rate and the number of acquisitions of loss-carrying firms is increased after relaxing country-specific anti-tax loss trafficking rules. The procedure for this examination is the same as for Section 3.IV.II. I test the second part of my hypotheses 2a and 2b using the known different dependent variables for the loss ratio and the number of loss acquisitions and the indicator variable *Relax*, which is one if the country has weakened its anti-tax loss trafficking rule compared to 2011, and zero otherwise.

Table 3.9 reports the results from the OLS (column (1) – (6)) and PPML (column (7) – (12)) regressions. Using the definition of a loss acquisition by negative earnings before taxes in the pre-deal-year (column (1) and column (7)), I find a positive and significant effect on the loss ratio and number of loss acquisitions, suggesting that relaxing the anti-tax loss trafficking rules increases the relative and absolute number of acquisitions of loss-carrying firms. The coefficient estimates suggest an about 7 percentage point increase in the acquisition rate of loss-carrying firms and an about 59 percent ($e^{0.461} = 1.585$) increase in the number of acquisitions of target firms with loss carryforwards. Furthermore, the coefficients of the estimates show a positive sign over all specifications, but the results for the loss ratio are not robust in their significance. With respect to the adjusted R^2, it can be noted that the OLS model does not follow the trend of the underlying data (esp. column (2), (4) and (5)) and therefore provides a poor fit (see Wooldridge, 2010). Nevertheless, the estimates for the absolute number of loss acquisitions allow the conclusion that the relaxing has a positive effect on the acquisition of loss-carrying firms. Further robustness checks can be found in the Appendix.[39]

[39] See Table 3.22 (Appendix) for further robustness tests.

Table 3.9: Effect of relaxing the restriction on the loss ratio and the number of loss acquisitions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Dependent variable	LossRatio $_{EBT}$	LossRatio $_{2Years}$	LossRatio $_{Sum}$	LossRatio $_{EBIT}$	LossRatio $_{PL}$	LossRatio $_{EBT\ 100\%}$	Loss-Acq $_{EBT}$	Loss-Acq $_{2Years}$	Loss-Acq $_{Sum}$	Loss-Acq $_{EBIT}$	Loss-Acq $_{PL}$	Loss-Acq $_{EBT\ 100\%}$
Relax	0.071*	0.038	0.137**	0.079	0.033	0.074**	0.461*	0.460*	0.594**	0.548**	0.476*	0.429
	(0.036)	(0.033)	(0.053)	(0.049)	(0.039)	(0.035)	(0.248)	(0.248)	(0.236)	(0.262)	(0.284)	(0.264)
Observations	172	170	170	172	172	171	171	170	170	171	171	170
Number of Countries	26	26	26	26	26	26	26	26	26	26	26	26
Adjusted R-squared / Pseudo LL	0.013	0.000	0.046	-0.002	-0.004	0.023	-526.34	-388.68	-522.84	-522.26	-528.72	-483.32
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Estimation with OLS (column (1)-(6)) and PPML (column (7)-(12)). The dependent variable is the number of loss acquisitions per country and year divided by the number of all acquisitions per country and year in column (1)-(6) and the number of loss acquisitions per country and year in column (7)-(12). In column (1) and (7) a loss acquisition is measured by negative earnings before taxes in the pre-deal-year, in column (2) and (8) a loss acquisition is measured by negative earnings before taxes in the pre-deal- and deal-year and in column (3) and (9) a loss acquisition is measured by a negative sum of earnings before taxes of the pre-deal- and deal-year. In column (4) and (10) a loss acquisition is measured by negative earnings before interest and taxes in the pre-deal-year, in column (5) and (11) a loss acquisition is measured by a loss per period in the pre-deal-year and in column (6) and (12) a loss acquisition is measured by negative earnings before taxes in the pre-deal-year, but the sample only includes 100% acquisitions. The main variable of interest is Relax. All variables are defined in Table 3.13 (Appendix). All regressions include control variables and country- and year-fixed effects. Robust standard errors (clustered at the country-level) are provided in parentheses. Stars behind the coefficients indicate the significance level, *** 1%, ** 5%, * 10%.

In sum, the results suggest that relaxing the anti-tax loss trafficking rules has a positive significant impact in particular on the number of acquisitions of loss-carrying firms (hypothesis 2b). The effect on the relative relation between loss acquisitions and all acquisitions in a country cannot be robustly confirmed (hypothesis 2a).

3.IV.IV Country Cases

The aforementioned used variables *Index, Tight* and *Relax* capture the aggregated effect of changes in the strictness of anti-tax loss trafficking rules on the ratio and absolute number of loss acquisitions across countries. I now focus on individual changes and explore the regulations in three countries, Germany, Spain and Greece, separately to corroborate my findings regarding hypotheses 2a and 2b.

In Germany, tax losses may be carried forward indefinitely for corporate income and trade tax purposes. However, the use of pre-acquisition losses is restricted by a general rule under which the loss carryforward of the target is forfeited if more than 50 percent of the shares will be acquired (a partial forfeiture, which already started at a 25 percent ownership change, was declared unconstitutional in 2017 for ownership changes after 12/31/2007). Nevertheless, the forfeiture of losses does not apply in certain cases. The Annual Tax Act 2018 stipulated that, since the tax year 2016, the exemption rule of Section 8d of the German Corporate Tax Act can be applied to prevent the targets' loss carryforward expiration. According to this exemption rule, the losses can be carried forward if the same activity of the target is continued after an acquisition.

The Spanish tax law already restricted tax loss carryforwards after a change in ownership in 2011. Tax losses could not be offset if the majority of the capital stock or the rights were acquired after the tax period to which the tax losses related and the former shareholders held less than 25 percent. An extension of the existing regulation came into force as of 01/01/2015 and amended the change of control rule. Since 2015, the use of tax losses of an acquired target firm is disallowed if the target's activities are extended or changed within two years after the change in ownership. This offence is measured in terms of the turnover.

In 2013, the Greek legislature published a new Law 4172/2013, which introduced a new restriction on the transfer of tax losses after a substantial change in ownership, and came into force from 2014 onwards. The change in ownership is deemed substantial if the ownership or voting rights of a target firm are changed at a percentage exceeding 33 percent during a tax year. As a result, the use of the target's loss carryforward is no longer permitted in the future,

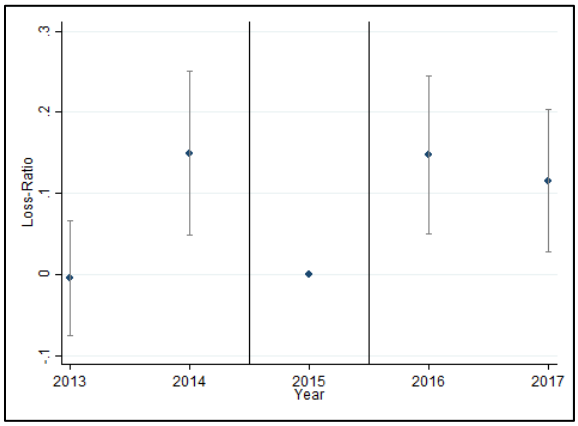
unless the acquirer proves that the transfer was made for commercial or business reasons and not for the purpose of tax avoidance.

To examine the country-specific effects of the change in legislation, I apply a DiD estimation method. One assumption of the DiD approach is the parallel trend in the treatment and control group which requires a similar behavior of the two groups before the reform. Due to data limitations, all countries without a change in the anti-tax loss trafficking serve for my control group. I test for the parallel trends of my two main dependent variables $LossRatio_{EBT}$ and $Loss\text{-}Acq_{EBT}$ by estimating a version of my baseline model (see eq. (3.2) in Section 3.III.II), in which I replace the DiD indicator (*Post* × *Treatment*) with a series of separate indicator variables: $Y_{EBT\,i,t} = \beta_0 + \beta_1(t_0 - 3)_t \times Treatment_i + \beta_2(t_0 - 2)_t \times Treatment_i + \beta_3(t_0 - 1)_t \times Treatment_i + \beta_4(t_0 + 1)_t \times Treatment_i + \beta_5(t_0 + 2)_t \times Treatment_i + \beta_6(t_0 + 3)_t \times Treatment_i + \gamma C_{i,t} + \alpha_i + \alpha_t + \varepsilon_{i,t}$ and expect the point-estimates in the pre-reform period to be insignificant to assume parallel trends. I use two respectively three leads and lags depending on the year of the treatment and therefore on the availability of historical or future years. I omit the interaction term for the treatment year t_0 because this year serves as the benchmark.

Figure 3.3, Figure 3.4 and Figure 3.5 provide point-estimates and two-tailed confidence intervals on the 90%-level for the treatment and control groups when using $LossRatio_{EBT}$ as the dependent variable. Figure 3.6, Figure 3.7 and Figure 3.8 present the results for the number of acquisitions of loss-carrying firms.[40] The results suggest that the pre-reform treatment effects are only partially insignificant. In Germany, one of the two pre-trend-effects is significant in each setting, indicating that the loss ratio and number of loss acquisitions is already different compared to the control countries before the change in regulation. In the context of the loss ratio, the problem is confirmed again that a linear model does not fit very well. Nevertheless, after relaxing the regulation on the expiration of the target's loss carryforwards, Figure 3.3 and Figure 3.6 conveys a positive effect on the relative acquisition rate (significant) and the absolute number of acquisitions of loss-carrying firms (insignificant). While in Spain and Greece the pre-reform trends are insignificant for the loss ratio (see Figure 3.4 and Figure 3.5), there are significant differences between the treatment and control groups preceding the change in legislation for the number of loss acquisitions. Overall, the parallel trend assumptions cannot be assumed as fulfilled, which weakens the persuasiveness of these analyses.

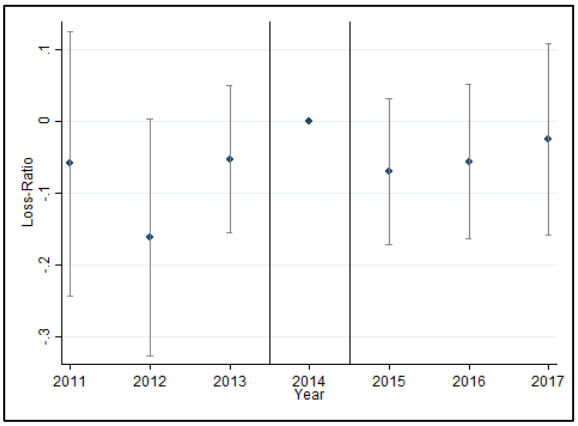
[40] The corresponding estimates can be found in Table 3.23 (Appendix) and Table 3.24 (Appendix).

Figure 3.3: Parallel trend: loss ratio – Germany



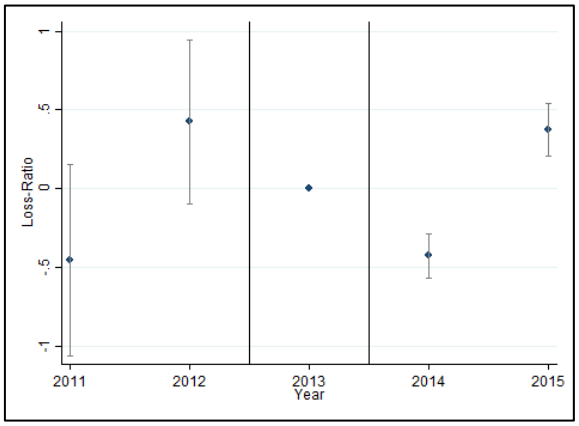
Notes: Estimation with OLS. The dependent variable is the number of loss acquisitions per country and year divided by the number of all acquisitions per country and year. A loss acquisition is measured by negative earnings before taxes in the pre-deal-year. The point estimators are generated by estimating the following regression model: $LossRatio_{EBT\,i,t} = \beta_0 + \beta_1 2013_t \times Treatment_i + \beta_2 2014_t \times Treatment_i + \beta_3 2016 \times Treatment_i + \beta_4 2017_t \times Treatment_i + \gamma C_{i,t} + \alpha_i + \alpha_t + \varepsilon_{i,t}$. Since I omit the DiD indicator for the year 2015, this year serves as the benchmark. The points indicate the point-estimates and the lines represent the 90 % confidence intervals. Corresponding estimates can be found in Table 3.23 (Appendix).

Figure 3.4: Parallel trend: loss ratio – Spain



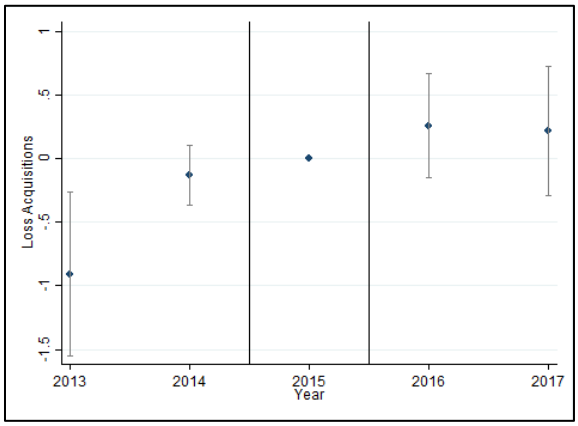
Notes: Estimation with OLS. The dependent variable is the number of loss acquisitions per country and year divided by the number of all acquisitions per country and year. A loss acquisition is measured by negative earnings before taxes in the pre-deal-year. The point estimators are generated by estimating the following regression model: $LossRatio_{EBT\,i,t} = \beta_0 + \beta_1 2011_t \times Treatment_i + \beta_2 2012_t \times Treatment_i + \beta_3 2013 \times Treatment_i + \beta_4 2015_t \times Treatment_i + \beta_5 2016_t \times Treatment_i + \beta_6 2017_t \times Treatment_i + \gamma C_{i,t} + \alpha_i + \alpha_t + \varepsilon_{i,t}$. Since I omit the DiD indicator for the year 2014, this year serves as the benchmark. The points indicate the point-estimates and the lines represent the 90 % confidence intervals. Corresponding estimates can be found in Table 3.23 (Appendix).

Figure 3.5: Parallel trend: loss ratio – Greece



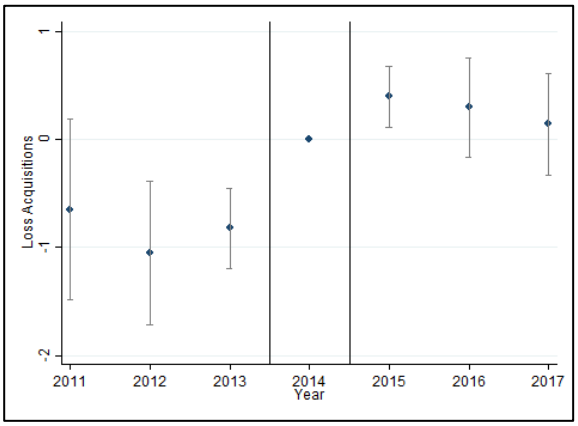
Notes: Estimation with OLS. The dependent variable is the number of loss acquisitions per country and year divided by the number of all acquisitions per country and year. A loss acquisition is measured by negative earnings before taxes in the pre-deal-year. The point estimators are generated by estimating the following regression model: $LossRatio_{EBT\,i,t} = \beta_0 + \beta_1 2011_t \times Treatment_i + \beta_2 2012_t \times Treatment_i + \beta_3 2014 \times Treatment_i + \beta_4 2015_t \times Treatment_i + \gamma C_{i,t} + \alpha_i + \alpha_t + \varepsilon_{i,t}$. Since I omit the DiD indicator for the year 2013, this year serves as the benchmark. The points indicate the point-estimates and the lines represent the 90 % confidence intervals. Corresponding estimates can be found in Table 3.23 (Appendix).

Figure 3.6: Parallel trend: number of loss acquisitions – Germany



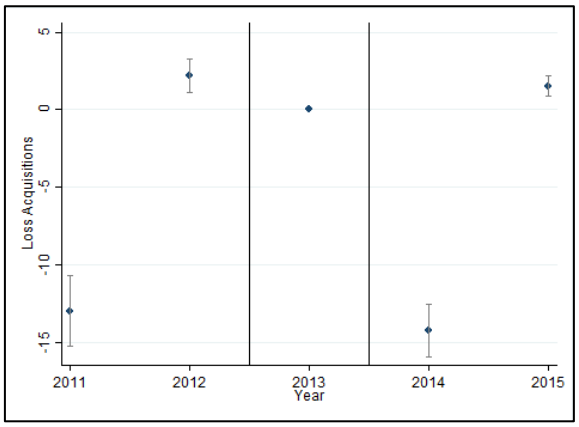
Notes: Estimation with PPML. The dependent variable is the number of loss acquisitions per country and year. A loss acquisition is measured by negative earnings before taxes in the pre-deal-year. The point estimators are generated by estimating the following regression model: $Loss - Acq_{EBT\,i,t} = \beta_0 + \beta_1 2013_t \times Treatment_i + \beta_2 2014_t \times Treatment_i + \beta_3 2016 \times Treatment_i + \beta_4 2017_t \times Treatment_i + \gamma C_{i,t} + \alpha_i + \alpha_t + \varepsilon_{i,t}$. Since I omit the DiD indicator for the year 2015, this year serves as the benchmark. The points indicate the point-estimates and the lines represent the 90 % confidence intervals. Corresponding estimates can be found in Table 3.24 (Appendix).

Figure 3.7: Parallel trend: number of loss acquisitions – Spain



Notes: Estimation with PPML. The dependent variable is the number of loss acquisitions per country and year. A loss acquisition is measured by negative earnings before taxes in the pre-deal-year. The point estimators are generated by estimating the following regression model: $Loss - Acq_{EBT\,i,t} = \beta_0 + \beta_1 2011_t \times Treatment_i + \beta_2 2012_t \times Treatment_i + \beta_3 2013 \times Treatment_i + \beta_4 2015_t \times Treatment_i + \beta_5 2016_t \times Treatment_i + \beta_6 2017_t \times Treatment_i + \gamma C_{i,t} + \alpha_i + \alpha_t + \varepsilon_{i,t}$. Since I omit the DiD indicator for the year 2014, this year serves as the benchmark. The points indicate the point-estimates and the lines represent the 90 % confidence intervals. Corresponding estimates can be found in Table 3.24 (Appendix).

Figure 3.8: Parallel trend: number of loss acquisitions – Greece



Notes: Estimation with PPML. The dependent variable is the number of loss acquisitions per country and year. A loss acquisition is measured by negative earnings before taxes in the pre-deal-year. The point estimators are generated by estimating the following regression model: $Loss - Acq_{EBT\,i,t} = \beta_0 + \beta_1 2011_t \times Treatment_i + \beta_2 2012_t \times Treatment_i + \beta_3 2014 \times Treatment_i + \beta_4 2015_t \times Treatment_i + \gamma C_{i,t} + \alpha_i + \alpha_t + \varepsilon_{i,t}$. Since I omit the DiD indicator for the year 2013, this year serves as the benchmark. The points indicate the point-estimates and the lines represent the 90 % confidence intervals Corresponding estimates can be found in Table 3.24 (Appendix).

Nonetheless, also considering the results of Section 3.IV.I to 3.IV.III, the results of the DiD approach can give an idea of the country-specific effects with some caution. I estimate eq. (3.2) (see Section 3.III.II) and employ the same dependent variables and the same set of control variables. The variable of main interest is the interaction term *Post* × *Treatment*, whose coefficient β_1 represents the effect of the change in legislation on the acquisition rate and number of acquisitions of loss-carrying firms in the selected country.

Table 3.10 reports the results for the loss ratio and Table 3.11 contains the results for the number of loss acquisitions. Column (1) of each table explores the change in the anti-tax loss trafficking rule in Germany, according to which the loss carryforward is only forfeited if there is both a change in ownership and a change in activity. Accordingly, relaxing the restriction is expected to have a positive effect as losses will increasingly remain usable after the acquisition and thus valuable for the acquirer. In column (2) the Spanish reform setting is examined. In Spain, the change also led to a concretization in the restriction that loss carryforwards only expire after an acquisition if not only the ownership structure but also the target's activity changes within two years. Accordingly, as of this amendment, more loss carryforwards of target firms can be offset against future profits, so that a positive effect on the acquisition rate and number of acquisitions of loss-carrying firms can be expected. The Greek reform is subject of column (3). While there was no explicit provision in the pre-reform period, the introduction is very likely to lead to a devaluation of the target's loss carryforwards as losses can no longer be used if 33 percent of the shares in the target are acquired. This low threshold combined with the fulfilment of the single criterion of a change in ownership reduces the attractiveness of acquiring loss-carrying firms and may have a negative effect on the loss ratio and loss acquisitions.

The findings of Table 3.10 and Table 3.11 provide the following insights. First, the coefficient for the German reform is positive as expected, but only significant and small in its magnitude for the loss ratio. This weak finding could partially steam from the fact that the relaxation of the restriction was introduced retroactively, which may also be indicated by the significant effect in t+2. Second, the treatment effect for the Spanish change in the anti-tax loss trafficking rule is insignificant and very close to zero for the loss ratio, suggesting that the relative acquisition rate of loss-carrying firms does not change after the reform. In contrast to this is the result for the loss acquisitions as the dependent variable, which indicates that the relaxing of the restriction does have a positive effect on the number of acquisitions of loss-carrying firms. Third, the estimated treatment effect for the Greek reform is negative for both dependent variables, but only significant for the loss ratio. The results should also be interpreted cautiously

due to the volatility of the dependent variable in Greece. However, the result conditionally supports the assumption that the introduction of a restriction reduces the attractiveness of acquiring targets with loss carryforwards. I refrain from interpreting the magnitude of the effects, mainly because the assumption of the parallel trend in the pre-reform period does not hold.

Table 3.10: Treatment effect on loss ratio

Dependent variable	(DE) LossRatio $_{EBT}$	(ES) LossRatio $_{EBT}$	(GR) LossRatio $_{EBT}$
Treatment x Post	0.099**	-0.008	-0.821***
	(0.045)	(0.056)	(0.143)
Observations	151	151	151
Number of Countries	23	23	23
Adjusted R-squared	0.018	0.025	0.154
Country FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Controls	Yes	Yes	Yes

Notes: Estimation with OLS. The dependent variable is the number of loss acquisitions per country and year divided by the number of all acquisitions per country and year. In all columns a loss acquisition is measured by negative earnings before taxes in the pre-deal-year. The regressions are based on the model presented in eq. 3.2 (see Section 3.III.II). Column (1) estimates the treatment effect for the German reform. Column (2) estimates the treatment effect for the Spanish reform. Column (3) estimates the treatment effect for the Greek reform. All regressions include control variables and country- and year-fixed effects. Robust standard errors (clustered at the country-level) are provided in parentheses. Stars behind the coefficients indicate the significance level, *** 1%, ** 5%, * 10%.

Table 3.11: Treatment effect on number of loss acquisitions

Dependent variable	(DE) Loss-Acq $_{EBT}$	(ES) Loss-Acq $_{EBT}$	(GR) Loss-Acq $_{EBT}$
Treatment x Post	0.478	0.601*	-0.667
	(0.361)	(0.314)	(0.500)
Observations	150	150	150
Number of Countries	23	23	23
Pseudo LL	-494.81	-500.40	-485.28
Country FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Controls	Yes	Yes	Yes

Notes: Estimation with PPML. The dependent variable is the number of loss acquisitions per country and year. In all columns a loss acquisition is measured by negative earnings before taxes in the pre-deal-year. The regressions are based on the model presented in eq. 3.2 (see Section 3.III.II). Column (1) estimates the treatment effect for the German reform. Column (2) estimates the treatment effect for the Spanish reform. Column (3) estimates the treatment effect for the Greek reform. All regressions include control variables and country- and year-fixed effects. Robust standard errors (clustered at the country-level) are provided in parentheses. Stars behind the coefficients indicate the significance level, *** 1%, ** 5%, * 10%.

Overall, it can be concluded that, despite their weaknesses, the results at least do not contradict the hypotheses 2a and 2b and, together with the results from the Sections 3.IV.I - 3.IV.III, support the assumption that the design of anti-tax loss trafficking rules has an impact on the

acquisition activity with respect to targets with loss carryforwards. Since the effect in terms of relaxing the provisions comprise only changes that aim to concretize the objective of the rule and thus only prohibit the use of loss carryforwards when both the ownership and activity of the target changes, it can be concluded that a targeted rule can increase the acquisition activity in a country with respect to acquisitions of loss-carrying firms. This finding should encourage legislators of countries to enact targeted and specific regulations that address only the exploitation of firms with loss carryforwards and thus purely tax-motivated acquisitions, rather than overly broad regulations that make acquisitions other than tax-motivated acquisitions unattractive. Consequently, the attractiveness of the target's loss carryforwards remains in force in addition to various other determinants for acquisitions.

3.IV.V Discussion of the Results

My results are subject to limitations with regard to the underlying data and the identification strategy, in addition to the weaknesses noted in the sections. First, the sample period is limited due to the different time horizons of the two data bases used, Zephyr and Amadeus, on the one hand, and the partial impossibility of linking M&A deals to financial statement information due to changing identification numbers, on the other hand. This results in a limited coverage of 14,544 deals across 26 European countries in seven years. Therefore, it is only possible to use country-specific dependent variables instead of splitting by additional characteristics (e.g. industry, see Steffens, 2015). Moreover, the deficiencies of the data coverage can be a reason for the volatility of the dependent variable in some countries over time. This also contributes to the fact that a linear regression model is not suitable for all specifications.

Second, although the use of indicator variables (e.g., Dreßler and Overesch, 2013) and categorial variables (e.g., Bührle, 2021; Lohse and Riedel, 2013) is applied in the literature to identify effects of regulations, it is fraught with weaknesses. The variables cannot control for specifics and cannot estimate on a case-by-case basis whether the loss carryforward expires for certain acquisitions. Nevertheless, their use is sufficient for the aim of this study, as I focus on identifying a country-specific effect whether the design of anti-tax loss trafficking rules affects the acquisition rate and the number of acquisitions of loss-carrying firms.

Third, the variation in the anti-tax loss trafficking rules is small since only four countries changed the strictness of their restrictions in the sample period. Therefore, because of the fixed effects, the results are based only on these country changes. Finally, I cannot rule out the possibility that other confounding effects affect the acquisition rate and number of acquisitions of loss-carrying firms. One possible aspect is the group taxation. In these regimes, it is possible

to net the results of all affiliated firms. In this respect, however, there may be no incentive to acquire a firm with loss carryforwards, since pre-group losses are not usable under group taxation and therefore do not represent any value for future group tax savings, regardless of the anti-tax loss trafficking rule. In addition, group taxation systems refer mostly to only national firms, so that cross-border offsetting is usually not possible. If a target firm already belongs to the group and the acquisition is merely a restructuring within the group, the loss carryforwards are generally not affected by the loss transfer restrictions, so this fact encourages finding no effect. Against this background, group taxation should actually have no meaningful effect on the dependent variables.

Despite these limitations, my paper provides first evidence on the effect of anti-tax loss trafficking rules on the acquisition rate and number of acquisitions of loss-carrying firms and is therefore related to different strands of literature. I add to the literature on acquisition decisions, especially acquiring loss-carrying firms and shed light on the impact of tax loss treatment rules. I am the first to show that tax loss offset rules have an effect on acquirers' acquisition behavior. Nevertheless, evidence on anti-tax loss trafficking rules is still rare (e.g., Bührle, 2021; Steffens, 2015). A deeper understanding of the effect of loss transfer regulations, e.g., how these provisions affect the direction of acquisitions or lead to evasive acquisition decisions, would be a worthwhile goal for future research.

3.V. Conclusion

Tax systems worldwide tax profits and losses asymmetrically. Instead of an immediate tax refund, losses have to be offset against profits of the previous or subsequent periods. Consequently, a firm only receives tax savings in the future at the time a profit is generated and simultaneously offset against the accumulated loss carryforwards. In M&A processes, these potential future tax savings due to tax loss carryforwards are attractive to corporate acquirers looking to reduce their overall tax burden in the future. In order to counteract a purely tax-motivated acquisition in terms of using accumulated tax loss carryforwards of the target firm, countries enacted so called anti-tax loss trafficking rules. These country-specific provisions generally apply in the event of changes in ownership, activity, or a combination of both and result in an expiration and thus a devaluation of the target's tax loss carryforwards.

In this paper, I examine the effect of anti-tax loss trafficking rules on the acquisition rate and the number of acquisitions of target firms with loss carryforwards. Since the target's loss carryforwards expire depending on the design of the loss transfer restriction, I expect that the stricter the anti-tax loss trafficking rules, the lower the relative rate and the absolute number of

acquisitions of loss-carrying firm. Accordingly, relaxing the provisions should create incentives to acquire targets with accumulated tax losses, while tightening the rule and thus increasing forfeitures of losses should lead to a decline in acquisitions of loss firms. To test my hypotheses, I use a panel data set of acquisitions of European target firms linked to financial accounting information and aggregated at the country-level. I employ a linear and a pseudo Poisson regression to examine the effect on the acquisition rate and the number of acquisitions of loss-carrying firms, respectively. A difference-in-differences approach for separate country cases accompanies these analyses.

I find that anti-tax loss trafficking rules indeed have an effect on the acquisition of targets with loss carryforwards. The coefficient for the strictness of the restriction is negatively significant, suggesting that stricter provisions prevent acquisitions of loss-carrying firms. Splitting this effect and examining each country separately allows me to draw the following conclusions: Tightening the anti-tax loss trafficking rule may lead to a decrease in the acquisition rate and the number of acquisitions of loss-carrying firms, while relaxing provisions will cause an increase.

Taking together, my findings have interesting policy implications. Since the design of anti-tax loss trafficking rules affects the attractiveness and therefore the acquisition of targets with loss carryforwards, legislators should enact regulations that are as precise and targeted as possible, that apply exclusively to the intended purpose and do not penalize acquisitions that are less tax-motivated in order to pave the way for potentially profitable firms to recover.

3.VI. Appendix

Table 3.12: Sample selection process

Selection criteria	Number of unique deals
Zephyr	
Excluding:	
Zephyr update version 30 (November 2017)	1,040,700
(1) Deals without TargetBvDIDNumber	(220,901)
(2) Uncompleted Deals	(116,986)
(3) Deals without information on acquired stakes	(173,889)
(4) Completed deals until 2006	(126,934)
(5) Deals with non-European target firms	(263,416)
(6) Dealtype other than acquisition	(29,389)
(7) Duplicates cleanup	(20,227)
Preliminary number of unique deals	88,958
Amadeus	
Excluding:	
(8) Target firms without financial data	(57,796)
(9) Completed deals until 2009	(5,995)
(10) Target is a non-corporation	(458)
(11) Industry cleanup (NACE 35-39, 64-66)	(2,892)
(12) Targets located in Estonia	(162)
(13) Acquired stake < 75%	(7,388)
Final number of unique deals	14,267
Final number of unique target firms	14,544

Notes: This table provides details on the sample selection process. Based on all deals available in Zephyr (November 2017), I exclude deals without target identifiers (TargetBvDIDNumber) (1), deals which are not completed until the export of the database (2) and deals with missing information on acquired stakes (3). The time restriction to deals before 2007 (4) and the restriction to European deals (5) are necessary due to the scope of information on Amadeus. I focus on acquisitions because I cannot consider special exceptions of the regulations that apply to other dealtypes (e.g. mergers) (6). In the final step of the Zephyr selection process, I check for duplicates to make sure I only count a deal once (7). This selection results in 88,958 deals with 68,668 unique target firms. Controlling for financial information in Amadeus reduces the sample (8). Due to the ten-year data availability in the online version of Amadeus, only deals completed in 2010 at the earliest can be considered (9). Since the regulations affect only corporations, other legal forms are excluded (10). Furthermore, I exclude firms in the utility and finance industry (11) and in Estonia (12) because of the special tax regulations and tax system. Finally, I require an acquisition stake of at least 75 percent to ensure that the potential loss is affected by the tax loss transfer rule (13).

Table 3.13: Variable definitions

Variable	Description
Dependent variables	
Loss-Ratio $_{EBT}$	Number of loss acquisitions per country and year divided by the number of all acquisitions per country and year; a loss acquisition is measured by negative earnings before taxes in the pre-deal-year
Loss-Ratio $_{2Years}$	Number of loss acquisitions per country and year divided by the number of all acquisitions per country and year; a loss acquisition is measured by negative earnings before taxes in the pre-deal- and deal year
Loss-Ratio $_{Sum}$	Number of loss acquisitions per country and year divided by the number of all acquisitions per country and year; a loss acquisition is measured by a negative sum of earnings before taxes of the pre-deal- and deal-year
Loss-Ratio $_{EBIT}$	Number of loss acquisitions per country and year divided by the number of all acquisitions per country and year; a loss acquisition is measured by negative earnings before interest and taxes in the pre-deal-year
Loss-Ratio $_{PL}$	Number of loss acquisitions per country and year divided by the number of all acquisitions per country and year; a loss acquisition is measured by a loss per period in the pre-deal-year
Loss-Acq $_{EBT}$	Number of loss acquisitions per country and year; a loss acquisition is measured by negative earnings before taxes in the pre-deal-year
Loss-Acq $_{2Years}$	Number of loss acquisitions per country and year; a loss acquisition is measured by negative earnings before taxes in the pre-deal- and deal year
Loss-Acq $_{Sum}$	Number of loss acquisitions per country and year; a loss acquisition is measured by a negative sum of earnings before taxes of the pre-deal- and deal-year

Loss-Acq $_{EBIT}$	Number of loss acquisitions per country and year; a loss acquisition is measured by negative earnings before interest and taxes in the pre-deal-year
Loss-Acq $_{PL}$	Number of loss acquisitions per country and year; a loss acquisition is measured by a loss per period in the pre-deal-year
Main variables of interest	
Index	Loss transfer restriction category, 0 = no explicit rule, 1 = denial of loss transfer after a change in ownership and activity (cumulative), 2 = denial of loss transfer after a change in activity, 3 = denial of loss transfer after a change in ownership, 4 = denial of loss transfer after a change in activity or ownership (see Table 3.16 (Appendix), Source: Bührle and Spengel, 2020)
Tight	Indicator variable, equal to one in years in which the loss transfer restriction was tightened compared with 2011
Relax	Indicator variable, equal to one in years in which the loss transfer restriction was relaxed compared with 2011
Treatment	Indicator variable, equal to one for the country in which the anti-tax loss trafficking rule changed during the sample period
Post	Indicator variable, equal to one for years in which there was a change in the strictness of the anti-tax loss trafficking rule compared to 2011
Controls	
GDP♣	Lagged logarithm of GDP in constant (2010) US $
Growth♣	Lagged annual GDP growth in %
Credit♣	Lagged domestic credit to private sector (% of GDP)
STR♠	Top statutory corporate income tax rate
Trade♣	Lagged logarithm of the trade ratio
Inflation♣	Lagged inflation
Service Sector♣	Value added of services (% of GDP)
Corruption♦	Control of corruption (captures perceptions of the extent to which public power is exercised for private gain)

RuleLaw♦	Rule of law (captures perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence)
GovEffectiveness♦	Government effectiveness (captures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies)
RegQuality♦	Regulatory Quality (captures perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development)
LCF Limit♠	Number of years a loss carryforward is available, 50 if unlimited
LCB Limit♠	Number of years a loss carryback is available, 0 if not available
Same Country Ratio	Number of acquisitions per country and year where acquirer and target are in the same country divided by the number of all acquisitions per country and year

Notes: This table reports the variable definitions. **Source:** ♣ World Development Indicators, World Bank 2021; ♠ IBFD and EY, 2011 – 2017 ♦ Worldwide Governance Indicators, World Bank 2021.

Table 3.14: Distribution of deals across countries per target

Country		Country		Country		Country	
AT	157	ES	744	IE	142	PL	1,230
BE	420	FI	558	IT	521	PT	129
BG	985	FR	1,157	LT	43	RO	204
CY	3	GB	4,395	LU	21	SE	1,003
CZ	645	GR	15	LV	71	SI	44
DE	896	HR	43	MT	6	SK	70
DK	320	HU	116	NL	606		14,544

Notes: This table provides details on the sample distribution of the target countries.

Table 3.15: Tax loss treatment rules in the EU28 countries

Country	2011	2012	2013	2014	2015	2016	2017
AT	∞	∞	∞	∞	∞	∞	∞
BE	∞	∞	∞	∞	∞	∞	∞
BG	5	5	5	5	5	5	5
CZ	5	5	5	5	5	5	5
DE	∞^{1}	∞^{1}	∞^{1}	∞^{1}	∞^{1}	∞^{1}	∞^{1}
DK	∞	∞	∞	∞	∞	∞	∞
ES	15	18	18	18	∞	∞	∞
FI	10	10	10	10	10	10	10
FR	∞^{3}	∞^{1}	∞^{1}	∞^{1}	∞^{1}	∞^{1}	∞^{1}
GB	∞^{1}	∞^{1}	∞^{1}	∞^{1}	∞^{1}	∞^{1}	∞^{1}
GR	5	5	5	5	5	5	5
HR	5	5	5	5	5	5	5
HU	∞	∞	∞	∞	5	5	5
IE	∞^{3}	∞^{3}	∞^{3}	∞^{3}	∞^{3}	∞^{3}	∞^{3}
IT	∞	∞	∞	∞	∞	∞	∞
LT	∞	∞	∞	∞	∞	∞	∞
LU	∞	∞	∞	∞	∞	∞	17
LV	8	∞	∞	∞	∞	∞	∞
MT	∞	∞	∞	∞	∞	∞	∞
NL	9^{1}	9^{1}	9^{1}	9^{1}	9^{1}	9^{1}	9^{1}
PL	5	5	5	5	5	5	5
PT	4	5	5	12	12	12	5
RO	7	7	7	7	7	7	7
SE	∞	∞	∞	∞	∞	∞	∞
SI	∞	∞	∞	∞	∞	∞	∞
SK	7	7	7	4	4	4	4

Notes: This table provides an overview of loss carryforward and loss carryback provisions in the EU28 countries for the years 2011 to 2017 (except Cyprus and Estonia). If a loss carryforward is restricted in time, the number corresponds to the length of the loss carryforward period. For the purpose of the analysis, I set the number of years to 50 when a loss carryforward is indefinitely possible. The superscript number reports the number of years of a loss carryback, if possible. **Source:** IBFD and EY, 2011 – 2017.

Table 3.16: Categorization of anti-tax loss trafficking rules in the EU28 countries

Country	2011	2012	2013	2014	2015	2016	2017
AT	1	1	1	1	1	1	1
BE	3	3	3	3	3	3	3
BG	3	3	3	3	3	3	3
CZ	1	1	1	1	1	1	1
DE	3	3	3	3	3	1	1
DK	3	3	3	3	3	3	3
ES	3	3	3	3	1	1	1
FI	3	3	3	3	3	3	3
FR	2	2	2	2	2	2	2
GB	1	1	1	1	1	1	1
GR	0	0	0	3	3	3	3
HR	1	1	1	1	1	1	1
HU	0	1	1	1	1	1	1
IE	3	3	3	3	3	3	3
IT	1	1	1	1	1	1	1
LT	1	1	1	1	1	1	1
LU	0	0	0	0	0	0	0
LV	1	1	1	1	1	1	1
MT	0	0	0	0	0	0	0
NL	1	1	1	1	1	1	1
PL	0	0	0	0	0	0	0
PT	3	3	3	3	3	3	3
RO	0	0	0	0	0	0	0
SE	3	3	3	3	3	3	3
SI	1	1	1	1	1	1	1
SK	0	0	0	0	0	0	0

Notes: This table provides an overview of the anti-tax loss trafficking rules in the EU28 countries for the years 2011 to 2017 (except Cyprus and Estonia). Category 0 implies that no explicit rule exists. Losses expire in category 1 countries after a change in ownership and activity (cumulative requirement). In category 2, a loss transfer is denied after a change in activity. Category 3 rules link the loss expiration to a change in ownership. In countries with restrictions of category 4, loss carryforwards will forfeit after a change in ownership or activity (one criterion is sufficient). **Source:** Bührle and Spengel, 2020 with deviations in Greece, Ireland and Portugal.

Table 3.17: Distribution of loss ratio across countries

	Obs.	Mean	Std. Dev.	Min	Max
AT	7	0.350	0.084	0.250	0.500
BE	7	0.324	0.062	0.228	0.403
BG	7	0.347	0.161	0	0.480
CZ	7	0.362	0.713	0.280	0.500
DE	7	0.277	0.047	0.231	0.361
DK	2	0.298	0.114	0.217	0.379
ES	7	0.369	0.069	0.280	0.450
FI	7	0.233	0.045	0.185	0.306
FR	7	0.325	0.048	0.274	0.402
GB	7	0.298	0.040	0.223	0.347
GR	7	0.400	0.5033	0	1
HR	6	0.309	0.179	0	0.538
HU	7	0.357	0.171	0.133	0.600
IE	7	0.420	0.202	0.143	0.714
IT	7	0.371	0.071	0.290	0.475
LT	6	0.250	0.207	0	0.500
LU	6	0.528	0.452	0	1
LV	7	0.416	0.243	0.167	0.857
MT	5	0.200	0.447	0	1
NL	7	0.352	0.147	0.111	0.500
PL	7	0.422	0.048	0.353	0.481
PT	7	0.396	0.146	0.227	0.667
RO	7	0.472	0.150	0.217	0.688
SE	7	0.288	0.047	0.236	0.347
SI	7	0.405	0.140	0.167	0.500
SK	7	0.375	0.128	0.125	0.500

Notes: This table provides an overview over the distribution of the variable LossRatio_{EBT} across countries.

Table 3.18: Distribution of number of loss acquisitions across countries

	Obs.	Mean	Std. Dev.	Min	Max
AT	7	2.571	1.272	1	5
BE	7	17	4.163	13	25
BG	7	46.571	65.740	0	168
CZ	7	23.571	25.774	7	79
DE	7	11.571	2.992	9	17
DK	2	10.500	0.707	10	11
ES	7	32	7.980	23	44
FI	7	16	4.282	10	23
FR	7	41	7.303	33	50
GB	7	53.286	10.161	40	70
GR	7	1	1.528	0	4
HR	6	2.5	2.429	0	7
HU	7	5.143	1.952	2	8
IE	7	3.714	2.360	1	7
IT	7	24.143	3.716	19	29
LT	6	0.833	0.408	0	1
LU	6	1	0.894	0	2
LV	7	3.857	2.478	1	8
MT	5	0.200	0.447	0	1
NL	7	3.429	1.902	1	7
PL	7	41	36.355	12	107
PT	7	5.857	2.410	4	11
RO	7	11.286	8.077	4	28
SE	7	36.143	6.914	27	47
SI	7	2.571	1.512	1	5
SK	7	3.286	1.890	1	

Notes: This table provides an overview over the distribution of the variable Loss-Acq$_{EBT}$ across countries.

Table 3.19: Summary statistics for all independent and control variables

	Obs.	Mean	Std. Dev.	Min	Max
Index	172	1.494	1.157	0	3
Tight	172	0.058	0.235	0	1
Relax	172	0.029	0.169	0	1
GDP	172	26.305	1.487	22.970	28.960
Growth	172	1.791	3.087	-9.133	25.163
Credit	172	85.589	35.710	28.128	185.359
STR	172	0.229	0.064	0.090	0.380
Trade	172	4.684	0.482	3.951	5.973
Inflation	172	1.345	1.558	-1.736	6.091
Service Sector	172	63.368	6.652	42.963	79.332
Corruption	172	0.963	0.802	-0.267	2.3130
RuleLaw	172	1.113	0.628	-0.112	2.100
LCF_Limit	172	30.541	21.547	4	50
LCB_Limit	172	0.297	0.700	0	3
GovEffectiveness	172	1.097	0.570	-0.329	2.241
RegQuality	172	1.146	0.472	0.148	2.047
Same Country Ratio	171	0.489	0.243	0	1

Notes: This table provides summary statistics for all variables. All variables are defined in Table 3.13 (Appendix).

Table 3.20: Effect of strictness categorization on loss ratio and number of loss acquisitions – different controls

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable	LossRatio $_{EBT}$	LossRatio $_{EBT}$	LossRatio $_{EBT}$	LossRatio $_{EBT}$	Loss-Acq $_{EBT}$	Loss-Acq $_{EBT}$	Loss-Acq $_{EBT}$	Loss-Acq $_{EBT}$
Index	-0.135*	-0.114**	-0.124**	-0.106**	-0.208	-0.268**	-0.222**	-0.238**
	(0.066)	(0.053)	(0.058)	(0.050)	(0.149)	(0.107)	(0.105)	(0.117)
GDP	0.181	0.172	0.154		2.342	0.824	2.253	
	(0.450)	(0.346)	(0.379)		(1.764)	(1.669)	(1.819)	
Growth	0.000	-0.003	-0.001		0.055	0.053	0.055	
	(0.007)	(0.008)	(0.007)		(0.036)	(0.034)	(0.035)	
Credit	0.003	0.003	0.004*		0.014**	0.008	0.014**	
	(0.002)	(0.002)	(0.002)		(0.006)	(0.005)	(0.006)	
STR	0.110	0.166	-0.078	-0.461	-7.839	-5.786	-7.672	-4.786
	(0.545)	(0.608)	(0.531)	(0.473)	(5.412)	(3.537)	(5.587)	(4.321)
Trade	-0.080	0.235	0.003		6.482**	7.909**	6.442**	
	(0.558)	(0.600)	(0.487)		(3.213)	(3.348)	(3.286)	
Inflation	-0.024	-0.029	-0.032		0.096	0.118	0.095	
	(0.019)	(0.021)	(0.021)		(0.115)	(0.113)	(0.116)	
Service Sector	-0.011	-0.005	-0.019*	0.023	0.160	0.153	0.159	0.123*
	(0.011)	(0.011)	(0.010)	(0.017)	(0.130)	(0.103)	(0.129)	(0.074)
Corruption	0.212	0.239*	0.211	0.321**	1.722***	2.276***	1.667***	1.619***
	(0.155)	(0.132)	(0.155)	(0.145)	(0.544)	(0.760)	(0.542)	(0.596)
RuleLaw	-0.225	-0.220	-0.153	-0.381	-2.962***	-2.507***	-2.936***	-2.289***
	(0.198)	(0.246)	(0.179)	(0.231)	6.482**	7.909**	6.442**	(0.684)
LCF_Limit	-0.002				0.002			
	(0.003)				(0.008)			
LCB_Limit	-0.003				-0.044			
	(0.035)				(0.069)			
GovEffectiveness		-0.493*		-0.498*		-1.792		-1.036
		(0.253)		(0.256)		(1.104)		(0.899)
RegQuality		0.377		0.439		-0.135		0.336
		(0.363)		(0.313)		(0.694)		(0.845)

Dependent variable	(1) LossRatio $_{EBT}$	(2) LossRatio $_{EBT}$	(3) LossRatio $_{EBT}$	(4) LossRatio $_{EBT}$	(5) Loss-Acq $_{EBT}$	(6) Loss-Acq $_{EBT}$	(7) Loss-Acq $_{EBT}$	(8) Loss-Acq $_{EBT}$
Same Country Ratio			0.056				0.122	
			(0.166)				(0.503)	
GDP pC $_{no\ Lag}$				0.000				0.000
				(0.000)				(0.000)
Growth $_{no\ Lag}$				0.016**				0.011
				(0.006)				(0.043)
Credit $_{no\ Lag}$				0.004*				0.012*
				(0.002)				(0.007)
Inflation $_{no\ Lag}$				0.025				-0.131
				(0.032)				(0.101)
Trade $_{no\ Lag}$				1.064				7.316*
				(0.782)				(3.854)
Observations	172	172	171	172	171	171	170	171
Number of Countries	26	26	26	26	26	26	26	26
Adjusted R-squared/ Pseudo LL	0.060	0.111	0.077	0.173	-525.98	-504.76	-525.84	-517.20
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Estimation with OLS (column (1)-(4)) and PPML (column (5)-(8)). The dependent variable is the number of loss acquisitions per country and year divided by the number of all acquisitions per country and year in column (1)-(4) and the number of loss acquisitions per country and year in column (5)-(8). In all columns a loss acquisition is measured by negative earnings before taxes in the pre-deal-year. In column (1) and (5), I control for timing restrictions of loss carryforwards and the possibility of loss carrybacks (e.g., Chiang et al., 2014). Column (2) and (6) use further controls for the regulatory quality and the government effectiveness. I include a relative rate for domestic acquisitions to all acquisitions in column (3) and (7) since domestic acquisitions have different determinants than cross-border (e.g., Erel et al., 2012). In column (4) and (8), I use the control variables without lagging for one period to prove that this does not affect the results. The main variable of interest is Index (see Table 3.1). All variables are defined in Table 3.13 (Appendix). All regressions include country- and year-fixed effects. Robust standard errors (clustered at the country-level) are provided in parentheses. Stars behind the coefficients indicate the significance level, *** 1%, ** 5%, * 10%

Table 3.21: Effect of tightening the restriction on the loss ratio and number of loss acquisitions – different controls

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable	LossRatio $_{EBT}$	LossRatio $_{EBT}$	LossRatio $_{EBT}$	LossRatio $_{EBT}$	Loss-Acq $_{EBT}$	Loss-Acq $_{EBT}$	Loss-Acq $_{EBT}$	Loss-Acq $_{EBT}$
Tight	-0.513	-0.455	-0.485*	-0.346	-0.036	-0.290	-0.192	-0.241
	(0.303)	(0.281)	(0.282)	(0.259)	(0.437)	(0.440)	(0.393)	(0.361)
GDP	0.102	0.030	0.019		2.686	0.920	2.304	
	(0.523)	(0.435)	(0.432)		(1.947)	(1.801)	(1.996)	
Growth	-0.000	-0.003	-0.001		0.048	0.050	0.051	
	(0.008)	(0.008)	(0.008)		(0.033)	(0.034)	(0.033)	
Credit	0.003	0.002	0.003		0.013**	0.006	0.011**	
	(0.002)	(0.002)	(0.002)		(0.005)	(0.005)	(0.005)	
STR	0.136	0.258	0.058	-0.520	-8.177	-6.558	-8.191	-5.420
	(0.518)	(0.649)	(0.484)	(0.562)	(5.821)	(4.093)	(6.075)	(4.766)
Trade	-0.219	0.115	-0.126		6.556*	8.290**	6.765*	
	(0.560)	(0.602)	(0.505)		(3.348)	(3.541)	(3.479)	
Inflation	-0.039	-0.040	-0.041*		0.095	0.116	0.097	
	(0.023)	(0.024)	(0.024)		(0.122)	(0.123)	(0.125)	
Service Sector	-0.013	-0.005	-0.018*	0.024	0.158	0.166	0.163	0.135*
	(0.010)	(0.011)	(0.010)	(0.015)	(0.130)	(0.109)	(0.131)	(0.079)
Corruption	0.070	0.122	0.088	0.218	1.522***	1.808***	1.323***	1.221**
	(0.122)	(0.117)	(0.134)	(0.144)	(0.484)	(0.649)	(0.513)	(0.515)
RuleLaw	-0.346	-0.350	-0.274	-0.483*	-2.953***	-2.698***	-2.915***	-2.478***
	(0.206)	(0.256)	(0.204)	(0.246)	(0.740)	(0.591)	(0.764)	(0.710)
LCF_Limit	-0.001				0.009			
	(0.003)				(0.006)			
LCB_Limit	0.022				-0.029			
	(0.037)				(0.066)			
GovEffectiveness		-0.455*		-0.467*		-1.791		-1.023
		(0.239)		(0.245)		(1.121)		(0.921)
RegQuality		0.417		0.480		0.293		0.765
		(0.351)		(0.298)		(0.705)		(0.908)

Dependent variable	(1) LossRatio $_{EBT}$	(2) LossRatio $_{EBT}$	(3) LossRatio $_{EBT}$	(4) LossRatio $_{EBT}$	(5) Loss-Acq $_{EBT}$	(6) Loss-Acq $_{EBT}$	(7) Loss-Acq $_{EBT}$	(8) Loss-Acq $_{EBT}$
Same Country Ratio			0.059				0.146	
			(0.160)				(0.501)	
GDP pC $_{no\ Lag}$				0.000				0.000
				(0.000)				(0.000)
Growth $_{no\ Lag}$				0.017**				0.016
				(0.007)				(0.044)
Credit $_{no\ Lag}$				0.003				0.010
				(0.002)				(0.007)
Inflation $_{no\ Lag}$				0.025				-0.137
				(0.031)				(0.101)
Trade $_{no\ Lag}$				0.972				7.567*
				(0.807)				(3.990)
Observations	172	172	171	172	171	171	170	171
Number of Countries	26	26	26	26	26	26	26	26
Adjusted R-squared/ Pseudo LL	0.068	0.120	0.082	0.166	-528.48	-510.05	-530.23	-521.52
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Estimation with OLS (column (1)-(4)) and PPML (column (5)-(8)). The dependent variable is the number of loss acquisitions per country and year divided by the number of all acquisitions per country and year in column (1)-(4) and the number of loss acquisitions per country and year in column (5)-(8). In all columns a loss acquisition is measured by negative earnings before taxes in the pre-deal-year. In column (1) and (5), I control for timing restrictions of loss carryforwards and the possibility of loss carrybacks (e.g., Chiang et al., 2014). Column (2) and (6) use further controls for the regulatory quality and the government effectiveness. I include a relative rate for domestic acquisitions to all acquisitions in column (3) and (7) since domestic acquisitions have different determinants than cross-border (e.g., Erel et al., 2012). In column (4) and (8), I use the control variables without lagging for one period to prove that this does not affect the results. The main variable of interest is Tight. All variables are defined in Table 3.13 (Appendix). All regressions include country- and year-fixed effects. Robust standard errors (clustered at the country-level) are provided in parentheses. Stars behind the coefficients indicate the significance level, *** 1%, ** 5%, * 10%

Table 3.22: Effect of relaxing the restriction on the loss ratio and number of loss acquisitions – different controls

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable	LossRatio $_{EBT}$	LossRatio $_{EBT}$	LossRatio $_{EBT}$	LossRatio $_{EBT}$	Loss-Acq $_{EBT}$	Loss-Acq $_{EBT}$	Loss-Acq $_{EBT}$	Loss-Acq $_{EBT}$
Relax	0.084	0.031	0.082*	0.030	0.424	0.526**	0.461*	0.495*
	(0.055)	(0.061)	(0.044)	(0.052)	(0.359)	(0.234)	(0.249)	(0.256)
GDP	0.630	0.473	0.494		2.571	1.075	2.492	
	(0.402)	(0.368)	(0.347)		(1.787)	(1.717)	(1.880)	
Growth	-0.006	-0.008	-0.006		0.052	0.050	0.052	
	(0.010)	(0.010)	(0.010)		(0.035)	(0.033)	(0.034)	
Credit	0.003	0.002	0.003*		0.014**	0.008*	0.014**	
	(0.002)	(0.002)	(0.002)		(0.006)	(0.005)	(0.006)	
STR	-0.750	-0.501	-0.724	-1.167	-8.085	-6.124*	-7.917	-5.018
	(0.971)	(0.884)	(0.865)	(0.876)	(5.486)	(3.628)	(5.594)	(4.282)
Trade	0.018	0.344	0.101		6.558**	8.005**	6.517**	
	(0.568)	(0.610)	(0.499)		(3.264)	(3.367)	(3.300)	
Inflation	-0.018	-0.023	-0.021		0.101	0.124	0.100	
	(0.017)	(0.021)	(0.020)		(0.117)	(0.115)	(0.117)	
Service Sector	-0.011	-0.002	-0.016	0.027	0.161	0.156	0.160	0.125*
	(0.010)	(0.011)	(0.010)	(0.017)	(0.131)	(0.103)	(0.128)	(0.074)
Corruption	0.082	0.102	0.093	0.183	1.716***	2.235***	1.652***	1.616***
	(0.130)	(0.142)	(0.154)	(0.150)	(0.548)	(0.769)	(0.549)	(0.592)
RuleLaw	-0.091	-0.165	-0.020	-0.307	-2.929***	-2.493***	-2.898***	-2.256***
	(0.211)	(0.238)	(0.203)	(0.221)	(0.747)	(0.569)	(0.764)	(0.678)
LCF_Limit	-0.001				0.002			
	(0.003)				(0.008)			
LCB_Limit	-0.000				-0.049			
	(0.036)				(0.069)			
GovEffectiveness		-0.462*		-0.458*		-1.774		-1.021
		(0.242)		(0.238)		(1.093)		(0.898)
RegQuality		0.528		0.595		-0.089		0.372
		(0.435)		(0.386)		(0.694)		(0.820)

Dependent variable	(1) LossRatio $_{EBT}$	(2) LossRatio $_{EBT}$	(3) LossRatio $_{EBT}$	(4) LossRatio $_{EBT}$	(5) Loss-Acq $_{EBT}$	(6) Loss-Acq $_{EBT}$	(7) Loss-Acq $_{EBT}$	(8) Loss-Acq $_{EBT}$
Same Country Ratio			0.078				0.142	
			(0.167)				(0.509)	
GDP pC $_{no\ Lag}$				0.000				0.000
				(0.000)				(0.000)
Growth $_{no\ Lag}$				0.012**				0.009
				(0.005)				(0.044)
Credit $_{no\ Lag}$				0.004*				0.012*
				(0.002)				(0.007)
Inflation $_{no\ Lag}$				0.024				-0.130
				(0.032)				(0.101)
Trade $_{no\ Lag}$				1.171				7.418*
				(0.778)				(3.833)
Observations	172	172	171	172	171	171	170	171
Number of Countries	26	26	26	26	26	26	26	26
Adjusted R-squared/ Pseudo LL	0.001	0.067	0.023	0.131	-526.15	-505.47	-526.02	-517.36
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Estimation with OLS (column (1)-(4)) and PPML (column (5)-(8)). The dependent variable is the number of loss acquisitions per country and year divided by the number of all acquisitions per country and year in column (1)-(4) and the number of loss acquisitions per country and year in column (5)-(8). In all columns a loss acquisition is measured by negative earnings before taxes in the pre-deal-year. In column (1) and (5), I control for timing restrictions of loss carryforwards and the possibility of loss carrybacks (e.g., Chiang et al., 2014). Column (2) and (6) use further controls for the regulatory quality and the government effectiveness. I include a relative rate for domestic acquisitions to all acquisitions in column (3) and (7) since domestic acquisitions have different determinants than cross-border (e.g., Erel et al., 2012). In column (4) and (8), I use the control variables without lagging for one period to prove that this does not affect the results. The main variable of interest is Relax. All variables are defined in Table 3.13 (Appendix). All regressions include country- and year-fixed effects. Robust standard errors (clustered at the country-level) are provided in parentheses. Stars behind the coefficients indicate the significance level, *** 1%, ** 5%, * 10%

Table 3.23: Parallel trend: loss ratio

Dependent variable	(DE) LossRatio $_{EBT}$	(ES) LossRatio $_{EBT}$	(GR) LossRatio $_{EBT}$
t-3		-0.058	
		(0.112)	
t-2	-0.004	-0.161	-0.450
	(0.043)	(0.100)	(0.370)
t-1	0.149**	-0.052	0.425
	(0.062)	(0.063)	(0.317)
t+1	0.147**	-0.069	-0.425***
	(0.059)	(0.062)	(0.086)
t+2	0.116**	-0.056	0.376***
	(0.054)	(0.065)	(0.102)
t+3		-0.024	
		(0.081)	
Observations	151	151	151
Number of Countries	23	23	23
Adjusted R-squared	0.001	-0.009	0.157
Country FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Controls	Yes	Yes	Yes

Notes: Estimation with OLS. The dependent variable is the number of loss acquisitions per country and year divided by the number of all acquisitions per country and year. In all columns a loss acquisition is measured by negative earnings before taxes in the pre-deal-year. The regressions are based on the following model: $LossRatio_{EBT_{i,t}} = \beta_0 + \beta_1(t_0 - 3)_t \times Treatment_i + \beta_2(t_0 - 2)_t \times Treatment_i + \beta_3(t_0 - 1) \times Treatment_i + \beta_4(t_0 + 1)_t \times Treatment_i + \beta_5(t_0 + 2)_t \times Treatment_i + \beta_6(t_0 + 3)_t \times Treatment_i + \gamma C_{i,t} + \alpha_i + \alpha_t + \varepsilon_{i,t}$. Column (1) estimates the treatment effects over time for the German reform. Column (2) estimates the treatment effects over time for the Spanish reform. Column (3) estimates the treatment effects over time for the Greek reform. All regressions include control variables, country- and year-fixed effects. Robust standard errors (clustered at the country-level) are provided in parentheses. Stars behind the coefficients indicate the significance level, *** 1%, ** 5%, * 10%.

Table 3.24: Parallel trend: number of loss acquisitions

Dependent variable	(DE) Loss-Acq $_{EBT}$	(ES) Loss-Acq $_{EBT}$	(GR) Loss-Acq $_{EBT}$
t-3		-0.648	
		(0.508)	
t-2	-0.907**	-1.052***	-13.004***
	(0.389)	(0.404)	(1.377)
t-1	-0.132	-0.820***	2.174***
	(0.143)	(0.226)	(0.655)
t+1	0.258	0.388**	-14.228***
	(0.249)	(0.169)	(1.033)
t+2	0.223	0.292	1.508***
	(0.310)	(0.277)	(0.402)
t+3		0.141	
		(0.285)	
Observations	150	150	150
Number of Countries	23	23	23
Pseudo LL	-491.50	-493.68	-481.75
Country FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Controls	Yes	Yes	Yes

Notes: Estimation with PPML. The dependent variable is the number of loss acquisitions per country and year. In all columns a loss acquisition is measured by negative earnings before taxes in the pre-deal-year. The regressions are based on the following model: $Loss - Acq_{EBT\,i,t} = \beta_0 + \beta_1(t_0 - 3)_t \times Treatment_i + \beta_2(t_0 - 2)_t \times Treatment_i + \beta_3(t_0 - 1) \times Treatment_i + \beta_4(t_0 + 1)_t \times Treatment_i + \beta_5(t_0 + 2)_t \times Treatment_i + \beta_6(t_0 + 3)_t \times Treatment_i + \gamma C_{i,t} + \alpha_i + \alpha_t + \varepsilon_{i,t}$. Column (1) estimates the treatment effects over time for the German reform. Column (2) estimates the treatment effects over time for the Spanish reform. Column (3) estimates the treatment effects over time for the Greek reform. All regressions include control variables, country- and year-fixed effects. Robust standard errors (clustered at the country-level) are provided in parentheses. Stars behind the coefficients indicate the significance level, *** 1%, ** 5%, * 10%.

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4. How expensive is the Abolition of Minimum Taxation in Europe? An Estimation of Tax Revenue Consequences

Rebecca Hoehl[41]

Working Paper[42]

Abstract:

The debate on an appropriate tax loss treatment is ongoing. The call for unrestricted offsetting of loss carryforwards against profits is based on empirical evidence that tax loss offset restrictions have real effects on corporate decisions. I estimate the tax revenue consequences for European countries resulting from an abolition of minimum taxation. Based on a firm-specific forward-looking microsimulation analysis, my estimates show that countries would have to forego 0.44 to 3 percent of their tax revenues that would result without a loss offset reform. The extrapolation for the German case forecasts a revenue deficit of 5.784 billion Euro for the first four years after the abolition.

Keywords: Corporate Taxation, Tax Loss Treatment, Tax Revenue Simulation

JEL Classification: E17 · H25 · K34

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4.I. Introduction

Loss offset regulations are subject to changes from time to time, as legislators try to influence the decision-making process of firms, for example to secure the liquidity and increase the attractiveness and advantageousness of investments during economic downturns (e.g., Dorn et al., 2020; Collier et al., 2020). Irrespective of economic development, firms demand for, as far as possible, equally governmental participation in losses as in profits, since asymmetric tax loss treatment has distortionary effects on their decision behavior (e.g., Graham et al., 2017; Auerbach, 1986). Nevertheless, loss carryforwards are usually subject to at least one limitation in Europe – either the amount of loss offset is restricted or the time in which loss carryforwards can be offset against profits is limited. One possibility to reduce restrictions on loss offsetting is to abandon minimum taxation in profit periods. However, a reform of tax loss offset provisions is always associated with financial deficits from a government's budgetary perspective. Because a government must balance its budget, it is important for legislators to know the potential impact of future tax reforms on tax revenues. The same applies to taxpayers with regard to the impact of a reform on their tax burden. Therefore, the aim of this study is to estimate the consequences of abolishing minimum taxation in Europe on tax revenues using a microsimulation approach. I assess the budgetary impact for each European country that applies a minimum taxation regime in 2014.

In contrast to existing microsimulation models, which mostly focus on a single country and use a backward-looking method, I use firm-specific data from firms in ten countries in the European Union and forecast future firm development in order to determine taxable income, considering countries' tax law restrictions with respect to dividend exemption and intra-group and inter-period loss offset. The forecasting is based on historical financial accounting data, to which the forecasting algorithm, provided by Oestreicher et al. (2014), is applied with adjustments. The taxable income is then multiplied with the tax rate to calculate the firms' tax burdens. To determine the reform effect resulting from the abolition of minimum taxation, taxable income, and thus taxes paid and tax revenues are determined twice – first using the current tax law and second applying the reform scenario. The relative reform effect corresponds to the difference between the tax revenue of the reform scenario and the tax revenue of the current tax law in relation to the tax revenue of the current tax law. In a second step, I extrapolate the relative reform consequences to absolute values for Germany. This investigation is related to the study of Oestreicher et al. (2012a), who evaluate different reform options for inter-period loss offset provisions with respect to tax bill and tax budget for Germany. Going beyond this study, I apply

an adjusted forecasting algorithm to a more recent dataset and expand the estimations to ten countries.

The paper is structured as follows. Section 4.II contains a short overview of tax loss offset regulations and their real effects on corporate decisions. In Section 4.III, I present the underlying data, describe the applied simulation approach, and illustrate how the tax revenue consequences and extrapolation are determined. Section 4.IV presents my results, while Section 4.V contains concluding remarks.

4.II. Real effects of tax loss offset regulations

In all European countries, a symmetric tax loss treatment corresponding to an immediate refund in the year of loss occurrence is not possible. Instead, losses incurred must be carried forward and offset against future profits.[43] Moreover, the loss carryforward is subject to a time limit on the one hand and the offset of losses is subject to an amount limit on the other hand in most countries. Over time, it can be observed that some countries relax their limitation rules with respect to the time limit, such that losses are less likely to expire unused, but introduce a minimum taxation in order to limit the possible loss offset per year (e.g., Spain, Portugal and Lithuania). These limitations due to using loss carryforwards lead to a situation in which governments do not participate in losses to the same extent as in profits. Consequently, investors have to consider taxes when deciding between two investment projects that have the same net present value before taxes but differ in terms of the probability of incurring losses, since tax loss offset provisions determine the scope of the corporate tax base and therefore affect the after-tax net present value. Because firm decisions cannot be made without considering tax consequences, theoretical and empirical studies examine the effects of asymmetric taxation of profits and losses on corporate decisions.

Theoretical findings and related empirical studies show that existing tax loss carryforwards reduce the tax incentive for debt financing (e.g., Feld et al., 2013; Buettner et al., 2011; Ramb and Weichenrieder, 2005; MacKie-Mason, 1990; DeAngelo and Masulis, 1980). Although a study analyzing directly the impact of changed loss offset provisions on the capital structure of firms is not available, some studies take account for loss offset regulations when using marginal tax rates and found a positive relation between debt and the marginal tax rate (e.g., Orihara, 2015; Koch, 2014a; Graham et al., 1998). Hence, it can be deduced that more (less) restrictive loss offset provisions reduce (increase) debt financing (e.g., Oestreicher et al., 2012a). In

[43] Only five European countries (DE, FR, GB, IE, NL) also offer a loss carryback option, which allows for an immediate tax refund if current losses can be offset against profits from previous period(s).

addition to the impact on firms' financing structure, loss offset regulations have also an effect on corporate investment decisions. Based on the theoretical considerations that corporate risk-taking is affected by the government's participation in losses (e.g., Domar and Musgrave, 1944) and investment activity depends on the firm's current and future tax status (e.g., Auerbach and Poterba, 1987; Auerbach, 1986), a variety of empirical studies provide evidence that tax loss offset provisions have real effects on the level of investment and risk-taking (e.g., Hoehl, 2022; Jacob, 2022; Heitzman and Lester, 2022; Dobridge, 2021; Bethmann et al., 2018; Langenmayr and Lester, 2018; Dreßler and Overesch, 2013). Some of these investigations show that an increase in loss compensation resulting from a less restrictive tax loss offset provision leads to an increase in corporate investment (e.g., Hoehl, 2022; Bethmann et al., 2018; Dreßler and Overesch, 2013). Furthermore, empirical evidence is provided for the fact that firms adjust their profit shifting behavior due to tax losses (e.g., Gamm et al., 2018; De Simone et al., 2017). All in all, it can be concluded that losses and their offset possibilities affect various corporate decisions.

Against this background, calls for an as unlimited as possible loss offset come as no surprise. In addition to the possibility of introducing an unlimited tax loss carryforward provision, the abolition of minimum taxation is a reform option that at least allows firms to offset all future profits against losses carried forward without restriction. Nevertheless, abandoning minimum taxation is associated with a certain risk for the tax authorities. Due to high accumulated losses, the abolition leads to non-taxation of firms with loss carryforwards despite generated profits, possibly over many years, which has an impact on the state's tax revenues.

In contrast to theoretical and empirical analyses, only a few studies have estimated the impact of loss offset provisions on tax revenues. Mueller (2006) examines the extent and structure of tax losses, their distribution among taxpayers and the revenue effect of loss offsetting on the basis of aggregated data from official income and corporate tax statistics for the periods 1989 to 2001. He concludes that a relaxation of loss offset limitations is not to be expected at the time of consideration due to insufficient loss recognition in the 1990s and therefore large resulting accumulated losses. Dwenger (2008) uses the microsimulation model BizTax (see Bach et al., 2008) to evaluate the fiscal effects of the introduction of minimum taxation in Germany. A discussion of the consequences of abolishing minimum taxation in Germany based on historical aggregated data was conducted by Dorenkamp (2010, 2011). He expects a revenue reduction of less than five percent of total corporate income and trade tax revenue. To the best of my knowledge, only one study estimates the possible consequences of abandoning minimum taxation with a forward-looking micro-level simulation. Oestreicher et al. (2012a) measures the

impact of reforming inter-period loss offset provisions (abolition of minimum taxation, limitation of loss carryforward period, abolition of the loss carryback option) for Germany. I follow this strand of literature and estimate the tax revenue consequences of abolishing minimum taxation for all countries in the European Union that apply such a restrictive offsetting regulation in 2014. Such a reform would result in an advantage for firms, as the offsetting of losses against future income would no longer be limited in terms of amount.[44] At the same time, this implies a reduction in tax revenues from the states' tax budget perspective. Due to fiscal burdens, the deficits of granting tax relief must be estimated as accurately as possible in order to implement regulations that are both effective and efficient.

4.III. Simulation approach

4.III.I Underlying data

The calculations are based on unconsolidated financial statement data of European corporations included in Bureau van Dijk's database Amadeus. By linking various data updates, I have data from 1994 to 2014.[45] I restrict my sample to countries that apply a minimum taxation rule[46] in 2014 in cases of loss offsetting.[47] Nevertheless, cross-border dividends distributed from the remaining European countries are also considered. For the simulation procedure, data is required on the one hand for firms for which the forecasting procedure is carried out (simulation firms) and on the other hand for peer firms whose past development is used for forecasting purposes.

Initially, I take advantage of the large sample and generate country-specific size-performance bins. In order to determine the (historical) development of return on assets and investment, I need information of three consecutive periods. 2,882,269 corporations fulfill this requirement. Firms with more than one available three-year dataset are considered more than once.

Since the simulation procedure requires information for at least one or two years prior to the simulation period, depending on the variable, data requirements for simulation firms are as follows:

- Industry classification: Information is necessary to apply the cluster-specific AR1-forecasting algorithm.

[44] The implications of cross-border loss relief due to a reform of group taxation in Europe are beyond the scope of this paper (e.g., Oestreicher and Koch, 2011; Oestreicher et al., 2011; Koch, 2010; Dahle and Baeumer, 2009).
[45] For building peer group bins, I consider data of the last eight years of the historical data.
[46] An overview of the applied minimum taxation regulations can be found in Table 4.8 (Appendix).
[47] Austria, Germany, Denmark, Spain, France, Hungary, Italy, Lithuania, Portugal and Slovenia apply a minimum taxation regime in 2014. Poland is not considered due to its unique restriction. Instead of limiting the offsettable income, only half of the losses may be offset in each period in Poland.

- Total assets in 2013 and 2014: Information is required for determining return on assets in the last historical year.
- Structure of assets in 2013 and 2014 (items: tangible fixed assets, intangible fixed assets, other fixed assets, current assets): The forecast of total assets is based on forecasting the different asset types.
- Profit/loss before taxation in 2013 and 2014: Forecast of future earnings requires information on the situation in the preceding year. A minimum of two historical years allows for a weak approximation of tax loss carryforwards.[48]

The selection process results in 1,811,527 simulation firms.[49]

4.III.II Approximation of tax loss carryforwards

The amount of tax loss carryforwards at the time of the simulation start is essential, on the one hand, for simulating tax revenue and tax burden and, on the other hand, for estimating the reform consequences of abolishing minimum taxation. Since tax loss carryforwards are not reported in annual accounts, the amount must be approximated by reported profits and losses in the balance sheets. The starting point for these estimates are the annual results from 1994 onwards. A simple consolidation of previous income would result in significant estimation errors. Therefore, I consider the most common difference between book and taxable income, the tax exemption of dividends, I take the effects of group relief into account and I apply inter-period tax loss-offset restrictions.[50]

In order to determine the firm's income before the application of group taxation and loss offset rules, it is necessary to calculate the tax exemption due to received dividends from earnings before taxes.[51] Since dividends are not disclosed separately in Amadeus, an approximation of the dividends included in the pre-tax income is required. Therefore, I use the item financial revenue and assume that firms with other fixed assets larger than zero have shareholdings in other companies (e.g., Oestreicher et al., 2014).[52] Based on historical data, I also determine a firm-specific dividend ratio equal to the median of financial revenues divided by earnings before taxes to simulate received dividends in the simulation period. However, this approach ignores the fact that financial revenues could be the sum of interest and dividend income.

[48] 1,282,632 simulation firms have at least 4 consecutive observations (2011 – 2014).
[49] The distribution of firms across the European countries can be found in Table 4.9 (Appendix).
[50] Information on tax regulations originate from European Tax Handbooks (IBFD, 1994 – 2014) and the EY Tax Guides (EY, 1994 – 2014).
[51] For reasons of technical simplification, the exemption is also applied even if tax law provides the credit method for dividends.
[52] If the amount of financial revenue is missing, I assume that the simulation firm did not receive any dividends in the respective year.

Nevertheless, I decided against the approach of Oestreicher et al. (2014) to determine dividends received as a sum over the distributed dividends of all subsidiaries, as the coverage of all shareholdings is very limited, especially with regard to the simulation firms.

The rules on group taxation and limited tax loss offsetting are then applied to the difference between earnings before taxes and the amount of tax-exempted dividends. I check whether the shareholding requirements of the country-specific group taxation regime are met and assume that firms opt to apply the regime in cases where group taxation is possible since such regimes allow for a direct offsetting of positive and negative income within a tax group.[53,54] I differentiate between a pooling of income on the level of the parent, where the income of subsidiaries is attributed to and taxed at the level of the tax group's head, and a group-relief and group-contribution system, where all results of a tax group are condensed and proportionally divided between the group members.[55] In applying the loss offset rules, I assume that firms use the opportunity of a loss carryback, if possible, since a direct loss offset with profits from previous periods results in an immediate tax refund. If a loss carryback is not possible due to a lack of positive income in the past or the absence of a loss carryback provision, only the restrictive regulations for a loss carryforward are applied (i.e., time-limited carryforward, amount-limited offset due to minimum taxation). The resulting loss carryforwards for the simulation firms at the end of 2014 are used to assess the consequences of the abolition of minimum taxation.

4.III.III Simulating firm's development

The underlying forecast used to determine the reform effects is based on a microsimulation (e.g., Oestreicher et al., 2014; Oestreicher et al., 2012a; Reister et al., 2008), in which firm's future development is simulated in a forward-looking manner, as opposed to a backward-looking microsimulation (e.g., Bach et al., 2016; Oestreicher and Koch, 2011; Bach et al., 2008; Oestreicher et al., 2008; Creedy and Gemmell, 2007), in which the reform setting is applied to historical company data. This method has the advantage that the reform scenario is applied to future revenue developments and is precisely not based on the assumption that the effects of a future reform are comparable to those that would have occurred if the reform had already taken place in the past.

[53] In Germany, I further control for the execution of the profit-/loss transfer agreement by checking whether the subsidiary's profit or loss has been transferred in the form of extraordinary income.
[54] The estimate of group income also suffers from incomplete disclosure of all tax group companies. In cases where the simulation firm is the only covered firm in the sample, group taxation is not applied.
[55] In cases of an overall loss, only loss-making firms will get a share of the group loss. If the overall group income is positive, the same procedure is applied so that only the profitable firms share in the group's profit.

In the empirical literature, different approaches to predicting future firm performance have been developed to measure simulated marginal tax rates. Forward-looking microsimulation studies have taken advantage of these considerations and use these approaches to estimate future income. The first of three currently prevailing forecasting procedures is a parametric approach, which assumes that a firm's taxable income follows a random walk with drift (e.g., Graham, 1996a; Graham, 1996b; Shevlin, 1990). Since the firm-specific parameters remain constant over time, this approach understates the volatility of future income and disregards the expectation that income is mean reverting (e.g., Koch, 2014b; Blouin et al., 2010). The second parametric approach estimates income based on a first-order autoregressive model (AR(1)) (see Graham and Kim, 2009), which overcomes most concerns of the random walk model (avoiding understatement of volatility, allowing for mean reversion). Nevertheless, estimations from both approaches could suffer from underestimations due to firm-specific stationarity. In contrast, Blouin et al. (2010) use a non-parametric, so called bin approach. Assuming that future firm development can be most accurately predicted by the performance of comparable firms rather than the historical development of the same firm, firms are assigned to a bin in advance to forecast its development based on the past performance of peer firms. Thus, the bin approach implicitly allows for mean reversion due to the repetition of bin assignment per simulation year and is stationary only with respect to the composition of the bins. However, a drawback is that inaccuracies may exist due to the use of cluster-specific instead of firm-specific parameters. Since all approaches were developed for consolidated U.S. firm data, Koch (2014b) provides evidence that the random walk model produces more measurement errors for EU firms than the autoregressive or non-parametric approach. Therefore, I generally follow the simulation approach of Oestreicher et al. (2014), who apply both a bin-based forecast and an autoregressive model to translate historical data into future firm development.[56] While the autoregressive simulation achieves good results especially for individual firms, the non-parametric approach has been shown to be most suitable when predicting returns across all companies in a sample (e.g., Koch, 2014b). Due to the aim of the microsimulation to assess the tax consequences of a reform, an appropriate distribution of taxable income across all firms is more important than a perfect prediction of individual firm performance. Therefore, the bin approach is the predominantly used forecasting algorithm. The AR(1)-estimates are only used if certain quality criteria are met (see Section 4.III.III.I). In order to obtain the firm's earnings before taxes as the product of return on assets and total assets, the two factors are forecasted independently for four years.

[56] The authors have shown that their used forecasting algorithm is sufficient when comparing realized and simulated values.

4.III.III.I Forecasting return on assets

For the application of the bin approach, the formation of country-specific size-performance bins is required. Each bin contains observations of comparable firms depending on size and performance, measured by total assets and return on assets, respectively (e.g., Blouin et al., 2010). Since this approach relies on the assumption that future firm performance is predicted by the return on assets growth of peer firms, three consecutive firm-year-observations are required to determine the growth factor ($\Delta ROA_{i,t}$).

$$\Delta ROA_{i,t} = \frac{ROA_{i,t} - ROA_{i,t-1}}{ROA_{i,t-1}}$$

I consider all three-year datasets available for the last eight historical years of the data and divide them into size-performance bins such that each bin contains about two hundred datasets.[57] At the first level, firms are assigned to size bins according to their level of total assets in the middle year of the three consecutive years ($t-1$). In a second step, each size bin is divided into performance bins to which observations are assigned according to their return on assets in $t-1$. The composition of the bins remains constant over the simulation period, while the assignment of the simulation firms to bins changes. Based on historical data, I determine return on assets ($ROA_{i,t}$) as follows:

$$ROA_{i,t} = \max\left(-2; \frac{EBT_{i,t}}{\left(\frac{TOAS_{i,t} + TOAS_{i,t-1}}{2}\right)}\right)$$

where $EBT_{i,t}$ is earnings before taxes and $TOAS_{i,t}$ is total assets. Restricting the return on assets to a minimum of minus two is intended to reduce the influence of outliers due to potential accounting errors (e.g., Oestreicher et al., 2014; Graham and Kim, 2009).

To forecast return on assets for simulation firms using the bin approach, the condensed growth rate of the respective bin $\Delta\widehat{ROA_{Bin}}$ is added to the firm-specific return on assets. Using a Monte Carlo simulation (50 iterations) based on the bin-specific median and standard deviation of the growth rate includes uncertainty:

$$\widehat{ROA_{i,t}} = ROA_{i,t-1} \cdot (1 + \Delta\widehat{ROA_{Bin}})$$

$$\text{with } \Delta\widehat{ROA_{Bin}} \sim N(\text{mean}(ROA_{Bin}); \sigma^2(ROA_{Bin}))$$

[57] Determination of the number of bins per country = $\sqrt{number\ of\ three-year\ datasets\ per\ country}/200$. The number of bins per country can be found in Table 4.11 (Appendix).

In addition to the bin approach, I also use the autoregressive approach established by Graham and Kim (2009) to forecast return on assets in order to benefit from the advantages of this method. Therefore, I estimate the firm's future return on assets as follows:

$$ROA_{i,t} = \mu_i + \rho_i \cdot ROA_{i,t-1} + \beta_i \cdot GDP_t + \epsilon_{i,t}$$
$$\text{with } \epsilon \sim N(0; \sigma_i^2)$$

where μ_i is the drift parameter, ρ_i is the first-order autoregressive parameter, β_i is the GDP coefficient and ϵ_i and σ_i represent random shocks and the volatility of shocks, respectively. In order to determine the coefficients, all available observations are considered in the regression. Since this approach requires at least four ROA-observations to estimate the parameters properly, I follow Graham and Kim (2009) and repeat the estimation for country-specific income-industry-clusters.[58] Nevertheless, I only refer to the cluster estimates if the number of observations is not sufficient for the firm-specific approach or the following quality criteria are not met: (1) the absolute value of the firm-specific estimate of the autoregressive parameter (ρ_i) is bigger than or equal to 0.8, (2) the volatility of random shocks (σ_i^2) is larger than 0.8 or (3) the long-run mean of the scaled income $\left(\frac{\mu_i}{1-\rho_i}\right)$ is larger than 0.6 (e.g., Graham and Kim, 2009). After estimating the parameters, I also apply a Monte Carlo simulation with 50 iterations to determine return on assets.[59]

Finally, I combine the results of the two forecasting procedures by using the mean value of the two estimates for the firm's return on assets if the coefficient of GDP (β_i) is statistically significant at the 20 percent level. Accordingly, this accounts for general economic development. Otherwise, I only use the forecasted value resulting from the bin approach.

4.III.III.II Forecasting total assets

To forecast total assets, I split this variable into its components tangible and intangible fixed assets, other fixed assets and current assets and apply separate approaches. The previous mentioned classification of the simulation firms into bins is also used for the forecasting procedure of tangible and intangible assets. First, I determine the change of net investment ($\Delta inv_{i,t}$) for all bin firms:

$$\Delta inv_{i,t} = inv_{i,t} - inv_{i,t-1}$$
$$\text{with } inv_{i,t} = \left(FA_{i,t} - OFA_{i,t}\right) - \left(FA_{i,t-1} - OFA_{i,t-1}\right)$$

where $FA_{i,t}$ is the book value of fixed assets and $OFA_{i,t}$ refers to the book value of other fixed assets. In a further step, the variable is condensed to the median values across all firms per bin

[58] I form six income- (two for loss firms, four for profitable firms) and 13 industry-clusters.
[59] $\widehat{ROA_{i,t}} = \mu_i + \rho_i \cdot ROA_{i,t-1} + \beta_i \cdot GDP_t + rn \cdot \sigma(\epsilon_{i,t})$ with $rn \sim N(0; 1)$.

(Δinv_{Bin}). Based on the median value of the relevant size-performance bin, the simulated book value of tangible ($TFA_{i,t}$) and intangible fixed assets ($IFA_{i,t}$) is defined as follows:

$$TFA_{i,t} + IFA_{i,t} = TFA_{i,t-1} + IFA_{i,t-1} + \widehat{inv_{i,t}}$$

$$\text{with } \widehat{inv_{i,t}} = inv_{i,t-1} + \text{median}(\Delta inv_{Bin})^{60}$$

The condensed median of the respective bin's net investment is also used to predict firm's other fixed assets, as I follow the assumption of Oestreicher et al. (2014) that investment in other fixed assets occurs at the same rate as in investment in tangible and intangible fixed assets:

$$OFA_{i,t} = OFA_{i,t-1} \cdot \left(1 + \frac{\widehat{inv_{i,t}}}{TFA_{i,t-1} + IFA_{i,t-1}}\right)$$

Current assets ($CA_{i,t}$) are forecasted by applying a firm-specific growth rate to the previous year's book value. The growth rate corresponds to the minimum of the last historical growth rate of fixed assets or a firm-specific growth factor (GF_i). The growth factor is based on the annual growth rate in the past. Thus, current assets are determined as follows:

$$CA_{i,t} = CA_{i,t-1} \cdot \min\left(1 + \frac{FA_{i,t} - FA_{i,t-1})}{FA_{i,t-1}};\ GF_i\right)$$

$$\text{with } GF_i = \left(\frac{FA_{i,first\ historical\ year}}{FA_{i,last\ historical\ year}}\right)^{1/last\ hist.year\ -\ first\ hist.year};\ GF_i \in [1;5]$$

The sum of the four components finally results in the firm's balance sheet total and thus the total assets ($TOAS_{i,t}$).

4.III.IV Estimation of Tax Revenue Consequences

The estimation of tax revenue consequences is based on the comparison between the revenues under the application of the current tax law and the revenues that would arise if minimum taxation was abolished. The starting point is therefore the determination of firms' tax liabilities. The decisive factor is the taxable income, to which the tax rate is applied in order to calculate the taxes payable. The taxable income ($TI_{i,t}$) of firm i in each simulation year t is determined according to the following equation:

$$TI_{i,t} = EBT_{i,t} - exempt\ dividends_{i,t} + group\ taxation_{i,t} + loss\ offset_{i,t}$$

where earnings before taxes ($EBT_{i,t}$) is forecasted as the product of return on assets ($ROA_{i,t}$) and total assets ($TOAS_{i,t}$). The determination of received dividends is based on a firm-specific

[60] $inv_{i,t-1}$, median(Δinv_{Bin}) and $\widehat{inv_{i,t}}$ are winsorized at the 1 percent and 99 percent levels to limit the effect of outliers.

dividend ratio equal to the median of financial revenues divided by earnings before taxes. The country-specific dividend exemption rules applicable in 2014 are applied to these dividends. The consequences of applicable group taxation rules are included as they may increase or decrease a firm's taxable income (see Section 4.III.II). If a firm has accumulated tax loss carryforwards in 2014, $loss\ offset_{i,t}$ denotes the offsetting of losses considering, on the one hand, the tax law in 2014 for the entire simulation period, and, on the other hand, the reform setting with respect to the non-application of the minimum taxation regulations. Thus, two taxable incomes per simulation firm and year are calculated. The relative tax revenue consequence for each country is determined as follows:

$$reform\ effect_c = \frac{\sum_{i=1}^{I}\sum_{2015}^{2018} Tax_{i,Reform} - \sum_{i=1}^{I}\sum_{2015}^{2018} Tax_{i,current\ law}}{\sum_{i=1}^{I}\sum_{2015}^{2018} Tax_{i,current\ law}}$$

where Tax_i is the firm-specific product of the firm's taxable income ($TI_{i,t}$) and the country-specific tax rate. The sum over all firms and all simulation years in a country of taxes to be paid results in the simulated tax revenue. By calculating the relative change between the tax revenue of the reform scenario and the tax revenue of the current tax law, the reform effect for each country can be determined.

4.III.V Extrapolation procedure for Germany

In order to estimate the consequences of the reform in absolute terms, I use the German corporate income and trade tax statistics for the year 2014 to extrapolate the relative reform effects to absolute tax revenue consequences for Germany. In order to account for distributional differences between the underlying dataset and the overall population of German firms, I divide my sample into twelve size classes for the purpose of extrapolation; six for firms with positive income and six for firms with negative income according to their earnings before taxes in 2014. For each size class, the sum of earnings before taxes is calculated and compared with the information on the amount of income from the tax statistics (see Table 4.1 for an overview of the data coverage). Thus, I determine an extrapolation factor for each class. Since firms with loss carryforwards are underrepresented in Amadeus, which would lead to an overestimation of tax revenue, I additionally control for the distribution of loss firms within the classes. These adjusted factors are applied to the simulated tax burdens (see Section 4.III.IV) for each size class and the two scenarios. The absolute tax revenue effect over the simulation periods due to an abolition of minimum taxation in Germany corresponds to the sum of the extrapolated differences between the tax revenues of the reform scenario and the tax revenues of the current tax law.

Table 4.1: Data coverage

Income class	Amount of taxpayers (statistics)	Amount of taxpayers (sample)	Coverage in percent	Taxpayers with LCF (statistics)	Taxpayers with LCF (sample)	Coverage in percent
Class 1 (- ∞; - 1m]	5,928	1,097	18.51	5,840	760	13.01
Class 2 (- 1m; - 500k]	5,040	343	6.81	4,876	228	4.68
Class 3 (- 500k; - 100k]	29,475	620	2.10	28,325	410	1.45
Class 4 (- 100k; - 50k]	27,164	178	0.66	25,783	110	0.43
Class 5 (- 50k; -10k]	101,625	230	0.27	95.685	135	0.14
Class 6 (-10k; 0)	211,276	120	0.06	200,909	74	0.04
Class 7 [0; 10k]	378,026	373	0.10	120,726	114	0.09
Class 8 (10k; 50k]	183,514	698	0.38	45,220	158	0.35
Class 9 (50k; 100k]	67,442	552	0.82	10,516	104	0.99
Class 10 (100k; 500k]	93,804	2,732	2.91	10,262	403	3.93
Class 11 (500k; 1m]	18,892	2,061	10.91	1,943	232	11.94
Class 12 (1m; ∞)	21,851	7,049	32.26	1,961	790	40.29
Total	1,144,037	16,053	1.40	552,046	3,518	0.64

Notes: This table reports the percentual data coverage of my sample relative to all German corporate income taxpayers. Column (1) shows the number of unlimited taxpayers in Germany in 2014. Column (2) reports the number of German corporations in Amadeus which meet the data requirements for the simulation approach.

4.IV. Results

4.IV.I Relative reform effects for European countries

Table 4.2 presents the relative revenue effects resulting from the abolition of minimum taxation in the European countries. First, the estimation provides the insight that countries will have to forego tax revenues of between 0.44 and 3.00 percent if they waive taxing a percentage of profits in periods of loss offset. In particular, in Italy, Lithuania and Portugal, the relative effect is comparatively small, which may be related to the relatively high share of offsettable income under minimum taxation (loss offset is restricted to 70 and 80 percent of income, respectively). In contrast, the effects are greater in Hungary and Slovenia due to a more restrictive minimum taxation regulation and therefore, an abolition of this restriction corresponds to a higher

concession to corporate taxpayers at the expense of tax revenues. Countries with a threshold up to which a full offset is possible can expect a budgetary deficit between 1.51 and 2.65 percent (France, Germany and Denmark). Second, the yearly estimations follow a declining trend in most countries, suggesting that the negative tax revenue effects dissipate over time. In Italy, there is even a positive effect in 2018 due to the reform, which leads to the conclusion that profits no longer have to be used to offset losses carried forward, but are subject to taxation in this year. Overall, a faster offsetting of losses due to a less restrictive regulation leads to an increase of future tax revenues since it is only a timing effect (only applies under the assumption that losses do not expire due to timing restrictions)[61].

Table 4.2: Relative reform effects in percent

Country	2015	2016	2017	2018	Overall
AT	- 3.21	- 3.25	- 2.08	- 3.45	- 3.00
DE	- 1.86	- 1.73	- 1.11	- 3.38	- 2.04
DK	- 2.72	- 2.81	- 3.35	- 1.82	- 2.65
ES	- 3.03	- 2.08	- 1.96	- 1.83	- 2.18
FR	- 2.99	- 1.49	- 0.82	- 0.69	- 1.51
HU	- 4.54	- 1.59	- 1.99	- 1.56	- 2.50
IT	- 1.30	- 0.95	- 0.88	1.05	- 0.55
LT	- 0.87	- 0.43	- 0.31	- 0.29	- 0.44
PT	- 1.42	- 0.64	- 0.66	- 0.42	- 0.79
SI	- 2.04	- 1.12	- 0.75	- 0.69	- 1.15

Notes: This table reports the relative reform effects on tax revenue in percent resulting from an abolition of minimum taxation. The relative effects correspond to the difference between the tax revenue of the reform scenario and the tax revenue of the current tax law in relation to the tax revenue of the current tax law.

The corresponding relative effects of the reform on the amount of accumulated tax loss carryforwards in a country can be found in Table 4.3. Firms can reduce their level of loss carryforwards up to 2.91 percent compared to the application of the minimum taxation restriction. Thus, the reform enables firms to reduce their (in some cases high) stocks of loss carryforwards relatively more. The comparatively small effects in Italy and Portugal may be caused by the fact that the use of losses up to the year 2010 (Italy) and 2013 (Portugal), respectively, was subject to a very restrictive time limit of five years. As a result, the volume of loss carryforwards is low in these countries.

[61] Only Spain and Portugal have time restrictions with regard to the utilization of loss carryforwards in 2014 (Spain: 18 years, Portugal: 12 years).

Table 4.3: Corresponding relative effects on the amount of tax loss carryforwards

Country	AT	DE	DK	ES	FR
LCF	- 1.18	- 1.14	- 1.95	- 2.51	- 0.90
Country	HU	IT	LT	PT	SI
LCF	- 1.50	- 0.55	- 2.91	- 0.76	- 1.50

Notes: This table reports the relative reform effects on the amount of tax loss carryforwards in percent resulting from an abolition of minimum taxation. The relative effects correspond to the difference between the tax loss carryforwards of the reform scenario and the tax loss carryforwards of the current tax law in relation to the tax loss carryforwards of the current tax law.

A split on the firm size should provide further insight into who benefits most from the reform. Thus, Table 4.4 displays the relative revenue effects for three different classes of firm size, hereby defining firms with a balance sheet total of 100,000 Euro as being small, firms with total assets of more than 1 million Euro as large firms, and all firms in between as medium-sized firms. The results show that small (and medium-sized) firms in Germany and Denmark do not benefit of the reform, as the threshold already enables a full loss offset. The same applies to Spain because the restriction only limits the loss offset if sales exceed 20 million Euro. The opposite effect can be observed in all other countries where especially small firms benefit from the reform.

Table 4.4: Relative reform effects in percent, split by firm size

Country	Small firms	Medium firms	Large firms
AT	- 19.5	- 4.88	- 3.00
DE	0	- 0.38	- 2.04
DK	0	0	- 2.65
ES	0	0	- 2.28
FR	- 5.80	- 1.03	- 1.50
HU	- 100	- 23.78	- 2.48
IT	- 0.96	- 0.67	- 0.53
LT	- 1.39	- 0.70	- 0.42
PT	- 3.04	- 1.10	- 0.70
SI	- 4.06	- 1.85	- 0.95

Notes: This table reports the relative reform effects in percent, subdivided by the firm size, resulting from an abolition of minimum taxation. Small firms are firms with total assets in 2014 of 100.000 Euro or less, medium-sized firms are firms with total assets in 2014 of more than 100.000 Euro but not more than 1 million Euro. Large firms have total assets in 2014 of more than 1 million Euro.

In principle, minimum taxation regulations have a lasting effect especially for firms with a very volatile earnings performance as losses accumulate. Therefore, I expect a higher relative reform effect for firms with a high volatility and split the sample firms with respect to their earnings volatility. A high volatility corresponds to a standard deviation of earnings above the mean of all standard deviations of the country. Firms with a low volatility are defined inversely. The results of Table 4.5 show a clear difference in favor of firms with a high volatility in Austria, Germany, Denmark, Spain and France. The effects in Italy and Lithuania are almost equal while there is a larger effect for firms with a low volatility in Hungary, Portugal and Slovenia. A cause for this reverse effect cannot be derived from the underlying estimates.

Table 4.5: Relative reform effects in percent, split by earnings volatility

Country	Firms with low volatility	Firms with high volatility
AT	- 1.14	- 3.82
DE	- 0.32	- 2.58
DK	- 1.26	- 2.79
ES	- 0.01	- 2.43
FR	- 0.03	- 1.86
HU	- 3.80	- 2.14
IT	- 0.88	- 0.47
LT	- 0.68	- 0.39
PT	- 1.73	- 0.67
SI	- 1.82	- 0.88

Notes: This table reports the relative reform effects in percent, subdivided by the firms' earnings volatility, resulting from an abolition of minimum taxation. High volatility firms have a standard deviation of earnings above the mean of all standard deviations of the country. The opposite holds for low volatility firms.

4.IV.II Absolute reform effect for Germany

A weakness of this estimation approach results from the underlying database, which covers a large proportion of all firms in the selected countries, but has large gaps due to missing balance sheet items, reducing the sample enormously. Therefore, the relative reform effect (see Section 4.III.IV) is not biased as long as the sample of simulation firms is a representative extraction of all corporations existing in a country. Since disclosure requirements often depend on size criteria, data coverage is better for large firms in particular than for small ones. However, in terms of quantity, there are more small and medium-sized firms than large corporations, so it cannot be assumed that the sample used is a representative extract of the total population (see the distribution of corporations in Germany with regard to the firm's size, Table 4.1). Against

this background, I estimate the absolute effects of the reform for Germany as an example, using corporate income and trade tax statistics.

Table 4.6 presents the estimation results for the absolute reform effect in Germany which corresponds to the sum of the extrapolated differences between the tax revenues of the reform scenario and the tax revenues of the current tax law. An abolition of minimum taxation in Germany results in a budgetary deficit of 5.784 billion Euro over the simulation period 2015 to 2018. The yearly estimates show that tax revenues are subject to variations since the offsetting depends on firms' performance. Since the accumulated loss carryforwards of unrestricted taxpayers amount to 638 billion Euro in 2014 according to the corporate income tax statistics (e.g., Statistisches Bundesamt, 2014), it can be expected that the balancing effect will not occur for a longer period. Nevertheless, this study only aims to an approximation of the costs of a tax loss offset reform, while theoretical and empirical studies provide evidence that corporate investment will increase with an increase in loss offsetting (e.g., Hoehl, 2022; Dreßler and Overesch, 2013). Therefore, greater profits may result due to an increase in loss offset, allowing for a faster return to a taxable status for German corporations and thus an increase in tax revenue in the long term.

Table 4.6: Absolute reform effects for Germany

Country	2015	2016	2017	2018	Overall
Tax revenue (in bn. Euro)	- 1.347	- 1.299	- 0.748	- 2.390	- 5.784

Notes: This table reports the absolute reform effects for Germany in billion Euro resulting from an abolition of minimum taxation. The absolute effect corresponds to the difference between the tax revenue of the reform scenario and the tax revenue of the current tax law.

4.IV.III Evaluation of the simulation model quality

In order to evaluate the forecasting accuracy of the simulation, the simulated values are compared with the real values achieved by these firms in the years 2015 to 2018. For this purpose, the simulation firms were uploaded into the online access of Amadeus. Due to continuous changing firm identifiers, a match was only possible for 1,168,168 firms. Therefore, the correlation coefficients in Table 4.7 are based on these observations.

Table 4.7: Forecasting quality

	2015	2016	2017	2018	Overall
Total assets	0.9679***	0.9266***	0.8832***	0.8420***	0.9017***
Profit/loss before taxes	0.6470***	0.5291***	0.4587***	0.3965***	0.5067***

Notes: This table reports the correlation coefficients of the simulated and realized values of total assets and profit/loss before taxes for each year and over all simulation periods.

These comparisons show that the forecast quality is satisfactory overall. The correlations between the forecasted and realized values with regard to the earnings before taxes range between 40 and 65 percent, while the relationship of the two different variables of total assets achieve coefficients between 84 and 97 percent.

4.IV.IV Discussion

The results of this study provide valuable estimates for legislators. Nevertheless, they are subject to certain limitations and assumptions. First, one limitation grounds on the underlying data quality. The investigation is based on annual financial statement data, as original micro-level tax return data is not available. Therefore, I consider the main relevant tax provisions, namely the exemption of dividends, the advantages of group taxation regimes and the loss offsetting. Despite this, discrepancies between the calculated and realized taxable income are possible. A further aspect with regard to the data quality is already mentioned in Section 4.IV.II and concerns the representativeness of the sample. It can be assumed that the relative reform effects (see Section 4.IV.I) are also dominated, in particular, by large firms. Anyhow, Table 4.4 also shows effects for small and medium-sized firms included in the sample.

Second, an advantage of the used microsimulation approach is the forward-looking estimation of tax revenue consequences. Therefore, the estimates are not based on the assumption that the effects of a future reform are comparable to those that would have occurred if the reform had already taken place in the past. But, a simulation can only be as good as the forecasting algorithm on which it is based. I thus rely on previous findings in the literature (e.g., Koch, 2014b; Oestreicher et al., 2014) and show in Section 4.IV.III that the simulated and realized values of total assets and earnings before taxes are highly correlated. Nevertheless, the development of a firm is static with regard to the development of the bin.

Third, the amount of dividends received relies on a simplified estimation. It neglects the fact that financial revenues also include financial income of equity investments like securities or bonds, for example. The approach of Oestreicher et al. (2014) of approximating dividends

received by distributed dividends of subsidiaries was not used due to the very incomplete coverage of corporate tax groups.

Fourth, a further limitation of this study refers to the estimation of tax loss carryforwards. They could be underestimated due to data gaps and the assumption that firms do not have any loss carryforwards prior to 1994. However, this second mentioned weakness exists only in countries that have had an unlimited loss offset rule for a long time. Furthermore, the stock of loss carryforwards increases over the simulation periods compared to 2014, applying the current tax loss carryforward regulations. Moreover, Oestreicher et al. (2012b) show that this estimation procedure has no significant effect on the relative change of tax revenues.

Despite these limitations, all in all the gained results are a first estimate of relative changes in tax revenue due to the abolition of minimum taxation in Europe. Future research should therefore concentrate on extrapolating the relative reform effects to absolute values for all other European countries, considering the differences between the distribution of available data and the population. Considering reliable behavioral responses due to the reform would also be a goal for future research. Because legislators need reliable estimates to assess the financial consequences of a reform and decide in favor of a less restrictive loss offset to incentivize investment.

4.V. Conclusion

The aim of this paper is to estimate the consequences on tax revenues due to abolishing minimum taxation in Europe using a firm-specific forward-looking microsimulation approach. Since the debate on an appropriate tax loss treatment is ongoing and empirical evidence shows that tax loss offset restrictions have real effects on corporate decisions, my results are relevant for legislators to be aware of the financial consequences resulting from reforming inter-period loss offsetting. My estimates show that countries would have to forego 0.44 to 3 percent of their tax revenues that would result without the abolition of minimum taxation. Separating the relative reform effect with respect to size and earnings volatility shows that large firms especially benefit from the reform if the current restriction reprieves small and medium-sized firms due to a threshold up to which an unrestricted offset is possible and that firms with a high volatility take a greater advantage of the reform than low volatility firms in some countries.

Since the relative reform effect is not biased as long as the sample of simulation firms is a representative extraction of all corporations existing in a country, I further extrapolate the

relative reform effects to absolute values for Germany. My results prognosticate a revenue deficit of 5.784 billion Euro for the first four years after an abolition of minimum taxation.

Overall, my results shed light on the relative tax revenue consequences resulting from abandoning minimum taxation in European countries. Future research should therefore take these relative effects up and should contribute to the estimation by extrapolating the relative reform effects to absolute values for other European countries, considering the differences between the distribution of available data and the population. Nevertheless, this and comparable studies can only serve as a basis for governmental decision-making. Ultimately, the decision to implement a reform must weigh not only the costs and benefits of the reform, but also the balance between government revenues and expenditures. Firms, at any rate, would welcome a less restrictive loss offset, as the state would participate comparatively more in losses.

4.VI. Appendix

Table 4.8: Overview of the minimum taxation regulations in 2014

Country	Minimum taxation regulation
Austria	loss offset restricted to 75% of income
Denmark	7,635 Mio. DKK without restriction, beyond that loss offset restricted to 60% of income exceeding this limit
France	1 Mio. € without restriction, beyond that loss offset restricted to 50% of income exceeding this limit
Germany	1 Mio. € without restriction, beyond that loss offset restricted to 60% of income exceeding this limit
Hungary	loss offset restricted to 50% of income
Italy	loss offset restricted to 80% of income
Lithuania	loss offset restricted to 70% of income
Portugal	loss offset restricted to 70% of income
Slovenia	loss offset restricted to 50% of income
Spain	turnover in the preceding year between 20 and 60 Mio. €: loss offset restricted to 50% of income, turnover in the preceding year over 60 Mio. €: loss offset restricted to 25% of income

Notes: This table presents the minimum taxation regimes in European countries in 2014.

Table 4.9: Distribution of simulation firms across countries

Country		Country		Country		Country	
AT	5,148	ES	410,251	IT	585,297	SI	41,799
DE	16,053	FR	518,524	LT	6,385		1,811,527
DK	1,768	HU	57,898	PT	168,404		

Notes: This table provides an overview of the distribution of simulation firms across European countries.

Table 4.10: Distribution of simulation firms across countries with a loss carryforward in 2014

Country		Country		Country		Country	
AT	1,592	ES	172,389	IT	257,458	SI	18,647
DE	3,518	FR	169,440	LT	1,703		742,711
DK	900	HU	33,119	PT	83,945		

Notes: This table provides an overview of the distribution of simulation firms with a loss carryforward in 2014 across European countries.

Table 4.11: Number of bins per country

Country		Country		Country		Country	
AT	100	ES	10,609	IT	14,161	SI	729
DE	841	FR	15,876	LT	100		
DK	25	HU	2,809	PT	4,900		

Notes: This table provides an overview of the number of bins used for the bin approach per country.

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5. Conclusion

The first two empirical studies in this thesis contribute to the literature on the effects of tax loss offset provisions on corporate investment behavior and thereby answer the call for research on the heterogeneity in the effect of taxes on investment (e.g., Jacob, 2022). The understanding of loss firms, the utilization and value of tax loss carryforwards, and how the existence of losses affects investment decisions has been imperfect (e.g., Hanlon and Heitzman, 2010). These two studies expand this understanding and inform policymakers about the positive effect of unrestricted tax loss offset provisions on the level of investment and acquisition activity. Finally, the third study of this thesis provides insights for legislators to the tax revenue consequences of a possible reform of tax loss offset provisions in Europe.

The first study examines the effect of corporate tax losses and their offsetting probability on investment decisions of firms. Using simulated marginal tax rates, which have the advantage of incorporating forward-looking expectations of corporate decision makers on the one hand and taking into account tax consequences in terms of the tax base on the other, the results show that losses and their offsetting probability have a significant effect on firms' investment behavior. This finding confirms the assumption that firms consider their firm-specific expectations about the emergence and use of losses when making investment decisions (e.g., Langenmayr and Lester, 2018; Auerbach and Poterba, 1987). Further, I provide evidence that the tax rate effect is the predominant decision factor of the corporate tax system. This aspect is important because quantifying the magnitude of the impact informs policymakers about the strength of the investment response. However, the main contribution of this study is the empirical verification that tax loss carryforwards have contrary effects – they increase investment from a tax perspective in order to achieve tax benefits resulting from offsetting loss carryforwards (e.g., Auerbach, 1986) and reduce investment from an economic perspective because of a lack of financial sources for further investment (e.g., Dreßler and Overesch, 2013).

In various cross-sectional tests, the understanding of the effects is deepened and the heterogeneity in the investment response identified. The results reveal that firms with repetitive losses and firms with financial constraints especially suffer from financing hurdles. Furthermore, firms that have only a short loss offset opportunity due to a limited loss carryforward have little incentives to increase their investments from a tax perspective compared to firms with long-term loss offset objectives, as achieving tax savings is more difficult due to the restrictive loss offset. Moreover, firms invest particularly in tangible assets and labor in order to achieve profits in the following periods that can be offset against

accumulated losses and refrain from long-term amortization assets like intangibles. All in all, the results are relevant for policymakers because they show that loss compensation is very important to encourage corporate investment. Based on the results, it is recommended to enact regulations that are as unrestrictive as possible so as not to discourage investment. In particular, an unlimited loss carryforward and no minimum taxation are recommended to enhance investment.

The second study investigates the impact of anti-tax loss trafficking rules on corporate acquisition decisions. Using European acquisitions, the results of this study show that the strictness of anti-tax loss trafficking rules have a negative effect on acquisitions of loss-carrying firms. Both the acquisition rate and the number of acquisitions of loss-carrying firms decrease with an increase in the severity of the rule, indicating that the stricter the anti-tax loss trafficking rules the lower the acquisitions of loss targets. When separating the effect, the findings on tightening the regulation suggest a reduced acquisition rate in targets with loss carryforwards, while the results for relaxing the restrictions indicate a positive significant impact in particular on the number of acquisitions of loss-carrying firms. Overall, the analyses provide evidence that the design of anti-tax loss trafficking rules affects acquisitions of targets with loss carryforwards. The policy implications of these findings are therefore that legislators should enact regulations that are as precise and targeted as possible, that apply exclusively to the intended purpose and do not penalize acquisitions that are less tax-motivated in order to pave the way for potentially profitable firms to recover, since the design of anti-tax loss trafficking rules affects the attractiveness and therefore the acquisition of targets with loss carryforwards.

The third study addresses the mentioned research necessity of the first study and estimates the tax revenue consequences for European countries resulting from an abolition of minimum taxation and thus relaxing loss offset regulations. Based on a firm-specific forward-looking microsimulation analysis, the estimates show that countries would have to forego 0.44 to 3 percent of their tax revenues that would result without the abolition of minimum taxation. Separating the relative reform effect with respect to size and earnings volatility shows that large firms especially benefit from the reform as the current restriction reprieves small and medium-sized firms due to a threshold up to which an unrestricted offset is possible and that firms with a high volatility take a greater advantage of the reform then low volatility firms in some countries. An extrapolation of the relative reform effects to absolute values prognosticates that Germany would have a revenue deficit of 5.784 billion Euro in the first four years after an abolition of minimum taxation. Therefore, the results support legislators in their decision on reforming the loss offset and serve as a basis to estimate the costs of such a reform.

Despite the results, which have an important contribution to the literature, the findings of this thesis are subject to several limitations as outlined in the respective chapters. Therefore, a brief summary of the main limitations should suffice here. The first limitation is the availability and quality of data. All three studies are based on financial accounting data since firm-level corporate tax return data is not accessible. By considering the main tax provisions, I comply with the attempt to capture as accurately as possible the real taxable income. In addition, it must be noted that the samples used are a distorted selection of the whole firm population, as large firms in particular are subject to greater disclosure requirements and are therefore covered relatively more than small companies. A further aspect with regard to the data is that there are gaps in the data. The second limitation of this thesis relates to the empirical identification and estimation approaches. In the first and third study, the results are based on simulations of taxable income. Although I have reconciled the forecasting algorithms to the objective of the respective study (e.g., Koch, 2014b), criticisms regarding for example stationarity remain. Furthermore, the second study is an aggregated country-level examination, which limits the ability to control for heterogeneity in acquirers' behavior and target firm characteristics.

Since the entire thesis deals with the impact of tax loss offsets, the level of tax loss carryforwards is essential. Thus, the third and final limitation with regard to this overview is the unavailability of the exact firm-level values of loss carryforwards. Against this background, an approximation is necessary. For an (almost) exact estimation of loss carryforwards, data from the date of incorporation would be required. Since this data is not available, at least long time horizons of the data are a benefit. This aspect particularly addresses the weakness of the second study. However, an underestimation of the amount of loss carryforwards must also be assumed in the other two studies. Despite estimating the level as accurately as possible, it must ultimately be trusted that the underestimation does not bias the results of the studies (e.g., Oestreicher et al., 2012b).

The results and limitations of the thesis point to further research opportunities. First, future research can contribute to a more complete understanding of the picture on how tax loss offset rules shape firms' investment decisions. The potential heterogeneity in investment responses to tax policy changes is an idea for future research since not all firms benefit equally from certain tax changes. Second, in the view of the second study, future firm-level investigations can contribute to the understanding how anti-tax loss trafficking rules affect the design of acquisitions. Third, estimating tax revenue consequences of other tax loss offset reforms (e.g., abandonment of time restricted tax loss carryforward provisions) inform legislators about the consequences for the states' budget. Finally, a potential area for future research is to provide

more insight into the magnitude of the effects that the tax rate and elements of the tax base can have on investment. Understanding the relative magnitudes, i.e., which items of the tax base affect firms more or less, is important not only for academics but also for policy makers as they balance potential investment responses against the revenue consequences of policy reforms.

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7. Declaration of own contribution

Study 1: *"Asymmetric Tax Loss Treatment and Corporate Investment Behavior: an Empirical Investigation using Simulated Marginal Tax Rates"*

- This study is single-authored.

Study 2: *"Anti-Tax Loss Trafficking Rules and the Acquisition of Loss-Carrying Firms"*

- This study is single-authored.

Study 3: *"How expensive is the Abolition of Minimum Taxation in Europe? An Estimation of Tax Revenue Consequences"*

- This study is single-authored.

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Rebecca Höhl

8. Declaration for admission to the doctoral examination

Ph.D. program in Economics

Declaration for admission to the doctoral examination

I confirm

1. that the dissertation “Essays on the Investment and Tax Revenue Effects of Tax Loss Offset Provisions” that I submitted was produced independently without assistance from external parties, and not contrary to high scientific standards and integrity,

2. that I have adhered to the examination regulations, including upholding a high degree of scientific integrity, which includes the strict and proper use of citations so that the inclusion of other ideas in the dissertation are clearly distinguished,

3. that in the process of completing this doctoral thesis, no intermediaries were compensated to assist me neither with the admissions or preparation processes, and in this process,
   - no remuneration or equivalent compensation were provided
   - no services were engaged that may contradict the purpose of producing a doctoral thesis

4. that I have not submitted this dissertation or parts of this dissertation elsewhere.

I am aware that false claims and the discovery of those false claims now, and in the future with regards to the declaration for admission to the doctoral examination can lead to the invalidation or revoking of the doctoral degree.

Goettingen, July 20, 2022

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Rebecca Höhl