Discussion Paper No. 10-097

Investment Impact of Tax Loss Treatment
– Empirical Insights from a Panel of Multinationals

Daniel Dreßler and Michael Overesch

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Non-Technical Summary

While profits are taxed, no immediate tax refund is granted if a corporation suffers losses. Losses can only be used to offset profits generated in other periods or by affiliated companies. The tax loss offset rules, however, significantly differ across countries. While only some countries grant a loss carryback option, a loss carryforward is always possible. Yet, in some countries the intertemporal loss offset is subject to time restrictions. Moreover, several countries have a group taxation which allows consolidation of profits and losses across affiliated firms.

This paper analyzes in how far multinational firms factor the differently strict tax loss treatment rules into their investment decisions. We consider two effects of tax loss treatment. First, we analyze whether the various types of conceivable loss offset provisions affect investment decisions when firms expect potential losses someday in the future. Secondly, we consider subsidiaries which have already suffered losses and analyze if their investment behavior changes once they have loss carryforwards.

For the empirical analysis, we use data of German multinationals taken from the Microdatabase Direct Investment of the German Central Bank (*Deutsche Bundesbank)*. Our data allows a comparison of the investment behavior of multinational subsidiaries in 41 host countries during the years 1996-2007.

Our results suggest that the existence of a group taxation rule in particular exerts a positive influence on investments, which is even stronger for firms with a relatively high probability to suffer losses. Regarding the investment structure, a group taxation regime makes multinational groups distribute their investments across more subsidiaries. Concerning the intertemporal loss offset, we find that investment levels are significantly affected by tax loss offset rules if a subsidiary operates in an industry where the probability to suffer losses is high. Interestingly, a broad time limit until unutilized losses forfeit, however, does not seem to hinder investments.

In the second part of our analysis, we trace effects of existing tax loss carryforwards on investment decisions. Our results suggest that the tax rate elasticity of investment actually is significantly reduced if a subsidiary can offset taxable profits with losses carried forward from previous periods.

Das Wichtigste in Kürze

Gewinne von Unternehmen werden im Jahr ihrer Realisierung besteuert. Verluste dagegen können steuerlich nur im Rahmen von Verlustverrechnungsregeln genutzt werden. Diese Regeln variieren von Land zu Land und über die Zeit. Nur einige wenige Länder gewähren einen Verlustrücktrag, ein Verlustvortrag hingegen ist überall möglich. In manchen Ländern ist der Verlustvortrag jedoch zeitlich beschränkt. Neben diesen intertemporalen Regeln zur Verlustverrechnung, bieten manche Länder ein Gruppenbesteuerungssystem, welches die Verrechnung von Gewinnen und Verlusten zwischen verbundenen Unternehmen ermöglicht.

Dieses Papier untersucht, inwieweit Unternehmen die unterschiedlich ausgestalteten Verlustverrechnungsregeln bei ihrem Investitionsverhalten berücksichtigen. Dabei betrachten wir zwei grundsätzliche Effekte der steuerlichen Verlustverrechnung. Erstens untersuchen wir, wie die unterschiedlichen Typen der Verlustverrechnung das Investitionsverhalten von Firmen beeinflussen, die potenziell mit zukünftigen Verlusten rechnen. Zweitens betrachten wir Tochtergesellschaften, die bereits Verluste erlitten haben und analysieren, ob sie ihr Investitionsverhalten angesichts der vorliegenden Verlustvorträge ändern.

Als Datengrundlage der empirischen Analyse dient die Direktinvestitionsdatenbank der Deutschen Bundesbank. Sie erlaubt den Vergleich des Investitionsverhaltens von multinationalen Tochterkapitalgesellschaften in 41 Ländern im Zeitraum 1996-2007.

Unsere empirischen Ergebnisse deuten darauf hin, dass insbesondere die Verfügbarkeit einer Gruppenbesteuerung das Investitionsverhalten positiv beeinflusst. Bei Firmen mit einem relativ hohen Verlustrisiko ist dieser Effekt besonders stark ausgeprägt. Hinsichtlich der Investitionsstruktur führt ein Gruppenbesteuerungssystem dazu, dass Investitionen über mehr Tochtergesellschaften gestreut werden. Im Hinblick auf die intertemporale Verlustverrechnung zeigt sich, dass insbesondere solche Firmen deutlich auf die Regelungsausgestaltung reagieren, die in Branchen mit hohem Verlustrisiko operieren. Eine zeitliche Begrenzung des Verlustvortrags scheint keinen negativen Einfluss auf Investitionen auszuüben, sofern der Vortragszeitraum hinreichend lang ist.

Im zweiten Teil unserer Analyse betrachten wir dann die Effekte existierender Verlustvorträge auf das Investitionsverhalten. Unsere Ergebnisse zeigen, dass die Steuersatzelastizität der Investitionen signifikant sinkt, wenn ein Unternehmen seine Gewinne mit Verlustvorträgen aus vergangenen Jahren verrechnen kann.

Investment Impact of Tax Loss Treatment

- Empirical Insights from a Panel of Multinationals*

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Abstract: We analyze the impact of tax loss treatment on the size and structure of multinational investments. Basically, two effects of tax loss treatment can be expected. First, firms make their investment decisions in the face of potential future losses. Then, the various types of conceivable loss offset provisions affect investment decisions. Secondly, existing loss carryforwards resulting from losses in the past affect the tax rate-elasticity of current investment decisions. The empirical analysis is based on data of German multinationals. The data is taken from the MiDi database provided by the German Central Bank (*Deutsche Bundesbank)*. Regarding the tax loss treatment of potential future losses, our regression results suggest that a short carryforward time limit lowers investments in industries having a high probability to make losses. Moreover, we find significant positive effects of group loss offsetting provisions on the size of investments and on the number of subsidiaries they are structured across. Concerning the effects of existing losses carried forward, we find a reduced tax rate elasticity of investments for companies shielded by existing losses.

Keywords: Corporate Taxation, Loss Treatment, Group Taxation, Multinational Firms, Empirical Analysis

JEL Classification: F23, H25, H32

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1. Introduction

Losses gain increased attention in times of economic crises. In such situations, countries support their banks and industrial enterprises. Grants are provided in the assumption that in the middle and long run, the respective company will recover and be able to repay the support. This is public interference in the face of private losses. What seems new has traditionally been embedded in the tax system of many states. By granting tax credits or reimbursing previously paid taxes for suffered losses, the state exerts an insurance function. Income taxation can therefore serve as a kind of automatic stabilizer (Devereux and Fuest, 2009; Buettner and Fuest, 2010). In this paper, we analyze the investment effects of tax loss treatment from the perspective of the potential beneficiary: the private company.

While profits are taxed, no immediate tax refund is granted if a corporation suffers losses. Losses can only be used to offset profits generated in other periods or by affiliated companies. The tax loss offset rules, however, significantly differ between countries. Almost all countries offer the opportunity to carry losses forward to subsequent periods. Across countries, the time span for a loss carryforward varies between two years and indefinitely. Moreover, a few countries also grant a loss carryback. Besides offering the possibility to shift losses along the time dimension, some countries also enable the offset of profits and losses among companies belonging to the same group. Interestingly, there is an overall tendency of relaxing the loss offset provisions during the last decade. While in 1996 31 out of 41 considered countries restricted the loss carryforward, in 2007 only 25 countries did so. The same holds true for the group taxation regimes which were granted in only 22 out of the 41 countries in 1996 but in 27 countries in 2007.

We aim at analyzing whether multinational firms structure their investments based on tax loss treatment rules. The different loss offset provisions, profit histories and particularly different probabilities to suffer losses provide for considerable variation for an empirical study. Multinational companies face the different tax loss offset rules and might consider the tax treatment when deciding on investments. The basic question to be answered is going to be if the tax loss treatment in the host country exerts an impact on investment decisions of subsidiaries. We analyze this question for two scenarios, regarding the investment impact of *potential* and of *present* losses. First, we look at how companies structure their investments in the general perception of potential future losses. In doing so, we focus on the size and structure of investments *potentially* generating losses in the future. Thereafter, we analyze

how subsidiaries react once they have already suffered losses and trace the determinants of investments *in the presence* of loss carryforwards. The policy implications might differ depending on which of the two strands is covered. A favorable tax loss treatment is expected to encourage multinational firms to invest more in that respective country. When taking account of the fact that firms are in different positions due to their respective loss history, the setup of the loss treatment rule naturally exerts effects on competition.

Our analysis relates to several previous empirical studies dealing with the impact of tax loss treatment on investment. Literature on this topic is comprehensive and can also be structured into two strands: investment aspects in sight of *potential* future losses and investment aspects in sight of *present* losses. Generally, there are numerous analytical papers, but empirical literature relating to investment aspects in sight of *potential* future losses is still rare. Early empirical studies by Hall and Jorgenson (1967) and by Cummins, Hassett and Hubbard (1996) suggest that firms react to loss offset restrictions by structuring their investments in a way that they can eventually net profits and losses. In their thorough empirical analysis, Devereux, Keen and Schiantarelli (1994) specifically trace the effects of restrictions on intertemporal loss offsetting using a panel of UK companies. While they conclude that including tax law asymmetries in a model does not improve its predictive power concerning investments, they also indicate that further research based on better micro data providing for more variation might possibly reveal that tax asymmetries have a more powerful impact on investment behavior.

For about two decades, the treatment of existing losses and the reactions of corporations have been analyzed empirically. Auerbach and Poterba (1987) present a comprehensive study based on Compustat data from 1981 to 1984. Besides concluding on aspects of loss carryforwards and financing, they reveal the concentration of losses in specific industries. The fact that tax loss treatment seems to differ in importance for firms depending on their respective industry has also been outlined in later studies by Cooper and Boynton (2004)[1] and by Altshuler et al. (2008).[2] We will elaborate on this variance in our empirical approach.

[1] The study by Cooper and Boynton (2004) is based on data from the Internal Revenue Service. It concludes that particularly the housing and the financial industry would benefit from the liquidity effect provided by extending the carryback from 2 to 5 years. Graham and Kim (2009) replicate their work by applying Compustat data and arrive at comparable results.

[2] Altshuler et al. (2008) trace the losses of the 2001 recession and distinguish by industries. Papers by Devereux (1989), Aarbu and MacKie-Mason (2003) and Cooper and Knittel (2006) also provide valuable insights that firms seem to structure their investments in a way that they can recover tax losses before they expire. A recent

In this paper, we aim at analyzing empirically the investment effects of tax loss treatment. Our empirical analysis is based on a rich firm level dataset on German multinationals provided by the German Central Bank (*Deutsche Bundesbank)*. The international variation in tax loss treatment is crucial for our analysis. We start with an analysis of effects when firms anticipate different tax treatments of *potential* future losses. First, we trace the effect of tax loss treatment on the amount of investments. We suppose that a company with a high probability to make losses will invest less if tax loss offsetting is restricted. Regarding the loss offset among affiliated companies, this is the case when no form of group loss offsetting is provided for. Our results suggest that the existence of a group taxation rule exerts a positive influence on investments, which is even stronger for firms with a relatively high probability to suffer losses. Concerning the intertemporal loss offset, we consider if there is no opportunity to carry back losses or a loss carryforward is limited. We find a significant influence if we consider the variation in industry probability to suffer losses in some years. Investment levels are significantly affected by tax loss offset rules if a subsidiary operates in an industry in which the probability to suffer losses is high. Moreover, we build on the strong results for a group taxation provision by taking a closer look at it. We analyze whether the possibility to offset losses among affiliated firms has an impact on the way companies structure their investments. Our results suggest that the number of subsidiaries per country, established by a multinational group, is indeed higher in those countries providing rules for loss consolidation between affiliated companies. If no group tax regime is available, multinationals tend to pool all activities carried in a host country within one subsidiary to ensure loss offsetting with profits from other activities.

In the second part of our analysis, we trace effects of *existing* tax loss carryforwards on investments. More precisely, we analyze to what extent the detrimental influence of a higher tax rate on investments is mitigated by an existing loss carryforward. Taking into account that future profits could effectively remain free of tax, existing losses should increase the quantity of investments and reduce the tax elasticity of investment. Our results suggest that, in fact, the tax rate elasticity of investment is significantly reduced if a subsidiary can offset current taxable profits with losses carried forward from previous periods.

The rest of the paper is organized as follows. In the following section we provide an overview of previous literature dealing with the effects of tax loss treatment and derive empirically

study of Edgerton (2009) shows that in the US, existing loss carryforwards limit the benefits of a newly granted bonus depreciation.

testable hypotheses. Thereafter, the data is presented in Section 3. In Section 4, we show regression results concerning the impact of tax loss treatment on investment behavior of firms which *potentially* will have losses. Section 5 presents empirical results on the effects of *existing* loss carryforwards. Finally, Section 6 concludes.

2. Investment Impact of Tax Loss Treatment

Basically, two effects of tax loss treatment can be distinguished. On the one hand, firms make their investment decisions in the face of potential future losses. Then, the various types of conceivable loss offset provisions should affect investment decisions. On the other hand, existing loss carryforwards resulting from losses in the past should affect the tax rate-elasticity of current investment decisions. Therefore, we follow the two strands found in the literature and distinguish between the impact of *potential* future losses and of *existing* losses. While the former case includes effects of tax loss regulations on all corporations potentially expecting losses, the latter only considers firms that have already suffered losses in the past and therefore have a loss carryforward.

2.1 Potential Losses

Tax Loss Treatment and Investments

If a company expects losses in the future, the loss treatment for tax purposes should affect the investment decision. Thus, it is not the subsidiary's tax status at the point of the investment decision that matters, but the country's tax regulations applicable to all companies and the firm's probability to suffer losses someday. An early fundamental paper on the impact of future *potential* losses is the work by Domar and Musgrave (1944). They compare the attractiveness of a riskless and a risky investment and analyze the influence of a tax loss treatment on an investor's readiness to assume risk. They conclude that, theoretically, a more generous loss treatment leads to a higher risk assumption.

Whenever a general full loss offset is denied, profits and losses are treated asymmetrically from a tax point of view. The theoretical implications of such asymmetries in tax loss treatment have been shown by Majd and Myers (1987) as well as Niemann (2008) for intertemporal loss offsets and by Donnelly and Young (2002) regarding the netting of losses within groups. All of these studies find a detrimental effect on investments caused by

unfavorable tax loss treatment - only the degree of the impact varies depending on which particular rule is regarded.[3]

The aspect of risk plays a crucial role in considering potential relationships between taxation and investments. The readiness to make risky investments might be influenced by the way profits are taxed and potential losses are considered. There has been a vivid discussion on taxation and risk in the literature. Mossin (1968), Näslund (1968) and Mintz (1981) analyze taxation and risk-taking. They conclude that in the full loss offset case, higher taxation increases risk averse investors' readiness to take risks, while in other settings the influence is ambiguous. Feldstein (1969) and Stiglitz (1969) by contrast oppose these analyses. According to them, no completely general theoretical assertion is possible and taxation might very well lead to risk reduction.

Eeckhoudt and Hansen (1982) pay particular attention to a partial loss offset and conclude that tightening it need not reduce the readiness to take risks. While MacKie-Mason (1990) stresses the potential benefits of nonlinear elements in the tax system, Eeckhoudt et al. (1997) point at supposed detrimental aspects. They show analytically that a tax regime restricting loss offsets lowers or even entirely abolishes the demand for risky investments of an otherwise risk-neutral firm. They conclude that the ratio of gross profit and the amount of tax exemption determines in how far risk aversion scales with gross profits.

All in all, the previous literature on risk-taking has found fairly clear predictions in a full loss offset scenario. In the real world, however, we find partial loss offsets with different degrees of tightness. Given the lack of a general theory on these real-world settings, an empirical test on how tax loss treatment affects investments, particularly embracing the aspect of risk, gains more importance. Therefore, we will analyze how the tax loss treatment of potential losses affects the size and structuring of investments of multinational firms.

The tax loss treatment differs among countries. While in almost all countries losses can be carried forward to subsequent fiscal years, only a few countries allow a loss carryback.

[3] Several works have shown that in an asymmetric tax system, counterbalancing rules can at least partly re-establish neutrality. Fane (1987), for example, suggests grossing up tax credits and liabilities by a risk-free interest rate and guaranteeing their consistency over time. By applying a real options approach, Niemann (1999) shows that there is a neutral depreciation schedule depending on the respective tax system. According to Panteghini (2005), neutrality can be approached by adjusting the firm's tax base depending on its level of returns.

Consequently, the value of the insurance provided by a tax loss offset regime differs among locations. While Domar and Musgrave (1944) discuss the loss offset provision in a rather general way, Barlev and Levy (1975) distinguish between the carryforward and the carryback provision. They show that the expiration of a loss carryforward essentially depends as much on the size of the loss suffered as on the sequence of consecutive profits and losses. They conclude from their analysis that a loss carryback provision is very valuable for increasing the probability of a successful offset, whereas the difference in effect between a limited and an unlimited loss carryforward is negligible.

A loss carryback results in an immediate cash inflow in form of a tax refund. Moreover, the past company results are well known and the consideration of an insecure future does not apply. Therefore, a loss carryback option for tax purposes should influence the investment decision even more strongly than an option to net profits and losses sometime in the future. The longer the granted carryback period, the stronger is the insurance. However, a carryback option effectively leads to tax refunds only if the subsidiary was profitable in the past.

It seems reasonable to suppose that the relevance of tax loss treatment differs among firms. We assume materialized losses to indicate that in the respective industry the general possibility of suffering losses is more strongly considered. Tax loss offsetting rules might be particularly important for firms having a high probability to suffer losses in some years. Taking into account the reasoning and findings by Auerbach and Poterba (1987) and Altshuler et al. (2008), we expect a particular effect of favorable tax loss treatment on firms engaging in very cyclical industries. Based on these considerations, we set up the following hypothesis:

H1: *The option of a loss carryback should foster investment because the tax refund serves as an insurance against part of the losses that are potentially to be suffered. The carryback option should particularly foster investing by firms that have a high probability to make losses.*

As mentioned above, only a few countries offer a loss carryback but all countries allow a carryforward of losses. Some countries, however, limit the maximum time span losses can be carried forward. The shorter the maximum time span which is provided for such intertemporal shifts, the higher is the risk of not being able to offset the losses. It can be assumed that companies invest less in countries where the time span potential losses can be carried forward

is limited. Once again, this consideration should particularly prevail for companies anticipating a high probability of suffering losses in several consecutive periods. Concerning the limitations of a loss carryforward, we set up the following hypothesis:

H2: *A smaller maximum number of years until the expiry of a loss carryforward should exert a detrimental effect on investment. The impact of limitations of a loss carryforward should be more pronounced for firms having a high probability of making losses.*

Loss offsetting along the time dimension is relevant when a single subsidiary is analyzed in an isolated way. If, however, a parent company has more than one subsidiary in a country, an offset among these different tax subjects might be attainable. This mitigates the need for profits earned by the loss making subsidiary itself to offset the loss. The major requirement for such an offset is a group taxation regime that allows the consolidation of profits and losses between affiliated companies. Different kinds of group taxation regimes such as group consolidation, group loss transfer, or consortium relief can be observed.[4] Despite differences in the respective setup, all these group taxation regimes enable the netting of profits and losses across group members. If a group taxation regime is in place, the risk that a loss forfeits is considered to be lower than if the intersubjective loss offset is denied. These considerations lead to the following hypothesis:

H3: *A group taxation regime should foster investments. The positive investment effect of a group taxation regime should be more pronounced for firms having a high probability of making losses.*

Group Taxation and Structure of Activities

If a country provides tax loss consolidation rules, a group could structure its investments by means of different separate legal entities. A multinational firm can split up the investments according to risks or business segments and in doing so benefits from limited liability. A well structured group of several subsidiaries in a country is likely to be appreciated by providers of capital. Becker and Fuest (2007) show analytically that symmetric taxation alone might

[4] In a consolidation system, the financial statements of companies belonging to the same group are either made up together or merged at the end of the fiscal year. When there is a system of group contribution, the profitable subsidiary is allowed to contribute a part or all of its profits to the subsidiary which suffered a loss. Correspondingly, losses are transferred among subsidiaries in a group relief system. In effect, all of these three systems enable the netting of profits and losses of different tax subjects.

ensure only partial neutrality because aspects of limited liability have to be taken into account.[5] In a group relief system, for example, losses can be offset for tax purposes while there is no need to effectively compensate the loss suffered by an affiliated company. Thus, the advantage of a possible tax loss offset comes free of any clearing requirements. In countries without a group taxation regime, however, the only way to ensure loss offsetting between different parts of the firm is incorporating all business activities in one legal entity. Therefore, we set up the following hypothesis regarding the impact of a group taxation regime on the structuring of investments:

H4: *The number of subsidiaries per country established by a parent company should be higher in those countries providing consolidation of taxable profits and losses of affiliated firms.*

2.2 Existing Loss Carryforwards

The tax treatment of losses should also affect investment decisions if a firm has *already suffered* losses and therefore has a loss carryforward. As derived analytically by Auerbach (1986), a loss carryforward might foster investments. Auerbach (1986) analyzes the effects of tax law asymmetries and finds different effects of a loss carryforward on investments, depending on its size and the profitability of a firm. A small loss carryforward should hinder investments. A bigger loss carryforward is supposed to give the advantage of temporarily setting the firm in a tax exempt position. If a firm has a loss carryforward, returns to investment can be credited against the losses carried forward. Thus, a firm with a loss carryforward is, to a certain extent, tax exempt. If we only consider the present and possible future status of a company and disregard the past, then the firm with a loss carryforward is supposed to invest more than a firm without the opportunity to reduce its future tax base. Given that there are sufficient funds to invest, this should result in an investment exceeding the one in a world without taxation or with a perfect loss offset.[6]

Nevertheless, there are also arguments suggesting a lower level of investment if a company has a loss carryforward. A company showing a loss carryforward has suffered losses in the

[5] The influence of limited liability on risk-taking is widely discussed in the empirical finance literature. See Esty (1998), Ang et al. (2000), Bitler et al. (2005), Kose et al. (2008) and Laeven and Levine (2009) for further insights. Due to the fact that we only consider corporations and disregard partnerships in this study, there is no variation in terms of liability limitations.

[6] In a subsequent study, Altshuler and Auerbach (1990) use tax return data for U.S. nonfinancial corporations and find an increasing amount of unused tax credits. Given the absence of investment incentives during the analyzed period, they base this rise in a restriction on the ability for firms to obtain refunds for tax losses.

past and therefore might lack internal financing. This could have a detrimental effect on investment levels. Moreover, in the case of multinational firms, this could lead to less investment if local managers have to run for capital provided by the parent company and losses signal that the business model of the subsidiary is not successful.

H5: *Based on the tax effect, an existing loss carryforward should result in a higher investment level. If liquidity or signaling effects prevail, the effect of a loss carryforward on the investment level should be negative.*

Moreover, the level of the corporate tax rate does not affect investment decisions anymore as a profit has a more positive net effect for the company with the loss carryforward. The company simply does not have to pay the entire profit tax, depending on the amount of past losses. While previous studies find negative effects of the corporate tax rate on investment decisions (for a survey on the tax effect on investments of multinationals see De Mooij and Ederveen, 2003), this general relationship should be alleviated once losses are present. In the presence of a loss carryforward, the taxrate elasticity of investments should be lower in absolute value, due to the fact that the company can net its carryforward against future profits, which then stay effectively untaxed. This supposed relationship has been worked out analytically by Creedy and Gemmel (2008).

In some countries, an alternative minimum tax requires that a company pays a minimum amount of taxes in a certain year although it has no taxable profits. Then, a subsidiary is obliged to pay a minimum amount of taxes, albeit a sufficient amount of losses carried forward is available to offset current profits. Therefore, the application of an alternative minimum tax countervails the effects of an existing loss carryforward on the tax rate elasticity of investment decisions. We set up the following testable hypothesis:

H6: *An existing loss carryforward should reduce the tax rate elasticity of investment decisions. A minimum tax should counteract this effect.*

3. Data and Descriptive Statistics

The empirical analysis uses the *MiDi* database for multinationals, which is provided by the German Central Bank (*Deutsche Bundesbank)*. The comprehensive micro database covers information on both direct investment positions held in Germany by foreign companies and direct investment positions of German enterprises held abroad. The data allows us to trace groups and their affiliates over time. Panel data is currently available for the period from 1996 to 2007. The data collection is imposed by German law which requires reporting for certain international transactions and positions.[7] This aspect of MiDi is worth emphasizing as we are thus able to observe virtually all major German outbound investments. In this study, we only analyze subsidiaries which are located outside Germany and are owned by a group having its headquarters in Germany.[8] Moreover, we exclude subsidiaries from the financial industry. We consider a sample of German subsidiaries located in 41 countries. This consists of the four BRIC countries[9], 29 countries which were members of the OECD in 2007[10], and the eight EU member states which were not OECD countries.[11]

In our basic regressions analyzing effects on investment decisions, we consider majority-owned and directly-held subsidiaries.[12] Our basic sample consists of 51,933 observations of 10,677 subsidiaries belonging to 4,142 German parent companies. In addition, we consider a different sample when testing Hypothesis 4, which deals with the impact of group taxation regimes on group structures. Since we analyze group structures, we only regard 100 percent participations but also include indirectly-held subsidiaries. In this case, we can use more than 80,000 observations for our regressions dealing with the fourth hypothesis. Note that this higher number of observations includes more than 15,000 observations of holding companies

[7] Sec. 26 of Foreign Trade and Payments Act (*Aussenwirtschaftsgesetz*) in connection with Foreign Trade and Payments Regulation (*Aussenwirtschaftsverordnung*). Since 2002, FDI has to be reported if the participation is 10% or more and the balance-sheet total of the respective foreign investment in Germany exceeds 3 million Euros. For details see Lipponer (2008). Though previous years showed lower threshold levels, we apply this one uniformly for all years in the panel. For general interpretations of the dataset from a tax and finance perspective see Mintz and Weichenrieder (2010).

[8] We exclude observations from mining, agriculture, non-profit and membership organizations because special tax regimes may be available. Furthermore, we exclude observations whose German parent is not an incorporated and legally independent entity, as well as subsidiaries which are not legally independent.

[9] The BRIC countries are Brasil, Russia, India and China.

[10] These covered OECD countries in 2007 are Australia, Austria, Belgium, Canada, The Czech Republic, Denmark, Finland, France, Greece, Hungary, Iceland, Ireland, Italy, Japan, Luxembourg, Mexico, The Netherlands, New Zealand, Norway, Poland, Portugal, The Slovak Republic, South Korea, Spain, Sweden, Switzerland, Turkey, The United Kingdom and The United States.

[11] These EU countries are Bulgaria, Cyprus, Estonia, Latvia, Lithuania, Malta, Slovenia and Romania.

[12] We restrict our basic sample to directly-held subsidiaries because more complex ownership structures might be associated with enhanced tax planning opportunities. Wamser (2008), for example, shows that the tax elasticity of investment decisions is different in the case of indirectly-held subsidiaries.

which are not included when it comes to the other hypotheses due to their general lack of fixed and intangible assets.

As dependent variable, we particularly consider the investment level in fixed assets of each subsidiary. Moreover, in the additional regressions dealing with group structures, the number of legally independent and incorporated subsidiaries held by the same German parent company in one host country serves as the dependent variable. In addition, we transform the number of subsidiaries held by a German parent in a certain host country to a binary variable having the value one if the number of subsidiaries is more than one, and zero otherwise.

The firm-level data provides information on the existence of current losses and losses carried forward. First, we use this information to construct a variable which indicates the probability to make losses for subsidiaries engaged in the same industry. This variable *LRI* is the loss ratio per industry measured as the ratio of observable loss situations in a certain industry in a year divided by all subsidiaries regarding that industry in that certain year. A higher value can serve as a proxy of a higher probability of making losses. In doing so, we identify firms which are likely to benefit more from a favorable tax treatment of losses.[13] Across the time dimension of our sample, the overall mean value of *LRI* rises from 0.264 in 1998 to its maximum of 0.291 in 2001 and then declines to 0.218 in 2007. A closer look shows cyclical changes of *LRI* in some industries while in other industries the probability to suffer a loss is less affected by changes in the overall economy. The food industry is an example for an industry which is almost unaffected by cyclical changes. Its value of *LRI* was 0.261 in 2001 and 0.262 in 2007. By contrast, the industry of data processing shows significant fluctuation in LRI of, for example, 0.473 in 2001 and 0.255 in 2007.[14] Secondly, we construct a dummy variable *LCF Exists* indicating whether the respective subsidiary has accumulated losses in the past that can be utilized for an intertemporal offset.[15] Notably, almost 30% of all observations show a loss carryforward.

[13] Alvarez and Koskela (2008) use volatility measures when analyzing the readiness to take risks. We will apply this convincing method here in categorizing industries ex post on the basis of their volatility in terms of positive and negative business outcomes.

[14] The subsidiaries showing the highest values of *LRI* across all years are those operating in the tourism industry (0.417), the housing industry (0.400) and the restaurant industry (0.398). Low values can be observed in the industries of advertising (0.115), market and opinion research (0.149) and the pharmaceutical industry (0.199).

[15] Our firm-level data only provides financial accounting data. We use the information on the existence of a loss carryforward taken from financial accounting as a proxy for the existence of a tax loss carryforward.

Furthermore, our study rests on the application of tax variables described in the following. First of all, we consider the statutory corporate tax rates for each host country in each year. Secondly, in our case, the tax loss treatment regulations are of major importance. The time spans in which losses can be carried back or forward differ strongly both between countries and over time. The maximum loss carryback period is six years; but only six of the analyzed countries offer a loss carryback at all. The carry backward period amounts to two and a half years on average across those countries providing for such a rule. Table 7 in the Annex shows the countries where it is generally possible to carryback losses. We form a dummy variable *Carryback Option* which equals one if a host country provides for a carryback rule and the subsidiary had profits in the past. [16] Therefore, the dummy variable is one if the subsidiary is in effect individually able to carryback losses.

In 2007, the loss carryforward is limited in time in 25 countries while there are no limitations in 16 out of the 41 countries considered. However, eight of the latter countries restrict the loss carryforward during some of the covered years. Seven of those 25 countries which restrict the loss carryforward grant a limit of at least ten years in 2007. In five countries, a loss can no longer be utilized after seven to nine years; one country shows a barrier of six years and twelve countries set their barriers at five years. Please refer to Table 5 in the Annex for a detailed overview of the loss carryforward provisions. First, we use a dummy variable *LCF limited*, which is one if the maximum time a loss can be carried forward is limited, otherwise it is zero. Secondly, we split up the variable indicating whether the loss carryforward is limited. The dummy variable *LCF limited* ≤ 5 is one if a loss carryforward is limited up to 5 years while the dummy *LCF limited* >5 indicates if a loss carryforward is limited but does not expire during a time span shorter than 6 years.

Moreover, we consider the possibility to consolidate losses within a group of firms. While cross-border loss offset is hardly ever allowed, some host countries offer a loss consolidation between affiliated companies located in that respective country. More precisely, 27 of the 41 considered countries offer the possibility of national group taxation in 2007. Our variable *Group Taxation* shows whether or not such a rule exists in the respective country and year. In nine of these countries, the regulations show variation across the considered years. Table 8 in the Annex provides further insights in group taxation rules in the analyzed countries. Furthermore, we regard the existence of a minimum taxation rule. We consider a binary

[16] As only very few countries provide the opportunity for a loss carryback, we do not distinguish between different time frames when it comes to loss carryback options.

Table 1: Descriptive Statistics

Variable	Definition	Sample A		Sample B	
		Mean	Std. Dev.	Mean	Std. Dev.
Fixed Assets	Fixed and intangible assets reported in the financial statements; measured in EUR '000.	12,653	75,061	8,931	69,191
Number of Subsidiaries	The number of subsidiaries of one German-based group in one specific country outside Germany in a given year.			1.353	1.261
Various Subsidiaries	Dummy variable showing if the parent company has more than one (1) or only one (0) subsidiary in a country in the respective year.			.179	.383
Former Profit	Dummy variable showing if the company had (1) or did not have (0) a profit in the previous period.	.737	.440		
Count Industries	Number of industries a group conducts business in. This count variable is based on the NACE industry classification.			2.275	1.660
Loss Ratio per Industry (LRI)	The loss ratio of the industry, i.e. observed losses in a certain industry during a year divided by all observations of this industry in this year.	.256	.055		
LCF Exists	Dummy variable showing if the subsidiary regarded has (1) or does not have (0) a loss carryforward.	.290	.454		
Tax Rate	Statutory profit tax rate	.320	.068	.324	.071
Carryback Option	Dummy variable showing if the company can (1) or cannot (0) carryback potential future losses. If the variable is 1, the company had profits in the past and resides in a country offering a loss carryback rule.	.181	.385		
Group Taxation	Dummy variable showing if the country of the subsidiary provides (1) or does not provide (0) for the netting of profits and losses of different legal entities. Group relief, group contribution or other consolidation rules are considered as equivalents.	.669	.471	.693	.461
LCF limited	Dummy variable showing if a country limits (1) or does not limit (0) the maximum time a loss can be carried forward without forfeiting.	.644	.479		
LCF limited ≤ 5	Dummy variable showing if there has been a maximum loss carryforward period of five or less years (1) or if the barrier was broader or even nonexistent (0).	.331	.470		
LCF limited > 5	Dummy variable showing if there has been a limited maximum loss carryforward period of six or more years (1) or not (0).	.314	.464		

Table 1: Continued

Variable	Definition	Sample A		Sample B	
		Mean	Std. Dev.	Mean	Std. Dev.
Mintax	Dummy variable showing if a country has (1) or does not have (0) a minimum taxation rule.	.229	.420		
GDP	Gross Domestic Product measured in billion current USD.	1,725	2,979	1,750	3,000
GDP per Capita	Gross Domestic Product per home country national; measured in current USD '000.	24.890	14.464	25.620	14.139
Inflation Rate	Inflation rate based on consumer prices.	.032	.050	.033	.092
CountryRisk	OECD Country Risk Classification Method measures the country credit risk. Risk categories span from a low credit risk (0) to a high credit risk (7).	.756	1.397	.670	1.358

Sample A is the basic sample and consists of 51,933 observations. Sample B is applied for Hypothesis 4 and consists of 80,282 observations. Firm-specific variables are derived from the MiDi database of the German Central Bank. The tax variables are derived from information taken from the IBFD Tax Handbooks and the Worldwide Corporate Tax Guides by Ernst & Young. *GDP*, *GDP per Capita* and *Inflation Rate* stem from the World Development Indicators, edition 2009. *Country Risk* is based on information provided by the OECD.

variable *Mintax* which is one if a minimum taxation rule is applied. Table 6 in the Annex covers the aspect of an existing minimum taxation across the considered countries and years. As non-tax control variables, we apply data from various sources. We use host country *GDP*, *GDP per Capita*, and the *Inflation Rate*, all taken from the World Bank's World Development Indicators. The *Country Risk* scaling from 0 to 7 with higher values corresponding to higher risk is derived from the OECD. Table 1 summarizes all variables employed in this study.

4. Impact of Tax Treatment of Potential Future Losses

4.1 Tax Loss Treatment and Investment Levels

We start with a test of the hypotheses set up in Section 3.1 dealing with the impact of tax loss treatment rules on investments.

Estimation Approach

As dependent variable we consider the balance sheet item fixed assets of subsidiary *i* in year *t*. We estimate equations of the following type:

$$ln(Fixed\ Assets)_{i,\,k,\,t} = \beta_0 + \beta_1 ln(Fixed\ Assets)_{i,t-1} + \beta_2 TaxRate_{i,t} + \beta_3 LRI_{k,\,t} + X_{i,t}\beta_4 + \delta_i + \gamma_t + \varepsilon_{i,k,t} \quad (1)$$

First, we take into account the persistence of the fixed assets by using a dynamic model which captures adjustment costs (Chirinko, 1993). In this sense, the approach reflects the marginal decision of the firm in terms of the scale of investment conditional on the chosen location. Moreover, we consider the statutory tax rate, a vector of non-tax controls X and a subsidiary-specific effect δ_i as well as a year effect γ_t. Furthermore, the variable LRI considers the loss probability measured by the ratio of loss making companies per year in industry *k*.

Two aspects of our econometric model are worth mentioning. First, we control for subsidiary-specific heterogeneity, which is eliminated by taking first differences. Secondly, we capture dynamics by including the fixed assets from a previous period. Note that this dynamic specification corresponds to the marginal decision of the firm on how much to invest over time. Yet, such a specification requires considering that our time-series information is not sufficient to avoid what is called a dynamic panel bias (Nickell, 1981). We therefore follow the literature and apply the generalized method of moments (GMM) estimator suggested by Arellano and Bond (1991). We report two-step difference GMM estimations and standard errors which are corrected for finite sample bias (Windmeijer, 2005). Lagged levels are used to instrument the lagged dependent variable.

As pointed out above, losses can be offset among tax subjects and over time. Therefore, we subsequently include the dummy variables described in Section 4, which indicate whether a group taxation regime, a loss carryback option or a limitation of the loss carryforward is applied in the respective host country. Moreover, each of these variables interacts with the loss ratio of the industry. The coefficients of these interaction terms show whether the effects of the tax loss treatment rules are more pronounced for subsidiaries that are supposed to have a higher probability of suffering losses.

Regression Results

Table 2 shows the regression results dealing with the investment impact of tax loss treatment rules. While column (1) shows regression results according to the equation stated above, the additional specifications regard the potential effects of the tax loss treatment on investments. Apart from coefficient estimates and standard errors, we report the Arellano and Bond (1991)

test on auto-correlation of residuals. The validity of the GMM-estimator relies on the absence of second-order auto-correlation. The numbers shown in Table 2 are *p*-values, suggesting that no significant second-order auto-correlation exists. Finally, the Hansen J-test (Hansen, 1982) of over-identifying restrictions indicates that the validity of $Fixed\ Assets_{i,t-2}$ as an additional instrument cannot be rejected at any reasonable level of significance.

As found in previous studies, our results confirm that the tax rate has a negative impact on investment levels. The point estimator of column (1) suggests that a tax rate which is one percentage point higher is associated with 0.325 percent less investment in fixed assets. However, this is only a short-run effect. Provided that we employ a dynamic estimation approach, the long run effect amounts to -0.543.[17]

Let us briefly discuss the effects of the control variables. A profit in the former period leads to higher investments, which can be attributed to increased liquidity as well as to positive signaling effects if local managers run for investment funds provided by the CEO. We do not find significant effects for the size of the host country's local market indicated by the GDP. This seems to come as a surprise, but it should, however, be taken into account that we estimate in first differences. Therefore, our approach removes time-invariant cross-country variations from the regressions. The GDP per capita, which can be interpreted as a proxy of labor costs, shows a positive and significant coefficient. This can be explained by the substitution effect between labor and capital in the production process. In the face of high labor costs, labor is substituted by capital, which is our dependent variable. Regarding the country risk, our results suggest that a higher country risk is associated with less investment by subsidiaries of German multinationals. Finally, we find a positive effect of the inflation rate on investment in fixed assets. This finding can be explained by the advantage of intra-group exchanges and an increased incentive for real investments as compared to investments in the capital market.

Specifications (2) and (3) take into account the influence of a group taxation regime. As the regression results in column (2) show, the existence of a group taxation rule exerts a significant positive effect on the stock of fixed assets, which is our measure for investments. The size of the effect amounts to 0.205, meaning that in a country enabling the netting of

[17] By assuming that $ln(Fixed\ Assets_{i,t}) = ln(\ Fixed\ Assets_{i,t-1})$ in the long-run equilibrium and by rearranging Equation (1), the long-run effect can be calculated as $\beta_2/(1-\beta_1)$. Using the point estimators of column (1) in Table 2, the long run effect is -0.325 / (1-0.402) = -0.543.

profits and losses of different tax subjects belonging to the same group, investments are 20.5 percent higher than in countries not providing for such a rule. Moreover, we consider the probability of making losses by the variable *LRI*; however, we do not find any statistically significant effect for the plain *LRI* variable. In column (3) we insert an interaction term between the dummy variable, indicating that a group taxation regime exists, and the loss ratio of the industry. The additional positive coefficient for the interaction suggests that the existence of a group taxation regime is even more relevant for subsidiaries facing a relatively high risk of suffering losses.

We proceed with an analysis of the inter-temporal tax loss treatment. The hypothesis H1 states that a company which has the opportunity to carryback potential losses should invest more because it does not have to bear the full loss itself. The regression result in column (4) indicates that the option of a loss carryback might really exert a positive impact on investments; but, as regressions (5) and (6) reveal, this conclusion cannot be drawn once we control for a profit in the previous period. These results suggest that it is the previous profit of the subsidiary which drives investment. By contrast, the additional opportunity to receive a tax refund if losses can be carried back to that previous period has no significant impact on investment. Given that the interaction term between the dummy indicating a carryback option and the industry-level probability of making losses in column (6) is insignificant, this is also true for firms operating in industries with a higher loss probability. It should be mentioned, however, that only six of the considered countries allow a loss carryback and that the variation across time is limited regarding this aspect (see Table 7 in the Annex). Therefore, the results should be interpreted with some caution.

Furthermore, we analyze whether a limitation of the time span a loss can be carried forward exerts a negative effect on investment decisions. Column (7) shows a negative, but not statistically significant impact of such a barrier on investments. In column (8), we again differentiate between firms which are rather unlikely to suffer losses and firms operating in industries associated with a high probability of making losses. The interaction term of the dummy indicating the existence of a loss carryforward limitation and the loss ratio of the industry shows a significant negative coefficient. This means that companies facing a higher probability of suffering losses in the future tend to invest less in countries limiting the maximum period of a loss carryforward. The observation of a differing effect of the tax loss

Table 2: Investment Effects of Tax Loss Treatment Rules

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
ln (Fixed Assets$_{t-1}$)	.402***	.403***	.404***	.403***	.402***	.402***	.404***	.404***	.404***
	(.036)	(.036)	(.036)	(.036)	(.036)	(.036)	(.036)	(.036)	(.036)
Tax Rate	-.325***	-.339***	-.338***	-.341***	-.340***	-.339***	-.347***	-.343***	-.333***
	(.123)	(.123)	(.123)	(.123)	(.123)	(.123)	(.124)	(.124)	(.124)
LRI	.056	.054	-.137	-.132	-.136	-.138	-.136	.080	.093
	(.064)	(.065)	(.112)	(.112)	(.112)	(.112)	(.112)	(.155)	(.156)
Group Taxation		.205***	.129**	.131**	.130**	.133**	.132**	.145**	.151**
		(.059)	(.066)	(.066)	(.066)	(.066)	(.066)	(.067)	(.069)
(Group Taxation) x LRI			.292**	.289**	.290**	.278**	.291**	.240*	.225*
			(.127)	(.127)	(.127)	(.131)	(.127)	(.131)	(.132)
Carryback Option				.033**	.021	.008			
				(.016)	(.017)	(.041)			
(Carryback Option) x LRI						.052			
						(.135)			
LCF limited							-.012	.056	
							(.015)	(.035)	
(LCFlimited) x LRI								-.272**	
								(.126)	
LCF limited $\leq$5									.112***
									(.044)
LCFlimited>5									.015
									(.037)
(LCF limited $\leq$5) x LRI									-.462***
									(.153)
(LCF limited> 5) x LRI									-.107
									(.134)
Former Profit	.018***	.018***	.018***		.015**	.015**	.018***	.018***	.018***
	(.007)	(.006)	(.006)		(.007)	(.007)	(.006)	(.006)	(.006)
ln (GDP)	-.440	-.316	-.287	-.322	-.301	-.305	-.265	-.264	-.260
	(.369)	(.371)	(.371)	(.371)	(.371)	(.372)	(.372)	(.372)	(.372)
ln (GDP per Capita)	.953***	.844**	.810**	.849**	.825**	.830**	.788**	.790**	.780**
	(.370)	(.372)	(.373)	(.372)	(.373)	(.374)	(.374)	(.374)	(.374)
Inflation Rate	.035*	.036*	.036*	.036*	.036*	.036*	.036*	.036*	.036*
	(.021)	(.021)	(.020)	(.020)	(.020)	(.020)	(.020)	(.020)	(.020)
Country Risk	-.036***	-.037***	-.036***	-.036***	-.036***	-.036***	-.036***	-.036***	-.035***
	(.010)	(.010)	(.010)	(.010)	(.010)	(.010)	(.010)	(.010)	(.010)
Observations	51,933	51,933	51,933	51,933	51,933	51,933	51,933	51,933	51,933
Subsidiaries	10,677	10,677	10,677	10,677	10,677	10,677	10,677	10,677	10,677
Number of IVs	62	63	64	64	65	66	65	66	68
AR(1) – test	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AR(2) - test	0.831	0.865	0.875	0.849	0.878	0.878	0.871	0.871	0.869
Hansen *J*-test	0.168	0.170	0.175	0.167	0.175	0.173	0.175	0.177	0.179

Dependent Variable: ln (Fixed Assets). Year dummies for 1997-2007 are included but not reported. Estimations in first differences follow Arellano and Bond (1991). Robust standard errors using the Windmeijer (2005) correction, are shown in parentheses. *, ** and *** show significance at the level of 10%, 5% and 1 % respectively. Numbers reported for the Hansen *J*-test of overidentification restrictions and for the test of 2nd order auto-correlation (AR(2)) are *p*-values.

treatment depending on the respective firm's industry confirms the analyses by Auerbach and Poterba (1987) and by Altshuler et al. (2008).

Finally, in column (9) we distinguish between a short period losses can be carried forward ($\leq$ 5 years) and a longer time span until a loss carryforward expires (> 5 years). Only in the case of the short carryforward period, we find a statistically significant effect for the interaction term with the industry-level loss probability. This means that a tight limit of the maximum loss carryforward period exerts a negative impact on investments of firms operating in industries where the probability to suffer losses is relatively high. The second interaction term covering the product of industry loss ratio with the dummy on observations where the carryforward is limited to periods between six and twenty years proves to be insignificant. This suggests that it hardly seems to have an impact on investment decisions if the loss carryforward is unlimited or if it forfeits after a rather long time span.[18] The different observable impact of the loss carryforward restriction depending on its severity reflects the expectations expressed in the previous literature.[19]

4.2 Group Taxation Regimes and Structure of Activities

Taking into account our strong results for the impact of the existence of a group taxation regime on investment decisions, we provide an additional analysis dealing with the impact of group taxation regimes on the structure of national subgroups of multinational firms. Here, a national subgroup includes all incorporated and wholly-owned subsidiaries located in a certain host country and belonging to the same German parent company. Tracing our hypothesis H4, we analyze whether the possibility of offsetting profits and losses between affiliated subsidiaries affects the legal structures of the activities in a host country.

Estimation Approach

First, we analyze the probability that there are several instead of just one subsidiary established by a certain German parent firm in the respective country. As the dependent

[18] The counterintuitive positive effect of *LCF limited* ≤ 5 only measures a hypothetical fraction of the overall effect and will not show this impact in reality. This can be seen by calculating the overall effect. The 1%-percentile of *LRI* shows a value of .167. Therefore, the overall effect is about zero for this lower boundary of LRI (0.167 x (-0.462) + 1 x 0.112 = 0.03) and negative for the rest of the sample covering industries with a higher probability to suffer losses.

[19] While the considerable effect of a severe carryforward limitation confirms the expectations by Eeckhoudt et al. (1997), the insignificance of limitations in longer time spans is in line with Barlev and Levy (1975) and MacKie-Mason (1990).

variable, we consider a binary variable indicating if a German parent company has organized its activities in a country by more than one subsidiary. If all activities carried out by a group in that respective host country are pooled within one subsidiary, the variable is zero.[20]

Formally, the decision of parent company *j* to structure its activities in a host country *h* in year *t* across more than one subsidiary is modeled as a discrete choice decision problem and is captured in an econometric model using a standard latent variable framework. Suppose that the observable decision to either use more than one subsidiary, y_{jt}, or to use only one subsidiary is related to the latent predisposition to use more than one subsidiary, y_{jt}^*, according to $y_{jt} = 1[y_{jt}^* > 0]$ where $1[.]$ is the indicator function. Suppose furthermore that a parent's predisposition towards using more than one subsidiary per host country is a function of the existence of group taxation and a vector *X* of firm- and host country-specific characteristics, a common period-specific effect γ_t, an unobservable parent-specific effect c_j and a residual $\varepsilon_{j,h,t}$. Choosing a linear specification for the latent variable provides us with

$$y_{jt}^* = \beta_1 Grouptaxation_{h,t} + X_{it}\beta_2 + \gamma_t + c_j + \varepsilon_{jht} \tag{2}$$

where β_1 and β_2 are the (vectors of) coefficients to be estimated.

We apply a fixed effects logit model (Chamberlain, 1980) for this estimation.[21] The fixed effects model assumes that the error $\varepsilon_{j,h,t}$ is distributed symmetrically around zero, with accumulative distribution function *G*. The binary response model thus takes the form

$$\begin{aligned} P\left(y_{jt} = 1 \middle| Grouptaxation_{ht}, X_{jt}, c_j\right) &= P\left(y_{jt}^* \middle| Grouptaxation_{ht}, X_{jt}, c_j\right) \\ &= G\left(\beta_1 Grouptaxation_{h,t} + X_{it}\beta_2 + \gamma_t + c_j\right) \end{aligned} \tag{3}$$

Secondly, the number of subsidiaries held by a German parent company in one country should be affected by the existence of a group taxation regime. In this case, we estimate a Poisson model. We model the number of subsidiaries *n* held by a German parent company *j* in a foreign country *h*. We are interested in the expected value of n_{jh} conditional on some control

[20] Note that we consider only those host countries where the respective parent company controls at least one subsidiary.
[21] A concise introduction to the logit model is provided by Winkelmann (2009).

variables X_{jh}, $E(n_{jh}|X_{jh})$, where X_{jh} contains, for instance, the country-specific variable indicating if a group taxation regime is applied. One way to express this is to use the exponential function as a functional form, $E(n_{jh}|X_{jh}) = \exp(X'_{jh}\beta)$. To determine the probability of n_{jh} given X_{jh}, we further assume a Poisson distribution with expectation $\lambda_{jh} \equiv \exp(X'_{jh}\beta)$. This implies the following probability function:

$$f(n_{jh}|X_{jh}) = \frac{\exp(-\lambda_{jh})\lambda_{jh}^{n}}{n!}, \qquad n = 1,\ 2,\ 3,... \tag{4}$$

In order to obtain the Poisson regression model, we use the above functional form for the intensity parameter λ_{jh} to construct the loglikelihood function. Subsequently, we can estimate the vector β using maximum likelihood methods.[22]

In both the panel logit estimation and the panel Poisson estimation, robustness of the standard errors is achieved by bootstrapping standard errors as suggested by Cameron and Trivedi (2009).[23] We apply fixed effects on the group level. We consider the same set of country level control variables as in the regressions dealing with investment decisions. In addition, we use a control variable which covers the number of industries the parent company operates in. We expect that a group which shows business activities in different industries will automatically structure its investments in a more sophisticated way.

Regression Results

Table 3 shows the regression results. Columns (1) to (4) refer to the panel fixed effects logit model, while columns (5) to (8) show the results for the count data model. All of the estimations relate to Hypothesis 4, predicting that the possibility to net profits and losses within the group should lead to a more distributed structure of investments.

[22] For general descriptions of the econometric setup of the Poisson estimation we refer to Cameron and Trivedi (2009) and Winkelmann (2008).

[23] Following the analysis of Andrews and Buchinsky (2002), we apply 400 repetitions.

Table 3: Effects of Group Taxation Regimes on Group Structures

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Group Taxation	.688***	.687***	.159**	.126**	.206***	.203***	.050***	.041***
	(.059)	(.058)	(.067)	(.074)	(.019)	(.017)	(.015)	(.014)
Count Industries		.303***	.316***	.317***		.102***	.100***	.100***
		(.030)	(.032)	(.034)		(.008)	(.007)	(.007)
ln (GDP)			.424***	.421***			.121***	.120***
			(.027)	(.026)			(.011)	(.010)
ln (GDP per Capita)			.272***	.169***			.061***	.035***
			(.041)	(.055)			(.009)	(.013)
Country Risk				-.085***				-.023***
				(.032)				(.007)
Inflation Rate				-.059				.022
				(.340)				(.023)
Observations	52,762	52,762	52,762	52,762	80,282	80,282	80,282	80,282
Groups	1,555	1,555	1,555	1,555	4,787	4,787	4,787	4,787
Log Likelihood	-22,962	-22,720	-21,648	-21,634	-89,390	-89,059	-88,037	-88,026

Columns (1) to (4) show the results of the panel logit estimation.The dependent variable is a binary variable indicating if a national subgroup of the same German multinational firm consists of more than one subsidiary. Columns (5) to (8) show the results of the Poisson estimation model. The dependent variable is the number of subsidiaries belonging to a national subgroup of the same German multinational firm. Fixed effects on group level are considered. Year dummies for 1997-2007 are included but not reported. Bootstrapped standard errors with 400 repetitions are shown in parentheses. *, ** and *** show significance at the level of 10%, 5% and 1 % respectively.

First, the results of the logit panel regressions presented in columns (1) – (4) of Table 3 show a positive effect for a group taxation regime on the existence of at least two separately incorporated subsidiaries of the same German parent company in the respective host country. There is a higher probability of establishing more than one subsidiary in a country having a group taxation rule than in one lacking such a rule. The size of the estimated coefficient of about 0.13 means, that the probability of founding two or more subsidiaries instead of just one subsidiary in a specific country rises by 13 percent if this country enables the netting of losses between legal entities. Therefore, the results suggest that a group taxation regime influences the way multinational groups structure their investments.[24]

The count model in estimations (5) to (8) leads to comparable results as the logit panel regression. According to the full scale estimation (8), about 4% more subsidiaries per group can be counted if a group taxation rule is offered.

[24]As a robustness check, we also estimated specifications similar to those presented in Columns (1) – (4) of Table 3 using a linear probability model. Those estimations all lead to qualitatively very similar results as the panel fixed effects logit model.

The control variables show the expected signs. A group having a higher variability of different industries establishes more subsidiaries per country. In the full scale estimation (4), for example, the size of this effect amounts to 0.317. This means that the probability of founding more than one subsidiary in a country increases by 31.7% if the German parent company is engaged in one more industry. The market size, approximated by the GDP of the host country, has a strong and positive effect on the number of subsidiaries founded there. GDP per capita, which serves as an indicator for both labor cost and the purchasing power in the host country, also shows a positive sign. The country risk control variable shows the expected sign and is significant. Since a higher value of the country risk variable represents a higher country risk, the negative sign indicates that the foundation of several instead of just one subsidiary is less likely in riskier countries. This finding suggests that a centralized structure might be assumed to be superior for avoiding fraud and for monitoring business in riskier countries.

5. Effects of Existing Losses Carried Forward and Investment Decisions

In this section, we consider existing losses carried forward. We aim at testing the impact of an existing loss carryforward on investment decisions.

Estimation Approach

In tracing Hypotheses 5 and 6 dealing with the effect of an existing loss carryforward on investment decisions, we consider investment levels of each subsidiary as the dependent variable. We use an empirical setting which is very similar to the one presented in Section 4.1. Again, we consider a dynamic specification that takes into account adjustment costs of the fixed asset stocks. As explanatory variables we consider the statutory tax rate, a vector of non-tax controls and a subsidiary-specific effect δ_i as well as a year effect γ_t. Again, we apply the GMM-estimator suggested by Arellano and Bond (1991).

Here we pay particular attention to the existence of a loss carryforward. Therefore, we insert the dummy variable *LCF Exists* indicating if the respective subsidiary has accumulated losses in the past. Moreover, we consider an interaction term between this indicator variable and the tax rate to estimate an impact of an existing loss carryforward on the tax rate elasticity of investments. While we expect a negative sign for the statutory tax rate, an adverse effect is expected for the interaction because the statutory tax rate should become less important if losses carried forward can be used to offset profits arising from new investments.

Table 4: Existing Losses Carried Forward and Tax Rate Elasticity of Investments

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
ln (Fixed Assets$_{t-1}$)	.402***	.402***	.403***	.404***	.405***	.403***	.403***
	(.036)	(.036)	(.036)	(.036)	(.036)	(.036)	(.036)
Tax Rate	-.325***	-.324***	-.403***	-.323***	-.399***	-.406***	-.396***
	(.123)	(.123)	(.127)	(.123)	(.127)	(.128)	(.127)
LCFExists		-.013	-.093**	-.018**	-.094**	-.100***	-.137**
		(.010)	(.048)	(.009)	(.048)	(.049)	(.058)
(Tax Rate) x (LCF Exists)			.244**		.235*	.250**	.363**
			(.144)		(.144)	(.145)	(.174)
Mintax						.007	.003
						(.024)	(.024)
(Mintax) x (LCF Exists)						.023	.132
						(.023)	(.091)
(Mintax) x (LCF Exists)							-.340
x (Tax Rate)							(.277)
LRI	.056	.054	.054	.057	.057	.053	.054
	(.064)	(.064)	(.065)	(.064)	(.065)	(.065)	(.065)
Former Profit	.018***	.016**	.017***			.017***	.017***
	(.007)	(.007)	(.007)			(.007)	(.007)
ln (GDP)	-.440	-.425	-.419	-.434	-.429	-.435	-.413
	(.369)	(.369)	(.369)	(.369)	(.369)	(.368)	(.369)
ln (GDPperCapita)	.953**	.937***	.928***	.947**	.940**	.946***	.924**
	(.370)	(.371)	(.371)	(.370)	(.370)	(.370)	(.370)
Inflation Rate	.035*	.035*	.035*	.035*	.035*	.035*	.035*
	(.021)	(.021)	(.020)	(.021)	(.021)	(.021)	(.021)
Country Risk	-.036***	-.036***	-.035***	-.035***	-.035***	-.037***	-.037***
	(.010)	(.010)	(.010)	(.010)	(.010)	(.010)	(.010)
Observations	51,933	51,933	51,933	51,933	51,933	51,933	51,933
Subsidiaries	10,677	10,677	10,677	10,677	10,677	10,677	10,677
Number of IVs	62	63	64	62	63	66	67
AR(1) – test	0.000	0.000	0.000	0.000	0.000	0.000	0.000
AR(2) – test	0.831	0.819	0.812	0.779	0.772	0.818	0.828
Hansen *J*-test	0.168	0.170	0.165	0.162	0.157	0.165	0.173

Dependent Variable: ln (Fixed Assets). Year dummies for 1997-2007 are included but not reported. Estimations in first differences follow Arellano and Bond (1991). Robust standard errors, using the Windmeijer (2005) correction, are shown in parentheses. *, ** and *** show significance at the level of 10%, 5% and 1 % respectively. Numbers reported for the Hansen *J*-test of overidentification restrictions and for the test of 2nd order auto-correlation (AR(2)) are *p*-values.

Regression Results

The results of the panel estimations are shown in Table 4. In column (1) we start with a base regression which equals specification (1) in Table 2 from Section 4.1. Thereafter, we take into account the existence of a loss carryforward in columns (2) - (5). The control variables show effects which are very similar to the results shown in Section 4.1.

Concerning the statements in Hypothesis 5, our empirical results suggest that the liquidity and signaling effects dominate the tax effect. An existing tax loss carryforward results in lower

investments in the periods to follow. The significant coefficients for an existing loss carryforward of about -0.14 in column (7), for example, suggests that investments measured by the stock of fixed assets are by about 14% lower if a loss carryforward is present as compared to a situation in which it was not present. This can be attributed to a liquidity effect or a signaling effect if the business activities generated losses in the past. One might argue that a subsidiary of a multinational group should not fall short of liquidity given its ability to demand funds from the parent company. Still, in this case the negative signal of a loss persists and might have a detrimental effect on the readiness of the CEO to go on investing in the respective subsidiary.

While we find a negative effect of taxes on investment decisions in general, columns (3) and (5) show that the tax effect is significantly smaller in absolute values if a subsidiary is still carrying forward losses. The interaction term between the statutory corporate income tax rate and a dummy variable indicating an existing loss carryforward is positive. This confirms our theoretical expectations outlined in Hypothesis 6. Once a loss carryfoward exists, future profits remain effectively untaxed as long as this loss carryforward can be utilized. In the estimation presented in column (5), the tax rate coefficient amounts to -0.372 and the interaction term between tax rate and the dummy indicating an existing loss carryforward is 0.297. This means that the presence of losses absorbs almost the entire negative tax rate effect, leaving only a negligible difference. This result confirms exactly what, for instance, Creedy and Gemmel (2008) have worked out analytically. It is plausible that the tax rate effect is not entirely counterbalanced because the size of the loss carryforward might not suffice to absorb all future profits and furthermore, as discussed above, in many countries loss carryforwards expire after some years.

Finally, columns (6) and (7) regard the impact of a minimum taxation rule. Based on Hypothesis 6, we would expect a counterbalancing effect for the impact of an existing loss carryforward on the tax rate elasticity of investments if a minimum taxation rule is applied. We are unable to identify any statistically significant effect of the minimum tax rule. The results, however, should be interpreted with caution since the empirical variation in the minimum tax rules is very limited in our data.

6. Discussion and Concluding Remarks

We have analyzed the investment impact of tax loss treatment using data of subsidiaries of multinational firms. First, we have focused on the treatment of *potential* losses. Regarding the impact of tax loss offset regulations on the size of investments, we generally find significant effects of provisions to offset profits and losses across affiliated firms. Moreover, we find significant effects of the intertemporal loss offset provision when paying particular attention to the probability of making losses. Based on our estimation results, a limitation of the maximum loss carryforward to five or less years has a detrimental effect on investments of a subsidiary in a generally risky industry. We are, however, unable to identify statistically significant effects of the possibility to carry a loss back to previous periods. Furthermore, our results suggest that the structures of investments are significantly affected by the existence of a group taxation regime. Multinationals seem to consider whether or not netting of profits and losses is possible when deciding on how to structure their investments in a host country.

Secondly, we have analyzed the impact of *existing* loss carryforwards on investments. Liquidity or signaling effects seem to exceed tax based profitability considerations which results in lower investments once loss carryforwards are present. Yet, we find a significantly reduced tax elasticity of investments for companies actually shielded by existing losses. The negative impact of a high corporate tax rate almost completely vanishes if a firm has a loss carryforward.

Given that many countries have changed their tax loss offset rules during the last decade, the regression results are generally interesting for policy-makers. Our empirical results suggest that companies indeed factor tax loss treatment into their investment decisions. This holds for firms which expect potential future losses and for firms which have existing losses. Hence, the basic question arises whether host countries should offer more favorable or less favorable rules to carry forward losses. When all companies face the risk of making losses but have not made them so far, generous tax treatment of carryforwards benefits investments and the time until loss carryforwards forfeit should not be too short. If some subsidiaries, however, already had losses in the past, these firms make their investment decisions based on *existing* loss carryforwards. Then the policy implication is not as straight forward. On the one hand, the existence of a loss carryforward is favorable, particularly in high-tax countries as the reduced tax rate elasticity of investments can channel additional foreign direct investments to the respective subsidiary. For example, if we suppose a tax rate of about 30%, the estimates of

column (3) in Table 4 suggest that the negative investment effect in the presence of a loss carryforward is almost completely offset by the significantly smaller detrimental effect of the tax rate.[25] On the other hand, a generous recognition of losses for tax purposes can distort the competition between those companies with and those without a loss carryforward because the former benefit from windfall profits which are paradoxically caused by their failure in the past. Thus, for the sake of fair competition, tax loss carryforwards should not be allowed to persist indefinitely. Therefore, restricting the maximum number of years until losses carried forward expire may not only be a good idea from a fiscal perspective. What is more, our results regarding the impact of the tax loss treatment on investment decisions of firms which will potentially make losses in the future suggest that a moderate restriction of the maximum time losses can be carried forward does not exert significant negative effects on investments.[26]

Besides the intertemporal loss offset, we have also analyzed intersubjective means of netting profits and losses. According to our results, a clear policy implication can be formulated for this case: Group taxation regimes have a significant positive investment effect. Quite naturally, only one out of 41 countries has abolished its group taxation rule since 1996 and six have even introduced one. In this light, countries without a group taxation regime so far might want to reconsider their policy. Interestingly, the European Commission has recently proposed to replace the prevailing international tax base allocation with a common consolidated tax base. The consolidation procedure would introduce a general European group taxation regime. Our results suggest that this could exert significant positive effects on investments of multinationals.

[25] Considering estimates of column (3) in Table 4, a loss carryforward exerts a negative effect of about -0.093 but also an offsetting effect of about 0.073 if we suppose a tax rate of about 30%.

[26] This can be seen from the results in column 9 of Table 2. A severe restriction of the loss carryforward shows a highly significant negative effect on the investments of companies facing a considerable possibility to suffer losses. By contrast, there is no statistically significant investment impact of a broad limit as compared to an unlimited loss carryforward.

Annex

Table 5: Maximum Loss Carryforward

Country	Loss CF 1996	Change	to	Change	to	Change	to	Loss CF 2007
Australia	∞							∞
Austria	7	1998	∞					∞
Belgium	4	1997	∞					∞
Brazil	∞							∞
Bulgaria	5							5
Canada	7	2005	10	2007	20			20
China	5							5
Cyprus	5	2003	∞					∞
Czech Republic	7	2004	5					5
Denmark	5	2002	∞					∞
Estonia	5	2000	7					7
Finland	10							10
France	5	2004	∞					∞
Greece	5							5
Hungary	5	2004	∞					∞
Iceland	8	2004	9	2005	10			10
India	8							8
Ireland	∞							∞
Italy	5							5
Japan	5	2002	7					7
Latvia	5							5
Lithuania	0	1998	3	1999	5			5
Luxembourg	∞							∞
Malta	∞							∞
Mexico	10							10
Netherlands	∞	2007	9					9
New Zealand	∞							∞
Norway	10	2006	∞					∞
Poland	3	1999	5					5
Portugal	6							6
Romania	2	1997	3	1998	5			5
Russia	5	2002	10					10
Slovak Republic	5							5
Slovenia	5	2006	7	2007	∞			∞
South Korea	5							5
Spain	5	1997	7	1999	10	2002	15	15
Sweden	∞							∞
Switzerland	7							7
Turkey	5							5
United Kingdom	∞							∞
USA	15	1998	20					20

The table shows the number of years an unused loss carryforward can persist. The symbol ∞ means that loss carryforwards do not expire at all. The second and the sixth column show the regulation in the respective country for the years 1996 and 2007, while the columns in between reveal when the changes took place. A dash means that there has been no further change as compared to the value presented in the previous column. In Austria for example, unused loss carryforwards forfeited after seven years in 1996. This limit has been abolished in 1998.

Table 6: Existence of Minimum Taxation

Country	Minimum Tax 1996	Change	to	Minimum Tax 2007
Austria	no	2001	yes	yes
Brazil	yes			yes
Poland	yes			yes
Russian Federation	yes	2007	no	no
Slovak Republic	yes	2005	no	no
USA	yes			yes

The table presents an overview of those countries which apply a form of minimum taxation. Changes in the application of the rules are shown in column three. In Austria, for example, there had not been a minimum taxation rule in 1996, but it was introduced in 2001 and still in effect in 2007. All countries of our sample which are not shown here do not have a minimum taxation in the entire time span of 1996-2007.

Table 7: Maximum Loss Carryback

Country	Loss Carryback 1996	Change	to	Loss Carryback 2007
Canada	3			3
Ireland	1			1
Netherlands	3	2007	1	1
Sweden	0	1999	6	6
United Kingdom	3	1998	1	1
USA	3	1998	2	2

The table presents an overview of those countries which grant resident companies to carry back a loss. The columns show the maximum number of years losses could be carried back. Changes are reported in column two. All countries not shown here do not provide for a loss carryback in the entire timespan of 1996-2007.

Table 8: Method of Group Taxation

Country	1996	Method in 1996	Change	to	2007
Australia	yes	Group Contribution	2002	Consolidation	yes
Austria	yes	Fiscal Unity			yes
Belgium	no				no
Brazil	no				no
Bulgaria	no				no
Canada	no				no
China	no				no
Cyprus	no		2003	Group Relief	yes
Czech Republic	no				no
Denmark	yes	Consolidation			yes
Estonia	yes				yes
Finland	yes	Group Contribution			yes
France	yes	Fiscal Unity			yes
Greece	no				no
Hungary	no				no
Iceland	no		1999	Consolidation	yes
India	no				no
Ireland	yes	Group Relief			yes
Italy	yes	TaxCredit Exchange	2000	Group Contribution	yes
			2004	Consolidation	yes
Japan	no		2002	Consolidation	yes
Latvia	no		1998	Group Relief	yes
Lithuania	no		2004	Group Contribution	yes
Luxembourg	yes	Fiscal Unity			yes
Malta	yes	Group Relief			yes
Mexico	yes	Consolidation			yes
Netherlands	yes	Consolidation			yes
New Zealand	yes	Group Relief			yes
Norway	yes	Group Contribution			yes
Poland	no		1997	FiscalUnity	yes
Portugal	yes	Consolidation			yes
Romania	no				no
Russian Federation	no				no
Slovak Republic	no				no
Slovenia	yes	Consolidation	2007	no	no
South Korea	no				no
Spain	yes	Consolidation			yes
Sweden	yes	Group Contribution			yes
Switzerland	yes				yes
Turkey	yes				yes
United Kingdom	yes	Group Relief			yes
USA	yes	Consolidation			yes

In a consolidation or fiscal unity system, the financial statements of companies belonging to the same group are either made up together or merged at the end of the fiscal year. When there is a system of group contribution, the profitable subsidiary is enabled to contribute a part or all of its profits to the subsidiary which suffered a loss. Correspondingly, losses are transferred among subsidiaries in a group relief system. In effect, all of these systems enable the netting of profits and losses of different tax subjects. Therefore, we apply a dummy variable if some kind of group taxation is available or not.

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