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Abstract: This paper analyzes the impact of countries' tax attractiveness on the allocation of risk within multinational groups. Our dataset contains subsidiaries located in 32 European countries and owned by parents from 90 different countries globally. We show that tax symmetry positively influences the relative amount of risk allocated to subsidiaries. Both time and amount limitations of loss offset rules matter. Higher statutory corporate tax rates in the country of the subsidiary decrease the relative amount of risk taken.

Keywords: International taxation; Tax attractiveness; Location decision; Multinational enterprise; Risk allocation

JEL classifications: F23, G32, H25

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1 Introduction

The relationship between risk and return is one of the most fundamental phenomena studied in theoretical and empirical economic research. It is the basis of important financial theories, such as the Portfolio Theory and the Capital Asset Pricing Model.

Although taxes distort the risk-return relationship in reality, the basic versions of these theories have been formulated in a world without taxes. One reason for this distortion is the asymmetry in the taxation of earnings. While profits lead to a tax liability, governments do not fully participate in losses. This disproportional taxation disadvantages investment projects with a high loss probability. The magnitude of the overtaxation of risky projects is not equal across countries. Differences in loss offset provisions, *loss carryback* and *loss carryforward* provisions, and *statutory tax rates* are determinants of the distortive effect, which can be set individually by each government.

The objective of this paper is to test whether the geographic allocation of risk within multinational groups is influenced by the tax attractiveness of countries. Our dataset contains corporations located in 32 European countries which are owned by parents from 90 different countries globally. We show that the design of *loss carryback* and *loss carryforward* rules and the *statutory tax rate* in the country of the subsidiary influence the risk allocation.

We make three major contributions to literature. First, we show that risk is allocated based on tax considerations within multinational groups, while other empirical studies do not account for the ownership structure in their sample. Second, our novel risk measure, the loss probability, better reflects the relevant risk than measures used in prior literature. Third, we are the first to show in a cross-country study that not only time restrictions but also amount limitations in loss offset rules matter.

The research question is relevant for governments and researchers. It is often bemoaned that risky activities (e.g. R&D) suffer from underinvestment. Although there are high societal rates of return to R&D activities[1], investment in R&D is below the socially desirable level[2]. We argue that the design of tax systems is one cause for this situation. The improvement of loss-offset provisions might be an option for governments to promote

[1]Margolis and Kammen (1999) show that studies in the field estimate social rates of return of 20-100 percent.

[2]Jones and Williams (1998) estimate that the optimal level of investment in R&D is three to four times the actual level.

risky investments and social welfare. Our risk and tax measures used could be relevant for other researchers in the field.

The following section describes the relationship between taxation and risk, identifies non-tax determinants, discusses measures of risk and derives the hypotheses to be tested. Section 3 presents the company sample and the variables used in our study. Section 4 describes the econometric framework. Section 5 summarizes the results and section 6 concludes.

2 Theoretical Considerations and Hypotheses

2.1 Taxation of Multinational Groups and Risk Taking

In theory, several seminal studies (see, e.g., Penner, 1964; Richter, 1960; Tobin, 1958; Domar and Musgrave, 1944) show that the amount of risk taken by rational private investors increases in the degree of symmetry of taxation, i.e. the equality of tax treatment for positive and negative pre-tax income.[3] In case of full symmetry, rational risk bearers even take more risk than in a world without taxes.[4] The tax rate determines the importance of tax symmetry for risk taking decisions. In case of a symmetric tax system, a higher statutory tax rate increases risk taking, whereas it reduces risk taking in an asymmetric tax system.

In reality, corporate tax systems of countries vary in their degree of symmetry but none[5] are neutral towards risk taking decisions (see, e.g. Haufler et al., 2014; Cullen and Gordon, 2007; Buchholz and Konrad, 2000; Eeckhoudt et al., 1997). In principle, profits and losses are treated asymmetrically by all tax systems. While profits result in tax payments, losses do not lead to immediate tax refunds. The reason for this setup is to prevent tax revenue shortfalls and fraudulent claims for tax refunds (see Haufler et al., 2014). Nevertheless, many countries allow losses to be offset against past and future losses. These provisions reduce tax asymmetry to a certain extent. However, given they are mostly limited in time and amount and require the existence of past or future profits, they do not lead to perfect tax symmetry. In addition, in case of loss carryforwards,

[3]See Schön (2014) for other theories that confirm the overtaxation of risky companies.

[4]Mintz (1981) shows that there are situations conditional on the capital structure and the production function in which higher tax rates can increase risk aversion for corporations even in case of full loss offset.

[5]Countries not levying corporate taxes at all are an exception.

companies have to forgo interest, since compensation for losses occurs in future periods.[6] Overall, prior literature suggests that the general asymmetric setup of existing tax systems prevails over symmetric loss offset features (see, e.g., Devereux and Fuest, 2009).[7]

Certain effects of limited tax symmetry on corporate risk taking decisions have been studied in prior literature. Analytically, corporations are shown to reduce risk by under-investing in risky projects, by conducting conglomerate mergers (see Green and Talmor, 1985) or by hedging with financial instruments (see Wahl and Broll, 2007; Smith and Stulz, 1985)[8] in limited loss offset regimes. Empirically, companies' risk appetite, investment behavior (see Langenmayr and Lester, 2013; Dressler and Overesch, 2013) and reaction to changes in loss offset rules (see Koch and Prassel, 2011) are influenced by tax considerations. Both the length (see Langenmayr and Lester, 2013; Dressler and Overesch, 2013) and amount limitations (see Koch and Prassel, 2011) of loss carryback and loss carryforward rules are found to play a role. From a policy perspective, Ewert and Niemann (2012) argue that neutrality of corporate tax systems towards risk taking is not compatible with neutrality towards the choice of the legal form. From an individual perspective, experiments show that individuals choose less risky options when losses cannot be offset (see Fochmann et al., 2012).

However, all empirical studies that directly investigate the impact of taxation on corporate risk taking treat companies as unrelated entities. In this paper we account for the ownership structure and investigate, whether multinationals consider taxes when deciding on their international allocation of risk.

2.2 Non-Tax Determinants of Risk

Besides taxation, literature has identified numerous other determinants of companies' observed risk taking. First, firm level characteristics play a role. *Firm size*, a proxy for the level of diversification, is found to be negatively related to risk (see, e.g. Li et al., 2013; Boubakri et al., 2013; John et al., 2008; Green and Talmor, 1985). Furthermore,

[6] Schanz and Schanz (2011) propose a compoundable loss carryforward, to heal this disadvantage.

[7] Devereux and Fuest (2009) could not find a stabilizing effect of the UK corporate tax system on investment during the financial crisis and attribute this fact to a lack of symmetry. Given the similarity in tax systems, the authors expect to find similar results in other countries.

[8] Mian (1996) finds mixed evidence for this argument when empirically investigating whether financial hedging activity is driven by tax considerations. However, she uses a sample of large corporations which are already relatively well diversified compared to smaller corporations.

firms with a higher *age* are observed to be less risky due to survivorship[9] and learning processes (see, e.g. Hora and Klassen, 2013; Pástor and Pietro, 2003). *Financial leverage* can be both a determinant of higher and lower overall company risk. On the one hand, equity holders have an incentive to take more overall company risk if leverage is high, as this increases the value of their equity having option-like characteristics (see, e.g., Leland, 1998). On the other hand, as leverage increases, the probability and expected costs for financial distress increase, which decreases risk appetite (see, e.g., Ertugrul et al., 2008). Moreover, companies with fast *sales growth* (see Smith Jr. and Watts, 1992), high *market-to-book ratios* (see Langenmayr and Lester, 2013; DeYoung et al., 2013) or in countries with fast *GDP growth* (see Boubakri et al., 2013), all three proxies for a large investment opportunity set, exhibit higher risk. Shareholders of this type of company tend to incentivize managers based on corporate performance (e.g. by using stock options), which induces these managers to take more risk (see Guay, 1999).

Second, industry level characteristics might matter. Results with regard to the impact of *market fragmentation* on risk are mixed. While John et al. (2008) argue that more competitive markets cause higher risk for individual participants, De Haan and Poghosyan (2012) and Soedarmono et al. (2013) find the opposite result in the banking market.

Third, country characteristics have been studied. *National culture* is found to influence corporate risk taking. Individualistic cultures foster risk taking while uncertainty avoiding and harmony seeking countries impede corporate risk taking (see Li et al., 2013).

Finally, individual managers' characteristics influence risk taking. If *executive compensation* is based on financial instruments that increase in value when volatility increases (e.g. stock options), managers tend to take more risk (see DeYoung et al., 2013; Deutsch et al., 2011; Wright et al., 2007; Coles et al., 2006; Rajgopal and Shevlin, 2002). Furthermore, *education* has been found to be both a positive and a negative indicator of risk appetite. On the one hand, *education* itself represents an investment and therefore less risk averse people self select themselves into higher education (see Belzil and Leonardi, 2007). On the other hand, the process of being educated itself has been found to increase risk aversion (see Jianakoplos and Bernasek, 1998; Hersch, 1996).

[9] Firms in higher age cohorts tend to contain lower risk companies since higher risk companies had more time to go out of business than in lower age cohorts.

2.3 Definition and Measurement of Risk

Based on the research question in this study, risk is the probability of a corporation suffering from a financial disadvantage due to limited loss offset rules in the tax code. Since we cannot observe this probability directly, we need to find a risk measure that is highly correlated to the theoretic definition of risk mentioned above and that can be measured based on observable data.

First, we chose a measure taking into account both systematic[10] and idiosyncratic[11] risk, since we take the view of single corporations invested in a limited set of projects. Second, we use a tax measure that captures downside risk only, since overtaxation occurs in case of negative returns.[12] In one of our robustness tests, we use a volatility based measure that captures both upside and downside risk. Third, we base our measure on operating risk.[13] We do not consider growth risk since the the growth of net operating assets does not determine whether a company's profitability is positive or negative. We also do not incorporate financing risk, since the leverage of individual group entities within multinational groups has been shown to be determined strategically based on non-risk related tax considerations (see Buettner et al., 2012; Tzioumis and Klapper, 2012; Fuest et al., 2011; Ruf, 2011; Arena and Roper, 2010; Huizinga et al., 2008; Desai et al., 2004). In order not to accidentally measure the strategic choice of capital structure in our study, we base our risk measure on operating risk only.

The risk measure applied by Langenmayr and Lester (2013), the three year volatility of the return on assets, is closest to our requirements. It is a measure of overall operating risk, however, two-sided. Furthermore, they calculate the variance based on a moving three year horizon of annual data only, which we deem too short for our purposes.[14]

We therefore define risk based on the loss probability derived from the volatility of return on assets measured over an eight year time horizon. This is a downside measure

[10] Systematic risk is the risk that a fully diversified investor has to bear.

[11] Idiosyncratic risk is the risk that can be diversified away. In fact, corporate income taxation can be interpreted as an insurance from a societal perspective, since the state aggregates idiosyncratic risks of individual agents (see, e.g., Schindler, 2008).

[12] There are well established measures of risk that are exclusively concerned with negative outcomes (*downside risk*). Value at Risk (VaR) is such an indicator. The VaR on a portfolio is the maximum loss expected over a given holding period, at a given level of confidence (see Dowd, 2002).

[13] Operating risk is measured as the variation in return on net operating assets (see Penman, 2013).

[14] The disadvantage of using a variance based measure is, that it aggregates observations over time. This impedes the use of a panel structure and limits the identification strategy to the cross-section (see, e.g., John et al., 2008).

of idiosyncratic and sytematic operating risk.

2.4 Hypotheses

Based on the theoretical considerations presented above, we can formulate our hypotheses tested in this paper. The first hypothesis relates the degree of symmetry of tax systems to corporate risk taking.

H1: The better the loss offset opportunities are in the country of a subsidiary compared to the group average, the higher the excess risk of that subsidiary is expected to be.

Our second hypothesis draws on the finding in prior literature that existing corporate tax systems are rather asymmetric, even in the presence of loss offset rules (see Devereux and Fuest, 2009). Unlike in case of perfectly symmetric tax systems, where higher statutory tax rates increase risk taking, we expect higher tax rates to increase the magnitude of overtaxation of risky investments and therefore to reduce the risk appetite of groups in a certain country compared to the group average.

H2: The lower the statutory tax rate in the country of a subsidiary is compared to the group average, the higher the excess risk of that subsidiary is expected to be.

3 Data

3.1 Company Sample

We use the AMADEUS database to retreive our company sample.[15] It contains information on European companies and their global ultimate owners.[16] Therefore, it is possible to identify corporations that belong to one multinational group. However, AMADEUS contains ownership information only at the point in time when the data is retreived. In case of M&A activity it is possible that we identify a subsidiary to be part of a group even before it was acquired. We therefore correct for M&A activity using the ZEPHYR database by eliminating all observations for acquired subisidaries in the year of acqusition and before.

[15] The database contains micro-level information on currently 18.2 million active companies located in 43 mostly European countries. It includes companies that have to file public accounts according to national law and fulfill either of the three criteria: turnover $\geq$ one million EUR, total assets $\geq$ two million EUR or number of employees $\geq$ 15.

[16] We define ultimate ownership based on a minimum direct or indirect holding of a 50% stake in a corporation.

Our final dataset includes a total of 110,391 corporations located in 32 different European countries comprising 12,255 multinational groups whose parents are located in 90 different countries globally. Table A1 in the appendix summarizes the sample by country.

3.2 Risk Variables

We use the excess loss probability of subsidiary i and group g ($\Delta pLoss_{ig}$) as our measure of risk. It is based on the volatility of the return on assets in year t ($ROA_{igt} = \frac{EBIT_{igt}}{\text{total assets}_{igt}}$)[17].[18]

$$Vol_{ig} = \sqrt{\frac{\sum_{t=1}^{T}(ROA_{igt} - \overline{ROA}_{ig})^2}{T-1}} \tag{1}$$

$\overline{ROA}_{ig}$ indicates the average ROA_{igt} of a company over time. T indicates the total number of years. We calculate the volatility based on the eight year horizon from the end of 2004 to the end of 2012. Only if data is available for at least four years in this time horizon we include a value for Vol_{ig} in our dataset. Next, we calculate z:

$$z_{ig} = \frac{0 - \overline{ROA}_{ig}}{Vol_{ig}} \tag{2}$$

Based on z_{ig} and the cumulative standard normal density function, we retrieve the probability of a subsidiary reporting a negative ROA_{igt}:

$$pLoss_{ig} = \Phi(z_{ig}) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{z} e^{\frac{-y^2}{2}} dy \tag{3}$$

This variable ranges between zero and one. Since we are interested in the allocation of risk within multinational groups, we calculate the excess risk of a certain subsidiary (i) over the group's (g) average ($\overline{pLoss}_g$).

$$\Delta pLoss_{ig} = pLoss_{ig} - \overline{pLoss}_g \tag{4}$$

In a robustness test, we replace our dependent variable, $\Delta pLoss_{ig}$, by ΔVol_{ig} defined

[17] We winsorize the upper and lower five percentiles of ROA.

[18] All formulas used to calculate the loss probability are taken from Sheskin (2011) and Russel and MacKinnon (2004).

Table 1: Descriptive Statistics

This table reports descriptive statistics for the variables used in the analysis of our two hypotheses. $\Delta pLoss_{ig}$ is the excess probability of a company reporting a negative return on assets over the group average. ΔVol_{ig} is the excess volatility of return on assets of a company over the group average. $\Delta LCB_{ig}^{years}/\Delta LCF_{ig}^{years}$ is the excess number of years (in logarithmic format) that a company is allowed to carry losses back/forward in its country of residence over the average across all group countries. $\Delta LCB_{ig}^{limit}/\Delta LCF_{ig}^{limit}$ indicate the excess amount limitation of loss carryback/carryforward rules. ΔSTR_{ig} is the excess *statutory tax rate* in the country of a subsidiary over the group average *statutory tax rate*. ΔTAX_{ig} is the excess *Tax Attractiveness Index* value in the country of the subsidiary over the group average. $\Delta Assets_{ig}$ is the excess of a company's total assets, in logarithmic format, over the group average. ΔAge_{ig} is the excess number of years since incorporation of a company over the group average. ΔHHI_{ig} is the excess Herfindahl Hirschman index, measured as the industry sum of the squared ratios of company sales over total industry sales, of a company over the group average. ΔLEV_{ig} is the excess leverage, measured as total liabilities over total assets, of companies over the group average. $\Delta GDPgrowth_{ig}$ is the average real GDP growth in a subsidiary country in excess of the group average. ΔFOR_{ig} is the excess of a dummy, that assumes a value of one if a subsidiary is in another country than the parent and a value of zero otherwise, over the group average. ΔEDU_{ig} indicates the excess share of enrollment in tertiary education in the country of a subsidiary over the group average.

Variables	N	Mean	Std. Dev.	Min	Median	Max
$\Delta pLoss_{ig}$	110,391	0.000	0.290	- 0.776	- 0.036	0.894
ΔVol_{ig}	110,391	0.000	0.065	- 0.243	- 0.012	0.377
ΔLCB_{ig}^{years}	110,391	0.000	0.315	- 1.290	0.000	1.295
ΔLCF_{ig}^{years}	110,391	0.000	0.843	- 4.450	0.034	4.145
ΔLCB_{ig}^{limit}	110,391	0.000	0.324	- 0.992	0.000	0.998
ΔLCF_{ig}^{limit}	110,391	0.000	0.124	- 0.984	0.005	0.968
ΔSTR_{ig}	110,391	0.000	0.035	- 0.232	0.002	0.177
ΔTAX_{ig}	110,391	0.000	0.069	- 0.300	- 0.001	0.319
$\Delta Assets_{ig}$	110,391	0.000	2.003	- 16.230	0.017	11.010
ΔAge_{ig}	110,391	0.000	14.784	- 70.750	- 2.143	138.170
ΔLEV_{ig}	110,391	0.000	0.327	- 1.258	0.000	1.536
$\Delta GDPgrowth_{ig}$	110,391	0.000	0.008	- 0.076	0.000	0.049
ΔHHI_{ig}	110,391	0.000	0.048	- 0.363	- 0.006	0.880
ΔFOR_{ig}	110,391	0.000	0.336	- 0.986	0.000	0.996
ΔEDU_{ig}	110,391	0.000	0.080	- 0.677	- 0.000	0.526

as the volatility of each company's ROA (Vol_{ig}) in excess of the group average ($\overline{Vol}_g$).

$$\Delta Vol_{ig} = Vol_{ig} - \overline{Vol}_g \tag{5}$$

Table 1 summarizes the risk variable. It shows that $\Delta pLoss_{ig}$ is censored between minus and plus one. The average $\Delta pLoss_{ig}$ is zero since deviations in the loss probability from the group average cancel out across all group members.

3.3 Tax Variables

In order to test *H1*, we include variables that measure the quality of loss offset rules.[19] First, we include the 2005-2012 average number of years losses can be carried back in a group country (LCB_{ig}^{years}) in excess of the group average accross all group entities 2005-2012 ($\overline{LCB}_{g}^{years}$). Since we expect a decreasing marginal effect of additional years, we use a natural logarithmic scale.[20]

$$\Delta LCB_{ig}^{years} = LCB_{ig}^{years} - \overline{LCB}_{g}^{years} \tag{6}$$

Second, we calculate the excess number of years losses can be carried forward in analogy to ΔLCB_{ig}^{years}. If losses can be carried forward indefinitely, we assign a value equal to $ln(99 + 1) = 4.61$.

$$\Delta LCF_{ig}^{years} = LCF_{ig}^{years} - \overline{LCF}_{g}^{years} \tag{7}$$

Third, we include a variable that accounts for amount limitations of loss carryback rules. Some countries, such as Germany, France and Singapore cap the amount of losses that can be carried back. LCB_{igt}^{limit} receives a value of one if there are no amount limitations. If the amount that can be carried back is limited, LCB_{igt}^{limit} receives a value of 0.5. If a loss carryback is not possible, LCB_{igt}^{limit} assumes a value of 0. LCB_{ig}^{limit} is the average value of LCB_{igt}^{limit} over time. Finally, we calculate the excess loss carryback limitation in the country of a subsidiary over the group average:

$$\Delta LCB_{ig}^{limit} = LCB_{ig}^{limit} - \overline{LCB}_{g}^{limit} \tag{8}$$

In analogy, we include a variable that indicates loss carryforward amount restrictions. Several countries only allow a loss offset due to existing loss carryforwards up to a certain percentage of pretax profit.[21] LCF_{igt}^{limit} receives a value equal to the share of pretax profits at which loss deduction is capped. LCF_{ig}^{limit} is the average value of LCF_{igt}^{limit} over time.

[19] We would have included a variable on group taxation regimes. Unfortunately, based on our dataset we are unable to tell which subsidiaries form a group for tax purposes.

[20] Before we calculate the natural logarithm we add one year. This ensures that a company located in a country that does not allow losses to be carried back receives a value of zero ($LCB_{ig}^{years} = \ln(0 + 1) = 0$) instead of an undefined value.

[21] We do not account for change-of-ownership provisions or cap-exempt amounts.

Again, we calculate the excess loss carryforward limitation in the country of a subsidiary over the group average:

$$\Delta LCF_{ig}^{limit} = LCF_{ig}^{limit} - \overline{LCF}_{g}^{limit} \tag{9}$$

In order to test hypothesis *H2*, we include the variable (ΔSTR_{ig}) calculated as the average *statutory tax rate* of a group corporation's residence country over time (STR_{ig}) in excess of the group countries' average *statutory tax rate* ($\overline{STR}_g$).

$$\Delta STR_{ig} = STR_{ig} - \overline{STR}_g \tag{10}$$

Finally, in one of our extensions, we include the excess *Tax Attractiveness Index* value (TAX_{ig}) in the country of a subsidiary over the group average ($\overline{TAX}_g$) as calculated in equation 11. The *Tax Attractiveness Index* is composed of 16 factors that measure a broad range of tax law details relevant for international tax planning (see Keller and Schanz, 2013, for details).

$$\Delta TAX_{ig} = TAX_{ig} - \overline{TAX}_g \tag{11}$$

3.4 Control Variables

As indicated in our literature survey, there are several non-tax factors that have been found to influence corproate risk taking. First, we use the excess of the natural logarithm of total assets (average 2005-2012 in thousand EUR) of a corporation ($Assets_{ig}$) over the group average ($\overline{Assets}_g$) to capture the size effect.

$$\Delta Assets_{ig} = Assets_{ig} - \overline{Assets}_g \tag{12}$$

Moreover, we include the excess age of companies (ΔAge_{ig}), calculated as the age of companies Age_{ig} in excess of the group average ($\overline{Age}_g$).[22]

$$\Delta Age_{ig} = Age_{ig} - \overline{Age}_g \tag{13}$$

Next, we control for the capital structure of companies. We include the leverage,

[22] We winsorize the upper first percentile of (Age_{ig}).

measured as the 2005-2012 average ratio of total liabilities over total assets LEV_{ig} in excess of the group average $(\overline{LEV_g})$.[23]

$$\Delta LEV_{ig} = LEV_{ig} - \overline{LEV}_g \tag{14}$$

Furthermore, we control for the fragmentation of markets. We include the excess Herfindahl Hirschman index, i.e. the industry[24] sum of squared ratios of firm sales over total sales, in a group country (HHI_{ig}) over the group average $(\overline{HHI}_g)$.

$$\Delta HHI_{ig} = HHI_{ig} - \overline{HHI}_g \tag{15}$$

In order to control for the country specific investment opportunity set, we include the excess $GDPgrowth_{ig}$ in a group country over the group average $(\overline{GDPgrowth_g})$.[25] Besides the argument that managers' compensation packages in companies with a large opportunity set incentivize them to take more risk, higher GDP growth tends to be associated with higher profits. A higher profitability decreases the loss probability.

$$\Delta GDPgrowth_{ig} = GDPgrowth_{ig} - \overline{GDPgrowth}_g \tag{16}$$

Next, we include a variable (FOR_{ig}), that indicates whether a subsidiary is owned by a foreign parent or not, in excess of the group average $(\overline{FOR_g})$. Multinationals might have a tendency of keeping risky activities in their home country.

$$\Delta FOR_{ig} = FOR_{ig} - \overline{FOR}_g \tag{17}$$

Our measure for the education within a country is based on the share of the age cohort in the population having finished secondary education, that is enrolled in tertiary education (EDU_{igt}). Again, we calculate the excess of the group country average (EDU_{ig}) over the group average $(\overline{EDU_g})$.

$$\Delta EDU_{ig} = EDU_{ig} - \overline{EDU}_g \tag{18}$$

[23] We winsorize the upper and lower five percentiles of LEV_{ig}

[24] The industry is defined by the four digit NAICS code.

[25] We refrain from including the company specific opportunity set, measured by the growth in sales, since sales data is not consistently reported for our sample and we would lose about half of our sample.

Table 1 summarizes the control variables. Note that we do not include any variables describing individual managers' risk appetite mainly for the reason that we have neither information on the executives of subsidiaries nor on their risk-appetite.

4 Methodology

The estimation strategy takes into account the specific properties of the dataset. The dependent variable, $\Delta pLoss_{ig}$, is censored from above (+1) and below (-1). We therefore use a type I Tobit model, that takes into account the upper and lower bound, to test the two hypotheses. In one of our robustness tests, we replace the dependent variable, $\Delta pLoss_{ig}$, by ΔVol_{ig}. This variable is not censored. We therefore use a standard OLS model with robust standard errors clustered by company. Furthermore, we estimate robust standard errors clustered by company. The regression model takes the following form:

$$\Delta pLoss_{ig} = \alpha + \beta_n Tax_{ign} + \beta_m Control_{igm} + \beta_j Industry_{igj} + \epsilon_{ig} \tag{19}$$

$\Delta pLoss_{ig}$ is the dependent variable measuring the excess loss probability of a company over the group average. Tax_{ign} is a placeholder for the n = 6 tax variables, ΔLCB_{ig}^{years}, ΔLCF_{ig}^{years}, ΔLCB_{ig}^{limit}, ΔLCF_{ig}^{limit}, ΔSTR_{ig}, ΔTAX_{ig}. $Control_{igm}$ is a placeholder for the m = 7 control variables, $\Delta Assets_{ig}$, ΔAge_{ig}, ΔLEV_{ig}, ΔHHI_{ig}, $\Delta GDPgrowth_{ig}$, ΔFOR_{ig}, ΔEDU_{ig}.

Finally, we control for industry fixed effects $Industry_{igj}$ by including industry dummies. We identify the industry of each subsidiary based on the two-digit NAICS code.

5 Results

5.1 Main Results

Table 2 shows the results of our regression analysis of the two hypotheses. Specifications I-IV include individual loss offset variables and ΔSTR_{ig}. Besides ΔSTR_{ig}, specification V jointly includes ΔLCB_{ig}^{years} and ΔLCF_{ig}^{years} and specification VI, ΔLCB_{ig}^{limit} and ΔLCF_{ig}^{limit}. We do not combine variables on amount and time limitations due to their high correlation (see table A2 on page 22 especially for the high correlation among the *loss carryback* variables).

Specification I shows that the coefficient for ΔLCB_{ig}^{years} is significantly positive. The more years a company can carry back its losses in comparision to the group average, the riskier the company tends to be relative to the group average. This result holds if ΔLCF_{ig}^{years} is included in the regression, as specification V shows. We also find a positive and significant association between ΔLCF_{ig}^{years} and $\Delta pLoss_{ig}$ in both specifications II and V. The higher the number of years companies can carry forward their losses in excess of the group average, the higher is their observed excess risk. Interestingly, we find that the effect size of ΔLCB_{ig}^{years} is higher than that of ΔLCF_{ig}^{years} as the coefficients in specifications I, II and V indicate. An additional year of *loss carryback* in comparison to the group average has a higher impact on excess risk taking (2.755 percentage points of additional marginal loss probability in excess of the group average) than another year of *loss carryforward* (0.822 percentage points of additional marginal loss probability in excess of the group average).[26] This is not surprising given a *loss carryback* results in an immediate tax refund. In the presence of positive interest rates, this refund has a higher present value than a tax refund paid in future periods due to a *loss carryforward*.

We find a similar result for ΔLCB_{ig}^{limit} and ΔLCF_{ig}^{limit}. The coefficients of both variables are significantly positive, as specifications III, IV and VI show. Due to the different scaling of the variables, a direct comparison of the effect size is not possible. If there exist limitations in the amount of losses that can be carried back in the country of a subsidiary, while the group on average does not have to cope with such limitations, the subsidiary is expected to have a marginal loss probability that is 2.118 percentage points lower than the group average. If the limitation to carry forward losses in the country of a subsidiary, expressed as a percentage of net income, is ten percentage points higher (i.e. less restrictive) than the group average, a subsidiary is expected to exhibit an excess marginal loss probability of 0.36 percentage points.

In summary, we find supportive evidence for hypothesis *H1* stating that better loss offset opportunities are positively related to excess risk. We find supportive results for *loss carryback* and *loss carryforward* rules. The longer the time period and the lower the

[26]The marginal probability is the predicted excess probabilty of reporting a negative return on assets given a company is allowed to carry losses back/forward one year longer than the group average and given all other variables in the regression assume their mean value. The stated values are based on the results of specifications I and II in table 2 and were obtained using the '*margins*' command in STATA.

amount restrictions these provisions contain, the more risk we observe compared to the group average.

Furthermore, we find a signifiantly negative coefficient for ΔSTR_{ig} in all specifications. The higher the *statutory tax rate* in a certain group country is compared to the group average, the less risk entities in this group country take relative to the group average. Therefore, our hypothesis $H2$ is supported. The effect is economically relevant, too. A company with a ten percent higher *statutory tax rate* than the group average has a 4.159 percentage points lower marginal loss probability[27] than the group average.

The control variable $\Delta Assets_{ig}$ has a significant negative coefficient in all specifications. As expected, larger companies are observed to be less risky, because they are better diversified. The theory that older than average companies have a lower probability of negative returns is also supported by our results. The coefficients of ΔAge_{ig} are significantly negative in all specifications. ΔLEV_{ig} is found to be significantly positively associated with $\Delta pLoss_{ig}$ in all specifications. This confirms the argument that, due to the option character of equity, shareholders have an incentive to increase risk when assuming more debt. For ΔHHI_{ig} we find a significantly positive coefficient in all specifications. It implies that a company in an industry that is more concentrated than the industries in which the other group members are active, on average, take relatively more risk. Therefore, our result supports the findings of De Haan and Poghosyan (2012). $\Delta GDPgrowth_{ig}$ is significantly negatively related to corporate risk taking. The argument that higher GDP growth rates improve profitability seems to outweigh the argument that higher GDP growth rates increase the opportunity set for corporations and therefore their risk taking. ΔFOR_{ig} is found to be significantly negatively related to excess risk taking in specifications I, III, IV and VI. This supports the hypothesis that multinational groups tend to keep risk in their home country. Similarly, ΔEDU_{ig} exhibits significantly negative coefficients in specifications II and IV. This result favors the argument that education increases risk aversion over the self-selection argument that less risk-averse individuals are more likely to pursue higher education.

In summary, we find supportive evidence for hypotheses $H1$ and $H2$. The less *loss carryforward* and *loss carryback* rules are restricted in amount and time, the more risk

[27] The marginal probability is the predicted probabilty of reporting a negative return on assets given the specified *statutory tax rate* and given all other variables in the regression assume their mean value. The values were obtained using the'*margins*' command in STATA.

subsidiaries are allocated. Time restrictions tend to be more severe for *loss carryback* than for *loss carryforward* rules. At the same time, a higher *statutory tax rate* decreases the amount of risk a group allocates to a country.

Table 2: Tax Attractiveness and the Allocation of Risk within Multinationals

This table describes the regression results for the test of our two hypotheses *H1* and *H2*. The dependent variable, $\Delta pLoss_{ig}$, is the excess probability of a company reporting a negative return on assets over the group average. $\Delta LCB_{ig}^{years}/\Delta LCF_{ig}^{years}$ is the excess number of years (in logarithmic format) that a company is allowed to carry losses back/forward in its country of residence over the average across all group countries. $\Delta LCB_{ig}^{limit}/\Delta LCF_{ig}^{limit}$ indicate the excess amount limitation of loss carryback/carryforward rules. ΔSTR_{ig} is the excess *statutory tax rate* in the country of a subsidiary over the group average *statutory tax rate*. $\Delta Assets_{ig}$ is the excess of a company's total assets, in logarithmic format, over the group average. ΔAge_{ig} is the excess number of years since incorporation of a company over the group average. ΔHHI_{ig} is the excess Herfindahl Hirschman Index, measured as the industry sum of the squared ratios of company sales over total industry sales, of a company over the group average. ΔLEV_{ig} is the excess leverage, measured as total liabilities over total assets, of companies over the group average. $\Delta GDPgrowth_{ig}$ is the average real GDP growth in a subsidiary country in excess of the group average. ΔFOR_{ig} is the excess of a dummy, that assumes a value of 1 if a subsidiary is in another country than the parent and a value of 0 otherwise, over the group average. ΔEDU_{ig} indicates the excess share of enrollment in tertiary education in the country of a subsidiary over the group average. Results are derived from a Tobit model controlling for industry fixed effects. Robust standard errors are clustered by company. The 1%, 5% and 10% significance level is indicated by ***, ** and *.

		Specification					
Variable	Exp.	I	II	III	IV	V	VI
ΔLCB_{ig}^{years}	+	0.040 ***				0.033 ***	
ΔLCF_{ig}^{years}	+		0.012 ***			0.006 ***	
ΔLCB_{ig}^{limit}	+			0.042 ***			0.042 ***
ΔLCF_{ig}^{limit}	+				0.036 ***		0.028 ***
ΔSTR_{ig}	-	- 0.380 ***	- 0.401 ***	- 0.303 ***	- 0.265 ***	- 0.416 ***	- 0.266 ***
$\Delta Assets_{ig}$	-	- 0.018 ***	- 0.018 ***	- 0.018 ***	- 0.018 ***	- 0.018 ***	- 0.018 ***
ΔAge_{ig}	-	- 0.001 ***	- 0.001 ***	- 0.001 ***	- 0.001 ***	- 0.001 ***	- 0.001 ***
ΔLEV_{ig}	+/-	0.135 ***	0.135 ***	0.135 ***	0.136 ***	0.135 ***	0.135 ***
ΔHHI_{ig}	+/-	0.166 ***	0.165 ***	0.164 ***	0.165 ***	0.166 ***	0.164 ***
$\Delta GDPgrowth_{ig}$	+/-	- 3.846 ***	- 3.762 ***	- 3.617 ***	- 3.606 ***	- 3.823 ***	- 3.483 ***
ΔFOR_{ig}	-	- 0.005 *	- 0.004	- 0.006 **	- 0.008 ***	- 0.003	- 0.006 **
ΔEDU_{ig}	+/-	- 0.007	- 0.022 **	- 0.002	- 0.054 ***	0.002	- 0.003
Const.	+/-	0.038 ***	0.039 ***	0.038 ***	0.037 ***	0.038 ***	0.038 ***
Observations		110,391	110,391	110,391	110,391	110,391	110,391
Groups		12,255	12,255	12,255	12,255	12,255	12,255
Industry FE		Included	Included	Included	Included	Included	Included
Log pseudol.		- 12,915	- 12,956	- 12,891	- 13,002	- 12,901	- 12,883
Estimation		Tobit	Tobit	Tobit	Tobit	Tobit	Tobit

5.1.1 Tax Attractiveness Index and the Allocation of Risk

Tax attractiveness has been defined in terms of specific factors, including ΔLCB_{ig}^{years}, ΔLCF_{ig}^{years}, ΔLCB_{ig}^{limit}, ΔLCF_{ig}^{limit} and ΔSTR_{ig}. Besides these specific measures, there exist a number of aggregate measures of tax attractiveness in literature. One of these measures is the *Tax Attractiveness Index* (see Keller and Schanz, 2013), which has been shown to help explain subsidiary location decisions (see Dinkel et al., 2014). Besides loss offset provisions and the *statutory tax rate* it takes into account a broad range of other factors relevant for the tax attractiveness of countries (e.g. the extensiveness of the double tax treaty network, withholding tax rates, etc.). These tax aspects play a role in decisions connected to the risk allocation decision. For example, in order to allocate risk to a country, a multinational needs to operate a subsidiary there, repatriate profits, etc. The *Tax Attractiveness Index* captures tax aspects that are relevant for those connected decisions. In this section we test whether the excess *Tax Attractiveness Index* value in the country of a subsidiary over the group average (ΔTAI_{ig}) helps to explain excess risk taken by this subsidiary.

Table A3 in the appendix shows the results of this analysis. The coefficient of ΔTAI_{ig} is significantly positively associated with the excess loss probability of a subsidiary. The more tax attractive a group country is in general, the more risk subsidiaries located therein are allocated. Therefore, we conclude that the *Tax Attractiveness Index* does have explanatory power in the decision how to allocate risk within multinationals.

5.2 Extensions and Robustness Test

5.2.1 Interaction of Tax Symmetry and the Statutory Tax Rate

In the previous section, we show that tax symmetry, as measured by *loss carryforward* rules, is positively related to excess risk taking and the *statutory tax rate* is negatively related. Theory suggests, that there exists a joint, interactive effect of the *statutory tax rate* and tax symmetry on risk taking. The negative effect of the *statutory tax rate* decreases (and eventually reverses) the more symmetric a tax system is. In our context this means, we expect a positive effect of the interaction terms of all variables characterizing excess tax symmetry (ΔLCB_{ig}^{years}, ΔLCF_{ig}^{years}, ΔLCB_{ig}^{limit} and ΔLCF_{ig}^{limit}) with the excess *statutory tax rate* (ΔSTR_{ig}) on excess risk taking.[28]

Table A4 in the appendix shows the result of the analysis of these interactions. We do find a significantly positive effect for interaction terms involving ΔLCF_{ig}^{years}, ΔLCB_{ig}^{limit} and ΔLCF_{ig}^{limit} in specifications II, III, V and VI. We do not find a significant interactive effect between ΔLCB_{ig}^{years} and ΔSTR_{ig}. Results for coefficients for the standalone variables remain unchanged compared to table 2 (not reported).

5.2.2 Riskiest Group Member as Reference Point

In our analyses presented so far, we use variables that are defined in excess of the group average. As a robustness test we rerun our main analysis with variables defined in excess of the value of the subsidiary with the highest observed loss probability within a group. Results, as presented in table A5 in the appendix, are largely unchanged compared to the results of our main analysis presented in table 2.

5.2.3 Volatility as Alternative Measure of Risk

As another robustness test, we replace the dependent variable, $\Delta pLoss_{ig}$, by ΔVol_{ig}. This variable measures the volatility of return on assets of companies in excess of the group average. Unlike the loss probability, this volatility based measure takes into account both upside and downside risk. Furthermore, it does not account for the average profitability (return on assets), as the loss probability does. It is these two distinctions that qualify $\Delta pLoss_{ig}$ as our preferred variable. Nevertheless, volatility based measures are used in related literature (see, e.g., Langenmayr and Lester, 2013). Therefore, we check whether our results change when using ΔVol_{ig} as the dependent variable.

Table A6 in the appendix presents the results from the corresponding regression analysis. When looking at the coefficients of the tax variables, we find that the results for tax variables are largely unchanged. Only ΔLCF_{ig}^{limit} now exhibits an unexpected negative coefficient that is significant at the 10 percent level.

[28] A check for multicollinearity reveals, that correlations of the interaction terms among each other and with other variables are moderate (<0.65) with the exception of the interactions of ΔLCB_{ig}^{years} and ΔLCB_{ig}^{limit} with ΔSTR_{ig} (0.92).

6 Conclusion

In this study we look at the risk allocation within multinationals and its tax determinants. In most previous studies analyzing corporate risk, the ownership structure among companies is either disregarded or groups are treated as black boxes. This study uses the subsidiary ownership information to analyze risk allocation within multinational groups and its tax determinants.

Using our dataset, which contains subsidiaries located in 32 European countries with parents from 90 countries globally, we show that factors which determine the symmetry of corporate taxation, *loss carryback* and *loss carryforward* provisions, help to explain the risk allocation within multinationals. The longer the period losses can be carried back or forward by a subsidiary compared to the group average or the lower the amount restrictions of the same provisions, the relatively more risk it takes. We also find that a higher *statutory tax rate* than the group average leads to a subsidiary taking comparatively less risk.

These results make three important contributions to literature. First, the ownership structure has been disregarded in related studies. We are the first to show that risk is allocated within multinational groups based on tax considerations. Second, we use the loss probability as our risk measure because we believe it better reflects the context specific risk faced by subsidiaries of multinationals than other measures used in related studies. Third, loss offset provisions, especially *loss carryforward* and *loss carryback* rules, have not been analysed in such detail. The result, that not only time restrictions but also amount restrictions in such provisions matter for risk-taking decisions, is novel in cross-country studies.

However, this study has limitations. Our measure of loss probability excludes financing risk. The problem is that capital structure related decisions within multinational groups are subject to tax planning themselves. In order to separate the effect of risk related tax planning we focus on operating risk. Furthermore, our dataset lacks a time dimension. Therefore, we cannot control for firm level fixed effects or infer causality. However, speaking to the latter point, the paper by (Koch and Prassel, 2011) shows that companies seem to react to changes in the asymmetry of taxation and therefore support our hypothesized direction of causality.

Nevertheless, the paper has implications for policy makers. We show that tax policy aiming to elevate risk-taking to a socially desirable level is not only important in an entrepreneurial context. Also, established multinational groups, which allocate risk strategically based on tax considerations, should be addressed by governments. In the field of empirical tax research, in which several decisions (e.g. capital structure, location of subsidiaries, location of patents, etc.) are well researched, the finding that multinationals allocate risk based on risk considerations is new. For researchers generally interested in corporate risk taking, the finding that risk is actively allocated among group members is an important result. It questions the treatment of multinationals as one homogenous entity. Furthermore, the detailed measurement and analysis of loss offset rules might be interesting for future research.

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A Appendix

A.1 Sample by Country

Table A1: Sample by Country

This table summarizes the company sample by country. *# parents* indicates the number of parents and *# subsidiaries* the number of subsidiaries resident in the respective country.

Country	# parents	# subsidiaries	Country	# parents	# subsidiaries
Algeria	1	-	Liechtenstein	26	-
Australia	51	-	Lithuania	36	507
Austria	486	2,423	Luxembourg	403	1,256
Bahamas	6	-	Macedonia	2	5
Bahrain	2	-	Malaysia	9	-
Belgium	702	6,766	Malta	36	190
Belize	1	-	Marshall Isl.	2	-
Bermuda	46	-	Mauritius	2	-
Bosnia-H.	3	-	Mexico	7	-
Brazil	15	-	Monaco	4	-
Brunei	1	-	Montenegro	3	9
Bulgaria	2	-	Netherlands	545	4,239
Canada	74	-	New Zealand	14	-
Cayman Isl.	41	-	Norway	391	5,716
Chile	6	-	Oman	1	-
China	19	-	Panama	5	-
Colombia	2	-	Poland	31	-
Croatia	27	34	Portugal	187	3,521
Curacao	30	-	Qatar	2	-
Cyprus	68	7	Romania	1	-
Czech Rep.	266	4,799	Russia	40	3,420
Denmark	736	4,899	San Marino	1	-
Egypt	1	-	Saudi Arabia	4	-
Estonia	52	1,228	Serbia	5	765
Finland	423	3,110	Seychelles	5	-
France	600	6,143	Singapore	23	-
Germany	1,452	9,796	Slovak Rep.	136	1,843
Gibraltar	7	-	Slovenia	74	728
Great Britain	702	20,501	South Africa	16	-
Greece	35	385	South Korea	29	-
Hong Kong	20	-	Spain	746	11,863
Hungary	19	109	St. Kitts & Nevis	2	-
Iceland	30	299	St. Lucia	1	-
India	51	-	St. Vincent	1	-
Iran	2	-	Sweden	410	-
Ireland	108	557	Switzerland	388	31
Israel	33	-	Taiwan	17	-
Italy	1,089	14,765	Thailand	4	-
Jamaica	1	-	Tunisia	1	-
Japan	272	-	Turkey	22	98
Kazakhstan	1	-	UAE	7	-
Kuwait	6	-	United States	1,052	-
Latvia	46	379	Uruguay	2	-
Lebanon	2	-	Venezuela	1	-
Libya	1	-	Virgin Isl.	23	-
Subtotal	**7,538**	**76,200**	**Total**	**12,255**	**110,391**

A.2 Correlation Matrix

Table A2: Correlation Matrix

This table reports the Pearson correlation coeficients for the independent variables used in the analysis of our two hypotheses. $\Delta pLoss_{ig}$ is the excess probability of a company reporting a negative return on assets over the group average. ΔVol_{ig} is the excess volatility of return on assets. $\Delta LCB_{ig}^{years}/\Delta LCF_{ig}^{years}$ is the excess number of years (in logarithmic format) that a company is allowed to carry losses back/forward. $\Delta LCB_{ig}^{limit}/\Delta LCF_{ig}^{limit}$ indicate the excess amount limitation of loss carryback/carryforward rules. ΔSTR_{ig} is the excess *statutory tax rate*. ΔTAI_{ig} is the excess *Tax Attractiveness Index* value. $\Delta Assets_{ig}$ is the excess of a company's total assets, in logarithmic format. ΔAge_{ig} is the excess number of years since incorporation of a company. ΔHHI_{ig} is the excess Herfindahl Hirschman Index, measured as the industry sum of the squared ratios of company sales over total industry sales. ΔLEV_{ig} is the excess leverage, measured as total liabilities over total assets. $\Delta GDPgrowth_{ig}$ is the excess real GDP growth. ΔFOR_{ig} is the excess of a dummy, that assumes a value of 1 if a subsidiary is in another country than the parent and a value of 0 otherwise. ΔEDU_{ig} indicates the excess share of enrollment in tertiary education.

		1	2	3	4	5	6	7	8	9	10	11	12	13
1	ΔLCB_{ig}^{years}	1.000												
2	ΔLCF_{ig}^{years}	0.513	1.000											
3	ΔLCB_{ig}^{limit}	0.907	0.503	1.000										
4	ΔLCF_{ig}^{limit}	- 0.117	0.019	0.066	1.000									
5	ΔSTR_{ig}	0.198	0.349	0.038	- 0.247	1.000								
6	ΔTAI_{ig}	0.455	0.500	0.592	- 0.012	- 0.006	1.000							
7	$\Delta Assets_{ig}$	0.057	0.105	0.067	- 0.007	0.095	0.097	1.000						
8	ΔAge_{ig}	0.089	0.121	0.095	- 0.010	0.145	0.086	0.207	1.000					
9	ΔLEV_{ig}	0.016	0.020	0.020	0.015	0.025	- 0.018	- 0.062	- 0.077	1.000				
10	ΔHHI_{ig}	0.015	0.023	0.025	- 0.004	0.017	- 0.001	0.007	0.007	- 0.004	1.000			
11	$\Delta GDPgrowth_{ig}$	0.018	- 0.097	- 0.031	- 0.173	- 0.374	0.160	- 0.008	- 0.003	- 0.040	- 0.010	1.000		
12	ΔFOR_{ig}	- 0.135	- 0.212	- 0.080	0.025	- 0.222	- 0.037	- 0.145	- 0.111	0.077	- 0.029	0.120	1.000	
13	ΔEDU_{ig}	- 0.310	- 0.250	- 0.291	0.080	0.003	- 0.319	- 0.043	- 0.021	- 0.003	- 0.022	- 0.216	- 0.017	1.000

A.3 Extensions and Robustness Tests - Tables

Table A3: Tax Attractiveness Index and the Allocation of Risk

This table describes the regression results for the analysis of the impact of tax attractiveness, as measured by the *Tax Attractiveness Index*, on the allocation of risk within multinationals. The dependent variable, $\Delta pLoss_{ig}$, is the excess probability of a company reporting negative return on assets over the group average. ΔTAI_{ig} is the excess *Tax Attractiveness Index* value in a group country over the group average. $\Delta Assets_{ig}$ is the excess of a company's total assets, in logarithmic format, over the group average. ΔAge_{ig} is the excess number of years since incorporation of a company over the group average. ΔHHI_{ig} is the excess Herfindahl Hirschman Index, measured as the industry sum of the squared ratios of company sales over total industry sales, of a company over the group average. ΔLEV_{ig} is the excess leverage, measured as total liabilities over total assets, of companies over the group average. $\Delta GDPgrowth_{ig}$ is the average real GDP growth in a subsidiary country in excess of the group average. ΔFOR_{ig} is the excess of a dummy, that assumes a value of 1 if a subsidiary is in another country than the parent and a value of 0 otherwise, over the group average. ΔEDU_{ig} indicates the excess share of enrollment in tertiary education in the country of a subsidiary over the group average. Results are derived from a Tobit model controlling for industry fixed effects. Robust standard errors are clustered by company. The 1%, 5% and 10% significance level is indicated by ***, ** and *.

Variable	Exp.		
ΔTAI_{ig}	+	0.198	***
$\Delta Assets_{ig}$	-	- 0.018	***
ΔAge_{ig}	-	- 0.001	***
ΔLEV_{ig}	+/-	0.135	***
ΔHHI_{ig}	+/-	0.166	***
$\Delta GDPgrowth_{ig}$	+/-	- 3.452	***
ΔFOR_{ig}	+/-	- 0.002	
ΔEDU_{ig}	+/-	0.004	
Const.	+/-	0.039	***
Observations		110,391	
Groups		12,255	
Industry FE		Included	
Log pseudol.		- 12,967	
Estimation		Tobit	

Table A4: Interaction of Tax Symmetry and the Statutory Tax Rate

This table describes the regression results for the analysis of interactions between loss offset rules and the *statutory tax rate*. The dependent variable, $\Delta pLoss_{ig}$, is the excess probability of a company reporting a negative return on assets over the group average. $\Delta LCB_{ig}^{years}/\Delta LCF_{ig}^{years}$ is the excess number of years (in logarithmic format) that a company is allowed to carry losses back/forward in its country of residence over the average across all group countries. $\Delta LCB_{ig}^{limit}/\Delta LCF_{ig}^{limit}$ indicate the excess amount limitation of loss carryback/carryforward rules. ΔSTR_{ig} is the excess *statutory tax rate* in the country of a subsidiary over the group average *statutory tax rate*. Controls (not reported) include $\Delta Assets_{ig}$ is the excess of a company's total assets, in logarithmic format, over the group average. ΔAge_{ig} is the excess number of years since incorporation of a company over the group average. ΔHHI_{ig} is the excess Herfindahl Hirschman Index, measured as the industry sum of the squared ratios of company sales over total industry sales, of a company over the group average. ΔLEV_{ig} is the excess leverage, measured as total liabilities over total assets, of companies over the group average. $\Delta GDPgrowth_{ig}$ is the average real GDP growth in a subsidiary country in excess of the group average. ΔFOR_{ig} is the excess of a dummy, that assumes a value of 1 if a subsidiary is in another country than the parent and a value of 0 otherwise, over the group average. ΔEDU_{ig} indicates the excess share of enrollment in tertiary education in the country of a subsidiary over the group average. Results are derived from a Tobit model controlling for industry fixed effects. Robust standard errors are clustered by company. The 1%, 5% and 10% significance level is indicated by ***, ** and *.

		Specification					
Variable	Exp.	I	II	III	IV	V	VI
ΔLCB_{ig}^{years}	+	0.040 ***				0.033 ***	
ΔLCB_{ig}^{years} x ΔSTR_{ig}	+	- 0.014				- 0.086	
ΔLCF_{ig}^{years}	+		0.012 ***			0.007 ***	
ΔLCF_{ig}^{years} x ΔSTR_{ig}	+		0.052 **			0.052 *	
ΔLCB_{ig}^{limit}	+			0.043 ***			0.042 ***
ΔLCB_{ig}^{limit} x ΔSTR_{ig}	+			0.117 *			0.156 **
ΔLCF_{ig}^{limit}	+				0.037 ***		0.031 ***
ΔLCB_{ig}^{limit} x ΔSTR_{ig}	+				0.203		0.352 **
ΔSTR_{ig}	-	- 0.381 ***	- 0.394 ***	- 0.294 ***	- 0.266 ***	- 0.414 ***	- 0.254 ***
Const.	+/-	0.038 ***	0.038 ***	0.038 ***	0.037 ***	0.038 ***	0.038 ***
Observations		110,391	110,391	110,391	110,391	110,391	110,391
Groups		12,255	12,255	12,255	12,255	12,255	12,255
Industry FE		Included	Included	Included	Included	Included	Included
Log pseudolikelihood		- 12,915	- 12,954	- 12,889	- 13,001	- 12,899	- 12,879
Controls		Included	Included	Included	Included	Included	Included
Estimation		Tobit	Tobit	Tobit	Tobit	Tobit	Tobit

Table A5: Riskiest Group Member as Reference Point

This table describes the regression results for the robustness test using alternative specifications of variables. The dependent variable, $\Delta pLoss_{ig}$, is the excess probability of a company reporting negative return on assets over the group member bearing most risk. $\Delta LCB_{ig}^{years}/\Delta LCF_{ig}^{years}$ is the excess number of years (in logarithmic format) that a company is allowed to carry losses back/forward in its country of residence over the riskiest subsidiary. $\Delta LCB_{ig}^{limit}/\Delta LCF_{ig}^{limit}$ indicate the excess amount limitation of loss carryback/carryforward rules. ΔSTR_{ig} is the excess *statutory tax rate* in the country of a subsidiary over the country of the riskiest group member. $\Delta Assets_{ig}$ is the excess of a company's total assets, in logarithmic format, over the size of the riskiest subsidiary. ΔAge_{ig} is the excess number of years since incorporation of a company over the riskiest subsidiary. ΔLEV_{ig} is the excess leverage, measured as total liabilities over total assets, of companies over the leverage of the riskiest subsidiary. ΔHHI_{ig} is the excess Herfindahl Hirschman Index, measured as the industry sum of the squared ratios of company sales over total industry sales, of a company over the riskiest group member. $\Delta GDPgrowth_{ig}$ is the average real GDP growth in a subsidiary country in excess of the riskiest group member. ΔFOR_{ig} is the excess of a dummy, that assumes a value of 1 if a subsidiary is in another country than the parent and a value of 0 otherwise, over the riskiest group member. ΔEDU_{ig} indicates the excess share of enrollment in tertiary education in the country of a subsidiary over the country of the subsidiary with the highest loss probability. Results are derived from a Tobit model controlling for industry fixed effects. Robust standard errors are clustered by company. The 1%, 5% and 10% significance level is indicated by ***, ** and *.

		Specification											
Variable	Exp.	I		II		III		IV		V		VI	
ΔLCB_{ig}^{years}	+	0.050	***							0.045	***		
ΔLCF_{ig}^{years}	+			0.013	***					0.006	***		
ΔLCB_{ig}^{limit}	+					0.049	***					0.048	***
ΔLCF_{ig}^{limit}	+							0.035	***			0.023	
ΔSTR_{ig}	-	- 0.211	***	- 0.205	***	- 0.103	***	- 0.075	***	- 0.241	***	- 0.073	***
$\Delta Assets_{ig}$	-	- 0.006	***	- 0.006	***	- 0.006	***	- 0.006	***	- 0.006	***	- 0.006	***
ΔAge_{ig}	-	- 0.001	***	- 0.001	***	- 0.001	***	- 0.001	***	- 0.001	***	- 0.001	***
ΔLEV_{ig}	+/-	0.023	***	0.024	***	0.023	***	0.025	***	0.023	***	0.023	***
ΔHHI_{ig}	+/-	0.090	***	0.090	***	0.093	***	0.091	***	0.090	***	0.093	***
$\Delta GDPgrowth_{ig}$	+/-	- 3.512	***	- 3.468	***	- 3.283	***	- 3.268	***	- 3.524	***	- 3.183	***
ΔFOR_{ig}	+/-	- 0.018	***	- 0.015	***	- 0.018	***	- 0.020	***	- 0.016	***	- 0.017	***
ΔEDU_{ig}	+/-	- 0.049	***	- 0.077	***	- 0.051	***	- 0.110	***	- 0.041	*	- 0.052	***
Const.	+/-	- 0.388	***	- 0.389	***	- 0.389	***	- 0.390	***	- 0.387	***	- 0.389	***
Observations		110,391		110,391		110,391		110,391		110,391		110,391	
Groups		12,255		12,255		12,255		12,255		12,255		12,255	
Industry FE		Included		Included		Included		Included		Included		Included	
Log pseudolikelihood		- 36,888		- 37,028		- 36,876		- 37,102		- 36,871		- 36,869	
Estimation		Tobit		Tobit		Tobit		Tobit		Tobit		Tobit	

Table A6: Volatility as Alternative Measure of Risk

This table describes the regression results for the robustness test using volatility as an alternative measure of risk. The dependent variable, $\Delta Vola_{ig}$, is the excess volatility of return on assets over the group average. $\Delta LCB_{ig}^{years}/\Delta LCF_{ig}^{years}$ is the excess number of years (in logarithmic format) that a company is allowed to carry losses back/forward in its country of residence over the average across all group countries. $\Delta LCB_{ig}^{limit}/\Delta LCF_{ig}^{limit}$ indicate the excess amount limitation of loss carryback/carryforward rules. ΔSTR_{ig} is the excess *statutory tax rate* in the country of a subsidiary over the group average *statutory tax rate*. $\Delta Assets_{ig}$ is the excess of a company's total assets, in logarithmic format, over the group average. ΔAge_{ig} is the excess number of years since incorporation of a company over the group average. ΔHHI_{ig} is the excess Herfindahl Hirschman Index, measured as the industry sum of the squared ratios of company sales over total industry sales, of a company over the group average. ΔLEV_{ig} is the excess leverage, measured as total liabilities over total assets, of companies over the group average. $\Delta GDPgrowth_{ig}$ is the average real GDP growth in a subsidiary country in excess of the group average. ΔFOR_{ig} is the excess of a dummy, that assumes a value of 1 if a subsidiary is in another country than the parent and a value of 0 otherwise, over the group average. ΔEDU_{ig} indicates the excess share of enrollment in tertiary education in the country of a subsidiary over the group average. Results are derived from a Tobit model controlling for industry fixed effects. Robust standard errors are clustered by company. The 1%, 5% and 10% significance level is indicated by ***, ** and *.

		Specification											
Variable	Exp.	I		II		III		IV		V		VI	
ΔLCB_{ig}^{years}	+	0,007	***							0,006	***		
ΔLCF_{ig}^{years}	+			0,002	***					0,001	***		
ΔLCB_{ig}^{limit}	+					0,012	***					0,012	***
ΔLCF_{ig}^{limit}	+							- 0,001				- 0,003	*
ΔSTR_{ig}	-	- 0,119	***	- 0,124	***	- 0,104	***	- 0,108	***	- 0,127	***	- 0,108	***
$\Delta Assets_{ig}$	-	- 0,011	***	- 0,011	***	- 0,011	***	- 0,011	***	- 0,011	***	- 0,011	***
ΔAge_{ig}	-	- 0,000	***	- 0,000	***	- 0,000	***	- 0,000	**	- 0,000	***	- 0,000	***
ΔLEV_{ig}	+/-	0,046	***	0,046	***	0,046	***	0,046	***	0,046	***	0,046	***
ΔHHI_{ig}	+/-	0,023	***	0,023	***	0,023	***	0,023	***	0,023	***	0,022	***
$\Delta GDPgrowth_{ig}$	+/-	0,148	***	0,164	***	0,207	***	0,156	***	0,153	***	0,192	***
ΔFOR_{ig}	+/-	0,006	***	0,007	***	0,007	***	0,006	***	0,007	***	0,007	***
ΔEDU_{ig}	+/-	- 0,003		- 0,006	**	0,003		- 0,011	***	- 0,001		0,003	
Const.	+/-	- 0,005	***	- 0,005	***	- 0,005	***	- 0,005	***	- 0,005	***	- 0,005	***
Observations		110,391		110,391		110,391		110,391		110,391		110,391	
Groups		12,255		12,255		12,255		12,255		12,255		12,255	
Industry FE		included		included		included		included		included		included	
R squared		0.20		0.20		0.21		0.20		0.20		0.21	
Estimation		OLS		OLS		OLS		OLS		OLS		OLS	

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