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Debt shifting in response to international tax incentives

Evidence from European multinational corporations

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NORWEGIAN SCHOOL OF ECONOMICS

Abstract

This study examines whether national and international tax factors can explain leverage decisions of European multinational corporations. Using the model specification proposed by Møen, Schindler, Schjelderup and Tropina (2011), the study predicts that an affiliate's leverage depends on host country statutory corporate tax rate and differences between host country tax rate and foreign tax rates. Differences in international tax rates influence international debt shifting whose main idea is claiming interest income in low-tax countries and interest expenses in high-tax countries. Predictions of the model form the basis of my main research question and sub-questions, which are tested on a data sample of European multinational firms and their majority-owned subsidiaries, obtained from firm-level Amadeus database. Historical ownership data on majority-owned subsidiaries of European multinational firms is initially obtained from firm-level Orbis database. The obtained results show that an affiliate's financial structure depends on three tax mechanisms: host country corporate tax rate, external debt shifting mechanism and internal debt shifting mechanism. Due to correlation between the tax mechanisms, omission of any of them from the specification would bias the estimated effect on affiliate's leverage of the other tax mechanisms that are included in the specification. Assuming a constant historical ownership structure over the sample period would result in misclassified subsidiary-parent relations and a subsequent downward bias in the estimated effect of international debt shifting mechanisms on affiliate's leverage. Hence, adjustments to historical ownership structure changes are necessary to obtain unbiased estimates of variables that are measured based on data on all affiliates within the multinational group. Finally, European multinational corporations with majority-owned affiliates outside Europe must also be considered carefully. Capital structures of European affiliates which belong to these multinational corporations seem to be less responsive to international tax incentives. This finding can be explained by measurement errors in the international debt shifting mechanisms that arise due to disregarding financial and tax data on affiliates outside Europe that belong to the multinational group.

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1. Introduction

Companies worldwide are prone to adjust their capital structures in order minimize tax payments in response to different tax legislations. This activity is referred to as tax avoidance, planning or engineering, and can be done domestically or worldwide, by taking advantage of different taxation regimes in various countries. What firms think is a legal tax planning may be considered tax evasion by tax authorities – the issue is a grey area where it is unclear what is legal (Møen, Schindler, Schjelderup & Tropina, 2011). The two main strategies used by multinational firms for tax planning activities are abusive transfer pricing and international debt shifting. In my study, I will focus on international debt shifting whose main idea is claiming tax deductions on interest expenses in high tax countries and paying tax on interest income in low tax countries.

As revealed by public incidents, several global multinational companies pay very low taxes. For example, Google paid a tax rate of only 2.6% on its non-U.S. profits in 2012 because it shifted most of its overseas profits to an affiliate in Bermuda, which does not levy a corporate tax (Bergin, 2013). Starbucks had reported a taxable profit in only 1 year during a 15 year period in the United Kingdom in 2013 ("Starbucks pays," 2013). Furthermore, Apple has been claimed to be searching for "the Holy Grail of tax avoidance", as the multinational company has used a sophisticated net of offshore entities and avoided paying substantial amounts of income taxes in the U.S. (Trotman, 2013). Hence, as multinational firms are globally expanding and have devoted substantial investments to implement sophisticated tax avoidance strategies, it is particularly interesting to examine the relation between their capital structures and international taxation.

Moreover, profit shifting by multinational companies is a substantial political concern and a growing field in public finance. The Organisation for Economic Co-operation and Development (OECD) has recognized that base erosion and profit shifting is a global problem and requires coordinated solutions, as tax engineering activities erode the objectivity and integrity of tax systems worldwide. Fifteen actions are developed within the OECD/G20 BEPS (Base Erosion and Profit Shifting) Project in order to provide governments with instruments needed to address the widespread issue of tax avoidance and to guarantee taxation of profits where economic activities yielding the profits are performed and where value creation occurs. The first measures and reports were published in September 2014, but there still is work to be completed in 2015. Non-OECD and non-G20 countries are also

involved on a par, which is the first time ever regarding tax issues (OECD, n.d.a). Also Norway has committed to implement an automatic exchange of information starting 2017 with respect to tax evasion (Finansdepartementet, 2014). The United Nations (UN) Tax Committee is also engaged in the fight against tax avoidance (United Nations, n.d.).

The main advantage of debt financing is that interest payments to lenders are usually fully deductible for corporate tax purposes, while dividend payments to shareholders are paid out of net-of-tax income. Accordingly, debt financing is usually preferred over equity, and debt tax shield is an important determinant of capital structures of both domestic and multinational companies. The incentive to use debt increases with the corporate tax rate; therefore, high corporate tax rates are often associated with higher corporate indebtedness. Overall, due to the tax benefits of debt financing, companies tend to have more debt than it would be optimal for non-tax considerations. A firm which does not own any foreign affiliates only considers the domestic tax system while planning its capital structure. However, defining its capital structure is more complicated for a multinational company whose affiliates operate in different countries. A multinational firm profits from shifting income to low-tax countries and allocating its total debt internationally across domestic and foreign affiliates in order to reduce the global tax burden. It is able to use the debt tax shield more efficiently than a domestic firm by moving debt from lower-taxed affiliates to affiliates facing higher tax rates (Huizinga, Laeven & Nicodeme, 2008, p. 81). Consequently, the financial structure of a multinational firm reflects the tax systems of all its affiliates worldwide.

Even though Modigliani and Miller (1958) highlighted the importance of differences in marginal tax rates for firm's optimal debt policy, the empirical literature on capital structure choice was not very successful in identifying the importance of tax advantage of debt until early 2000s. Mintz and Smart (2004) were one of the first to study profit shifting of multinational firms. The authors show that it is optimal for a multinational firm to borrow in high-tax jurisdictions and declare its interest income in the lowest-taxed jurisdiction. Furthermore, even though several empirical papers study international debt shifting and multinational firms' leverage responses to tax, they disagree on the mechanism. Among these, Huizinga et al. (2008) were one of the first to present a model of the optimal financial structure of a multinational firm in response to both tax and non-tax considerations. They consider the optimal allocation of external debt and test the model's predictions on European firms. Furthermore, Egger, Eggert, Keuschnigg and Winner (2010) have developed a

theoretical model of internal debt shifting mechanism. Their results show that multinational firms have substantially higher debt-to-asset ratios than purely domestic firms, and that this difference is especially pronounced in countries with high corporate tax rates.

Both of the above-mentioned papers use total debt-to-asset ratio as the dependent variable in their empirical analyses, even though Huizinga et al. (2008) examine only external debt shifting and Egger et al. (2010) examine only internal debt shifting. Hence, the individual contributions of standard debt tax shield and external debt shifting mechanism on firms' leverage are biased in the study by Huizinga et al. (2008) because internal debt shifting mechanism has been omitted from their analysis. The individual contributions of standard debt tax shield and internal debt shifting mechanism on firms' leverage are biased in the study by Egger et al. (2010) because external debt shifting mechanism has been omitted from their analysis. Consequently, the empirical results of these studies cannot be interpreted as unambiguous as the results can be affected by an omitted variable bias due to focus on either external or internal debt shifting. This issue characterizes most of the empirical papers that analyse leverage responses to tax, which is a substantial gap in the existing research. Møen et al. (2011) were the first to show that both internal and external debt shifting mechanisms are equally relevant determinants of leverage choices of German multinational companies. They use a micro-level Midi database on German multinational companies, provided by the Deutsche Bundesbank. The results show that it is optimal for a multinational firm to use both internal and external debt in order to minimize the global tax burden and maximize the firms' profits.

Examination of the previous research forms the basis of my main research question:

Is a European multinational firm's capital structure responsive to international tax incentives?

To answer the main research question, four sub-questions are proposed:

(1) Are external and internal debt shifting mechanisms important determinants of capital structures of majority-owned European affiliates that belong to European multinational firms?

(2) How substantial is the omitted variable bias arising from omitting any of the tax mechanisms from specification while estimating the impact of tax on firms' leverage?

(3) Are correctly specified historical ownership relations between subsidiaries and parent firms important while examining debt shifting among affiliates of European multinational firms?
(4) Do European multinational firms that have majority-owned affiliates outside Europe react differently to tax incentives than European firms with only European affiliates?

Hence, the additional contributions of my thesis to the existing literature are fourfold. Firstly, as Møen et al. (2011) use data only on German multinational firms, it is an open question whether their findings carry over to a data sample of European multinational firms. Variation in corporate tax rates is much larger when considering European multinational firms; therefore, the obtained results on the impact of tax on firms' leverage can be substantially different. Thus, the first and main contribution of my thesis is investigation of whether international debt shifting mechanisms are significant determinants of capital structures of European multinational firms found in the Amadeus database.

Secondly, the previous literature on corporate leverage responses to tax is characterized by an omitted variable bias and does not truly describe the profit maximizing behaviour of European multinational companies due to its exclusive focus only on one of the debt shifting mechanisms. Omitted variable bias leads to biased individual contributions on affiliates' leverage of the other tax mechanisms that are included in the specification. Hence, the second contribution of my thesis is investigation of significance of the omitted variable bias found in the previous literature.

Furthermore, several studies that examine capital structure responses to tax and use the Amadeus database to obtain data on multinational firms and their subsidiaries assume a constant historical ownership structure over their sample periods. As an example, empirical results and descriptive statistics presented by Huizinga et al. (2008) show that the authors assume a constant ownership structure over their sample period of 10 years (1994 – 2003). However, this assumption leads to misclassified subsidiary-parent relations as ownership structures tend to change over time. Therefore, the third contribution of my thesis is examination of importance of correctly specified historical ownership relations between subsidiaries and parent firms while analysing the debt shifting behaviour of European multinational firms. Moreover, the quality of my obtained estimates is improved, compared to studies which do not adjust for historical ownership changes.

Finally, previous studies that obtain data from the Amadeus database cannot examine whether European multinational firms own any affiliates outside Europe, as the Amadeus database provides data only on firms in Europe. Combination of ownership data from the Orbis database and financial data from the Amadeus database allows me to distinguish European multinational firms with non-European affiliates. Thus, the fourth contribution of my thesis is examination of differences in leverage responses to tax between European multinational corporations that have majority-owned affiliates outside Europe and firms without majority-owned affiliates outside Europe.

In order to answer the research questions and address the existing gaps in literature, I use the model specification proposed by Møen et al. (2011, pp. 8 – 14) on a data sample of majority-owned affiliates of European multinational firms. The model considers the optimal capital structure of a multinational firm, accounting for various costs and benefits of both internal and external debt and the possible debt tax shield effects associated with both of them. According to the model, there exist three debt tax shield effects that multinational companies can exploit to reduce their global tax burden: the standard debt tax shield effect and external and internal debt shifting effects, representing international debt shifting (Møen et al., 2011; pp. 2 – 3). The model yields that the affiliate's optimal debt-to-asset ratio is positively related to all three debt tax shield effects, represented by three tax mechanisms: the host country corporate tax rate (standard debt tax shield effect), the sum of asset-weighted differences between host country tax rate and tax rates of other affiliates within the multinational group (defined as weighted tax difference or external debt shifting effect), and the difference between host country tax rate and tax rate of the lowest-taxed affiliate within the multinational group (defined as maximum tax difference or internal debt shifting effect).

I initially obtain historical ownership data on European firms in the firm-level Orbis database, and then use the firm-level Amadeus database to find financial data on these European firms and their majority-owned subsidiaries over the sample period (2003 – 2014). Contrary to several other studies that use the Amadeus database and assume a constant historical ownership structure, my data sample is adjusted for ownership structure changes over the sample period. The total number of parent firms is 143,405 over the sample period, while the total number of subsidiaries is 229,703, operating in 39 European countries. Overall, there are 1,039,827 affiliate-year observations over the sample period of 12 years. In robustness tests, the sample is extended and includes purely domestic firms in Europe (non-multinational firms), which increases the number of observations to 3,792,982. All

regressions include parent (group) fixed effects (and in robustness tests, also subsidiary fixed effects), industry fixed effects and year dummies in order to control for common factors among multinational corporations, industries and years that have an effect on firms' optimal leverage policies.

Even in presence of multicollinearity arising from correlation between the three tax mechanisms, their coefficients can still be estimated. The economic significance of the estimated tax mechanisms can be assessed when considering a multinational firm which consists of two affiliates – one foreign subsidiary and the parent firm. The two affiliates are of equal size and the foreign subsidiary is located in a country with a higher corporate tax rate than the parent firm. Consider that the subsidiary's host country increases the statutory corporate tax rate by 10 percentage points, keeping everything else constant. According to my obtained estimates, the total effect on the subsidiary's debt-to-asset ratio will be an increase of 2.42 percentage points, while the total effect on the parent firm's debt-to-asset ratio will be a decrease of 0.27 percentage points. For an affiliate with an average total debt-to-asset ratio in the sample (0.59), an increase in the statutory corporate tax rate of 10 percentage points will lead to an increase in the total debt of approximately 4.1%. 68% of this increase is explained by the standard debt tax shield, which can be exploited by both purely domestic firms and multinational firms. 32% of this increase is explained by the international debt shifting mechanisms, where the maximum tax difference mechanism contributes approximately two times more than the weighted tax difference mechanism.

Furthermore, correlation between the tax mechanisms leads to an omitted variable bias if any of the tax mechanisms are omitted from the regression specification. When the host country corporate tax rate is the only tax mechanism included in the specification, its coefficient is biased upwards by approximately 51%. This specification is appropriate for a sample of purely domestic firms, as they do not engage in international debt shifting activities. If the maximum tax difference variable has been omitted from the analysis, the omitted variable bias is approximately 16% for coefficient on the statutory tax rate variable and 41% for coefficient on the weighted tax difference variable. As an example, Huizinga et al. (2008) do not consider internal debt shifting in their specification. Furthermore, if the weighted tax difference variable has been omitted from the analysis, the omitted variable bias is approximately 20% for coefficient on the statutory tax rate variable and 22% for coefficient on the maximum tax difference variable. All previous studies which examine the sensitivity

of total or external debt-to-asset ratio with respect to taxation do not consider external debt shifting in their specifications, except Huizinga et al. (2008) and Møen et al. (2011).

Robustness of the obtained results is tested in several ways. Firstly, the data sample is split into large and small multinational firms in order to examine the potential heterogeneity between large and small firms. The results show that large multinational firms are more likely to engage in international debt shifting than small multinational firms. Large multinational firms may be better able to pursue tax engineering activities due to more income, better connections and more affiliates facing different tax rates, which makes it less costly for large firms to avoid paying high taxes.

Furthermore, existence of preferential tax regimes in Belgium, the Netherlands and Luxembourg contributes to lower effective tax rates of multinational firms. I examine whether the lower effective tax rates create a measurement error in the estimated coefficients on tax mechanisms by adjusting corporate tax rates downwards for affiliates involved in financial services or holding activities in these countries. This adjustment decreases the estimated coefficient on the statutory corporate tax rate variable and slightly increases the estimated coefficients on the international debt shifting mechanisms. The small changes in coefficients after the adjustment can be explained by importance of more precise adjustments to corporate tax rates that are necessary to derive the effective tax rates.

In order to examine whether inclusion of purely domestic firms in the main data sample changes the estimated coefficients on the three tax mechanisms, I expand the data sample and include purely domestic firms in addition to multinational firms. The estimated coefficient on the standard debt tax shield mechanism decreases, while coefficients on the international tax mechanisms increase. The results indicate that inclusion of domestic firms in the sample reduces the standard debt tax shield advantage. This can be explained by relatively many loss-making firms among small domestic firms, which have little incentives to use debt tax shield.

To examine whether an assumption about a constant historical ownership structure over the sample period biases my results, I assume that subsidiary-parent relations remain constant over the sample period of 12 years. In contrast to other authors who claim that misclassified subsidiary-parent relations are unlikely to be a major concern in their studies, my results show that misclassifications bias the estimated coefficients on the tax mechanisms, and especially the weighted tax difference variable. This shows that misclassified historical

ownership relations introduce a particularly large bias in the estimated coefficients on variables which are constructed based on data on all affiliates within the multinational group.

Furthermore, the main data sample includes multinational corporations which have majority-owned affiliates also outside Europe. To examine whether leverage responses to tax differ for European multinational firms that have affiliates outside Europe and European multinational firms that do not have affiliates outside Europe, I divide the main data sample into two parts, based on ownership of non-European affiliates. The results show that affiliates which belong to parent firms without any affiliates outside Europe are more responsive to the international debt shifting mechanisms. This observation can be explained by a potential measurement error in the international debt shifting mechanisms that arises due to disregarding financial and tax data on non-European affiliates that belong to the multinational group.

The next robustness test focuses on existence of holding companies in the data sample. A multinational firm can establish a holding company, endow it with a very high amount of debt and then use these funds of the holding company to shift equity to other affiliates within the multinational group. Hence, the holding company can have a very high level of debt, while other affiliates within the thinly capitalized multinational group seem to have very low leverage. If the main data sample consists of a few heavily indebted affiliates (holding companies) and many affiliates with very small levels of debt, it might lead to biased estimates of the effect of tax on affiliates' leverage. In order to control for highly leveraged holding companies, I create an aggregated total debt-to-asset ratio per multinational firm per country which aggregates information from all firm's affiliates that operate within a particular country. The obtained results show an increase in coefficients on all tax mechanisms, suggesting that multinational firms' capital structures are more responsive to tax than was estimated originally. The results suggest that existence of holding companies exerts a downward bias in the estimated coefficients on all tax mechanisms in the original specification.

Furthermore, approximately 23% of affiliates in the main data sample have loss carry-forwards. To examine whether loss carry-forwards affect tax elasticity of debt negatively, I create interaction terms of all tax mechanisms with a loss carry-forward dummy variable. The results show a significant adverse impact of loss carry-forward on the estimated effects of corporate tax rate and weighted tax difference variables on affiliates' leverage, and a significant positive impact of loss carry-forward on the estimated effect of maximum tax

difference variable on affiliates' leverage. The same results are obtained when the data sample is split into two parts – the affiliates that report loss carry-forwards and the affiliates that do not report loss carry-forwards. The standard debt tax shield and external debt shifting mechanisms are less important for leverage decisions of affiliates with loss carry-forwards, while internal debt shifting mechanism is more important for their leverage decisions, compared to affiliates that do not report loss carry-forwards. The high responsiveness of loss-making affiliates' leverage to the maximum tax difference variable suggests that multinational firms use internal debt to finance loss-making affiliates.

To examine whether multinational firms respond to the tax mechanisms in a non-linear fashion, I include quadratic tax mechanisms in the regression specification. The estimated coefficients on the quadratic statutory corporate tax rate and the quadratic maximum tax difference variables are negative, which suggests that the tax effect on leverage is concave in the statutory corporate tax rate and the maximum tax difference. The estimated coefficient on the quadratic weighted tax difference variable is positive, which suggests that for a higher weighted tax difference the marginal effect of tax on leverage increases and the affiliate is likely to receive even more external debt.

Finally, to control for potential unobserved subsidiary heterogeneity characterizing their leverage, I include subsidiary fixed effects in the regression. The results show that subsidiary fixed effects reduce the effect of tax mechanisms on affiliates' leverage. Coefficients on all tax mechanisms decrease, and coefficient on the maximum tax difference variable becomes statistically insignificant and negative. This suggests that subsidiary fixed effects substantially reduce variation in the data. When regressions control for no subsidiary or group fixed effects, coefficients on the statutory corporate tax rate and maximum tax difference variables substantially decrease, while coefficient on the weighted tax difference variable substantially increases. The extreme changes in the estimated coefficients confirm the importance of controlling for fixed effects, as there exists substantial heterogeneity among parent firms and subsidiaries in the data sample.

In the remainder of this paper, section 2 presents literature review. Section 3 discusses methodology. Section 4 presents data and descriptive statistics. Section 5 discusses endogeneity issues. Section 6 presents empirical results. Section 7 discusses robustness of results with respect to various sample and specification choices and extensions of the main results. Section 8 concludes the paper.

2. Literature review

The study by Modigliani and Miller (1958) established that in a world with taxes, when interest expenses on debt are tax deductible, firm's value increases with leverage. The additional value is created by issuing debt instead of equity, which results in tax savings for the firm. However, even though the study emphasized that tax has an impact on firm's optimal capital structure, only a few empirical studies focused on different capital structure theories until early 2000s. Rajan and Zingales (1995), using data on 7 countries and allowing for international variation in tax rates, started filling the gap in knowledge by examining firms' capital structure choices. While examining the impact of institutional differences on leverage, they found that taxes influence the aggregate corporate leverage in a country. This finding was contrary to the existing empirical literature on capital structure choice claiming that taxes have no impact on firms' financing patterns.[1]

There are several papers that show that taxes influence leverage decisions of multinational corporations. Booth, Aivazian, Demirgüç-Kunt and Maksimovic (2001), using a dataset on 10 developing countries, conclude that countries which offer a higher debt tax shield advantage are characterized by highly indebted multinational firms. Furthermore, using data on U.S. foreign-controlled corporations, Mills and Newberry (2004) find that foreign multinational firms with low average foreign tax rates have more indebted foreign-controlled corporations than firms with high average foreign tax rates. Ramb and Weichenrieder (2005) find that tax rate differentials have an impact on internal loans of foreign affiliates operating in Germany. Also Arena and Roper (2010), using a dataset on 23 countries, find that tax-based incentives can explain the location choice of multinational firms' debt. Their results suggest that different international tax rates and tax regimes affect where a multinational firm will locate its external debt and how much debt it will locate abroad. In addition, the analysis shows that if a multinational firm has a foreign subsidiary that operates in a country which provides a relatively greater tax advantage of debt than other affiliates, the firm is willing to increase the amount of debt issued there.

Furthermore, several empirical studies quantify the effect of changes in tax rate on leverage decisions by multinational firms. Alworth and Arachi (2001), using panel data on Italian companies, find that both personal and corporate tax rates influence companies' financing decisions. Their results show that an increase in the marginal corporate tax rate by

[1] As an example, Mayer (1990).

100 basis points increases the ratio of growth of total debt to total assets by approximately 8 basis points (p. 375). Altshuler and Grubert (2003) find that controlled foreign corporations (CFCs) of U.S. multinational firms in high-tax countries have much more debt than CFCs in low-tax countries. Moreover, an increase in the foreign statutory tax rate by 1 percentage point is associated with an increase of approximately 0.4 percentage points in the total debt-to-asset ratio of the CFC (p. 107). Also Mintz and Weichenrieder (2005), using panel data on German outbound foreign direct investment (FDI), find that debt-to-asset ratio is positively related to the host country corporate tax rate. Their analysis shows that an increase in the corporate tax rate by 10% is associated with an increase in the debt-to-asset ratio of manufacturing firms by 5.6 percentage points (p. 10). Using a dataset on multinational firms in the European Union, Moore and Ruane (2005) find that an increase in the corporate tax rate by 10% increases subsidiary debt-to-asset ratios by 3.5% (p. 18). However, if a tax credit system is active in the home country, the positive relationship between corporate tax rate and leverage vanishes.

Several authors examine how changes in interest allocation rules or thin capitalization rules affect leverage decisions of multinational firms. Froot and Hines (1995) investigate how the change in U.S. interest allocation rules in 1986 affected investment and financing choices of U.S. multinational corporations. The results show that tax deductibility of interest expenses decreased after the change in 1986, which led to an increased cost of debt and decreased debt usage. Also Jog and Tang (2001) investigate the impact of U.S. tax reform on debt-shifting behaviour of U.S. and Canadian multinational corporations. The authors show that the subsequent reduction in Canadian corporate tax rate in the late 1980s led to decreased debt-to-asset ratios of Canadian affiliates. Furthermore, Büttner, Overesch, Schreiber and Wamser (2012) investigate how financing and investment decisions of German multinational firms are affected by thin capitalization rules that limit tax deductibility of interest expenses. The analysis shows an adverse impact of thin capitalization rules on multinational firms' financial structures, which suggests that the rules effectively reduce affiliates' debt. Moreover, the study finds that introduction of thin capitalization rules increases tax sensitivity of capital stock investment decisions and decreases tax sensitivity of debt-to-asset ratio in countries that impose the rules. Also Blouin, Huizinga, Laeven and Nicodeme (2014) investigate how thin capitalization rules affect financial structures of foreign affiliates of U.S. multinational firms. The results show that thin capitalization rules have a significant effect on affiliates' leverage choices. Restrictions on the total debt of an affiliate reduce its total

debt-to-asset ratio by 1.9%, and restrictions on the internal debt of an affiliate reduce its internal debt-to-asset ratio by 6.3%. In addition, restricted internal debt decreases affiliate's total debt-to-asset ratio by 0.8%, which implies that regulations directed towards limiting internal leverage have also an indirect effect on affiliate's total leverage (p. 20).

All the above-mentioned papers provide evidence that financial structures of multinational companies across the world comply with the purpose of tax minimization. However, empirical literature examining whether and to what extent debt is used for profit shifting (utilizing the internal and external debt shifting mechanisms) or whether tax minimization effects reflect the conventional tax shelter of debt finance (utilizing the statutory tax rate mechanism), is not so broad. Even though interest deductions from taxable income result in tax revenue losses for host country in both instances, difference between them is important for tax policy. If standard debt tax shield is the main mechanism behind tax minimization, restraints on interest deductions from taxable income can be implemented as a countermeasure. If profit shifting is the main mechanism, any restrictions can lead to a shift towards other profit shifting mechanisms; thus, decreasing or removing differences in effective tax rates worldwide is the ultimate countermeasure.

Mintz and Smart (2004) were one of the first to study profit shifting of multinational firms. The authors examine corporate income tax competition and financial planning strategies of multinational firms whose affiliates are located in multiple jurisdictions, which allows them to shift profits from jurisdictions with high corporate tax rates to those with low corporate tax rates. The model shows that it is optimal for a multinational firm to borrow in high-tax jurisdictions and declare its interest income in the lowest-taxed jurisdiction. By utilizing such a mechanism, the multinational firm maximizes the value of tax deductibility of interest expenses and minimizes the taxes paid on interest income. In addition, the model shows that inter-jurisdictional tax engineering can lead to asymmetries in statutory corporate tax systems around the world, when one jurisdiction becomes a tax haven to attract income, while others have higher statutory corporate tax rates. Moreover, an increased tax competition from tax havens can result in increased corporate tax rates by jurisdictions with already high tax rates. The authors find that profit shifting has a significant influence on taxable income in Canada. The elasticity of taxable income with respect to taxes is 4.9 for firms that engage in profit shifting, while the elasticity is 2.3 for similar firms that do not shift income (p. 1161).

Furthermore, Desai, Foley and Hines (2004) find that tax incentives affect the level and composition of U.S. multinational firms' debt. The results show that increased corporate tax rates lead to a higher use of debt – an increase in the local corporate tax rate by 10% leads to 2.8% higher debt-to-asset ratios of affiliates experiencing the increase in tax rate. Moreover, tax rate differences affect the use of internal debt to a greater extent than the use of external debt – the elasticity of use of external debt with respect to corporate tax rate is 0.19, while the tax elasticity of internal debt is 0.35 (p. 2453). However, the authors do not have data on internal transactions among affiliates; therefore, they cannot investigate internal lending activities of financial coordination centres that undertake banking services within multinational firms. Financial coordination centres are frequently used by multinational firms worldwide and are located in countries with preferential tax regimes for banking services (for example, Belgium). Due to omission of data on internal capital market transactions, the tax sensitivity of internal debt can be underrated (Møen et al., 2011, p. 6).

Egger, Eggert, Keuschnigg and Winner (2010) compare debt-to-asset ratios of domestic and foreign plants and investigate whether differences between them can be explained by the global corporate tax system. Differences between debt-to-asset ratios arise because multinational firms can shift debt across jurisdictions where their affiliates are located, which increases incentives to adjust affiliates' capital structures in response to different tax rates. Using a dataset on European firms, they show that foreign firms have substantially higher debt-to-asset ratios than domestic firms, and that this difference increases with the host country statutory tax rate. In addition, debt shifting is found to be a common mechanism for international tax planning of multinational companies. However, the dataset that the authors use does not have data on internal debt nor the overall ownership structures of multinational firms. Moreover, the authors disregard the total bankruptcy costs that the parent firm has to bear, and the external debt shifting mechanism in their analysis.

Findings of the study by Büttner and Wamser (2013) conform to those of Mintz and Smart (2004). The authors investigate internal debt exclusively as a profit shifting mechanism, using a dataset on German multinational firms. Their results show that tax differences among affiliates of a multinational firm have a significant influence on firm's internal debt. The analysis confirms that multinational firms whose subsidiaries operate in countries with low corporate tax rates use relatively more internal debt. Moreover, if the difference between the host country corporate tax rate and the lowest corporate tax rate among the firm's subsidiaries worldwide increases, the use of internal debt increases as well.

However, the tax effects that the study finds are quite small. This indicates that German firms do not actively engage in internal debt shifting, which can be partly explained by German controlled foreign corporation rules.

My paper is closely related to studies by Huizinga, Laeven and Nicodeme (2008) and Møen, Schindler, Schjelderup and Tropina (2011). Huizinga et al. (2008) use a model of firms' optimal external leverage choices in response to international taxation, and test the model on European firms in the Amadeus database. The authors distinguish whether a firm is a parent or a subsidiary of a multinational firm or a purely domestic firm, and take into consideration tax systems of all countries where the multinational firm operates. They find that if the corporate tax rate increases by 10%, the debt-to-asset ratio of an entirely domestic firm will increase by 1.8% (p. 81). However, the debt-to-asset ratio of a multinational firm is affected by both national and international taxes. Therefore, the debt-to-asset ratio of a multinational firm is more sensitive to corporate tax rates, and the firm is more willing to engage in debt shifting. The authors assume that the parent firm ensures credit guarantees for affiliates' leverage, which implies that an increase in the total debt-to-asset ratio of the multinational corporation leads to a higher bankruptcy risk at the parent level. In order to mitigate the increased bankruptcy risk, the multinational firm shifts its external debt among affiliates in different countries in response to their tax rates. For example, if the tax rate in a country increases, it becomes more attractive to increase the amount of debt in affiliates that operate in the country. However, an increased use of leverage leads to a higher bankruptcy risk of the multinational corporation. Hence, the multinational firm has to decrease the use of debt in other subsidiaries worldwide in order to reduce the bankruptcy risk.

Due to external debt shifting among affiliates worldwide, multinational firms are able to use debt tax shield to a greater extent than entirely domestic firms, while maintaining an acceptable bankruptcy risk. As an example, consider a multinational firm consisting of two affiliates of equal size that operate in different countries. A 10% higher tax rate in a country leads to a 2.4% higher debt-to-asset ratio of the affiliate in the specific country, while the debt-to-asset ratio of the other affiliate decreases by 0.6% (p. 81). This shows that affiliates' capital structures are affected by the local corporate tax rate and tax rates of the parent firm and other affiliates of the multinational firm through the external debt shifting mechanism. The authors claim that if the external debt shifting mechanism is disregarded in the analysis, the total effect of corporate tax rates on affiliates' financial structures is understated by 29% (p. 101). However, the results of the study can be biased due to omission of internal debt

shifting mechanism, which is likely to influence the total leverage of a multinational firm. The authors discuss the internal debt shifting mechanism and use a difference in tax rates between parent company and its affiliates in order to capture the effect. However, they conclude that the effect is insignificant and tax incentives to shift internal debt do not influence their results. As claimed by Møen et al. (2011, p. 8), such a conclusion can arise because the appropriate mechanism to account for internal debt shifting is a difference in tax rates between an affiliate and the lowest-taxed affiliate within the multinational corporation.

Hence, Møen et al. (2011) try to reduce the omitted variable bias, which is likely to be present in the paper by Huizinga et al. (2008), by adding the internal debt shifting mechanism to the model. The authors are the first to examine a multinational firm's choice between internal and external debt shifting. The results show that companies should undertake both internal and external debt shifting in order to reduce their global tax burden. By examining both debt shifting mechanisms, the study ensures that incentives for external debt shifting affect only external debt and do not influence internal debt, and vice versa for internal debt shifting. The authors use micro-level data on German multinational firms, which contains information on internal and external debt of parent companies and affiliates. The empirical results show that if a multinational firm consists of two affiliates of equal size and tax rate of the highest-taxed affiliate increases by 10 percentage points, affiliate's total leverage ratio will increase by 4.6 percentage points, while the other affiliate's leverage ratio will decrease by 1.4 percentage points (p. 4). If an affiliate has an average leverage ratio (0.62), then its total debt will increase by approximately 7.4% (p. 4). The standard debt tax shield explains approximately 40% of this increase, and 60% of the increase is explained by the international debt shifting, where internal and external debt shifting mechanisms are of approximately equal importance (p. 4). When the international debt shifting mechanisms are omitted from the specification and the host country corporate tax rate is the only tax variable that affects firms' capital structures, the estimation bias for the standard debt tax shield mechanism is approximately 140% (p. 4). If the external debt shifting mechanism is omitted from the specification (as in Egger et al. (2010)), the effect of the standard debt tax shield on debt-to-asset ratio is overestimated by 100%, while the effect of internal debt shifting mechanism is biased upwards by 40% (p. 4). If the internal debt shifting mechanism is omitted from the specification (as in Huizinga et al. (2008)), the bias for the standard debt tax shield is 9%, while the bias for the external debt shifting mechanism is 4% (p. 4).

3. Methodology

3.1. Theoretical background

The methodology part of my paper follows the model specification proposed by Møen et al. (2011, pp. 8 – 14). By reproducing the model by Møen et al. (2011) and testing it on a data sample of European multinational firms, I examine whether predictions of the model are generally applicable to European companies.

The model assumes that a multinational firm is a pure holding company operating in the parent country *p*, which has majority-owned affiliates located in $i = 1, \dots, n$ countries that are owned directly and without any ownership chains. Each affiliate owns fixed assets K_i, which is the necessary amount of capital to produce a homogenous good by the production function $y_i = f(K_i)$. Capital costs r are given exogenously, according to a small country assumption. Capital K_i is financed by parent firm's equity investment E_i, external third-party debt D_i^E or parent (internal) debt D_i^I. Therefore, an affiliate's balance sheet identity can be expressed as $K_i = E_i + D_i^E + D_i^I$, where each affiliate's equity E_i is fully owned by the parent. The parent's balance sheet identity can be expressed as $\sum_{i \neq p}^{n} E_i = E_p + D_p^E + D_p^I$. The multinational firm assures that all its affiliates obtain the necessary amount of equity in order to have an appropriate level of real capital and a tax-efficient capital structure (Huizinga et al., 2008, p. 94; Møen et al., 2011, p. 8).

While deciding upon its capital structure, a multinational firm considers several factors, both related and unrelated to taxation. Usage of internal and external debt is characterized by different benefits and costs that an affiliate incurs, which, according to trade-off theory, must be balanced while choosing the optimal capital structure (Robichek & Myers, 1966, pp. 19 – 20). Multinational firms take into consideration both reputational and financial costs because public information about a firm's tax avoidance erodes its image and affects directly its profits. Bauweraerts and Vandernoot (2013, p. 3) emphasize the increasing attention paid to social responsibility and the harmful consequences that tax avoidance can cause to a firm. Furthermore, separation between firm's ownership and management leads to another issue. The chief executive officer's (CEO) performance is measured in terms of wealth created for firm's shareholders, which encourages the CEO to avoid taxes, even though it can damage the firm's reputation. Moreover, agency costs arise if the CEO uses tax savings resulting from tax avoidance to hide his rent extraction, for example, excessive salary

or perquisites. If shareholders become aware of that, the price of firm's shares can substantially decrease (Chen, Chen, Cheng & Shevlin, 2010, p. 60).

To derive cost functions of internal and external debt, benefits and costs associated with both types of debt must be considered. A benefit of internal debt, as compared to equity, is that its interest expenses are tax deductible. Usage of internal debt provides a debt tax shield, while payments associated with equity, for example, dividends, are entirely appropriated from firms' profits, which leads to a preference for debt financing (Kemsley & Nissim, 2002, p. 2047).

However, costs of internal debt are associated with tax engineering expenses arising from willingness to avoid or lessen thin capitalization rules or controlled foreign company (CFC) rules (Simmler, 2014, pp. 7 – 8). Tax authorities are aware of profit shifting opportunities offered by internal debt and know that multinational firms have incentives to increase usage of internal debt in high-tax countries. Tax authorities are determined to levy taxes on the appropriate taxable income; therefore, many countries monitor multinational companies and have implemented anti-tax avoidance laws in order to limit profit shifting. Countries in the European Union have implemented thin capitalization rules that limit tax deductibility of interest (Đukić, 2011; Webber, 2010). Many European countries have also implemented controlled foreign corporation rules that limit profit shifting to low-tax countries, as certain amounts of income earned by controlled foreign corporations must be included in the income of parent firms.[2,3] Even though there exists a whole consultancy industry focusing on tax avoidance and exploitation of loopholes in anti-tax avoidance regulations, circumventing the rules is costly. Designing strategies to avoid anti-tax avoidance regulation and asking for specialized experts, lawyers and accountants' advice for manipulating internal debt, hiding transactions or finding loopholes in the regulations highly increases the costs of internal debt (Ruf & Schindler, 2012, p. 7; Schindler & Schjelderup, 2014, pp. 6, 12).

Moreover, it is easier to avoid anti-tax avoidance rules, the smaller the share of internal debt in the firm's total assets. The amount of advice by tax consultants that is

[2] Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Italy, Lithuania, Norway, Portugal, Spain, Sweden, Turkey and United Kingdom are European countries that have implemented the controlled foreign company legislation, according to Deloitte (2014).

[3] The Court of Justice of the European Union made a Cadbury-Schweppes decision on September 12, 2006, where it ruled that taxation based on controlled foreign company (CFC) legislation is an infringement to the freedom of establishment. Consequently, the CFC rules do not exert a substantial role in Europe since 2006.

necessary to be able to deduct interest expenses on internal debt from taxable income is likely to be convex in the level of internal debt (Fuest & Hemmelgarn, 2005, p. 513). Also, it is more expensive to conceal tax avoidance activities if a firm is highly indebted and has low taxable profits due to very high interest deductions. Affiliates that have low profits due to substantially higher leverage than other similar affiliates are more likely to be audited. In order to reduce the probability of an audit or avoid it at all, the firm must hire accountants and lawyers who are even more specialized. This implies that concealment costs of internal debt are likely to grow with the amount of profits shifted (Schindler & Schjelderup, 2014, p. 7).

Furthermore, a benefit of external debt is that it reduces information asymmetries between management and shareholders. Consequently, consistent with pecking order theory, firms that suffer from information asymmetries try not to issue equity due to large agency costs associated with equity, and issue more debt instead (Myers & Majluf, 1984, p. 215). External debt contracts usually demand that managers must report the relevant information to investors, who can control how well the managers follow agreements and assess whether they manage resources in the best interests of the firm (Healy & Palepu, 2001, p. 408 – 410). In addition, financial leverage helps to discipline otherwise overspending managers and align their interests more closely to those of the firm, as interest payments on debt reduce the free cash flow within the firm. Hence, management must work with due care, skip overspending on perks, implement profitable projects and be efficient in order to maintain firm's profitability and ability to pay back its financial obligations by the due date to prevent bankruptcy. If managers are unable to ensure that, the company may become bankrupt and managers may lose their jobs. Thus, the more external debt the firm has, the less free cash flow is available for managers and the smaller the potential agency costs are between management and shareholders (Jensen, 1986, p. 324).

Furthermore, companies are likely to have external debt if their ability to undertake potentially profitable investment opportunities is limited by owners' resources. If the owner of the firm cannot raise capital for new investments, he encounters an opportunity loss equal to the value that he could obtain by undertaking the additional investment opportunities. Consequently, even though he suffers agency costs of debt, he is willing to incur them in order to obtain additional capital. The owner is likely to increase the amount of debt that the firm has as long as the marginal increase in wealth from the new investments projects is

larger than the marginal agency costs of debt, and these agency costs are smaller than costs caused by issuance of new equity (Jensen & Meckling, 1976, p. 52).

However, there are three disadvantages that characterize firms with external leverage. Firstly, after debt has been supplied, equity holders tend to undertake very risky projects because they benefit from any profit growth, but their risk is limited. External lenders anticipate this and require high borrowing premium and loan covenants from the borrowing firms to reduce lenders' risk, which increases costs of external debt (Jensen & Meckling, 1976, p. 45). Secondly, large amounts of debt can induce management to act too risk-averse and skip profitable investment opportunities (underinvestment problem), as managers risk losing their salary and reputation. Avoiding value increasing but risky investments reflects managers' job insurance, while contributing negatively to shareholders' wealth (Cornell & Shapiro, 1988, p. 11). Finally, willingness to increase financial leverage can result in excessive borrowing and increased bankruptcy risk if a firm is unable to fulfil its debt obligations. For example, liquidation cost is one of the components of bankruptcy costs, characterizing the decrease in firm's value due to liquidation of assets. An increased probability of liquidation implies that proceeds that lenders will obtain in case of firm's default are smaller. Therefore, firms that are characterized by potential liquidation costs incur higher debt financing costs (Warner, 1977).

To derive expressions for costs of internal and external debt, I assume, in line with Huizinga et al. (2008, p. 94) and Møen et al. (2011, p. 9), that the cost functions are separable, convex in leverage ratios and proportional to capital employed. Cost functions are separable because costs and benefits of internal and external debt are different. Internal debt can be seen as tax-favoured equity, as it neither affects bankruptcy risk nor reduces information asymmetries, nor restricts free cash flow of the firm. Moreover, the firm cannot benefit from monitoring by external creditors. Furthermore, capital market is assumed to be perfect, even though the model takes into consideration taxation and bankruptcy costs. This assumption in combination with the argumentation above implies that a firm's total cost function is additively separable in external and internal debt (Schindler & Schjelderup, 2012, p. 638). Furthermore, convexity related to internal debt arises due to the additional effort that has to be exerted to hide tax avoidance from tax authorities, while convexity of external debt is related to the higher premium that must be paid due to asymmetric information between lenders and borrowers (Schindler & Schjelderup, 2010, p. 7).

Hence, the expression for costs of internal debt is as following:

$$C^I(b_i^I) = \frac{\eta}{2} \cdot (b_i^I)^2 \cdot K_i \text{ if } b_i^I > 0, \text{ and } C^I(b_i^I) = 0 \text{ if } b_i^I \leq 0, \quad (1)$$

where $b_i^I = \frac{D_i^I}{K_i}$ reflects the internal debt-to-asset ratio in affiliate *i*, and η is a positive constant. As observable from the expression, internal debt costs are positive and proportional to capital employed. Concealment costs increase with the amount of internal debt that the firm has and are equal to zero if the firm does not have any internal debt.

Furthermore, the cost function of external debt is expressed as follows:

$$C^E(b_i^E) = \frac{\mu}{2} \cdot (b_i^E - b^*)^2 \cdot K_i - \frac{\mu}{2} \cdot (b^*)^2 \cdot K_i, \quad (2)$$

where $b_E^i = \frac{D_i^E}{K_i}$ reflects the external debt-to-asset ratio in affiliate *i*, μ is a positive constant and b^* reflects the optimal external debt-to-asset ratio in affiliate *i* in absence of taxation, based only on incentive considerations. Any deviations from the optimal external leverage ratio imply incentive-related agency costs for the firm. As observable from the expression, external debt costs are positive, proportional to capital employed and increase with the amount of external debt that the firm has.

As discussed above, an increased use of external leverage increases the risk of potential bankruptcy costs. Huizinga et al. (2008) were the first to analyse bankruptcy costs together with the external debt shifting mechanism by assuming that the parent firm will bail out any affiliate, which is in the risk of becoming bankrupt. However, the concept that the parent company is willing to bail out its subsidiaries has been applied before (Luciano & Nicodano, 2014, p. 2741). For example, Friedman, Johnson and Mitton (2003, p. 744) show that entrepreneurs are willing to provide private funds to help their subsidiaries which are close to bankruptcy. Also Riyanto and Toolsema (2008, p. 2179) claim that, in order to explain the existence of pyramidal ownership structure, higher-level firms must bail out lower-level firms. Moreover, Keillor, Wilkinson and Kannan (2011, p. 73) claim that practical considerations require that the parent firm provides an implicit guarantee on affiliates' debt. If there is no implicit guarantee, lenders require explicit guarantees from the parent firm before they lend their funds to the affiliate. In fact, a survey by Stobaugh (1970) shows that no medium or large multinational firms would allow their affiliates to default on debt, even if an affiliate did not have a parent firm guarantee. Furthermore, only 17% of small multinational firms would allow an affiliate to default on debt (pp. 51 – 52). This shows that

multinational firms have a moral obligation to guarantee for the debt of their affiliates, and that the guarantees do not necessarily have to be explicit, but can be implicit as well (Shapiro, 1978, p. 218). For example, distress of an affiliate could badly impact parent firm's reputation, or the affiliate might be relevant to other operations of the firm. This implies that leverage decisions of different affiliates within a multinational corporation become interdependent, and leverage of an affiliate depends on corporate tax rates of all other affiliates of the multinational group even if there exists no direct borrowing between them (Büttner & Wamser, 2013, p. 66). In line with these studies, I assume that the parent company ensures credit guarantees for affiliates' leverage.

Therefore, the bankruptcy risk of a multinational firm depends on its total external debt-to-asset ratio, expressed as $b_f = \frac{\sum_i D_i^E}{\sum_i K_i}$. b_f can also be written as asset-weighted average of affiliate-specific leverage ratios b_i^E, or $\sum_i b_i^E \rho_i$, where $\rho_i = \frac{K_i}{\sum_i K_i}$ reflects the share of total assets of an affiliate *i* in the total assets of the multinational firm. Furthermore, following Huizinga et al. (2008), I denote C_f to be the expected bankruptcy costs of the multinational corporation, which are quadratic in the corporation's leverage ratio b_f and proportional to its total assets. As only loss-making firms incur bankruptcy costs, the costs are assumed to be not tax deductible (Huizinga et al., 2008, p. 94).

The bankruptcy costs of a multinational corporation are expressed as follows:

$$C_f = \frac{\gamma}{2} \cdot b_f^2 \cdot \sum_i K_i = \frac{\gamma}{2} \cdot \frac{\left(\sum_i D_i^E\right)^2}{\sum_i K_i}, \tag{3}$$

where γ is a positive constant.

Considering the production function of an affiliate *i* and the cost functions of capital and debt that decrease the potential dividend payments, the economic profit of an affiliate *i* is expressed as follows:

$$\pi_i^e = f(K_i) - r \cdot K_i - C^E(b_i^E) - C^I(b_i^I).$$

Furthermore, the taxable profit of an affiliate *i* can be found by considering tax deductibility of interest expenses. Following Møen et al. (2011, p. 10), I have assumed that the costs of equity are not tax deductible, which is a common practice worldwide. Another assumption, in line with Møen et al. (2011, p. 10), is that the costs of debt are not tax deductible from taxable income, which is a relevant assumption to specify the necessary equations for further empirical analysis. Costs of debt may be associated with asymmetric

information between investors and managers or with acts in violations of the tax code, which supports argumentation for their not tax deductibility (Schindler & Schjelderup, 2010, p. 9).

Therefore, the taxable profit of an affiliate *i* is expressed as follows:

$$\pi_i^t = f(K_i) - r \cdot (D_i^E + D_i^I).$$

In order to find expressions for profit after corporate tax of an affiliate *i*, I define values of an affiliate *i* in a country *i*: V_i^L for a leveraged affiliate and V_i^U for a non-leveraged affiliate.

Then, the after-corporate tax profit of an affiliate *i* in country *i* is expressed as follows:

$$\pi_i = \underbrace{\pi_i^e - t_i \cdot \pi_i^t}_{=V_i^L} =$$

$$= \underbrace{(1 - t_i) \cdot f(K_i) - r \cdot K_i}_{=V_i^U} + t_i \cdot r \cdot (D_i^E + D_i^I) - C^E(b_i^E) - C^I(b_i^I), \qquad (4)$$

where t_i is defined as the statutory corporate tax rate in country *i*.

Furthermore, dividends π_i that affiliates send back to the parent firm can be levied with a non-resident withholding tax, a parent tax on repatriated dividends and a corporate income tax t_i. If so, double tax relief may be provided for the already paid corporate income tax and the non-resident withholding tax. This implies that tax costs of equity depend on tax rates and double tax relief provisions of the parent country (Huizinga et al., 2008). However, European countries follow the exemption method, which implies that corporate shareholders are exempted from taxes on dividends and capital gains (Lang, Pistone, Schuch & Staringer, 2013, pp. 67 – 69; Wendt, 2009, pp. 65 – 67). Therefore, withholding taxes do not matter in Europe and I have not accounted for them in the further analysis, which is in line with Møen et al. (2011, p. 11).[4] Consequently, the total after-corporate tax profit or the value of the multinational corporation equals the sum of profits of all its affiliates.

The total value of a multinational corporation is expressed as follows:

$$\pi_P = V^L = \sum_i V_i^L - C_f = \sum_i \pi_i - C_f. \qquad (5)$$

[4] Huizinga et al. (2008) present a detailed information on the international tax system, including corporate taxation and double tax relief systems, bilateral withholding taxes and bilateral tax treaties between European countries (p. 83 - 93).

Specifically, the relation between V^L and V^U is the following:

$$V^L = V^U + \sum_i t_i(D_i^E + D_i^I) - C_f - \sum_i C_i^E - \sum_i C_i^I.$$

Values of an unleveraged firm and a leveraged firm are different due to tax benefits and non-tax costs of debt, which are incurred by the leveraged firm. The aim of a multinational firm is to maximize its leveraged value V^L by choosing the optimal level of internal and external leverage in each affiliate. To set up profit maximization problem of a multinational corporation after corporate taxation of affiliates worldwide, I use equations (1) to (4). The objective function must be maximized by considering that the total sum of lending and borrowing among affiliates belonging to the multinational corporation must be equal to zero.

The maximization problem of a multinational corporation is expressed as follows:

$$\max_{D_i^E,\, D_i^I} \pi_P = \sum_i \{(1 - t_i) \cdot f(K_i) - r \cdot K_i + t_i \cdot r \cdot (D_i^E + D_i^I)$$

$$-\frac{\mu}{2} \cdot \left(\frac{D_i^E}{K_i} - b^*\right)^2 \cdot K_i - \frac{\mu}{2} \cdot (b^*)^2 \cdot K_i - \frac{\eta}{2} \cdot \left(\frac{D_i^I}{K_i}\right)^2 \cdot K_i\} - \frac{\gamma}{2} \cdot \frac{(\sum_i D_i^E)^2}{\sum_i K_i}$$

$$s.t.\ \sum_i r \cdot D_i^I = 0.$$

Then, the first order conditions with respect to external and internal debt, are expressed as follows:

$$D_i^E: t_i \cdot r - \mu \cdot \left(\frac{D_i^E}{K_i} - b^*\right) - \gamma \frac{\sum_i D_i^E}{\sum_i K_i} = 0, \tag{6}$$

$$D_i^I: t_i \cdot r - \eta \cdot \frac{D_i^I}{K_i} - m \cdot r = 0, \tag{7}$$

where m is the Lagrangian multiplier, which reflects shadow cost of shifted interest expenses. The optimal solution to minimize these expenses and maximize internal debt tax shield is when $m = min_i t_i$. This implies that the affiliate facing the lowest corporate tax rate should operate as the internal financial coordination centre of the multinational corporation and lend internally to other affiliates. Hence, this function can be assumed by any affiliate, not only the parent firm. Moreover, this shows that the optimal solution for a profit-maximizing multinational company is to use internal debt. Thus, an analysis that does not account for internal debt does not reflect the optimal capital structure of a multinational firm and is therefore biased.

Mintz and Smart (2004) were the first to claim that internal bank should be located in a tax haven country, and affiliates located in high-tax countries should borrow and declare their interest income in the internal bank to increase firm's after-tax profits (pp. 1152 – 1153).[5] This mechanism helps to explain the abundance of internal banks of multinational corporations in Belgium, Luxembourg and the Netherlands. As these countries offer very low effective tax rates due to specific tax systems and as dividends are not taxed when shifted among European affiliates, multinational firms can benefit from preferential taxation systems by locating their internal banks in these countries.[6]

Following Møen et al. (2011, p. 12), I number the countries and assume that country 1 faces the lowest corporate tax rate of the multinational corporation. Then, $min_i t_i = t_1$. The net tax advantage variable $(t_i - t_1)$ that Mintz and Smart (2004) use in their study is referred to as *maximum tax difference* by Møen et al. (2011), and I use the same definition in my paper for the internal debt shifting mechanism.

By reordering elements of the first order condition for internal debt (equation (7)), the optimal internal debt-to-asset ratio is expressed as follows:

$$b_i^I = \frac{r}{\eta} \cdot (t_i - m) = \frac{r}{\eta} \cdot (t_i - t_1) > 0, \forall\, i > 1, \text{ and } b_i^I = 0 \text{ if } i = 1. \tag{8}$$

Internal debt-to-asset ratio is zero for an internal bank ($i = 1$), as it only lends internal debt to other subsidiaries of the multinational corporation. The amount of internal debt L_1 that the internal bank lends to other affiliates is expressed as follows:

$$L_1 = \sum_{i>1} D_i^I. \tag{9}$$

By reordering elements of the first order condition for external debt (equation (6)) (details in Appendix A), the optimal external debt-to-asset ratio is expressed as follows:

$$b_i^E = \beta_0 + \beta_1 \cdot t_i + \beta_2 \cdot \sum_{j \neq i} \rho_j (t_i - t_j), \tag{10}$$

where $\beta_0 = \frac{\mu b^*}{\mu+\gamma}$, $\beta_1 = \frac{r}{\mu+\gamma}$, $\beta_2 = \frac{\gamma r}{(\mu+\gamma)\mu}$ and $\rho_j = \frac{K_j}{\sum_j K_j}$, which reflects the share of total assets of an affiliate j in the total assets of the multinational corporation. β_0, by

[5] Formula One uses this strategy to reduce its global taxation. Several highly leveraged firms that belong to Delta Topco Holding pay 15% interest on their internal debt, while internal bank of the corporation is located on the Channel Island Jersey, which is a tax haven (Møen et al., 2011, p. 3; Sylt & Reid, 2011, pp. 17 – 36).

[6] As an example, Statoil and Statkraft have established their financial coordination centres in Belgium in order to benefit from the low effective corporate tax rates on interest income. The actual tax rates that the firms paid in 2012 were 8.4% for Statoil and 12.4% for Statkraft, even though the statutory corporate tax rate in Belgium was 34% (Bjørnestad, 2013).

incorporating term b^*, balances bankruptcy costs of external leverage against incentive-related agency costs of choosing a different amount of leverage than the optimal external debt-to-asset ratio based on incentive considerations. Furthermore, the optimal external leverage ratio consists of two tax mechanisms. Firstly, the *standard debt tax shield mechanism* is represented by the statutory corporate tax rate in the host country of an affiliate *i* (t_i). Huizinga et al. (2008) refer to the mechanism as the *domestic effect* of taxation on the optimal leverage, as the standard debt tax shield can be utilized by purely domestic firms located in country *i* as well. The mechanism implies that a higher corporate tax rate in country *i* is associated with a higher external debt tax shield; therefore, a higher b_i^E.

The other tax mechanism in equation (10) reflects the impact of international tax differences among affiliates of a multinational corporation on an affiliate's optimal external leverage in country *i*. This mechanism is referred to as the *international* or *debt-shifting mechanism* by Huizinga et al. (2008) and as the *weighted tax difference* by Møen et al. (2011) as the term weights international tax differences ($t_i - t_j$) by affiliates' asset shares ρ_j. The external debt shifting mechanism implies that for a level of overall bankruptcy costs C_f, external debt should be located in affiliates that face the highest corporate tax rates in order to maximize firm's tax savings. If the statutory corporate tax rate increases in a country where an affiliate *i* operates, it is optimal for the multinational firm to allocate more debt to this affiliate and reduce the amount of debt in other affiliates in order to keep the overall bankruptcy costs under control. Therefore, the optimal external debt-to-asset ratio in country *i* is negatively related to the statutory corporate tax rate in country *j*. Furthermore, a change in tax rate leads to a larger change in the weighted tax difference variable for a relatively small affiliate because the variable sums up the asset shares of all other affiliates that belong to the multinational firm ($j \neq i$). Hence, in case of debt shifting between affiliates of different sizes, the smaller affiliate will experience a bigger change in its leverage ratio.

Finally, by summing up the expressions for internal and external debt, the total debt-to-asset ratio of an affiliate *i* is expressed as follows:

$$b_i = \beta_0 + \underbrace{\beta_1 \cdot t_i}_{(i)} + \underbrace{\beta_2 \cdot \sum_{j \neq i} \rho_j \left(t_i - t_j\right)}_{(ii)} + \underbrace{\beta_3 \cdot (t_i - t_1)}_{(iii)}, \forall\, i > 1, \tag{11}$$

where $\beta_3 = \frac{r}{\eta}$, and

$$b_1 = \beta_0 + \underbrace{\beta_1 \cdot t_1}_{(i)} + \underbrace{\beta_2 \cdot \sum_{j \neq 1} \rho_j \left(t_1 - t_j\right)}_{(ii)} \text{ if } i = 1, \tag{12}$$

since $b_1 = b_1^E + b_1^I = b_1^E$, as $b_1^I = 0$.

The specification (11) shows that the total debt-to-asset ratio of an affiliate *i* increases with:

(i) the domestic corporate tax rate t_i due to the standard debt tax shield mechanism,

(ii) the weighted tax difference $\sum_{j \neq i} \rho_j (t_i - t_j)$ due to overall bankruptcy costs and the external debt shifting mechanism,

(iii) the maximum tax difference $(t_i - t_1)$ due to the internal debt shifting mechanism.

However, if the parent company does not guarantee for affiliates' debt and does not bail out affiliates facing bankruptcy, then the external debt shifting mechanism is not active, and the internal debt shifting mechanism is the only component of international debt shifting (Møen et al., 2011, p. 14).

3.2. Theoretical predictions of the model

There are three main theoretical predictions of the model. Firstly, a value-maximizing multinational firm engages in both internal and external debt shifting, motivated by differences in statutory corporate tax rates of its affiliates worldwide. This implies that the three tax mechanisms are correlated, as they all depend on the host country statutory corporate tax rate. Hence, the previous empirical studies which omit any of the debt shifting mechanisms suffer from an omitted variable bias and do not accurately depict the profit-maximizing behaviour of multinational companies. The individual contributions on affiliates' leverage of the tax mechanisms that are included in the specification are biased in these studies (Møen et al., 2011, p. 3).

Another prediction of the model is that the internal financial coordination centre, which undertakes internal lending activities within a multinational firm, should reside in the country with the lowest effective corporate tax rate in order to maximize worldwide profits. This structure has been indicated by Mintz and Smart (2004, pp. 1152 – 1153) as the optimal mechanism to ensure that interest income is taxed at the lowest tax rate possible and interest expenses are deducted from taxable income in higher-taxed affiliates.

Furthermore, the model predicts that multinational companies should balance their external debt across affiliates worldwide in order to maximize the external debt tax shield. If the corporate tax rate increases in a country, it becomes profitable to rebalance the firm's

capital structure and increase the amount of debt in affiliates that operate in this country. However, higher external leverage increases bankruptcy risk of the multinational firm, which is mitigated by decreasing the amount of debt in lower-taxed affiliates. Hence, changes in tax policy in one country lead to changes in capital structures of all affiliates of the multinational firm worldwide. The external debt shifting mechanism constitutes an advantage to a multinational firm, as it can exploit the debt tax shield to a greater extent than domestic firms and still maintain the overall risk of bankruptcy low.

3.3. Empirical strategy

The theoretical equations (11) and (12) can be expressed as the following regression specification:

$$b_{pit} = \beta_0 + \beta_1 \cdot t_{pit} + \beta_2 \cdot \sum_{j \neq i} \rho_{pjt}\left(t_{pit} - t_{pjt}\right) + \beta_3 \cdot (t_{pit} - t_{p1t}) + \gamma X_{pit} + \delta_t + \sigma_I + \alpha_p + \varepsilon_{pit}. \quad (13)$$

The dependent variable b_{pit} is the total debt-to-asset ratio of an affiliate *i*, which belongs to a multinational corporation *p* in year *t*. The optimal ratio consists of both optimal external and internal leverage ratios; therefore, it is affected by all three previously discussed tax mechanisms. The right hand side of the regression consists of several independent variables. t_{pit} is the host country corporate tax rate, which has an effect on the optimal level of external leverage. $\sum_{j \neq i} \rho_{pjt}\left(t_{pit} - t_{pjt}\right)$ is the weighted tax difference variable, which reflects external debt shifting and also has an effect on the optimal level of external leverage. $(t_{pit} - t_{p1t})$ is the maximum tax difference variable, which reflects internal debt shifting and has an effect on the optimal level of internal leverage. Furthermore, X_{pit} is a vector of firm-level and country-level control variables, δ_t is a vector of time dummies, σ_I and α_p are industry and parent fixed effects, and ε_{pit} is an error term.[7] The affiliate-specific control variables and year, industry and parent (group) fixed effects have been added to the regression specification in order to control for unobserved heterogeneity in the data. Year fixed effects capture aggregate shocks occurring over the sample period, while affiliate-specific control variables capture heterogeneity characterizing affiliates' financing costs. As borrowing costs tend to vary across industries, industry fixed effects are also added to the

[7] Control variables are discussed in a greater detail in section 4.4.

specification. Finally, parent fixed effects capture the group-specific risk that can influence affiliates' borrowing costs. Moreover, parent fixed effects control for the international location structure of a multinational group.[8] As I want to examine the effect that the three tax mechanisms have on the optimal total leverage, then β_1, β_2 and β_3 are the main coefficients that I am interested in.

[8] Discussion on the importance of inclusion of group fixed effects is provided in section 5.

4. Data and descriptive statistics

4.1. Data sources and sample restrictions

I use the firm-level Orbis database provided by Bureau van Dijk in order to obtain historical ownership data on European firms. The ownership database consists of owner and subsidiary links worldwide on more than 40 million companies, while the archived data on ownership structures is available since January 2003. The database provides information on full ownership structures, allowing also for indirect ownership. After obtaining ownership data on majority-owned affiliates of European parent firms for a time period of 12 years (2003 – 2014), I use the firm-level Amadeus database provided by Bureau van Dijk in order to find financial data on these European parent firms and their majority-owned subsidiaries.[9,10] It is necessary to initially obtain the historical ownership information through the Orbis database as the Amadeus database does not provide historical ownership data. Information on ownership structure is available only for the last reported date.[11] An assumption about a constant ownership structure would lead to misclassified subsidiary-parent relations as ownership structures tend to change over time.[12] Therefore, the Orbis database is used initially in order to eliminate such misclassifications.

The Amadeus database provides financial information on approximately 21 million private and public companies in Europe (Bureau van Dijk, n.d.). The data is presented in a universal and standardized format in order to increase its comparability across countries. Even though harmonization in accounting standards and practices within the European Union has made it easier to compare accounting formats across European countries, there still exist differences in accounting practices. Hence, cross-country studies that compare behaviour of heterogeneous firms using standardized accounts based on different accounting conventions are associated with a bit of caution (Klapper, Laeven & Rajan, 2004, p. 8). However, after

[9] A detailed description of how to obtain historical ownership data in the Orbis database and financial data in the Amadeus database is provided in Appendix E.

[10] Financial data for year 2014 is not available for all multinational firms in the Amadeus database yet. Consequently, only approximately 0.2% of the final data sample consists of financial data from 2014.

[11] Historical ownership data is available on Amadeus DVDs; however, the library does not provide access to this data.

[12] The assumption about a constant historical ownership structure is tested in robustness checks. See section 7.4.

applying inclusion criteria and data trimming procedures, any biases characterizing the data should have substantially decreased.[13]

As the Amadeus database only has information on European subsidiaries, I cannot examine how tax differences between affiliates located in Europe and affiliates located in other world countries influence leverage choices of European multinational firms.[14] However, as European multinational firms usually create the largest part of their revenues from operations in Europe, this limitation cannot be considered as a major concern. Also, it is likely that other factors and country characteristics are highly important for financial structures of non-European affiliates; for example, development of financial markets, financial stability and corruption in the country (Møen et al., 2011, p. 15).[15]

In my analysis, a firm is considered to be a subsidiary if at least 50% of its shares belong to another firm (the parent firm). A multinational firm is defined as a parent firm which owns at least one foreign subsidiary. Furthermore, most multinational firms publish both consolidated and unconsolidated financial statements. While consolidated financial statements describe activities within the parent firm and its subsidiaries, non-consolidated financial statements directly show the local activities occurring within the parent firm and within each of its subsidiaries. Therefore, in line with Huizinga et al. (2008, pp. 95 – 96), I use only unconsolidated statements in my analysis. The use of unconsolidated statements helps to avoid double counting of firms and subsidiaries and makes the data more comparable as not all European countries require consolidation of firms' financial accounts (Klapper et al., 2004, p. 9). As the financial data is provided in the local currency of a subsidiary, I convert all accounting data into euros, according to the exchange rate from local currency to euros at the financial reporting date.

The main data sample consists of 1,039,827 affiliate-year observations of European multinational firms, operating in 39 countries. However, the number of observations does not reflect all the majority-owned European subsidiaries of European parent firms whose Bureau van Dijk ID codes (BvD ID codes) were initially found by the Orbis database. Data trimming

[13] Inclusion criteria and data trimming procedures are discussed in Table 1.

[14] I control for majority-owned non-European affiliates that belong to European multinational corporations in robustness tests. See section 7.5.

[15] Lehmann, Sayek and Kang (2004), examining leverage choices of U.S. majority-owned foreign affiliates in 53 countries, find that their financial leverage increases with exchange rate variation and financial development. Desai et al. (2004), using data on 3,700 U.S. multinational firms that have foreign affiliates located in more than 150 countries, find that foreign affiliates borrow less external debt in countries characterized by undeveloped capital markets or poor creditor rights due to higher local borrowing costs.

procedures and selection criteria used in order to obtain the main sample are shown in Table 1. Firstly, the Amadeus database did not find affiliate-year financial data on several affiliates based on their BvD ID codes (12% of the initial sample); thus, these affiliate-year observations are subsequently excluded from the main data sample. Furthermore, the number of observations decreased as I dropped consolidated accounts from the sample. As discussed above, non-consolidated accounts are used in the study because they directly reflect the local activities occurring within the parent firm and within each of its subsidiaries. Furthermore, the number of observations decreased as I dropped purely domestic firms from the data sample.[16] For purely domestic firms, the weighted tax difference and the maximum tax difference variables are equal to zero, as all affiliates and the parent firm are located in the same country. As I am willing to examine how tax affects debt structures of multinational firms exclusively, I dropped purely domestic firms from the main sample.[17] Furthermore, I dropped the affiliate-year observations that entered the data sample more than once per same parent and per same year in order to avoid double counting of some affiliate-year observations. Finally, I dropped the affiliate-year observations with extreme total debt-to-asset ratios which were outside [0;1] interval, and the affiliate-year observations with missing firm-level or country-level control variables.[18]

[16] This approach is in line with the data sample choice by Møen et al. (2011), who also examine only multinational firms in their analysis. Huizinga et al. (2008) use data on all European firms; thus, they include also purely domestic firms in the main analysis (p. 81). The sample is reduced to multinational firms in robustness tests (pp. 102 – 104), which does not change the estimated coefficients on tax variables significantly.

[17] Purely domestic firms are included in the data sample in robustness tests. See section 7.3.

[18] Firm-level and country-level control variables are discussed in section 4.4.

Table 1: Data trimming procedures

The table shows data selection criteria and trimming procedures used in order to obtain the main sample. The main sample consists of majority-owned European affiliates of European multinational firms, whose historical ownership data has been obtained from the Orbis database and financial data has been obtained from the Amadeus database. Units of observation are affiliates of European firms. The restriction (4) is relaxed in a robustness test in section 7.3. Summary statistics and descriptions of the variables are presented in Table 2.

	Number of observations	Percentage
(1) All affiliate-year historical ownership observations of European firms from Orbis (2003 – 2014)	12,099,264	100%
(2) All affiliate-year financial data observations of European firms found by Amadeus, based on Orbis BvD ID codes	10,647,352	88%
(3) Dropped affiliate-year observations with consolidated accounts	8,783,747	73%
(4) Dropped purely domestic firms	2,748,379	23%
(5) Dropped affiliate-year observations occurring more than once per same parent	1,996,373	16%
(6) Dropped affiliate-year observations with extreme total debt-to-asset ratios	1,605,336	13%
(7) Dropped affiliate-year observations with missing firm-level or country-level control variables	1,039,827	9%
Final sample	1,039,827	9%

4.2. Dependent variable

The dependent variable used in regressions is the total debt-to-asset ratio, defined as ratio of total liabilities to total assets. Total liabilities are calculated as the sum of non-current liabilities and current liabilities. Non-current liabilities consist of long-term debt and other non-current liabilities, for example, bonds payable, long-term lease obligations and product warranties. Current liabilities consist of loans, creditors and other current liabilities, for example, short-term notes payable.

4.3. Tax mechanisms

The first tax mechanism – the standard debt tax shield mechanism – is the host country statutory corporate tax rate t_i. Data on statutory corporate tax rates in Europe was obtained from KPMG's corporate tax rates table and corporate and indirect tax rate survey (KPMG, n.d.; KPMG, 2009), and the OECD's corporate income tax rates table and economic surveys (OECD, n.d.b.; OECD, 2013b). The model predicts that the statutory corporate tax

rate should have a positive effect on affiliates' external leverage due to tax deductibility of interest expenses.

Furthermore, the second tax mechanism – the external debt shifting mechanism – is captured by the weighted tax difference term $\sum_{j \neq i} \rho_j (t_i - t_j)$, referred to as tax incentive to shift debt by Huizinga et al. (2008). The variable is expressed as the weighted sum of differences between the corporate tax rate faced by an affiliate *i* and tax rates faced by the parent firm and all other affiliates that belong to the multinational corporation. The weight of each affiliate is calculated as the share of affiliate's total assets in the total assets of the multinational corporation. The model predicts that the weighted tax difference variable should have a positive effect on affiliates' external leverage through the external debt shifting mechanism. This implies that the higher the weighted tax difference variable of an affiliate *i* due to a higher tax rate of this affiliate or due to a reduction in tax rates of other affiliates, the more external debt this affiliate will borrow.

Finally, the third tax mechanism – the internal debt shifting mechanism – is captured by the maximum tax difference term $(t_i - t_1)$. The variable is expressed as the difference between the tax rate of an affiliate *i* and the tax rate of the lowest-taxed affiliate within the multinational corporation. The model predicts that the maximum tax difference variable should have a positive effect on affiliates' internal leverage through the internal debt shifting mechanism. This implies that the higher the maximum tax difference variable of an affiliate *i* due to a higher tax rate of this affiliate or due to a reduction in tax rate of the lowest-taxed affiliate within the multinational group, the more internal debt this affiliate will borrow from the lowest-taxed affiliate.

4.4. Control variables

My analysis focuses on the effect of different tax mechanisms on the optimal leverage of a multinational corporation. However, firm's optimal leverage can be affected also by other factors, not accounted for by the model. Therefore, to reduce the potential omitted variable bias, I include four firm-level and four country-level control variables in the analysis, following Huizinga et al. (2008) and Møen et al. (2011). Furthermore, regressions include time dummy variables (not reported in result tables) and parent (group) and industry fixed

effects.[19] The fixed effects help to remove the effect of time-invariant characteristics and account for the unobserved heterogeneity in debt policies among multinational corporations, industries and time periods.

4.4.1. Firm-level control variables

Fixed asset ratio (tangibility)

Fixed asset ratio (tangibility) of an affiliate *i* is expressed as a ratio of affiliate's fixed assets to total assets. Different studies have shown that the type of assets owned by a firm influence its capital decisions; however, direction of the effect that the fixed asset ratio has on firm's leverage is not entirely clear.

Tangible assets, such as property, plant and equipment, are easier to value than intangible assets, such as value of goodwill from an acquisition. Consequently, if a firm has a high proportion of tangible assets, it is able to use them as a collateral and can easily borrow externally. Moreover, tangible assets decrease creditors' risk because creditors can more easily reclaim a bankrupt firm's tangible assets. Tangible assets retain more value in liquidation, which implies that creditors have a better guarantee of repayment and the expected distress costs are lower (Drobetz & Fix, 2005, p. 88; Rajan & Zingales, 1995, p. 1451; Titman & Wessels, 1988, p. 3). The lower creditors' risk increases their willingness to supply loans, which shows a positive effect of tangibility on firm's leverage. The positive effect has been found by several authors; for example, Sibilkov (2009) who claims that costs of issuing debt are lower for a firm with high asset tangibility (p. 1194), and Campello and Giambona (2013), Çekrezi (2013) and Rajan and Zingales (1995) who find a strong positive relation between asset tangibility and firm's leverage.

Nevertheless, tangible assets can be illiquid and problematic to redeploy, which implies that their value can substantially decrease after a liquidation or reallocation (Campello & Giambona, 2013, p. 1363). Furthermore, pecking order theory shows that costs of issuing equity are lower for a firm with a high proportion of fixed assets due to the lower information asymmetry associated with fixed assets. Hence, the pecking order theory predicts a lower leverage ratio for a firm with more tangible assets (Frank & Goyal, 2009, p. 19). Tangible assets are also associated with depreciation deductions, which constitute a non-debt tax shield and act as a substitute for debt in tax minimization strategies. The depreciation tax

[19] Specifications with subsidiary fixed effects and no subsidiary or parent fixed effects are tested in robustness checks. See section 7.9.

shield is an alternative and less costly approach to reduce tax expenses, which decreases benefits of the debt tax shields. Therefore, the use of debt becomes less attractive, which shows a negative relation between the optimal level of debt and fixed assets (Cloyd, Limberg & Robinson, 1997, p. 264; de Mooij, 2011, p. 4).

Firm size

Firm size variable is measured by an affiliate's sales and is expressed as a logarithm of sales.[20] Size has been empirically found to be strongly related to firm's capital structure; however, the effect of size on equilibrium leverage is ambiguous. Findings of studies that use international data show that firms' indebtedness and size have a positive relation in most countries (Booth et al., 2001, p. 105). For example, Rajan and Zingales (1995) find that indebtedness is positively related to size in all major industrialized countries except Germany (p. 1422).

Firm's size is an important determinant of its leverage for several reasons. Large firms are able to borrow at more favourable financing terms because higher sales have a positive effect on firms' cash flows and large firms also tend to diversify their financing sources. Consequently, their greater and cheaper access to external funds through debt markets can lead to an increased indebtedness of large firms (Booth et al., 2001). Furthermore, firm's size reflects its default probability, as it is harder to liquidate large firms, and recovery rate is higher for large firms in case of financial distress (Kurshev & Strebulaev, 2007, p. 1). Also, as implied by trade-off theory, large firms tend to have lower bankruptcy risks and therefore incur lower cost monitoring and smaller agency costs (Booth et al., 2001, pp. 100 – 101). For example, Warner (1977) finds that large firms have a lower ratio of bankruptcy costs to the firm's market value (p. 337). Size may also reflect volatility of firm's assets, as small firms often operate in developing and volatile industries. Fama and French (2002) test the volatility prediction using trade-off and pecking-order theories. The trade-off model predicts that firms with less variable earnings have more leverage because they are less likely to default. Similarly, the pecking order model also predicts a negative relation between volatility of net cash flows and leverage. The authors hypothesize that large firms have less volatile earnings and find a positive relation between size and leverage.

[20] The Amadeus database did not report sales data on any firms located in Denmark, Ireland, Russia and the United Kingdome. To avoid excluding firms located in these countries from the main data sample as a result of data trimming procedures, I use firms' operating revenue (turnover) as a variable for firm size in these countries.

Furthermore, costs of issuing debt and equity are also related to firm's size as size can characterize the information that is available to outside investors. Information asymmetry between firm and investors is lower for large firms, as such firms are continuously monitored by investors. As equity is more sensitive towards information asymmetry than debt, large firms should be more capable of issuing equity than small firms, which should result in a higher preference for equity relative to debt in large firms (Rajan & Zingales, 1995, p. 1457). Moreover, as implied by the pecking order theory, large firms are survivors and tend to have more equity financing (Booth et al., 2001). Smith (1977) claims that small firms pay much more than large firms to issue new equity and also slightly more to issue long-term debt. He finds that, the smaller the firm, the larger the underwriting commissions; therefore, small firms are likely to be more indebted than large firms. However, examination of equity issuances data in Canada, Japan, the United Kingdom and the United States shows that large firms tend to have smaller net equity issuances than small firms (Rajan & Zingales, 1995, p. 1457).

Loss carry-forward

Loss carry-forward variable is expressed as a dummy variable equal to 1 if an affiliate has losses that it can carry forward, and 0 otherwise. As revealed by the previous research, the effect of firm's loss carry-forwards on its financial leverage is ambiguous.

Loss carry-forwards reduce firm's future tax payments, which implies that they act as non-debt tax shields and can lead to a lower demand for debt tax shields (Dwenger & Steiner, 2012, p. 23; Givoly, Hayn, Ofer & Sarig, 1992, p. 352). MacKie-Mason (1990) claims that if a U.S. firm has a loss carry-forward, the firm is less likely to issue debt due to an already high tax shield (p. 1472). The effective tax reduction resulting from an increased use of debt is likely to be zero. As empirically shown by Auerbach (1985), a firm with a loss carry-forward is likely to issue less debt than a firm without any losses to be carried forward. For example, if a firm with a substantial loss carry-forward wants to undertake an investment project, it is likely that the firm has to borrow short-term due to lack of retained earnings. Any long-term borrowing is smaller than for a firm without a loss carry-forward (p. 307).

However, loss carry-forwards from previous periods may explain other firm's characteristics, for example, its expected performance, which may indicate a positive relation between firm's loss carry-forwards and its financial leverage. In addition, affiliates experiencing financial difficulties may be unable to retain profits and consequently should

have less equity capital. Therefore, they might undertake more debt to finance their activities (Gopalan, Nanda & Seru, 2007, p. 766).

Profitability

Profitability variable is expressed as a ratio of affiliate's earnings before interest, tax, depreciation and amortization (EBITDA) to total assets.[21] Effect of profitability on firm's optimal leverage ratio is ambiguous and can be explained by two theories: static trade-off theory and pecking order theory.

Firstly, according to the static trade-off theory, a firm follows a target debt-to-equity ratio, determined by benefits and costs associated with debt (debt tax shield, financial distress costs and agency costs). The theory suggests a positive relationship between profitability and leverage as higher profits lead to more income to use for debt service payments and more taxable profits to protect from taxation. Moreover, profitable firms may be perceived as relatively riskless, which increases their ability to obtain credit (Myers, 1993, p. 84).

Secondly, the pecking order theory states that firms follow a hierarchy of financial decisions when determining their capital structures. Initially, firms want to finance their investments entirely by internal debt or retained earnings. If they need also external financing to finance a project, they first apply for a bank loan, then for public debt, and finally issue equity. Therefore, the pecking order theory suggests a negative relationship between profitability and leverage, as profitable firms generate high earnings and can use their profits to pay down debt obligations or simply finance investments through retained earnings instead of debt (Chiang, Chan & Hui, 2002, p. 434; Mendell, Sydor & Mishra, 2006). For example, Graham (2000) finds that profitable firms use debt conservatively, using Boeing and Intel as examples of profitable firms. His findings show that if the firms have faced an unprofitable period and return to the profitable state again, their leverage decreases to or below the debt level which they had during the unprofitable period. This implies that the firms become less indebted as soon as they are profitable enough (p. 1924). This result is in line with the finding by Myers (1993), who claims that the most significant evidence against implications of the trade-off theory is the significant inverse relation between debt and profitability (pp. 83 – 84). The author explains this negative relation by slow adjustments to firms' optimal debt ratios. For example, if sudden unexpectedly high profits push a firm's actual debt ratio below

[21] The Amadeus database did not report EBITDA data on any firms located in Russia. To avoid excluding firms located in Russia from the main data sample as a result of data trimming procedures, I use earnings before interest and tax (EBIT) as a variable for firm profitability in Russia.

the target and there exist transaction costs characterizing adjustments back to the optimal debt ratio, there seems to be a negative relation between profitability and leverage. Furthermore, if firms invest to keep up with industry growth, then the rates of real investment are similar within an industry. The least profitable firms are likely to have less internal funds or retained earnings for implementation of new projects than profitable firms; therefore, they are likely to borrow more externally (p. 85).

4.4.2. Country-level control variables

Inflation

Inflation variable is expressed as the annual percentage change in consumer price index, as reported by the World Development Indicators of the World Bank (n.d.b), the World Economic Outlook Database of the International Monetary Fund (2014) and the Consumer Prices Database of the OECD (2015). As debt contracts are written in nominal terms, changes in inflation always tend to have real effects (Gomes, Jermann & Schmid, 2014, p. 3). However, the direction of the effect that inflation has on firm's leverage is ambiguous.

On the one hand, inflation can lead to higher risk premiums and higher nominal interest rates, which decrease the attractiveness of debt. Inflation can also reduce the tax advantage of debt by decreasing the real value of deductible interest payments if the payments depend on the historical value of debt and if interest rates are fixed (Huizinga et al., 2008, p. 100).

On the other hand, the trade-off theory states that leverage is positively related to expected inflation (Frank & Goyal, 2009, p. 19; Taggart, 1985, p. 40). Several studies that examine the effect of inflation on firm's capital structure conclude that inflation enhances debt financing as it decreases the real value of currently outstanding corporate debt, improves firm's balance sheet and decreases its default risk (Hochman & Palmon, 1985; Modigliani, 1982). Furthermore, nominal interest payments consist of the actual interest payments and a compensation for reduction in the real value of the principal. Firms are allowed to deduct their entire nominal interest expense for the corporate income tax, which implies that an increase in the nominal interest rate induced by inflation increases the tax advantage of debt (Gu, de Mooij & Poghosyan, 2015, pp. 184, 198; Jaffe, 1978, pp. 1442 – 1443). Hence, the share of pre-tax operating income paid in taxes declines with the rate of inflation and debt financing becomes more attractive (Mintz & Weichenrieder, 2010, p. 132; Modigliani & Cohn, 1979, p. 27).

Corruption

Corruption variable is expressed as a logarithm of annual corruption index in each country, as reported by the Worldwide Governance Indicators of the World Bank (n.d.a). The variable shows the extent to which public power is used to obtain private benefits and captures the risk of investors' expropriation by firm's management or by public officials and politicians. The index shows the country's score in a range from -2.5 to 2.5, with 2.5 indicating a country with a very low level of corruption.[22] Thus, the higher the index, the less corrupt the country. As revealed by the previous research, the effect of corruption on firm's leverage is ambiguous.

Several authors find that corrupt countries have more indebted firms, which can be explained by two reasons. Firstly, as debt obligations are contractual and legally binding, debt provides a higher degree of monitoring ability and enforcement by investors than equity. More indebted firms tend to be more protected from expropriation by managers or bureaucrats, which increases the attractiveness of leverage in corrupt countries (Fan, Rui & Zhao, 2008, p. 346; Venanzi, Naccarato & Abate, 2014, p. 24). Also, as found by Han, Titman and Twite (2012), firms that operate in countries characterized by weak laws and high public sector corruption tend to have high leverage and borrow more short-term debt, as short-term debt is harder to expropriate (p. 29). Secondly, it may be easier for a corrupt bureaucrat to channel funds to connected firms as loans through a bank that he controls, rather than through equity market that he cannot influence to such an extent (La Porta, De Silanes & Shleifer, 2002; Sapienza, 2004).

However, the effect of corruption on firm's leverage can be negative, as it may be harder to obtain credit in countries characterized by high corruption. Also, interest rates are likely to be higher in countries with weak legal efficiency, where creditors are exposed to a high risk and low negotiation power in the event of borrower's default (Aggarwal & Kyaw, 2008, p. 416). Moreover, firms may consider it risky to borrow in countries characterized by a highly corrupt public sector.

Growth opportunities

Growth opportunities variable is expressed as the median annual growth in sales per industry and country, following Huizinga et al. (2008, p. 100) and Møen et al. (2011, p. 18).

[22] I have adjusted the range of corruption index to be within [0;10] interval, where 10 indicates a country with a very low level of corruption. The logarithm is taken from these adjusted values.

As revealed by the previous research, the impact of growth opportunities on firm's leverage is ambiguous.

As revealed by the existing literature on agency problems, firm's stockholders tend to make sub-optimal investments in order to extract wealth from debtholders and maximize equity value rather than the total firm value. Increased growth opportunities enhance this conflict as there is more flexibility regarding firm's future investments. Firstly, managers may have incentives to underinvest in future growth opportunities, which is described as the underinvestment problem (Johnson, 2003, p. 209; Rajan & Zingales, 1995, p. 1456). The reason is that a portion of benefit from investments in growth opportunities belongs to debtholders, which implies that the net present value accruing to stockholders can be even negative. Furthermore, managers may be willing to overinvest in future growth opportunities if these investments are substantially more risky than the firm's current assets. Moreover, managers may undertake risky negative net present value projects, which increase the value of equity and decrease the value of risky debt even more (Jensen & Meckling, 1976). Reduction in firm's value due to less efficient investment decisions is an important component of agency costs of debt. If bondholders are rational, they anticipate these stockholder incentives and require a higher cost of debt (Billett, King & Mauer, 2007, p. 700). Therefore, it is in the firm's and stockholders' interests to reduce the potential conflicts regarding future growth opportunities. This can be done through reducing firm's debt, including restrictive debt covenants in agreements, or decreasing debt maturity (Barclay, Marx & Smith, 2003, pp. 150, 154, 161; Barclay & Smith, 1995, p. 610; Myers, 1977, p. 161).

Furthermore, Titman and Wessels (1998) claim that growth opportunities can be considered as assets that increase firm's value, but do not act as a collateral nor create any current taxable income (p. 4). Hence, borrowing can be difficult for firms which have low current income or low tangible assets, even though their growth opportunities are high. Therefore, debt and growth opportunities are likely to be negatively related.

However, several studies find a positive relation between growth opportunities and leverage. If owners of a rapidly growing firm consider growth opportunities unsustainable and risky, they are willing to pass on the higher risk to debtholders. Also, if a substantial new growth opportunity is discovered, the owners of the firm might be unwilling to issue equity, as the price might not be high enough to reflect the firm's actual value. The owners may prefer to finance the new investment initially with debt, and when the project becomes

profitable, the firm may pay back its debt by issuing equity at a much higher price or through retained earnings. Moreover, the economic and political networks of owners of rapidly growing firms may provide them with an easy access to the credit market. It has also been observed that the credit market is more likely to finance firms with better future growth expectations (Awan, Bhatti, Ali & Qureshi, 2010, p. 96). Another explanation for the positive relation between growth opportunities and leverage is that firms with rapidly growing sales often need to expand their fixed assets (Gupta, 1969, pp. 524, 528). These firms have a greater future need for funds and also retain more earnings. Therefore, according to the trade-off theory, high-growth firms are willing to issue more debt in order to maintain their target debt-to-asset ratios, which shows a positive relationship between leverage and growth opportunities (Awan et al., 2010, p. 91).

Creditor rights

Creditor rights variable is expressed as a logarithm of annual strength of legal rights index as reported by the World Development Indicators of the World Bank (n.d.c). The index describes how well collateral and bankruptcy regulations protect the rights of borrowers and lenders, thereby promoting borrowing and lending within a country. The index ranges from 0 to 12, with higher values indicating that the regulations protect the rights of borrowers and lenders and increase access to credit.[23] As revealed by the previous literature, the impact of creditor rights on firm's leverage is ambiguous.

On the one hand, the supply side view, which focuses on the supply side of the financial market or investors, suggests that strong creditor protection induces lenders to provide credit at more favourable terms, promotes finance and growth and leads to a higher corporate leverage (Demirgüç-Kunt & Maksimovic, 1998, p. 2122; La Porta, Lopez-De-Silanes, Shleifer & Vishny, 1997, p. 1149; Qian & Strahan, 2007, p. 2821). Moreover, strong creditor rights lead to a better allocation of resources (Vig, 2013, p. 924). As claimed by González and González (2008), when creditor rights are weak, firms with high agency costs of debt find it hard to borrow because financial institutions expect underinvestment and other issues (p. 365). Thus, lenders in countries characterized by weak creditor protection tend to require high levels of collateral and demand collateral forms that have a small dilution risk (Davydenko & Franks, 2008, p. 601). Also, lenders require increased control rights via specific agreements; for example, restrictive covenants that demand low dividend payments

[23] I have adjusted the range of creditor rights index to be within [0;10] interval, where 10 indicates a country with a very high creditor protection. The logarithm is taken from these adjusted values.

of debtor firms (Brockman & Unlu, 2009, p. 276; Miller & Reisel, 2012, p. 7; Nini, Smith & Sufi, 2009, p. 401). Lenders may also be willing to lend short-term in order to control borrowers' opportunistic behaviour by threatening of not renewing the loan. Higher creditor protection reduces these issues and increases firms' access to credit. Credit access is especially improved for firms with substantial proportion of intangible assets (assets that cannot be used as collateral, such as R&D and advertising), with low profitability, high growth opportunities and highly volatile returns. Giannetti (2003) finds that in the U.K., which has very strong creditor rights, firms with highly volatile returns are still able to borrow long-term. Strengthened creditor rights make the use of debt maturity to control borrowers inessential. Therefore, lenders are willing to increase debt maturity for firms with volatile returns, which increases survival of temporarily illiquid firms (p. 200).

On the other hand, the demand side view, which focuses on the demand side of the financial market or corporations, suggests that strong creditor protection makes firms unwilling to make long-term cash flow commitments to repay debt. In countries characterized by strong creditor rights, management can be easily laid off upon default and replaced by creditors or neutral third-party trustees. As managers do not want to lose job and control upon financial distress, they tend to issue less leverage in countries characterized by strong creditor rights (Cho, Ghoul, Guedhami & Suh, 2014, p. 41; Rajan & Zingales, 1995, p. 1444).

4.5. Descriptive statistics

4.5.1. Parent firms and subsidiaries by country

Information on the number of parent firms and subsidiaries by country is provided in Panel A of Table 2. As discussed previously, the Amadeus database only provides financial data on firms located in Europe. The total number of parent firms is 143,405 over the sample period of 12 years, while the total number of subsidiaries is 229,703. The number of parent firms that are included in the main data sample as affiliates is 31,414; hence, the total number of affiliates in the main data sample is 261,117. The data sample does not include data on all the parent firms over the sample period (143,405 firms) due to data trimming procedures and removal of parent firm-year observations with missing or extreme data from the main data sample. Overall, there are 1,039,827 affiliate-year observations in the main data sample, representing 108,135 parent firm-year observations and 931,692 subsidiary-year observations. There are on average 7 observations per affiliate and 119 observations per

corporate group. The number of affiliate-year observations per corporate group varies with the number of subsidiaries per multinational firm. The number of subsidiaries per multinational group vary substantially as well – the smallest corporate groups have only 1 subsidiary, while the largest group has 1,812 subsidiaries.

Furthermore, the table lists the number of parent firms by home country and the number of subsidiaries by home country and host country. For each subsidiary of a multinational corporation, the home country is specified as the country where its parent firm is located, and the host country is specified as the country where the subsidiary operates itself. This means that home country and host country are equal for a domestic subsidiary, as it operates in the same country as the parent firm. As an example, consider Austria. There are 5,402 subsidiaries that are located in Austria (Austria is their host country). Furthermore, there are 10,789 subsidiaries whose parent firms are located in Austria (Austria is their home country). Finally, 6,377 parent firms are located in Austria (Austria is their home country), out of which 1,640 parent firm enter the main data sample as affiliates themselves. As observable in the table, Germany, Italy, the Netherlands and the United Kingdom are home countries for more than 10,000 parent firms each in the data sample. Furthermore, France, Germany, Italy, the Netherlands and the United Kingdom are home countries for more than 20,000 subsidiaries each in the data sample. This implies that there are relatively many subsidiaries whose parent firms are located in one of these countries. Furthermore, France, Germany, Italy and Romania are host countries for more than 20,000 subsidiaries each in the data sample. This implies that relatively many subsidiaries are located in these countries. Finally, there are no subsidiaries located in Albania, Andorra, Belarus, Gibraltar, Kosovo, Monaco, San Marino and Turkey in the main data sample, as a result of data trimming procedures.

Number of subsidiaries by host country represents only subsidiaries and excludes the number of parent firms from the main data sample. Number of parent firms represents all the parent firms of multinational groups that own subsidiaries in the main data sample. Hence, the total number of parent firms is 143,405, even though only 31,414 parent firms enter the main data sample as affiliates themselves as a result of data trimming procedures. As an example, consider a multinational corporation consisting of 3 entities – a parent firm and two subsidiaries. The parent firm is located in Albania, while its subsidiaries are located in Austria. If no financial data on the parent firm is found in the Amadeus database, the parent firm-observation does not enter the main data sample due to data trimming procedures.

However, the historical ownership data from the Orbis database still shows that the parent firm owns the two subsidiaries. Hence, the parent firm will be counted in the number of parent firms by home country in Albania, and the two subsidiaries will be counted in the number of subsidiaries by home country in Albania and number of subsidiaries by host country in Austria. Accordingly, even though Panel A shows that there exist 208 parent firms by home country in Albania, there are no financial coordination centres or other affiliates located in Albania in the main data sample (as observable in Panel B) due to lack of financial data on these parent firms and a subsequent removal from the main data sample.

Huizinga et al. (2008) discuss the number of parent firms and subsidiaries in their data sample as well (p. 97). Two differences arise, when compared to my data sample. Firstly, the total number of subsidiaries is not equal by home and host countries in my data sample, while it is equal in the data sample of Huizinga et al. (2008). This occurs because my data sample is adjusted for ownership changes over the sample period, while the empirical results and descriptive statistics presented by Huizinga et al. (2008) show that the authors assume a constant ownership structure over their sample period of 10 years.[24] Due to this assumption, subsidiaries are owned by the same parents over the sample period and the number of subsidiaries by home and host countries are the same. However, the number of subsidiaries by home country is higher than the number of subsidiaries by host country in my data sample due to the changing historical ownership structure. The home country (country of the parent firm) is likely to change over time, which results in more home country observations per subsidiary than host country observations.

Another difference can be observed while comparing the number of parent firms by home country and the number of subsidiaries by home country. In the data sample of Huizinga et al. (2008), the number of parent firms by home country is always smaller than the number of subsidiaries by home country, while such a relation cannot be observed in my data sample. Also this difference arises due to the changing ownership structure in my data sample and the assumption about a stable historical ownership structure in the data sample of Huizinga et al. (2008). In the study by Huizinga et al. (2008), subsidiaries are owned by the same parent firms over the sample period of 10 years. As each parent firm owns at least one subsidiary, there are fewer parent firms by home country than subsidiaries by home

[24] Even though the authors do not explicitly state such an assumption, they also do not state that the ownership structure is adjusted for historical ownership changes. Based on their empirical results and descriptive statistics, it seems that the authors have assumed a constant historical ownership structure.

country. However, subsidiaries can be owned by several parents over the sample period in my data sample. If the new parent firm operates in the same home country as the previous parent firm, the number of parent firms by home country increases, while the number of subsidiaries by home country does not change. Consequently, the changing ownership structure leads to more parent firms by home country than subsidiaries by home country in some countries.[25]

4.5.2. Financial coordination centres and other affiliates by country

Information on the number of potential financial coordination centres and the number of other affiliates (all affiliates except the potential financial coordination centres) by home and host countries is provided in Panel B of Table 2. According to the model, I have assumed that the potential financial coordination centre of a multinational corporation is the lowest-taxed affiliate within the corporate group. Even though locating the financial coordination centre in the lowest-taxed affiliate is the optimal choice according to tax-efficient financing structure, not all multinational firms act accordingly. Hence, the financial coordination centres observable in the table do not necessarily reflect the actual financial coordination centres of European multinational firms.

As observable in the table, the most financial coordination centres are located in Romania, Italy and the United Kingdom. Location of financial coordination centres in Romania can be explained by its relatively low corporate tax rate (on average, 17%). Furthermore, location of financial coordination centres in Italy and the United Kingdom can be explained by the relative abundance of subsidiaries located in these countries, as observable in Panel A of Table 2, and the relatively lower statutory corporate tax rates in these countries, compared to other countries which host relatively many subsidiaries.[26] Therefore, it is likely that many subsidiaries that are located in Italy and the United Kingdom are classified as financial coordination centres in the data sample. Furthermore, France,

[25] As observable in Panel A of Table 2, number of parent firms by home country exceeds the number of subsidiaries by home country in Albania, Belarus, Hungary, Macedonia, Moldova, Montenegro, Turkey and Ukraine.

[26] Italy is host country for more than 20,000 subsidiaries, while the United Kingdom is host country for more than 17,000 subsidiaries in the data sample. As compared to France, which is host country for more than 20,000 subsidiaries as well, Italy's and the United Kingdom's average corporate tax rates are approximately 7 percentage points lower (average corporate tax rate in France – approximately 34%, average corporate tax rates in Italy and the United Kingdom – approximately 28% and 27%, respectively).

Germany and Italy are host countries for most affiliates which do not act as financial coordination centres in the data sample. This can be explained by the relatively many affiliates which are located in these countries, as observable in Panel A of Table 2.[27]

Finally, the total number of potential financial coordination centres is larger than the total number of other affiliates in the main data sample, which reflects the tendency of multinational firms to establish several affiliates in the lowest-taxed country. As all affiliates which operate in the lowest-taxed country are automatically labelled as potential financial coordination centres, the total number of financial coordination centres is likely to be large. As an example, consider a multinational firm that consists of the parent firm, located in Norway, and three subsidiaries, located in Latvia. As the statutory corporate tax rate is lower in Latvia, compared to Norway, the three subsidiaries are counted as potential financial coordination centres, while the parent firm is counted as other affiliate. Also, the high total number of financial coordination centres reflects the abundance of multinational firms which have only one or two subsidiaries (44% of multinational firms in the data sample have less than 3 subsidiaries). As one or two of these subsidiaries are likely to be labelled as the lowest-taxed affiliates of the multinational group, the relative number of potential financial coordination centres is likely to be high. Finally, the same affiliate can be counted twice as both financial coordination centre and other affiliate in different years, based on the minimum tax rate within the multinational group. This also contributes to a relatively high number of potential financial coordination centres, compared to other affiliates. However, a higher number of financial centres than other affiliates is not realistic, as it is rather unlikely that multinational firms own more financial coordination centres than other affiliates on average.[28]

[27] France, Germany and Italy are host countries for more than 20,000 subsidiaries each in the data sample.

[28] The total number of affiliates in Panel B of Table 2 (300,917) is not equal to the total number of affiliates in Panel A of Table 2 (261,117) due to the changing ownership structure over time. As ownership links change and affiliates are bought and sold among multinational firms, the classification of affiliates as financial coordination centres or as other affiliates (all affiliates except financial coordination centres) changes over the sample period, responding to changes in tax rates of affiliates within the multinational corporation. Thus, the total number of affiliates in Panel B is higher than the total number of affiliates in Panel A, as some affiliates are classified as both financial coordination centres and other affiliates in different years due to the changing ownership structure and changes in the minimum tax rate of the corporate group.

4.5.3. Financial leverage and tax mechanisms by country

Panel C of Table 2 displays summary statistics of financial leverage and the three tax mechanisms by countries in the data sample. Firstly, financial leverage is defined as the total debt-to-asset ratio.[29] As observable in the table, the average affiliate leverage is 0.591, ranging from 0.35 in Macedonia to 0.79 in Liechtenstein. The average host country corporate tax rate ranges from 0.06 in Moldova to 0.35 in Malta. Furthermore, the weighted tax difference variable reflects the weighted sum of differences between the corporate tax rate faced by an affiliate and the tax rates faced by all other affiliates that belong to the multinational corporation. A positive weighted tax difference variable implies that the multinational firm is willing to shift external debt to affiliates located in the particular country, while a negative weighted tax difference variable implies that the multinational firm is willing to shift external debt out of affiliates located in the particular country. As observable in the table, affiliates located in Moldova and Liechtenstein are likely to attract least external debt, while affiliates located in Malta and France are likely to attract most external debt.

As a hypothetical example for calculation of the weighted tax difference variable, consider a multinational corporation that consists of two subsidiaries A and B and parent firm C. All the three entities are of equal size. The weighted tax difference of subsidiary A is the asset-weighted sum of differences between the corporate tax rate faced by the subsidiary A (t_A) and the tax rates faced by the parent firm C (t_C) and the subsidiary B (t_B). The weighted tax difference of subsidiary A is calculated as $\sum_{j \neq i} \rho_j (t_i - t_j) = \sum_{j \neq A} \rho_j (t_A - t_j) = \frac{1}{3}(t_A - t_B) + \frac{1}{3}(t_A - t_C)$. If the corporate tax rate faced by subsidiary A exceeds the corporate tax rates faced by parent firm C and subsidiary B, then the weighted tax difference variable is positive and the multinational corporation is willing to shift external debt away from subsidiary B and parent firm C to subsidiary A.[30]

Finally, the maximum tax difference variable reflects the difference between the corporate tax rate faced by an affiliate and the tax rate of the lowest-taxed affiliate within the multinational corporation. Maximum tax difference variable equals zero for financial coordination centres, as they are the lowest-taxed affiliates within multinational firms. For

[29] See Appendix C for variable definitions and data sources.

[30] As an example, if t_A is 0.3, while t_B is 0.1 and t_C is 0.05, then the weighted tax difference of subsidiary A equals 0.15.

other affiliates, the maximum tax difference variable is always positive, and an increase in the maximum tax difference enhances the multinational firm's incentives to shift more internal debt to the affiliate facing the increase.[31] As observable in Panel C of Table 2, affiliates located in Cyprus, Montenegro and Macedonia are likely to attract least internal debt, while affiliates located in Malta and France are likely to attract most internal debt.

Table D1 in Appendix D shows the year-by-year summary statistics of the total debt-to-asset ratio and the three tax mechanisms. As observable in the table, the average total debt-to-asset ratio has a tendency to decrease over time from 0.62 in 2003 to 0.54 in 2014. The variation in the leverage ratio has been approximately constant, with a slight tendency to increase over time. Also the average statutory corporate tax rate has decreased during the sample period from 0.31 in 2003 to 0.25 in 2014, while its variation has slightly increased. The average weighted tax difference variable has been relatively constant over time, ranging from -0.007 to -0.001, while its variation has slightly decreased in the latest years. Finally, the maximum tax difference variable has also been relatively constant over time, ranging from 0.024 to 0.067, with a slight tendency to decrease in the latest years. The variation in the maximum tax difference variable has slightly decreased over time from 0.068 in 2003 to 0.041 in 2014. Decreased variation in the weighted tax difference and maximum tax difference variables reflects the overall decrease in statutory corporate tax rates and convergence in European statutory corporate tax rates over time.

4.5.4. Dependent and independent variables

Summary statistics for the lowest-taxed affiliates and other affiliates

Panel D of Table 2 shows summary statistics for the dependent variable and independent variables used in the analysis, distinguishing between the lowest-taxed affiliates within a multinational corporation and other affiliates (all affiliates except lowest-taxed affiliates). As observable in the table, the lowest-taxed affiliates constitute 45% of the data sample, which is a relatively large proportion.[32] The lowest-taxed affiliates are assumed to act as financial coordination centres that lend money to all other affiliates within the multinational corporation. By comparing characteristics of the lowest-taxed affiliates and

[31] Maximum tax difference variable can increase due to two reasons – due to an increase in the corporate tax rate of the affiliate or due to a decrease in the corporate tax rate of the financial coordination centre of the multinational corporation.

[32] Explanations behind the relatively large number of the lowest-taxed affiliates within multinational firms are discussed in section 4.5.2.

other affiliates, I examine whether the model's predictions hold for the data sample. As observable in the table, the lowest-taxed affiliates are smaller than other affiliates in terms of sales and total assets. According to total assets, other affiliates are 2.7 times larger than the lowest-taxed affiliates, which shows that financial coordination centres mainly lend money to other affiliates within the corporate group and are less likely to engage in production activities. Furthermore, when comparing leverage ratios, long-term and short-term debt, financial expenses and interest paid, the lowest-taxed affiliates tend to borrow less and pay less interest than other affiliates. This observation supports the model's prediction that the lowest-taxed affiliates are less leveraged than other affiliates. However, according to net lending, calculated as debtors minus creditors, the lowest-taxed affiliates seem to have smaller net lending than other affiliates. Moreover, it seems that affiliates in the data sample have no net debt on average, as the average net lending variable is positive. 66% of affiliates in the data sample have positive net lending, and, out of these, 45% are the lowest-taxed affiliates. The affiliates that have positive net lending face slightly lower tax rates than other affiliates (26%, compared to 27%). Hence, the model's prediction that the lowest-taxed affiliates are net lenders is not supported by the data.

Furthermore, the average statutory corporate tax rate in the data sample is 0.27, with a standard deviation of 0.07. The lowest-taxed affiliates have a lower average statutory corporate tax rate by definition, which is 0.23. When compared to other affiliates, the average statutory tax rate is approximately 6 percentage points higher for the other affiliates. This suggests that the corporate tax rates in Europe are not highly dispersed. Furthermore, the average weighted tax difference in the sample is -0.005, while the average maximum tax difference is 0.05. The average weighted tax difference is negative for the lowest-taxed affiliates, while it is positive for other affiliates, which can be explained by the lower statutory corporate tax rates of the lowest-taxed affiliates. The average maximum tax difference equals 0 for the lowest-taxed affiliates, while it is positive for other affiliates, which can also be explained by the lower corporate tax rates of the lowest-taxed affiliates.

Summary statistics for actual financial coordination centres and other affiliates

Panel E of Table 2 shows summary statistics for the dependent variable and independent variables used in the analysis, distinguishing between the actual financial coordination centres and other affiliates (all affiliates except the actual financial coordination centres). I find the actual financial coordination centres of multinational firms in the main data sample by searching for "coordination centre", "coordination center", "treasury centre"

and "treasury center" in company names. As a result, I find 27 financial coordination centres that belong to 36 parent firms over the 12 year sample period. As ownership relations change over time, the same financial coordination centre can be owned by different parent firms, which explains the larger number of parent firms than financial coordination centres. The average total debt-to-asset ratio of financial coordination centres is 11 percentage points lower than the average total leverage ratio of other affiliates, which is in line with the model's prediction that financial coordination centres tend to be less leveraged than other affiliates. Furthermore, total assets, total debt, financial expenses and interest paid of the financial coordination centres are substantially higher, compared to other affiliates. Also the average net lending of financial coordination centres is much larger than net lending of other affiliates, which is in line with the model's prediction that internal banks act as net lenders. Finally, the average statutory corporate tax rate of financial coordination centres is 7 percentage points higher than tax rate of other affiliates, despite the relatively lower total debt-to-asset ratio of financial coordination centres. However, 24 out of 27 coordination centres are located in Belgium, which has a preferential tax regime. Hence, the effective tax rate actually faced by the financial coordination centres is much lower. I calculate the average actual tax rate that these financial coordination centres pay in Belgium based on their profit and loss statements. The results show that the actual tax rate paid is only 5.1%, calculated by dividing the actual tax expenses by profit and loss before tax. This implies that using statutory corporate tax rates while trying to find the financial coordination centres in the main analysis might not capture the actual financial coordination centres, as the statutory corporate tax rate in Belgium is rather high.[33]

Panel F of Table 2 shows summary statistics for the dependent variable and independent variables used in the analysis only for those multinational groups whose actual financial coordination centres were found in the data sample. The table distinguishes between the actual financial coordination centres, parent firms and other affiliates (all affiliates except the actual financial coordination centres and parent firms). As observable in the table, financial coordination centres have a smaller average leverage ratio than parent firms and other affiliates within the multinational group. Furthermore, even though the average corporate tax rate of financial coordination centres is larger than the average tax rate of parent firms and other affiliates, the effective corporate tax rate of financial coordination centres is

[33] See section 7.2. for a discussion on the preferential tax regime in Belgium, and a robustness test which adjusts the statutory corporate tax rates for preferential tax regimes in Belgium, the Netherlands and Luxembourg.

significantly lower. The actual financial coordination centres are larger than parent firms and other affiliates in terms of total assets, and also have more total debt. Finally, coordination centres have a substantially higher net lending than parent firms and other affiliates within the multinational group.

Overall, the obtained summary statistics show that the actual financial coordination centres of multinational firms behave according to the model's predictions – financial coordination centres are net lenders, they have lower total leverage ratios than other affiliates that belong to the multinational group, and they are located in the lowest-taxed countries or face preferential tax regimes.

Summary statistics for parent firms and other affiliates

Panel G of Table 2 shows summary statistics for the dependent variable and independent variables used in the analysis, distinguishing between parent firms and other affiliates (all affiliates except parent firms). As observable in the table, the number of parent firms whose financial data was found by the Amadeus database is 31,414, which represents approximately 10% of all affiliate-year observations in the main data sample or 22% of all parent firms in the main data sample. Parent firms are approximately 3 times larger than other affiliates and have 4 times more debt. Accordingly, their financial expenses and interest paid are also much higher. The total debt-to-asset ratio is slightly lower for parent firms, compared to other affiliates. Moreover, even though parent firms represent only 10% of affiliates that have positive net lending, their net lending is substantially larger than net lending of other affiliates, despite their larger average statutory corporate tax rate. Hence, even though parent firms are not likely to be the lowest-taxed affiliates – only 38% of parent firms are located in the lowest-taxed country of the multinational group – there exists substantial lending from parent firms in the data sample.

This implies that parent firms tend to lend out more than predicted by the model, which appears sub-optimal based on the theory for tax-efficient financing structures. The finding that parent firms are more indebted than subsidiaries and also act as net lenders can be explained by cheaper borrowing of external debt at the headquarters' level of the multinational firm. If the parent firm is able to centrally borrow external debt at a lower cost than subsidiaries, it can transfer these funds as internal debt to these subsidiaries, substituting their need for external debt. As an example, if subsidiaries have specific unfavourable characteristics or face an adverse institutional environment, they might incur high external

debt costs. As observable in the table, parent firms are located in less corrupt countries than other affiliates, which might increase their access to external financing. Furthermore, centralized external borrowing at the headquarters' level might result in scale economies and benefit the whole multinational group. Moreover, if internal debt can be used as a commitment device to mitigate the adverse characteristics of subsidiaries within the multinational group, external debt at the subsidiary level can become affordable as a result. Finally, substantial net lending at the parent level can occur if small multinational firms have small financial resources and knowledge to set up an internal bank in the lowest-taxed country (Niesten-Dietrich, 2014). Hence, small multinational firms may use the parent firm for lending purposes. However, a deeper analysis of net lending at the parent level requires data for internal and external debt, which is unavailable in the Amadeus database.

Table 2: Descriptive statistics

Panel A shows the number of parent firms and subsidiaries by home and host countries in the main data sample. "Number of parent firms as affiliates in the data sample" shows only those parent firms that enter the main data sample as affiliates. "Number of subsidiaries by host country" represents only subsidiaries and excludes the number of parent firms from the main data sample. Panel B shows the number of potential financial coordination centres (the lowest-taxed affiliates) and other affiliates (all affiliates except the lowest-taxed affiliates) by host countries. Panel C shows the sample averages of total debt-to-asset ratio and the three tax mechanisms by host countries. In all panels, "-" implies that there are no observations from the specific country in the data set. Panel D shows the summary statistics for dependent variable and independent variables, distinguishing between the lowest-taxed affiliates and other affiliates. Panel E shows the summary statistics for dependent variable and independent variables, distinguishing between the actual financial coordination centres and other affiliates. Panel F shows the summary statistics for dependent variable and independent variables of the multinational groups with the actual financial coordination centres, distinguishing between the actual financial coordination centres, parent firms and other affiliates. Panel G shows the summary statistics for dependent variable and independent variables, distinguishing between parent firms and other affiliates. The dependent variable is the *total debt-to-asset ratio*, which is the ratio of total liabilities to total assets. The independent variables that I am most interested in are the three tax mechanisms: (1) the *statutory corporate tax rate* of the host country from KPMG's corporate tax rates table and corporate and indirect tax rate survey, and OECD's corporate income tax rates table and economic surveys; (2) the *weighted tax difference*, expressed as the weighted sum of differences between the corporate tax rate faced by an affiliate and the tax rates faced by all other affiliates that belong to the multinational firm; (3) the *maximum tax difference*, expressed as the difference between the tax rate of an affiliate's host country and the tax rate of the lowest-taxed affiliate of the multinational corporation. The firm-level control variables are: (1) *fixed asset ratio* (tangibility), measured as a ratio of affiliate's fixed assets to total assets; (2) *firm size*, expressed as a logarithm of affiliate's sales; (3) *loss carry-forward*, expressed as a dummy variable, equal to 1 if a subsidiary has losses to carry forward, and 0 otherwise; (4) *profitability*, expressed as a ratio of earnings before interest, tax, depreciation and amortization (EBITDA) to total assets. Furthermore, the country-level control variables are: (1) *inflation*, expressed as the annual percentage change in the consumer price index, reported by the World Development Indicators of the World Bank, World Economic Outlook Database of the International Monetary Fund and the Consumer Prices Database of the OECD; (2) *corruption*, expressed as a logarithm of annual corruption index in each country, reported by the Worldwide Governance Indicators of the World Bank; higher index indicates lower level of corruption; (3) *growth opportunities*, expressed as the median annual growth in sales per industry and country; (4) *creditor rights*, expressed as a logarithm of annual strength of legal rights index, reported by the World Development Indicators of the World Bank; higher index indicates higher creditor rights. Finally, several variables (expressed in millions of euros) have been included to test the model's predictions about the lowest-taxed affiliates: (1) *total assets*; (2) *long-term debt*; (3) *short-term debt*; (4) *financial expenses*; (5) *interest paid;* (6) *net lending*, measured as debtors minus creditors. The summary statistics cover the main sample of European multinational parent firms and their subsidiaries, based on up to 12 years of data (2003 – 2014) for each parent firm and subsidiary.

Panel A: Number of parent firms and subsidiaries

Country	Number of parent firms	Number of parent firms as affiliates in the data sample	Number of subsidiaries	
	By home country	By home country	By home country	By host country
Albania	208	-	202	-
Andorra	25	-	26	-
Austria	6,377	1,640	10,789	5,402
Belarus	824	-	716	-
Belgium	5,230	2,175	11,293	8,953
Bosnia and Herzegovina	339	86	429	998
Bulgaria	696	167	774	2,089
Croatia	863	344	1,278	2,222
Cyprus	6,531	16	7,073	5
Czech Republic	2,781	885	3,288	11,481

Table 2 (continued)

Panel A: Number of parent firms and subsidiaries

Country	Number of parent firms	Number of parent firms as affiliates in the data sample	Number of subsidiaries	
	By home country	By home country	By home country	By host country
Denmark	3,805	686	6,497	1,836
Estonia	942	598	1,476	4,047
Finland	2,654	678	5,358	3,285
France	8,589	3,394	26,345	23,485
Germany	18,056	3,529	31,594	20,026
Gibraltar	243	-	270	-
Greece	1,682	118	1,921	1,427
Hungary	4,485	457	4,087	1,630
Iceland	186	18	294	133
Ireland	1,870	265	3,494	2,590
Italy	13,597	3,876	23,302	21,676
Kosovo	3	-	6	-
Latvia	452	150	557	5,165
Liechtenstein	601	-	671	1
Lithuania	1,024	171	1,173	919
Luxembourg	4,724	736	7,644	2,128
Macedonia	172	5	160	11
Malta	367	53	444	141
Moldova	529	4	490	15
Monaco	164	-	168	-
Montenegro	119	12	116	31
Netherlands	11,382	1,062	20,136	3,273
Norway	1,960	855	4,482	4,907
Poland	1,400	299	2,150	8,943
Portugal	1,087	523	2,400	4,414
Romania	520	123	637	22,986
Russia	5,040	87	8,487	11,482
San Marino	32	-	33	-
Serbia	483	167	695	3,775
Slovakia	1,103	567	1,254	7,577
Slovenia	1,146	362	1,640	1,504
Spain	4,691	2,473	11,858	13,471
Sweden	5,139	2,307	12,193	8,010
Switzerland	6,705	10	10,644	23
Turkey	3,011	45	2,592	-
Ukraine	1,500	27	1,457	2,036
United Kingdom	10,068	2,444	20,487	17,606
Total	143,405	31,414	253,080	229,703

Table 2 (continued)

Panel B: Number of financial coordination centres and other affiliates

Country	Number of potential financial coordination centres	Number of other affiliates
	By host country	By host country
Austria	4,343	3,682
Belgium	4,846	8,283
Bosnia and Herzegovina	1,051	34
Bulgaria	2,221	104
Croatia	1,695	1,283
Cyprus	21	-
Czech Republic	10,994	3,017
Denmark	1,505	1,458
Estonia	3,325	1,736
Finland	1,888	3,142
France	7,613	22,090
Germany	9,458	16,237
Greece	998	996
Hungary	1,259	1,384
Iceland	129	34
Ireland	2,713	192
Italy	14,813	15,001
Latvia	5,241	213
Liechtenstein	1	1
Lithuania	1,006	305
Luxembourg	1,995	1,013
Macedonia	16	-
Malta	31	168
Moldova	19	3
Montenegro	41	-
Netherlands	2,653	2,504
Norway	2,598	4,610
Poland	8,139	2,767
Portugal	3,263	3,536
Romania	22,643	1,352
Russia	8,336	4,543
Serbia	3,846	607
Slovakia	7,127	1,689
Slovenia	1,217	953
Spain	7,058	12,415
Sweden	6,637	6,911
Switzerland	30	7
Turkey	32	13
Ukraine	1,484	763
United Kingdom	12,542	13,044
Total	164,827	136,090

Table 2 (continued)

Panel C: Financial leverage (total debt-to-asset ratio) and tax mechanisms

Country	Total debt-to-asset ratio	Statutory corporate tax rate	Weighted tax difference	Maximum tax difference
Austria	0.615	0.251	-0.010	0.051
Belgium	0.587	0.340	0.013	0.100
Bosnia and Herzegovina	0.602	0.104	-0.040	0.001
Bulgaria	0.520	0.114	-0.052	0.001
Croatia	0.602	0.200	-0.020	0.039
Cyprus	0.468	0.100	-0.016	0.000
Czech Republic	0.514	0.201	-0.024	0.020
Denmark	0.560	0.250	-0.006	0.040
Estonia	0.452	0.213	-0.008	0.020
Finland	0.578	0.257	-0.008	0.051
France	0.635	0.345	0.015	0.103
Germany	0.632	0.321	0.011	0.071
Greece	0.643	0.255	-0.015	0.063
Hungary	0.585	0.188	-0.064	0.040
Iceland	0.523	0.185	-0.019	0.009
Ireland	0.543	0.125	-0.067	0.001
Italy	0.689	0.284	-0.002	0.055
Latvia	0.586	0.150	-0.019	0.002
Liechtenstein	0.787	0.125	-0.075	0.013
Lithuania	0.568	0.155	-0.038	0.007
Luxembourg	0.537	0.291	-0.007	0.042
Macedonia	0.354	0.100	-0.028	0.000
Malta	0.496	0.350	0.028	0.125
Moldova	0.373	0.063	-0.118	0.003
Montenegro	0.362	0.090	-0.030	0.000
Netherlands	0.563	0.264	-0.017	0.053
Norway	0.651	0.280	0.002	0.051
Poland	0.531	0.191	-0.040	0.016
Portugal	0.592	0.280	-0.010	0.052
Romania	0.569	0.167	-0.013	0.003
Russia	0.568	0.207	-0.010	0.020
Serbia	0.634	0.113	-0.033	0.002
Slovakia	0.557	0.213	-0.024	0.019
Slovenia	0.584	0.202	-0.019	0.039
Spain	0.596	0.312	0.005	0.072
Sweden	0.645	0.261	-0.008	0.049
Switzerland	0.548	0.214	-0.051	0.015
Turkey	0.594	0.208	-0.001	0.026
Ukraine	0.494	0.241	0.000	0.039
United Kingdom	0.564	0.272	-0.007	0.056

Table 2 (continued)

Panel C: Financial leverage (total debt-to-asset ratio) and tax mechanisms

Country	Total debt-to-asset ratio	Statutory corporate tax rate	Weighted tax difference	Maximum tax difference
Total	0.591	0.266	-0.005	0.053

Panel D: Summary statistics for the lowest-taxed affiliates and other affiliates

Variable	Full sample		Lowest-taxed affiliates		Other affiliates	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Total debt-to-asset-ratio	0.591	0.281	0.577	0.292	0.603	0.271
Statutory tax rate	0.266	0.066	0.231	0.067	0.294	0.050
Weighted tax difference	-0.005	0.037	-0.016	0.037	0.003	0.038
Maximum tax difference	0.053	0.067	0.000	0.000	0.096	0.063
Fixed asset ratio	0.319	0.312	0.322	0.317	0.316	0.307
Log (Sales)	15.157	2.742	14.295	2.823	15.856	2.462
Loss carry-forward	0.229	0.420	0.234	0.424	0.225	0.418
Profitability	0.149	0.266	0.166	0.292	0.135	0.241
Inflation	2.768	2.329	3.345	2.804	2.299	1.718
Log (Corruption index)	1.617	0.647	1.421	0.731	1.776	0.517
Growth opportunities	0.038	0.184	0.050	0.216	0.029	0.154
Log (Creditor rights index)	1.593	0.386	1.670	0.390	1.530	0.370
Total assets (mln)	101.571	1,058.930	51.939	788.529	141.893	1234.33
Long-term debt (mln)	15.047	270.545	8.233	200.644	20.070	312.113
Short-term debt (mln)	26.803	9,965.100	8.787	380.370	39.895	13,090.600
Financial expenses (mln)	2.886	67.695	1.364	25.916	4.087	87.549
Interest paid (mln)	1.870	32.641	1.144	22.736	2.327	37.550
Net lending (mln)	2.986	78.897	1.750	52.652	3.889	93.523
Number of affiliate-year observations	1,039,827		466,108		573,719	
Number of parent firms	143,405		143,405		70,500	
Number of affiliates	261,117		164,827		136,090	

Panel E: Summary statistics for the actual financial coordination centres and other affiliates

Variable	Full sample		Actual financial coordination centres		Other affiliates	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Total debt-to-asset-ratio	0.591	0.281	0.479	0.294	0.591	0.281
Statutory tax rate	0.266	0.066	0.336	0.018	0.266	0.066
Weighted tax difference	-0.005	0.037	0.008	0.015	-0.005	0.038
Maximum tax difference	0.053	0.067	0.114	0.074	0.053	0.067
Fixed asset ratio	0.319	0.312	0.156	0.269	0.319	0.312
Log (Sales)	15.157	2.742	15.362	1.951	15.157	2.742
Loss carry-forward	0.229	0.420	0.067	0.251	0.229	0.420
Profitability	0.149	0.266	0.008	0.033	0.149	0.266

Table 2 (continued)

Panel E: Summary statistics for the actual financial coordination centres and other affiliates

Variable	Full sample		Actual financial coordination centres		Other affiliates	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Inflation	2.768	2.329	2.297	1.136	2.768	2.329
Log (Corruption index)	1.617	0.647	1.918	0.194	1.617	0.647
Growth opportunities	0.278	0.498	0.149	0.445	0.278	0.498
Log (Creditor rights index)	1.593	0.386	1.453	0.153	1.593	0.386
Total assets (mln)	101.571	1,058.93	3,587.36	9,383.75	100.774	1,048.20
Long-term debt (mln)	15.047	270.545	130.273	464.69	15.016	270.468
Short-term debt (mln)	26.803	9,965.10	1,830.39	8,507.53	26.346	9,965.40
Financial expenses (mln)	2.886	67.695	103.951	267.155	2.861	67.552
Interest paid (mln)	1.870	32.641	23.034	43.815	1.864	32.635
Net lending (mln)	2.986	78.897	71.191	323.128	2.969	78.734
Number of affiliate-year observations	1,039,827		238		1,039,589	
Number of parent firms	143,405		36		143,405	
Number of affiliates	261,117		27		261,090	

Panel F: Summary statistics for the multinational firms with the actual financial coordination centres

Variable	Full sample		Actual financial coordination centres		Parent firms		Other affiliates	
	Mean	St. dev.	Mean	St. dev.	Mean	St. dev.	Mean	St. dev.
Total debt-to-asset ratio	0.545	0.289	0.479	0.294	0.597	0.229	0.548	0.288
Statutory tax rate	0.295	0.058	0.336	0.018	0.332	0.023	0.292	0.059
Weighted tax difference	-0.023	0.054	0.008	0.015	0.004	0.013	-0.025	0.055
Maximum tax difference	0.127	0.067	0.114	0.074	0.080	0.062	0.129	0.066
Fixed asset ratio	0.332	0.323	0.156	0.269	0.701	0.259	0.337	0.320
Log (Sales)	16.53	2.740	15.362	1.951	17.790	2.228	16.589	2.766
Loss carry-forward	0.202	0.402	0.067	0.251	0.265	0.444	0.211	0.408
Profitability	0.110	0.202	0.008	0.033	0.051	0.062	0.117	0.208
Inflation	2.477	1.719	2.297	1.136	2.389	1.291	2.490	1.755
Log (Corruption index)	1.822	0.456	1.918	0.194	1.945	0.063	1.814	0.470
Growth opportunities	0.201	0.434	0.149	0.445	0.164	0.426	0.204	0.434
Log (Creditor rights index)	1.566	0.329	1.453	0.153	1.473	0.195	1.575	0.337
Total assets (mln)	643.0	3,541.9	3,587.4	9,383.75	1,870.4	6,001.2	427.02	2,545.46
Long-term debt (mln)	99.85	961.25	130.27	464.690	784.78	3,881.0	83.209	822.661

Table 2 (continued)

Panel F: Summary statistics for the multinational firms with the actual financial coordination centres

Variable	Full sample		Actual financial coordination centres		Parent firms		Other affiliates	
	Mean	St. dev.	Mean	St. dev.	Mean	St. dev.	Mean	St. dev.
Short-term debt (mln)	193.7	2,450.0	1,830.4	8,507.53	420.47	1,410.8	73.141	1,096.03
Financial expenses (mln)	14.07	84.764	103.95	267.155	37.321	86.873	7.397	45.679
Interest paid (mln)	5.906	27.457	23.034	43.815	28.228	80.367	3.943	21.765
Net lending (mln)	22.23	196.56	71.191	323.128	3.683	64.713	19.062	185.319
Number of affiliate-year observations	3,936		238		68		3,630	
Number of parent firms	36		36		36		36	
Number of affiliates	923		27		17		879	

Panel G: Summary statistics for parent firms and other affiliates

Variable	Full sample		Parent firms		Other affiliates	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Total debt-to-asset-ratio	0.591	0.281	0.560	0.265	0.595	0.283
Statutory tax rate	0.266	0.066	0.284	0.053	0.263	0.067
Weighted tax difference	-0.005	0.037	0.003	0.016	-0.006	0.040
Maximum tax difference	0.053	0.067	0.048	0.055	0.053	0.068
Fixed asset ratio	0.319	0.312	0.422	0.294	0.307	0.312
Log (Sales)	15.157	2.742	15.994	2.676	15.059	2.733
Loss carry-forward	0.229	0.420	0.224	0.417	0.230	0.421
Profitability	0.149	0.266	0.110	0.219	0.153	0.270
Inflation	2.768	2.329	2.190	1.457	2.835	2.401
Log (Corruption index)	1.617	0.647	1.819	0.383	1.593	0.667
Growth opportunities	0.038	0.184	0.032	0.172	0.039	0.186
Log (Creditor rights index)	1.593	0.386	1.528	0.375	1.600	0.386
Total assets (mln)	101.571	1,058.930	255.189	1,894.200	83.742	912.137
Long-term debt (mln)	15.047	270.545	35.073	433.653	12.515	242.111
Short-term debt (mln)	26.803	9,965.100	92.672	21,402.500	18.801	7,464.55
Financial expenses (mln)	2.886	67.695	7.859	98.423	2.285	62.948
Interest paid (mln)	1.870	32.641	4.491	65.784	1.511	24.837
Net lending (mln)	2.986	78.897	6.018	126.324	2.618	71.010
Number of affiliate-year observations	1,039,827		108,135		931,692	
Number of parent firms	143,405		31,414		143,405	
Number of affiliates	261,117		31,414		229,703	

5. Endogeneity issues

The theoretical model is based on an assumption that variation in the tax mechanisms in exogenous with respect to firms' leverage decisions (Møen et al., 2011, p. 20). However, there exist several sources of variation characterizing the tax variables that can be correlated with changes in firms' capital structures.

Firstly, corporate tax rates vary both across countries and across time, which affects all three tax mechanisms. An endogeneity issue arises if leverage decisions of multinational firms influence the tax changes over time. For example, large multinational corporations can act influentially and exert a pressure on governments in order to obtain preferable tax rates. However, the resulting tax changes are unlikely to be directly linked to the leverage choices of affiliates that operate in these countries. Nevertheless, an endogeneity problem emerges if countries' governments alter their tax rates due to high debt shifting activity by firms that are located there. Huizinga et al. (2008) control for this potential endogeneity issue by using populations of affiliate and parent countries as instrumental variables while constructing effective tax rates. Their obtained results are very similar to the baseline regression; hence, they do not find evidence for this endogeneity problem (p. 109). Consequently, I assume that corporate tax rates are exogenous with respect to leverage choices of multinational corporations.

Secondly, variation in location choices of affiliates creates changes in the international debt shifting mechanisms (maximum tax difference and weighted tax difference variables). Also variation in assignment of capital among affiliates within multinational firms creates changes in the weighted tax difference variable. Thus, a potential endogeneity issue arises because investment decisions and capital structure decisions are done simultaneously, determining both location of affiliates and assignment of capital among affiliates within the group. For example, the problem occurs if a firm uses internal debt only for non-tax reasons and it has also established its financial coordination centre in a country with a low corporate tax rate. In order to deal with this potential issue, I follow Huizinga et al. (2008) and Møen et al. (2011) and include both affiliate-specific control variables and parent (group) fixed effects in regressions. As claimed by Büttner and Wamser (2013, p. 70), inclusion of control variables and group fixed effects in the specification should control for changes in affiliates' leverage that do not arise from tax engineering activities, but are correlated with the tax mechanisms.

Büttner and Wamser (2013) discuss an example of a country which has a higher tax rate than the lowest-taxed affiliate within the multinational group. Initially the firm does not have any affiliates located in this country. However, the country's corporate tax rate decreases in the next period below the current minimum tax rate of the multinational group; therefore, the firm decides to restructure its international location and places an affiliate in the country. Consequently, the change in the international location structure increases the maximum tax difference variable for all other affiliates worldwide. The authors claim that the resulting increase in usage of internal debt is an endogenous change because it is an outcome of the firm's reaction to tax rate changes. Hence, the authors state that this endogenous change may bias their estimates even in presence of group fixed effects (pp. 70 – 71, 78). However, Møen et al. (2011) emphasize that even though the change in the international location structure is an endogenous decision, the consequent change in the maximum tax difference variable occurs due to an exogenous change in the tax rate. An issue can arise if the sensitivity of international location structure with respect to changes in tax rates differs among multinational firms; however, such permanent differences should be absorbed by the group fixed effects (p. 22). When using group fixed effects, the specification controls for any cross-sectional variation among multinational firms; thus, it utilizes only variation in tax mechanisms within each firm.

Based on the discussion above, the assumption that variation in the tax mechanisms in exogenous with respect to firms' leverage decisions seems reasonable.

6. Empirical results

6.1. Main variables of interest

In this section I examine whether the theoretical predictions of the model hold for European multinational firms and their majority-owned European affiliates over the sample period (2003 – 2014). At first I analyse how the total debt-to-asset ratio is affected by the tax mechanisms. Then I examine the potential omitted variable biases associated with omitting any of the tax mechanisms from the specification. Furthermore, I assess the economic importance of the estimated coefficients on the tax mechanisms. Finally, I discuss how the total debt-to-asset ratio is affected by the control variables.

The main regression results are presented in Table 3. For each observation, the weighted tax difference and maximum tax difference variables have been constructed. All regressions in the table control for parent, industry and year fixed effects. The R-squared values reported in all regressions are not adjusted for variance explained by the fixed effects variables (parents, industries and years). This implies that the overall effect of fixed effects variables on the fit of the model is not quantified; hence, the reported R-squared values are rather small.

Regression (1) includes only the three tax mechanisms, and the results show that all three coefficients of interest are positive and statistically significant at the one percent level. The significance of the two international debt shifting mechanisms implies that an affiliate's leverage reflects the overall international tax system faced by the multinational corporation. Furthermore, regression (2) includes also the control variables, which leads to a decrease in the estimated coefficients on the tax mechanisms, as compared to regression (1). Coefficient on the statutory corporate tax rate decreases by 12.1 percentage points, coefficient on the weighted tax difference variable decreases by 6.3 percentage points, and coefficient on the maximum tax difference variable slightly decreases by 0.3 percentage points. This implies that there exists a substantial subsidiary heterogeneity characterizing their leverage decisions, which is captured by the subsidiary-specific control variables. However, after inclusion of the control variables, the estimated coefficients on all tax mechanisms are still statistically significant and positive.

Focusing on regression (2), the estimated size of β_1, 0.164, reflects the effect of host country statutory corporate tax rate on affiliate's total leverage. When the host country tax

rate increases by one percentage point, affiliate's total debt-to-asset ratio increases by 0.164 percentage points. The estimated coefficient is similar to the estimates found by Huizinga et al. (2008, p. 101) and Møen et al. (2011, p. 24), which are 0.184 and 0.197 respectively.[34] Furthermore, the two international debt shifting variables capture the effects which apply for multinational firms only. Firstly, the estimated size of β_2, 0.054, reflects the effect of weighted tax difference on affiliate's total leverage. When the weighted tax difference increases by one percentage point, affiliate's total debt-to-asset ratio increases by 0.054 percentage points. The estimated coefficient is 6.6 percentage points smaller than the coefficient reported by Huizinga et al. (2008, p. 101), and 22.5 percentage points smaller than the coefficient reported by Møen et al. (2011, p. 24).[35] Furthermore, the estimated size of β_3, 0.051, reflects the effect of maximum tax difference on affiliate's total leverage. When the maximum tax difference increases by one percentage point, affiliate's total debt-to-asset ratio increases by 0.051 percentage points. The estimated coefficient is 6.9 percentage points lower than the coefficient reported by Møen et al. (2011, p. 24).

[34] Huizinga et al. (2008) refers to the variable as the "domestic" effect, as the coefficient on the statutory corporate tax rate reflects the impact of taxation on the optimal leverage ratio that applies for both purely domestic firms and multinational firms (p. 95).

[35] Huizinga et al. (2008) refers to the variable as the "international debt shifting" effect, as their specification includes only the weighted tax difference variable as the effect applying for multinational firms only (p. 95). The authors disregard the maximum tax difference variable (internal debt shifting mechanism) in their analysis.

Table 3: Impact of tax mechanisms on total debt-to-asset ratio

The dependent variable in all regressions is the total debt-to-asset ratio. Detailed variable definitions are given in Table 2. Regression (1) includes only the three tax mechanisms as independent variables. Regression (2) adds control variables to the specification. Regressions (3) and (4) examine the omitted variable bias occurring if maximum tax difference or weighted tax difference variables are omitted from the analysis. Regressions (5) to (7) examine the omitted variable bias occurring if two tax mechanisms are omitted from the analysis. The regressions are estimated by the ordinary least squares and include parent, industry and year fixed effects. The sample consists of majority-owned affiliates of European multinational firms over 12 years (2003 – 2014). White's (1980) heteroskedasticity-robust standard errors are reported in the parentheses. * denotes significance at 10% level, ** denotes significance at 5% level, *** denotes significance at 1% level.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Statutory tax rate	0.285***	0.164***	0.190***	0.197***	0.248***		
	(0.016)	(0.016)	(0.015)	(0.013)	(0.010)		
Weighted tax difference	0.117***	0.054***	0.076***			0.232***	
	(0.018)	(0.017)	(0.016)			(0.011)	
Maximum tax difference	0.054***	0.051***		0.062***			0.174***
	(0.012)	(0.012)		(0.011)			(0.008)
Fixed asset ratio		-0.065***	-0.065***	-0.065***	-0.065***	-0.065***	-0.065***
		(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Log (Sales)		0.027***	0.027***	0.027***	0.027***	0.028***	0.028***
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Loss carry-forward		0.093***	0.093***	0.093***	0.093***	0.093***	0.093***
		(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Profitability		-0.044***	-0.044***	-0.044***	-0.044***	-0.044***	-0.044***
		(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Inflation		0.001***	0.001***	0.001***	0.001***	0.001***	0.001***
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Log (Corruption index)		-0.009***	-0.009***	-0.009***	-0.008***	-0.004***	-0.000
		(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)
Growth opportunities		0.022***	0.022***	0.022***	0.022***	0.021***	0.021***
		(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Log (Creditor rights index)		-0.037***	-0.037***	-0.038***	-0.038***	-0.040***	-0.043***
		(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Lowest-taxed affiliates excluded	No	No	No	No	No	No	No
Parent, industry, year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	1,039,827	1,039,827	1,039,827	1,039,827	1,039,827	1,039,827	1,039,827
Number of parent firms	143,405	143,405	143,405	143,405	143,405	143,405	143,405
R-squared	0.0104	0.0551	0.0556	0.0546	0.0550	0.0564	0.0531

The tax mechanisms are interrelated both between each other and among all affiliates worldwide that belong to the multinational corporation. Firstly, the tax variables are correlated by construction (each tax mechanism includes the host country corporate tax rate t_{pit}), with correlation coefficients approximately 0.4, as observable in Table 4. Furthermore, a change in the corporate tax rate in a country *j* affects both the leverage decisions of affiliates which are located there, and the leverage decisions of all other affiliates worldwide that belong to the multinational corporation through the weighted tax difference variable. An increase in a country's corporate tax rate increases the weighted tax difference of affiliates located there, which consequently leads to higher total debt-to-asset ratios of these affiliates. However, the weighted tax difference decreases for affiliates located in other countries, which leads to lower total debt-to-asset ratios of these affiliates. For an affiliate *pi*, a change in the host country corporate tax rate, t_{pit}, by one percentage point affects its total leverage through all three tax mechanisms; thus, the total effect equals $\beta_1 + \beta_2(1 - \rho_{pit}) + \beta_3$.[36] As observable from the equation, the total effect on the debt-to-asset ratio decreases in the relative size of affiliate *pi*, as shifting external debt from a small to a large affiliate constitutes a larger change in the total debt-to-asset ratio of the small affiliate than of the large affiliate.

Table 4: Correlation matrix between tax mechanisms

The tax mechanisms are correlated by construction. This table shows the pairwise correlation estimates between the tax variables. Detailed variable definitions are given in Table 2.

	Statutory tax rate	Weighted tax difference	Maximum tax difference
Statutory tax rate	1		
Weighted tax difference	0.4237	1	
Maximum tax difference	0.4811	0.2946	1

6.2. Omitted variable bias

Even though there exists multicollinearity between the tax mechanisms, their individual contributions on firms' leverage can still be statistically identified. However, this also implies that the correlation leads to an omitted variable bias if any of the tax mechanisms are omitted from the specification. As observable in Table 3, regressions (5) to (7), the omitted variable bias is substantial if only one of the tax mechanisms enters the regression specification. In regression (5), where the host country corporate tax rate is the only tax

[36] Given that the affiliate *pi* is not the financial coordination centre of the multinational group.

mechanism included in the specification, the estimated coefficient is biased upwards by approximately 51%.[37] As observable in Table 3, regressions (3) and (4), the estimated coefficients are biased upwards also if only one of the tax mechanisms is omitted from the specification. If the maximum tax difference variable is omitted from the analysis, as in regression (3), the omitted variable bias is approximately 16% for coefficient on the statutory tax rate variable and 41% for coefficient on the weighted tax difference variable.[38] If the weighted tax difference variable is omitted from the analysis, as in regression (4), the omitted variable bias is approximately 20% for coefficient on the statutory tax rate variable and 22% for coefficient on the maximum tax difference variable.[39] Hence, the omitted variable bias overestimates the individual importance of the tax mechanisms on determining affiliates' leverage if any of the tax mechanisms are omitted from the specification. However, it does not necessarily imply that the total tax sensitivity of leverage is overestimated. Omitted variable bias rather inappropriately estimates the allocation of the total tax effect on the different tax mechanisms, not the magnitude of the total tax effect in general.

6.3. Relative importance of tax mechanisms

To assess economic importance of the estimated coefficients on the tax mechanisms, a hypothetical example can be considered.[40] Consider a multinational corporation that consists of two affiliates of equal size – one foreign subsidiary and the parent firm.[41] The foreign subsidiary is located in a country with a higher corporate tax rate than tax rate of the parent firm. The subsidiary's host country increases the statutory corporate tax rate by 10 percentage points, keeping everything else constant. Table 5 shows the economic importance

[37] Jog and Tang (2001) investigate the impact of U.S. tax reform on the debt-shifting behaviour of U.S. and Canadian multinational corporations, using only Canadian corporate tax rate as the independent variable. Altshuler and Grubert (2003) examine the impact of statutory tax rate on the total debt-to-asset ratio of controlled foreign corporations (CFCs) of U.S. multinational firms. Using a dataset on multinational firms in the European Union, Moore and Ruane (2005) estimate the impact of corporate tax rates on firms' leverage ratios, controlling for individual subsidiary characteristics. These are only a few studies that omit the international debt shifting mechanisms from their specifications.

[38] Huizinga et al. (2008) omit the maximum tax difference variable from their specification.

[39] All previous studies which examine sensitivity of total or external debt-to-asset ratio with respect to tax have omitted the weighted tax difference variable from their specifications, except Huizinga et al. (2008) and Møen et al. (2011).

[40] The hypothetical example is discussed also by Huizinga et al. (2008, pp. 100 – 102) and Møen et al. (2011, p. 27).

[41] The weighted tax difference variable is expressed as $\sum_{j \neq i} \rho_{pjt}(t_{pit} - t_{pjt})$. As the parent firm and the subsidiary are of equal size, then $\rho_{pjt} = 0.5$. Thus, the weighted tax difference variable of the subsidiary i equals $0.5(t_{pit} - t_{pjt})$.

of the tax mechanisms on affiliates' leverage. The total effect on the subsidiary's debt-to-asset ratio is an increase of 2.42 percentage points. The effect found is 2.15 percentage points lower than the effect found by Møen et al. (2011, p. 26), and 0.2 percentage points lower than the effect found by Huizinga et al. (2008, pp. 101 - 102). For an affiliate with an average total debt-to-asset ratio in the sample (0.59), an increase in the statutory corporate tax rate by 10 percentage points leads to an increase in the total debt of approximately 4.1% (= (0.59 + 0.0242) / 0.59). Considering the tax mechanisms separately, the biggest effect on the total debt-to-asset ratio comes from the statutory corporate tax rate, which refers to the preference for debt over equity due to tax deductibility of interest payments. Also Møen et al. (2011) and Huizinga et al. (2008) find that the standard debt tax shield mechanism contributes relatively most to changes in affiliate's leverage. Internal debt shifting mechanism has the second highest contribution, and external debt shifting mechanism contributes relatively least to changes in affiliate's total leverage in my data sample. In the study by Møen et al. (2011), the two international debt shifting mechanisms are of about equal importance (p. 27). Furthermore, the external debt shifting mechanism not only affects the leverage choice of the affiliate that experiences the tax rate change, but also the leverage choice of the other affiliate. This implies that the 0.27 percentage point increase in the subsidiary's total debt-to-asset ratio due to external debt shifting reduces the total debt-to-asset ratio of the other affiliate (the parent firm) by 0.27 percentage points.

Table 5: Relative importance of tax mechanisms

This table shows the economic importance of the estimated coefficients on the tax mechanisms. As a hypothetical example, consider a multinational firm that consists of two affiliates of equal size - one foreign subsidiary and the parent firm. The foreign subsidiary is located in a country with a higher corporate tax rate than tax rate of the parent firm. The host country of the subsidiary increases the corporate tax rate by 10 percentage points, keeping everything else constant. Using the estimated coefficients from Table 3, regression (2), the table shows the direct and relative contributions of each of the tax mechanisms on the percentage point change in affiliate's total debt-to-asset ratio. The first row ("Tax rate") shows the direct effect of change in the statutory corporate tax rate, which characterizes firm's preference for debt over equity due to tax deductibility of interest expenses. The second row ("Weighted tax difference") shows the effect of external debt shifting, and the third row ("Maximum tax difference") shows the effect of internal debt shifting. Detailed variable definitions are given in Table 2.

	Coefficient	Change in t_{it}	ρ_{it}	Percentage point change in total debt-to-asset ratio	Relative contribution
Tax rate	0.164	0.1		1.64	68%
Weighted tax difference	0.054	0.1	0.5	0.27	11%
Maximum tax difference	0.051	0.1		0.51	21%
Total				2.42	100%

6.4. Control variables

The estimated coefficients on all firm-level and country-level control variables are statistically significant. Of the firm-level variables, fixed asset ratio is negatively related to affiliates' debt, which can be explained by depreciation deductions of tangible assets that constitute a non-debt tax shield and act as a substitute for debt financing.[42]

Logarithm of sales enters the regression positively, which is in line with the argument that large firms are able to borrow at more favourable financing terms due to their greater access to capital markets, lower default probability and less volatile assets.[43]

Loss carry-forward affects leverage positively, which suggests that firms with loss carry-forwards tend to have less retained earnings and equity capital; therefore, they are willing to undertake more debt to finance their activities.[44]

Profitability variable enters the regression negatively, which is in line with the pecking order theory of capital structure. Profitable firms can use their profits to reduce debt obligations or simply finance investments with retained earnings instead of debt.[45,46]

Of the country-level control variables, inflation has a positive effect on leverage, as it decreases the real value of currently outstanding corporate debt and reduces cost of debt, which increases tax advantage of debt financing.[47]

Logarithm of corruption index enters the regression negatively, which suggests that firms in corrupt countries are more leveraged. This finding can be explained by the high degree of monitoring ability and enforcement of debt financing, as debt obligations are contractual and legally binding. Hence, firms in corrupt countries tend to issue more debt and less equity to protect themselves from expropriation by management or bureaucrats. Another explanation for more indebted firms in corrupt countries is that it may be easier for corrupt bureaucrats to channel funds to connected firms as loans through banks that they control, rather than through equity market that they cannot influence to such an extent.[48]

Growth opportunities have a positive effect on affiliates' debt, which can be explained by shareholders' willingness to pass on the risk to debtholders if firms' growth forecasts are

[42] Findings consistent with DeAngelo & Masulis (1980), Frank & Goyal (2009) and other studies.
[43] Findings consistent with Booth et al. (2011), Fama & French (2002) and other studies.
[44] Findings consistent with Gopalan et al. (2007).
[45] Findings consistent with Graham (2000), Myers (1993) and other studies.
[46] More discussion on the firm-level control variables and their impact on firms' indebtedness is presented in section 4.4.1.
[47] Findings consistent with Frank & Goyal (2009), Mintz & Weichenrieder (2010), Modigliani (1982) and other studies.
[48] Findings consistent with La Porta et al. (2002), Venanzi et al. (2014) and other studies.

unsustainable and risky. Moreover, the economic and political networks of owners of rapidly growing firms may provide them with an easy access to the credit market, as the credit market is more likely to finance firms with better future growth expectations.[49]

Logarithm of creditor rights index enters the regression negatively, which suggests that firms in countries with strong creditor rights are less leveraged. This finding is in line with the demand side view of the financial market, which claims that strong creditor protection makes firms unwilling to make long-term cash flow commitments to repay debt. In countries characterized by strong creditor rights, management can be easily laid off upon default and replaced by creditors or neutral third-party trustees. Hence, managers tend to issue less debt in countries with strong creditor rights.[50,51]

[49] Findings consistent with Awan et al. (2010) and Gupta (1969).

[50] Findings consistent with Cho et al. (2014) and Rajan & Zingales (1995).

[51] More discussion on the country-level control variables and their impact on firms' indebtedness is presented in section 4.4.2.

7. Robustness tests and extensions

7.1. Large and small multinational firms

Large multinational firms may be better able to pursue tax engineering activities due to more income, better connections and more affiliates facing different tax rates than small multinational firms, which makes it less costly for large multinational firms to avoid paying high taxes. In order to examine the potential heterogeneity between large and small firms, I control for the size of multinational firms in regressions. Firstly, I split the data sample according to the median number of foreign subsidiaries of multinational firms (3 subsidiaries), which can be observed in regressions (1) and (2) in Table 6. The smallest multinational firms with one or two subsidiaries constitute 44% of the data sample. I also split the sample according to the median total assets of multinational firms (52.3 million euros), which can be observed in regressions (3) and (4). As observable in the table, large multinational firms are more likely to engage in international debt shifting than small multinational firms. Coefficients on the weighted tax difference and maximum tax difference variables decrease and become statistically insignificant when only the smallest multinational firms are included in the data sample, which shows that these firms are less responsive to changes in the international debt shifting mechanisms. This finding can be explained by the potentially large fixed costs associated with international debt shifting activities. Consequently, only firms that have reached a certain size are able to overcome the prohibitive costs and shift debt across countries. Another explanation for the small estimated coefficients on international debt shifting variables is that the parent fixed effects applied to regressions are very close to having subsidiary fixed effects, which are likely to absorb a significant amount of variation in affiliates' leverage.

However, the estimated coefficient on the statutory corporate tax rate variable is larger for small multinational firms, compared to large firms. As small firms are less likely to engage in tax planning due to cost reasons, they might become more responsive to statutory corporate tax rate changes that affect affiliates' leverage decisions in host countries. Hence, the standard debt tax shield mechanism or the general preference for debt might matter most for small multinational firms. Moreover, as large multinational firms actively engage in

international debt shifting activities, the relative importance of the standard debt tax shield mechanism might decrease for large multinational firms.[52]

To examine whether very large multinational firms react differently to tax incentives, the main regression is run on the 25% largest multinational firms in the sample, which have at least 527.6 million euros in total assets. As observable in regression (5), very large multinational firms are slightly less responsive to the standard debt tax shield mechanism than large multinational firms (as compared to regression (4)). However, coefficients on the international debt shifting mechanisms are very similar to those of large multinational firms. Thus, there seem to be no substantial differences in leverage responses to tax mechanisms, when comparing large and very large multinational firms.

I also examine whether leverage responses to tax mechanisms are different for the 10% largest multinational firms, which have at least 4,294 million euros in total assets. As observable in regression (6), the estimated coefficient on the standard debt tax shield mechanism is largely unchanged (slightly lower by 0.2 percentage points, as compared to regression (5) on the very large multinational firms). However, the coefficient is statistically insignificant as a result of an increased standard error due to the smaller sample size. The estimated coefficient on the weighted tax difference variable is 6 percentage points lower, as compared to regression (5), and also statistically insignificant. This can be explained by a potentially large measurement error, while calculating the weighted tax difference variable, which depends on financial and tax data on all affiliates that belong to the multinational group. The median number of subsidiaries per multinational group is 58 among the 10% largest firms, while the median number of subsidiaries is only 3 for the whole data sample. Consequently, for a very large multinational group which has many subsidiaries, potential measurement errors can be particularly large. Finally, the maximum tax difference variable is 5 percentage points larger, as compared to regression (5), which indicates more internal debt shifting of the 10% largest multinational firms.

Finally, regression (7) is run on all multinational firms in the data sample and includes dummy variables for the sales quintile to which an affiliate belongs in a particular year,

[52] This finding can be explained by thin capitalization rules that are defined over internal and external debt. Causing the same concealment costs in circumventing the rules, the optimal mix of external and internal debt is reached when the marginal agency costs of external debt equal the marginal tax payments in the internal bank. Beyond that point, internal debt is always cheaper, as its tax costs are constant, while agency costs of external debt increase further. This implies that multinational firms in such a setting have external debt that does not react to the standard debt tax shield mechanism at all (Fellkjær & Steinum, 2013).

instead of logarithm of sales as a measure of firms' size. The smallest firms are in the quintile 1, which is left out from the specification. As observable in the table, there exists a positive relation between firm's size and its leverage ratio, as the estimated coefficients on all sales quintiles are positive. Moreover, the estimated coefficients increase with firm's size. Hence, the larger the firm, the more leverage it is likely to have.

Table 6: Large and small multinational firms

This table splits data sample into large and small multinational firms (MNCs) according to the total number of foreign subsidiaries of the multinational firm (regressions (1) and (2)), and according to the total assets of the multinational firm (regressions (3) and (4)). The median number of subsidiaries is 3, while the median value of total assets is 52.3 mln euros. Regression (5) is run on a sample of the 25% largest MNCs (total assets at least 527.6 mln euros). Regression (6) is run on a sample of the 10% largest MNCs (total assets at least 4,294 mln euros). Regression (7) is run on the sample of all MNCs, and includes sales quintiles instead of logarithm of sales. The dependent variable in the regressions is the total debt-to-asset ratio. Detailed variable definitions are given in Table 2. The regressions are estimated by the ordinary least squares and include parent, industry and year fixed effects. The sample consists of majority-owned affiliates of European multinational firms over 12 years (2003 – 2014). White's (1980) heteroskedasticity-robust standard errors are reported in the parentheses. * denotes significance at 10% level, ** denotes significance at 5% level, *** denotes significance at 1% level.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Small MNCs	Large MNCs	Small MNCs	Large MNCs	Very large MNCs	Very large MNCs	All MNCs
	< 3 subsidiaries	≥ 3 subsidiaries	< 52.3 mln euro	≥ 52.3 mln euro	≥ 527.6 mln euro	≥ 4,294 mln euro	
Statutory tax rate	0.222***	0.165***	0.229***	0.126***	0.101**	0.099	0.178***
	(0.023)	(0.028)	(0.024)	(0.027)	(0.046)	(0.083)	(0.016)
Weighted tax difference	0.041	0.081**	0.043	0.075***	0.081*	0.015	0.061***
	(0.026)	(0.034)	(0.031)	(0.026)	(0.044)	(0.081)	(0.017)
Maximum tax difference	0.026	0.049***	0.037	0.061***	0.058***	0.109***	0.049***
	(0.025)	(0.014)	(0.023)	(0.014)	(0.020)	(0.033)	(0.012)
Fixed asset ratio	-0.004	-0.081***	0.007**	-0.090***	-0.100***	-0.119***	-0.062***
	(0.004)	(0.002)	(0.003)	(0.002)	(0.003)	(0.004)	(0.002)
Log (Sales)	0.025***	0.029***	0.027***	0.028***	0.027***	0.027***	
	(0.001)	(0.000)	(0.001)	(0.000)	(0.000)	(0.001)	
Sales quintile 2							0.080***
							(0.002)
Sales quintile 3							0.116***
							(0.002)
Sales quintile 4							0.147***
							(0.002)
Sales quintile 5							0.188***
							(0.002)
Loss carry-forward	0.069***	0.105***	0.074***	0.106***	0.108***	0.104***	0.090***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
Profitability	-0.054***	-0.039***	-0.049***	-0.040***	-0.036***	-0.040***	-0.048***
	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)	(0.004)	(0.001)
Inflation	0.001***	-0.001***	0.001***	-0.001***	-0.001***	-0.000	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.000)
Log (Corruption index)	-0.033***	-0.007***	-0.031***	-0.006***	0.008***	0.021***	-0.008***
	(0.003)	(0.002)	(0.003)	(0.002)	(0.002)	(0.004)	(0.002)
Growth opportunities	0.010***	0.031***	0.013***	0.028***	0.024***	0.024***	0.024***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.004)	(0.006)	(0.002)

Table 6 (continued)

	(1) Small MNCs	(2) Large MNCs	(3) Small MNCs	(4) Large MNCs	(5) Very large MNCs	(6) Very large MNCs	(7) All MNCs
	< 3 subsidiaries	≥ 3 subsidiaries	< 52.3 mln euro	≥ 52.3 mln euro	≥ 527.6 mln euro	≥ 4,294 mln euro	
Log (Creditor rights index)	-0.050***	-0.030***	-0.063***	-0.022***	-0.017***	-0.022***	-0.037***
	(0.003)	(0.002)	(0.003)	(0.002)	(0.002)	(0.004)	(0.001)
Lowest-taxed affiliates excluded	No	No	No	No	No	No	No
Parent, industry, year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	460,619	579,208	519,887	519,940	259,886	104,130	1,039,827
Number of parent firms	137,556	21,511	131,643	22,450	5,352	1,004	143,405
R-squared	.0429	.0771	.0493	.0789	0.0801	.1007	0.0515

7.2. Preferential tax regimes

The empirical results show that all tax mechanisms have a positive and statistically significant effect on the total debt-to-asset ratios of European affiliates that belong to European multinational firms. However, the economic importance of the tax mechanisms, especially the two international debt shifting mechanisms, is relatively small. This observation can occur because international debt shifting is not a common method for tax avoidance or because statutory corporate tax rates do not reflect the effective tax rates that multinational corporations actually face. This suggests that the use of statutory corporate tax rates while calculating the tax mechanisms might create a measurement error and a subsequent downward bias in the estimated coefficients. As an example, a difference between statutory corporate tax rates and effective corporate tax rates arises when countries offer tax benefits for internal banks (financial coordination centres) of multinational firms. The preferential tax regimes and tax benefits are likely to significantly reduce the effective tax rates that multinational firms pay in these countries. This is particularly important because many multinational firms have established their financial coordination centres in Belgium, the Netherlands and Luxembourg (Mintz, 2004, p. 422; Weichenrieder & Mintz, 2008, p. 4).

Belgium had a coordination centre regime until 2005, where the taxable profit of coordination centres was calculated according to "cost plus" method – a mark-up (the "plus") was applied to expenses (the "cost") associated with a transaction. However, a substantial portion of operating expenses was omitted from the costs of the coordination centre while

calculating the taxable profit. Hence, the effective tax rate that financial coordination centres actually paid in Belgium was negligible (Green, 2003; Quaghebeur, 2005, p. 14). Consequently, by 2003, more than 200 multinational companies had set up their financial coordination centres in Belgium (Green, 2003, p. 23).[53] Multinational firms that engaged in the coordination centre regime accounted for 33% of Belgium's FDI inflows and 36% of FDI outflows during the time period from 1995 to 2005 (United Nations, 2007, p. 77). In 2005 Belgium introduced the notional interest deduction regime (applicable from tax year 2006), which reduces tax discrimination between debt and equity by enabling firms to subtract a notional interest charge on equity from taxable profits. Also this regime encourages firms to set up their affiliates in Belgium due to reductions in firms' taxable profits. In 2012 Belgian law firm Laga made a survey in which 80% of respondent firms claimed that the notional interest deduction regime was relevant for their operations (American Chamber of Commerce in Belgium, n.d.).

Also the Netherlands offers substantially lower effective corporate tax rates on interest, royalties, dividend and capital gains income from foreign subsidiaries. The Netherlands hosts approximately 12,000 mailbox companies that channel 4 billion euros every year and pay very low taxes on their operations (SOMO, 2014).[54] Attracted by the Netherlands' tolerant regulations and many tax treaties, multinational firms such as Dell, Google, Merck & Co. and Yahoo have shifted their profits through the country. Using sophisticated schemes, for example, "Dutch Sandwich", multinational firms shifted 10.2 trillion euros through the Netherlands in 2010 (Drucker, 2013).

Furthermore, companies use Luxembourg as a tax conduit because they can send money in and out and pay very low taxes. Luxembourg also offers specific financial holding regimes. More than 170 of Fortune 500 companies have established an affiliate in Luxembourg, and the country has the highest foreign investment in the European Union. The capital city Luxembourg hosts 148 global banks, and there are more than 40,000 companies registered in the country (Walt, 2015). Moreover, Luxembourg uses secret tax agreements

[53] As compared to Panel B of Table 2, 4,846 potential financial coordination centres have been set up in Belgium during 2003 – 2014, according to my data sample. This implies that substantially more multinational firms have established their financial coordination centres in Belgium after 2003. This can be explained by the increased amount and size of European multinational firms, by increased globalization in Europe, and by a higher firms' willingness to undertake tax saving activities and minimize the global tax burden. However, note that I have assumed that the potential financial coordination centres in my data sample are the lowest-taxed affiliates within multinational firms; hence, they might not be a perfect approximation of reality.

[54] Mailbox companies do not have an important commercial presence in a country and do not actively engage in economic activities.

with multinational firms that provide tax allowances for more than 350 firms worldwide, as revealed by the so-called LuxLeaks papers, released at the end of 2014 (Galizia, Cabra, Williams, Díaz-Struck & Rudder, 2014). The data shows that auditing companies, such as PricewaterhouseCoopers and EY, have allowed large multinational firms to avoid paying large amounts of taxes in their home countries.

If a multinational corporation locates its financial coordination centre in one of the countries with preferential tax regimes, the effect of the lower effective tax rate is not picked up by the specification when calculating the tax mechanisms. Moreover, as the statutory corporate tax rates are relatively high in these countries, coefficients on the maximum tax difference variable of all affiliates that belong to the multinational firm are likely to be downward biased. In order to examine the effective tax rates that multinational firms pay in Belgium, the Netherlands and Luxembourg, I calculate the average actual tax rates that firms have paid based on their profit and loss statements.[55] As observable in Table 7, firms in all industries pay approximately half the statutory corporate tax rate, which can be explained by various allowances, loss carry-forwards and other individual firm characteristics. When considering only firms involved in financial services industries and holding activities, the difference is even larger – the statutory corporate tax rate is approximately three times larger than the actual tax rate. Hence, financial coordination centres of multinational firms in Belgium, the Netherlands and Luxembourg face a lower effective tax rate than the statutory corporate tax rate in my data sample.[56]

Table 7: Actual tax rates

This table compares the average actual tax rates that multinational firms pay in Belgium, the Netherlands and Luxembourg (based on taxation expenses reported in their profit and loss statements) with the average statutory corporate tax rates. A distinction is made between the actual tax rates faced by affiliates in all industries and only affiliates involved in financial services industries and holding activities. The sample consists of majority-owned affiliates of European multinational firms over 12 years (2003 – 2014).

	Actual tax rate		Statutory corporate tax rate
Country	All industries	Financial services industries and holding activities	All industries
Belgium	0.170	0.132	0.340
Netherlands	0.147	0.084	0.264
Luxembourg	0.108	0.075	0.291

[55] I calculate the actual tax rate by dividing the actual taxation paid by the profit and loss before tax.

[56] The same conclusion is reached in section 4.5.4., where I calculate the effective tax rate of the actual financial coordination centres in the data sample. The effective tax rate faced by financial coordination centres in Belgium is 5.1%.

This suggests that the rather low economic importance of the international tax mechanisms estimated in the main specification may be explained by the preferential tax regimes and subsequent measurement errors in the tax mechanisms. To examine whether existence of preferential tax regimes leads to a downward bias in the estimated coefficients on the tax mechanisms, I adjust corporate tax rates downwards for affiliates that operate in financial services industries or engage in holding activities in Belgium, the Netherlands and Luxembourg. I adjust corporate tax rates for these affiliates to 13.2% in Belgium, 8.4% in the Netherlands and 7.5% in Luxembourg, which are the actual tax rates that multinational firms pay in these countries.

Regression (1) in Table 8 shows results of the original specification of regression (2) in Table 3, while regressions (2) and (3) show the original specifications of regressions (3) and (4) in Table 6 in order to make the results more easily comparable. As observable in regression (4) in Table 8, results are robust to the adjustment for preferential tax regimes. As compared to the initial specification, coefficient on the statutory corporate tax rate has slightly decreased, while coefficients on the international debt shifting mechanisms have increased. Coefficient on the weighted tax difference variable has increased by 0.6 percentage points, while coefficient on the maximum tax difference variable has increased by 0.4 percentage points. This suggests that the adjustment for preferential tax regimes has slightly decreased the measurement errors in estimated coefficients, which led to a downward bias in the coefficients initially. Thus, the lower corporate tax rates proxy for the effective tax rates that financial coordination centres face in Belgium, the Netherlands and Luxembourg.

I also check whether the estimated coefficients change when I adjust tax rates downwards to 10% for these affiliates, in line with Møen et al. (2011, p. 33). The choice of 10% tax rate is based on available data on Norwegian firms that have financial coordination centres in Belgium, the Netherlands or Luxembourg and pay approximately 10% as their corporate tax rate. The obtained coefficients on the tax mechanisms are largely unchanged, compared to regression (4). Furthermore, I examine whether the estimated coefficients change when I adjust tax rates downwards to 5.1% for these affiliates, based on the actual tax rate paid by financial coordination centres in Belgium, as found in section 4.5.4. After this adjustment, coefficients on the tax mechanisms are slightly larger, compared to regression (4). Finally, I examine whether coefficients on the tax mechanisms increase when tax rates in Malta and Switzerland are also adjusted downwards to reflect preferential tax regimes in these countries. Malta has an attractive tax regime for foreign companies (Vella,

2014), while Switzerland has one of the largest financial sectors in the world due to its banking sector's secrecy ("Switzerland's Financial Identity Crisis," 2014). Also after this adjustment the coefficients on the two international debt shifting variables increase only slightly, which can be explained by the relatively few potential financial coordination centres in the data sample that are located in Malta and Switzerland (31 and 30 affiliates respectively). As changes in the estimated coefficients on the tax mechanisms are rather small, the obtained results are not reported in the study.

Overall, the estimated coefficients on the weighted tax difference and maximum tax difference variables increase only slightly after the adjustment for preferential tax regimes. A potential explanation is controlled foreign corporation (CFC) rules that are used in many countries in order to limit profit shifting to lower-taxed countries (OECD, 2013a, p. 16). While the rules applicable to controlled foreign corporations vary among countries, the main mechanism is that parent firms of multinational companies must include in their income certain amounts earned by their controlled foreign corporations. Egger and Wamser (2011) examine German CFC rules and find that the rules have a significant effect on multinational firms' operations. The authors claim that CFC rules are associated with much less real investment due to the high corporate tax rate in Germany (p. 18). Furthermore, Ruf and Weichenrieder (2012) examine German CFC rules during the time period from 1996 to 2005 and find that the rules successfully restrict profit shifting to low-tax countries and are an important measure to limit tax avoidance (p. 1507).

However, the Court of Justice of the European Union made the Cadbury-Schweppes decision on September 12, 2006, where it ruled that taxation based on CFC legislation is a violation of the freedom of establishment (Court of Justice, 2006). Consequently, the CFC rules do not exert a substantial role in Europe since 2006.[57] Evidence of this has been found by Ruf and Weichenrieder (2013) who examine whether the decision by the Court of Justice affected the allocation of passive assets of German multinational firms. The paper shows that passive investments in European countries with low statutory corporate tax rates (Ireland, Estonia, Latvia and Poland) increased compared to countries with low corporate tax rates outside Europe (p. 11). Hence, the results show that after the Cadbury-Schweppes case in 2006, the CFC rules became harder to apply in Europe. This suggests that the rules might still have limited tax avoidance and reduced possibilities to engage in preferential tax regimes during the time period from 2003 to 2006 in my data sample. Thus, the effect of tax

[57] European CFC rules are still applicable for affiliates outside Europe.

mechanisms on firms' leverage, when adjusted for preferential tax regimes, might be underestimated during this time period.

Another potential explanation for the rather small increase in coefficients on the international debt shifting mechanisms is that only the largest multinational firms might be able to engage in the preferential tax regimes and exploit the lower effective tax rates. To examine this possibility, I divide the data sample into large and small multinational firms, based on total assets of multinational firms. The median value of total assets is 52.3 million euros, which is used as a threshold to divide the sample. Regression (5) in Table 8 shows results for the sample of small multinational firms, while regression (6) shows results for the sample of large multinational firms.

As observable in regression (5), coefficients on the statutory corporate tax rate and the weighted tax difference variables have slightly decreased, while coefficient on the maximum tax difference variable has increased and become statistically significant, as compared to regression (2). Furthermore, as observable in regression (6), coefficients on the statutory corporate tax rate and the maximum tax difference variables have slightly increased, while coefficient on the weighted tax difference variable has slightly decreased, as compared to regression (3). Overall, the estimated coefficients are largely unchanged after the adjustment for preferential tax regimes, and it seems that the adjustment does not affect large multinational firms to a greater extent than small firms. This suggests that the ability to engage in the preferential tax regimes and subsequently face lower effective tax rates does not vary according to size of the multinational firm.

As the adjustment for preferential tax regimes changes the estimated coefficients on the tax mechanisms only slightly, statutory corporate tax rates seem to be a good enough approximation to the effective tax rates of multinational firms. However, the use of statutory corporate tax rates in the main analysis is still likely to bias the estimated coefficients on the tax mechanisms downwards due to the measurement error that arises because statutory corporate tax rates are larger than the effective tax rates. More precise adjustments to statutory corporate tax rates are necessary in order to derive the effective tax rates faced by multinational firms.[58]

[58] As an example, the effective tax rates calculated by Huizinga et al. (2008) are adjusted for double taxation and double tax relief and take into account taxation of dividends in both host and home countries. Even though it seems that international double taxation is no longer important in Europe, a study by business federation BUSINESSEUROPE concluded that double taxation is still an issue, which hinders cross-border business and investments in Europe (BUSINESSEUROPE, 2013, p. 3). Hence, the effective tax rates calculated by Huizinga et al. (2008) may be better proxies for the effective tax rates than statutory corporate tax rates.

Table 8: Preferential tax regimes

The dependent variable in all regressions is the total debt-to-asset ratio. Detailed variable definitions are given in Table 2. Regression (1) shows the original specification of regression (2) in Table 3, while regressions (2) and (3) show the original specifications of regressions (3) and (4) in Table 6 in order to make the results more easily comparable. In regression (4) corporate tax rates are adjusted downwards to 13.2% in Belgium, 8.4% in the Netherlands and 7.5% in Luxembourg for affiliates involved in financial services industries or holding activities. In regressions (5) and (6) I divide the sample into large and small firms according to total assets of the multinational group. The regressions are estimated by the ordinary least squares and include parent, industry and year fixed effects. The sample consists of majority-owned affiliates of European multinational firms over 12 years (2003 – 2014). White's (1980) heteroskedasticity-robust standard errors are reported in the parentheses. * denotes significance at 10% level, ** denotes significance at 5% level, *** denotes significance at 1% level.

	(1)	(2)	(3)	(4)	(5)	(6)
		Original			Preferential tax regimes	
	All firms	Smallest	Largest	All firms	Smallest	Largest
Statutory tax rate	0.164***	0.229***	0.126***	0.162***	0.213***	0.140***
	(0.016)	(0.024)	(0.027)	(0.016)	(0.024)	(0.026)
Weighted tax difference	0.054***	0.043	0.075***	0.060***	0.034	0.073***
	(0.017)	(0.031)	(0.026)	(0.017)	(0.031)	(0.025)
Maximum tax difference	0.051***	0.037	0.061***	0.055***	0.056**	0.063***
	(0.012)	(0.023)	(0.014)	(0.012)	(0.022)	(0.014)
Fixed asset ratio	-0.065***	0.007**	-0.090***	-0.065***	0.006**	-0.090***
	(0.002)	(0.003)	(0.002)	(0.002)	(0.003)	(0.002)
Log (Sales)	0.027***	0.027***	0.028***	0.028***	0.027***	0.028***
	(0.000)	(0.001)	(0.000)	(0.000)	(0.001)	(0.000)
Loss carry-forward	0.093***	0.074***	0.106***	0.093***	0.074***	0.106***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Profitability	-0.044***	-0.049***	-0.040***	-0.043***	-0.049***	-0.040***
	(0.001)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)
Inflation	0.001***	0.001***	-0.001***	0.001***	0.001***	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Log (Corruption index)	-0.009***	-0.031***	-0.006***	-0.009***	-0.031***	-0.007***
	(0.002)	(0.003)	(0.002)	(0.002)	(0.003)	(0.002)
Growth opportunities	0.022***	0.013***	0.028***	0.022***	0.013***	0.028***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Log (Creditor rights index)	-0.037***	-0.063***	-0.022***	-0.037***	-0.064***	-0.021***
	(0.001)	(0.003)	(0.002)	(0.001)	(0.003)	(0.002)
Lowest-taxed affiliates excluded	No	No	No	No	No	No
Parent, industry, year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	1,039,827	519,887	519,940	1,039,827	519,887	519,940
Number of parent firms	143,405	131,643	22,450	143,405	131,643	22,450
R-squared	0.0551	.0493	.0789	0.0552	.0493	.0793

7.3. Domestic firms

The international debt shifting mechanisms are only active for multinational firms, as there is no variation in affiliates' tax rates for purely domestic firms. Thus, my main analysis is done on multinational firms, which is in line with Møen et al. (2008) who also examine only multinational firms in their analysis. However, Huizinga et al. (2011) use data on all European companies in their main data sample. Only in robustness tests the authors exclude purely domestic firms from the data sample and test the specification on multinational firms only. Their obtained results are very similar to results of the benchmark regression, run on all European firms in the Amadeus database (p. 102).

In order to examine whether inclusion of purely domestic firms changes the estimated coefficients on the tax mechanisms in my data sample, I extend the main data sample and include also purely domestic firms in the analysis. Regression (1) in Table 9 restates the original specification of regression (2) in Table 3 for an ease of comparison. The main data sample is extended in regression (2) and includes also purely domestic firms in Europe. As a result, coefficient on the statutory corporate tax rate variable decreases by 9.1 percentage point, while coefficients on the weighted tax difference and maximum tax difference variables increase by 5.5 percentage points and 4.7 percentage points respectively. Hence, inclusion of domestic firms in the data sample reduces the effect of the standard debt tax shield on affiliates' leverage. This can be explained by low net income of small domestic firms, and by relatively many loss-making firms among small domestic firms.[59] Loss carry-forwards act as alternative tax shields for loss-making firms, which implies that these firms have little incentives to use the debt tax shield. Furthermore, even though purely domestic firms constitute approximately 72% of the data sample in regression (2) and the international debt shifting variables equal zero for these firms due to no variation in statutory corporate tax rates within the firm, the effect of the international tax mechanisms on affiliates' leverage increases in the extended sample.

To check whether the obtained results differ depending on size of domestic firms that are included in the extended sample, I divide the sample of domestic firms into large and small firms. Threshold is the median value of total assets of domestic firms, which is 6.86 million euros in the data sample. Regression (3) is run on all multinational firms and small

[59] The median net income is approximately 7.4 times larger of large domestic firms, as compared to small domestic firms.

purely domestic firms (total assets of the firm less than 6.86 million euros). Regression (4) is run on all multinational firms and large purely domestic firms (total assets of the firm more than or equal to 6.86 million euros).

As observable in the table, coefficient on the statutory corporate tax rate variable decreases by 11.7 percentage points when small domestic firms are included in the sample, while the coefficient decreases by 1.6 percentage points when large multinational firms are included in the data sample. This indicates that inclusion of domestic firms in the data sample reduces the effect of the standard debt tax shield on affiliates' leverage, especially when small domestic firms enter the data sample. As discussed above, small domestic firms have low net income and tend to incur losses; therefore, they have little incentives to use the debt tax shield. Furthermore, inclusion of domestic firms in the data sample increases coefficients on the international tax mechanisms, especially when small domestic firms enter the data sample. As small domestic firms are less responsive to the standard debt tax shield, which leads to a substantially lower estimated coefficient on the statutory tax rate variable after inclusion of small domestic firms, multinational firms tend to overcompensate in the data sample, which leads to higher estimated coefficients on the two international tax mechanisms.

To examine whether exclusion of loss-making multinational and domestic firms changes the estimated coefficients on the tax mechanisms, I run the regressions (2) to (4) on a data sample that excludes firms with loss carry-forwards. I have not reported the obtained results in the study, as the estimated coefficients on all tax mechanisms increase only slightly in all regressions. Coefficient on the statutory corporate tax rate variable is still rather small in regressions (2) and (3), as compared to the original regression (1). This suggests that small domestic firms tend to have specific characteristics or other non-debt tax shields that reduce their incentives to exploit the standard debt tax shield.

Furthermore, to check whether the estimated coefficients on the tax mechanisms change when only comparable domestic firms enter the data sample, I use propensity score matching technique. This technique is used in the study by Egger et al. (2010) to match foreign-owned firms with comparable domestically owned firms. Firstly, I find the probability of being a multinational firm by probit model, assuming a normal cumulative density function. I use several observable variables as determinants of whether the firm is likely to be a multinational firm – the age of the firm, its profitability, growth opportunities and sales. Older firms are more likely to become multinationals than firms which have existed only for a few years. Furthermore, as revealed by Helpman, Melitz and Yeaple (2004),

multinational firms tend to be more productive, which suggests that they are more likely to experience high growth, profitability and growing sales than purely domestic firms (p. 300). I have not reported the results of the probit model in the thesis; however, the estimated results show that all variables have a statistically significant and positive effect on probability of being a multinational firm. This suggests that older, more profitable, larger (in terms of sales) and growing firms are more likely to be multinational firms.

Furthermore, the predicted probability of being a multinational firm (the estimated propensity score) is used as a matching mechanism to construct a group of purely domestic firms that are very similar to the multinational firms, based on the observable variables discussed above. I use the nearest matching estimator to find for each multinational firm (treated unit) one or several comparable purely domestic firms (untreated units). Finally, I drop multinational firms and their matched domestic counterparts whose propensity scores are below 25% or over 75% in order to arrive at a sample of comparable domestic and multinational firms. Firms with propensity scores below 25% are very unlikely to be multinational firms, which suggests that these firms might be small, unprofitable and rather unresponsive to tax incentives; therefore, they are excluded from the data sample.[60] Firms with propensity scores above 75% are very likely to be multinational firms; hence, domestic firms with more than 75% probability of being multinational firms might have specific characteristics or unfavourable features that prevent them from becoming multinational firms. These characteristics might influence their leverage responses to tax; thus, these firms are excluded from the data sample.

As observable in regression (5), coefficient on the statutory corporate tax rate variable decreases by 3.7 percentage points, while coefficients on the weighted tax difference and maximum tax difference variables increase by 1.7 and 3.4 percentage points respectively after inclusion of comparable domestic firms in the data sample. The estimated coefficients on the tax mechanisms are similar to the coefficients in regression (4), where large purely domestic firms are included in the data sample. This occurs because large domestic firms are more likely to be multinationals; hence, they enter the data sample in regression (5), while small domestic firms are excluded from this sample.

Finally, regression (6) is run only on purely domestic firms in Europe. Only statutory corporate tax rate changes and changes in control variables within a country identify the

[60] As found in section 7.1., small multinational firms are less responsive to international tax incentives than large firms.

coefficient on the statutory corporate tax rate variable for purely domestic firms. As observable in the table, coefficient on the statutory corporate tax rate variable is positive, which suggests that domestic firms' leverage increases with an increase in the standard debt tax shield. However, the coefficient is statistically insignificant, which can be explained by parent fixed effects that substantially reduce variation in data on purely domestic firms.[61] Furthermore, the rather small and insignificant coefficient on the standard debt tax shield mechanism can be explained by small purely domestic firms that enter the data sample. As discussed above, small domestic firms have less incentives to use the debt tax shield as they have low net income and alternative non-debt tax shields.

[61] I also estimate the regression on purely domestic firms without any parent fixed effects; however, the coefficient on the statutory corporate tax rate becomes negative and statistically significant. This suggests that control for group fixed effects is necessary due to heterogeneity among firms in the data sample. Finally, I estimate the regression on purely domestic firms with subsidiary fixed effects, which increases the coefficient on the statutory corporate tax rate more than two times, and it becomes statistically significant.

Table 9: Domestic firms

The dependent variable in the regressions is the total debt-to-asset ratio. Detailed variable definitions are given in Table 2. Regression (1) shows the results of the original specification of regression (2) in Table 3 in order to make the results more easily comparable. Regression (2) extends the main sample and includes majority-owned affiliates of purely domestic European firms in the data sample. Regression (3) extends the main sample and includes small purely domestic firms in the data sample (with total assets less than 6.86 mln euros). Regression (4) extends the main sample and includes large purely domestic firms in the data sample (with total assets more than or equal to 6.86 mln euros). Regression (5) is run on comparable multinational and domestic firms that, according to propensity score matching, have a 25% to 75% probability to be multinational firms. Regression (6) is run on purely domestic firms only. The regressions are estimated by the ordinary least squares and include parent, industry and year fixed effects. The sample used in regression (1) consists of majority-owned affiliates of European multinational firms (MNCs) over 12 years (2003 – 2014), while the sample used in regressions (2) to (5) adds data on majority-owned affiliates of purely domestic European firms. The sample used in regression (6) consists of majority-owned affiliates of purely domestic European firms over 12 years (2003 – 2014). White's (1980) heteroskedasticity-robust standard errors are reported in the parentheses. * denotes significance at 10% level, ** denotes significance at 5% level, *** denotes significance at 1% level.

	(1) Original	(2) All MNCs and domestic	(3) MNCs and small domestic	(4) MNCs and large domestic	(5) Comparable MNCs and domestic	(6) Domestic
Statutory tax rate	0.164***	0.073***	0.047***	0.148***	0.127***	0.015
	(0.016)	(0.007)	(0.009)	(0.009)	(0.010)	(0.009)
Weighted tax difference	0.054***	0.109***	0.112***	0.060***	0.071***	
	(0.017)	(0.010)	(0.011)	(0.011)	(0.013)	
Maximum tax difference	0.051***	0.098***	0.092***	0.076***	0.085***	
	(0.012)	(0.007)	(0.008)	(0.007)	(0.008)	
Fixed asset ratio	-0.065***	-0.032***	-0.016***	-0.058***	-0.061***	-0.016***
	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Log (Sales)	0.027***	0.028***	0.030***	0.026***	0.028***	0.028***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Loss carry-forward	0.093***	0.062***	0.062***	0.071***	0.075***	0.054***
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Profitability	-0.044***	-0.043***	-0.042***	-0.047***	-0.047***	-0.040***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Inflation	0.001***	0.000	0.000***	0.000	-0.001***	0.000**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Log (Corruption index)	-0.009***	-0.008***	-0.006***	-0.007***	-0.007***	-0.014***
	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Growth opportunities	0.022***	0.010***	0.010***	0.017***	0.020***	0.007***
	(0.002)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
Log (Creditor rights index)	-0.037***	-0.028***	-0.033***	-0.029***	-0.026***	0.016***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Lowest-taxed affiliates excluded	No	No	No	No	No	No
Parent, industry, year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	1,039,827	3,792,982	2,416,406	2,416,407	1,956,861	2,753,155
Number of parent firms	143,405	553,653	450,752	287,420	144,419	425,045
R-squared	0.0551	0.0525	.0502	.0611	0.0731	0.0463

7.4. Constant historical ownership structure

As discussed in section 4.1., the Amadeus database does not provide historical ownership data, and information on ownership structures of European firms is available only for the last reported date. An assumption about a constant historical ownership structure would lead to misclassified subsidiary-parent relations as ownership structures tend to change over time. Misclassifications arise regarding which multinational firms own which subsidiaries in the time period before the last reported year. Consequently, a significant noise can be introduced in the international debt shifting mechanisms as they depend on statutory corporate tax rates and asset shares of all affiliates that belong to the multinational corporation. In order to eliminate such misclassifications, I use the Orbis database initially to obtain historical ownership data on European firms, and afterwards link this data with financial data from the Amadeus database.

However, several authors use ownership data from the Amadeus database and assume a constant ownership structure over their sample periods. As an example, the empirical results and descriptive statistics presented by Huizinga et al. (2008) show that the authors assume a constant ownership structure over their sample period of 10 years (1994 – 2003) and do not discuss the possible biases that such an assumption might introduce. Furthermore, Dharmapala and Riedel (2013) examine income shifting of multinational firms in response to tax and assume a constant ownership structure over their sample period of 11 years (1995 – 2005). Even though the authors discuss the drawbacks of assuming a constant historical ownership structure as of the last reported date (2005 in their sample), they claim that, in line with previous studies, it is not an important concern. The authors claim that inclusion of some subsidiaries in the data sample which were not affiliated with the parent firm in the earlier years introduces noise in the estimated coefficients that leads to a downward bias in their results (p. 99). Also Budd, Konings and Slaughter (2005), examining whether multinational firms share their profits across borders during the time period from 1993 to 1998, and Miniaci, Parisi and Panteghini (2014), analysing the link between subsidiary capital structure and tax in Europe during the time period from 1998 to 2007, acknowledge that the Amadeus database does not provide historical ownership data and assume a constant ownership structure over their time periods.

In order to examine whether an assumption about a constant historical ownership structure would introduce a bias in my results, I assume that the ownership structure as of

2014 (the last year for which ownership data is available in the Orbis database) holds for the whole sample period from 2003 to 2014. Thus, I assume that subsidiary-parent relations remain constant over a period of 12 years.

The obtained results are observable in regression (2) in Table 10. Regression (1) restates the original specification of regression (2) in Table 3 to make the results more easily comparable. As observable in the table, the number of observations have increased by 22% due to misclassifications in firms' ownership structures over time. The new data sample includes affiliates, which were not actually affiliated with their parent firms in the earlier years. Furthermore, the number of parent firms has decreased by approximately 7%, as any parent firms and their subsidiaries that ceased their operations before 2014 are excluded from the new data sample. Only parent firms and their majority-owned subsidiaries that were active in 2014 enter the new data sample. This introduces a survivorship bias in the data sample – firms that perform worst are likely to be excluded from the sample as they no longer exist in 2014, while firms that were successful enough to survive until 2014 are included in the sample. As observable in regression (2), coefficient on the weighted tax difference variable has decreased by more than 50% and become statistically insignificant when ownership structure is assumed to be constant over the sample period of 12 years. Coefficient on the maximum tax difference variable has remained approximately constant, while coefficient on the statutory tax rate variable has increased by 6 percentage points. The substantial decrease in the estimated coefficient on the weighted tax difference variable shows the importance of correctly classified historical subsidiary-parent relations. When historical relations are misclassified, it affects the total assets of the multinational corporation, each affiliate's share in the total assets, and the differences in statutory corporate tax rates among affiliates within the multinational group. Thus, the subsequent bias in the estimated coefficient on the weighted tax difference variable is likely to substantial. Moreover, misclassified ownership structures are also likely to bias the coefficient on the maximum tax difference variable, as it depends on the statutory corporate tax rate of the corporation-specific lowest-taxed affiliate.

The obtained coefficients on the international tax mechanisms can also be biased downwards because minority-owned subsidiaries are included in the data sample as majority-owned subsidiaries due to misclassified subsidiary-parent relations. The parent firm is unable to substantially influence financial policies or capital structures of minority-owned subsidiaries in response to the tax mechanisms. Moreover, coordination of several owners'

interests is difficult if they face different financing and tax conditions, which leads to conflicts of interest due to different goals with respect to profit shifting and other financial choices.

In contrast to other authors who claim that misclassified subsidiary-parent relations are unlikely to be a major concern in their studies, my results show that the misclassifications introduce a bias in the estimated relation between affiliates' leverage and tax. Bias in the estimated coefficients is particularly large bias when the independent variables are constructed based on data on all affiliates within the multinational group.

Table 10: Constant historical ownership structure

The dependent variable in the regressions is the total debt-to-asset ratio. Detailed variable definitions are given in Table 2. Regression (1) shows the results of the original specification of regression (2) in Table 3 in order to make the results more easily comparable. Regression (2) is run on a data sample that assumes a constant historical ownership structure over the sample period, based on subsidiary-parent relations as of 2014. The regressions are estimated by the ordinary least squares and include parent, industry and year fixed effects. The sample consists of affiliates of European multinational firms over 12 years (2003 – 2014). White's (1980) heteroskedasticity-robust standard errors are reported in the parentheses. * denotes significance at 10% level, ** denotes significance at 5% level, *** denotes significance at 1% level.

	(1) Original	(2) Constant historical ownership
Statutory tax rate	0.164***	0.224***
	(0.016)	(0.013)
Weighted tax difference	0.054***	0.020
	(0.017)	(0.014)
Maximum tax difference	0.051***	0.050***
	(0.012)	(0.011)
Fixed asset ratio	-0.065***	-0.061***
	(0.002)	(0.001)
Log (Sales)	0.027***	0.022***
	(0.000)	(0.000)
Loss carry-forward	0.093***	0.084***
	(0.001)	(0.001)
Profitability	-0.044***	-0.050***
	(0.001)	(0.001)
Inflation	0.001***	0.002***
	(0.000)	(0.000)
Log (Corruption index)	-0.009***	-0.026***
	(0.002)	(0.001)
Growth opportunities	0.022***	0.028***
	(0.002)	(0.001)
Log (Creditor rights index)	-0.037***	-0.029***
	(0.001)	(0.001)
Lowest-taxed affiliates excluded	No	No
Parent, industry, year fixed effects	Yes	Yes
Number of observations	1,039,827	1,269,198
Number of parent firms	143,405	133,478
R-squared	0.0551	0.0524

7.5. Majority-owned subsidiaries outside Europe

If European parent firms have majority-owned subsidiaries also outside Europe, the parent firms are able to shift debt and profits to these subsidiaries as well. As an example, a parent firm may have a majority-owned subsidiary located in a tax haven outside Europe, where the effective corporate tax rate is almost zero. The multinational firm might send all income to this subsidiary, while the subsidiary would act as a financial coordination centre and lend out money to all other affiliates within the multinational group. However, this effect would not be picked up by the maximum tax difference variable because my data sample includes only European affiliates. Thus, the maximum tax difference variable might seem smaller than it actually is due to unavailability of financial data on subsidiaries outside Europe. Also the weighted tax difference variable would be unadjusted for the total assets and corporate tax rates of subsidiaries outside Europe due to unavailability of their financial data. Hence, existence of majority-owned non-European affiliates of European multinational firms is likely to bias the estimated coefficients on the international debt shifting mechanisms.

Huizinga et al. (2008) discuss that due to this limitation of the Amadeus database, they cannot examine how tax differences between European affiliates and non-European affiliates affect capital structure choices of European multinational firms. The authors claim that this is not an important concern as European multinational firms are likely to obtain the largest part of their income from operations in Europe (p. 96). Møen et al. (2011) control for majority-owned affiliates outside Europe in their main analysis by restricting their data sample to German multinational firms that have all their affiliates in Europe. In robustness tests, the authors run regressions on an extended sample of affiliates of German multinational firms around the world, and an extended sample of affiliates of German multinational firms in Europe, irrespective of whether the firms have other affiliates outside Europe. The model performs worse in the extended sample of affiliates around the world, which can be explained by better data quality in European countries and presence of other factors which are more important for investments outside Europe than taxation. However, the model performs better in the extended sample of affiliates in Europe (coefficients are more accurately estimated), which can be explained by the increased sample size and inclusion of large multinational firms in the extended data sample (p. 35 – 38).

In order to examine whether leverage responses to tax differ for European multinational firms that have majority-owned affiliates outside Europe and European

multinational firms that do not have majority-owned affiliates outside Europe, I firstly obtain historical ownership data on majority-owned affiliates of European multinational firms outside Europe from the Orbis database. Then I check whether the parent firms in my main data sample own any affiliates outside Europe, based on the historical ownership information. Regression (1) in Table 11 restates the original specification of regression (2) in Table 3 to make the results more easily comparable. Regression (2) in Table 11 includes only European multinational firms with majority-owned affiliates outside Europe, while regression (3) includes only European multinational firms without majority-owned affiliates outside Europe. Firms with affiliates outside Europe constitute 35% of the main sample. As observable in regression (2), when only the firms which have affiliates outside Europe are included in the data sample, coefficient on the statutory corporate tax rate variable increases by 6.2 percentage points. However, coefficient on the weighted tax difference variable decreases by 4.3 percentage points and loses its statistical significance, while coefficient on the maximum tax difference variable decreases by 1.2 percentage points and becomes less statistically significant.

Changes in the estimated coefficients in regression (2) can be explained by a potential measurement error in the international debt shifting variables that arises due to disregarding financial and tax data on affiliates outside Europe. Coefficient on the weighted tax difference variable is affected most because it depends on asset shares and tax data on all affiliates that belong to the multinational group. If the multinational firm has many majority-owned affiliates outside Europe, the estimated coefficient on the weighted tax difference variable is particularly biased. Coefficient on the maximum tax difference variable is affected less because it depends only on tax rate of the lowest-taxed affiliate within the multinational group. If the lowest-taxed affiliate is located in Europe, the estimated coefficient is unbiased. If the lowest-taxed affiliate is located outside Europe, the multinational firm might still decide to establish its financial coordination centre in the lowest-taxed affiliate in Europe, considering development of financial markets, corruption and creditor rights protection outside Europe. Hence, bias in the estimated coefficient on the maximum tax difference variable is likely to be rather small, compared to bias in the estimated coefficient on the weighted tax difference variable.

Furthermore, as observable in regression (3), when only the firms which do not have any affiliates outside Europe are included in the data sample, coefficients on the statutory corporate tax rate and weighted tax difference variables decrease by 1.6 and 0.8 percentage

points respectively, while coefficient on the maximum tax difference variable increases by 1.1 percentage point. The results suggest that the international debt shifting mechanisms have a larger effect on leverage decisions of European multinational firms which do not have any affiliates outside Europe. This occurs because potential measurement errors in the international debt shifting variables are much smaller for these firms as financial and tax data on their European affiliates is available in the data sample.

Furthermore, I include a dummy variable (*Out of Europe dummy*) in the regression that equals 1 if a multinational firm has affiliates outside Europe, and 0 otherwise. As observable in regression (4), coefficients on the tax mechanisms change only slightly and retain their statistical significance, while the estimated coefficient on the dummy variable is statistically significant and positive. Hence, if a European multinational firm has majority-owned affiliates outside Europe, the debt-to-asset ratio of its European affiliates is 0.4 percentage points higher on average, compared to firms without any affiliates outside Europe. This suggests that multinational firms tend to locate their financial coordination centres in tax havens outside Europe, which reduces the maximum tax difference variable of all affiliates within the multinational group and leads to a higher leverage.

However, all large multinational firms are likely to have affiliates outside Europe, which introduces a selection bias in the estimated coefficient on the dummy variable. To reduce the selection bias, I create two other dummy variables. The first dummy variable (*Lower than minimum tax dummy*) equals 1 if a multinational firm has majority-owned affiliates outside Europe whose minimum statutory corporate tax rate (tax rate of the lowest-taxed affiliate outside Europe) is lower than the minimum tax rate among firm's European affiliates. If the multinational firm has majority-owned affiliates outside Europe whose statutory corporate tax rate is lower than the tax rate of the lowest-taxed affiliate in Europe, I expect that the debt level of its European affiliates should increase. Furthermore, the second dummy variable (*Higher than maximum tax dummy*) equals 1 if a multinational firm has majority-owned affiliates outside Europe whose maximum statutory corporate tax rate (tax rate of the highest-taxed affiliate outside Europe) is higher than the maximum tax rate among firm's European affiliates. If the multinational firm has majority-owned affiliates outside Europe whose statutory corporate tax rate is higher than the tax rate of the highest-taxed affiliate in Europe, I expect that the debt level of its European affiliates should decrease.

As observable in regression (5), coefficients on the tax mechanisms change only slightly and retain their statistical significance. The estimated coefficient on the *Lower than*

minimum tax dummy is statistically significant and positive, which suggests that multinational firms tend to establish their financial coordination centres in tax havens outside Europe. As effective tax rates that financial coordination centres pay in tax havens are very low, the maximum tax difference variable of all affiliates that belong to the multinational group increases. Hence, if a multinational firm has a majority-owned affiliate outside Europe whose tax rate is smaller than the tax rate of the lowest-taxed affiliate in Europe, the total leverage ratio of firm's European affiliates is 0.6 percentage points higher on average, compared to firms without such affiliates outside Europe. Furthermore, also the estimated coefficient on the *Higher than maximum tax dummy* is statistically significant and positive. This suggests that if a multinational firm has a majority-owned affiliate outside Europe whose tax rate is higher than the tax rate of the highest-taxed affiliate in Europe, the total leverage ratio of firm's European affiliates is 0.4 percentage points higher on average, compared to firms without such affiliates outside Europe. This finding does not conform to the expected results that debt-to-asset ratios of European affiliates should decrease if higher-taxed affiliates are located outside Europe due to higher tax savings available outside Europe.

The rather small coefficient on the *Lower than minimum tax dummy* and the small and positive coefficient on the *Higher than maximum tax dummy* suggest that multinational firms take other concerns into account while deciding upon debt shifting to affiliates outside Europe. Development of financial markets, political stability and corruption level in the country might influence the willingness of multinational firms to adjust capital structures of their affiliates outside Europe in response to tax incentives. Furthermore, also withholding taxes matter for debt shifting to affiliates outside Europe. Hence, leverage decisions of European affiliates are likely to be affected to a rather small extent if the multinational firm has affiliates outside Europe.

Table 11: Majority-owned affiliates outside Europe

The dependent variable in the regressions is the total debt-to-asset ratio. Detailed variable definitions are given in Table 2. Regression (1) shows the results of the original specification of regression (2) in Table 3 in order to make the results more easily comparable. Regression (2) is run on a sample of European affiliates that belong to European multinational firms (MNCs) which have majority-owned affiliates outside Europe. Regression (3) is run on a sample of European affiliates that belong to European multinational firms which do not have any majority-owned affiliates outside Europe. Regression (4) includes *Out of Europe* dummy variable which equals 1 if a multinational firm has majority-owned affiliates outside Europe, and 0 otherwise. Regression (5) includes *Lower than minimum tax dummy* which equals 1 if a multinational firm has majority-owned affiliates outside Europe whose minimum corporate tax rate is lower than the minimum tax rate among firm's European affiliates, and *Higher than maximum tax dummy* which equals 1 if a multinational firm has majority-owned affiliates outside Europe whose maximum corporate tax rate is higher than the maximum tax rate among firm's European affiliates. The regressions are estimated by the ordinary least squares and include parent, industry and year fixed effects. The sample consists of majority-owned affiliates of European multinational firms over 12 years (2003 – 2014). White's (1980) heteroskedasticity-robust standard errors are reported in the parentheses. * denotes significance at 10% level, ** denotes significance at 5% level, *** denotes significance at 1% level.

	(1) Original	(2) MNCs with affiliates outside Europe	(3) MNCs without affiliates outside Europe	(4) Out of Europe dummy	(5) Min and max tax dummies
Statutory tax rate	0.164***	0.226***	0.148***	0.166***	0.164***
	(0.016)	(0.029)	(0.021)	(0.016)	(0.015)
Weighted tax difference	0.054***	0.011	0.046*	0.056***	0.052***
	(0.017)	(0.027)	(0.026)	(0.017)	(0.015)
Maximum tax difference	0.051***	0.039**	0.062***	0.048***	0.052***
	(0.012)	(0.016)	(0.019)	(0.012)	(0.010)
Out of Europe dummy				0.004***	
				(0.002)	
Lower than minimum tax dummy					0.006***
					(0.001)
Higher than maximum tax dummy					0.004***
					(0.001)
Fixed asset ratio	-0.065***	-0.101***	-0.023***	-0.065***	-0.062***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)
Log (Sales)	0.027***	0.028***	0.027***	0.027***	0.028***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Loss carry-forward	0.093***	0.108***	0.081***	0.093***	0.090***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Profitability	-0.044***	-0.042***	-0.043***	-0.044***	-0.046***
	(0.001)	(0.002)	(0.002)	(0.001)	(0.002)
Inflation	0.001***	-0.002***	0.002***	0.001***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Log (Corruption index)	-0.009***	-0.012***	-0.012***	-0.009***	-0.009***
	(0.002)	(0.002)	(0.003)	(0.002)	(0.001)
Growth opportunities	0.022***	0.031***	0.015***	0.022***	0.021***
	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)

Table 11 (continued)

	(1) Original	(2) MNCs with affiliates outside Europe	(3) MNCs without affiliates outside Europe	(4) Out of Europe dummy	(5) Min and max tax dummies
Log (Creditor rights index)	-0.037***	-0.030***	-0.040***	-0.037***	-0.037***
	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)
Lowest-taxed affiliates excluded	No	No	No	No	No
Parent, industry, year fixed effects	Yes	Yes	Yes	Yes	Yes
Number of observations	1,039,827	368,207	671,620	1,039,827	1,039,827
Number of parent firms	143,405	13,665	137,415	143,405	143,405
R-squared	0.0551	0.0464	0.1011	0.0544	.0559

7.6. Holding companies

Multinational firms are often characterized by indirect ownership structures that involve holding companies. Holding companies do not usually produce any products or services themselves, but they are established by multinational firms to implement tax efficient financing in firms' affiliates.[62] Several countries offer special tax regimes for interest income and dividends that holding companies receive; for example, foreign affiliates located in Belgium, the Netherlands, Luxembourg and Switzerland are able to obtain tax allowances if they mainly provide internal financial services or operate as holding companies (Weichenrieder, 1996, p. 41).[63] Consequently, Belgium, the Netherlands, Luxembourg and Switzerland are host countries for many holding companies in Europe (Mintz & Weichenrieder, 2010, pp. 46, 80). Hence, a tax saving financing structure is possible if parent firm provides the holding firm with equity, and the holding firm forwards these funds as debt to other affiliates within the multinational group. Unlike dividend payments, interest expenses of subsidiaries to the holding company are tax deductible, and if the holding

[62] For a broader discussion on advantages of indirect ownership structures and holding companies, see Mintz and Weichenrieder (2010, pp. 77 – 122).

[63] Also thin capitalization rules historically allowed a preferential treatment for holding companies. As an example, before 2001 German thin capitalization rules had a safe haven ratio (total debt-to-equity ratio) equal to 9:1 for holding companies, while it was 3:1 for other companies. In 2001 the safe haven ratio was reduced to 1.5:1 for ordinary companies and to 3:1 for holding companies, which still allowed potential loopholes in the rules. Finally, in 2004 the safe haven ratio was set at 1.5:1 for all companies (Overesch & Wamser, 2010, pp. 564 – 565; Weichenrieder & Windischbauer, 2008, pp. 3 – 4).

company is tax exempt on its interest income, it might be possible to send the interest income back to the parent firm almost tax-free.[64]

Another potential mechanism how multinational firms can use holding companies for tax purposes affects my analysis directly. The parent firm can establish a holding company with the main purpose to endow it with a very high amount of debt. These funds can then be used by the holding company to shift equity to other affiliates within the multinational corporation. Thus, the holding company can be heavily leveraged, while it seems that other affiliates within the thinly capitalized multinational group have very low total debt-to-asset ratios. As an example, the Norwegian company Statoil Fuel & Retail was not thinly capitalized prior to being acquired by an international Canadian-owned retail group Alimentation Couche-Tard in 2012. After acquisition, Statoil Fuel & Retail was provided with a lot of equity capital from Couche-Tard Norway (Norwegian holding company that was the sole shareholder of Statoil Fuel & Retail after acquisition), which was used to repay Statoil Fuel & Retail's external debt. Consequently, firm's debt-to-asset ratio decreased. However, Couche-Tard Norway had received a lot of internal debt and equity capital from a heavily leveraged holding company in Luxembourg, and these funds were used to acquire Statoil Fuel & Retail and to increase Statoil Fuel & Retail's capital. Hence, even though it seemed that Statoil Fuel & Retail had a very low total debt, it actually belonged to a heavily leveraged multinational group and its actual leverage ratio substantially increased after the acquisition (Foss, 2014, pp. 37 - 56).

This financing structure might lead to biased estimates of the effect of tax on affiliates' leverage if the main data sample consists of a few heavily-indebted affiliates (holding companies) and many affiliates with small levels of debt. To control for the possibility that only one or a few affiliates are loaded with large amounts of debt, which they afterwards distribute as equity to other affiliates within the multinational group, I create one total debt-to-asset ratio per multinational firm per country which aggregates information from all firm's affiliates operating within a particular country.[65] Firstly, I aggregate total liabilities of all affiliates of the multinational firm that operate within a country to create the numerator of the aggregated total debt-to-asset ratio. Furthermore, I add equity of the holding company of the multinational firm within a country to the aggregated total liabilities of all affiliates of the multinational group within a country to create the denominator of the aggregated total

[64] For this to be possible, the dividends that the parent firm receives should be tax exempt.
[65] Aggregation procedure follows Foss (2014, pp. 23 – 30).

debt-to-asset ratio. Hence, I create one total debt-to-asset ratio per multinational firm, country and year. The same procedure is done in all countries where the multinational firm has affiliates. The aggregated total debt-to-asset ratio is expressed in equation (14):

$$TDAR_A = \frac{\sum_i D_i^E + \sum_i (D_i^I - F_i^I)}{V_1 + \sum_i D_i^E + \sum_i (D_i^I - F_i^I)}, \quad (14)$$

where $TDAR_A$ is the aggregated total debt-to-asset ratio of a multinational firm in country A, D_i^E is external debt of an affiliate i which belongs to the multinational firm and operates in the country A, D_i^I is internal debt of the affiliate i, F_i^I are internal receivables of the affiliate i, and V_1 is equity of the holding company which belongs to the multinational firm and operates in the country A. As the Amadeus database does not provide data on internal transactions within firms, it is not possible to obtain information on F_i^I or the internal receivables of affiliates within a multinational firm. Consequently, I aggregate total liabilities without deduction of internal receivables, which leads to double counting of internal transactions within a firm. If the firm has no internal debt, the aggregated total debt-to-asset ratio is unbiased. However, the more internal debt and internal receivables there are within the firm, the more the aggregated total debt-to-asset ratio is biased upwards.

Aggregation allows using only one observation of aggregated total debt-to-asset ratio per multinational firm, country and year, instead of observations of several affiliates. As the high leverage of the holding company is added to the aggregated leverage within a country, the multinational concern appears thinly-capitalized and the bias in the effect of tax mechanisms on total leverage is eliminated. Moreover, using only equity of the holding company while calculating the aggregated total assets (denominator of the aggregated total debt-to-asset ratio) eliminates the bias that arises because affiliates have received a lot of equity from the highly leveraged holding companies.

Regression (1) in Table 12 restates the original specification of regression (2) in Table 3 to make the results more easily comparable. Regression (2) is run on the aggregated data sample to control for highly leveraged holding companies. As observable in the table, the number of observations and number of parent firms are substantially smaller in regression (2). This occurs because I assume that the holding company within a particular country is an affiliate whose NACE Rev. 2 industry code refers to activities of holding companies (code 6420). If there are no such affiliates within a particular country per multinational firm and year, the aggregation procedure cannot be implemented; therefore, I do not include the multinational firm-country observation in the data sample. Furthermore, the number of

observations decreases because the new data sample consists of aggregated multinational firm observations per country, instead of many observations of different affiliates per multinational firm and country.

After the adjustment for holding companies, coefficient on the statutory corporate tax rate variable increases by 12 percentage points, coefficient on the weighted tax difference variable increases by 8 percentage points, and coefficient on the maximum tax difference variable increases by 0.8 percentage points. Hence, the results show that multinational firms engage in more external and internal debt shifting than was estimated in the original specification. Moreover, leverage decisions of multinational firms are also more responsive to the standard debt tax shield mechanism after the adjustment.

Furthermore, aggregation leads to changes in coefficients on firm-level control variables, as aggregated observations per multinational firm, country and year are created also for these variables. Coefficient on the fixed asset ratio increases by 22.6 percentage points and changes its sign from statistically negative to positive, coefficient on the logarithm of sales increases by 4.5 percentage points, coefficient on the loss carry-forward variable decreases by 7.9 percentage points, and coefficient on the profitability variable decreases by 14.2 percentage points. Changes in the estimated coefficients on firm-level control variables occur because the unit of observation in the data sample is no longer an affiliate, but an aggregated multinational firm-country observation. Consequently, the aggregated data sample is considerably smaller than the data sample used in the original specification. Furthermore, a selection bias might be present in the new data sample. As an example, only firms that have holding companies enter the sample, which might characterize rather large multinational firms with many affiliates. Leverage responses of such firms to control variables might differ from the average response of all firms that are included in the original data sample.

The obtained results suggest that existence of holding companies and the resulting lower leverage of other affiliates within multinational firms lead to a downward bias in the estimated coefficients on all tax mechanisms in the original specification. Leverage responses to tax seem to be substantially higher after the adjustment, which suggests that multinational firms engage in more international debt shifting than was estimated initially. However, the findings can be influenced by a selection bias because only firms that have holding companies enter the aggregated data sample. If only large firms have holding companies, coefficients on the tax mechanisms might increase in the new data sample because large firms are more likely

to engage in international debt shifting, as found in section 7.1. Furthermore, the findings can be influenced by a potentially erroneous construction of the aggregated total debt-to-asset ratio. If the aggregated debt-to-asset ratio is biased due to double counting of internal receivables and payables, the estimated coefficients on the tax mechanisms might be biased as well, especially coefficient on the maximum tax difference variable, which represents internal debt shifting. Thus, a more precise construction of the aggregated debt-to-asset ratio is necessary in order to examine the actual effect of tax on aggregated leverage. To construct a precise aggregated leverage ratio, another database must be used to obtain financial data, as the Amadeus database does not provide data on internal transactions.

Table 12: Holding companies

The dependent variable in the regression (1) is the total debt-to-asset ratio. The dependent variable in the regression (2) is the aggregated total debt-to-asset ratio, which aggregates data per each multinational firm, country and year. Detailed variable definitions are given in Table 2. Regression (1) shows the results of the original specification of regression (2) in Table 3 in order to make the results more easily comparable. Regression (2) controls for the existence of holding companies in the data sample and the resulting lower leverage of other affiliates. Firm-level control variables are aggregated per each multinational firm, country and year in regression (2). The regressions are estimated by the ordinary least squares and include parent, industry and year fixed effects. The sample consists of majority-owned affiliates of European multinational firms over 12 years (2003 – 2014) in regression (1), while the sample in regression (2) consists of aggregated multinational firm-country observations of European multinational firms over 12 years (2003 – 2014). White's (1980) heteroskedasticity-robust standard errors are reported in the parentheses. * denotes significance at 10% level, ** denotes significance at 5% level, *** denotes significance at 1% level.

	(1) Original	(2) Control for holding companies
Statutory tax rate	0.164***	0.284***
	(0.016)	(0.075)
Weighted tax difference	0.054***	0.134**
	(0.017)	(0.066)
Maximum tax difference	0.051***	0.059
	(0.012)	(0.045)
Fixed asset ratio	-0.065***	0.161***
	(0.002)	(0.005)
Log (Sales)	0.027***	0.072***
	(0.000)	(0.001)
Loss carry-forward	0.093***	0.014***
	(0.001)	(0.003)
Profitability	-0.044***	-0.186***
	(0.001)	(0.008)
Inflation	0.001***	-0.001
	(0.000)	(0.001)
Log (Corruption index)	-0.009***	0.004
	(0.002)	(0.004)
Growth opportunities	0.022***	0.010**
	(0.002)	(0.005)
Log (Creditor rights index)	-0.037***	-0.019***
	(0.001)	(0.004)
Lowest-taxed affiliates excluded	No	No
Parent, industry, year fixed effects	Yes	Yes
Number of observations	1,039,827	59,625
Number of parent firms	143,405	5,865
R-squared	0.0551	0.1516

7.7. Loss carry-forwards

As discussed in section 6.4., loss carry-forward dummy variable enters the regression with a positive sign, which suggests that the dummy variable explains specific characteristics of the firm, for example, its expected performance, which may indicate a positive relation between firm's loss carry-forwards and its financial leverage. Also, firms with loss carry-forwards are likely to have no retained earnings, less equity and more incentives to use debt to finance their activities. However, as discussed by Büttner, Overesch and Wamser (2011), affiliates with loss carry-forwards have less incentives to engage in tax avoidance, as loss carry-forwards act as non-debt tax shields and offset affiliates' taxable profits. The authors use an interaction term between statutory corporate tax rate and loss carry-forward dummy in their analysis and find that the there exists a significant negative effect of loss carry-forward on tax elasticity of debt-to-asset ratio (p. 118).

In order to examine whether loss carry-forwards affect tax elasticity of debt negatively in my data sample as well, I create interaction terms between all three tax mechanisms and the loss carry-forward dummy. Regression (1) in Table 13 restates the original specification of regression (2) in Table 3 to make the results more easily comparable. As observable in regression (2) which includes the loss carry-forward interaction terms, the interaction term between statutory tax rate and loss carry-forward, and between weighted tax difference and loss carry-forward affect affiliates' leverage negatively. The interaction term between maximum tax difference and loss carry-forward affects affiliates' leverage positively; however, coefficient on the maximum tax difference variable alone has decreased by 4 percentage points and become statistically insignificant after inclusion of interaction terms in the specification.

Hence, my results confirm a significant adverse effect of loss carry-forward on the estimated effect of corporate tax rate and weighted tax difference variables on affiliates' total leverage. Regression (2) suggests that if an affiliate has losses to be carried forward, the effect of statutory tax rate on its total debt-to-asset ratio decreases by approximately 62%, while the effect of weighted tax difference variable decreases by approximately 265% and becomes negative. Finally, the effect of maximum tax difference variable increases substantially and becomes statistically significant at 1%. These findings seem to be particularly relevant because approximately 23% of affiliates in the main data sample have loss carry-forwards. The standard debt tax shield and external debt shifting mechanisms are less important for

leverage decisions of affiliates with loss carry-forwards, while internal debt shifting mechanism is more important for their leverage decisions than for affiliates that do not report loss carry-forwards. The increased effect of maximum tax difference variable on loss-making affiliates' leverage suggests that multinational firms tend to use internal debt to finance loss-making affiliates.

Finally, I divide the data sample into two parts – the affiliates that report loss carry-forwards and the affiliates that do not report loss carry-forwards, to examine whether effects of the tax mechanisms on affiliates' total leverage differ between these affiliates. Regression (3) is run on affiliates without loss carry-forwards, while regression (4) is run on affiliates with loss carry-forwards. As observable in the table, the estimated coefficients on statutory corporate tax rate and weighted tax difference variables are smaller and statistically insignificant for the sample of affiliates with loss carry-forwards, as compared to the sample of affiliates without loss carry-forwards. However, the estimated coefficient on maximum tax difference variable is slightly larger for the sample of affiliates with loss carry-forwards. Hence, these findings confirm the results obtained above – leverage of affiliates with loss carry-forwards is less responsive to variation in corporate tax rate and weighted tax difference variables, and more responsive to variation in maximum tax difference variable than leverage of affiliates without loss carry-forwards.

In line with Büttner et al. (2011), these findings exhibit an implication for tax policies. As firms with loss carry-forwards are less willing to use more debt or engage in external debt shifting in response to tax incentives, the use of debt for tax avoidance activities should decrease during or after a financial crisis or a cyclical downturn in the economy. Thus, in case of a financial downturn, the anti-tax avoidance rules, such as thin capitalization regulations or earnings stripping rules, could be relaxed, as these regulations are based on the assumption that multinational firms use debt extensively to shift debt and avoid taxes (p. 118).

Table 13: Loss carry-forwards

The dependent variable in all regressions is the total debt-to-asset ratio. Detailed variable definitions are given in Table 2. Regression (1) shows the results of the original specification of regression (2) in Table 3 in order to make the results more easily comparable. Regression (2) includes loss carry-forward interaction terms to examine whether tax elasticity of debt differs for firms with loss carry-forwards. Regression (3) is run on affiliates without loss carry-forwards, and regression (4) is run on affiliates with loss carry-forwards. The regressions are estimated by the ordinary least squares and include parent, industry and year fixed effects. The sample consists of majority-owned affiliates of European multinational firms over 12 years (2003 – 2014). White's (1980) heteroskedasticity-robust standard errors are reported in the parentheses. * denotes significance at 10% level, ** denotes significance at 5% level, *** denotes significance at 1% level.

	(1) Original	(2) Loss carry-forward interactions	(3) Affiliates without loss carry-forwards	(4) Affiliates with loss carry-forwards
Statutory tax rate	0.164***	0.185***	0.222***	-0.035
	(0.016)	(0.016)	(0.018)	(0.039)
Weighted tax difference	0.054***	0.141***	0.058***	0.012
	(0.017)	(0.018)	(0.018)	(0.036)
Maximum tax difference	0.051***	0.011	0.045***	0.049***
	(0.012)	(0.012)	(0.013)	(0.021)
Statutory tax rate * Loss carry-forward		-0.115***		
		(0.013)		
Weighted tax difference * Loss carry-forward		-0.375***		
		(0.022)		
Maximum tax difference * Loss carry-forward		0.182***		
		(0.012)		
Fixed asset ratio	-0.065***	-0.065***	-0.069***	-0.069***
	(0.002)	(0.002)	(0.002)	(0.004)
Log (Sales)	0.027***	0.028***	0.028***	0.027***
	(0.000)	(0.000)	(0.000)	(0.001)
Loss carry-forward	0.093***	0.110***		
	(0.001)	(0.003)		
Profitability	-0.044***	-0.043***	-0.051***	-0.019***
	(0.001)	(0.001)	(0.002)	(0.003)
Inflation	0.001***	0.001***	0.001***	-0.000
	(0.000)	(0.000)	(0.000)	(0.001)
Log (Corruption index)	-0.009***	-0.009***	-0.004*	-0.018***
	(0.002)	(0.002)	(0.002)	(0.004)
Growth opportunities	0.022***	0.022***	0.023***	0.023***
	(0.002)	(0.002)	(0.002)	(0.004)
Log (Creditor rights index)	-0.037***	-0.037***	-0.038***	-0.031***
	(0.001)	(0.001)	(0.002)	(0.004)
Lowest-taxed affiliates excluded	No	No	No	No
Parent, industry, year fixed effects	Yes	Yes	Yes	Yes

Table 13 (continued)

	(1) Original	(2) Loss carry-forward interactions	(3) Affiliates without loss carry-forwards	(4) Affiliates with loss carry-forwards
Number of observations	1,039,827	1,039,827	801,434	238,393
Number of parent firms	143,405	143,405	125,5507	64,358
R-squared	0.0551	0.0552	0.0443	0.0679

7.8. Non-linear tax responses

All regression specifications presented in the study are linear in the tax mechanisms, based on previous literature and the theoretical model, where cost functions are quadratic. However, multinational firms might respond to the tax mechanisms in a non-linear fashion. For example, firms might be able to engage in tax planning activities without any costs initially; however, when thin capitalization rules become binding, costs of increasing the leverage even more might increase substantially (Møen et al., 2011, p. 39).[66] Also, as shown by Mintz and Weichenrieder (2010), the effect of corporate tax rate on firms' total debt-to-asset ratio might be concave in tax rate, which suggests that the marginal effect of tax on leverage decreases for higher corporate tax rates (pp. 132 – 133). In order to examine whether firms' leverage responses to tax are non-linear, I include quadratic tax mechanisms in the specification. Regression (1) in Table 14 restates the original specification of regression (2) in Table 3 to make the results more easily comparable. In regression (2) the quadratic terms of the three tax mechanisms are included in the specification.

As observable in Table 14, the estimated coefficients on the non-linear tax mechanisms are statistically significant (even though coefficient on the quadratic maximum tax difference variable is only significant at 10%). Moreover, the estimated coefficients on the quadratic statutory corporate tax rate variable and the quadratic maximum tax difference variable are negative, which shows evidence that the tax effects are concave in statutory corporate tax rate and maximum tax difference. This suggests that for a higher statutory corporate tax rate or for a higher difference between the host country corporate tax rate and the corporate tax rate of the financial coordination centre of the multinational group, the marginal effect of tax on the total debt-to-asset ratio decreases. Finally, the estimated

[66] Thin capitalization rules limit the amount of leverage for which interest is tax deductible; therefore, costs of increasing leverage above the threshold rise substantially (Blouin et al., 2014, p. 3).

coefficient on the quadratic weighted tax difference variable is positive, which suggests that for a higher weighted difference between the host country corporate tax rate and corporate tax rates of all other affiliates within the multinational group, the marginal effect of tax on the total leverage ratio increases and the affiliate is likely to receive even more external debt.

Also Møen et al. (2011) obtain negative coefficients on the quadratic statutory corporate tax rate variable and the quadratic maximum tax difference variable, and a positive coefficient on the quadratic weighted tax difference variable (p. 40). However, only coefficient on the quadratic weighted tax difference variable is statistically significant in their study, while all quadratic tax mechanisms are statistically significant in my study. Overall, their estimated responses of firms' leverage to non-linear tax mechanisms are similar to my estimates.

Table 14: Non-linear tax mechanisms

The dependent variable in the regressions is the total debt-to-asset ratio. Detailed variable definitions are given in Table 2. Regression (1) shows the results of the original specification of regression (2) in Table 3 in order to make the results more easily comparable. Regression (2) controls for non-linear tax responses and includes quadratic tax mechanisms in the specification. The regressions are estimated by the ordinary least squares and include parent, industry and year fixed effects. The sample consists of majority-owned affiliates of European multinational firms over 12 years (2003 – 2014). White's (1980) heteroskedasticity-robust standard errors are reported in the parentheses. * denotes significance at 10% level, ** denotes significance at 5% level, *** denotes significance at 1% level.

	(1) Original	(2) Non-linear tax responses
Statutory tax rate	0.164***	0.366***
	(0.016)	(0.055)
(Statutory tax rate)^2		-0.372***
		(0.097)
Weighted tax difference	0.054***	0.075***
	(0.017)	(0.018)
(Weighted tax difference)^2		0.393***
		(0.100)
Maximum tax difference	0.051***	0.079***
	(0.012)	(0.019)
(Maximum tax difference)^2		-0.154*
		(0.080)
Fixed asset ratio	-0.065***	-0.064***
	(0.002)	(0.002)
Log (Sales)	0.027***	0.028***
	(0.000)	(0.000)
Loss carry-forward	0.093***	0.093***
	(0.001)	(0.001)
Profitability	-0.044***	-0.044***
	(0.001)	(0.001)
Inflation	0.001***	0.001***
	(0.000)	(0.000)
Log (Corruption index)	-0.009***	-0.010***
	(0.002)	(0.002)
Growth opportunities	0.022***	0.022***
	(0.002)	(0.002)
Log (Creditor rights index)	-0.037***	-0.036***
	(0.001)	(0.001)
Lowest-taxed affiliates excluded	No	No
Parent, industry, year fixed effects	Yes	Yes
Number of observations	1,039,827	1,039,827
Number of parent firms	143,405	143,405
R-squared	0.0551	0.0546

7.9. Fixed effects

All regressions presented in the study have included parent, industry and year fixed effects. Parent fixed effects control for systematic differences among multinational firms, year fixed effects capture aggregate shocks occurring over the sample period, and industry fixed effects capture differences in borrowing costs across industries.[67] However, if there exist systematic differences among subsidiaries, the obtained results can be biased due to omitted variables at the subsidiary level. In order to deal with this potential issue, I included affiliate-specific control variables in the previous regressions to capture heterogeneity characterizing affiliates' financing costs. Another method to control for potential unobserved subsidiary heterogeneity that characterizes their leverage is to include subsidiary fixed effects in the regression.[68]

Regression (1) in Table 15 restates the original specification of regression (2) in Table 3 to make the results more easily comparable. Regression (2) is estimated with subsidiary fixed effects. As observable in the table, coefficients on all tax mechanisms decrease, and coefficient on the maximum tax difference variable becomes statistically insignificant and negative in regression (2). However, for many affiliates in the data sample, financial data is available for less than 12 years – on average, 7 years of financial data are available per affiliate. For firms with short availability of data, it is rather difficult to precisely estimate subsidiary fixed effects (Huizinga et al., 2008, p. 112). Nevertheless, even when I restrict the data sample to include only affiliates with at least 10 years of financial data, coefficients on the tax mechanisms are similar. The obtained results suggest that subsidiary fixed effects substantially reduce variation in the data. Hence, control for heterogeneity among multinational firms seems to be more relevant while estimating leverage responses to tax than control for heterogeneity among subsidiaries in my data sample.

Finally, in order to examine what occurs when regression controls for no subsidiary or parent (group) fixed effects, I run the regression without any subsidiary or parent fixed effects (industry and year fixed effects remain in the regression). As observable in regression (3), coefficients on the statutory corporate tax rate and maximum tax difference variables have decreased, when compared to regression (1), by 8 percentage points and 19.4 percentage

[67] More discussion on the choice of fixed effects is provided in section 3.3. and section 5.

[68] Due to inclusion of subsidiary fixed effects, I drop parent (group) fixed effects and industry fixed effects from the regression. Year fixed effects remain in the regression.

points respectively. Coefficient on the weighted tax difference variable has increased by 31.2 percentage points. Hence, the substantial changes in coefficients on the tax mechanisms confirm the importance of controlling for fixed effects in the regression, as there exists substantial heterogeneity among parent firms and subsidiaries in the data sample.

Table 15: Fixed effects

The dependent variable in all regressions is the total debt-to-asset ratio. Detailed variable definitions are given in Table 2. Regression (1) shows the results of the original specification of regression (2) in Table 3 in order to make the results more easily comparable. Regression (2) includes subsidiary and year fixed effects. Regression (3) includes industry and year fixed effects. The regressions are estimated by the ordinary least squares. The sample consists of majority-owned affiliates of European multinational firms over 12 years (2003 – 2014). White's (1980) heteroskedasticity-robust standard errors are reported in the parentheses. * denotes significance at 10% level, ** denotes significance at 5% level, *** denotes significance at 1% level.

	(1) Original	(2) Subsidiary fixed effects	(3) No fixed effects
Statutory tax rate	0.164***	0.130***	0.084***
	(0.016)	(0.012)	(0.008)
Weighted tax difference	0.054***	0.017**	0.366***
	(0.017)	(0.008)	(0.009)
Maximum tax difference	0.051***	-0.004	-0.143***
	(0.012)	(0.004)	(0.005)
Fixed asset ratio	-0.065***	0.033***	-0.055***
	(0.002)	(0.002)	(0.001)
Log (Sales)	0.027***	0.028***	0.018***
	(0.000)	(0.000)	(0.000)
Loss carry-forward	0.093***	0.055***	0.094***
	(0.001)	(0.001)	(0.001)
Profitability	-0.044***	-0.073***	-0.046***
	(0.001)	(0.001)	(0.001)
Inflation	0.001***	0.002***	0.000*
	(0.000)	(0.000)	(0.000)
Log (Corruption index)	-0.009***	-0.045***	-0.008***
	(0.002)	(0.003)	(0.001)
Growth opportunities	0.022***	0.008***	0.022***
	(0.002)	(0.001)	(0.002)
Log (Creditor rights index)	-0.037***	-0.011***	-0.033***
	(0.001)	(0.002)	(0.001)
Lowest-taxed affiliates excluded	No	No	No
Parent, industry, year fixed effects	Yes		
Subsidiary, year fixed effects		Yes	
Industry, year fixed effects			Yes
Number of observations	1,039,827	1,039,827	1,039,827
Number of parent firms	143,405	143,405	143,405
R-squared	0.0551	0.0426	.0619

8. Conclusion

Companies worldwide are prone to adjust their capital structures in order minimize tax payments in response to different tax legislations. Hence, examination of tax-efficient leverage structures is an important concern both for multinational corporations and for tax authorities that are determined to reduce the extent of tax avoidance. The previous literature has established that corporate financing structures depend on both tax factors and non-tax considerations, such as bankruptcy costs and agency costs. However, even though several empirical papers study international debt shifting and multinational firms' leverage responses to tax, they disagree on the mechanism.

Consequently, my study aims to close four gaps in the existing literature. Firstly, I explore whether international debt shifting mechanisms are significant determinants of capital structures of European multinational firms. More specifically, I consider sensitivity of firms' leverage to national and international corporate tax rates, represented by three tax mechanisms. The standard debt tax shield mechanism is the host country statutory corporate tax rate, relevant for both domestic firms and multinational firms. The external debt shifting mechanism (weighted tax difference) is measured as the weighted sum of differences between the corporate tax rate faced by an affiliate and tax rates faced by the parent firm and all other affiliates that belong to the multinational firm. The internal debt shifting mechanism (maximum tax difference) is measured as the difference between the corporate tax rate faced by an affiliate and the tax rate of the lowest-taxed affiliate within the multinational firm. Secondly, I investigate significance of omitted variable bias that is present in the previous literature, arising from omitting one of the debt shifting mechanisms from the analysis. Furthermore, I examine whether correctly specified historical ownership relations between subsidiaries and parent firms are important for analysis of debt shifting behaviour of European multinational firms. Finally, I examine whether European affiliates that belong to multinational firms with majority-owned affiliates outside Europe respond differently to tax incentives than European affiliates of multinational firms whose all affiliates operate in Europe.

I use the model specification proposed by Møen et al. (2011) and test the model's predictions on a large data sample of European multinational firms and their majority-owned European affiliates during the time period from 2003 to 2014. The empirical results show that affiliates' leverage depends on the host country corporate tax rate and the corporate tax

rates of all other affiliates that belong to the multinational corporation, as all tax mechanisms are statistically significant and positive determinants of affiliates' leverage. The findings confirm that international debt shifting among affiliates within a multinational group is a widely used technique of European multinational firms. These results provide answer to the first sub-question of my thesis – external and internal debt shifting mechanisms are important determinants of leverage structures of European multinational firms.

As a hypothetical example, consider a multinational corporation that consists of two affiliates – one foreign subsidiary and the parent firm. The two affiliates are of equal size and the foreign subsidiary is located in a country with a higher corporate tax rate than the parent firm. Consider that the subsidiary's host country increases the corporate tax rate by 10 percentage points, keeping everything else constant. According to my obtained estimates, the total effect on the subsidiary's debt-to-asset ratio will be an increase of 2.42 percentage points, while the total effect on the parent firm's debt-to-asset ratio will be a decrease of 0.27 percentage points. The effect found is 2.15 percentage points lower than the effect found by Møen et al. (2011) and 0.2 percentage points lower than the effect found by Huizinga et al. (2008). For an affiliate with an average total debt-to-asset ratio in the sample (0.59), an increase in the statutory corporate tax rate of 10 percentage points will lead to an increase in the total debt of approximately 4.1%. 68% of this increase is explained by the standard debt tax shield which can be exploited by both purely domestic firms and multinational firms. 32% of this increase is explained by the international debt shifting mechanisms, where the maximum tax difference mechanism contributes approximately two times more than the weighted tax difference mechanism.

Even though the effects of the international debt shifting mechanisms on affiliates' leverage are statistically significant, the effects are rather small. This can be explained by existence of preferential tax regimes for financial coordination centres, which leads to lower effective tax rates in countries with such jurisdictions. As statutory corporate tax rates are used as approximations for effective corporate tax rates in my study, the estimated coefficients on the international debt shifting mechanisms are likely to be biased downwards due to measurement error.

Nevertheless, control for international debt shifting is highly important while examining multinational firms' leverage responses to tax due to correlation between the tax mechanisms. Correlation leads to an omitted variable bias if any of the tax mechanisms are omitted from the specification. When the host country corporate tax rate is the only tax

mechanism included in the specification, its coefficient is biased upwards by approximately 51%. If the maximum tax difference variable has been omitted from the analysis, the omitted variable bias is approximately 16% for coefficient on the statutory tax rate variable and 41% for coefficient on the weighted tax difference variable. If the weighted tax difference variable has been omitted from the analysis, the omitted variable bias is approximately 20% for coefficient on the statutory tax rate variable and 22% for coefficient on the maximum tax difference variable. These results provide answer to the second sub-question of my thesis – there exists a substantial omitted variable bias arising from omitting any of the tax mechanisms from the specification. Thus, the previous studies that examine firms' leverage responses to tax and omit any of the tax mechanisms from their analyses are characterized by biased estimated coefficients on the tax mechanisms that are included in the specification.

Furthermore, adjustments for historical ownership changes between subsidiaries and parent firms are important while examining firms' leverage responses to tax. Even though several studies claim that misclassified ownership relations are not a major concern in their analyses, my results show the importance of correctly specified corporate structures. The international debt shifting mechanisms are particularly affected if historical ownership relations are misclassified, as these variables are constructed based on data on all affiliates within the multinational group. The obtained results provide answer the third sub-question of the thesis – correctly specified historical ownership relations between subsidiaries and parent firms are important while examining debt shifting behaviour of European multinational firms.

Finally, empirical results show that European affiliates that belong to multinational firms with majority-owned affiliates outside Europe are more indebted. Moreover, these affiliates seem to be less responsive to international tax incentives than affiliates that belong to multinational firms with only European affiliates. The obtained results can be explained by a potential measurement error in the international debt shifting variables that arises due to disregarding financial and tax data on affiliates outside Europe. Coefficient on the weighted tax difference variable is affected most because it depends on asset shares and tax data on all affiliates that belong to the multinational group. These findings provide answer to the fourth sub-question of the thesis – European multinational firms that have majority-owned affiliates outside Europe seem to react differently to tax incentives than European firms with only European affiliates due to measurement errors in the international tax mechanisms.

Overall, based on my obtained results, I can answer the main research question of the thesis – capital structures of European multinational firms are responsive to international tax incentives.

8.1. Suggestions and discussion

As revealed by the obtained results, international debt shifting of European multinational firms leads to lower taxable profits and corporate taxation levels in high-taxed countries. Lower-taxed countries are likely to benefit from international debt shifting because firms that operate in these countries tend to be less leveraged, which leads to higher corporate taxation levels in the lower-taxed countries. However, it seems that the lower-taxed countries have to reduce their budgeted expenses, even though many multinational firms have located their affiliates in these countries. As an example, the Netherlands that has a preferential tax regime had a budget deficit of 24.9 billion euros in 2012. Moreover, the 27 member states of the European Union had a total annual budget deficit of 519.5 billion euros in 2012. Hence, while multinational firms are able to avoid taxes and exploit preferential tax regimes, countries in Europe face budget deficits and must cut funding or salaries for the public sector (Drucker, 2013).

Moreover, international debt shifting is likely to create deadweight losses due to costs of implementing debt shifting strategies for multinational firms and efficiency costs arising from deviations from firms' optimal leverage ratios based on non-tax considerations (Dischinger, Glogowsky & Strobel, 2010, p. 3). In order to eliminate these deadweight losses and reduce international debt shifting, an international harmonization of effective corporate tax rates is necessary. Another mechanism to fight tax avoidance can be an introduction of a common consolidated corporate tax base for multinational firms' activities in different countries. The European Commission has already proposed a plan for establishing a common consolidated corporate tax base for firms' EU-wide activities. However, the tax base reform requires a unanimous support from all countries within the European Union, which might demand intense political pressure and be rather difficult to achieve (Oliver & Houlder, 2015).

Furthermore, the obtained results show that large multinational firms are relatively more likely to engage in international debt shifting than small multinational firms. Hence, specific policy mechanisms can be designed to focus especially on the largest multinational corporations and limit their ability to shift debt across affiliates for tax avoidance reasons.

Also, as tax incentives to use more leverage or engage in external debt shifting decrease when firms have losses to carry forward, the use of debt for tax avoidance reasons is likely to decrease during or after a financial crisis or a cyclical downturn in the economy. Thus, in case of a financial downturn, the anti-tax avoidance rules, such as thin capitalization regulations or earnings stripping rules, could be relaxed, as these regulations are based on the assumption that multinational firms use debt extensively to shift debt and avoid taxes.

Overall, increased transparency of tax information and more stringent requirements from multinational firms are necessary to ensure a fair tax system. If tax authorities do not implement mechanisms to reduce international debt shifting in response to tax incentives, multinational firms will continue to exploit loopholes in regulations and use debt extensively to shift profits and avoid taxes.

Finally, there are two suggestions based on my study that can be implemented in the future research within debt shifting of multinational firms. Firstly, it might be interesting to examine firms that change their status from domestic firms to multinational firms and vice versa over time. As changes in the status create large changes in the international debt shifting variables, tracing the entire history of firms that change their status and examining their leverage responses to the status change might lead to interesting findings. Secondly, using a dataset which has data on firms' internal and external leverage would allow examining firms' responses to taxation in terms of changes in both internal and external debt. Also summary and descriptive statistics would allow a deeper analysis of whether the data sample supports the model's predictions, for example, when examining net lending at the parent firm or financial coordination centre level.

Appendix A. Optimal external debt-to-asset ratio

In order to find the optimal external debt-to-asset ratio of an affiliate *i*, I reorder the first order condition for external debt (equation (6))[69]:

$$\mu \cdot b_i^E = \mu \cdot b^* + t_i \cdot r - \gamma b_i^E \cdot \rho_i - \gamma \cdot \sum_{j \neq i} b_j^E \cdot \rho_j, \quad (15)$$

where $\rho_i = \frac{K_i}{\sum_i K_i}$ represents the real capital employed in affiliate *i* as a share of the total real capital employed in the multinational corporation.

Furthermore, by subtracting equation (6) for an affiliate *j* from equation (6) for an affiliate *i*, the following expression is obtained:

$$b_j^E = b_i^E - \frac{t_i - t_j}{\mu} \cdot r. \quad (16)$$

Inserting equation (16) into equation (15) results in:

$$\mu \cdot b_i^E = \mu \cdot b^* + t_i \cdot r - \gamma b_i^E \cdot \rho_i - \gamma \cdot b_i^E \sum_{j \neq i} \rho_j + \gamma \cdot \sum_{j \neq i} \frac{t_i - t_j}{\mu} \cdot r \cdot \rho_j. \quad (17)$$

Following Huizinga et al. (2008) and Møen et al. (2011), this approach requires an assumption that withholding taxes are equal in all countries.

Furthermore, $\sum_{j \neq i} \rho_j$ can be expressed as following:

$$\sum_{j \neq i} \rho_j = \sum_{j \neq i} \frac{K_j}{\sum_i K_i} = \frac{\sum_i K_i - K_i}{\sum_i K_i} = 1 - \rho_i. \quad (18)$$

Then equation (18) can be inserted into equation (17). By gathering all terms with b_i^E on the left hand side, I obtain the optimal external debt-to-asset ratio as in equation (10).

[69] Equations following Møen et al. (2011, p. 43).

Appendix B. Statutory corporate tax rates

Table B1 shows statutory corporate tax rates by European countries in the data sample over the sample period (2003 – 2014). Tax rates are reported in percentages. Data on statutory corporate tax rates in Europe was obtained from KPMG's corporate tax rates table and corporate and indirect tax rate survey (KPMG, n.d.; KPMG, 2009), and the OECD's corporate income tax rates table and economic surveys (OECD, n.d.b.; OECD, 2013b).

Table B1: Statutory corporate tax rates

Country	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Albania	23	23	23	20	20	10	10	10	10	10	10	15
Andorra	5	5	5	5	5	5	5	5	5	5	10	10
Austria	34	34	25	25	25	25	25	25	25	25	25	25
Belarus	24	24	24	24	24	24	24	24	24	18	18	18
Belgium	34	34	34	34	34	34	34	34	34	34	34	34
Bosnia and Herzegovina	30	30	30	10	10	10	10	10	10	10	10	10
Bulgaria	24	20	15	15	10	10	10	10	10	10	10	10
Croatia	20	20	20	20	20	20	20	20	20	20	20	20
Cyprus	15	15	10	10	10	10	10	10	10	10	13	25
Czech Republic	31	28	26	24	24	21	20	19	19	19	19	19
Denmark	30	30	28	28	25	25	25	25	25	25	25	25
Estonia	26	26	24	23	22	21	21	21	21	21	21	21
Finland	29	29	26	26	26	26	26	26	26	25	25	20
France	35	35	35	34	34	34	34	34	34	34	34	33
Germany	40	39	39	39	39	30	30	30	30	30	30	30
Gibraltar	22	22	22	22	22	22	10	10	10	10	10	10
Greece	35	35	32	29	25	25	25	24	20	20	26	26
Hungary	18	16	16	17	20	20	20	19	19	19	19	19
Iceland	18	18	18	18	18	15	15	18	20	20	20	20
Ireland	13	13	13	13	13	13	13	13	13	13	13	13
Italy	34	33	33	33	33	28	28	28	28	28	28	31
Kosovo	20	20	20	20	20	20	10	10	10	10	10	10
Latvia	19	15	15	15	15	15	15	15	15	15	15	15
Liechtenstein	13	13	13	13	13	13	13	13	13	13	13	13
Lithuania	15	15	15	15	15	15	20	15	15	15	15	15
Luxembourg	30	30	30	30	30	30	29	29	29	29	29	29
Macedonia	15	15	15	15	12	10	10	10	10	10	10	10
Malta	35	35	35	35	35	35	35	35	35	35	35	35
Moldova	20	20	18	15	15	0	0	0	0	12	12	12
Monaco	33	33	33	33	33	33	33	33	33	33	33	33
Montenegro	20	20	9	9	9	9	9	9	9	9	9	9
Netherlands	35	35	32	30	26	26	26	26	25	25	25	25
Norway	28	28	28	28	28	28	28	28	28	28	28	27

Table B1 (continued)

Country	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Poland	27	19	19	19	19	19	19	19	19	19	19	19
Portugal	33	28	28	28	27	27	27	27	27	32	32	23
Romania	25	25	16	16	16	16	16	16	16	16	16	16
Russia	24	24	24	24	24	24	20	20	20	20	20	20
San Marino	17	17	17	17	17	17	17	17	17	17	17	17
Serbia	14	12	10	10	10	10	10	10	10	10	15	15
Slovakia	25	19	19	19	19	19	19	19	19	19	23	22
Slovenia	25	25	25	25	23	22	21	20	20	20	17	17
Spain	35	35	35	35	33	30	30	30	30	30	30	30
Sweden	28	28	28	28	28	28	26	26	26	26	22	22
Switzerland	24	24	21	21	21	21	21	21	21	21	21	18
Turkey	30	33	30	20	20	20	20	20	20	20	20	20
Ukraine	30	30	25	25	25	25	25	25	25	21	19	18
United Kingdom	30	30	30	30	30	28	28	28	26	24	23	21

Appendix C. Variable definitions and data sources

Table C1 provides definitions and data sources for dependent and independent variables used in the study.

Table C1: Variable definitions and data sources

Variable	Definition	Source
Total debt-to-asset ratio (financial leverage)	Ratio of total liabilities to total assets	Amadeus
Aggregated total debt-to-asset ratio	Numerator of aggregated total debt-to-asset ratio: Aggregated total liabilities of all affiliates of the multinational firm that operate within a country	Amadeus
	Denominator of aggregated total debt-to-asset ratio: Sum of equity of the holding company of the multinational firm within a country and aggregated total liabilities of all affiliates of the multinational firm within a country	
Statutory corporate tax rate (standard debt tax shield mechanism)	Host country statutory corporate tax rate of an affiliate *i*	KPMG's corporate tax rates table and corporate and indirect tax rate survey; OECD's corporate income tax rates table and economic surveys
Weighted tax difference (external debt shifting mechanism)	Asset-weighted sum of differences in the corporate tax rate faced by an affiliate *i* and tax rates faced by the parent firm and all other affiliates that belong to the multinational corporation	KPMG's corporate tax rates table and corporate and indirect tax rate survey; OECD's corporate income tax rates table and economic surveys
Maximum tax difference (internal debt shifting mechanism)	Difference between the corporate tax rate faced by an affiliate *i* and tax rate of the lowest-taxed affiliate in the multinational corporation	KPMG's corporate tax rates table and corporate and indirect tax rate survey; OECD's corporate income tax rates table and economic surveys
Fixed asset ratio (tangibility)	Ratio of fixed assets to total assets	Amadeus
Firm size	Logarithm of sales	Amadeus
	Logarithm of firms' operating revenue (turnover) for firms located in Denmark, Ireland, Russia and the United Kingdome	

Table C1 (continued)

Variable	Definition	Source
Loss carry-forward	Dummy variable equal to 1 if a firm has losses that it can carry forward	Amadeus
Profitability	Ratio of earnings before interest, tax, depreciation and amortization (EBITDA) to total assets	Amadeus
	Ratio of earnings before interest and tax (EBIT) to total assets for firms located in Russia	
Inflation	Annual percentage change in the consumer price index	World Development Indicators of the World Bank; World Economic Outlook Database of the International Monetary Fund; Consumer Prices Database of the OECD
Corruption	Logarithm of annual corruption index. Corruption index is within [0;10] interval, where 10 indicates a country with a very low level of corruption	Worldwide Governance Indicators of the World Bank
Growth opportunities	Median annual growth in sales per industry and country	Amadeus
Creditor rights	Logarithm of annual strength of legal rights index. Strength of legal rights index is within [0;10] interval, where 10 indicates a country with a very high creditor protection	World Development Indicators of the World Bank
Sales quintile	Dummy variables for the sales quintile to which a firm belongs in a particular year	Amadeus
Out of Europe dummy	Dummy variable equal to 1 if the multinational firm has majority-owned affiliates outside Europe	Orbis Ownership database
Lower than minimum tax dummy	Dummy variable equal to 1 if the multinational firm has majority-owned affiliates outside Europe whose minimum statutory corporate tax is lower than the minimum tax rate among firm's European affiliates	Orbis Ownership database; KPMG's corporate tax rates table and corporate and indirect tax rate survey; OECD's corporate income tax rates table and economic surveys
Higher than maximum tax dummy	Dummy variable equal to 1 if the multinational firm has majority-owned affiliates outside Europe whose maximum statutory corporate tax is higher than the maximum tax rate among firm's European affiliates	Orbis Ownership database; KPMG's corporate tax rates table and corporate and indirect tax rate survey; OECD's corporate income tax rates table and economic surveys

Table C1 (continued)

Variable	Definition	Source
Statutory tax rate * Loss carry-forward; Weighted tax difference * Loss carry-forward; Maximum tax difference * Loss carry-forward	Loss carry-forward interaction terms between tax mechanisms and the loss carry-forward dummy	Amadeus; KPMG's corporate tax rates table and corporate and indirect tax rate survey; OECD's corporate income tax rates table and economic surveys
(Statutory tax rate)^2; (Weighted tax difference)^2; (Maximum tax difference)^2	Quadratic tax mechanisms	KPMG's corporate tax rates table and corporate and indirect tax rate survey; OECD's corporate income tax rates table and economic surveys

Appendix D. Year-by-year summary statistics

Table D1 provides year-by-year summary statistics of the total debt-to-asset ratio and the tax mechanisms.

Table D1: Year-by-year summary statistics

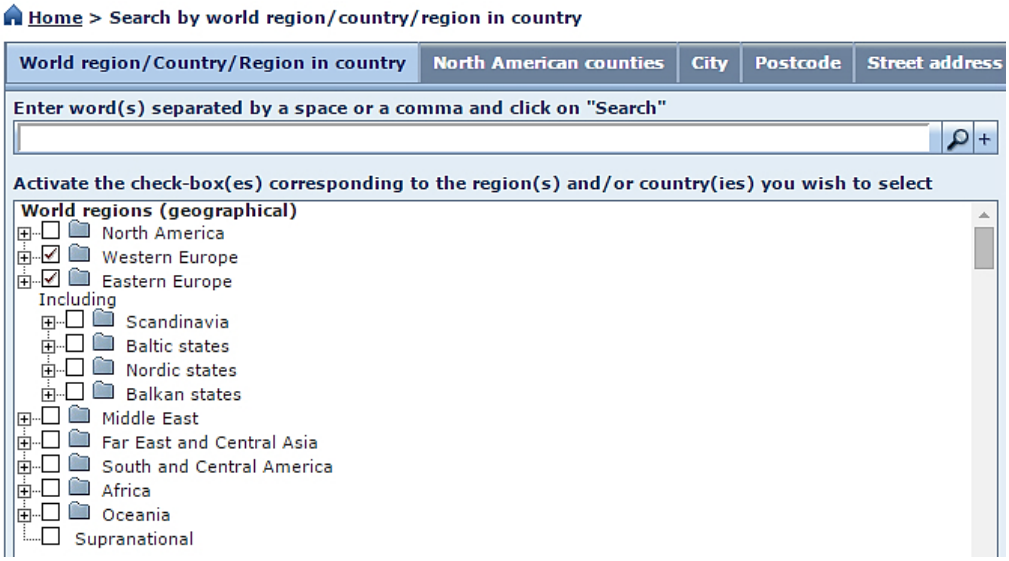
Variable	Year	Mean	Standard deviation	Observations
Total debt-to-asset ratio	2003	0.624	0.263	6,899
Total debt-to-asset ratio	2004	0.615	0.261	36,172
Total debt-to-asset ratio	2005	0.614	0.264	48,776
Total debt-to-asset ratio	2006	0.611	0.263	62,705
Total debt-to-asset ratio	2007	0.608	0.268	78,701
Total debt-to-asset ratio	2008	0.601	0.273	92,519
Total debt-to-asset ratio	2009	0.588	0.283	127,367
Total debt-to-asset ratio	2010	0.584	0.282	124,409
Total debt-to-asset ratio	2011	0.588	0.288	163,983
Total debt-to-asset ratio	2012	0.584	0.288	165,357
Total debt-to-asset ratio	2013	0.570	0.293	130,770
Total debt-to-asset ratio	2014	0.544	0.277	2,169
Statutory corporate tax rate	2003	0.312	0.052	6,899
Statutory corporate tax rate	2004	0.299	0.058	36,172
Statutory corporate tax rate	2005	0.287	0.078	48,776
Statutory corporate tax rate	2006	0.292	0.070	62,705
Statutory corporate tax rate	2007	0.293	0.069	78,701
Statutory corporate tax rate	2008	0.273	0.058	92,519
Statutory corporate tax rate	2009	0.262	0.061	127,367
Statutory corporate tax rate	2010	0.266	0.061	124,409
Statutory corporate tax rate	2011	0.255	0.062	163,983
Statutory corporate tax rate	2012	0.254	0.064	165,357
Statutory corporate tax rate	2013	0.242	0.066	130,770
Statutory corporate tax rate	2014	0.251	0.055	2,169
Weighted tax difference	2003	-0.006	0.038	6,899
Weighted tax difference	2004	-0.006	0.039	36,172
Weighted tax difference	2005	-0.007	0.043	48,776

Table D1 (continued)

Variable	Year	Mean	Standard deviation	Observations
Weighted tax difference	2006	-0.007	0.045	62,705
Weighted tax difference	2007	-0.006	0.046	78,701
Weighted tax difference	2008	-0.005	0.037	92,519
Weighted tax difference	2009	-0.005	0.037	127,367
Weighted tax difference	2010	-0.006	0.039	124,409
Weighted tax difference	2011	-0.005	0.037	163,983
Weighted tax difference	2012	-0.005	0.037	165,357
Weighted tax difference	2013	-0.002	0.034	130,770
Weighted tax difference	2014	-0.001	0.029	2,169
Maximum tax difference	2003	0.045	0.068	6,899
Maximum tax difference	2004	0.053	0.072	36,172
Maximum tax difference	2005	0.057	0.075	48,776
Maximum tax difference	2006	0.064	0.076	62,705
Maximum tax difference	2007	0.067	0.076	78,701
Maximum tax difference	2008	0.055	0.065	92,519
Maximum tax difference	2009	0.053	0.065	127,367
Maximum tax difference	2010	0.056	0.066	124,409
Maximum tax difference	2011	0.051	0.064	163,983
Maximum tax difference	2012	0.050	0.064	165,357
Maximum tax difference	2013	0.039	0.057	130,770
Maximum tax difference	2014	0.024	0.041	2,169

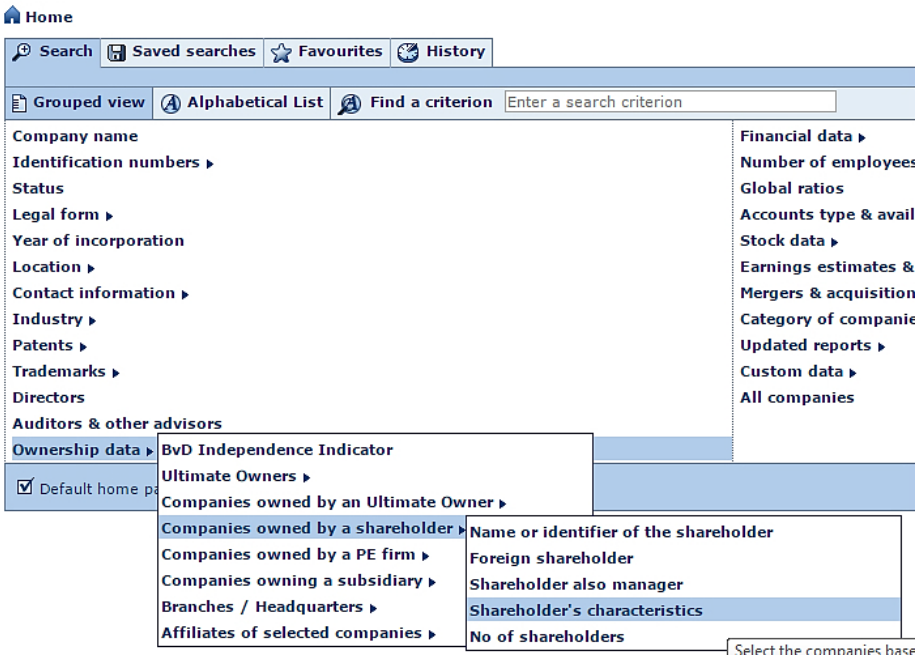
Appendix E. Obtaining data in Orbis and Amadeus databases

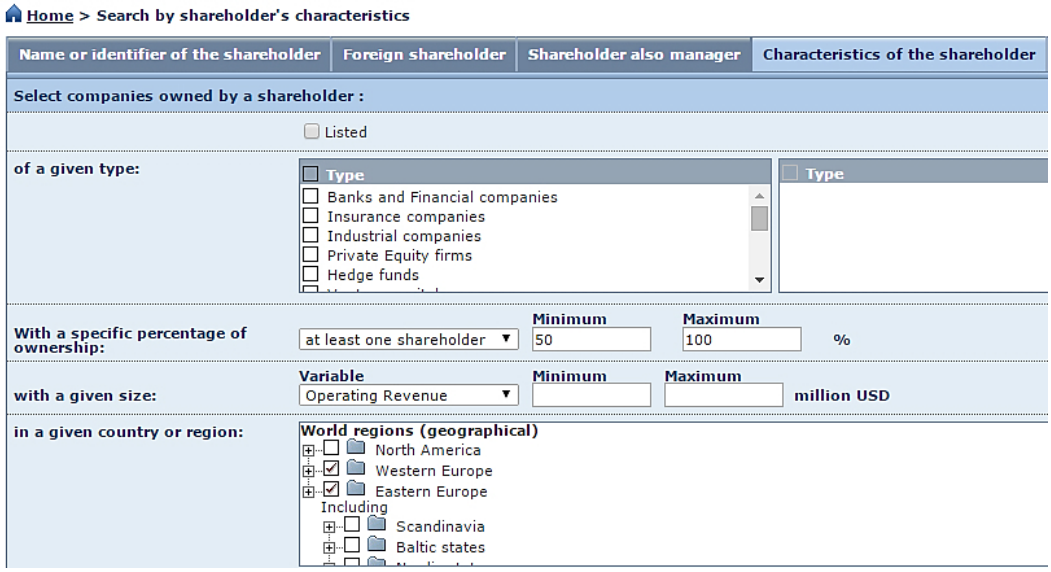
1. To obtain historical ownership data on European multinational firms, start with the Orbis database. Firstly, choose region of subsidiaries (Location – World region/ Country/ Region in country). As I examine European subsidiaries only, I select Western Europe and Eastern Europe regions.



2. Select only subsidiaries that are owned by a shareholder (Ownership data – Companies owned by a shareholder – Shareholder's characteristics). As I examine European multinational firms only, I select Western Europe and Eastern Europe

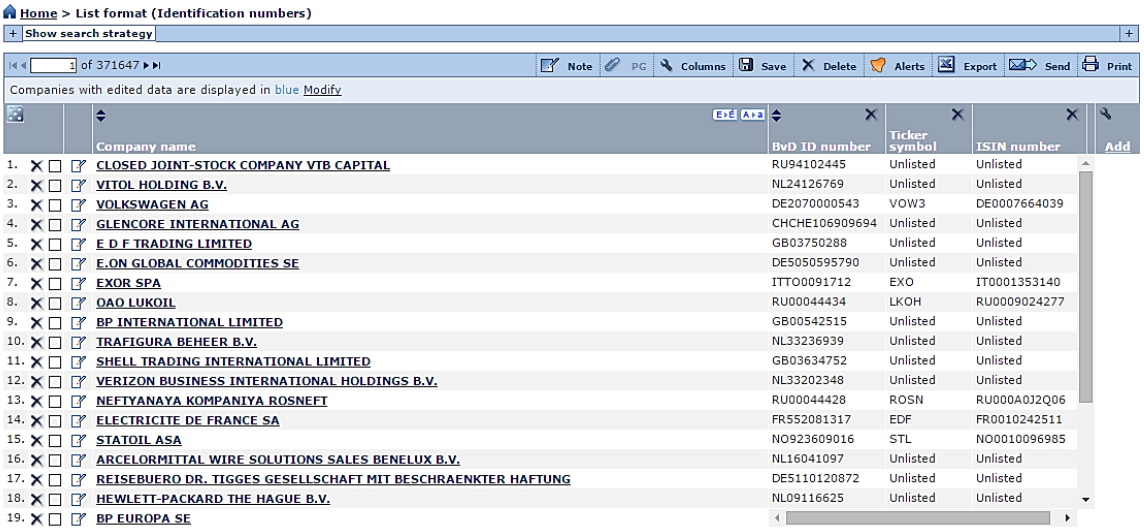
regions. Furthermore, I select the option that at least one shareholder owns at least 50% in the subsidiary, as I examine only majority-owned subsidiaries.



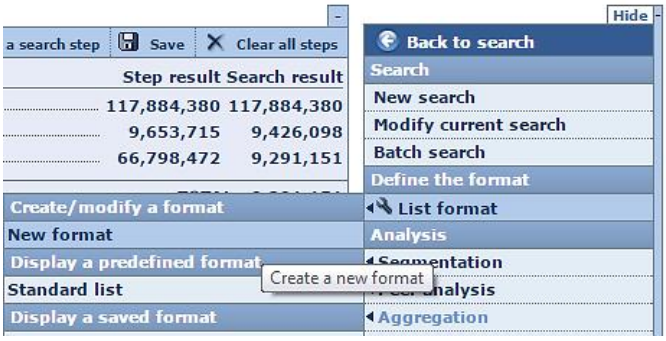


After defining regions of subsidiaries and their shareholders, the search strategy shows how many subsidiaries are found as a search result.

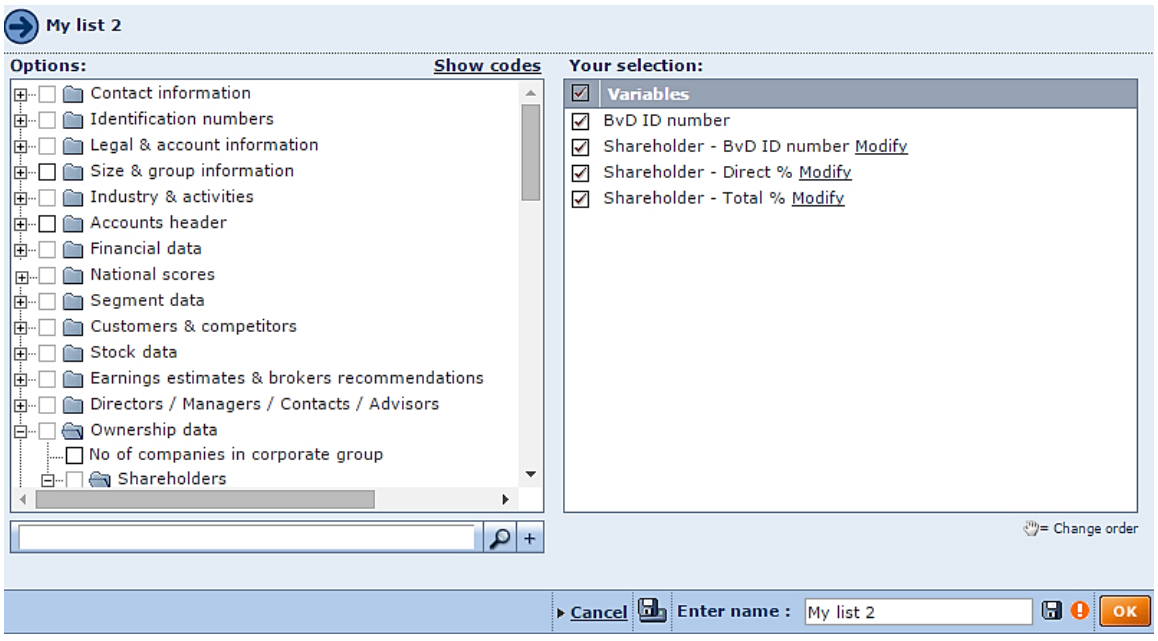
3. Click “View list of results” to view the list of subsidiaries found as a search result, their BvD ID numbers, ticker symbols and ISIN numbers.



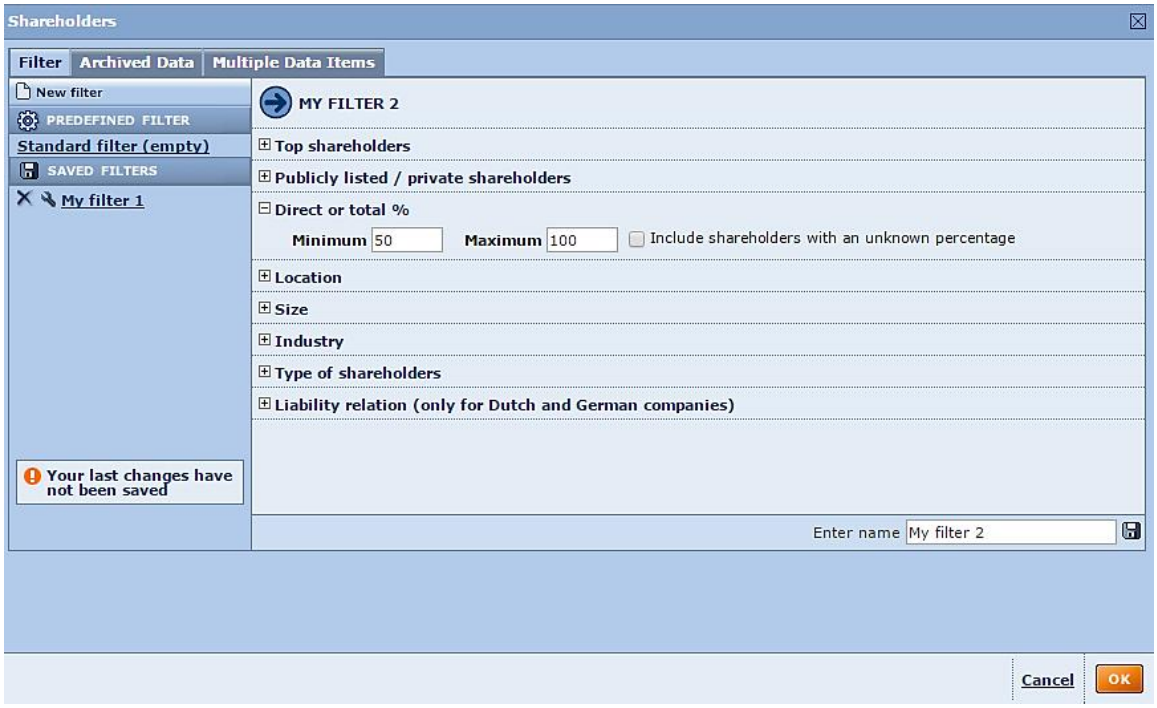
4. To obtain ownership data on the subsidiaries found, a new list must be defined (Define the format – List format – Create/ modify a format – New format).



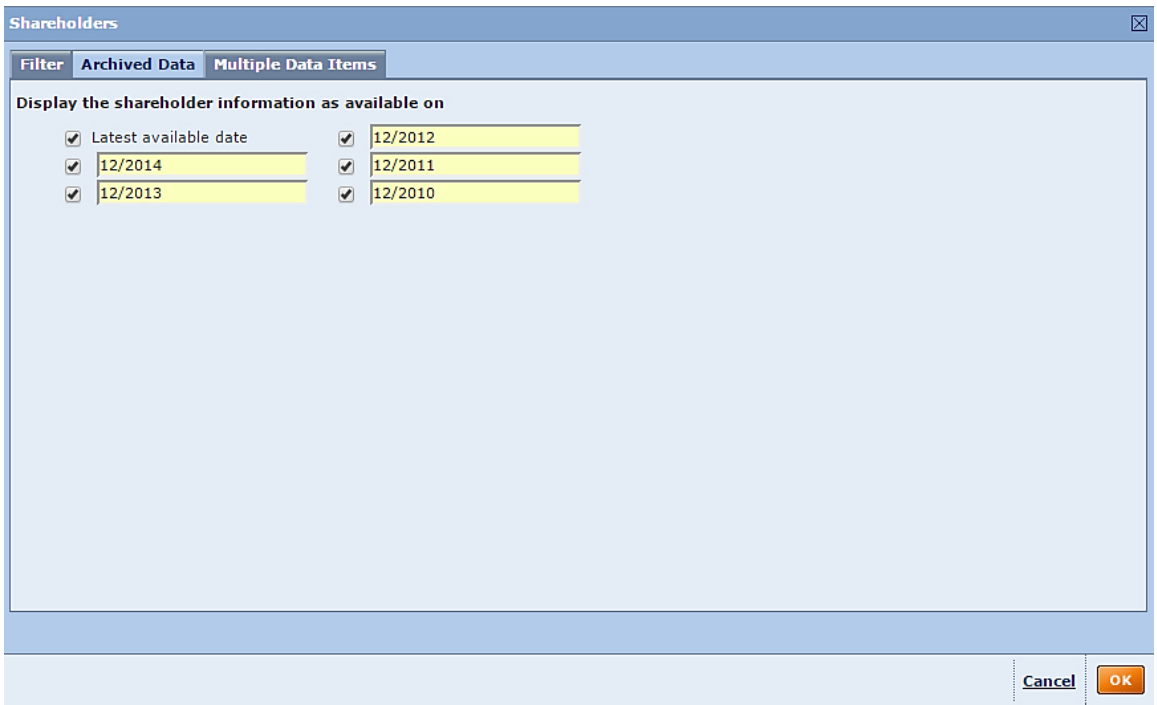
Furthermore, choose Identification numbers – BvD ID number; Ownership data – Shareholders – Shareholder information – BvD ID number, Direct %, Total %.



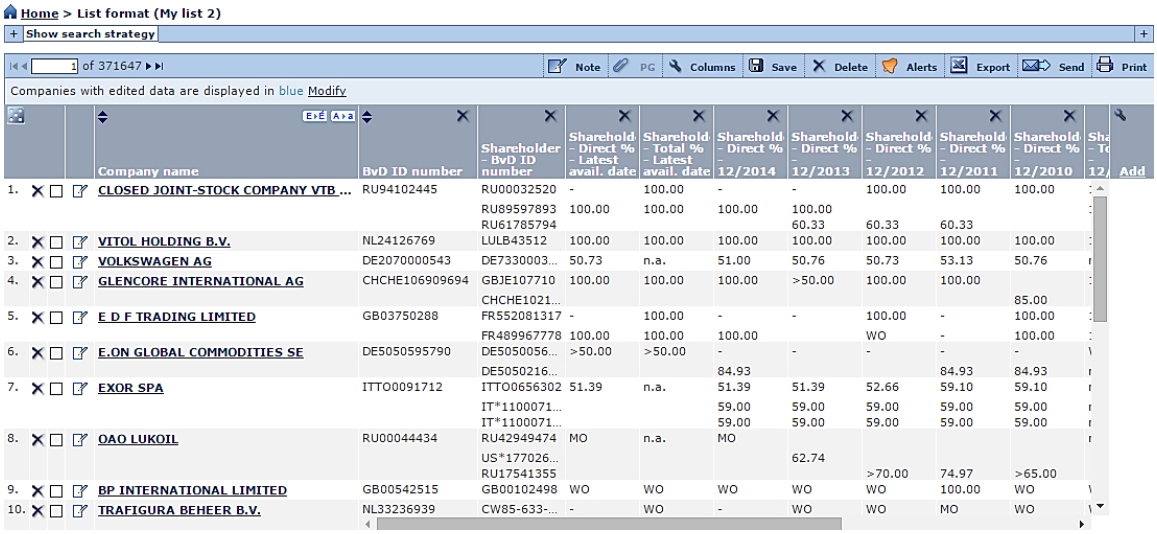
Then click on “Modify”, next to the Shareholder – BvD ID number entry. In “Filter” tab, click on “Direct of total %”, to choose which shareholders to display in the list. As I examine only majority-owned subsidiaries, I select that the ownership share is at least 50%.



To obtain historical ownership data on subsidiaries, click on “Archived Data” tab and select the years for which historical ownership data is necessary.

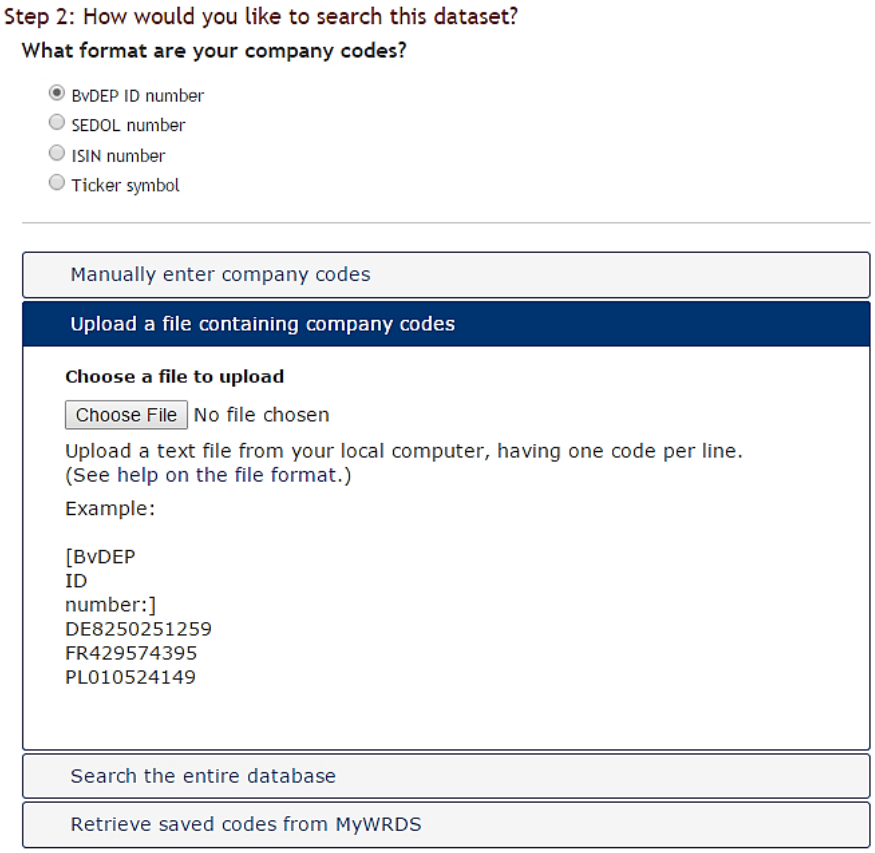


The obtained list on historical ownership relations between subsidiaries and shareholders can be exported to Excel by clicking “Export” tab.



	Company name	BvD ID number	Shareholder – BvD ID number	Shareholding – Direct % – Latest avail. date	Shareholding – Total % – Latest avail. date	Shareholding – Direct % – 12/2014	Shareholding – Direct % – 12/2013	Shareholding – Direct % – 12/2012	Shareholding – Direct % – 12/2011	Shareholding – Direct % – 12/2010
1.	CLOSED JOINT-STOCK COMPANY VTB ...	RU94102445	RU00032520	-	100.00	-	-	100.00	100.00	100.00
			RU89597893	100.00	100.00	100.00	100.00			
			RU61785794				60.33	60.33	60.33	
2.	VITOL HOLDING B.V.	NL24126769	LULB43512	100.00	100.00	100.00	100.00	100.00	100.00	100.00
3.	VOLKSWAGEN AG	DE2070000543	DE7330003...	50.73	n.a.	51.00	50.76	50.73	53.13	50.76
4.	GLENCORE INTERNATIONAL AG	CHCHE106909694	GBJE107710	100.00	100.00	100.00	>50.00	100.00	100.00	
			CHCHE1021...							85.00
5.	E D F TRADING LIMITED	GB03750288	FR552081317	-	100.00	-	-	100.00	-	100.00
			FR489967778	100.00	100.00	100.00		WO	-	100.00
6.	E.ON GLOBAL COMMODITIES SE	DE5050595790	DE5050056...	>50.00	>50.00	-	-	-	-	-
			DE5050216...			84.93			84.93	84.93
7.	EXOR SPA	ITTO0091712	ITTO0656302	51.39	n.a.	51.39	51.39	52.66	59.10	59.10
			IT*1100071...			59.00	59.00	59.00	59.00	59.00
			IT*1100071...			59.00	59.00	59.00	59.00	59.00
8.	OAO LUKOIL	RU00044434	RU42949474	MO	n.a.	MO				
			US*177026...				62.74			
			RU17541355					>70.00	74.97	>65.00
9.	BP INTERNATIONAL LIMITED	GB00542515	GB00102498	WO	WO	WO	WO	WO	100.00	WO
10.	TRAFIGURA BEHEER B.V.	NL33236939	CW85-633-...	-	WO	-	WO	WO	MO	WO

5. To obtain financial data on subsidiaries and their shareholders, use the Amadeus Financials database. In Step 2, choose the format of company codes (BvDEP ID number), and either manually enter company codes from the Orbis database or upload a file containing company codes.



Appendix F. Do file of the main specification

```
*** DO FILE OF THE MAIN SPECIFICATION
encode nace_prim_code, gen(nacerev2primarycodes)
rename fias fixedassets
rename toas totalassets
rename ncli noncurrentliabilities
rename culi currentliabilities
rename turn sales
rename plbt plbeforetax
rename taxa taxation
rename plat plaftertax
rename ebta ebitda
rename cntrycde countryisocode
rename pcntrycde pcountryisocode
rename parents_code parents_final
rename pl net_income
*** DROP PURELY DOMESTIC FIRMS
generate foreign=(countryisocode!=pcountryisocode)
label variable foreign "=1 if foreign; =0 if domestic"
egen id_parent = group( parents_final )
bysort id_parent year: egen MNC=max(foreign)
label variable MNC "=1 if MNC; =0 if domestic firm"
drop if MNC==0
*** CHECK IF ALL OBSERVATIONS HAVE COUNTRY ISO CODES AND PARENT
    COUNTRY ISO CODES
sort countryisocode
sort pcountryisocode
*** MERGE OBSERVATIONS WITH TAX RATES
merge m:m year countryisocode using "C:\Users\Aija\Desktop\Aija Orbis\Effective Corporate
    Tax Rates.dta", generate(_mergeTax)
sort _mergeTax
drop if _mergeTax==2
drop if _mergeTax==1
merge m:m year pcountryisocode using "C:\Users\Aija\Desktop\Aija Orbis\Parents Effective
    Corporate Tax Rates 22.03.dta", generate(_mergeParentTax)
drop if _mergeParentTax==2
drop if _mergeParentTax==1
***
rename fixedassets fixedassets_sub
rename totalassets totalassets_sub
rename sales sales_sub
rename plbeforetax plbeforetax_sub
rename taxation taxation_sub
rename plaftertax plaftertax_sub
rename ebitda ebitda_sub
rename net_income net_income_sub
***
egen id_subsidiary = group(subsidiary_code)
gen taxrate_percentage=taxrate/100
label variable taxrate_percentage "Statutory tax rate"
```

```
*** ACCOUNTS IN DIFFERENT CURRENCIES - MUST CONVERT INTO EUROS
gen fixed_assets_euro=fixedassets_sub*exchrate2
gen total_assets_euro=totalassets_sub*exchrate2
gen sales_euro=sales_sub*exchrate2
gen plbeforetax_euro=plbeforetax_sub*exchrate2
gen taxation_euro=taxation_sub*exchrate2
gen plaftertax_euro=plaftertax_sub*exchrate2
gen ebita_euro=ebitda_sub*exchrate2
gen noncurrentliabilities_euro=noncurrentliabilities*exchrate2
gen currentliabilities_euro=currentliabilities*exchrate2
gen net_income_euro=net_income_sub*exchrate2
gen debt_euro=debt*exchrate2
gen cred_euro=cred*exchrate2
gen fiex_euro=fiex*exchrate2
gen inte_euro=inte*exchrate2
gen ltdb_euro=ltdb*exchrate2
gen loan_euro=loan*exchrate2
*** CREATE SUBSIDIARY-YEAR OBSERVATIONS PER VARIABLES USED, DUE TO
    SLIGHT REPORTING DIFFERENCES IN FINANCIAL DATA PER SUBSIDIARY, PER
    YEAR
egen fixed_assets = mean( fixed_assets_euro), by( subsidiary_code year )
egen total_assets= mean( total_assets_euro ), by( subsidiary_code year )
gen total_assets_mil=total_assets/1000000
label variable total_assets_mil "Total assets(mln)"
label variable total_assets "Total assets"
generate total_liabilities_euro= noncurrentliabilities_euro+ currentliabilities_euro
replace total_liabilities_euro= currentliabilities_euro if noncurrentliabilities_euro==. &
    total_liabilities_euro==.
replace total_liabilities_euro= noncurrentliabilities_euro if currentliabilities_euro==. &
    total_liabilities_euro==.
egen total_liabilities= mean( total_liabilities_euro ), by( subsidiary_code year )
egen sales= mean( sales_euro), by( subsidiary_code year )
label variable sales "Sales"
egen plbeforetax  = mean( plbeforetax_euro ), by( subsidiary_code year )
egen taxation= mean( taxation_euro ), by( subsidiary_code year )
egen plaftertax= mean( plaftertax_euro ), by( subsidiary_code year )
egen ebitda= mean( ebita_euro ), by( subsidiary_code year )
egen net_income = mean( net_income_euro ), by( subsidiary_code year )
egen debtors=mean( debt_euro ), by( subsidiary_code year )
egen creditors=mean (cred_euro), by( subsidiary_code year )
egen financial_expenses=mean(fiex_euro), by( subsidiary_code year )
label variable financial_expenses "Financial expenses (mln)"
egen interest_paid=mean(inte_euro), by( subsidiary_code year )
label variable interest_paid "Interest paid (mln)"
egen long_term_debt=mean(ltdb_euro), by( subsidiary_code year )
label variable long_term_debt "Long-term debt (mln)"
egen short_term_debt=mean(loan_euro), by( subsidiary_code year )
label variable short_term_debt "Short-term debt (mln)"
*** DROP SUBSIDIARY-YEAR OBSERVATIONS THAT OCCUR MORE THAN ONCE PER
    PARENT FIRM IN THE SAME YEAR
by subsidiary_code year, sort: gen pid = _n
```

```
bysort subsidiary_code year id_parent: generate drop_parent=1 if year==year[_n + 1] &
      id_parent==id_parent[_n + 1]
label variable drop_parent "=1 if parents are the same and years the same; =0 otherwise"
drop if drop_parent==1
drop loan effectivetaxrate taxrate_benelux_smaller taxrate_belenux efftaxrate_smaller_benelux
      belenux_actual _mergeTax ptaxrate peffectivetaxrate ptaxrate_benelux_smaller
      ptaxrate_belenux pefftaxrate_smaller_benelux pbelenux_actual _mergeParentTax  ptoas
      cred ncas sales_sub fire fiex fipl plbeforetax_sub taxation_sub plaftertax_sub
      net_income_sub inte ebitda_sub pexchrate2 fixedassets_sub totalassets_sub
      fixed_assets_euro total_assets_euro sales_euro plbeforetax_euro taxation_euro
      plaftertax_euro ebita_euro noncurrentliabilities_euro currentliabilities_euro
      net_income_euro total_liabilities_euro
*** CONTROL VARIABLES
merge m:m year countryisocode using "C:\Users\Aija\Desktop\Aija Orbis\Creditor rights.dta",
      generate(_mergeCreditorRights)
drop if _mergeCreditorRights==2
drop if _mergeCreditorRights==1
label variable log_creditor_rights_index "Log(Creditor rights index)"
merge m:m year countryisocode using "C:\Users\Aija\Desktop\Aija Orbis\Inflation.dta",
      generate(_mergeInflation)
drop if _mergeInflation==2
rename inflation_percentage_points inflation_percentage_points_pp
gen inflation_percentage_points=inflation_percentage_points_pp*100
label variable inflation_percentage_points "Inflation"
merge m:m year countryisocode using "C:\Users\Aija\Desktop\Aija Orbis\Political risk
      index.dta", generate(_mergePoliticalRisk)
drop if _mergePoliticalRisk==2
label variable log_political_risk "Log(Political risk index)"
merge m:m year countryisocode using "C:\Users\Aija\Desktop\Aija Orbis\Corruption
      index.dta", generate(_mergeCorruption)
drop if _mergeCorruption==2
label variable log_corruption_index "Log(Corruption index)"
gen profitability=ebitda/total_assets
label variable profitability "Profitability"
generate log_sales=ln(sales)
label variable log_sales "Log(Sales)"
sort subsidiary_code year
bysort subsidiary_code: gen growth_opp=(sales-sales[_n-1])/sales[_n-1]
bysort  nacerev2primarycodes countryisocode year: egen growth_opp_final=median(
      growth_opp)
rename growth_opp growth_sales
rename growth_opp_final growth_opp
label variable growth_opp "Growth opportunities"
gen loss_carryforward=( net_income<0)
label variable loss_carryforward "Loss carry-forward"
gen fixed_asset_ratio= fixed_assets/ total_assets
label variable fixed_asset_ratio "Fixed asset ratio"
gen net_lender=debtors-creditors
label variable net_lender "Net lending"
drop creditorrights scale0100 creditor_rights_index creditor_rights_index_0_10
      _mergeCreditorRights inflation inflation_percent _mergeInflation politicalriskindex
      indexonscale0100 political_risk_0_10 _mergePoliticalRisk corruptionindex
```

```
        corruptionindex0100 corruption_index corruption_index_0_10 _mergeCorruption
        growth_sales
*** DROP OBSERVATIONS WITH EXTREME TOTAL DEBT-TO-ASSET RATIOS (TDARs)
generate tdar=total_liabilities/total_assets
sum tdar
drop if tdar<0
drop if tdar>1
label variable tdar "Total debt-to-asset-ratio"
*** TOUSE
gen touse = !missing(id_parent, log_creditor_rights_index, profitability,
        nacerev2primarycodes, tdar, taxrate_percentage, log_sales, fixed_asset_ratio,
        inflation_percentage_points, log_corruption_index, growth_opp, loss_carryforward,
        net_lender, financial_expenses, interest_paid, long_term_debt, short_term_debt )
drop if touse==0
*** MAXIMUM TAX DIFFERENCE VARIABLE
bysort id_parent year: egen tax_min=min(taxrate)
gen max_tax_diff=(taxrate - tax_min)/100
label variable max_tax_diff "Maximum tax difference"
gen NLS=( max_tax_diff!=0)
label variable NLS "NLS (not the lowest taxed subsidiary)"
*** WEIGHTED TAX DIFFERENCE VARIABLE
egen total_assets_MNC = total( total_assets ), by(id_parent year)
generate share= total_assets/ total_assets_MNC
drop if taxrate==.
set more off
local i=1
bysort id_parent year: egen Sb=count( id_subsidiary )
egen MaxSb=max(Sb)
while(taxrate[_n+`i']!=.)&`i'<=MaxSb{
bysort id_parent year: gen wdiff`i'=((taxrate-taxrate[_n+`i'])/100)*(share[_n+`i'])
replace wdiff`i'=0 if wdiff`i'==.
bysort id_parent year: gen wdiff_`i'=((taxrate-taxrate[_n-`i'])/100)*(share[_n-`i'])
replace wdiff_`i'=0 if wdiff_`i'==.
local i=`i'+1
}
egen weighted_tax_diff=rowtotal(wdiff*)
drop wdiff*
label variable weighted_tax_diff "Weighted tax difference"
*** DESCRIPTIVE STATISTICS
replace touse = !missing(id_parent, log_creditor_rights_index, profitability,
        nacerev2primarycodes, tdar, weighted_tax_diff, taxrate_percentage, max_tax_diff,
        log_sales, fixed_asset_ratio, inflation_percentage_points, log_corruption_index,
        growth_opp, loss_carryforward, net_lender, financial_expenses, interest_paid,
        long_term_debt, short_term_debt )
labsumm tdar taxrate_percentage weighted_tax_diff max_tax_diff fixed_asset_ratio log_sales
        loss_carryforward profitability inflation_percentage_points log_corruption_index
        growth_opp log_creditor_rights_index total_assets_mil long_term_debt short_term_debt
        financial_expenses interest_paid net_lender if touse
labsumm tdar taxrate_percentage weighted_tax_diff max_tax_diff fixed_asset_ratio log_sales
        loss_carryforward profitability inflation_percentage_points log_corruption_index
        growth_opp log_creditor_rights_index total_assets_mil long_term_debt short_term_debt
        financial_expenses interest_paid net_lender if touse & NLS==1
```

```
labsumm tdar taxrate_percentage weighted_tax_diff max_tax_diff fixed_asset_ratio log_sales
      loss_carryforward profitability inflation_percentage_points log_corruption_index
      growth_opp log_creditor_rights_index total_assets_mil long_term_debt short_term_debt
      financial_expenses interest_paid net_lender if touse & NLS==0
codebook id_parent if touse
*** YEAR DUMMIES
tabulate year, gen(yr)
*** REGRESSIONS OF MAIN SPECIFICATION
eststo clear
eststo: felsdvreg tdar taxrate_percentage weighted_tax_diff max_tax_diff yr* if touse,
      ivar(id_parent ) jvar(nacerev2primarycodes) feff(feff) peff(peff) xb(xb) res(res)
      mover(mover) mnum(mnum) pobs(pobs) group(group) robust
predict tdarp1 if touse
corr tdar tdarp1 if touse
di r(rho)^2
outreg, se sdec(3) starloc(1) starlevels(10 5 1)  summstat(r2\N) summdec(0) summtitles("R-
      squared"\"Number of observations") varlabels  colwidth(20)  ctitles("OLS regression
      results""(1)") basefont(fs10)
eststo: felsdvreg tdar taxrate_percentage weighted_tax_diff max_tax_diff log_sales
      fixed_asset_ratio inflation_percentage_points log_corruption_index growth_opp
      loss_carryforward log_creditor_rights_index profitability yr* if touse, ivar(id_parent )
      jvar(nacerev2primarycodes) feff(feff) peff(peff) xb(xb) res(res) mover(mover)
      mnum(mnum) pobs(pobs) group(group) robust
predict tdarp2 if touse
corr tdar tdarp2 if touse
di r(rho)^2
outreg, se sdec(3) starloc(1) starlevels(10 5 1)  summstat(r2\N) summdec(0) summtitles("R-
      squared"\"Number of observations") varlabels  colwidth(20)  ctitles("OLS regression
      results""(2)") basefont(fs10) merge
eststo: felsdvreg tdar taxrate_percentage weighted_tax_diff log_sales fixed_asset_ratio
      inflation_percentage_points log_corruption_index growth_opp loss_carryforward
      log_creditor_rights_index profitability yr* if touse, ivar(id_parent )
      jvar(nacerev2primarycodes) feff(feff) peff(peff) xb(xb) res(res) mover(mover)
      mnum(mnum) pobs(pobs) group(group) robust
predict tdarp3 if touse
corr tdar tdarp3 if touse
di r(rho)^2
outreg, se sdec(3) starloc(1) starlevels(10 5 1)  summstat(r2\N) summdec(0) summtitles("R-
      squared"\"Number of observations") varlabels  colwidth(20)  ctitles("OLS regression
      results""(3)") basefont(fs10) merge
eststo: felsdvreg tdar taxrate_percentage max_tax_diff log_sales fixed_asset_ratio
      inflation_percentage_points log_corruption_index growth_opp loss_carryforward
      log_creditor_rights_index profitability yr* if touse, ivar(id_parent )
      jvar(nacerev2primarycodes) feff(feff) peff(peff) xb(xb) res(res) mover(mover)
      mnum(mnum) pobs(pobs) group(group) robust
predict tdarp4 if touse
corr tdar tdarp4 if touse
di r(rho)^2
outreg, se sdec(3) starloc(1) starlevels(10 5 1)  summstat(r2\N) summdec(0) summtitles("R-
      squared"\"Number of observations") varlabels  colwidth(20)  ctitles("OLS regression
      results""(4)") basefont(fs10) merge
```

```
eststo: felsdvreg tdar taxrate_percentage log_sales fixed_asset_ratio
    inflation_percentage_points log_corruption_index growth_opp loss_carryforward
    log_creditor_rights_index profitability yr* if touse, ivar(id_parent )
    jvar(nacerev2primarycodes) feff(feff) peff(peff) xb(xb) res(res) mover(mover)
    mnum(mnum) pobs(pobs) group(group) robust
predict tdarp5 if touse
corr tdar tdarp5 if touse
di r(rho)^2
outreg, se sdec(3) starloc(1) starlevels(10 5 1)  summstat(r2\N) summdec(0) summtitles("R-
    squared"\"Number of observations") varlabels  colwidth(20)  ctitles("OLS regression
    results""(5)") basefont(fs10) merge
eststo: felsdvreg tdar weighted_tax_diff log_sales fixed_asset_ratio
    inflation_percentage_points log_corruption_index growth_opp loss_carryforward
    log_creditor_rights_index profitability yr* if touse, ivar(id_parent )
    jvar(nacerev2primarycodes) feff(feff) peff(peff) xb(xb) res(res) mover(mover)
    mnum(mnum) pobs(pobs) group(group) robust
predict tdarp6 if touse
corr tdar tdarp6 if touse
di r(rho)^2
outreg, se sdec(3) starloc(1) starlevels(10 5 1)  summstat(r2\N) summdec(0) summtitles("R-
    squared"\"Number of observations") varlabels  colwidth(20)  ctitles("OLS regression
    results""(6)") basefont(fs10) merge
eststo: felsdvreg tdar max_tax_diff log_sales fixed_asset_ratio inflation_percentage_points
    log_corruption_index growth_opp loss_carryforward log_creditor_rights_index
    profitability yr* if touse, ivar(id_parent ) jvar(nacerev2primarycodes) feff(feff) peff(peff)
    xb(xb) res(res) mover(mover) mnum(mnum) pobs(pobs) group(group) robust
predict tdarp7 if touse
corr tdar tdarp7 if touse
di r(rho)^2
outreg using Main_specification.doc, se sdec(3) starloc(1) starlevels(10 5 1)  summstat(r2\N)
    summdec(0) summtitles("R-squared"\"Number of observations") varlabels  colwidth(20)
    ctitles("OLS regression results""(7)") basefont(fs10) merge
esttab est1 est2 est3 est4 est5 est6 est7 using Main_specification_esttab.doc, r2 se star(* 0.10
    ** 0.05 *** 0.01) compress obslast nonum varwidth(30) label
    mtitles("(1)""(2)""(3)""(4)""(5)""(6)""(7)") title("OLS regression results") drop(yr*) b(3)
    se(3) r2(3)
```

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