



Estimating the Effect of Corporate Income Tax Reductions

A comparative case study on the capital structure of financial corporations

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Abstract

This thesis aims to investigate the effects of a corporate income tax rate change on financial corporations' capital structure. We perform two case studies on financial corporations located in Austria and the Netherlands to answer this question. These studies take place over a decade from 2000 – 2010 using nine OECD-countries as controls. For the estimation of the effect of corporate taxation, we apply the synthetic control method. We construct a counterfactual outcome for both countries, where no change to the corporate income tax rate occurred. We do this by constructing a weighted average of control countries unaffected by such a change to the corporate income tax rate.

We find that both Austrian and Dutch financial corporations on average lowered their debt-to-equity ratios a little over 30 % compared to its synthetic control. Our results indicate that there is a positive effect of a change to the corporate income tax rate on the capital structure of financial corporations.

To test the significance of our estimates we conduct placebo tests to see if we get results of similar magnitude when considering countries that did not implement such tax reforms. The results of these test are however ambiguous, where we find an effect of taxes on capital structure to be significant when conducting a one-sided hypothesis test, but we do not when conducting a two-sided test. Our results are also robust when we place different restrictions on the synthetic control. The fact that we get results of similar magnitude for both Austria and the Netherlands assures us that our results are quite robust. Consequently, we find that there is a strong indication of corporate income taxes positively affecting the capital structure of financial corporations.

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This thesis marks the end of our Master of Science program in Economics and Business Administration at NHH (Norwegian School of Economics).

The process has been long and challenging, but also rewarding. We walked into an exciting yet foreign territory, and we came out with a great amount of knowledge in both the economical and statistical fields.

We would like to take this opportunity to thank our supervisor Floris T. Zoutman. He has shown great interest in our thesis throughout the entire process, and we appreciate his valuable suggestions and feedback along the way.

Emil Kristofer Johansen

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1. Introduction

This introductory chapter presents the development of corporate income taxation and capital structure of financial corporations in the OECD, as well as posing the research question.

1.1 Background

The impact of taxes on the capital structure of firms is a topic that has received extensive research. Since Miller and Modigliani expanded their capital structure theory in 1963 to account for taxes, researchers have tried to estimate this effect. Previous findings are contradictory, where some find a causal relationship between taxes and capital structure, and others do not.

The trend of tax reforms decreasing the statutory corporate income tax rate started in the mid-1980s with the United Kingdom and the United States as pioneering countries (OECD, 2011). This trend has lasted up until now and does not seem to subside, and almost every OECD-country has reduced their corporate income tax rate over this period. The OECD average corporate income tax rate was reduced from 47.5 % in 1981 to 25 % in 2015 (OECD, 2016a). Consequently, there should be huge potential for studies regarding these tax changes.

The corporate income tax is a distortive tax, i.e. it leads to inefficiency. In this thesis, we are interested in the distortion that originates from the ability to deduct interest expenses from the tax base. In almost all countries, cost of equity receives no such benefit. Several countries have implemented measures to mitigate this problem such as thin-capitalization rules and notional interest deduction. These initiatives are somewhat complex and often in violation of EU-law.¹ In addition, research has shown that the corporate income tax is in fact the most distortive (Johansson, Heady, Arnold, & Brys, 2008). This makes a simple reduction of the corporate income tax rate seem rather compelling.

Previous research on the impact of corporate income taxation on capital structure has mainly been regarding non-financial corporations. Leverage of financial corporations closely track the business cycles. Variation in the stock market is likely the prime driver of this effect, but

¹ See Dourado and de la Feria (2008) and Crowe Horwath (2009) for examples.

looking past this it seems that the capital structure of financial corporations follow a decreasing trend. The average debt-to-equity ratio is almost halved from over eight in 1995 to well under five in 2014 (OECD, 2016b). This makes a causal relationship between corporate income tax and capital structure of financial corporations seem plausible.

Consequently, we want to examine if one or more of these reductions to the corporate income tax rate led to a significant reduction of the average debt-to-equity ratio of the financial corporations located there. For this research, it would be expedient to compare the countries that changed their statutory corporate income tax rate to countries that did not, thus conducting a comparative case study. However comparing at an aggregated level is complicated due to the lack of valid comparisons, because countries are very heterogeneous.

To overcome this obstacle we employ the synthetic control method first introduced by Abadie and Gardeazabal (2003), where we use a weighted average of control countries that resembles the country of interest in terms of certain characteristics. The intuition is that this “synthetic control” is thought to represent the country of interest, in the absence of a change to the corporate income tax rate, better than any control country alone.

1.2 Research question

Our thesis seeks to answer the following research question:

What is the effect of a change to a country's corporate income tax rate on the debt-to-equity ratio of financial corporations located there?

We try to answer this question by investigating the difference in capital structure between the country of interest and its synthetic counterpart in the period following the change to the corporate income tax rate.

2. Case study

For our empirical analysis, we identify two countries that possess the characteristics necessary to be eligible for our study. These characteristics relates to the magnitude of the change to the corporate income tax rate and the stability of it before and after. Consequently, we propose the study of the two following cases: Austria's Steuerreformgesetz 2005 (hereafter referred to as Tax Reform Act 2005) and the three subsequent Dutch tax reforms of 2005, 2006 and 2007.

2.1 Austria

For our study, we have chosen the case of Austria's Tax Reform Act 2005. In 2005, Austria implemented this tax reform resulting in a reduction of the corporate income tax rate from 34% to 25%. As a result Austria went from being one of the higher taxed to one of the lower taxed countries in the OECD.

We based our choice of Austria on a meticulous assessment of each country's compliance with our criteria for an appropriate candidate. The first criteria was long time series both before and after the tax change, thus making it possible to evaluate the effect of the change in the corporate income tax rate. The second was a stable period with no tax changes prior to the tax change we are considering. Finally, the tax reform had to be of such a large scale that it could potentially lead to a significant change in the capital structure of the affected firms.

Looking at figure 2.1, we can see that the corporate income tax of Austria has only had three changes from 1981 until now. The changes also happened with long intervals between them. This makes Austria an ideal candidate for our study, because of the compliance with the abovementioned criteria. One might ask why we did not select the tax reform from 1988, but that is due to lacking data.



Figure 2.1: Austrian statutory corporate income tax rate (Source: Own creation based on OECD data)

If we look at figure 2.2, we can see that the Austrian debt-to-equity ratio follow approximately the same pattern as the OECD average described in part 1.1, but with a lower use of debt compared to equity throughout the whole period. A substantial decrease in the debt-to-equity ratio that coincides with the Tax Reform Act 2005 is also apparent, thus implying a relationship between the tax reduction and the reduction in the debt-to-equity ratio.²

² The selection of Austria's Tax Reform Act 2005 for this case study was not based on the dependent variable (debt-to-equity ratio), because it would have led to selection bias. We describe the development in the debt-to-equity ratio solely for an illustrational purpose.

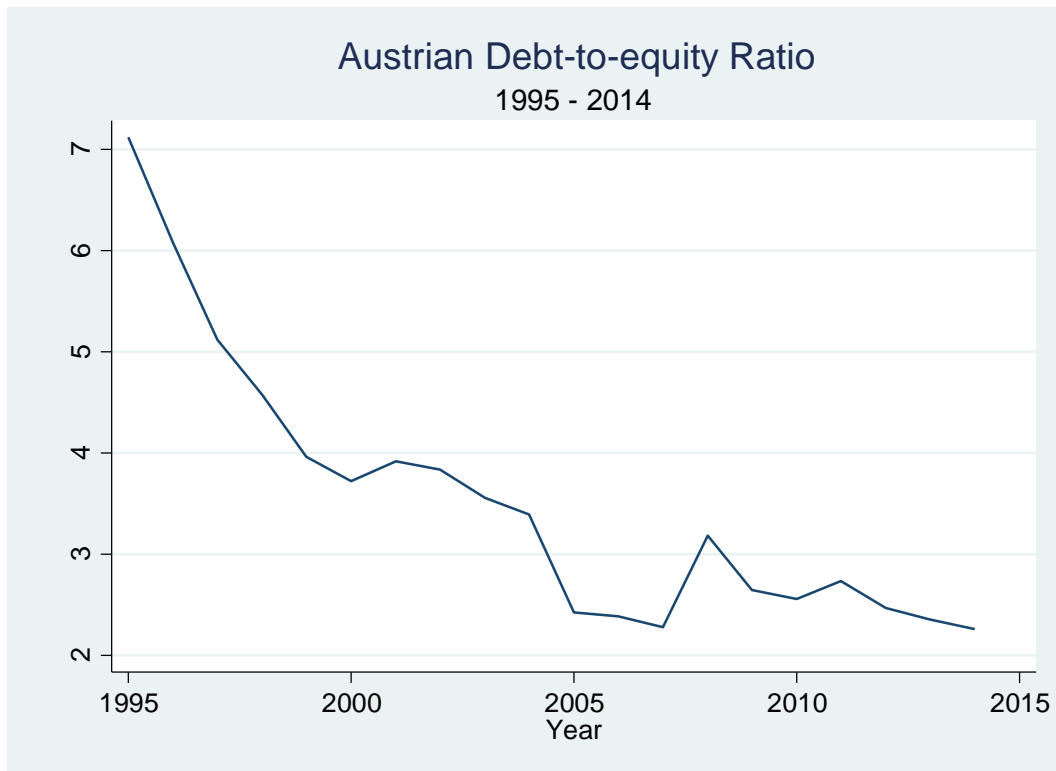


Figure 2.2: Austrian debt-to-equity ratio (Source: Own creation based on OECD data)

2.2 The Netherlands

The Netherlands has also completed a significant reduction to the corporate income tax rate in the years 2005, 2006 and 2007. Over this period, the tax rate was decreased from 34.5 % to 25.5 %, a total reduction of 9 %. In this case, however the implementation of the tax reduction occurred gradually. As illustrated by figure 1.5, we see that the tax rate was at a stable 35 % from 1990 – 2004, apart from a small change of 0.5 % in 2002. Then three subsequent reductions to the corporate income tax rate occurred, 3 % in 2005, 1.9 % in 2006 and 4.1 % in 2007, thus adding up to a total of 9 %.

The Netherlands qualifies as a good candidate as there has been no tax rate reforms in the pre-treatment period.³ The last change in corporate tax rate was in 1989, and thus we can conclude that this change will not have any effect on our study. With the three tax reductions

³ Here we disregard the small 0.5 % change in 2002, claiming that it is of too small magnitude to have any effect on the capital structure of firms.

accumulating to 9 %, we get a combined reduction of the same magnitude as that of Austria. The Netherlands will therefore make a good candidate to study with these criteria fulfilled.



Figure 2.3: Dutch statutory corporate income tax rate (Source: Own creation based on OECD data)

Figure 2.4 shows us the Dutch debt-to-equity ratio. The business cycles are not present as is the case for Austria. We can however see a rapid rise in the early 2000s, but the debt-to-equity ratio remains high until 2005. In the years after the debt-to-equity ratio drops, thus coinciding with the Dutch tax reforms. A slight increase around the financial crisis is apparent though, but then it decreases again throughout the period. Consequently, there might be a causal relationship between the three subsequent Dutch tax reforms of 2005, 2006, and 2007 and the reduction in the Dutch financial corporations' capital structure.

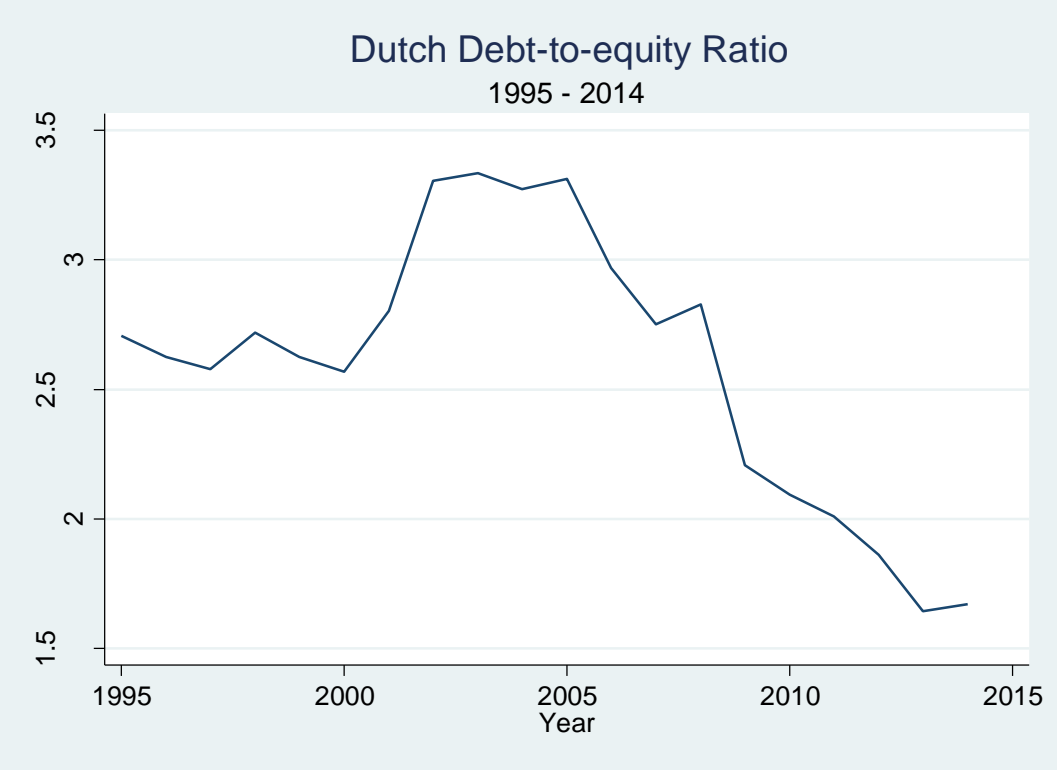


Figure 2.4: Dutch debt-to-equity ratio (Source: Own creation based on OECD data)

3. Literature Review

We will now present research previously done on the effect of taxes on corporate capital structure. First, we will establish an overview of important literature on this topic. We then explain our contribution to the topic, and why its a good addition to research within this field.

3.1 Previous research

Modern day theory on the capital structure of firms started with Miller and Modigliani in 1958. They showed that the capital structure does not affect the value of firms in a perfect capital market. In 1963, Miller and Modigliani expanded their theory to account for taxes. When introducing taxes to a perfect capital market, Miller and Modigliani found that firms only choose debt financing due to the debt tax shield.⁴

In 1975, Allan J. Taub studied the determinants of firms' capital structure. In his study, Taub also investigated the role of taxes on capital structure. Little previous research existed on this topic, and the results showed that an increase in the tax rate had a negative impact on the debt-to-equity ratio. This was contrary to Miller and Modigliani's findings, and Taub explained that there are several holes in his approach, and therefore he suggested that there was a need for further research before a significant result could be found (Taub, 1975).

Peles and Sarnat (1979) based their research on the British tax reform effective from 1966. The tax reform included a big rise in the corporate income tax rate from 15 % to 40 % on net corporate profits (Peles & Sarnat, 1979). In addition to the retained profits being subject to corporate income tax rate, the distributed profits (dividends) would also be liable to individual income taxation. With the reform in mind, it was believed that the debt-to-equity ratio would rise, as the benefit of the tax shield was now significantly larger. The results showed that the tax reform had indeed affected the capital structure. This study did however include two major policy changes. Both corporate and personal taxation was changed. The change in

⁴ For a more detailed discussion of Miller and Modigliani's papers and the following trade-off theory we refer to section 4.

capital structure is therefore a summed effect of these two major changes (Peles & Sarnat, 1979).

In 1992, Givoly, Hayn, Ofer and Sarig studied the 1986 US tax reform and its effect on the capital structure of firms (Givoly, Hayn, Ofer, & Sarig, 1992). The tax reform act of 1986 was a comprehensive reform that affected both the corporate sector as well as the private sector. On the corporate level, the reform attempted to make taxation equal for all firms compared to the previous system. The tax reform included a broadened definition of what was taxable income, as well as a reduction in the top marginal rate from 46 % to 34 % (Wilkie, Young, & Nutter, 1996). The results of the research showed that the tax reforms had an effect on the capital structure of the firms. The findings indicate that the corporate income tax rate, non-debt tax shields as well as individual taxation all play a role in the firm's choice of financing (Givoly et al., 1992).

Alworth and Arachi (2001) studied the effects of both personal and corporate income tax rate on the firm's decision of capital structure. Focusing on Italian firms, they investigated if a change in the marginal tax rate of firms would affect the debt-to-assets ratio as well as if a change in personal taxes would do this. The research indicates that the tax considerations do effect the firm's decision of financing. However, Alworth and Arachi list a couple of errors regarding their research, such as selection bias among the companies as well as not being able to show the effects on the debt-to-equity ratio (Alworth & Arachi, 2001).

Previous research indicates that the corporate taxes do play a role in the firm's choice of capital structure. Some recent papers, while agreeing with previous conclusions about tax relevancy in corporate capital structure, show that the degree of influence may not be that high.

In 2007, Overesch and Voeller did an empirical analysis on how both corporate and personal taxes influence the choice of capital structure of firms. In line with previous research, Overesch and Voeller also found that both corporate and personal taxes affect the firms' choice of capital structure. They also focused on smaller firms, and found that they are more susceptible to the tax changes, estimating a more than four times higher tax elasticity compared to the other firms. Despite these conclusions, they also found that the tax effects are

not as large as one would think. This indicates that there are other factors that affect the firm's decision when it comes to the choice of capital structure (Overesch & Voeller, 2008).

MacKinlay contributed in 2012 with his paper on the corporate income tax rate and its effects on capital structure. With a new approach, he came to a slightly different conclusion compared to previous contributors. He suggested in his paper that corporate taxes does not have as big influence on the firms' choice of leverage as previously anticipated. MacKinlay investigated if the effects of taxes on the firm is significant on the firm's overall debt, i.e. how much debt the firm decides to take up in total. The findings showed that the corporate income tax rate does somewhat influence the amount of debt; however the effect is much more subtle than previously believed. It is more likely that the tax rate affects the decision of taking up debt when there are high interest rates as well. With his research, MacKinlay also showed that taxes are more likely to affect the composition of debt, rather than the total amount.

Previous research has mainly focused on non-financial corporations, due to the regulations imposed on financial corporations and differences in their funding procedure. There are however, some studies covering financial corporations. Langedijk, Nicodème, Pagano, and Rossi (2014) provide a review of several studies on the impact of corporate income taxation on the capital structure of financial corporations. Among these, the studies by de Mooij and Keen (2012) and de Mooij, Keen, and Orihara (2014) are worth mentioning, because these studies found that financial corporations responded to corporate income tax changes in a similar way as previously estimated for non-financial corporations.

The study that perhaps come the closest to this thesis is the study by Schandlbauer (2013). In this paper, Schandlbauer estimates the effect of an increase in the local U.S state corporate tax rate. By using the difference-in-differences method, he finds that banks subject to the tax increase significantly increases their non-depository leverage ratio by 6.4 %.

3.2 Contribution

The consensus is that the corporate income tax rate influences the firm's composition of financing. Recently researchers have found that the corporate tax rate may not have as big impact on capital structure as previously thought, thus there are still many uncertainties on how taxes affect the firms' decision of capital structure. We aim to contribute to the series of work previously done by utilizing a new approach to investigate this topic, while previous research has usually applied standard regression analysis to investigate the effects of a tax reform.

Our focus is to investigate how changes in the corporate income tax rate will affect the firm's capital structure. Our approach is to do a comparative case study that isolates the effect of the change to the corporate income tax rate. We utilize a relatively new method for this analysis, called the synthetic control method, first introduced by Abadie and Gardeazabal in 2003. This method has previously not been applied to this topic; therefore, we supplement existing research with a new approach. The synthetic control method is well suited for comparative case studies as it allows us to compare the real changes against a weighted average of control countries, assumed to represent the development in the absence of the tax change. Comparing to the study by Schandlbauer (2013), the synthetic control method lets us estimate a much more appropriate control that is not based on a subjective assessment of the similarity to the affected country.

In addition to using the synthetic control method, previously unused in this topic, we also focus exclusively on financial corporations, a group usually withdrawn from this kind of study. Recent research on the effect of corporate taxation on the capital structure of financial corporations indicates however, as previously mentioned, that a causal relationship exists. Consequently, we believe that the previous results have been encouraging enough to merit further investigation using the synthetic control method.

4. Theoretical Framework

We will now present the theoretical framework that our hypothesis will be based on. First, we address the capital structure in a perfect capital market. Secondly, we consider the capital structure in an imperfect market using the trade-off theory.

4.1 Capital structure

Firms are dependent on capital in order to finance its projects and to facilitate growth. There are two main sources of financing: debt and equity. The combination of these sources of financing makes up the capital structure.

Modern research on the effect of capital structure on the value of firms differentiates between a perfect and an imperfect capital market. A perfect capital market has no agency or transaction costs. There are also no taxes or asymmetrical information in perfect capital markets (Berk & DeMarzo, 2014). As we know from the real world, capital markets are far from perfect, but the theory on capital structure in perfect capital markets serves as an excellent starting point to understand the factors that affect the choice of capital structure.

Miller and Modigliani's paper from 1958 is the fundament of modern capital structure theory, where they found that the capital structure of a firm does not affect the firm's value within a perfect capital market. Miller and Modigliani followed up their research in 1963, where they introduced taxes to this otherwise perfect capital market. These two papers have spawned many interesting research topics around the capital structure of firms. Consequently, the theories forwarded in these papers lay the fundament of the theory applied in this thesis.

There are two theories that tries to explain the choice of capital structure, namely the trade-off theory and the pecking order theory (Frank & Goyal, 2007). In this thesis, we apply the trade-off theory to develop our hypotheses, because of the existence of an optimal capital structure under this theory. Many factors influence the optimal capital structure, and it will be vary between firms. These factors include among others the corporate income tax rate, government regulations, various benefits and costs of debt, etc.

The corporate income tax rate can influence the choice of financing due to the concept of tax shields, which in turn affects the attractiveness of debt financing. A firm can reduce their income taxes by taking on debt, because the interest on debt is a tax-deductible expense. The benefits of debt correlates with the size of the tax shield. As the corporate income tax rate increases, the tax shield will also increase in size. The increased tax shield will stimulate the firm into taking up more debt, however due to the costs involved there will be a point where taking on more debt will not be beneficial. We will address the trade-off theory more thoroughly in part 4.2.

The pecking order theory, first forwarded by Donaldson (1961) with later updates by Majluf and Myers (1984), does not propose that an optimal capital structure exists. This theory bases itself on asymmetric information between managers and investors, and the impact of this asymmetry on the cost of each type of financing. This establishes the following pecking order: retained earnings are preferred to issuance of debt and equity, issuance of debt is preferred to equity, and issuance of equity is regarded as a last resort. Consequently, if our results fail to confirm the trade-off theory, the pecking order theory could help us explain such a finding.

4.1.1 Capital structure in a perfect market

In 1958, Miller and Modigliani researched the importance of a firm's capital structure and concluded that the composition of financing is irrelevant for the firm's value. They conducted this research under the assumption that the firm is in a perfect capital market. Based on this they described the mechanics of capital structure with two propositions (Modigliani & Miller, 1958).

The first proposition, explains that the firm's total value remains the same regardless of capital structure in a perfect capital market.

Modigliani-Miller Proposition I:

A firm's total market value is independent of its capital structure (Modigliani & Miller, 1958).

$$\text{Equation 1: } V_u = V_l = V_A$$

The equation shows us that the value of the unlevered firm V_u is equal to the value of the levered firm V_l that is also equal to value of the total assets V_A . The essence of this proposition is that the firm's market value will not change depending on the source of financing. The choice of capital structure will not affect the firms cash flow, therefore it will not alter the firm's market value either (Modigliani & Miller, 1958). How the firm chooses its financial structure will only affect how the value of assets allocates between equity and debt on the balance sheet. The market value is still the same independent of the capital structure, given that the firm is in a perfect capital market.

The second proposition states that a higher debt-to-equity ratio will lead to higher required return on equity. This is true since a higher ratio of debt will increase the risk for shareholders.

Modigliani-Miller Proposition II:

The cost of equity of a leveraged firm increases with the firm's market value debt-to-equity ratio (Modigliani & Miller, 1958).

From equation 1 in the previous section, we can express the return on unlevered equity R_U to be the weighted average of the required return on levered equity R_E , and debt R_D :

$$\text{Equation 2: } \frac{E}{E+D} R_E + \frac{D}{E+D} R_D = R_U$$

We can rearrange equation 2 to find the equation for return on levered equity, R_E

$$\text{Equation 3: } R_E = R_U + \frac{D}{E} (R_U - R_D)$$

This equation shows us that the required return on levered equity R_E is the sum of the required return on unlevered equity R_U and the additional return due to the risk of leverage $\frac{D}{E} (R_U - R_D)$ (Berk & DeMarzo, 2014).

The propositions of Miller and Modigliani (1958) hold true in a perfect capital market, which means that they do not represent the real world in a realistic manner. Although we cannot apply the propositions to the real world, they can serve as a fundament to work on. If the

firm's capital structure were to matter, then it would be a result of an imperfect market (Berk & DeMarzo, 2014).

4.1.2 Capital structure in an imperfect market

Miller and Modigliani showed later on in 1963 that capital structure does indeed matter in the real world. This was a result of Miller and Modigliani's introduction of taxes to their original model from 1958. With the introduction of taxes came also the benefits of the tax shield. In this imperfect market, firms have the possibility to deduct interest payments from the tax base, therefore making the composition of the capital structure relevant, as there is now benefits of having debt.

Miller and Modigliani modified their two propositions in this research paper to account for taxes.

Proposition I:

The value of the levered firm is the sum of the unlevered firm plus the interest tax shield (Modigliani & Miller, 1963).

$$\text{Equation 4: } V_L = V_U + T_C D$$

With the introduction of taxes, we can now modify equation 1 from Miller Modigliani 1958 to equation 4. The value of the levered firm V_L is now equal to the value of the unlevered firm V_U plus the product of the corporate income tax rate T_C and the amount of debt D . The interest tax shield $T_C D$ is considered a perpetual value, thus removing the interest rate from the equation (Modigliani & Miller, 1963). We can see from the equation that the value of the firm increases when the amount of debt increases, thus firms would choose to be fully debt-financed in this imperfect market.

Furthermore, the introduction of taxes also modify the second proposition of Miller and Modigliani (1958). We can now formulate equation 3 as follows:

Proposition II:

$$\text{Equation 5: } R_E = R_U + \frac{D}{E} (R_U - R_D) (1 - T_C)$$

As shown the tax shield benefit is now also included when calculating the required return on unlevered equity, and we can see that it lowers the risk/required return.

4.2 Trade-off theory of capital structure

The trade-off-theory first forwarded by Kraus and Litzenberger (1973) is essential in the determination of an optimal capital structure. As the name implies this theory involves a trade-off between the benefits and costs of debt. This framework introduces financial distress costs, and thus firms weigh the benefits of having a tax shield against the costs of financial distress associated with leverage to achieve an optimal capital structure (Berk & DeMarzo, 2014). The trade-off-theory well formulated by Berk and DeMarzo states that “the total value of a levered firm equals the value of the firm without leverage plus the present value of the tax savings from debt, less the present value of financial distress costs.” (Berk & DeMarzo, 2014).

$$\text{Equation 6: } V^L = V^U + PV(\text{Interest tax shield}) - PV(\text{Financial distress costs})$$

Equation 6 shows that the value of the leveraged firm V^L has benefits and costs. PV is the present value of the interest tax shield, while V^U is the value of the unlevered firm. The interest tax shield is the beneficial part for the firm. However, there will be a limit to how much debt the firm can take before this advantage becomes unprofitable. If the debt is too high then it is more likely to incur financial distress costs. Bankruptcy costs are a typical example of financial distress costs. If the costs exceed the benefits of the tax shield then it will no longer be profitable for the firm to take up more debt. This is the trade-off for the firm (Berk & DeMarzo, 2014).

With financial distress costs added to the equation, we can illustrate the optimal level of leverage with figure 4.1 below.

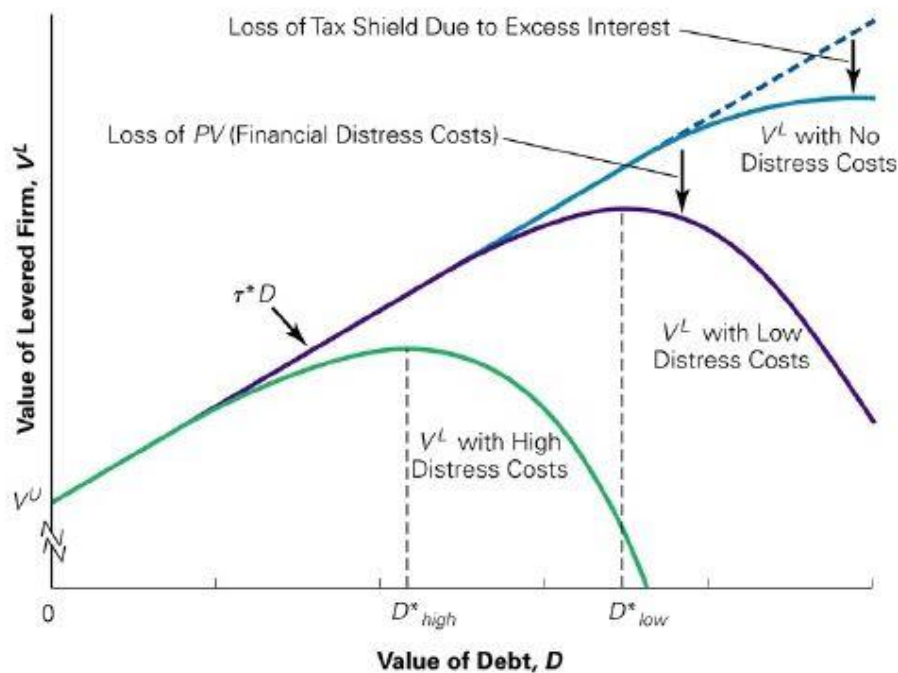


Figure 4.1: Value of levered firm as a function of value of debt (Berk & DeMarzo, 2014)

Figure 4.1 is a depiction of equation 6, and illustrates that the value of the levered firm depends on the level of debt. If there were no distress costs, the value of the levered firm would follow the blue line (V^L with no Distress Costs). Consequently, the value of the firm is higher with no distress costs and the value decreases proportionally with the introduction of distress costs.

The trade-off framework can however be expanded further, as we should also include the agency benefits and costs of debt. Agency costs of debt arise when managers act in the interest of shareholders as opposed to the firm as a whole, thus profiting at the expense of debtholders. Agency benefits of debt relates to the principal-agent problem where managers, known as agents, act in their own self-interest. The uptake of debt can for instance discourage such behaviour by tying up funds so that managers have little leeway when it comes to corporate spending. Firms will therefore risk that the manager will prioritize their own interests at the expense of the interest of the shareholders and debtholders. Including these

benefits and costs to the trade-off model is thus essential in the process of optimizing the capital structure (Berk & DeMarzo, 2014).

$$\text{Equation 7: } V^L = V^U + PV(\text{Interest Tax Shield}) - PV(\text{Financial Distress Costs}) - PV(\text{Agency Costs of Debt}) + PV(\text{Agency Benefits of Debt})$$

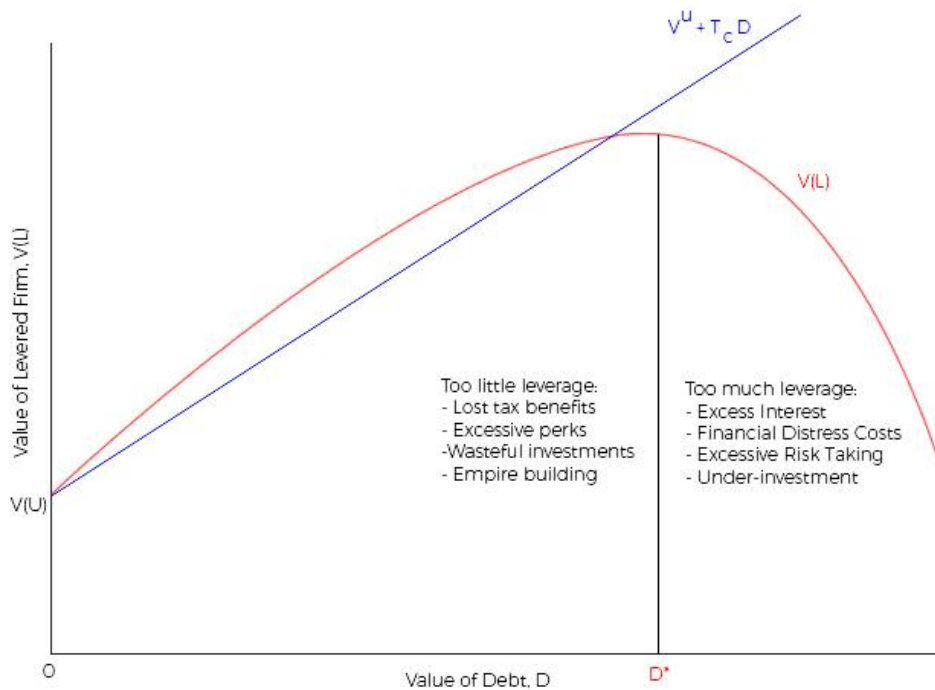


Figure 4.2: Optimal leverage - Net effect of costs and benefits of debt (Source: Berk and DeMarzo (2014))

The optimal level of debt varies depending on the tax rate as well as the additional distress costs and agency costs. Figure 4.2 shows us the optimal level of debt when we include, tax shields, financial distress, and agency benefits and costs of debt. As shown in the figure there is a point where it is not beneficial to have more debt due to the costs associated with it exceeding the benefits. The firms should seek to set a debt-to-equity ratio that maximizes the firm's value given the corporate income tax rate and the other benefits and costs of debt.

Møen, Schindler, Schelderup and Tropina (2011) find that multinational corporations have even stronger incentives to take up debt, by showing that the standard tax shield is not the only tax mechanism that affects multinational firms' capital structure. In addition, external and internal debt shifting affects the choice of capital structure for multinational firms. This means that if a country increases/reduces its corporate income tax rate, then it will become relatively more/less attractive to place debt in that country compared to the other countries where the multinational firm has located its affiliates. The reason for this is that the tax reform increases/decreases the tax savings from interest expenses in that country while the costs of debt remains the same. Consequently, it becomes more profitable to shift debt to/from the country with the tax reform in order to maximize the value of the multinational firm as a whole (Møen, Schindler, Schjelderup, & Tropina, 2011).

The essence of the previous theory translated to our study implies that: a tax increase/reduction would lead to an increase/reduction to the value of the tax shield while leaving the costs of debt unchanged. This means the attractiveness of having debt as opposed to equity would increase/decrease if we assume that all else remain equal. Consequently, we would expect that a tax increase/reduction would lead to higher/lower leverage.

5. Methodology

This chapter will present the methodological approach used in the study. Firstly, we present the empirical research method, and then we describe and explain the choice of dataset in light of this method. Lastly, we formulate a hypothesis based on the previously presented theory. This section is of great importance when trying to produce empirical inference in a correct manner.

5.1 Comparative case studies

In order to estimate the effect of Austria's Tax Reform Act 2005 (Steuerreformgesetz 2005) on the capital structure of the financial corporations situated there, it would be expedient to compare the change in Austria to a country that did not implement a similar change in the statutory corporate income tax rate. A comparative case study like this introduces several problems that might lead to a wrongful estimation of the effect of the treatment, in this case a tax reform.

Governments typically implement policy interventions at aggregate levels affecting aggregated units. This is also the case for Austria's Tax Reform Act 2005 and the three Dutch tax reforms. The choice of control group becomes troublesome when we are considering aggregate data. In our case, countries must be regarded as very heterogeneous with big variations in the characteristics of each country. This leads to a probable inability of other countries to produce the counterfactual, i.e. the outcome for the treated country in the absence of treatment. Therefore, it may happen that the differences we see between the treated unit and the control group are not due to the treatment, but the different characteristics of the countries. Another issue is that one often picks control groups based on subjective assessments of the similarity between the treated and the control group that might lead to cognitive bias (Abadie, Diamond, & Hainmueller, 2010). Based on the abovementioned obstacles, Abadie et al. propose a computational approach to the choice of control group called the synthetic control method.

Under these circumstances, one can assume that a weighted average of the control units represents the counterfactual better than any control unit alone. This approach lets us also

choose a control in an objective manner, thus removing any control selection bias if the synthetic control is able to replicate the counterfactual outcome.

5.2 The synthetic control method

5.2.1 The model

Following Abadie et al. (2010) the synthetic control is created out of $J + 1$ regions (in our case countries), where only the first country receives treatment. In our study, this translates to Austria and the Netherlands being the only countries to receive a change to their corporate income tax rate. Since we can only have one treated unit, we have to use the synthetic control method for Austria and the Netherlands separately. This leaves us with the remaining J countries as potential control countries, in what Abadie et al. refer to as “the donor pool”.

Further Abadie et al. (2010) let Y_{it}^N be the value of the outcome variable if unit $i = 1, \dots, J + 1$ did not receive any treatment at time $t = 1, \dots, T$. Where T_0 is the number of pre-treatment periods, and $1 \leq T_0 < T$. This implies that we need at least one pre-treatment period and one post-treatment period to be able to apply the synthetic control method. Consequently Abadie et al. also introduce Y_{it}^I , which is the value of the outcome variable if country i received treatment in the interval $[T_0 + 1, T]$, i.e. in the post-treatment period. Abadie et al. assume that the treatment has no effect on the outcome of the untreated countries, and the periods prior to the treatment for all countries.

Abadie et al. (2010) defines the effect of the treatment of country i at time t as $\alpha_{it} = Y_{it}^I - Y_{it}^N$ and an indicator variable D_{it} that is equal to one if country i received treatment at time t . Thus we have that the observed value of the outcome variable Y_{it} , defined by Abadie et al., is given by the following equation: $Y_{it} = Y_{it}^N + \alpha_{it}D_{it}$. As previously mentioned only country 1 receives treatment in the period $[T_0 + 1, T]$, thus is only D_{it} equal to one for country 1 in this period. Consequently, we are looking to estimate $(\alpha_{1T_0+1}, \dots, \alpha_{1T})$, where $\alpha_{1t} = Y_{1t}^I - Y_{1t}^N = Y_{1t} - Y_{1t}^N$ for $t > T_0$ since the observed outcome is when country 1 receives treatment. This leaves us with the estimation of Y_{it}^N , i.e. what would happen to country 1 in the absence of treatment, which we earlier referred to as the counterfactual.

Abadie et al. (2010) assume that estimation of the following factor model gives Y_{it}^N

$$Y_{it}^N = \delta_t + \theta_t Z_i + \lambda_t \mu_i + \varepsilon_{it},$$

where δ_t is an unknown common factor with constant factor loadings across units, Z_i is a $(r \times 1)$ vector of observed covariates (not affected by the intervention), θ_t is a $(1 \times r)$ vector of unknown parameters, λ_i is a $(1 \times F)$ vector of unobserved common factors, μ_i is an [sic] $(F \times 1)$ vector of unknown factor loadings, and the error terms ε_{it} are unobserved transitory shocks at the region level with zero mean. (Abadie et al., 2010)

Further Abadie et al. (2010) introduces a $(J \times 1)$ vector W that contains weights $W = (w_2, \dots, w_{J+1})'$, where $w_j \geq 0$ for $j = 2, \dots, J+1$ and $w_2 + \dots + w_{J+1} = 1$. Consequently, all weights are between zero and one, and sum up to one. This rules out extrapolation as a method of obtaining the synthetic control.⁵ Every combination of W gives a synthetic control. The following weighted factor model can express every synthetic control:

$$\sum_{j=2}^{J+1} w_j Y_{jt} = \delta_t + \theta_t \sum_{j=2}^{J+1} w_j Z_j + \lambda_t \sum_{j=2}^{J+1} w_j \mu_j + \sum_{j=2}^{J+1} w_j \varepsilon_{jt}$$

Thereafter Abadie et al. (2010) proves that if we assume that there exists a vector $W = (w_2^*, \dots, w_{J+1}^*)$, then these weights will give us a synthetic control that will provide us with an unbiased estimate of the treatment effect. These optimal weights entail that:

$$\sum_{j=2}^{J+1} w_j^* Y_{j1} = Y_{11}, \quad \sum_{j=2}^{J+1} w_j^* Y_{j2} = Y_{12}, \dots,$$

⁵ We address the advantages and disadvantages of this exclusion in part 5.3.3.

$$\sum_{j=2}^{J+1} w_j^* Y_{jT_0} = Y_{1T_0}, \quad \& \quad \sum_{j=2}^{J+1} w_j^* Z_j = Z_1.$$

Consequently, the estimator for the treatment effect is equal to:

$$\hat{\alpha}_{1t} = Y_{1t} - \sum_{j=2}^{J+1} w_j^* Y_{jt}$$

Of course such weights rarely exists, so Abadie et al. (2010) forward that one can choose weights so that the previous equations hold approximately.

Further, Abadie et al. (2010) introduce a $(T_0 \times 1)$ vector $K = (k_1, \dots, k_{T_0})$ that provides linear combinations of pre-treatment outcomes $\bar{Y}_i^K = \sum_{s=1}^{T_0} k_s Y_{is}$. Different choices of K can give us the outcome for a single period, the average of the pre-treatment period, or even some weighted average. Thereafter Abadie et al. forward that one can allow for M sets of K , i.e. K_1, \dots, K_M , where one can choose M freely. Later in part 5.2.3 we address the issue of choosing which and how many vectors K we should use to create the synthetic control.

Thereafter Abadie et al. (2010) introduce a $(k \times 1)$ vector $X_1 = (Z_1', \bar{Y}_1^{K_1}, \bar{Y}_1^{K_2}, \dots, \bar{Y}_1^{K_M})'$ that contains the pre-treatment value of the covariates and the M different sets of pre-treatment values for the outcome variable for the treated country, where $k = r + M$. Analogous to X_1 , Abadie et al. introduce a $(k \times J)$ vector X_0 that contains these variables for the untreated countries in the donor pool. Consequently, W^* is chosen so that it minimizes the distance between X_1 and $X_0 W$. Abadie et al. propose the use of $\|X_1 - X_0 W\|_V = \sqrt{(X_1 - X_0 W)' V (X_1 - X_0 W)}$, where V is a $(k \times k)$ symmetric and positive semidefinite matrix. V gives weights to the different variables contained in X_1 and X_0 , so that they can have different impact on the choice of the synthetic control. The most expedient choice of V is the one that minimizes the root mean squared prediction error, hereby referred to as the RMSPE, of the synthetic control estimator, i.e. the one that minimizes the difference between the treated region and its synthetic control. We apply this method to choose V using nested

optimization.⁶ This involves searching amongst positive semidefinite V -matrices and sets of W -weights until the pre-treatment RMSPE is minimized, i.e. a dual optimization.

5.2.2 Inference

The use of regular approaches to statistical inference is especially complicated in comparative case studies as mentioned by Abadie, Diamond, and Hainmueller (2015), “because of the small-sample nature of the data, the absence of randomization, and the fact that probabilistic sampling is not employed to select sample units”. We can overcome these limitations however by using what Abadie and Gardeazabal (2003) first referred to as “placebo tests”. These tests will be able to tell us if the control group is able to represent the counterfactual in a good way and if the treatment effect is statistically significant. The intuition is that if we apply the synthetic control method to a country that did not receive treatment, and we get similar or larger effects then we cannot conclude that there has been any treatment effect for the treated unit.

There are two types of placebo tests “in-time placebos” and “in-space placebos” introduced by Abadie et al. (2010). When using in-time placebos we reassign the treatment to a period where no treatment occurred, and see if we get similar effects. When using in-space placebos we reassign the treatment to the control countries in our donor pool that did not get any treatment. Again, we look for similar effects in order to assess the validity of our estimate. If the number of countries in our donor pool is of a certain size, we can perform a quantitative comparison as proposed in Abadie et al. (2015). We can perform this by using p-values calculated by dividing the number of effects of identical or larger size by the total number of effects estimated.

Abadie et al. (2010) introduced two in-space placebo tests, which we adopt. The first is a one-sided test, where one ranks the treatment effects, i.e. the difference between the real and the synthetic country, of the treated and the untreated countries. One ranks the treatment effects in ascending or descending order depending on whether we expect a negative or positive treatment effect respectively. If the synthetic control has a poor fit in the pre-treatment period,

⁶Dube and Zipperer (2014) find that using the nested optimization procedure to construct synthetic controls produces significantly better fit than the regular regression-based approach.

then one discards the respective country from the test. Translated to our study, we examine how many countries that got a negative treatment effect of the same or larger magnitude as the treated country.

Statistically we are testing if the following hypotheses are true:

- H_0 = no effect of treatment,
- H_1 = negative effect of treatment.

The second test introduced by Abadie et al. (2010) is a two-sided test, where one ranks the ratios of the respective countries' post- and pre-treatment RMSPEs in a descending order. Then one examines how many of the untreated countries that got the same or larger RMSPE ratio compared to the treated country.

Statistically we are testing if the following hypotheses are true:

- H_0 = no effect of treatment,
- H_1 = effect of treatment.

5.2.3 Robustness

We also test the robustness of our results using several robustness tests. We perform these tests by placing several restrictions on the construction of the synthetic control. We implement similar tests to those put forward by Abadie et al. (2015), as well as some that is especially expedient for our case. We restrict the covariates used to create the synthetic control by excluding covariates in order to examine if some of the covariates drives our results. We perform the same test regarding the control countries, thus leaving out one country at a time to examine if our results are just a coincidence due to the selection of a single country. In addition, we test the robustness of our results by expanding the sample period. We do this to check if the synthetic control estimator is biased due to the number of pre-treatment periods being small compared to the transitory shocks in the factor model, explained in section 5.2.1. If the synthetic control follows a similar trajectory, this test assures us that this should be of no concern to us.

Dube and Zipperer (2014) addresses the issue of which variables one should choose as predictors. They state that although Abadie et al. (2010) provides a solution on how to choose the weight of each predictor, they do not provide a solution to what variables one should use as predictors. In the context of part 5.2.1 this refers to the choice of variables to include in the vectors X_1 and X_0 . The solution to this problem is to “use a cross-validation procedure to choose from different sets of predictors” as Dube and Zipperer puts it. The validation is the average post-treatment RMSPE for all the control units. This lets us evaluate the prediction error of a specific set of predictors. Ideally, we would like a model where, in the absence of changes to other drivers of capital structure, the RMSPE is as low as possible in both the pre- and post-treatment period, except for the treated country where we want a high post-treatment RMSPE. Dube and Zipperer defines the average post-treatment RMSPE as:

$$\text{Average RMSPE} = \sqrt{\frac{1}{J} \times \sum_{i=2}^J MSPE_i},$$

where the MSPE is the RMSPE for country i , defined in section 5.2.1, squared. In order to achieve results unaffected by the treatment we exclude Austria and the Netherlands as potential donors for this test.

We test four different predictor sets where we shift the pre-treatment outcomes for the outcome variable that we include as predictors for the synthetic control. Kaul, Klößner, Pfeifer and Schieler (2016a) advocates the use of only a single pre-treatment measure for the outcome variable as a predictor. Kaul et al. show that including all pre-treatment outcomes as predictors leads to all other predictors receiving zero weights. This holds even when the predictor variables actually have very large predictive power for the outcome. The result of this could be severely biased results and significantly different synthetic controls. Although including every pre-treatment outcome as predictors would lead to the best pre-treatment fit of the synthetic control, this need not be the case for the post-treatment fit. Further Kaul et al. propose that one should use the average or the last pre-treatment value of the outcome variable as predictor. The average would lead to a good fit over the entire pre-treatment period and the last value would lead to a good fit at the treatment cut-off. In the context of part 5.2.1, this refers to the choice of which vectors K and how many different sets of K , known as M , one should use to construct the synthetic control.

Based on this we test predictor sets including the average value, the last value and the entire set of pre-treatment values of the outcome variable. We test these predictor sets by taking the natural logarithm of the outcome variable and predictor variables. We do this because each country has very distinctive levels of leverage throughout the sample period. This makes the treatment effect of a country that has a very high average debt-to-equity ratio potentially higher than that of a country with a lower average debt-to-equity ratio. We fix this by examining percentage changes to the outcome variable. One might argue that the tax rates should be higher for the countries with more leverage if our theory is valid, but there are numerous factors affecting the capital structure of firms, and thus we cannot draw such a simple conclusion. To justify our choice of model we also test a predictor set using linear values.

5.2.4 Advantages and disadvantages of the synthetic control method

As mentioned in the introductory part of this section, the synthetic control is especially applicable for studies at an aggregate level with a small sample. The synthetic control method is also attractive because of a few other features. In section 5.2.1, we put forward that the synthetic control method restricts the weights given to control units to be positive and to sum to one. Consequently ruling out extrapolation as an option to construct the synthetic control. This restriction reduces the uncertainty and risk of estimating a wrong counterfactual, because we cannot estimate values outside the convex hull of observations. The restriction to interpolate also has a downside, because we are not able to produce a synthetic control for countries where the outcome variable has extreme values that lies outside the convex hull of the donor pool observations.

The usual problem of omitted variable bias that researchers face is no issue, because the synthetic control method mitigates if not removes this problem. Abadie et al. (2015) explain this rather eloquently:

Only units that are alike in both observed and unobserved determinants of the outcome variable as well as in the effect of those determinants on the outcome variable should produce similar trajectories of the outcome variable over extended periods of time.

Transparency is another feature that the synthetic control method holds (Abadie et al., 2010). The synthetic control is a weighted average, thus it makes each donor country's contribution explicit. It also shows how the treated and the synthetic control matches on pre-treatment outcomes and the predictor variables. Abadie et al. (2015) shows that regular regression approaches also uses a linear combination of the untreated units that sums to one, but this is only implicit. Consequently, each control country's contribution to the control is not visible.

The synthetic control method utilizes the regular difference in differences approach, but loosens the restriction that the unobserved characteristics of individual units have to be constant over time. This is often a very strong assumption; therefore, it is expedient not having to make it.

Although the synthetic control method has various attractive features, it also has some limitations. The assumption that the outcomes of the untreated countries are unaffected by the treatment received by the treated unit is not always valid.

If we translate the findings in Møen et al. (2011), presented in section 4.2, to the cases of the Austrian Tax Reform Act 2005 and the three Dutch tax reforms, the reduction in the corporate income tax rate incentivizes multinational firms to shift debt from their Austrian or Dutch affiliates to affiliates located in higher taxed countries. In other words, this means that the tax reforms, known as the treatment, might affect the debt-to-equity ratios of financial corporations located in our control countries. We believe that if these mechanisms are present, the effect will be so small that we cannot identify it at an aggregate level. If such a bias should exist, it will overestimate the effect of the treatment.

The synthetic control method has also a few other limitations. We need observations for the outcome variable for all periods to be able to create a synthetic control, and use a country as a donor. It also limits research to one case at a time. Lastly, one cannot apply standard tests for inference when using the synthetic control method.

Overall, we are confident that the synthetic control method is highly appropriate for answering our research question, because the many advantages of this method surpasses the few limitations.

5.3 Dataset

5.3.1 Obtaining the dataset

We collected the data used in this study from the OECD-database with the exception of the equity indices that we collected from Macrobond. Our dataset contains annual data on all 34 OECD-countries from 1995-2014. The choice of these countries was partly because of the availability of data, but mostly because of the reliability of OECD's data. The choice of financial corporations as opposed to all corporations was partly because of the wider usage of leverage in this industry, thus potentially leading to more notable changes, but mostly because of the lack of research on these types of corporations. We started out with two datasets from OECD. The first one contains the debt-to-equity ratios of financial corporations located in OECD-countries from 1995-2014. This is the outcome variable used as a measure of the aggregated capital structure of each country. The second contains statutory corporate income tax rates of the same countries in the same period. Obviously, we cannot use this variable because it is subject to the reform, therefore we use it merely to find eligible treated units and control countries.

The macroeconomic explanatory variables that we obtained are short-term and long-term interest rates, GDP per capita, inflation and equity indices. Short-term interest rates are either three-month interbank offer rates, treasury bills, certificates of deposit or comparable instruments. Long-term interest rates are the yield of government bonds with ten years maturity. These rates are aggregated to an annual level by taking the arithmetic average. GDP per capita is measured in US dollars with constant prices using 2010 purchasing power parities. Inflation is measured as the average change in consumer prices between each year. The equity indices contain the index value of broad equity indices in order to measure the movement of the entire market. The indices have different scales thus complicating comparison. Consequently, we take the first difference between the natural logarithms to achieve comparable numbers. We do this because small changes in the logged variable are equivalent to percentage changes.

As previously mentioned we use log-transformed outcomes for all predictors. Inflation, or in this case deflation, is an exception to this since the logarithm of a negative number is not defined. The equity index variable is also always the first difference of the logs to maintain comparability across countries.⁷

5.3.2 Choosing control countries and sample period

When we decided the period and the donor pool of our study, we faced a trade-off between a short period with many potential donor countries and a long period with less potential donor countries. As previously mentioned, the majority of countries within the OECD changed their corporate income tax rate at some point between 1995 and 2014. This meant that we like Abadie et al. (2010), would have to discard countries that had a tax change similar to that of Austria. Another possibility was to adjust the period of the study so that a previous or future tax change was excluded from our sample period, thus making the country eligible for our donor pool.

This entailed that we had to set an upper limit on the tax changes that we would accept for our control countries. Consequently, we faced yet another trade-off between having additional potential donor countries and having a donor pool that could represent the counterfactual in a more correct manner.

We decided to set the limit at five percent, meaning that we discard all states that had a change in their corporate income tax rate of more than five percent throughout the period of this study. If changes in the tax rate of five percent or less lead to substantial changes in the capital structure of the financial corporations present in these countries, and we assigned one of these countries a positive weight in the synthetic control. Then we would if anything expect this to underestimate the effect of a change to the corporate income tax rate. The reason for this is that all countries in our donor pool had either no change or a decrease in their tax rate throughout the period, implying that the capital structure should stay the same or shift towards more equity financing.

⁷ For further details regarding the variables, we refer to appendix A.

Given the previously mentioned trade-off between a larger donor pool and a longer sample period and the five percent limit, we assessed the issue of choosing the duration of the sample period. We started out from 2005 and went one year back and one year forward until adding one year to our sample period would lead to fewer observations in total because of the discarded countries.

This procedure led to the selection of 2000 – 2010 as our sample period. As a result, the following eleven countries are eligible for our donor pool: Australia, Finland, France, Hungary, Japan, Norway, Spain, Sweden, Switzerland, United Kingdom and the United States. Further, we exclude Hungary and Japan from our donor pool since these countries have very different characteristics compared to the rest of the countries. Japan and Hungary have respectively very high and very low debt-to-equity ratios compared to the other countries in our dataset, and they are very different when it comes to the other variables in our dataset as well. Based on this, we exclude them in order to avoid possible interpolation bias. This leaves us with a donor pool of the remaining nine countries.

A donor pool of this size is attractive as it allows us to perform inference at the 10 % level, commonly used in tests of statistical significance. It also increases the probability that synthetic Austria resembles real Austria more closely regarding the debt-to-equity ratio compared to a smaller donor pool. The pre-treatment period will be from 2000 – 2004 giving us five years of pre-treatment data to base our matching of the explanatory variables on. The post-treatment period will consequently be from 2005 – 2010 giving us six years of data, enough to see if the tax reform lead to permanent change in the capital structure. Adding more years to the sample period at the expense of donor countries in order to perform in-time placebo studies was not an option, because our dataset only stretched from 1995 – 2010 leaving no room for a placebo study. However, in the analysis we, as previously mentioned in part 5.2.3, perform a robustness test where the sample period is from 1995 – 2014. Consequently, we can assess if the results that we get are just a coincidence. This will not let us perform any inference though, since it would result in too few control countries to perform placebo studies on.

5.3.3 Advantages and disadvantages of the dataset

The data in our dataset come from secondary sources; nonetheless, we consider our data highly reliable. This is mainly due to the trustworthiness of our sources, namely the OECD and Macrobond. Since our dataset contains data on OECD-countries only, the countries are comparable with similar characteristics. As briefly mentioned earlier, this makes us confident that interpolating between most of the countries in our donor pool will not lead to any bias.

The consistency in our data is also good, because all our data is measured using the same or similar approaches. However, the debt-to-equity ratios and the GDPs are calculated using the respective countries' national accounts. Unfortunately, not all of these national accounts are compiled according to the current international statistical standard for national accounts called the System of National Accounts 2008 (SNA 2008) (van de Ven, 2015).

In order to sustain consistency in our data we excluded countries that still produce national accounts according to the old System of National Accounts 1993 (SNA 1993), for instance Japan. Figures from OECD indicates that changing from SNA 1993 to SNA 2008 led to a weighted average increase in the GDP of OECD-members of 3.8 percentage points⁸ (van de Ven, 2015). By excluding countries still using SNA 1993, with the exception of debt-to-equity ratios, we reduce the possibility of introducing measurement error bias.

Our dataset contains aggregated data as opposed to estimates of the aggregate data. This helps us eliminate some of the uncertainty concerning the estimation of the parameters of interest. In other words, sampling error and bias become non-existent when we are using aggregate data. Consequently, we can solely focus on the uncertainty that comes from the ability of the control group to produce the counterfactual (Abadie et al. 2010).

The period of our dataset is relatively short when we compare it to other studies that utilize the synthetic control method. In order to become even more confident in the ability of the synthetic control to represent the counterfactual we would have liked that the dataset spanned over a longer period. This comes from the possibility of introducing bias if the number of pre-treatment periods are small compared to the transitory shocks in the factor model presented in

⁸For more information on the impact of the change from SNA 1993 to SNA 2008 we refer to van de Ven (2015)

section 5.2.1. Extension of our dataset is not possible however, if we want to be able to perform any inference. This is because of the previously mentioned long-run scarcity of countries with no changes to the corporate income tax rate.

5.4 Hypothesis

In section 4, we presented a well-established theory concerning the optimal capital structure of a firm, namely the trade-off theory, where firms balance the benefits against the costs of debt. When we are considering a tax change, then the trade-off theory implies that the debt-to-equity ratio will depend positively on the tax rate. This applies when we assume that all the other factors that affects the optimal capital structure remain equal. In reality, this is of course not the case, but given that the synthetic control is able to reproduce the counterfactual, we can isolate the effect of the tax reform. This means that we assume that the synthetic control captures all the other factors affecting the optimal capital structure.

Implementing this to the case of Austria's Tax Reform Act 2005 and the Dutch tax reforms of 2005, 2006 and 2007, means that the reduction of the tax rate would lead to a reduction in the debt-to-equity ratios of the financial corporations present there all else equal. Allowing change in the other factors that affect the optimal capital structure means that the change in the debt-to-equity ratio is not obvious when the tax rate changes. What we can say is that the reduction in the tax rate should make the debt-to-equity ratio of real Austria/Netherlands lower than that of the synthetic control. This means that we can observe a treatment effect even if the debt-to-equity ratio increases in the post-treatment period, as long as the increase is less than the synthetic control's. Of course, we would have a stronger implication of a treatment effect if the debt-to-equity ratio fell, meaning that the effect of the tax change was probably stronger than any effects affecting the debt-to-equity ratio in the opposite direction.

To summarize, we expect that the debt-to-equity ratio of Austria and the Netherlands should become considerably lower than the ratio of its synthetic counterpart in the post-treatment period. We expect this change to occur right after the treatment for Austria, and more gradually for the Netherlands. This is due to the gradual implementation of the Dutch tax reduction. We expect both to remain this way throughout the rest of the period, since no other changes to the tax rate occurred. Statistically, this implies the following hypotheses:

- H_0 = no effect of treatment, i.e. the change to the corporate income tax rate did not affect the capital structure of financial corporations.
- H_1 = positive effect of treatment, i.e. the change to the corporate income tax rate affected the capital structure of financial corporations positively.

6. Analysis

In this part, we will present and analyze data and results returned from running the synth-package for STATA. First, we present the results for Austria and analyse the values and graphs, then we conduct inference about the effect of the tax rate reduction, and lastly we check the robustness of our results. We then analyze the effect of the changes to the Dutch corporate income tax rate. We present the results for the Netherlands, then we conduct inference about the effects of the tax changes, and lastly we check the robustness of these results as well. Finally we compare our results for these countries.

6.1 Austria

A natural comparison to Austria would be the control group average. Figure 6.1 plots the development in the log debt-to-equity ratio of Austria versus the average of the control countries. We can observe that there is a substantial diversion of the graphs already in the pre-treatment period, starting as early as 2001. This premature change of direction indicates that the average of the control countries is not a good control group to utilize. Using the synthetic control method, we aim to compose a synthetic Austria that will function as a more accurate control group, i.e. one that replicates the counterfactual outcome more correctly.

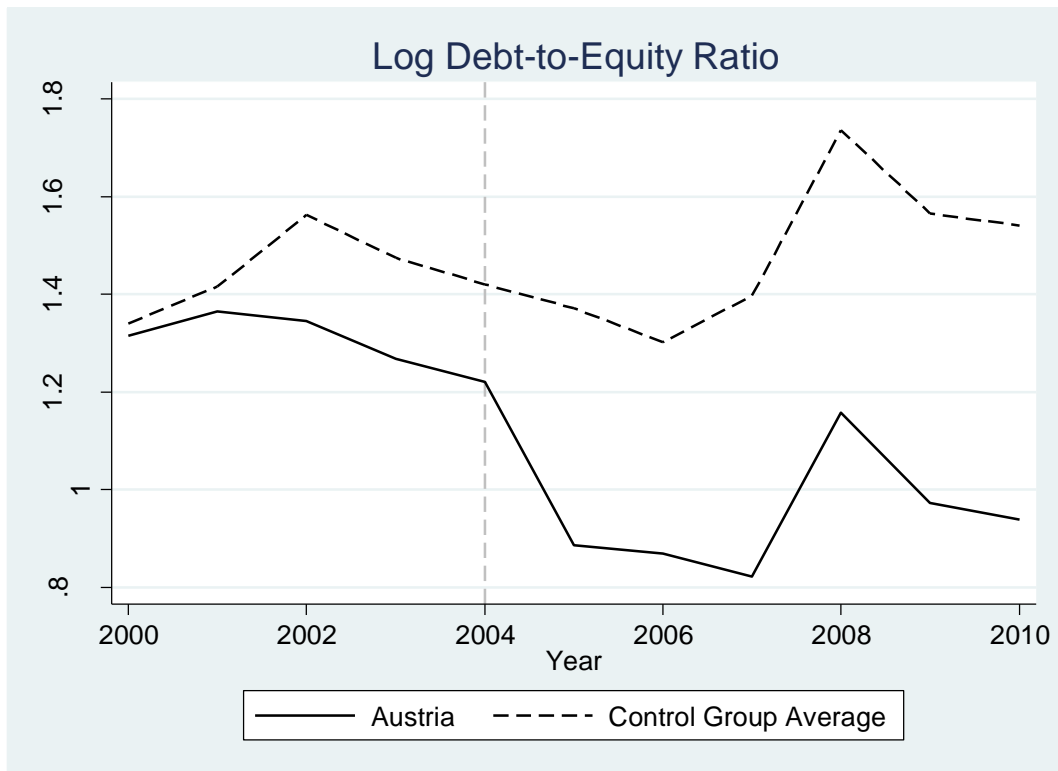


Figure 6.1: Log debt-to-equity ratio of Austria versus the average of the control countries

6.1.1 Results for Austria

As concluded above the comparison group needs improvement in order to be eligible for comparison with Austria. Using the synth-package for STATA, we construct a synthetic Austria. In order to build an accurate synthetic Austria we use countries with similar political and economic traits to Austria, as well as including variables that can be used as predictors for the development in the debt-to-equity ratio.

Below is Table 6.1, which displays the results from constructing the synthetic Austria. The table shows us the predictor means of the real Austria, as well as the synthetic Austria and the average of the other control countries. We can see that the synthetic results are quite similar to the real Austria, indicating that the model has composed a better fitting control group than the average. The difference between real Austria and the average of the control countries is in general larger than the difference between real Austria and synthetic Austria. Debt-Equity ratio 2004, inflation, government bonds 3m are all improved with the synthetic model. The debt-to-equity ratio in 2004 is substantially closer to the real Austria. The variables that

deviate between Austria and its synthetic control are not able to explain much of the variation in the outcome variable, and thus they compose only a small amount of the synthetic control.

Predictor	Austria	Synthetic Austria	Average of control countries
Ln (Government bonds 3m)	1.144	1.144	1.151
Ln (Government bonds 10y)	1.556	1.556	1.556
Ln (GDP/capita)	10.556	10.556	10.575
Inflation	2.06	2.06	2.05
Ln (Equity index _t) – Ln (Equity index _{t-1})	0.142	-0.044	-0.040
Ln (Debt-Equity ratio 2004)	1.221	1.263	1.420

Table 6.1: Predictor means for Austria

The results also provided us with a pre-treatment RMSPE of approximately 0.077. This RMSPE is quite low, which indicates that the level of error in the model is low, and it is therefore able to produce a good counterfactual.

Table 6.2 shows us which of the countries that received weights in the calculation of the synthetic Austria. The model found that France, Norway, Spain, Switzerland and the United States are the best-suited countries to produce a synthetic Austria in the pre-treatment period. However, only three of the countries compose the majority of the synthetic control, namely France, Norway and the United States. The synthetic control weights France significantly higher than the other countries, with weighting ranging from 4-19 times higher than the other weight-receiving countries. The rest of the countries in the donor pool receive zero weights, which means that they are not used for the construction of the Austrian synthetic control.

Country	Weight
Australia	-
Finland	-
France	0.626
Norway	0.15
Spain	0.078
Sweden	-
Switzerland	0.033
United Kingdom	-
United States	0.113

Table 6.2 - Country weights for synthetic Austria

Figure 6.2 shows us a comparison of synthetic Austria and real Austria. Compared to figure 6.1 we can observe a clear improvement of fit, which indicates that the synthetic Austria is a better control subject to study.

The graph shows us how the natural logarithm of the debt-to-equity ratio has developed over the sample period. The pre-treatment period lines follow the same trends with minor deviations. Implementation of treatment occurred in 2005, and thus we see an immediate drop in the debt-to-equity ratio. This drop is apparent from the point of implementation until the end of the treatment period we have investigated. The first year there was a drop of about 30 % in the debt-to-equity ratio. The drop increased slightly in the coming years. On average, the reduction in the debt-to-equity ratio was approximately 35 %. This figure indicates that there is a connection between the reduction of the corporate income tax rate and the capital structure of firms.

There is also sign of the financial crisis of 2007-08 in the figure. The financial crisis was a time of uncertainty, and the signs of it are present in the capital structure of firms as well. We see an upward trend in the debt-to-equity ratio at the start of the crisis. The post-treatment debt-to-equity ratio peaks in 2008, and then the amount of leverage falls significantly downwards at the end of our sample period. The steep rising of the debt-to-equity ratio is

quite substantial with an increase of about 40 % from 2007 to 2008. Even though there was a notable increase, the difference between real Austria and synthetic Austria remains. We also see that the tax reform and the financial crisis lead to change in the debt-to-equity ratio of comparable magnitude, thus indicating a very strong effect of taxes on the capital structure of firms.

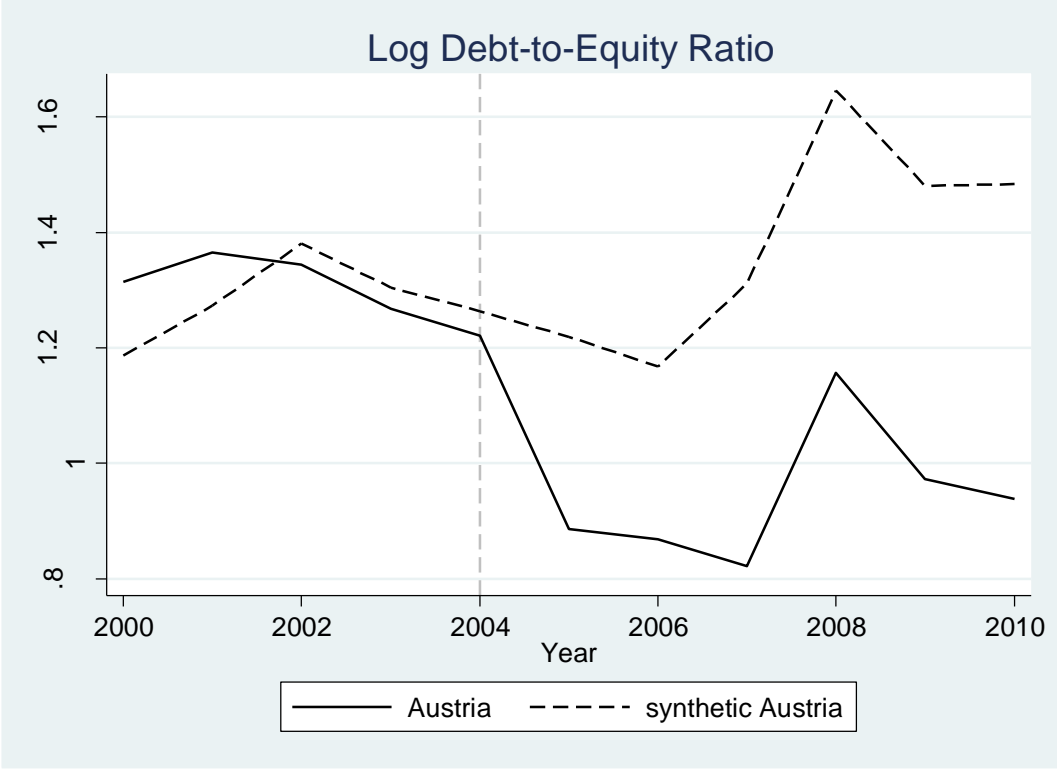


Figure 6.2: Log debt-to-equity of Austria versus the synthetic Austria

As mentioned above, figure 6.2 indicates that reduction of the corporate income tax rate has led to a reduction of the debt-to-equity ratio.

Figure 6.3 isolates the treatment effect from figure 6.2. The figure shows us the difference between real Austria and the synthetic Austria. There is relatively small fluctuations in the pre-treatment period. As implementation of the treatment occurred in 2005, there is a drastic fall, indicating that the treatment has had an effect on the debt-to-equity ratio. This figure indicates once again that there is a relation between the treatment and the reduction of the debt-to-equity ratio.

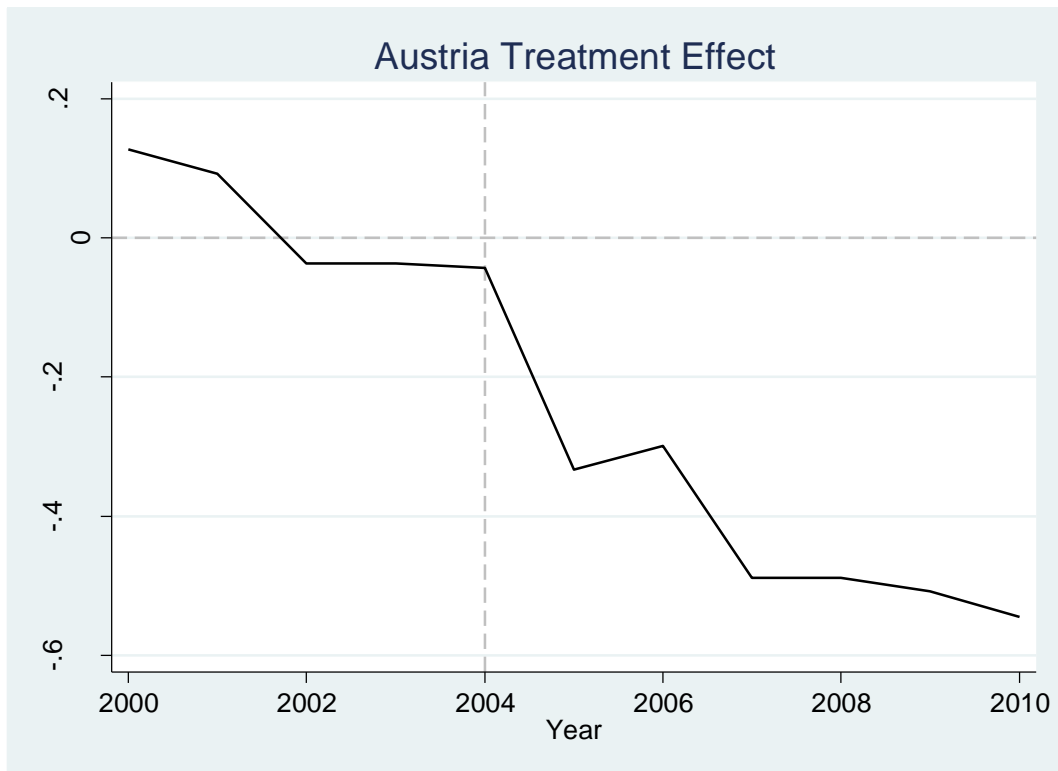


Figure 6.3: Treatment effect of Austria

6.1.2 Inference about the effect of the Austrian Tax Reform Act 2005

Firstly, we present the treatment effect for Austria and the nine control countries, i.e. the difference between the synthetic control and the actual country. This refers to the in-space placebo tests in part 5.2.2. Here we assess the probability of chance driving our results. Again, we are examining how often results of such scale occur when we perform the synthetic control method on a random country that did not implement such a change to the corporate income tax rate throughout our sample period. Based on the distribution of these estimated gaps, that measure the treatment effect, we can evaluate the significance of our results.

Figure 6.4 shows the results from the placebo test. All the grey lines are the estimated treatment effects for the control countries. The highlighted black line shows the country that actually received treatment, in this case Austria. What strikes one is the remarkable negative treatment effect of Austria, i.e. the large drop in the average log debt-to-equity ratio for financial corporations located in Austria compared to synthetic Austria. The treatment effect

stands out as the lowest right away from 2005, and lasts throughout the sample period all the way to 2010. This is a clear indication of an actual treatment effect, because it becomes apparent the period after treatment, and it is not transitory.

From figure 6.4, we can see that the synthetic control method provides a good fit for the debt-to-equity ratio before the implementation of the Austrian Tax Reform Act 2005. If the synthetic controls did not fit the log debt-to-equity ratios in the pre-treatment period very well, then we would have to interpret the large post-treatment gaps as lacks of fit as opposed to real treatment effects. In section 6.1.1 we found that the pre-treatment RMSPE of Austria is approximately 0.077. The average RMSPE of the control countries is approximately 0.088, and thus almost as low as that of Austria. This indicates that the synthetic control method is applicable to all donor countries. The country with the highest RMSPE in the pre-treatment period is Finland with 0.209, well under thrice as large as Austria's.

The good fit for the placebo synthetic controls in the pre-treatment period is present, most likely because we trimmed the donor pool for countries, namely Hungary and Japan, which had values for the outcome variable that did not belong to the convex hull of the values of the outcome variables for the other countries. As mentioned, we excluded these countries based on possible interpolation bias, because we experienced that if we included these countries in the donor pool then the synthetic controls were substantially different for countries that weighted these countries.

The other issue is that the synthetic control would not have been able to reproduce the log debt-to-equity ratio for these countries in the pre-treatment period, because of the exclusion of extrapolation as a method to construct the synthetic control. As a result, the synthetic control method would not have been a good way to estimate the counterfactual for these countries. Thus, we would have to discard these countries from the placebo tests regardless of any interpolation bias, because we would have to consider any difference between the synthetic control and the actual country in the post-treatment period as a lack of fit. Consequently, we did not need to discard any of the states that we included in the placebo tests.

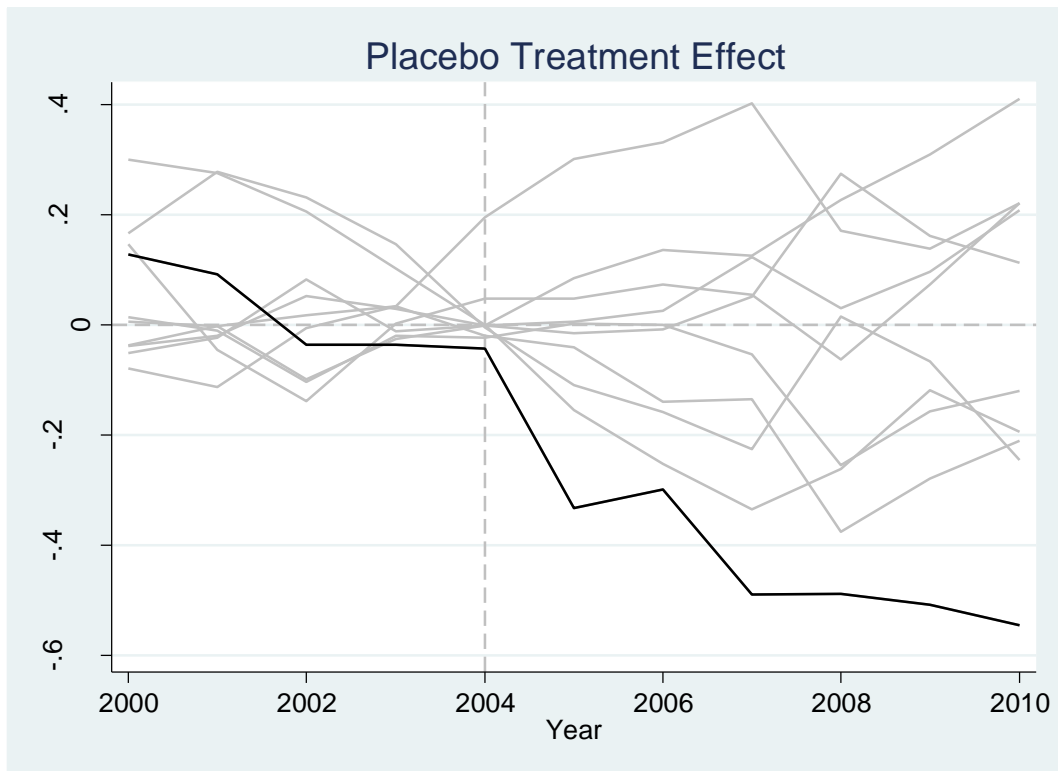


Figure 6.4: Treatment effect of Austria and control countries.

Based on our results we can assess if there is a causal relationship between Austria's Tax Reform Act 2005 and the average debt-to-equity ratio of Austrian financial corporations. Since our donor pool contains nine countries, we can perform inference at the 10 % level, as mentioned in part 5.2.2 under this one-sided hypothesis test. The probability, i.e. p-value, of estimating a gap as large as Austria's under a random permutation of the treatment among our donor countries is 10 %. Consequently, we reject the null hypothesis and conclude that the Austrian Tax Reform Act 2005 did negatively affect the average debt-to-equity ratio of Austrian financial corporations.

Next, we consider the post-/pre- treatment RMSPE ratios of Austria and the control countries. This lets us assess the post-treatment RMSPE compared to the pre-treatment RMSPE. The intuition is that the larger the pre-treatment RMSPE gets, the larger the post-treatment RMSPE needs to be in order to assure us that there has been a treatment effect. Of course, this only applies within reasonable limits, because a high pre-treatment RMSPE indicates a lack of

fit instead of a real treatment effect no matter how large the post-treatment RMSPE is in comparison.

The issue with this test is that it does not take the direction of the treatment into account, since it is a two-sided test. With part 5.2.1 in mind, we know that one calculates the RMSPE as the root mean squared prediction error, and when we square the prediction error, we lose information about the direction of it. This means that a country that has a synthetic control that follows the real value of the outcome variable closely in the pre-treatment period scores well compared to a deviating synthetic control all else equal, which is a good thing.

The issue is that a country scores well if its synthetic control deviates greatly both over and under the real value of the outcome in the post-treatment period. A fluctuating gap between the synthetic control and the real country in the post-treatment period is certainly no sign of a treatment effect, especially not in our case. In our setting, we are only interested in the possible existence of a treatment effect not the direction of it. Based on our theory and previous research we are confident that if the corporate income tax rate has a significant effect on the capital structure of financial corporations then it is positive, i.e. a reduction of the corporate income tax rate leads to a reduction of the debt-to-equity ratio of firms.

Consequently, a synthetic control that deviates over the real value of the outcome variable in the post-treatment period gets a high post-/pre-treatment RMSPE ratio even though it is not a sign of a treatment effect. Regardless this test is good for assessing the magnitude of the treatment effect.

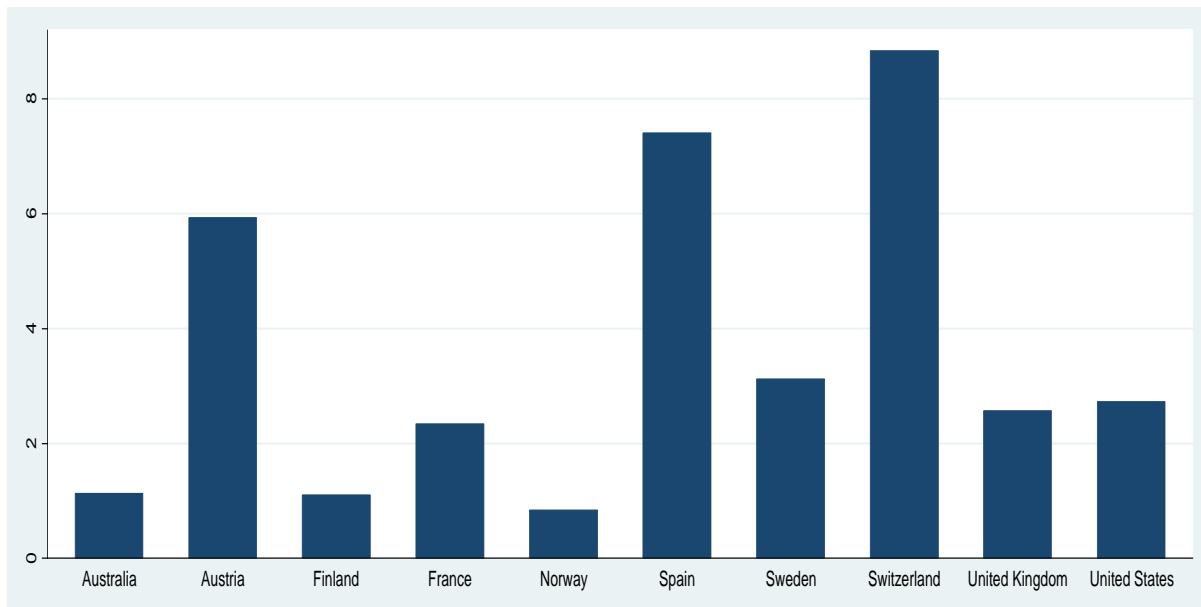


Figure 6.5: Post-/Pre-treatment RMSPE ratio of Austria and the control countries

If we study the bar graph in figure 5.4, we see that especially three countries stand out among the others in terms of post-/pre-treatment RMSPE ratio. In descending order, they are Switzerland, Spain and Austria.

Switzerland gets the highest RMSPE ratio due to an excellent pre-treatment fit with RMSPE at about 0.025, which is by far the lowest among all the countries in our sample. Together with a moderately gap in the post-treatment period at about half of Austria's, this gives Switzerland the highest RMSPE ratio. Besides the low pre-treatment RMSPE Switzerland is also one of the countries that was closest to our five percent limit regarding changes to the corporate income tax rate, as mentioned in part 5.3.2, with an accumulated tax change over the sample period of 3.76 percentage points. This means that a smaller treatment effect could actually be present, because the treatment effect of Switzerland has in fact the same sign as Austria's, i.e. the synthetic control has a higher log-debt-to-equity ratio than the actual country in the entire post-treatment period.

Another possibility is Switzerland's proximity to Austria in culture, language and of course distance. This might entail that the countries are quite similar in terms of capital structure of financial corporations as well. Austria's debt-to-equity level was in fact about the same as

Switzerland's after the reduction of the corporate income tax rate to approximately the same level as Switzerland's.

Spain on the other hand has a positive treatment effect, i.e. the synthetic control has a lower log debt-to-equity ratio than Spain in the post-treatment period. A part of Spain's high RMSPE ratio attributes to a very good pre-treatment fit, but the real driver of this increase in leverage is most likely due to Spain's prominent role as one of the countries afflicted by the European sovereign debt crisis. Throughout our sample period, Spanish financial corporations more than doubled their debt-to-equity ratio from 3.153 to 6.968. No other country in our sample experienced such a large increase in their debt-to-equity ratio both relatively and absolutely. A property boom driven by corporations fuelled this increase in leverage, which came to a halt under the European sovereign debt crisis (Lane, 2012). Consequently, we actually expected a gap between Spain and its synthetic control.

This is because the synthetic control originates from a period with moderate levels of debt of Spanish financial corporations, and almost all the countries in the donor pool experienced a reduction in the debt-to-equity ratio over the course of the sample period. This leaves us a country that increased its leverage considerably and a synthetic control that experienced no such increase. The other countries that were largely afflicted by the European sovereign debt crisis, namely Greece, Italy, Portugal and Ireland, are not included in our sample because of too large changes to the capital income tax rates or missing data. This probably increases the treatment effect of Spain because these countries would mitigate the treatment effect by moving the synthetic control upwards if they were to receive weights in the synthetic control.

Nevertheless, the probability of acquiring a RMSPE ratio of Austria's magnitude under a random permutation is 30 %. With a p-value of 30 %, we fail to reject our null hypothesis. Consequently, we cannot conclude that the Austrian Tax Reform Act lead to a significant reduction in the average debt-to-equity ratio of Austrian financial corporations.

6.1.3 Robustness of the Austrian synthetic control

As mentioned in the methodology part 5.2.3 we conduct several robustness tests to evaluate if specific countries or variables drive our results, and if our results hold over time. Firstly, we will present a robustness test that excludes one of the donor countries at a time. In part 6.1.1 we found that a weighted combination of France, Norway, Spain, Switzerland and the United States resembles Austria in the pre-treatment period. By excluding one of these countries at a time, we will be able to determine if any of them drive our results. If exclusion of one or more of them leads to a substantially different synthetic control, we will consequently lose confidence in the synthetic control's ability to represent the counterfactual in a proper manner. Of course, the less countries we have available in our donor pool, the more lenient we have to be regarding what variation we allow in the synthetic control.

If we consider figure 6.5, we see that the synthetic control is in fact very robust to the exclusion of control countries. Not a single country stands out as a prime driver of our results. Not even the exclusion of France, the highest weighted country, alters the synthetic control substantially. We can also see that the trajectory of the synthetic control is approximately the same, and the exclusion of different control countries only shifts the curve up or down. The only difference that is somewhat notable is the exclusion of France and Norway leading to a lower synthetic control at the end of the sample period.

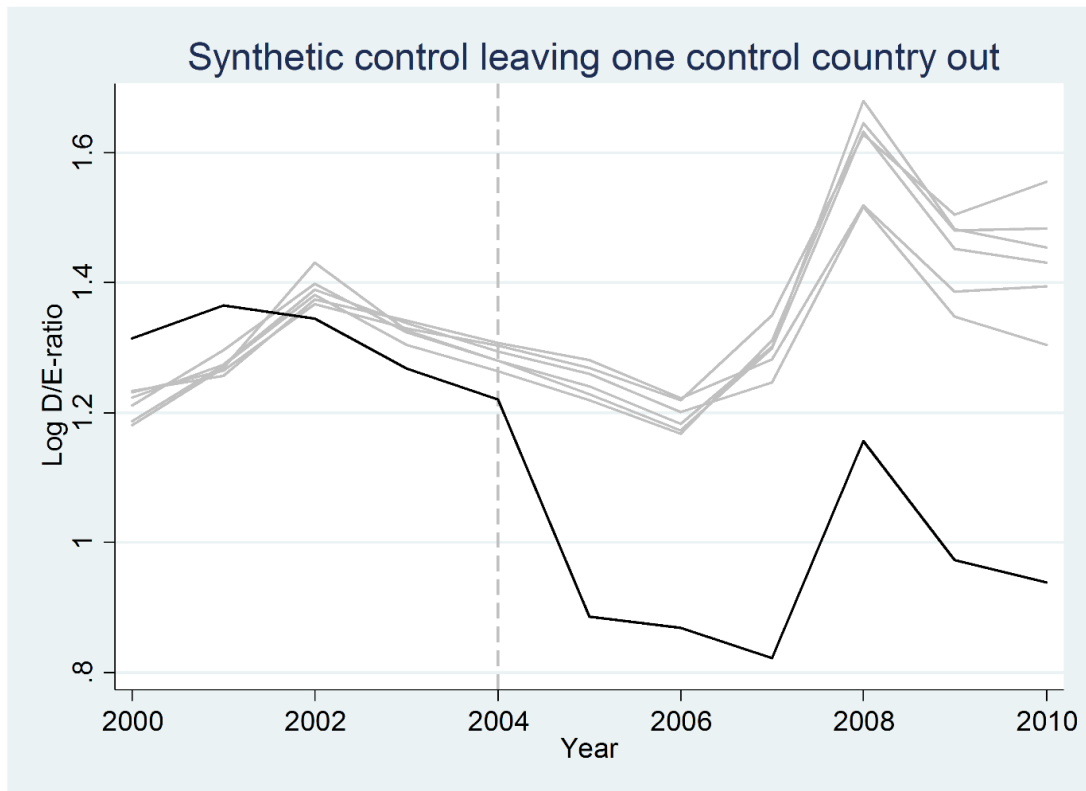


Figure 6.6: Austrian synthetic control leaving one control country out

Based on figure 6.6 we can conclude that no single country drives the synthetic control in a particular direction. Thus, the synthetic control is robust regarding the control countries, as the treatment effect is clearly visible regardless which control country we exclude.

Then, we present a similar graph but this time we examine if any of the predictors drive our results substantially. As with the control countries, we now exclude one predictor at a time to determine if any of the predictors alter the synthetic control. As presented in part 5.3.1 the predictors are short-term and long-term interest rates, GDP per capita, inflation, equity indices and the last pre-treatment debt-to-equity ratio. If we consider figure 6.6 we see a very similar graph to the one with exclusions of control countries. Again, we see that the trajectory of the synthetic control is approximately unaltered when excluding a certain predictor variable and the only notable change is that the curve shifts up or down.

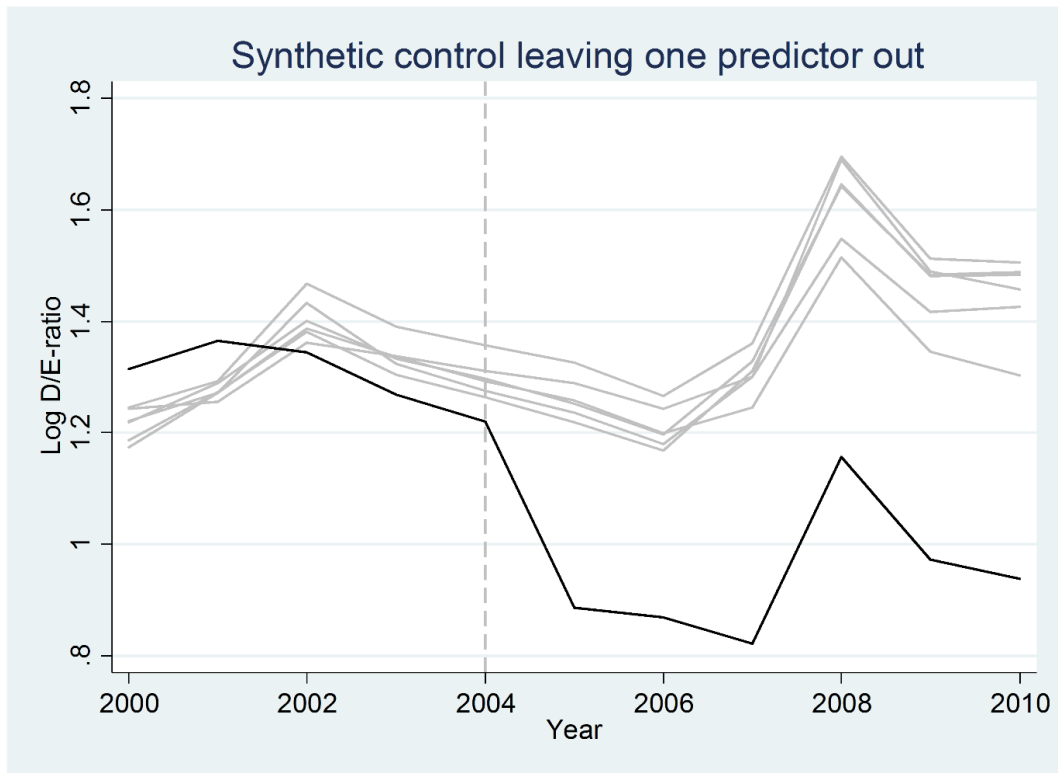


Figure 6.7: Austrian synthetic control leaving one predictor out

Based on the results displayed in figure 6.7 we conclude that the synthetic control is indeed robust to the exclusion of any of the predictors. This means that no single predictor variable drives our results. Consequently, this test upholds our belief in the ability of the synthetic control to replicate the counterfactual.

Lastly, we conduct a robustness test where we expand the sample period to examine if the synthetic control is biased. In part 5.2.1, the need for a long pre-treatment period became apparent. This was because of the possible bias originating from a short pre-treatment period compared to the transitory shocks of the factor model. If we get a similar trajectory for the synthetic control, this test assures us that our estimates are unbiased with respect to the sample period. Of course, we lose many control countries, as previously mentioned, when we expand the sample period. If our results do not hold, and we get a substantially different synthetic control, then it could just be that the remaining countries are not able to replicate the counterfactual. If we expand the sample period back to 1995 and forward to 2014, there are

four eligible countries for the donor pool, namely Finland, France, Norway and the United States. These countries did not experience a single tax change of over five percent and did not accumulate a tax change of over five percent during the sample period either.

If we consider figure 6.8 we see that the synthetic control is still following somewhat the same trajectory. Although the treatment effect seems smaller in the long run, it is still very much present. The fit of the synthetic control in the pre-treatment period is excellent as well. The pre-treatment RMSPE is approximately 0.050 and thus in fact lower over this period. France, Norway and the United States were all part of the initial synthetic control, and thus it is plausible that the excellent synthetic control is to some extent a result of those countries being donors.

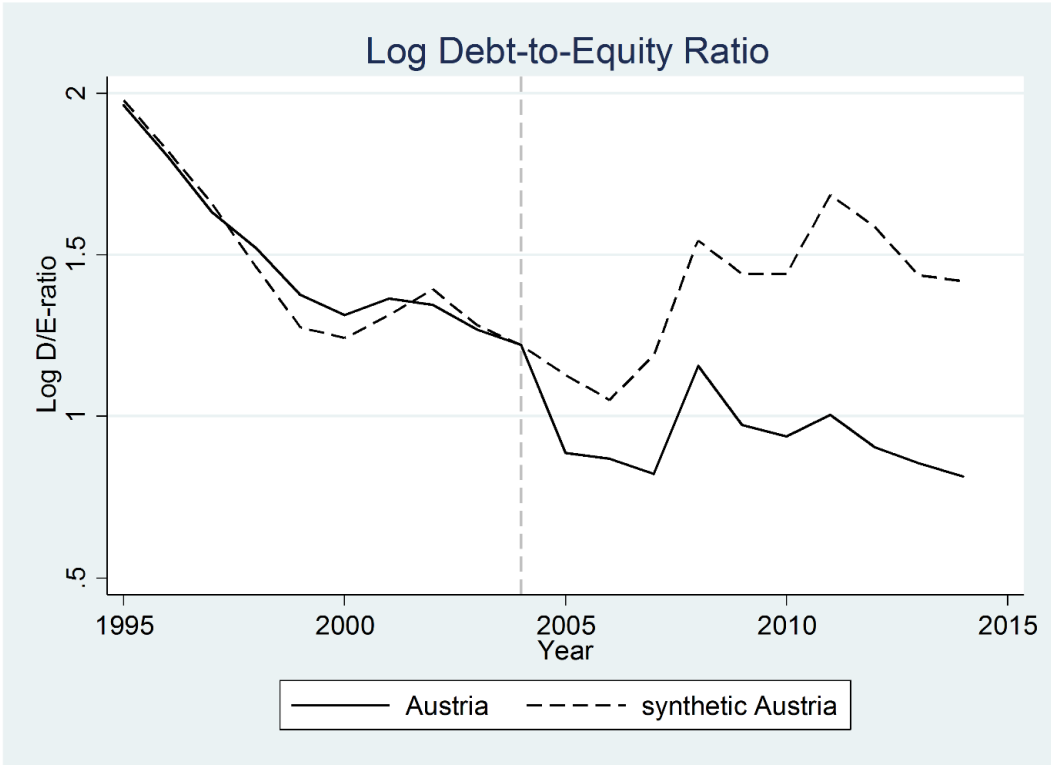


Figure 6.8: Austrian synthetic control 1995 - 2014

This result assures us that bias originating from too few pre-treatment periods is not an issue. With these three tests of robustness backing our results, we can be confident that our synthetic control is able to produce the counterfactual outcome of Austria.

6.2 The Netherlands

Figure 6.9 plots the log debt-to-equity ratio development of the Netherlands versus the average of the control countries. The two curves deviate from the beginning until the end of the sample period. It is apparent that comparing the real Netherlands to the average of the control countries will not work well for estimating the effect of the reduced corporate income tax rate. The usage of the control group average is even worse for the Netherlands compared to Austria. The deviation in the pre-treatment period continues in the same manner after the treatment has occurred. This indicates that these two groups are completely different to begin with; thus, the average of the control countries cannot help us estimate the effect of the tax reduction.

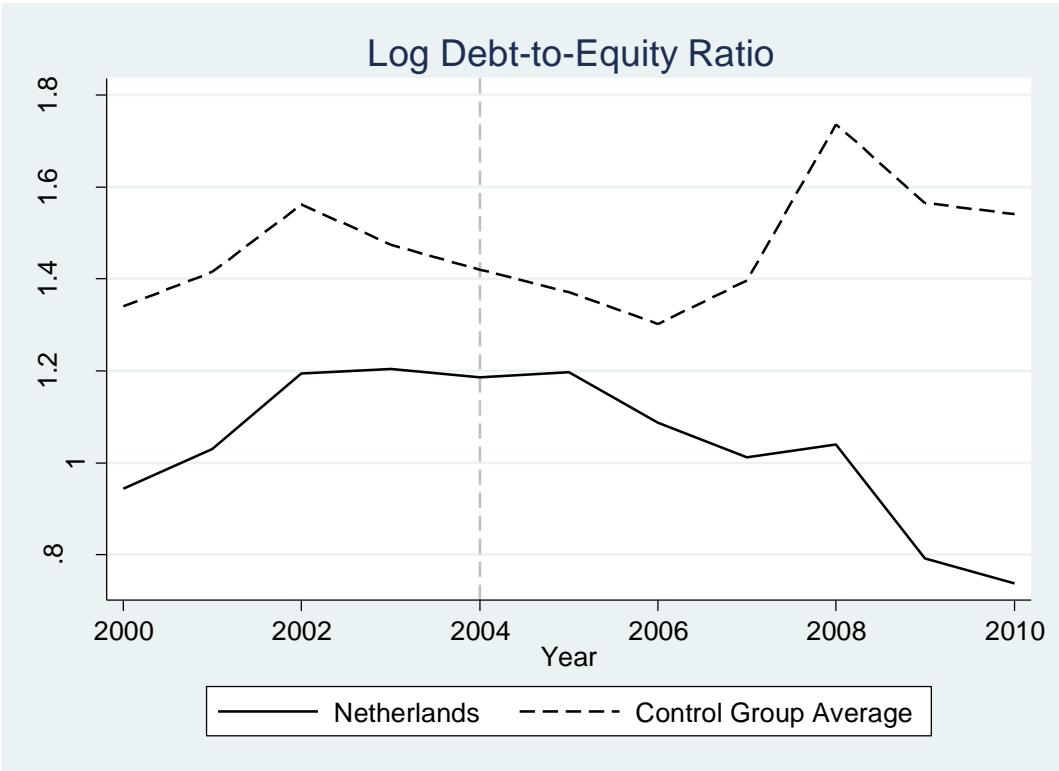


Figure 6.9: Log debt-to-equity ratio of the Netherlands versus the average of the control countries

6.2.1 Results for the Netherlands

We construct a synthetic the Netherlands in order to produce an improved comparison compared to the average of the control countries. We apply the same predictors that we used for Austria. Below is Table 6.3, which displays the results from constructing the synthetic Netherlands. The table shows us the predictor means of the real Netherlands, as well as the synthetic Netherlands, and the average of the other control countries.

In general, we observe that there is a considerable improvement of fit between the values of the real Netherlands and the synthetic Netherlands, compared to the donor pool average. In particular, we observe that the values for debt-Equity ratio 2004 and inflation are substantially closer for the synthetic Netherlands than for the average of the control units.

Predictor	Netherlands	Synthetic Netherlands	Average of control units
Ln (Government bonds 3m)	1.144	1.123	1.255
Ln (Government bonds 10y)	1.540	1.545	1.585
Ln (GDP/capita)	10.632	10.440	10.566
Inflation	2.62	2.423	2.194
Ln (Equity index _t) – Ln (Equity index _{t-1})	-0.120	-0.048	-0.084
Ln (Debt-Equity ratio 2004)	1.186	1.188	1.445

Table 6.3: Predictor means for the Netherlands

The results provided us with a pre-treatment RMSPE of 0.099. The RMSPE, while slightly higher than Austria's, is still low. The low RMSPE indicates again that the error in the model is low, and that it is applicable to act as the counterfactual. The higher RMSPE compared to Austria becomes apparent when studying the average values of the predictors, because we see that some of them deviate more than they did for Austria.

Table 6.4 shows us the countries that received weights in the calculation of the synthetic Netherlands. The synthetic control consists of France, Spain, Switzerland and the United

States. France and Spain share the majority of the weights. The other countries left in the donor pool received zero weights, which means that they are not a part of the synthetic Netherlands.

Country	Weight
Australia	-
Finland	-
France	0.559
Norway	-
Spain	0.377
Sweden	-
Switzerland	0.005
United Kingdom	-
United States	0.06

Table 6.4: Country weights for the synthetic Netherlands

Figure 6.10 shows us a comparison of the synthetic Netherlands and the real Netherlands. We observe once more how well the synthetic composition fits compared to the average of the control countries. The two groups are much closer in behaviour in the pre-treatment period. The Netherlands has had several reductions of the corporate income tax rate over the treatment period. The drop occurred first in 2005 with a 3 % reduction, followed by a 1.9 % reduction in 2006, and lastly a 4.1% reduction in 2007, thus leading to an accumulated tax reduction of 9 %, equal to that of Austria. This is why we see a much more gradual change to the debt-to-equity ratio in the Netherlands compared to Austria. After all three tax reforms were effective, the debt-to-equity ratio of financial corporations in the Netherlands were on average around 30 % lower compared to the synthetic control group.

The pre-treatment lines follow the same trend, and at the end of the pre-treatment period, there is almost no deviation between the two. This indicates a good match and works in our

favour of estimating the effect of the reduction of the corporate income tax rate. The first treatment occurred in 2005, and we see that within short time there is a reduction in the debt-to-equity ratio. This drop continues as the timeline approaches 2007. We can observe that compared to the synthetic line, the debt-to-equity ratio is much lower. So far, the figure indicates that there is a connection between the reduction of corporate tax rate and the capital structure of the financial corporations in the Netherlands.

The next large reduction of the corporate income tax rate is effective from 2007. Roughly, at the same time the financial crisis hits, therefore we have two conflicting forces. The financial crisis, as shown for Austria led to an increase in the debt-to-equity ratio. According to theory, a reduction of the corporate income tax rate makes debt less attractive; therefore, a reduction of debt-to-equity ratio is expected. The sum of these effects lead to a slight increase in the debt-to-equity ratio. The increase is relatively smaller than the increase Austria experienced, approximately 3 %. This neutralization is likely due to the reduction of the corporate income tax occurring in stages. In the same period, Austria had a stable corporate income tax; therefore, the financial crisis had a visibly larger effect on the debt-to-equity in this case. Again, there is a difference present between the real and the synthetic groups, indicating that the previous reduction and period of lower tax has affected the debt-to-equity ratio.

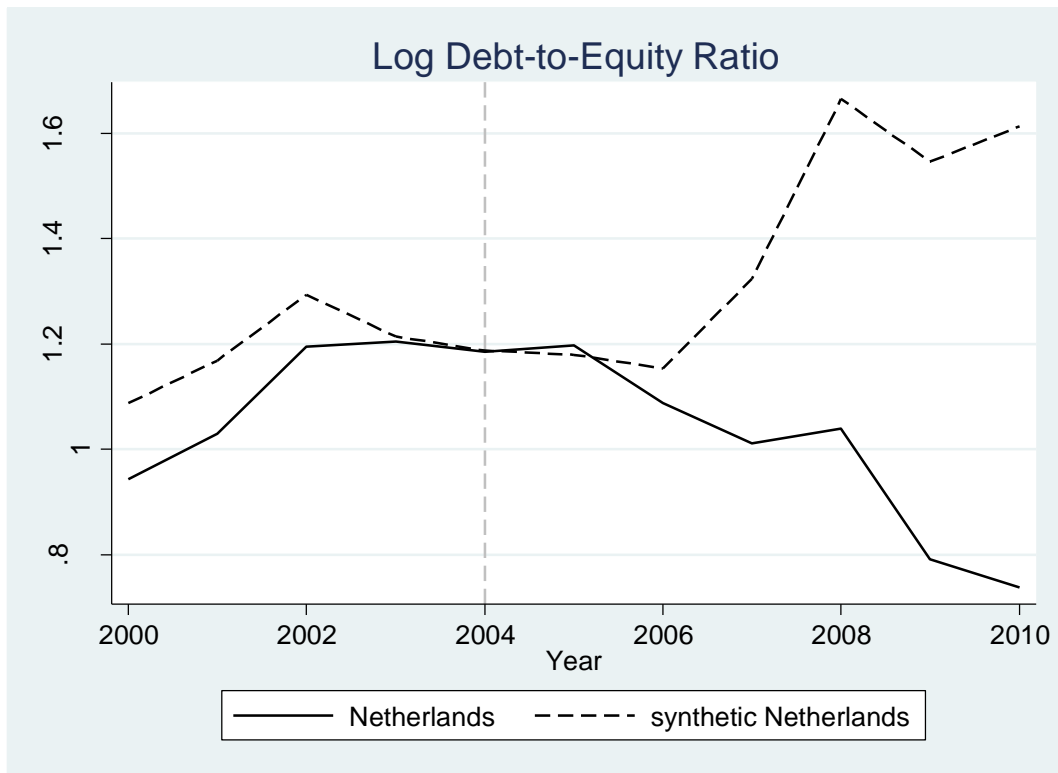


Figure 6.10: Log debt-to-equity ratio of the Netherlands versus the synthetic Netherlands

Figure 6.11 shows the treatment effect obtained from figure 6.10. The figure shows us the difference between the real Netherlands and the synthetic Netherlands. We can observe that the pre-treatment period is quite stable. Due to the tax reduction being gradual, we see a slowly escalating treatment effect, and after the last tax cut occurred, we see a substantial treatment effect. The drop is apparent throughout the entire post-treatment period, thus indicating that it is not transitory. Once again, the figure indicates that there is a relation between the treatment and the debt-to-equity ratio.

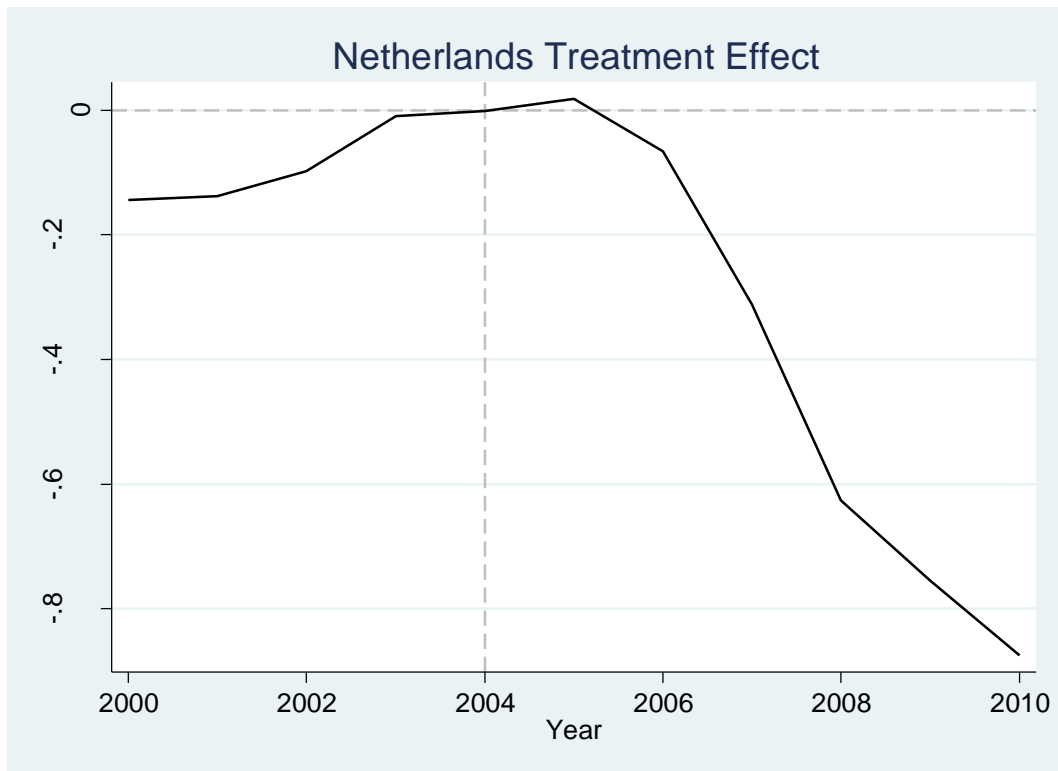


Figure 6.11: Treatment effect of the Netherlands

6.2.2 Inference about the effect of the Dutch tax reductions in 2005, 2006 and 2007

In this part, we follow the same approach as we did with Austria. Firstly, we present the placebo synthetic controls alongside that of the Netherlands. Again, the grey lines are all the placebos and the highlighted black line is the treated country, namely the Netherlands.

If we consider figure 6.12 we see that the Dutch line does not stand out at the start of the post-treatment period in contrast to Austria's from part 6.1.2. However as we get further into the post-treatment period we see that the Dutch treatment effect clearly stands out as the largest. This is in fact something that we would expect due to the gradual change to the Dutch corporate income tax rate. As previously mentioned the Dutch corporate income tax rate reduction was only by 3 % in 2005 followed by 1.9 % in 2006. This accumulates to a change of 4.9 %, which is under the limit we accept for our donor countries. Thus, we do not expect a significant change to the debt-to-equity ratio that early into the post-treatment period.

In 2007 when the accumulated change had reached 9 %, we clearly see that the Dutch treatment effect stands out. At this point, it is the lowest among all the control countries slightly lower than Finland. Throughout the rest of the post-treatment period, the gap between the Netherlands and its synthetic control increases and stays the lowest.

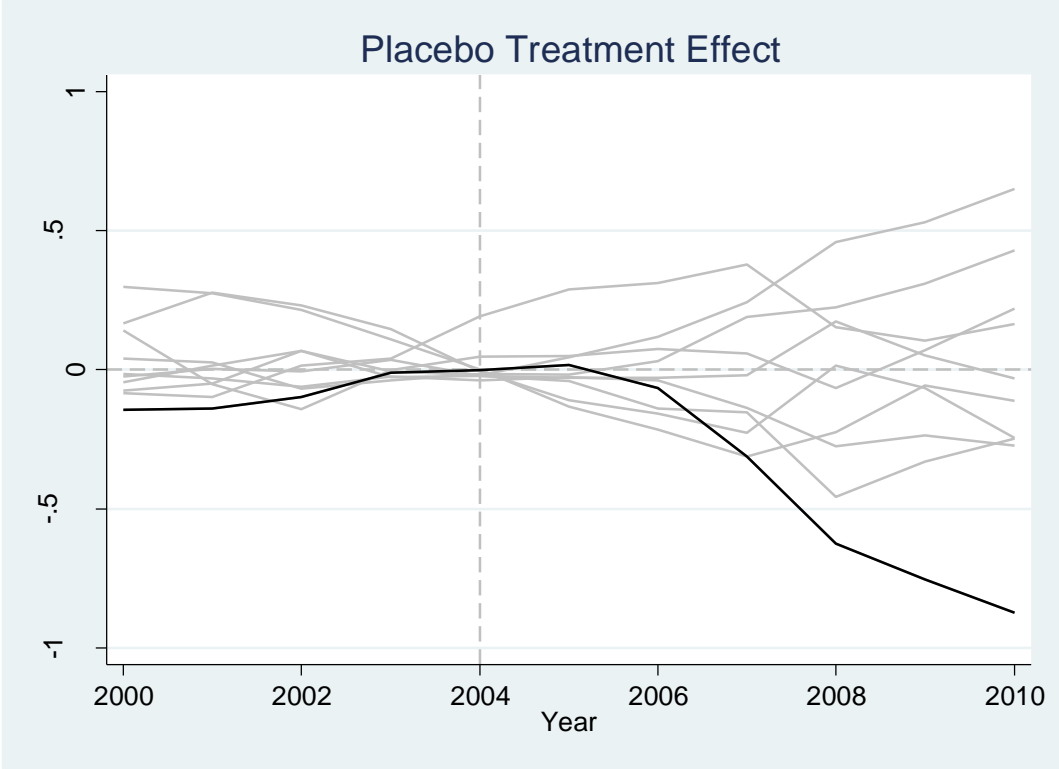


Figure 6.12: Treatment effect of the Netherlands and the control countries

Based on the placebo graph we can evaluate the significance of our results for the Netherlands. The chance of obtaining a gap of the Netherlands' magnitude under a random permutation test is 10 %, and thus we reject the null hypothesis. Consequently, we conclude that the Dutch tax reductions lead to a significant reduction to the average debt-to-equity ratios. This is in line with our findings in part 6.1.2 for Austria.

Secondly, we evaluate the Dutch post-/pre-treatment RMSPE ratio to those of the control countries. If we contemplate figure 6.13, we see that although the Dutch bar is one of the more distinguished, it is far from the largest. Switzerland and Spain clearly stand out as

having the highest RMSPE ratios. Then we have France, the United States and the Netherlands in descending order with RMSPEs at around five. The Netherlands has the largest post-treatment gap so the relatively low RMSPE ratio is due to a worse pre-treatment RMSPE than the control countries that gets a high RMSPE ratio. The Netherlands has a pre-treatment RMSPE of 0.099, which is in fact a little over the average of 0.089.

Switzerland and Spain has treatment gaps much like the ones we saw in part 6.1.2. France and the United States gets a decent sized RMSPE ratio because of an excellent pre-treatment fit. France gives substantial weight to the Netherlands in its synthetic control, thus will the synthetic control have a low log-debt-to-equity ratio in the post-treatment period.

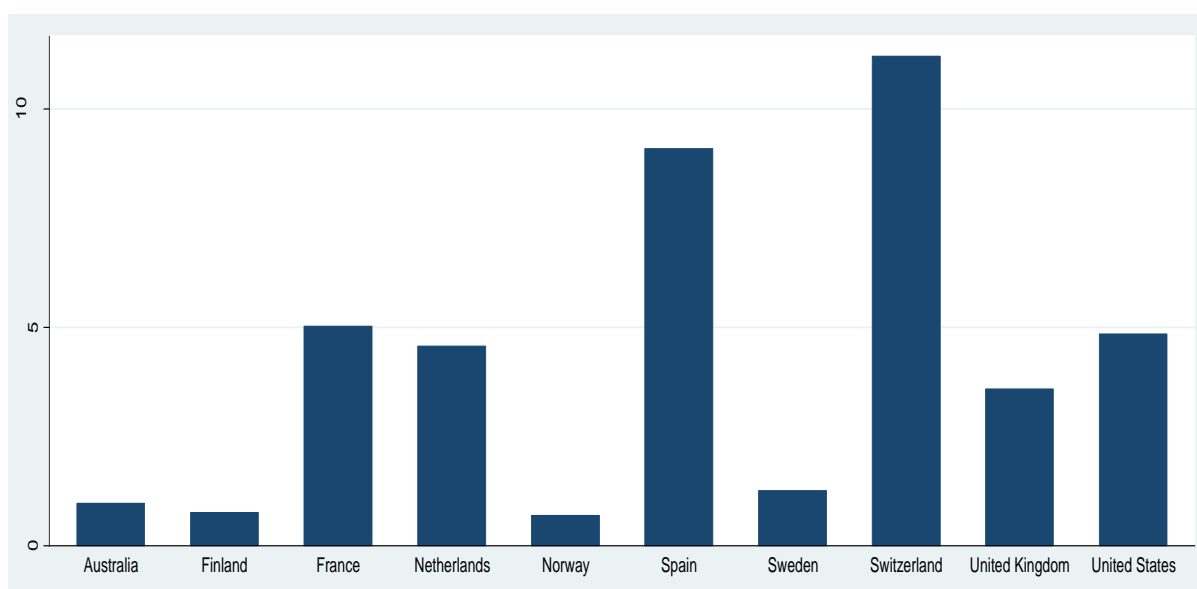


Figure 6.13: Post-/Pre-treatment RMSPE ratio of the Netherlands and the control countries

Based on the result we fail to reject the null hypothesis since the p-value of our test is 0.5, i.e. it is a 50 % chance that chance drives our results. This is also in line with the findings in part 6.1.2, and again we attribute the high p-value to the low pre-treatment RMSPE of the treated country. Again, we must remember that this test can be thought of as a two-sided hypothesis test, thus being more restrictive than the previous one-sided test when it comes to rejecting the null hypothesis.

6.2.3 Robustness of the Dutch synthetic control

Firstly, we will conduct the robustness test for control countries. From part 6.2.1, we found that the Dutch synthetic control is composed of France, Spain, Switzerland and the United States. To see if any of these countries drive our results in a particular direction, we exclude each country one at a time so that we have a donor pool consisting of eight countries at each iteration. If our Dutch synthetic control is robust enough, we should see no significant change to its trajectory for all iterations.

If we consider figure 6.14, we see that the synthetic control seems rather similar for each iteration. The top line is the synthetic control with no restrictions, and we see that exclusion of any of the control countries leads to a lower estimated treatment effect. Still the treatment effects are salient, even for the lowest outcome. Again, the trajectories of the synthetic controls are similar only parallel shifted. One line stands out though and that is the synthetic control excluding Switzerland. This shows a conspicuous reduction of the treatment effect, but the effect is still large. Here we will like to point out that the exclusion of Switzerland leads to no big distortion to the Austrian synthetic control, and thus it seems that there is no systematic effect of removing Switzerland from the control.

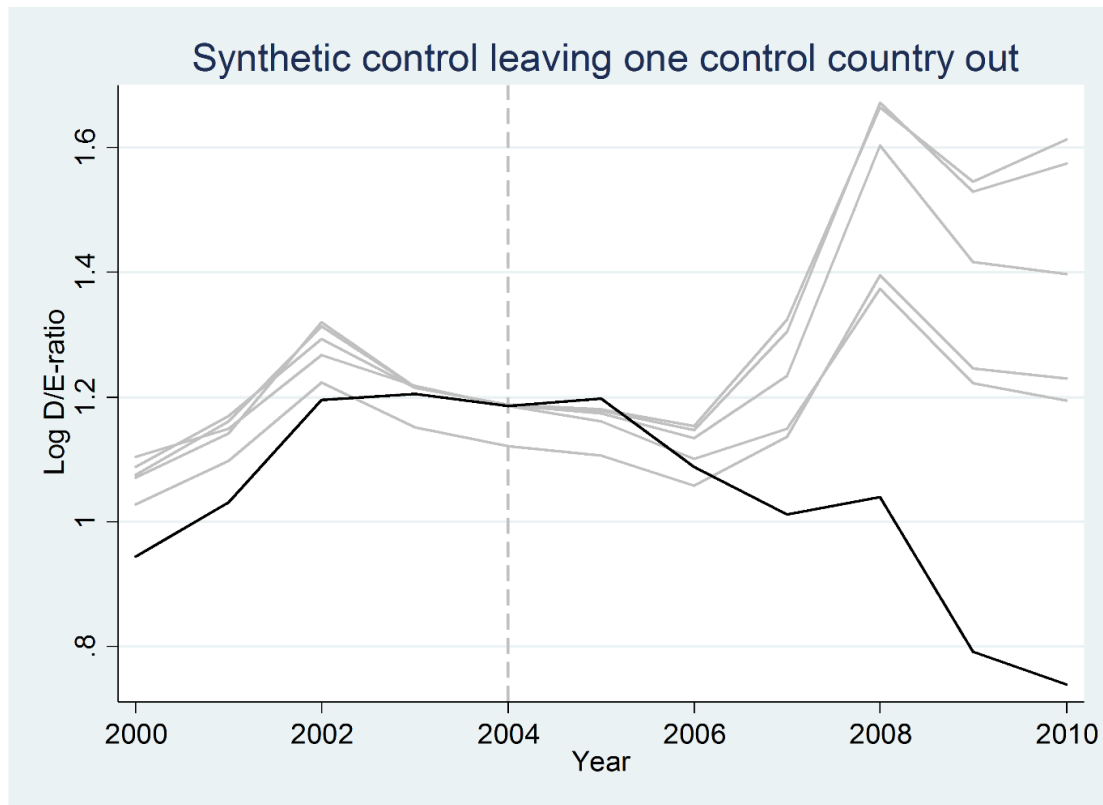


Figure 6.14: Dutch synthetic control leaving one control country out

Based on the results above we find that no particular country drives our results in a particular direction. The salient treatment effect remains present no matter which control country we exclude, although it subsides in some of the iterations.

Secondly, we conduct the leave-one-out robustness test for our predictors. If we consider figure 6.15, we can see that there is some variation to the Dutch synthetic control. However, this variation is as before not altering the trajectory of the synthetic control much. The only difference that is conspicuous is as before that the curves parallel shift somewhat. The curve that is the lowest throughout the whole sample period is the synthetic control excluding the last pre-treatment value for the outcome variable, thus it seems to inflate the synthetic control a little. Regardless we still see a strong treatment effect in the end.

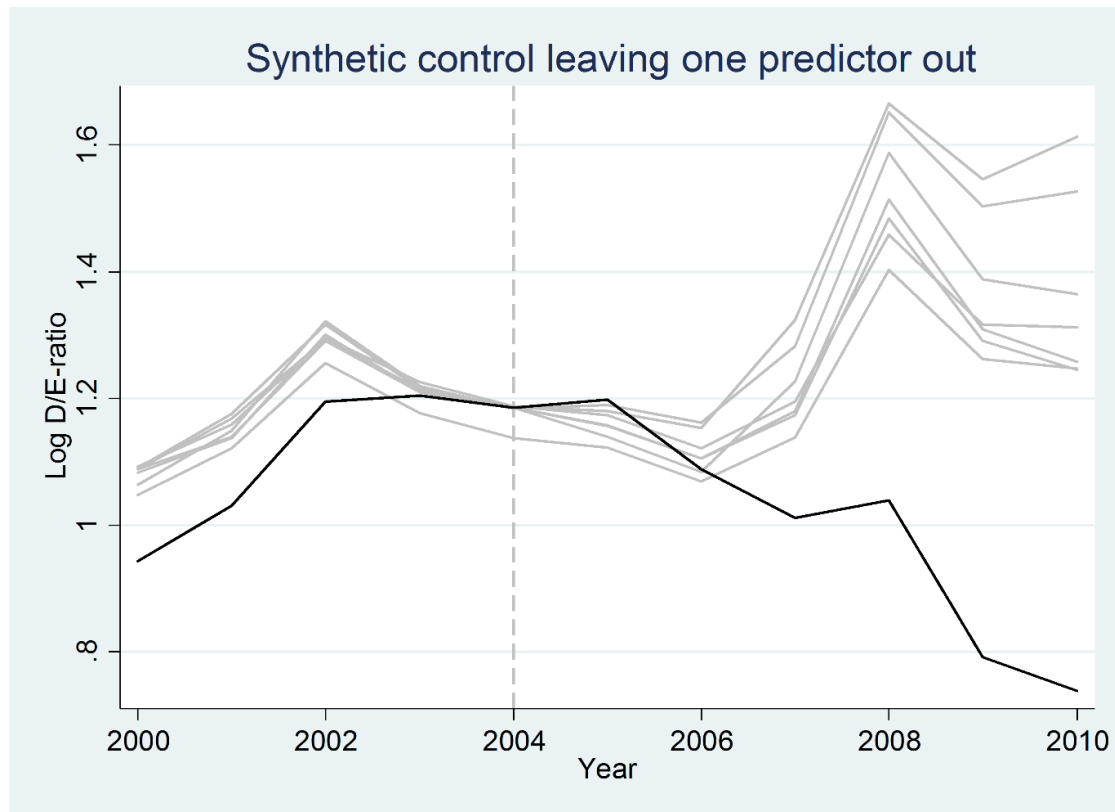


Figure 6.15: Dutch synthetic control leaving one predictor out

Based on our findings we conclude that no predictor drives our results. Although we observe that the exclusion of some variables leads to a lower treatment effect, the effect is still very salient.

Finally, we conduct the extended timeline robustness test. Again, we are interested if the pre-treatment period is sufficiently long enough to prevent bias. Similar results for the synthetic control will assure us that our estimation is applicable as the counterfactual. If we contemplate figure 6.16, we can see that the synthetic control is not such a good fit. This applies particularly in the start of the pre-treatment period. From 1998 and onwards however seems the synthetic control to provide a decent fit. The trajectory of the synthetic control is similar to the initial from 1998 and onwards, though only lower. This could indicate a lower treatment effect than estimated. Regardless we should not overly focus on this test since it consists of only four control countries, and consequently it has as high pre-treatment RMSPE as 0.198.

The graph looks similar to the one that excluded Switzerland as a control country, and this could explain why we estimate a lower treatment effect. Switzerland could however not be included as a control country due to a large change to the corporate income tax rate over the course of the period. The scarcity of control countries hinders us from exploring if there is some other weighted combination that could have reproduced the initial Dutch synthetic control.

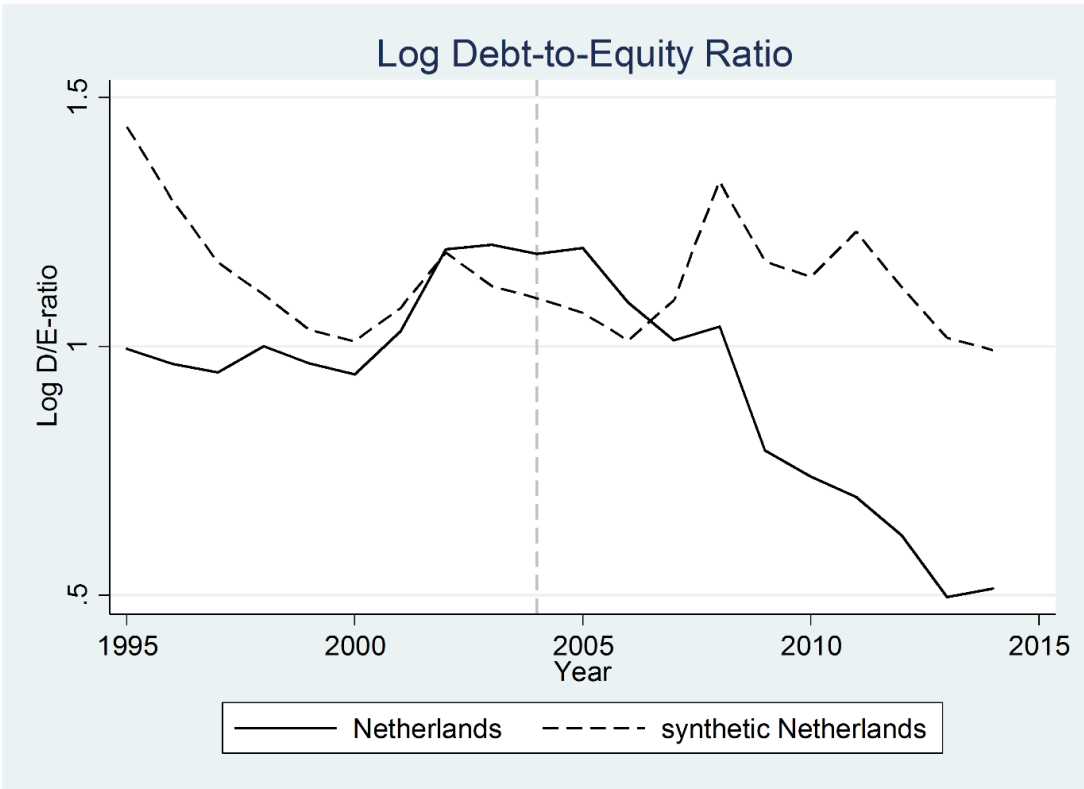


Figure 6.16: Dutch synthetic control 1995 – 2014

Based on our results we find that the synthetic control holds slightly over an extended sample period. Although it seems like the treatment effect could be overestimated. Still there is a treatment effect from 2007 and onwards which is in accordance with our previous findings.

6.3 Robustness of predictor variables

Finally, we test which set of predictors that produces the most reliable results. As mentioned, in part 5.2.3 we want to find the set that minimizes the post-treatment prediction error, i.e. the set that yields the lowest post-treatment RMSPE ratios. Again, we are only examining the donor countries in order to make sure that the treatment does not steer our choice of predictor set. If the synthetic control is able to replicate the counterfactual fully for each country, then we should expect to see no treatment effects. This applies since no counterfactual exist regarding a significant change to the corporate income tax rate for the control countries, because no such change did ever occur throughout the sample period. Another attractive feature of this test is that it holds for both Austria and the Netherlands, because they share the same donor pool and sample period.

As previously mentioned we are testing the following four predictor sets:

1. Average log debt-to-equity ratio
2. Last pre-treatment log debt-to-equity ratio
3. All pre-treatment log debt-to-equity ratios
4. A linear set including the last pre-treatment debt-to-equity

If we consider table 6.5 we see that all the predictor sets give similar prediction errors. We see that our specification using the last pre-treatment value of the outcome variable as a predictor gives the lowest measurement error. This also suggests that the last pre-treatment value is better at predicting the future values than the average value. What strikes one is that predictor set three containing all pre-treatment values of the outcome variable produces the highest measurement error. This is in strong contrast to what is the case in the pre-treatment period. In the pre-treatment period, “one cannot do any better in terms of pre-intervention MSPE than to include every pre-intervention outcome” as Dube and Zipperer (2014) puts it. Consequently, we are strongly discouraged from using this predictor set. We also see that a linear predictor set is not as good as a logarithmic, and it is only preferred to predictor set three.⁹ Predictor set

⁹We converted the linear values to natural logarithmic before calculating the RMSPE, thus ensuring comparability across the different predictor sets.

one is quite similar to set two, which is as expected since a single value does not usually deviate much from the average, when the average originates from a short and stable period.

Predictor set	1	2	3	4
Average post-treatment RMSPE	0.207 ¹⁰	0.197	0.281	.204

Table 6.5: Predictor sets

With our findings in mind, we conclude that the use of predictor set two is best for constructing the synthetic controls. This allows us to get a good cut-off, i.e. a small gap between the synthetic control and the actual country at the time of treatment, as well as having a low measurement error in the post-treatment period for the control countries.

6.4 Comparison of the effects of the tax reductions of Austria and the Netherlands

In the previous parts, we presented our results for Austria and the Netherlands. Since we applied the synthetic control method to two countries, it would be expedient to compare our results. This will let us become more or less confident in the reliability of our results.

Firstly, we will look at the synthetic controls ability to act as the counterfactual outcome. We know from both of the cases that the synthetic control provides a good fit in the pre-treatment period. The average of the control countries for example is inferior in terms of pre-treatment fit. The Austrian synthetic control has a little lower pre-treatment RMSPE than the Dutch, and thus is the synthetic control a little more reliable as a counterfactual. The Austrian synthetic control follows the outcome for the real Austria closely over the entire pre-treatment period as opposed to the Dutch synthetic control that has a little larger gap in the beginning but has almost no prediction error in the end.

¹⁰ For the estimation of the Swiss synthetic control using predictor set one, we failed to use the nested optimization method, due to the minimization never converging. Consequently, we used the previously mentioned regression-based approach to obtain the synthetic control with the smallest RMSPE.

When it comes to inference, we conclude that both treatments was statistically significant at the 10 % level when we studied the placebo graphs, i.e. the corporate income tax rate has a positive effect on the debt-to-equity ratio of firms. Our results did not hold however when we calculated the RMSPE ratios, thus we failed to reject the null hypotheses when conducting this test. As mentioned, we should not read too much into it, since this test only considers the absolute deviation, and we are only interested in negative treatment effects. Regardless this tells us that our results might not have big enough magnitude to justify a classification as a real treatment effect. But then again this is a two-sided test, and thus it is more restrictive when it comes to rejecting the null hypothesis. In addition the estimated post-treatment gaps for both Austria and the Netherlands the biggest in their respective studies and this seems like no coincidence. We also found that the pre-treatment fit of some of the control countries was exceptionally good, thus giving a high RMSPE-ratio. Consequently, it was the synthetic controls' inability to provide as good pre-treatment fit as some of the control countries had, which led to our results being insignificant under this test.

When we tested the robustness of our results, we found that our findings are quite robust to the introduction of several restrictions to the synthetic control. Both the Austrian and the Dutch synthetic controls follow almost the same trajectory under every restriction on control countries and predictor variables. Austria's synthetic control is the most robust one though. It has the lowest variation when we impose restrictions on it, and it holds exceptionally well when we expand the sample period. The restrictions does not make us revise the treatment effect in any particular direction. Some of the restrictions inflates the treatment effect and some deflates it.

For the Netherlands, the restrictions make us revise our estimates downwards. This might indicate a little lower treatment effect than we initially estimated. When we extend the sample period the Dutch synthetic control is a bad approximation, and we get an unsatisfactory pre-treatment fit. Although these robustness tests make us question the size of the Dutch treatment effect, it is still present in all iterations. Together with the strong results we get for the Austrian case there is a strong indication of a genuine treatment effect.

If we are to address the overall hypothesis, namely a positive effect of treatment, i.e. the change to the corporate income tax rate affected the capital structure of financial corporations

positively. We are careful about concluding that the change to the corporate income tax rate significantly affected the capital structure of financial corporations, since not all our tests of significance led to the rejection of the null hypothesis. However, there is a clear indication of a treatment effect, due to large treatment estimates for both our studies, the one-sided placebo tests of significance, and the robustness tests.

7. Conclusion

The purpose of this thesis has been to answer the following question:

What is the effect of a change to a country's corporate income tax rate on the debt-to-equity ratio of financial corporations located there?

In order to answer the question we have employed the synthetic control method. This has allowed us to compare the development in the capital structure of financial corporations subject to a tax reform to that of a weighted average of control states that represent the development in the absence of such a reform.

The synthetic control method indicates for both Austria and the Netherlands that the reduction of the corporate income tax rate led to a reduction of the debt-to-equity ratios of financial corporations located there. Comparing Austria to its synthetic counterpart indicates a reduction in the debt-to-equity ratio of around 30 % for the first year. This effect only increased throughout the period, and on average, it was approximately 35 %. The Netherlands on the other hand has a more gradual change to the capital structure of financial corporations. However, this is in line with the gradual change to the Dutch corporate income tax rate. After all three tax reforms were effective, the debt-to-equity ratio of financial corporations in the Netherlands were around 30 % lower than for its synthetic counterpart, i.e. of comparable magnitude to Austria. The average reduction was approximately 32 % over the post-treatment period.

To assess the significance of our results, we used placebo studies on the control countries, where we calculated the chance of getting an effect of equal or larger magnitude relative to the treated country. Under the one-sided placebo test, we rejected the null hypothesis for both countries, thus concluding that the reduction of the corporate income tax rate led to lower debt-to-equity ratios of financial corporations. However, when we conducted the two-sided RMSPE ratio test, we failed to reject the null hypothesis for both countries, thus we could not conclude that there was any causal relationship between the corporate income tax rate and the debt-to-equity ratio for financial corporations.

When we assessed the robustness of our results, we found that the Austrian synthetic control seems robust to any restriction we impose on it. The trajectory of the synthetic control is almost unaltered in every case, and the treatment effect does not seem to increase or decrease substantially under any of the restrictions. The Netherlands however might have a slightly overestimated treatment effect, because many of the robustness tests produce less significant treatment effects.

The fact that we get similar results for both Austria and the Netherlands means that the effect of taxes on the capital structure of firms is quite robust. Together with the rejections of the null hypotheses in the one-sided tests and the robustness tests, this makes us confident in the validity of our findings. To answer our research question we believe that there are very strong indications of a causal relationship between corporate income taxes and the capital structure of financial corporations. However further research is required if one was to make any conclusions.

Further research within this topic could be to study the effect of corporate income taxes on the capital structure of financial corporations in other countries, or the effect on the capital structure of non-financial corporations. One could also expand the study by including non-OECD countries, but at the risk of getting less reliable data in some cases. The pooled synthetic control method forwarded by Dube and Zipperer (2014) is very applicable to this kind of study, since it allows for treatment of multiple units and varying intensity of treatment. In light of the numerous tax reforms, this would be a natural step forward. By expanding the sample period one could also apply the cross-validation approach forwarded by Abadie et al. (2015) to choose predictor weights, thus reducing the risk of overfitting the synthetic control. Then one should however adopt the Monte Carlo study introduced by Kaul, Klößner, Pfeifer and Schieler (2016b) to increase the robustness of the method.

If we are to elaborate on the limitations of this study, a few points can be mentioned. First of all a larger dataset would be of great importance, thus we could check whether the synthetic control follows the actual country over an extensive amount of time. This would also enable us to study the effects of earlier tax reforms. Another limitation is that we could not set as strict cut-off as we ideally wanted regarding tax changes in the donor pool, thus our results could be slightly biased. As previously mentioned would such bias lead to underestimation of

the effect of taxes on capital structure. Finally, although our results strongly indicate a significant effect of taxes on capital structure, we cannot generalize this finding to hold for financial corporations in other countries or non-financial corporations.

8. Appendix

Appendix A: Data sources

As previously mentioned our data originates from the OECD or Macrobond. We collected our original data for all 34 OECD-countries in the period 1995 – 2014. Due to restrictions introduced by using the synthetic control method, we ended up using data for 10 countries in the period 2000 – 2010. In the following, we provide an overview over all variables used and their respective sources.

- Debt-to-equity-ratio for financial corporations. Source: OECD National Accounts Statistics Database, available at stats.oecd.org
- Statutory corporate income tax rate. Source: OECD Tax Database, available at stats.oecd.org
- Short-term interest rate. Source: OECD Financial Statistics dataset, available at stats.oecd.org
- Long-term interest rate. Source: OECD Financial Statistics dataset, available at stats.oecd.org
- GDP per capita. Source: OECD Productivity Database, available at stats.oecd.org
- Inflation. Source: OECD Key Economic Indicators Database, available at stats.oecd.org
- Broad equity index. Source: Macrobond database, available through Macrobond software program.

Appendix B: Do-file

```
*Synth.do
*Panel data by country and year
lear
    version 14.0
et more off
*Install synth package for comparative case studies
sc install synth, replace all
*Set working directory
d "\\Lire\Stud$\S105717\My Documents\Master\Final"
*Obtain dataset master thesis
    use "Masterthesis.dta", clear
*Merge with dataset containing equity indices
    qui merge 1:1 country year using "Equity.dta", nogenerate
*Set type double to avoid rounding errors
    set type double, permanently
*Converting variable country from string to numeric
    encode country, generate(country2)
*Delete string variable country
    drop country
*Rename country2 to country
    rename country2 country
*Make Stata recognize variables as numeric
    destring deratio taxrate interest10y interest10y gdpcapita inflation equity, replace
*Declare data set panel
    tsset country year
*Generate natural logarithmic variables
    gen lnderatio = ln(deratio)
    gen lngdpcapita = ln(gdpcapita)
    gen lninterest3m = ln(interest3m)
    gen lninterest10y = ln(interest10y)
    gen lnequity = ln(equity)
*Generate the differences for equity indices
    gen difflnequity = d.lnequity
*Delete all observations in year 1999
    drop if year < 2000
*Save edited file for later use
    save "Masterthesis2.dta", replace
*Create the synthetic control
    synth lnderatio lninterest3m lninterest10y lngdpcapita inflation diffnequity lnderatio(2004), trunit(2)
trperiod(2005) keep(synthresult, replace) nested fig
    graph export graphaustriafig.emf, replace
*Create placebo synthetic controls
    tempname resmat
    forvalues i = 1/10 {
        synth lnderatio lninterest3m lninterest10y lngdpcapita inflation diffnequity lnderatio(2004), trunit(`i')
trperiod(2005) keep(placebo`i', replace) nested
        matrix `resmat' = nullmat(`resmat') \ e(RMSPE)
        local names `"'names' "`i'""
        }
    mat colnames `resmat' = "RMSPE"
    mat rownames `resmat' = `i'
    matlist `resmat', row("Treated Unit")
*Create graph showing treated and synthetic country with reference lines for treatment period 2004
```

```

*Open dataset
  use "synthresult.dta", clear
*Prepare dataset for graphing
  rename _time year
  rename _Y_treated deratio
  rename _Y_synthetic synthderatio
  gen tr_effect = deratio - synthderatio
  drop if missing(year)
*Save dataset for later use
  save "synthresult.dta", replace
*Create graph
  twoway (line deratio year, lcolor(black) lpattern(solid)) (line synthderatio year, lcolor(black) lpattern(dash)),
  xline(2004, lpattern(dash) lcolor(gs12)) ytitle("D/E-ratio") xtitle("Year") title("Debt-to-Equity")
*Save graph
  graph export "graphaustria.emf", replace
*Create graph showing difference between treated and synthetic country with reference lines for zero difference and
treatment period 2004
  twoway (line tr_effect year, lcolor(black) lpattern(solid)), yline(0, lpattern(dash) lcolor(gs12)) xline(2004,
  lpattern(dash) lcolor(gs12)) ytitle("Treatment effect") xtitle("Year") title("Austria Treatment Effect")
*Save graph
  graph export "graphdiff.emf", replace
*Create graph showing treated country and mean of all control countries with reference line for treatment period 2004
*Open dataset for construction of the mean
  use "Masterthesis2.dta", clear
*Make dummy equal one if treated and zero if not
  gen treatment = 0
  replace treatment = 1 if country == 2
*Save for later use
  save "Masterthesis2.dta", replace
*Take the mean of all countries except treated
  collapse (mean) lnderatio if treatment == 0, by(year)
*Rename variable
  rename lnderatio meanderatio
*Save dataset
  save "meanderatio.dta", replace
*Open dataset to obtain the treated country's deratio
  use "synthresult.dta", clear
*Prepare dataset for graphing
  keep deratio synthderatio year
*Merge the datasets
  qui merge 1:1 year using "meanderatio.dta", nogenerate
*Create graph
  twoway (line deratio year, lcolor(black) lpattern(solid)) (line meanderatio year, lcolor(black) lpattern(dash)),
  xline(2004, lpattern(dash) lcolor(gs12)) ytitle("D/E-ratio") xtitle("Year") title("Debt-to-Equity")
*Save graph
  graph export "graphmean.emf", replace
*Calculate the average value of the predictors for the control group
*Open dataset for construction of the mean
  use "Masterthesis2.dta", clear
*Make dummy equal to one if pre-treatment period and zero if not
  gen pre = 0
  replace pre = 1 if year < 2005
*Calculate mean of log-debt-to-equity ratio 2004
  egen lnderatio(2004) = mean(lnderatio) if year == 2004 & treatment == 0

```

```

*Take the mean of all the predictors for the control group in the pre-treatment period
collapse(mean) lnderatio2004 lninterest3m lninterest10y lngdpcapita inflation diffInequity if treatment == 0 & pre
== 1
*Save results
save "predictormeans.dta", replace
*Create graph showing placebo tests for all control countries as well as the actual treated country with reference lines
for zero difference and treatment period 2004
*Prepare datasets for graphing
forval i=1/10 {
use "placebo`i'.dta", clear
rename time year
gen tr_effect_`i' = _Y_treated - _Y_synthetic
keep year tr_effect_`i'
drop if missing(year)
save "placebo`i'.dta", replace
}
*Merge the datasets into one
use "placebo1.dta", clear
forval i=2/10 {
qui merge 1:1 year using "placebo`i'.dta", nogenerate
}
*Create placebo graphs
local lp
forval i=1/10 {
local lp `lp' line tr_effect_`i' year, lcolor(gs12) ||
}
twoway `lp' || line tr_effect_2 year, lcolor(black) legend(off) xline(2004, lpattern(dash) lcolor(gs12)) yline(0,
lpattern(dash) lcolor(gs12)) ytitle(Treatment effect) xtitle(Year) title("Placebo Treatment Effect")
*Save graph
graph export "graphplacebo.emf", replace
*Calculate the pre- and post-treatment Root Mean Squared Prediction Error(RMSPE) and ratio of them
forval i = 1/10 {
use "placebo`i'.dta", clear
gen sq_effect_`i' = tr_effect_`i'^2
qui egen premspe`i' = mean(sq_effect_`i') if year < 2005
qui egen postmspe`i' = mean(sq_effect_`i') if year >= 2005
collapse premspe`i' postmspe`i'
gen prrmspe`i' = sqrt(premspe`i')
gen postrmspe`i' = sqrt(postmspe`i')
gen rmsperatio`i' = postrmspe`i' / prrmspe`i'
keep rmsperatio`i'
qui save "rmspe`i'.dta", replace
}
*Merge datasets for graphing
use "rmspe1.dta"
forval i = 2/10 {
qui merge 1:1 _n using "rmspe`i'.dta", nogenerate
}
*Transpose data and prepare for graphing
xpose, clear
rename v1 rmsperatio
save "rmsperatio.dta", replace
*Collect country variable and compile with rmsperatio
use "Masterthesis2.dta", clear

```

```

collapse (mean)deratio, by(country)
keep country
qui merge 1:1 _n using "rmsperatio.dta", nogenerate
*Create RMSPE-ratio graph
graph bar (asis) rmsperatio, over(country) xsize(12)
*Save graph
graph export "rmsperatio.emf", replace
*Robustness test for control units
*Obtain dataset
use "Masterthesis2.dta", clear
*Define panel variables
tsset country year
*Create synthetic control
synth Inderatio lninterest3m lninterest10y lngdpcapita inflation diffinequity Inderatio(2004), trunit(2)
trperiod(2005) keep(counit1, replace) nested
*Create synthetic control excluding France as counit
synth Inderatio lninterest3m lninterest10y lngdpcapita inflation diffinequity Inderatio(2004), trunit(2)
trperiod(2005) counit(1 3 5 6 7 8 9 10) keep(counit2, replace) nested
*Create synthetic control excluding Norway as counit
synth Inderatio lninterest3m lninterest10y lngdpcapita inflation diffinequity Inderatio(2004), trunit(2)
trperiod(2005) counit(1 3 4 6 7 8 9 10) keep(counit3, replace) nested
*Create synthetic control excluding Spain as counit
synth Inderatio lninterest3m lninterest10y lngdpcapita inflation diffinequity Inderatio(2004), trunit(2)
trperiod(2005) counit(1 3 4 5 7 8 9 10) keep(counit4, replace) nested
*Create synthetic control excluding Switzerland as counit
synth Inderatio lninterest3m lninterest10y lngdpcapita inflation diffinequity Inderatio(2004), trunit(2)
trperiod(2005) counit(1 3 4 5 6 7 9 10) keep(counit5, replace) nested
*Create synthetic control excluding US as counit
synth Inderatio lninterest3m lninterest10y lngdpcapita inflation diffinequity Inderatio(2004), trunit(2)
trperiod(2005) counit(1 3 4 5 6 7 8 9) keep(counit6, replace) nested
*Prepare datasets for graphing
use "counit1.dta", clear
rename _time year
rename _Y_treated deratio
rename _Y_synthetic synthderatio1
keep year deratio synthderatio1
drop if missing(year)
save "counit1.dta", replace
forval i=2/6 {
use "counit`i'.dta", clear
rename _time year
rename _Y_synthetic synthderatio`i'
keep year synthderatio`i'
drop if missing(year)
save "counit`i'.dta", replace
}
*Merge the datasets into one
use "counit1.dta", clear
forval i=2/6 {
qui merge 1:1 year using "counit`i'.dta", nogenerate
}
*Create graphs for synthetic controls leaving one predictor out
local lp
forval i=1/6 {

```

```

    local lp `lp' line synthderatio`i' year, lcolor(gs12) ||
    }
    twoway `lp' ||line deratio year, lcolor(black) legend(off) xline(2004, lpattern(dash) lcolor(gs12)) yline(0,
lpattern(dash) lcolor(gs12)) ytitle(Ln(Deratio)) xtitle(Year) title("Synthetic control removing one control country at a
time")
*Save graph
    graph export "graphcounit.emf", replace
*Robustness test for predictors
*Obtain dataset
    use "Masterthesis2.dta", clear
*Create synthetic control
    synth lderatio lninterest3m lninterest10y lngdpcapita inflation diffinequity lderatio(2004), trunit(2)
trperiod(2005) keep(synth1, replace) nested
*Create synthetic control leaving diffinequity out
    synth lderatio lninterest3m lninterest10y lngdpcapita inflation lderatio(2004), trunit(2) trperiod(2005)
keep(synth2, replace) nested
*Create synthetic control leaving lngdpcapita out
    synth lderatio lninterest3m lninterest10y inflation diffinequity lderatio(2004), trunit(2) trperiod(2005)
keep(synth3, replace) nested
*Create synthetic control leaving inflation out
    synth lderatio lninterest3m lninterest10y lngdpcapita diffinequity lderatio(2004), trunit(2) trperiod(2005)
keep(synth4, replace) nested
*Create synthetic control leaving lninterest10y out
    synth lderatio lninterest3m lngdpcapita inflation diffinequity lderatio(2004), trunit(2) trperiod(2005)
keep(synth5, replace) nested
*Create synthetic control leaving lninterest3m out
    synth lderatio lninterest10y lngdpcapita inflation diffinequity lderatio(2004), trunit(2) trperiod(2005)
keep(synth6, replace) nested
*Create synthetic control leaving lderatio out
    synth lderatio lninterest3m lninterest10y lngdpcapita inflation diffinequity, trunit(2) trperiod(2005) keep(synth7,
replace) nested
*Prepare datasets for graphing
    use "synth1.dta", clear
    rename _time year
    rename _Y_treated deratio
    rename _Y_synthetic synthderatio1
    keep year deratio synthderatio1
    drop if missing(year)
    save "synth1.dta", replace
    forval i=2/7 {
    use "synth`i'.dta", clear
    rename _time year
    rename _Y_synthetic synthderatio`i'
    keep year synthderatio`i'
    drop if missing(year)
    save "synth`i'.dta", replace
    }
*Merge the datasets into one
    use "synth1.dta", clear
    forval i=2/7 {
    qui merge 1:1 year using "synth`i'.dta", nogenerate
    }
*Create graphs for synthetic controls leaving one predictor out
    local lp

```



```

forval i=1/7 {
    local lp `lp' line synthderatio `i' year, lcolor(gs12) ||
    }
    twoway `lp' ||line deratio year, lcolor(black) legend(off) xline(2004, lpattern(dash) lcolor(gs12)) yline(0,
lpattern(dash) lcolor(gs12)) ytitle(Ln(Deratio)) xtitle(Year) title("Synthetic control leaving one predictor out")
*Save graph
    graph export "graphpredictor.emf", replace
*Create synthetic control with an extended timeline
*Set working directory
    cd "\\Lire\Stud$\S105717\My Documents\Master\Final\Extended timeline"
*Obtain dataset master thesis
    use "extended timeline.dta", clear
*Merge with dataset containing equity indices
    qui merge 1:1 country year using "extended equity.dta", nogenerate
*Set type double to avoid rounding errors
    set type double, permanently
*Converting variable country from string to numeric
    encode country, generate(country2)
*Delete string variable country
    drop country
*Rename country2 to country
    rename country2 country
*Make Stata recognize variables as numeric
    destring deratio taxrate interest10y interest10y gdpcapita inflation equity, replace
*Declare data set panel
    tsset country year
*Generate natural logarithmic variables
    gen lnderatio = ln(deratio)
    gen lngdpcapita = ln(gdpcapita)
    gen lninterest3m = ln(interest3m)
    gen lninterest10y = ln(interest10y)
    gen lnequity = ln(equity)
*Generate the differences for equity indices
    gen difflnequity = d.lnequity
*Delete all observations in year 1994
    drop if year < 1995
*Save edited file for later use
    save "extended timeline2.dta", replace
*Create the synthetic control
    synth lnderatio lninterest10y lninterest3m inflation lngdpcapita difflnequity lnderatio(2004), trunit(1)
trperiod(2005) keep(synthresult, replace) nested fig
*Open dataset
    use "synthresult.dta", clear
*Prepare dataset for graphing
    rename _time year
    rename _Y_treated deratio
    rename _Y_synthetic synthderatio
    gen tr_effect = deratio - synthderatio
    drop if missing(year)
*Save dataset for later use
    save "synthresult.dta", replace
*Create graph
    twoway (line deratio year, lcolor(black) lpattern(solid)) (line synthderatio year, lcolor(black) lpattern(dash)),
xline(2004, lpattern(dash) lcolor(gs12)) ytitle("D/E-ratio") xtitle("Year") title("Debt-to-Equity")

```

```

*Save graph
  graph export "graphaustria.emf", replace
*Perform predictor test
*Set working directory
  cd "\\Lire\Stud$\S105717\My Documents\Master\Final\Predictortest"
*Obtain dataset master thesis
  use "Masterexaus.dta", clear
*Merge with dataset containing equity indices
  qui merge 1:1 country year using "Equityexaus.dta", nogenerate
*Converting variable country from string to numeric
  encode country, generate(country2)
*Delete string variable country
  drop country
*Rename country2 to country
  rename country2 country
*Make Stata recognize variables as numeric
  destring deratio taxrate interest10y interest10y gdpcapita inflation equity, replace
*Declare data set panel
  tsset country year
*Generate natural logarithmic variables
  gen lnderatio = ln(deratio)
  gen lngdpcapita = ln(gdpcapita)
  gen lninterest3m = ln(interest3m)
  gen lninterest10y = ln(interest10y)
  gen lnequity = ln(equity)
*Generate the differences for equity indices
  gen diffjnequity = d.lnequity
*Delete all observations in year 1999
  drop if year < 2000
*Save edited file for later use
  save "Masterexaus2.dta", replace
*Create placebo synthetic controls for set 1
  tempname resmat
  forval i = 1/9 {
    synth lnderatio lninterest3m lninterest10y lngdpcapita inflation diffjnequity lnderatio, trunit(`i') trperiod(2005)
  }
keep(placeholder `i', replace) nested
  matrix `resmat' = nullmat(`resmat') \ e(RMSPE)
  local names `"'names' `"'i'""""
  }
  mat colnames `resmat' = "RMSPE"
  mat rownames `resmat' = `i'
  matlist `resmat', row("Treated Unit")
*Create placebo synthetic controls for set 2
  tempname resmat
  forval i = 1/9 {
    synth lnderatio lninterest3m lninterest10y lngdpcapita inflation diffjnequity lnderatio(2004), trunit(`i')
  }
trperiod(2005) keep(placeholder2 `i', replace) nested
  matrix `resmat' = nullmat(`resmat') \ e(RMSPE)
  local names `"'names' `"'i'""""
  }
  mat colnames `resmat' = "RMSPE"
  mat rownames `resmat' = `i'
  matlist `resmat', row("Treated Unit")
*Create placebo synthetic controls for set 3

```

```

tempname resmat
forval i = 1/9 {
    synth lnderatio lninterest3m lninterest10y lngdpcapita inflation difflinequity lnderatio(2000) lnderatio(2001)
lnderatio(2002) lnderatio(2003) lnderatio(2004), trunit(`i') trperiod(2005) keep(placebo3`i', replace) nested
    matrix `resmat' = nullmat(`resmat') \ e(RMSPE)
    local names `"'names' "'`i'""'
    }
    mat colnames `resmat' = "RMSPE"
    mat rownames `resmat' = `i'
    matlist `resmat', row("Treated Unit")
*Create placebo synthetic controls for set 4
tempname resmat
forval i = 1/9 {
    synth deratio interest3m interest10y gdpcapita inflation difflinequity deratio(2004), trunit(`i') trperiod(2005)
keep(placebo4`i', replace) nested
    matrix `resmat' = nullmat(`resmat') \ e(RMSPE)
    local names `"'names' "'`i'""'
    }
    mat colnames `resmat' = "RMSPE"
    mat rownames `resmat' = `i'
    matlist `resmat', row("Treated Unit")
*Prepare dataset 1
forval i = 1/9 {
    use "placebo1`i'.dta", clear
    rename _time year
    gen tr_effect `i' = _Y_treated - _Y_synthetic
    keep year tr_effect `i'
    drop if missing(year)
    save "placebo1`i'.dta", replace
    }
*Prepare dataset 2
forval i = 1/9 {
    use "placebo2`i'.dta", clear
    rename _time year
    gen tr_effect `i' = _Y_treated - _Y_synthetic
    keep year tr_effect `i'
    drop if missing(year)
    save "placebo2`i'.dta", replace
    }
*Prepare dataset 3
forval i = 1/9 {
    use "placebo3`i'.dta", clear
    rename _time year
    gen tr_effect `i' = _Y_treated - _Y_synthetic
    keep year tr_effect `i'
    drop if missing(year)
    save "placebo3`i'.dta", replace
    }
*Prepare dataset 4
forval i = 1/9 {
    use "placebo4`i'.dta", clear
    rename _time year
    gen tr_effect `i' = ln(_Y_treated) - ln(_Y_synthetic)
    keep year tr_effect `i'

```

```

drop if missing(year)
save "placebo4`i`.dta", replace
}
*Calculate the pre- and post-treatment Root Mean Squared Prediction Error(MSPE) for set 1
forval i = 1/9 {
use "placebo1`i`.dta", clear
gen sq_effect = tr_effect_`i`^2
qui egen premspe = mean(sq_effect) if year < 2005
qui egen postmspe = mean(sq_effect) if year >= 2005
collapse premspe postmspe
keep premspe postmspe
qui save "avgmspe1`i`.dta", replace
}
*Calculate the pre- and post-treatment Root Mean Squared Prediction Error(MSPE) for set 2
forval i = 1/9 {
use "placebo2`i`.dta", clear
gen sq_effect = tr_effect_`i`^2
qui egen premspe = mean(sq_effect) if year < 2005
qui egen postmspe = mean(sq_effect) if year >= 2005
collapse premspe postmspe
keep premspe postmspe
qui save "avgmspe2`i`.dta", replace
}
*Calculate the pre- and post-treatment Root Mean Squared Prediction Error(MSPE) for set 3
forval i = 1/9 {
use "placebo3`i`.dta", clear
gen sq_effect = tr_effect_`i`^2
qui egen premspe = mean(sq_effect) if year < 2005
qui egen postmspe = mean(sq_effect) if year >= 2005
collapse premspe postmspe
keep premspe postmspe
qui save "avgmspe3`i`.dta", replace
}
*Calculate the pre- and post-treatment Root Mean Squared Prediction Error(MSPE) for set 4
forval i = 1/9 {
use "placebo4`i`.dta", clear
gen sq_effect = tr_effect_`i`^2
qui egen premspe = mean(sq_effect) if year < 2005
qui egen postmspe = mean(sq_effect) if year >= 2005
collapse premspe postmspe
keep premspe postmspe
qui save "avgmspe4`i`.dta", replace
}
*Merge dataset 1
use "avgmspe11.dta", clear
forval i = 2/9 {
append using "avgmspe1`i`.dta"
}
collapse (mean) premspe postmspe
rename premspe avgpremspe1
rename postmspe avgpostmspe1
qui save "predictorset1.dta", replace
*Merge dataset 2
use "avgmspe21.dta"

```

```

forval i = 2/9 {
  append using "avgmspe2`i'.dta"
}
collapse (mean) premspe postmspe
rename premspe avgpremspe2
rename postmspe avgpostmspe2
qui save "predictorset2.dta", replace
*Merge dataset 3
use "avgmspe31.dta"
forval i = 2/9 {
  append using "avgmspe3`i'.dta"
}
collapse (mean) premspe postmspe
rename premspe avgpremspe3
rename postmspe avgpostmspe3
qui save "predictorset3.dta", replace
*Merge dataset 4
use "avgmspe41.dta"
forval i = 2/9 {
  append using "avgmspe4`i'.dta"
}
collapse (mean) premspe postmspe
rename premspe avgpremspe4
rename postmspe avgpostmspe4
qui save "predictorset4.dta", replace
*Merge the sets for comparison
use "predictorset1.dta", clear
forval i = 2/4 {
  qui merge 1:1 _n using "predictorset`i'.dta", nogenerate
}
forval i = 1/4 {
  gen avgpremspe`i' = sqrt(avgpremspe`i')
  gen avgpostmspe`i' = sqrt(avgpostmspe`i')
  drop avgpremspe`i' avgpostmspe`i'
}
save "predictorsets.dta", replace

```

9. References

- Abadie, A., & Gardeazabal, J. (2003, March). The Economic Costs of Conflict: A Case Study of the Basque Country. *American Economic Review*, Vol. 93, No. 1, ss. 113-132.
- Abadie, A., Diamond, A., & Hainmueller, J. (2010, June). Synthetic Control Methods for Comparative Case Studies: Estimating the Effect of California's Tobacco Control Program. *Journal of American Statistical Association*, Vol. 105, No. 490, ss. 493-505.
- Abadie, A., Diamond, A., & Hainmueller, J. (2015, April). Comparative Politics and the Synthetic Control Method. *American Journal of Political Science*, Vol. 59, Issue 2, ss. 495-510.
- Alworth, J., & Arachi, G. (2001, August). The Effect of Taxes on Corporate Financing Decisions: Evidence from a Panel of Italian Firms. *International Tax and Public Finance*, Vol. 8, Issue 4, ss. 353-376.
- Berk, J., & DeMarzo, P. M. (2014). *Corporate Finance* (3.. utg.). Boston: Pearson.
- Crowe Horwath. (2009). *International Master Tax Guide 6th*. Sydney: CCH Australia Limited.
- de Mooij, R., & Keen, M. (2012). *Debt, Taxes, and Banks*. Washington, D.C.: International Monetary Fund.
- de Mooij, R., Keen, M., & Orihara, M. (2014). *Taxation, Bank Leverage, and Financial Crises*. Washington, D.C.: International Monetary Fund.
- Donaldson, G. (1961). *Corporate debt capacity : a study of corporate debt policy and the determination of corporate debt capacity*. Boston: Harvard University, Graduate School of Business Administration.
- Dourado, A. P., & de la Feria, R. (2008). *Thin Capitalization Rules in the Context of the CCCTB*. Oxford: Oxford University Centre for Business Taxation.
- Dube, A., & Zipperer, B. (2014). *Pooled synthetic control estimates for continuous treatment: An application to minimum wage case studies*. Unpublished paper.
- Frank, M. Z., & Goyal, V. K. (2007, December 8). Trade-Off and Pecking Order Theories of Debt. I B. E. Eckbo (Red.), *Handbook of Empirical Corporate Finance: Empirical Corporate Finance, Volume 1* (ss. 135-202). North-Holland/Elsevier.
- Givoly, D., Hayn, C., Ofer, A. R., & Sarig, O. (1992). Taxes and Capital Structure: Evidence from Firms' Response to the Tax Reform Act of 1986. *The Review of Financial Studies*, Vol. 5, No. 2, ss. 331-355.
- Johansson, Å., Heady, C., Arnold, J., & Brys, B. a. (2008). *Tax and Economic Growth*. Paris: Organisation for Economic Co-operation and Development.
- Kaul, A., Klößner, S., Pfeifer, G., & Schieler, M. (2016a). *Synthetic Control Methods: Never Use All Pre-Intervention Outcomes as Economic Predictors*. Working paper.

- Kaul, A., Klößner, S., Pfeifer, G., & Schieler, M. (2016b). *Comparative Politics and the Synthetic Control Method Revisited: A Note on Abadie et al. (2015)*. Saarbrücken: Saarland University.
- Kraus, A., & Litzenberger, R. H. (1973, September). A State-Preference Model of Optimal Financial Leverage. *The Journal of Finance*, Vol. 28, No. 4, ss. 911-922.
- Lane, P. R. (2012, Summer). The European Sovereign Debt Crisis. *The Journal of Economic Perspectives*, Vol. 26, No. 3, ss. 49-67.
- Langedijk, S., Nicodème, G., Pagano, A., & Rossi, A. (2014). *Debt Bias in Corporate Taxation and the Costs of Banking Crises in the EU*. Working paper N. 50.
- Mackinlay, A. (2012). *(How) Do Taxes Affect Capital Structure?* Virginia Tech.
- Majluf, N. S., & Myers, S. C. (1984). *Corporate Finance and Investment Decisions When Firms Have Information The Investors Do Not Have*. Cambridge: National Bureau of Economic Research.
- Modigliani, F., & Miller, M. H. (1958, June). The Cost of Capital, Corporate Finance and the Theory of Investment. *The American Economic Review*, Vol. 48, No. 3, ss. 261-297.
- Modigliani, F., & Miller, M. H. (1963, June). Corporate Income Taxes and the Cost of Capital: A Correction. *The American Economic Review*, Vol. 53, No. 3, ss. 433-443.
- Møen, J., Schindler, D., Schjelderup, G., & Tropina, J. (2011). *International debt shifting: Do multinationals shift internal or external debt?* Munich: CESifo Working Paper Series.
- OECD. (2011). *Tax Reform Trends in OECD Countries*. Paris: OECD.
- OECD. (2016a). Tax database: Table II.1. Corporate income tax rate. Paris: OECD.
- OECD. (2016b). OECD National Accounts Statistics Database: Financial Indicators – Stocks. Paris: OECD.
- Overesch, M., & Voeller, D. (2008). *The Impact of Personal and Corporate Taxation on Capital Structure Choices*. ZEW - Centre for European Economic Research.
- Peles, Y. C., & Sarnat, M. (1979, February). Corporate Taxes and Capital Structure: Some Evidence Drawn from the British Experience. *The Review of Economics and Statistics*, Vol. 61, No. 1, ss. 118-120.
- Schandlbauer, A. (2016). *How do financial institutions react to a tax increase?* Odense: University of Southern Denmark - Department of Business and Economics.
- Taub, A. J. (1975, November). Determinants of the Firm's Capital Structure. *The Review of Economics and Statistics*, Vol. 57, No. 4, ss. 410-416.
- van de Ven, P. (2015, February). New standards for compiling national accounts: what's the impact on GDP and other macro-economic indicators? *OECD Statistics Brief*, No. 20, ss. 1-16.
- Wilkie, P. J., Young, J. C., & Nutter, S. E. (1996). Corporate Business Activity Before and After the Tax Reform Act of 1986. *Statistics of Income Bulletin* 16, ss. 32-45.