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The Relationship between Corporate Governance and Tax Avoidance – Evidence from Germany using a Regression Discontinuity Design

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Abstract

This paper analyses the relationship between corporate governance and tax avoidance. We use a regression discontinuity design (RDD) in a two-stage instrumental variable model and take advantage of the exogenous variation in the index membership around the DAX and MDAX threshold. We suppose the differences in corporate governance result from the value-weighted composition of the market capitalization-based indexes. We find a significant discontinuity in the level of the corporate governance characteristics at the cutoff. The largest MDAX firms show stronger corporate governance characteristics compared to the smallest DAX firms. Our analysis shows that strong corporate governance characteristics drive down the effective tax rate for the DAX companies. This paper contributes to existing research by establishing a causal relationship between governance and taxes. This study aims to highlight the wide-ranging effects of institutional investors, which channel in corporate policy, in this case tax management.

1 Introduction

Most large multinational companies manage their tax policies with specialized departments and the help of professional service firms. In this study, we analyze the relationship between corporate governance and the tax policy. The aim of the paper is to find out how the shareholder structure affects tax management. The institutional investors monitor the firms and influence the management. We test how the preferences of large shareholders channel in corporate tax policy. We test the hypothesis that corporate governance characteristics drive the tax policy by analyzing differences across the DAX and MDAX indexes.

This paper analyses the DAX and MDAX companies using a regression discontinuity design (RDD). The methodology aims to establish a causal relationship between tax and corporate governance. The RDD is a quasi-experimental method and provides a high external validity (Angrist and Lavy 1999). We use an instrumental approach and treat inclusion in the indexes as a quasi-random event (Bird and Karolyi 2017).

The aim of this paper is to establish a causality for the relationship of tax avoidance and firm characteristics. Many papers acknowledge possible endogenous distortions in the relationship between governance and tax (Desai and Dharmapala 2009). One solution is the use of instruments, for example treating changes in law and regulation as exogenous events. However, the firms affected by the change in legislation can anticipate and expect it. We use the index inclusion in the DAX and MDAX as an instrument because of the mechanical rule, which determines membership, is almost random and hard to manipulate.

There are few papers on the preferences of institutional investors on tax management, in particular for German firms. This is the first paper using RDD to analyses the relationship between corporate governance and tax avoidance for German firms. To our best knowledge, we bring the first evidence for a causal relationship for a German sample. This paper extends knowledge on the tax avoidance behavior of domestic firms. We aim to support the development of modern corporate governance systems. We further point out how institutional investors shape the corporate culture. The analysis is relevant for policy makers who are concerned about tax revenue. The findings are important for individual shareholders who may have different preferences compared to the institutional investors. The rise of passive investors impacts the management. It could both lead to desirable or adverse outcomes. A wide range of papers, as discussed in the subsequent section, find positive effects of institutional ownership on corporate governances and affirm the 'active' behavior of 'passive' investors. Nonetheless, changes in the shareholder structure appear to have a wide-ranging impact on corporate policy. We show that the effects channel into the tax policy. Our paper contributes to research by analyzing the implications of corporate governance on tax.

The paper continues with a brief overview of the recent literature on the relationship between corporate governance and tax (section 2). Subsequently, we discuss the methodology of our analysis (section 3). Section 4 discusses the findings. The paper ends with a brief conclusion (section 5).

2 Literature

The direction of the relationship between corporate governance and tax is ambiguous (Hanlon and Heitzman 2010). Hanlon and Heitzman (2010) emphasize the agency theory based argumentation that the reaction of firms on tax matters depends on firm-level governance structures. In the context of the institutional ownership literature, Minnick and Noga (2010) find a positive relationship between corporate governance and tax avoidance. Contrary, Khurana and Moser (2012) suggest a negative relation. Index inclusion is changing tax avoidance (Huseynov et al. 2017). The direction goes either way as shown by Huseynov et al. (2017), such that high levels of tax avoidance decrease and low level of tax avoiders increase once a firm is included in the index. Huseynov et al. (2017) argue that increased corporate governance causes the change in tax avoidance because institutional ownership increases upon index inclusion. The ambivalent relationship gives reason to seek further empirical evidence on the relationship. In the wider corporate governance literature, Desai and Dharmapala (2006) established that tax avoidance causes agency costs. Similarly, the paper by Armstrong et al. (2015) emphasizes the role of shareholder preferences regarding tax avoidance and explains how governance mechanisms can influence the relation in either direction. The index inclusion is relevant for tax matters because it can affect the tax policy of firms. The presence of institutional investors translates their preferences in corporate policy. Further, there is evidence that firms change their tax strategies in the short term (Dhaliwal et al. 2004). The use of a RDD is a rare method in the area of taxation (Hanlon and Heitzman 2010). The discontinuity in different tax rates applicable to different stock

market investors was one of the first analyses on cutoffs (Shackelford and Verrecchia 2002). However, the application of the statistical procedure known as RDD in the field of the tax literature took longer.

Studies doing capital market research on US samples frequently use the Russell 1000 and Russell 2000 cutoff for their RDD studies. Chang et al. (2015) show the impact of index inclusion on the stock prices and find a positive price movement for inclusion in the Russell 2000 while removal from the index results in a fall in prices. Appel et al. (2016) use the Russell threshold to analyze the impact of passive institutional investors and confirm their positive effects on governance. Institutional ownership, analyzed using the Russell discontinuity, increases firm transparency and positively impacts the information environment measured by disclosures, analyst coverage and liquidity (Boone and White 2015). The RDD study by Fich et al. (2015) shows that the presence of institutional investors holding large stakes leads to beneficial effects of monitoring. Bird and Karolyi (2016) find that beyond the changes in institutional ownership at the Russell 1000 / 2000, firms increase their corporate information disclosures in response to the demand of institutional investors. The recent studies using RDD on the Russell 1000 / 2000 exploit the threshold for US samples. The similarities with the DAX are striking. Our paper builds on the insights gained from the Russell literature and verifies the knowledge using a German sample. The effect of active shareholders such as hedge funds on firms' tax strategy leads to an increase in tax avoidance (Cheng et al. 2012). The engagement of institutional investors is likely to have an effect on the management and their compensation. Rego and Wilson (2012) stress the impact of management compensation such as equity risk incentive for managers to engage in risky tax avoidance.

There is a reason to assume that the effects of institutional ownership also have an impact on the corporate governance structures of German firms. We suggest that the comparatively large proportion of shares owned by institutional investors, as shown by the Deutsche Bundesbank (2014), affects the corporate governance of the DAX and MDAX firms in a similar fashion as previously demonstrated for the Russell 1000 and Russell 2000 firms. The literature showed how institutional ownership improves corporate governance. We rely on the relationship and base our analysis on a governance variable. Our analysis suggests that there is a discontinuity in the corporate governance characteristics at the threshold of the DAX and MDAX because the smallest firms in the DAX receive a lower weight compared to the largest firms in the MDAX, even though the firms are largely comparable. We test how these differences in governance channel in the tax management of the largest listed German firms.

3 Methodology

The regression discontinuity design was introduced in the field of experimental psychology by Campbell (1969). The reliance on instrumental variables in RDD studies accredits to the paper of van der Klaauw (2002) on the effect of financial aid offers on college enrollment. This analysis applies a regression discontinuity design on the DAX and MDAX indexes. The DAX includes the 30 most valuable companies listed on the Frankfurt stock exchange. The MDAX contains the subsequent 50 largest firms. The indexes measure the performance and the constitution depends on the trading volume as well as market capitalization. The inclusion index accounts for performance indicators as well (Deutsche Börse Group 2017). However, the index composition of the DAX and MDAX is quasi solely based on market capitalization. All shares in the two indexes trade frequently and are very liquid. Further, the DAX and the MDAX are value-weighted indexes, similar to the Russell 1000 and the Russell 2000. The value-weighted approach gives the firms with the largest market capitalization in the free float a higher weight in the respective index. As a result, the smallest firms in the DAX receive a relatively small weight compared to the largest firms in the MDAX even though the firms are similar regarding their size. We assume that

the differences in the weights lead to firms at the top of the index receive a higher degree of institutional ownership relative to those at the bottom (Bird and Karolyi 2017). We further assume that the increase in institutional ownership is associated with an increase in corporate governance (Gillan and Starks 2000). For the German equities, in particular, the DAX, institutional owners are the largest shareholder group (Deutsche Bundesbank 2014). Therefore, we expect high corporate governance characteristics to drive the tax policy. The differences in capitalization between the DAX and the MDAX are relatively small. We assume the assignment in the capitalization-weighted index near the threshold is quasi-random. According to the randomness assumption, firms cannot control the variations in the ranking at the margin (Crane et al. 2016).

Large institutional investors track the DAX. The shares in the index are frequently traded and among the most liquid in the German Prime Standard. Thus, we assume that the corporations in the DAX face a higher scrutiny of the markets. We expect a higher level of corporate governance. The DAX is presumably showing a higher level of active shareholders and active behavior of passive shareholders. We assume that institutional investors, such as funds, insurances, etc. track the DAX. The effects of institutional ownership on corporate governance are seen by both active and passive investors as mutual funds are actively exercising their voting rights and thereby affect the corporate governance structure of firms (Iliev and Lowry 2015). Thus, we assume that passive investors perform an active role in monitoring, which ultimately plays in the tax management of the companies. Further, managerial incentives are an essential governance function (Bird and Karolyi 2017).

The sharp difference at the threshold between the indexes is used as an exogenous variation in corporate governance. We use the discontinuity across the indexes as an instrument for a two-stage regression model. Our identification strategy assumes that index membership near the breakpoint is exogenous to the tax policy besides the effect via taxation. The underlying assumption of the RDD is that firms around the threshold differ regarding corporate governance but are similar in other aspects. The setting is ideal for a RDD because the inclusion in either index is based on a mechanical rule (Crane et al. 2016). As a result, firms around the threshold have little possibility to influence being part of either index. However, it is not possible to exclude the possibility that firms manage earnings or artificially drive up/down their valuations to be included in a particular index (Bird and Karolyi 2017). Further, there is no control for confounding factors that simultaneously affect the relationship, such as benchmarking.

The two-stage regression model follows the research design by Lee and Lemieux (2010). The corporate governance variable measures the level of the corporate governance characteristics in terms of a score ranging from 0 to 100 as derived from the Thompson Reuters Asset4 database. The “ETR” variable is the effective tax rate and measures tax avoidance. The dummy variable “Index” indicates membership on the DAX. The variable “Market Cap Rank” represents the market capitalization rank on a year-by-year basis. In the first stage, the corporate governance variable (“CGS”) is the dependent variable; the index membership dummy, the market capitalization rank, and their interaction variable are the independent variables. The market capitalization rank, the interaction variable of the index membership dummy, and the market capitalization rank are included as independent variables in the first stage. These control for the rule based inclusion in either index close to the threshold. In the second stage, the effective tax rate (“ETR”) is the dependent variable; the instrumented corporate governance by index membership, the market capitalization rank, and their interaction variables are the independent variables. Thus, we measure the effect of the instrumented corporate governance score on tax management. The regression model includes year fixed effects.

The two-stage regression model:

1. Stage: $CGS = \beta_1 + \beta_2\, Index + \beta_3\, Market\ Cap\ Rank + \beta_4\, Index * Market\ Cap\ Rank + \beta_5\, Controls + \varepsilon$

2. Stage: $ETR = \beta_1 + \beta_2 * \widehat{CGS} + \beta_3\, Market\ Cap\ Rank + \beta_4\, Index * Market\ Cap\ Rank + \beta_5\, Controls + \varepsilon$

In the first stage, the index dummy is a binary treatment variable, which is, in essence, a sharp type of RDD (Crane et al. 2016). Lee and Lemieux (2010) label a design with imperfect compliance as fuzzy if there is an imperfect inclusion or factors other than the threshold rule affect the probability of program participation. In contrast to the sharp RDD, the probability of treatment does not jump from 0 to 1 when the threshold is crossed (Lee and Lemieux 2010). According to Lee and Lemieux (2010), the imperfect compliance is only a randomized "intent to treat" e.g. if it cannot be ruled out that the instrument influences the outcome other than through the treatment receipt. The sharp type assumes that all units whose score is above the cutoff are assigned to the treatment condition and actually receive treatment, while those below the cutoff are assigned to the control condition do not receive the treatment (Cattaneo et al. 2017). In contrast, the fuzzy RDD design allows for some units which do not receive treatment besides having a score above the cutoff, while some units receive the treatment despite being assigned to the control condition (Cattaneo et al. 2017). The Maimonides study on school class size and performance (Angrist and Lavy 1999) is an example for a fuzzy design and the RDD paper on the German electricity taxation uses a sharp RDD (Flues and Lutz 2015). Theoretically, we cannot exclude imperfect compliance and label our research design as a fuzzy RDD setting. We rely on a fuzzy RDD as the effect of index inclusion goes through corporate governance (Bird and Karolyi 2017). There is no immediately observable change in tax policy across the threshold variation (Bird and Karolyi 2017). Similarly, Angrist and Pischke (2009) call the instrumental variable type of setup a fuzzy RDD. In this setting, the RDD is based on the discontinuity in the probability or expected value of treatment conditional on a covariate (Angrist and Pischke 2009). The fuzzy treatment is consistent with biases because the market capitalization rank is based on free float shares.

The control variables include the research and development expense scaled by total assets capturing innovation. The EBITDA scaled by total assets controls for profitability. The debt to equity ratio reflects the financing choice. The intangible assets scaled by total assets account for capital mobility. Property plant and equipment variable scaled by total assets mirrors the physical presence and mobility of the company. The occurrence of operating losses measured as a binary variable grasp the business cycles. The sales general and admin expense scaled by total assets introduce operational efficiency to the model. The capital expenditures scaled by total assets reflects investment. The cash scaled by total assets captures liquidity and cash management. Lastly, the market value to book value ratio controls for the effects of the valuation and expectations.

The instrumental variables approach is supposed to resolve some of the endogeneity problems associated with the relationship between tax policy and corporate governance. We treat the membership of either index as an exogenous variation in corporate governance. Further, we argue that variation in the tax policy does not drive index inclusion. The corporate governance structures vary around the DAX and MDAX threshold due to mechanical differences in the weighting of the index components. The membership of either index is not dependent on tax related matters. However, there are differences in the tax management for firms of different size. The index membership, in turn, is dependent on the size of the firms. The firms in the indexes are comparable over the

threshold regarding their characteristics. The similarity of the firms allows treating the threshold as a sufficiently exogenous variation.

We expect a difference in corporate governance between the DAX and MDAX companies. The DAX is the major index, which represents the German economy. It is the benchmark for a large variety of funds and investment products. Therefore, differences in the ownership structure are likely, and these may translate in the corporate governance of the companies. The difference between the indexes could arise from the investors' preferences. The DAX is comparable to other major indexes such as the FTSE 100 in the UK while the MDAX refers to midcap stocks more dependent on the domestic market.

The analysis at hand compares the tax policy of firms in one index to counterfactual firms in the other index. The test procedure implies that firms in the MDAX, which did not switch membership, are not expected to change the tax policy. However, the ETR should be lower compared to counterfactual firms in the DAX.

The management of firms may be able to manipulate index inclusion around the threshold, thus introducing a self-selection bias, as pointed out by Crane et al. (2016). However, we follow Crane et al. (2016) stating that the difference in market capitalization is arbitrary small and a precise control is hardly possible.

The sample relies on the information provided by the Deutsche Börse Group (2016). The panel data set contains the index composition for the years 2002 to 2016. We obtained the data from the Thompson Reuters Database. The analysis uses the actual index assignment on a year-by-year basis, instead of a prediction-based assignment. In the year 2002, the MDAX contained more than 50 firms, so the data was limited to the 50 largest firms by market capitalization for that year.

Besides the parametric setting above, we checked the robustness using non-parametric methods. The analysis is narrowed down to the threshold of the indexes. The smaller chosen bandwidth around the threshold reduces the sample size. Therefore, local linear nonparametric regressions are used to identify the discontinuity (Hahn et al. 2001). This method allows us to analyze a close window around the threshold. The non-parametric analysis helps to tackle small effects, differing relations away from the threshold and functions not well captured by polynomials (Cappelleri and Trochim 2015). The method is estimating the limits with local linear regressions (Hahn et al. 2001). The Wald estimator is subsequently interpreted as the RD estimator (Hahn et al. 2001).

4 Findings and Discussion

The level of tax avoidance should increase with index inclusion in the DAX because the level of institutional ownership rises. The argumentation states that DAX firms have higher levels of corporate governance and this leads to lower effective tax rates. Conclusively, we suppose that an increase in the corporate governance characteristics leads to higher tax aggressiveness. Contrary to previous research, we do not expect low tax rates of firms at the top of the MDAX to increase upon inclusion in the DAX as suggested by Bird and Karolyi (2017). Such an argumentation assumes the largest MDAX firms are weighted higher in the index, have a higher degree of institutional ownership, show higher corporate governance characteristics and therefore, have a lower tax rate. Upon inclusion in the DAX, these firms would then expected to show falling tax rates, as the attention of institutional investors decreases because of a lower index weight, thus lowering corporate governance, resulting in a higher tax rate.

Table 1: Description Variables

Variable Overview	
ETR	Effective tax rate
CGS	Corporate governance score
Index	Index membership (1 if DAX, 0 if MDAX)
RandD	Research and development expense *
EBITDA	Earnings before interest, tax, depreciation and amortization *
DtoE	Debt to equity ratio
Intangibles	Intangible assets *
PPE	Property plant and equipment *
OpLoss	Operating loss dummy
SGandA	Sales, general and admin expense *
CapEx	Capital expenditure *
Cash	Cash available *
MVtoBV	Market value to book value (equity)
MarketCapRank	Rank variable by market capitalization
DaxMVRank	Index membership times rank
*scaled by total assets	

The descriptive statistics (Table 2) give an overview over the variables. The mean of the effective tax rate is around 32.8 %. The mean corporate governance score averages around 34.3 %. The mean of the ETR is round about the German statutory tax rate.

Table 2: Descriptive statistics all variables

Variable	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**
ETR	1,023	32.79696	19.15482	3.16	150.58
CGS	862	34.26961	20.86166	2.98	87.13
Index	1,220	.3688525	.4826917	0	1
RandD	784	.0300707	.0332909	0	.2306325
EBITDA	1,148	.1103876	.0776783	-.1934875	.7779512
DtoE	1,174	179.1285	385.554	0	2463.14
Intangibles	1,176	.166177	.1683873	2.02e-07	.7589535
PPE	1,176	.24866	.2033416	.000049	.9666285
OpLoss	1,186	.1020236	.302807	0	1
SGandA	1,065	.1948949	.1656746	.0020284	1.102209
CapEx	1,159	.0441009	.0393732	0	.5353097
Cash	1,090	.0742872	.0671849	.0004984	.4610415
MVtoBV	1,177	2.270399	1.813	.31	10.56

Sorting by index reveals the differences in the corporate governance structures (Table 3). The mean corporate governance score for the DAX firms is around 43.4 % and for the MDAX firms around 26.0 %. The mean of the ETR is slightly lower for the DAX firms (31.0 %) compared to the MDAX (33.8 %).

Table 3: Descriptive statistics for the DAX and MDAX

Variable	**Obs**	**Mean**	**Std. Dev.**
DAX			
CGS	408	43.42056	20.3085
ETR	385	31.0446	15.86012
MDAX			
CGS	454	26.04584	17.70394
ETR	627	33.81703	20.96593

The descriptive statistics indicate that the shareholder rights score (Table 4) is higher for the DAX companies (57.2 %) compared to the MDAX companies (48.9 %). The higher score for the DAX may be the result of higher institutional ownership. Active investors work for their rights and can enforce their interests. The higher concentration of institutional owners in the DAX could increase the shareholder rights and corporate governance structure. Unfortunately, the shareholder rights score is based on only few binary data points. Subsequently, the database providers quotes a percentage score. A closer analysis of the underlying data shows a lack of variation in the data. Therefore, we rely on the corporate governance score.

Table 4: Shareholder rights score by index

Variable	**Obs**	**Mean**	**Std. Dev.**
DAX			
Shareholder Rights	408	57.2221	20.96933
MDAX			
Shareholder Rights	454	48.85172	28.41641

The correlation matrix (Table 5) gives the first indication how the variables employed in the analysis interact with each other. The effective tax rate is weak and negatively correlated to the corporate governance score.

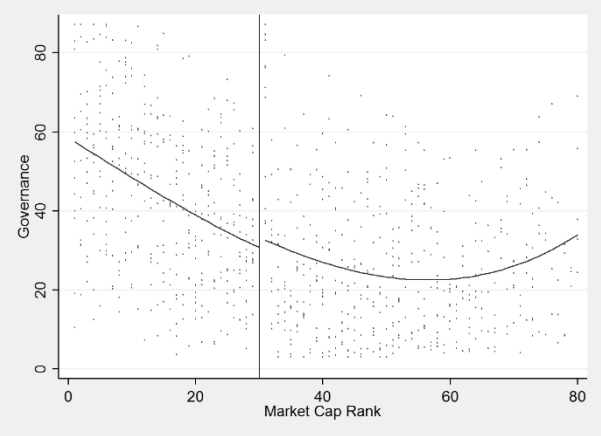
Table 5: Correlation matrix

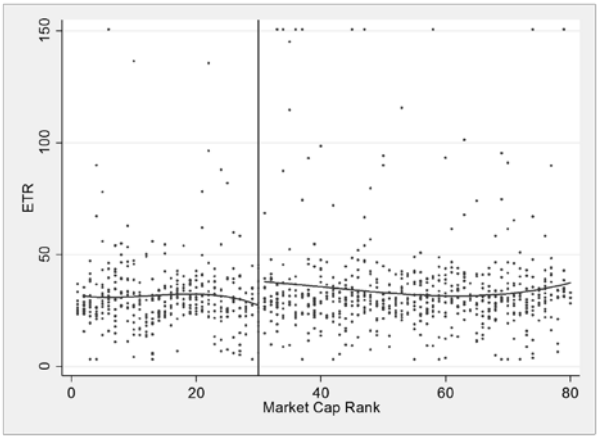
	ETR	**CGS**	**Index**	**RandD**	**EBITDA**	**DtoE**	**Intang~s**	**PPE**	**OpLoss**	**SGandA**	**CapEx**	**Cash**	**MVtoBV**
ETR	1.0000												
CGS	-0.0787	1.0000											
Index	-0.0703	0.3521	1.0000										
RandD	-0.0359	0.0654	0.0505	1.0000									
EBITDA	-0.1713	-0.1407	-0.0263	0.3573	1.0000								
DtoE	0.1463	0.0809	0.1987	-0.2882	-0.3596	1.0000							
Intangibles	-0.0391	0.1524	0.1352	-0.0305	-0.1157	0.0696	1.0000						
PPE	-0.0311	-0.1222	0.0128	-0.2155	0.0605	0.0959	-0.4411	1.0000					
OpLoss	0.1561	-0.0383	-0.0061	-0.1258	-0.0244	0.0770	-0.1258	0.1330	1.0000				
SGandA	0.0368	-0.1053	-0.0266	0.3236	0.4571	-0.3769	-0.0347	-0.2476	0.1197	1.0000			
CapEx	0.0076	-0.1239	-0.0224	0.0155	0.1482	0.0491	-0.3847	0.4506	0.0366	-0.0959	1.0000		
Cash	-0.0439	0.0060	-0.0744	0.1123	0.0800	-0.2846	-0.2867	-0.1989	-0.0126	0.2237	-0.0755	1.0000	
MVtoBV	-0.0072	0.0623	-0.0721	0.3964	0.5297	-0.2328	0.0082	-0.2535	-0.0937	0.4903	-0.0543	0.1235	1.0000

The graphical analysis of the discontinuity (Figure 1) provides the first insights. The graphs in the left column show the governance variable plotted on the market capitalization rank. All smoothing methods, polynomial, LOWESS (locally weighted scatterplot smoothing) and nonparametric local regressions show the discontinuity for the governance score at the cutoff at the 30th market capitalization rank, which is the threshold of the DAX and the MDAX. The governance score is lower for the smallest DAX companies compared to the largest MDAX firms. However, the increase in the governance variable for the bottom MDAX firms is puzzling. However, the local nature of regression discontinuity is not an issue for their external validity. We lack a clear explanation for the effect. Firms with comparatively small amounts of shares trading in the free float may explain why the governance score increases for the smallest MDAX companies. Similarly, the graphical analysis confirms that the tax rate is higher for the MDAX firms and drops at the DAX cutoff. The relation holds for the polynomial, LOWESS, and nonparametric local regression.

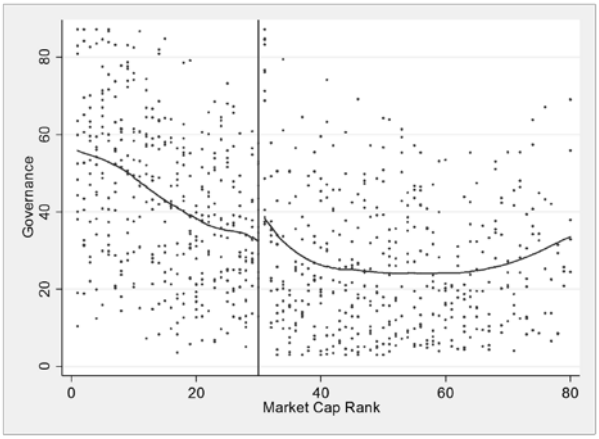
Table 6: Graphical analysis of the discontinuity

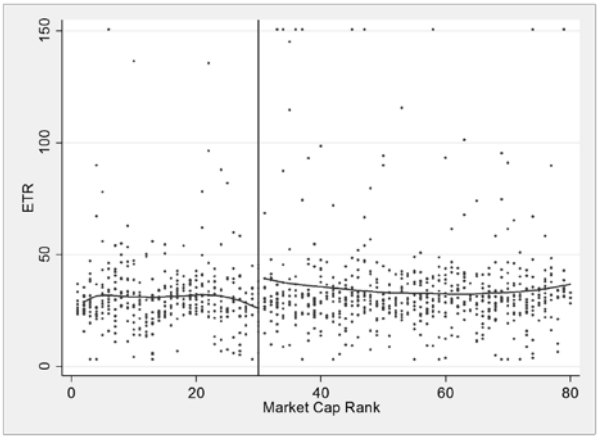
Third Polynomial (the left figure shows the governance score on the y-axsis and the market capitalization rank on the x-axsis; the right figure shows the effective tax rate on the y-axsis and the market capitalization rank on the x-axsis)



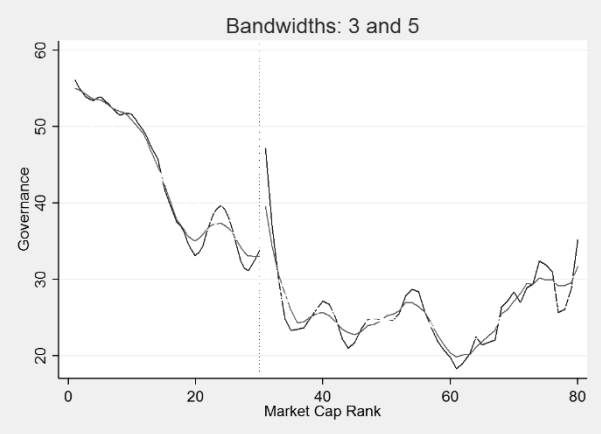


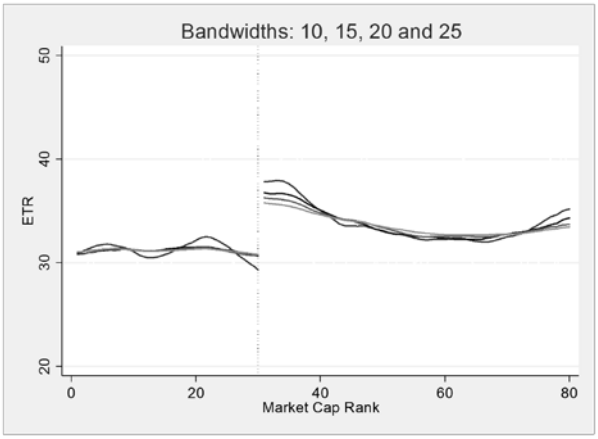
Lowess (the left figure shows the governance score on the y-axsis and the market capitalization rank on the x-axsis; the right figure shows the effective tax rate on the y-axsis and the market capitalization rank on the x-axsis)





Nonparametric – Kernel-weighted local polynomial smoothing (the left figure shows the governance score on the y-axsis and the market capitalization rank on the x-axsis; the right figure shows the effective tax rate on the y-axsis and the market capitalization rank on the x-axsis)





The firms in the DAX appear to be governed better compared to the MDAX firms. However, the firms at the bottom of the DAX show a lower governance level compared to the biggest MDAX firms. We propose that the difference comes from differences in institutional ownership. We argue that due to the value-weighted constitution the largest firms in MDAX are given a higher weight compared to the smallest firms in the DAX, even though the firms are roughly similar in size. Thus, the top MDAX firms show a higher level of institutional ownership and receive a greater attention by the shareholders. Therefore, the corporate governance score is higher for the largest firms in the MDAX than for the smallest firms in the DAX. The governance characteristics channel in the tax management. The institutional investors are likely to express preferences regarding the tax management. The tax rate is higher for the MDAX firms. The inclusion in the DAX may put companies under high pressure to lower the tax rate. The companies in the top of the MDAX show a higher tax rate compared to the firms in the mid-range of the index. The tax rate rises for the smallest companies in the MDAX. Possibly, the pressure to minimize the tax rate is reasonably higher for the DAX firms, so the tax rate significantly falls at the cutoff point. In this respect, we have a different finding compared to the analysis of the American companies in the Russell 1000/2000 (Bird and Karolyi 2017). The Russell 1000 firms showed a lower ETR compared to the Russell 2000 firms, however, Bird and Karolyi (2017) demonstrate that the smallest companies in the Russell 1000 have a higher tax rate compared to largest enterprises in the Russell 2000. Transferring the argumentation to the DAX companies, the largest MDAX firms should show increasing tax rates upon inclusion in the DAX where they were the smallest firms then. The phenomenon would occur assuming the largest MDAX firms face a higher pressure from investors and the pressure decreases upon inclusion in the DAX. This behavior would be possible because the value-weighted methodology gives the smallest DAX firms a lower weight relative to the largest DAX firms. The DAX/MDAX companies behave the other way, such that the smallest DAX firms still have a lower tax rate compared to the largest MDAX firms. We suggest the difference compared to the Russell firms stems from the relatively small number of companies in the German Prime Standard Indexes. Possibly, the pressure on tax management is always higher in the DAX companies due to other factors beyond corporate governance, e.g. industry benchmarking.

We conclude from the graphical analysis that the corporate governance characteristics are higher for the DAX firms than for the MDAX firms. However, at the cutoff, the largest MDAX firms show a higher governance score compared to the smallest DAX firms. The tax rate decreases significantly with the inclusion in the DAX. The firms in the DAX show a significantly lower tax rate. We proceed the analysis by testing the statistical significance of the graphical results using a two-stage least square regression model with year fixed effects. The first stage (Table 7, Column 1) tests the explanatory power of the index inclusion on corporate governance. We find that the dummy variables “Index” is highly significant and positively related to the corporate governance score. It follows that DAX membership is associated with higher corporate governance scores. The smaller the rank, i.e. the larger the firm, the higher is the likelihood to have a high corporate governance score. The regression analysis confirms the findings from the graphical analysis as shown above. The index inclusion variables have a high explanatory power of the corporate governance score. The inclusion in either index has a significant impact on the corporate governance characteristics.

The second stage of the regression model (Table 7, Column 2) analyses the relationship between the effective tax rate and the corporate governance characteristics instrumented by the index inclusion. The variation between DAX and MDAX is assumed to be sufficiently exogenous to serve as a strong instrument. As such, we are able to establish a causal relationship. We find that the corporate governance score stands in a negative relationship with

the ETR. It follows that higher governance characteristics are associated with a lower effective tax rate. This result confirms the findings from the graphical analysis above.

We argue that corporate governance is a driver of tax avoidance. The relationship between the tax rate and the corporate governance score is statistically significant and negative. The test procedure allows concluding that corporate governance strengths decrease the effective tax rate. This finding may be limited to the large multinational companies listed in the DAX and MDAX. However, to some extent, we can confirm the findings by Bird and Karolyi (2017). Hence, the relationship could be transferred to other comparable companies as well.

*Table 7: IV Regression analysis. In stage 1 (column 1), the corporate governance score is used as the dependent variable; the index dummy, the market capitalization rank, and the interaction are used as independent variables. In stage 2 (column 2), the effective tax rate is used as the dependent variable, the predicted corporate governance score, the market capitalization rank, and the interaction are used as independent variables. (Standard errors are presented in parentheses; *, ** and *** denote significance at the 10%, 5%, and 1% levels, respectively.)*

	(1)	**(2)**
	CGS	**ETR**
Index	14.6373***	
	(4.5408)	
$\widehat{CGS}$		-0.9703***
		(0.2936)
MarketCapRank	-0.2770***	-0.4875***
	(0.0783)	(0.1408)
DaxMVRank	-0.5507***	-0.3799***
	(0.1380)	(0.1055)
RandD	97.3818***	110.2001***
	(26.2424)	(40.3351)
EBITDA	-36.5888***	-106.3318***
	(13.9739)	(16.6756)
DtoE	-0.0057	0.0027
	(0.0122)	(0.0092)
Intangibles	0.7548	0.4249
	(5.6889)	(5.3825)
PPE	-11.8732	-10.7333
	(7.3585)	(8.3828)
OpLoss	0.3888	5.7889
	(2.9274)	(3.9215)
SGandA	-12.0788*	5.9516
	(6.4988)	(7.2112)
CapEx	5.2377	19.0374
	(23.7588)	(23.6395)
Cash	12.1292	1.5744
	(14.3350)	(13.2487)
MVtoBV	0.5012	0.9820
	(0.6493)	(0.5963)
No. of Obs.	570	654
R^2	0.3773	0.1146
Fixed Effects	Year	Year

As a next step, we verify the results above using nonparametric methods. The variables are specified as follows. The market capitalization rank is the running variable. The outcome variable is the governance score in the first step and the ETR in the second step. The assignment variable is the index dummy in the first step and the governance variable in the second step.

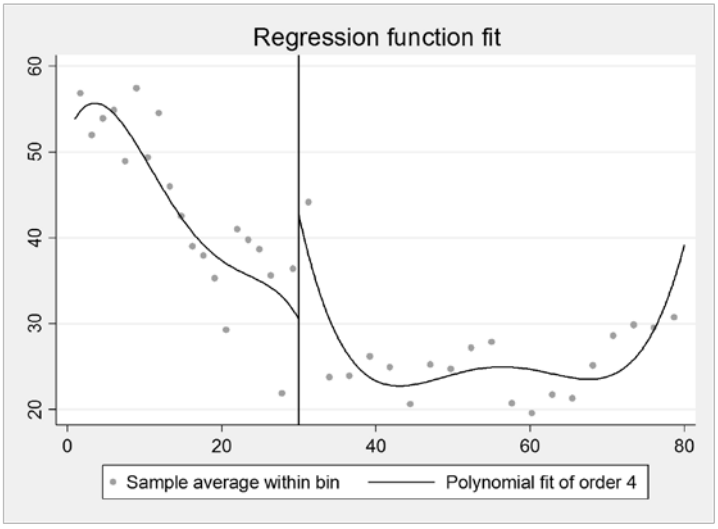
The model used is based on robust nonparametric confidence intervals (Calonico et al. 2014a). The design relies on local polynomial estimators to analyze the relation closely around the threshold. This method refines the test procedure by only testing smaller bandwidth of the sample. The test procedure is specified as a fuzzy RDD (Calonico et al. 2014b). The non-parametric analysis confirms the results above by using a different method which is giving reliable results for small samples such as the one at hand. The regressions with only several hundred observations are significantly smaller in comparison to the papers on the Russell 1000 and Russell 2000. However, the relationship observed in the US can be confirmed with the analysis of the German DAX and MDAX firms. The variance-covariance matrix estimator was computed for heteroscedasticity-robust nearest neighbor variance estimator (Calonico et al. 2014b).

The local-polynomial regression-discontinuity estimation with robust confidence intervals confirms the statistical significance of the discontinuity. The triangular kernel type emphasizes the observations around the cutoff. The test statistics (Table 8) show that the discontinuity is highly significant for the relationship between corporate governance and the market capitalization rank. Both the conventional estimation and the robust model show a significant result. The null hypothesis states equal conditional expectations at the cutoff (Calonico et al. 2017). The robust procedure calculates the optimal bandwidth (Skovron and Titiunik 2015). Variance estimators computed using on nearest neighbors calculated based on covariates (Calonico et al. 2014a). The subsequent model is not used to derive estimates themselves but the support the estimation of the optimal bandwidth with statistical significance. The bandwidth calculated below is 19 (in both directions). We find that a lower market capitalization rank (i.e. larger firm) is associated with higher governance.

*Table 8: Structural Estimates: Local-polynomial regression-discontinuity estimation of the CGS and the market capitalization rank. (Outcome (dependent variables): CGS. Running variable (Rank variables): MarketCapRank. Instrument: Index; Standard errors are presented in parentheses; *, ** and *** denote significance at the 10%, 5%, and 1% levels, respectively.)*

Method	**Coef.**	**Std. Err.**	**P>z**
Conventional	-9.1806**	(4.3074)	0.033
Robust	-***	-	0.000

Figure 1: Corresponding visualisation (the figure shows the governance score on the y-axsis and the market capitalization rank on the x-axsis).

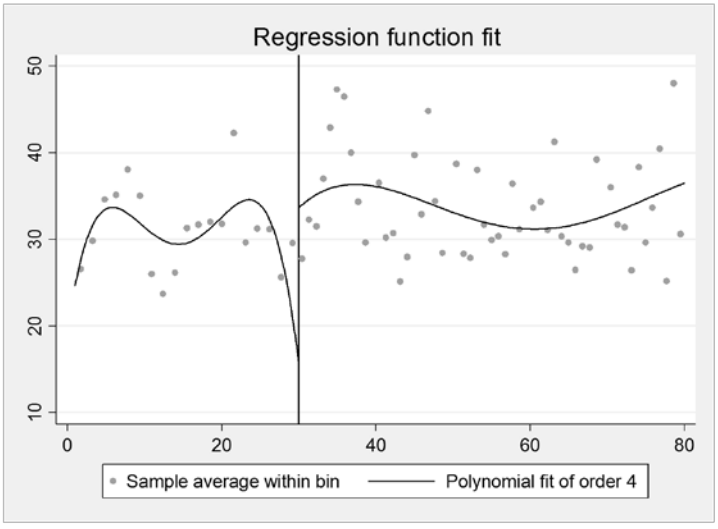


The nonparametric local polynomial estimators (Table 9) confirm a significant relation between the effective tax rate and the running variable. The calculated bandwidth is 14 (in both directions). The results show that a higher market capitalization rank (i.e. smaller firm) is associated with a higher ETR.

*Table 9: Structural Estimates: Local-polynomial regression-discontinuity estimation of the ETR and the market capitalization rank. (Outcome (dependent variables): ETR. Running variable(Rank variables): MarketCapRank. Instrument: CGShat; Standard errors are presented in parentheses; *, ** and *** denote significance at the 10%, 5%, and 1% levels, respectively.)*

Method	**Coef.**	**Std. Err.**	**P>z**
Conventional	2.8187**	1.3632	0.039
Robust	-**	-	0.049

Figure 2: Corresponding visualisation (the figure shows the ETR on the y-axsis and the market capitalization rank on the x-axsis).



The tables above do not specify the “robust” coefficients and standard errors for the line “robust”. Cattaneo et al. (2017) show that using OLS methods would assume a correctly specified model and disregard the nonparametric

approximation. The bias-corrected point estimator is suboptimal to the conventional point estimator in terms of point estimations when using a mean-squared error optimal bandwidth (Cattaneo et al. 2017). Proceeding otherwise would imply selecting a bandwidth according to a bias-variance trade-off but then proceeding the bias would be zero (Cattaneo et al. 2017).

The above analysis gives insight into the causes and effects of tax avoidance. However, it remains unclear whether the RDD results are transferable to other companies. The sample firms in the DAX and MDAX may not be representable for the rest of the economy due to their international focus and possible because of their shareholder structure. Nonetheless, more research may be able to clarify the preferences of institutional investors and how the preferences channel in the corporate decision-making.

5 Conclusion

This paper analyses the German Prime Standard firms listed on the Frankfurt Stock Exchange. We take advantage of the value-weighted index. The 30 largest companies are listed in the DAX, and the subsequent 50 companies are listed in the MDAX. The inclusion around the cutoff is quasi-random because the smallest firms in the DAX are similar to the largest firms in the MDAX. However, the index membership is determined by a mechanical formula. The firms themselves have no impact on the inclusion. Therefore, we use the quasi-random index inclusion as an exogenous source of variation and as an instrument in the two-stage regression model. The index membership matters as large institutional investors benchmark against the DAX and the MDAX. The value-weighted index constitution leads to a proportionately higher weighting of the largest firms by market capitalization. This leads to a different treatment of otherwise almost similar companies around the threshold. The presence of instructional investors, both active and passive ones, matters because of their monitoring and governance role. The institutional investors have preferences and these channel in the corporate tax policy.

This regression discontinuity analysis attempts to establish a causal link between corporate governance and tax management. The paper concludes that corporate governance affects tax management for the DAX and MDAX firms. We suggest higher corporate governance characteristics drive down the effective tax rate. This paper gained insight on the relationship between tax avoidance and corporate governance, however, the generalization of the results to all kind of firms may not hold, because we only analyzed Prime Standard equities in the most liquid German indexes. This phenomenon matters, because not all investors have the same preferences. These preferences may differ substantially with regard to risk attitudes. We point at the effects of a shareholder culture and attempt to explain how the tax avoidance culture among large multinational companies works.

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