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The effect of ownership concentration on firm risk and value: evidence from Germany

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Aim: This paper aims to understand the effects of ownership concentration on firm risk and value.

Design / Research methods: The author focuses on the largest publicly listed 91 German corporations in the time period 2010 to 2021. The resulting sample contains between 928 and 1051 observations and is analysed through a pooled OLS regression analysis. Ownership concentration is measured in terms of the number of blockholders, the size of the largest shareholder, and the Herfindahl Index of the ten largest shareholders. Firm value is captured with Tobin's Q and firm risk is computed as the annualised daily stock price volatility.

Conclusions / Findings: It is found that ownership concentration affects firm risk significantly negatively. Moreover, results suggest an inverse U-shape relationship between ownership concentration and firm value. This relationship can be explained by combining the negative effects of rising ownership concentration on firm risk with its implications for the creation of firm value.

Originality / Value of the article: The German market has used to have a network-like structure with a concentrated ownership structure. However, over the past two decades, it transformed towards a more Anglo-Saxon-like and market-based structure with a rather dispersed ownership structure. Furthermore, factors which govern the relationship between ownership concentration are used to explain parts of the relationship between firm value and ownership concentration in a new way, thereby adding value to understanding the latter, highly debated, relationship.

Keywords: Corporate Governance, Ownership Concentration, Blockholders, Firm Risk, Firm Value

JEL: G32

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1. Introduction

Every successful company balances the relationship between ownership and control, where the alignment of interests can be the driving force behind a firm's risk and value – a topic that has captivated the attention of researchers for almost a century. Berle and Means' publication *The Modern Corporation and Private Property* (1932) laid the foundation for a new line of research and has unsolved implications for several stakeholders to date. They argued that the role of profit maximization as a guide to resource allocation is undermined by the diffusion of ownership and control.

At its core lies the principal-agent problem, which stems from the misalignment of goals between the firm's owners (principals) and its management (agents). This problem arises from the delegation of decision-making authority by the principals to the agents, where both parties have conflicting incentives and information asymmetry. As a result, this misalignment leads to agency costs which may harm the firm's overall performance or increase its risk and thus has far-reaching implications for managers, firm owners and further stakeholders.

There are several ways for owners to address this problem. For instance, owners can monitor firm managers' decisions and thereby reduce the agency cost. Additionally, owners can govern a firm more directly by intervening into firm's operations. It has been argued that an important factor determining the degree of monitoring behaviour and interventions depends on ownership concentration (Shleifer, Vishny 1986). Researchers have established significant relationships between ownership concentration and firm risk and value – but with conflicting results (Becht et al. 2003; Michelberger 2016).

The relationship between ownership concentration on firm risk is generally negative, studies show (e.g., Rossetto et al. 2023). The majority of shareholders tend to show risk-averse behaviour, which becomes more pronounced as the amount of their investment, and hence the ownership concentration of a firm, increases. As a result, a higher ownership concentration can reduce the overall firm risk.

With respect to the effect of ownership concentration on firm value, researchers are inconclusive. On one side, there are positive effects of high ownership concentration on firm value, as a higher stake is associated with more monitoring

behaviour and owners can apply higher pressure to management through a threat of exit. On the other side, high ownership concentration can have a detrimental effect on firm value when it leads to over-monitoring (Aghion, Tirole 1997; Burkart et al. 1997), the misuse of power by large blockholders (Bhojraj, Sengupta 2003), or liquidity constraints (Bolton, von Thadden 1998; Edmans 2009).

On top of conflicting results presented in the literature, there have not been more recent studies investigating the impact of ownership concentration on firm risk and value. In 2000, Lehmann and Weigand claimed that a more network-like structure is found in Germany, where on average the largest shareholder controls 89% of voting stocks. However, between 2010 and 2021 the largest shareholder of German firms owned on average only 25% which is less than half the 63.96 percent that the largest shareholder controls in a European firm (Faccio et al. 2011). It is reasonable that the global convergence of governance systems (Yoshikawa, Rasheed 2009) has impacted the ownership structures of German firms. In line with this assumption, Stiglbauer (2010) suggested that Germany is developing towards a market-oriented system with a more dispersed ownership concentration. Such a market-oriented ownership structure is found in Anglo-Saxon markets, which have been of interest to previous researcher. Therefore, the central question at hand is how the relationships between ownership concentration, firm risk and value behave in the recently transformed, and more Anglo-Saxon-like, German market. As one of the world's top ten markets in terms of market capitalisation (World Bank 2023), the German stock market has established itself as a crucial player on the global stage and presents a valuable case for researchers to study.

This study aims to contribute to the on-going debate on corporate governance by empirically analysing the effects of ownership concentration on firm risk and firm value through a pooled OLS regression of 91 companies listed in Germany's most prominent stock submarkets over the time period 2010 to 2021.

In particular, it is found that there is a negative relationship between ownership concentration and firm risk, because larger shareholders are more risk-averse and influence agents' decisions towards their preferences. Moreover, results show that ownership concentration and firm value have an inverted U-shape relationship, which can be explained by factors which also affect the ownership concentration and firm

risk relationship, as well as balancing advantages and disadvantages of a higher ownership concentration on firm value.

The remainder of the paper is organized as follows. Section 2 presents the theoretical background and hypothesis development. Section 3 discusses the methodology, including data sources, sample and variables. Section 4 and 5 focus on analysis and empirical results. In Section 6, robustness tests are presented. Finally, section 7 discusses the findings and section 8 concludes.

2. Theoretical background and hypothesis development

2.1. Ownership concentration and firm risk

To examine the relationship between ownership concentration and firm risk, it is important to first understand the characteristics of firm owners. Two key factors influence this relationship.

First, any shareholder who invests in a particular firm has a stake in the company, making them a partial owner. As such, when firm owners exhibit risk-averse behaviour their risk-aversion becomes more pronounced as the size of their investment increases. Therefore, shareholders owning a high stake in a firm are relatively more risk averse than those who own a smaller stake.

Second, as a shareholder's stake increases, their monitoring activity also increases, and their influence on the management's decisions becomes greater. This is because when there are multiple principals, free riding occurs. However, as the number of principals decreases and consequently their stake increases, their relative benefit of monitoring is bigger and the free-riding problem can be overcome (Shleifer, Vishny 1986). As a result, larger shareholders are more likely to have a say in which projects are undertaken, as they can use their monitoring activity to influence management (Burkart et al. 1997).

Combining these two characteristics of firm owners, it becomes clear that large shareholders prefer lower risk/return projects, whereas smaller shareholders prefer projects with a higher risk/return ratio (Dhillon, Rossetto 2015). Furthermore, large shareholders can use their monitoring activity to pressure agents towards more risk-averse decisions.

The size of shareholders determines the degree of ownership concentration. That is, a firm with fewer shareholders owning larger stakes has a higher ownership concentration than a firm with multiple shareholders owning small stakes. Because a firm with high ownership concentration tends to have larger, more risk-averse shareholders, who are more likely to influence management's decisions towards their preferences, it is expected that a higher ownership concentration is negatively associated with firm risk.

Research exploring the effects of ownership concentration on firm risk has confirmed these dynamics in various ways. For example, John et al. (2008) found that the higher the share of the largest shareholder is, the lower firm risk becomes. Faccio et al. (2011), extended this research to the diversification of the largest blockholder. As the diversification of the largest blockholder increases, investment in that company becomes relatively smaller. Hence, the benefit of monitoring agents becomes relatively smaller, implying a lower engagement of monitoring and leading to a higher firm risk.

Due to differing opinions about risk choices between blockholders and smaller shareholders, i.e., blockholders are more risk-averse than smaller shareholders, Dhillon and Rossetto (2014) theorized that a second medium-sized blockholder can mitigate the conflict of interest between a single large blockholder that is more risk-averse and multiple smaller shareholders that are less risk-averse.

Accordingly, research has shown that firms with one blockholder are less risky than firms with two (Carlin, Mayer 2003), and that being a firm with multiple blockholders positively affects firm risk relative to a firm with one (Rossetto et al. 2023). In the same paper, a negative relationship between ownership concentration and firm risk was found using the Herfindahl index as the measure for ownership concentration.

Empirical research on the effect of ownership concentration on firm risk in Anglo-Saxon markets has consistently shown a negative relationship.

To test whether these findings are generalisable to the German market, the following hypothesis is developed:

Hypothesis 1: There is a negative relationship between ownership concentration and firm risk.

2.2. Ownership concentration and firm value

Creating firm value for stakeholders is a fundamental objective for any corporation, and studying influential factors, including ownership concentration, is essential in understanding its impact. However, to date, research on the effect of ownership concentration on firm value has been inconclusive (Becht et al. 2003).

Previous research outlined two main reasons why ownership concentration may be positively correlated with firm value.

The first reason is that since large blockholders have relatively more to lose, they become more risk-averse and their engagement in monitoring activities increases (Shleifer, Vishny 1986). Consequently, agents in a firm with a large blockholder, compared to a firm with a dispersed set of owners, are monitored more intensively by the large blockholder. As a result, information asymmetry and the misalignment of goals between principals and agents is reduced which reduces agency costs and ultimately adds firm value. Agents in a firm without a blockholder are less monitored and rather follow their own interest than those of the principals, leading to a higher agency cost and harming firm value. The creation of firm value based on the effect of ownership concentration has further been analysed and confirmed by more recent research (Admati et al. 1994; Huddart 1993).

The second reason why having large shareholders is more desirable to increase firm value is put forward by Admati and Pfeiderer (2009), and Edmans (2009). They argue that even if large blockholders cannot exercise “voice”, that is monitoring and influencing firm’s decision making, they still can govern agents through the “threat of exit”. A significant proportion of top management’s compensation can be attributed to stock compensation (Ofek, Yermack 2000). Therefore, by threatening to sell one’s shares in the firm and reducing the firm’s share price ex post, firm’s management is induced to create value ex ante.

At the same time, researchers found that high ownership concentration can have a negative relationship with firm value. One factor behind this negative relationship is that large shareholders may misuse their relatively higher power to the disadvantage of smaller ones (Bhojraj, Sengupta 2003), expropriating them instead of the firm management expropriating all shareholders (Shleifer, Vishny 1997). Findings by

Barclay and Holderness (1989), Dyck and Zingales (2004), and Nenova (2003) support the existence of this process.

Another factor which may decrease firm value is the over-monitoring of large blockholders (Aghion, Tirole 1994; Burkart et al. 1997). As large blockholders by definition have higher stakes, their over-monitoring pressures firm management into being too risk averse and not taking more costly, yet promising opportunities. With this reasoning in mind, it is plausible why there is empirical evidence that firm value is increased in the presence of two blockholders, instead of one (Lehmann, Weigand 2000; Maury, Pajuste 2005; Laeven, Levine 2008).

Lastly, a highly concentrated ownership can imply less stock liquidity and makes it more difficult for other investors to punish firm management (Bolton, von Thadden 1998; Edmans 2009). More recently Konjin et al. (2011) found a negative relationship between ownership concentration measured in terms of blockholder dispersion and a measure for firm value, Tobin's Q.

Burkart et al. (1997) argue that a trade-off between the benefits of monitoring and those of managerial initiative takes place with changes in ownership concentration. They reason that when ownership concentration is low, less monitoring takes place which induces the manager to take initiative. On the other side, managers are dis-incentivised to take initiative in firms with high ownership concentration because in those, they are intensively monitored by principals with high stakes. This line of reasoning suggests that the true relationship between ownership concentration and firm value may be non-linear, rather than linear. This is supported by Gedajlovic and Shapiro (1998), who found a significant negative, non-linear relationship between the size of the largest shareholder and return on total assets.

In sum, empirical evidence collected in Anglo-Saxon markets on the relationship between ownership concentration and firm value is inconclusive. Therefore, hypotheses 2a-c are formulated to test three alternative relationships:

Hypothesis 2a: There is a positive relationship between ownership concentration and firm value.

Hypothesis 2b: There is a negative relationship between ownership concentration and firm value.

Hypothesis 2c: There is a non-linear relationship between ownership concentration and firm value.

3. Methodology

3.1. Data sources and sample

The sample consists of an unbalanced panel data set of 91 German firms listed in the Germany's most prominent submarkets between the years 2010 and 2021. Together, the DAX and MDAX track the 80 largest companies in Germany based on their market capitalisation and further publicly available requirements (Börse Frankfurt 2023). The majority of data used in this article has been collected from the Refinitiv Eikon database. This is a well-known financial database that includes company data, market data, ownership data and more, making it a suitable source for this research. The retrieval of accounting, market and ownership data was achieved through the use of the specific ISIN codes of the companies. Only the EUR/USD exchange rates stem from the OECD database and firm age has been collected through the firm's public websites available on the open internet. From these sources, information has been gathered on the variables of companies that have been publicly listed the German DAX and MDAX index between the years 2010 to 2022 resulting in an initial sample size of 97 companies.

As in previous studies, specific companies are left out. For instance, the accounting data of the fraudulent company Wirecard cannot be trusted and therefore, Wirecard was dropped. Additionally, firms operating in the financial sector (banks) were excluded because their operations are tightly regulated and have a special business model (e.g., Demsetz, Lehn 1985). This led to a final sample size of 91 firms.

Next to that, large parts of accounting data for the year 2022 was missing at the time of retrieval (early 2023), which resulted in narrowing down the years to 2010 to 2021. Depending on the variable, the total number of observations ranges from 928 to 1,051. A detailed description of the variables and summary statistics can be found in Tables 1 and 2, respectively.

Table 1. Description and source of variables

Variable	Description	Source
TobQ	(BV total assets – BV common stock – Deferred income taxes + MV Equity) / BV total assets.	Eikon
AnnVola	Daily share price volatility computed annually in %.	Eikon
#blockh	Number of blockholders. A blockholder is defined as a shareholder holding at least 5%.	Eikon
%top1	Percentage held by the largest shareholder.	Eikon
HerfTop10	Herfindahl index calculated as the sum of squares of percentage held by the ten largest shareholders.	Eikon
Age	Age of the firm in years.	Internet
Size	MV of common equity in thousands of euros.	Eikon
Lev	Total outstanding debt / BV common stock.	Eikon
EURUSD	Exchange rate EUR to USD.	OECD
Notes: MV refers to market value, BV refers to book value.		

Table 2. Summary statistics of variables for 91 firms in sample

Variable	Mean	Median	Std. dev.	Min	Max	Count
TobQ	1.77	1.33	1.39	0.10	13.29	953
AnnVola	30.79	28.32	11.94	5.67	111.98	928
#blockh	1.87	2.00	1.28	0.00	9.00	946
%top1	0.25	0.16	0.22	0.00	0.95	946
HerfTop10	0.12	0.05	0.18	0.00	0.90	940
Age	66.89	50.00	52.63	0.00	174.00	1051
Size [a]	16,281,953	6,449,243	23,252,600	43	152,601,781	947
Lev	0.86	0.60	1.18	-10.21	13.48	972
EURUSD	0.83	0.85	0.07	0.72	0.90	1051
Notes: Variables are defined as in Table 1. [a] Size is given in thousands.						

3.2. Variables

3.2.1. Dependent variables

The first dependent variable is firm risk (*AnnVola*), which is measured as the annualized daily share price volatility as it has been done in previous studies (John et al. 2008; Faccio et al. 2011; Rossetto et al. 2023). Risk-averse investors tend to prefer firm with lower risk which is why firms with lower risk can attract more shareholders. The attraction of additional shareholders increases the demand for a given number of shares, positively affecting the firm's market value and hence, both managers and shareholders can benefit. On average, the sample reports an annual volatility of 30.79% which is equal to a daily share price volatility of 1.94%, considering 252 trading days.

The second dependent variable of interest is firm value (*TobQ*), which is defined as Tobin's Q. This metric has been used by previous researchers (Cho 1998; Himmelberg et al. 1999; Holderness et al. 1999, Konijn et al. 2011) and is the ratio of the market value of a firm's assets divided by its replacement cost. Here, the market value of the assets is calculated as the book value of total assets minus the book value of common stock and deferred income taxes plus the market value of equity. The replacement costs are calculated as the book value of the assets. Firm value is created when Tobin's Q increases as in this scenario firm managers are able to improve the firm's market value relative to its replacement costs. A value of at least one indicates that the market value of assets is larger than its replacement costs which for instance can be explained a positive earnings outlook. A value below one means that the replacement costs exceed the market value of assets. As a firm's replacement costs are more constant and owners have an interest in rising equity value, a higher Tobin's Q is desirable. The median value reported for *TobQ* is 1.33, which is slightly higher than one and indicates that between 2010 and 2021, German firms' market values exceeded their replacement costs by 33%.

3.2.2. Independent variables

The concept of ownership concentration comes in various forms. It can refer to the size or diversification of either the single largest blockholder or the multiple largest ones, the total number of blockholders, or a metric measuring ownership

concentration of multiple shareholders (e. g. by way of the so-called Herfindahl index, or the Gini coefficient). Depending on the definition of ownership and whether firm value or firm risk is studied, outcomes may differ. In this study, ownership concentration is the independent variable used to explain firms' changes in value and risk.

The first two variables measure the official size of shareholders, but this may not represent the true voting power of each shareholder since more complex cross-shareholdings different share classes can be present (Lehman, Weigand 2000). Nevertheless, previous research still successfully used variables that consider the size of shareholders.

To help overcome this problem and further strengthen this research the number of blockholders is used as another measure of ownership concentration. This variable is not directly connected to the size of a shareholder and hence strengthening the basis of this research. In total, three separate variables are used to capture ownership concentration; the number of blockholders, the size of the largest shareholder, and the Herfindahl Index of the ten largest shareholders.

First, the number of blockholders *(#blockh*) is used as a measure for ownership concentration. A blockholder is defined as a shareholder owning at least 5% of the outstanding shares. Since most countries demand public disclosures for shareholders owning at least 5%, this level is commonly used in research (Edmans, Holderness 2017). A firm consisting of only one blockholder and else consisting of shareholders owning less than 5% has a higher ownership concentration than a firm with multiple blockholders. In Table 3 it is reported that in 39% of the years, firms had one blockholder whereas in 53% multiple blockholders were present. Only in 8% of the years did firms have no single shareholder owning a higher share than 5%. This ownership structure is consistent throughout the years as in all years, most firms were having multiple shareholders, followed by one blockholder and lastly none. Thus, most German firms have a high ownership concentration.

Second, the percentage of all shares held by the largest blockholder (*%top1*) is employed to assess ownership concentration. When the largest blockholder owns a significant amount of the total shares and thus owns a high percentage of the firm, ownership concentration is high. As shown in Figure 1 in only 80 firm-years, a

shareholder of a firm owned less than 5% and hence had a diffused ownership structure. In about one quarter of the time, firms had a largest shareholder owning between 5% and 10%. In 50% of the years, the largest shareholder owned between 10% and 50% and in only 18% of the years over 50%. It is important to note, that in general owning more than 50% of a firm gives the majority of voting rights and hence almost fully controls the firm. Moreover, Table 3 reports that throughout the years, there was no large deviation between the average share owned by the largest shareholder.

Figure 1. Histogram of the number of years by percentage held by largest shareholder

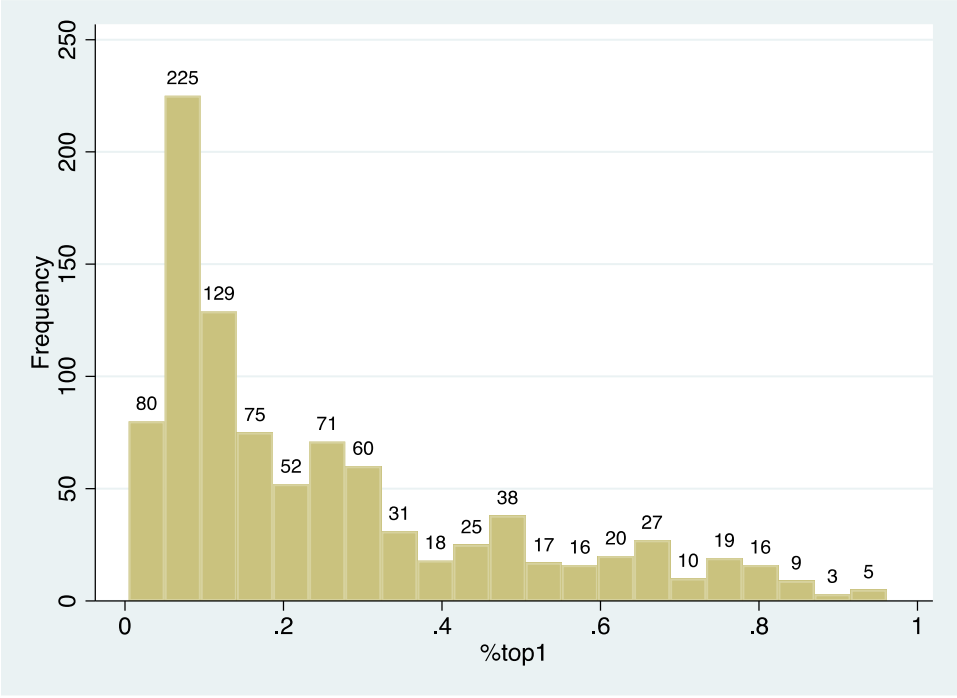


Table 1. Detailed summary for each ownership concentration measure by year

	Number (Percentage) of blockholders				**Mean (Standard Error)**	
Year	One blockholder	Multiple blockholders	Diffused ownership	*Total*	***%top1***	***HerfTop10***
2010	30	29	7	66	0.242	0.116
	(45%)	(45%)	(10%)	(7%)	(0.211)	(0.171)
2011	23	36	7	66	0.241	0.117
	(34%)	(55%)	(10%)	(7%)	(0.217)	(0.175)
2012	25	38	5	68	0.255	0.130
	(37%)	(56%)	(7%)	(7%)	(0.234)	(0.194)
2013	28	40	5	73	0.261	0.130
	(38%)	(55%)	(7%)	(8%)	(0.227)	(0.179)
2014	24	44	8	76	0.235	0.114
	(32%)	(58%)	(11%)	(8%)	(0.218)	(0.17)
2015	33	37	10	80	0.245	0.125
	(40%)	(48%)	(13%)	(8%)	(0.235)	(0.178)
2016	35	38	8	81	0.254	0.127
	(44%)	(46%)	(10%)	(9%)	(0.231)	(0.172)
2017	30	46	8	84	0.246	0.120
	(36%)	(55%)	(10%)	(9%)	(0.221)	(0.164)
2018	27	52	7	86	0.25	0.124
	(31%)	(60%)	(8%)	(9%)	(0.224)	(0.172)
2019	35	47	5	87	0.246	0.122
	(40%)	(54%)	(6%)	(9%)	(0.223)	(0.176)
2020	40	45	3	88	0.253	0.125
	(45%)	(51%)	(3%)	(9%)	(0.222)	(0.175)
2021	35	49	7	91	0.271	0.141
	(40%)	(53%)	(8%)	(10%)	(0.239)	(0.196)
Total	365	501	80	946	0.250	0.124
	(39%)	(53%)	(8%)	(100%)		
Notes: Variables are defined as in Table 1.						

Lastly, ownership concentration is captured by the Herfindahl index (*HerfTop10*). This index is usually used a measure for market concentration. In this case however, the all shares of a firm represent the market and each shareholder functions as a market

participant. It is calculated as the sum of squares of percentages owned by the ten largest shareholders. By construction, it ranges between a value of 1 which would equal a monopoly, or, in this case, one single shareholder, to 0 which would represent a fully diversified ownership structure. A higher value indicates higher ownership concentration and vice versa. As for *%top1*, Table 3 illustrates that the Herfindahl index does not change meaningfully over the sample period. The exact formula for the computation of the Herfindahl index is as follows:

$$HerfTop10 = (\%Top\#1)^2 + (\%Top\#2)^2 + \cdots + (\%Top\#10)^2$$

3.2.3. Control variables

Four control variables are used to improve the accuracy and validity of the statistical analysis. These are firm age, firm size, leverage, and the EUR/USD exchange rate.

Firm age (*Age*) cannot be influenced by ownership concentration. It is expected that older firms are more established and hence are less volatile than younger firms. (Rossetto et al. 2023). Moreover, older firms are experiencing more slack (Sharfman et al. 1988; George 2005) because their routinisation may hinder them from improving present inefficiencies (Le Mens et al. 2015). Additionally, as firm age increases costs tend to rise too (Dixon 1953). This suggests a negative relationship between firm value and age.

Firm size (*Size*), measured as market value of common equity, cannot easily be changed through ownership alterations. As this sample includes the largest listed German firms, it takes a substantial investment to make a significant impact. It is expected that bigger firms are less risky. This is explained by the leverage effect which states that a future stock volatility is inversely correlated to a stock price (Black 1976). It is found that this effect is stronger for smaller firms than for bigger ones (Cheung, Ng 1992). Firm value is expected to have a negative relation with firm size as mature firms have less growth opportunities and operate in more saturated markets (Konijn et al. 2011).

Leverage (*Lev*) is a suitable control variable because to have a significant effect on the debt-to-equity ratio as an (potential) owner is rather difficult since for large

stock-listed firms huge investments need to be made. Firms with higher leverage are more susceptible to financial and default risk and changes in earnings get magnified. Therefore, a positive relationship between leverage and firm risk is expected (Christie 1982). Higher leverage can increase firm value when it serves as a disciplinary role (Safieddine, Titman 1999) but it may decrease firm value because more risk is introduced (Fratini, Tettamanzi 2015). Other researchers found no significant relationship between leverage and firm value (Holderness et al. 1988; Mikkelson, Partch 1989). Hence, the effect of leverage on firm value is inconclusive.

Changes in the EUR/USD (*EURUSD*) exchange rate are determined by complex factors that are outside of the control of firm owners making it a suitable control variable. Depending on the country and specific exchange rate, the exchange rate significantly affects firm value (Dominguez, Tesar 2005). Over the years 2010 to 2021 the German economy constantly reported an export surplus (Statistisches Bundesamt 2023). As a result, on average, German firms benefit when the Euro weakens against the US Dollar because exports become cheaper. Therefore, a negative relationship between firm value and *EUR/USD* is expected.

This exchange rate exposure has significant effects on firm risk too. It was found that, especially during large swings of the German currency and the USD, German share prices became more volatile, and hence firm risk increased significantly (Glaum 2000).

4. Analysis

To analyse the effects of ownership concentration on firm risk and value and test the hypotheses, a pooled ordinary least squared (OLS) regression model was used. This method is chosen under the assumption that the German firms included in the sample have similar regression coefficients. Furthermore, it is assumed that the error terms are not correlated with independent variables and homoscedastic.

To ensure that the data fits the assumption of panel data analysis, the independent variables *TobQ* and *AnnVola* are screened for their unit root. Nonstationary was not a concern given that for *Tobin's Q* $\chi^2 = 294.34$ ($p < 0.01$) and for *Annual Volatility*

$\chi^2 = 336.46$ ($p < 0.01$) indicating that a shift in time does not lead to a change in the shape of the distribution. Next, homoscedasticity and multicollinearity are tested.

Homoscedasticity is tested through the Breusch-Pagan test and the hypothesis of normal error terms is rejected at the 1% confidence level. This result suggests that the assumption of equal variance of the residuals is violated. Multicollinearity is analysed based on a pairwise correlation matrix and VIF values, as depicted in Table 4. The correlation matrix was computed using the within-individual Pearson correlation coefficient between pairs of variables. This is because it is specifically designed for panel data, where multiple observations throughout the years 2010-2021 are nested within one firm. Most correlations are significant at the 1% confidence level, however, with low correlations.

Except for *EURUSD*, all independent variables show a significant correlation with the dependent variables *TobQ* and *AnnVola* indicating that they are suitable explanatory variables.

The highest correlation is found between *HerfTop10* and *%top1* (r = 0.963***) which is logical since the Herfindahl Index of the ten largest shareholders is highly dependent on the largest shareholder, especially when the largest shareholder is owning a large percentage of the firm. Furthermore, both are measuring ownership concentration and hence do not create problems as they are not used in a model simultaneously. Interestingly, the second highest correlation between *Age* and *#blockh* (r = -0.266***) is negative, meaning that older firms tend to have fewer shareholders keeping a significant stake in the firm, and vice versa. Moreover, *Size* and *%top1* (r = -0.266***) are negatively correlated, indicating that in larger firms it is less likely to find a shareholder owning a great proportion of shares.

Even though the correlation coefficients are generally low between the variables, the first column in Table 4 adds information as it presents the variance inflation factors (VIF) defined as $1/(1 - R^2)$ that are associated with the regression models. All VIF values are close to one, indicating no problem of multicollinearity.

With respect to the squared independent variables capturing ownership concentration, the VIF values were obtained using the sequential sum of squares method to capture the VIF separately for each variable. Also, for these variables, the VIF values are close to one and hence do not indicate multicollinearity.

Next to homoskedasticity and multicollinearity, there are concerns regarding autocorrelation because observations for a firm in a past year are likely correlated with the current year. Additionally, since the sample contains firms listed in the German stock market, a cross-sectional dependence is likely due the same location and neighbouring effects (Trueman 1994; Welch 2000; Feng, Seasholes 2004).

To address the concerns of heteroscedasticity, autocorrelation, and cross-sectional dependence, Driscoll and Kraay's (1998) nonparametric covariance matrix estimator in combination with a pooled OLS was used. This was achieved through Stata's "xtscc" program that produces standard errors robust to spatial and temporal dependence and that are heteroscedasticity- and autocorrelation-consistent (Hoechle 2007).

Finally, the regression models are presented. There are six regression models in total, where regression models 1–3 test the effect of ownership concentration on firm risk – hypothesis 1. Models 4–6 test the effect of ownership concentration on firm value. They focus on hypothesis 2c to ensure comprehensibility and prevent using excessive regression models. The linear hypotheses 2a and 2b are discussed after the analysis of models 4–6.

The pooled OLS regression models for firm i and time t are specified as follows:

$$AnnVola_{it} = \beta_0 + \beta_1 \times \#blockh_{it} + Controls_{it} + \varepsilon_{it} \quad (1)$$

$$AnnVola_{it} = \beta_0 + \beta_1 \times \%top1_{it} + Controls_{it} + \varepsilon_{it} \quad (2)$$

$$AnnVola_{it} = \beta_0 + \beta_1 \times HerfTop10_{it} + Controls_{it} + \varepsilon_{it} \quad (3)$$

$$TobQ_{it} = \beta_0 + \beta_1 \times \#blockh_{it} + \beta_2 \times \#blockh\_sq_{it} + Controls_{it} + \varepsilon_{it} \quad (4)$$

$$TobQ_{it} = \beta_0 + \beta_1 \times \%top1_{it} + \beta_2 \times \%top1\_sq_{it} + Controls_{it} + \varepsilon_{it} \quad (5)$$

$$TobQ_{it} = \beta_0 + \beta_1 \times HerfTop10_{it} + \beta_2 \times HerfTop10\_sq_{it} + Controls_{it} + \varepsilon_{it}, \quad (6)$$

where *#blockh_sq*, *%top1_sq*, and *HerfTop10_sq* are the squared explanatory variables and Controls are $\beta_2 \times Age_{it} + \beta_3 \times Size_{it} + \beta_4 \times Lev_{it} + \beta_5 \times EURUSD_{it}$. Definitions of all variables are stated in Table 1

Table 4. Pairwise correlation between all variables, 2010–2021

		VIF	*[1]*	*[2]*	*[3]*	*[4]*	*[5]*	*[6]*	*[7]*	*[8]*
TobQ	*[1]*		1							
AnnVola	*[2]*		0.036	1						
#blockh	*[3]*	*1.04*	0.149***	0.045*	1					
%top1	*[4]*	*1.15*	0.167***	-0.044*	-0.113***	1				
HerfTop10	*[5]*	*1.12*	0.127***	-0.072**	-0.142***	0.963***	1			
Age	*[6]*	*1.11*	-0.115***	-0.136***	-0.226***	-0.148***	-0.098***	1		
Size	*[7]*	*1.12*	-0.064*	-0.195***	-0.081**	-0.226***	-0.182***	0.221***	1	
Lev	*[8]*	*1.08*	-0.086***	0.096***	0.079**	-0.181***	-0.189***	-0.041	0.075**	1
EURUSD	*[9]*	*1.01*	0.127***	0.010	-0.004	0.008	0.011	0.025	0.090***	0.065**

Notes: Variables are defined as in Table 1. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. VIF values for blockh_sq, %top1_sq, and HerfTop10_sq, are 1.175, 1.080, and 1.126, respectively.

5. Empirical results

5.1. Regression results firm risk

Table 5. Effect of ownership concentration on firm risk Table 5 shows the results of the pooled OLS regressions for the effect of ownership concentration on firm risk (see equations 1–3). In all three regressions, firm risk is the dependent variable. In the first regression, the measure of ownership concentration is *#blockh*. In the second specification, it is *%top1*, and in the third *HerfTop10*. Furthermore, they are in line with previous studies, as in all three specifications, a higher value of each ownership concentration measure is associated with a lower degree of firm risk.

An increase of one *#blockh* has relatively small economic relevance as it is associated with a relatively low decrease of 0.562** ($p < 0.05$) (*AnnVola*). The economic impact of *%top1* and *HerfTop10* on volatility is more important because their coefficients are much larger. For instance, when the largest owner increases the percentage of shares owned by 1%, annual volatility is associated with a decrease of 4.177% ($p < 0.01$). Similarly, a 1% increase in (*HerfTop10*) is associated with a 6.582 ($p < 0.01$) decrease in (*AnnVola*).

The control variables *Age*, *Size*, and *Lev* exhibit consistent signs and are significant at the 1%, 1%, and 10% level, respectively. Moreover, the signs of their coefficients are consistent with those hypothesized in previous literature and hence served as eligible control variables in the model. However, the control variable *EURUSD* was not significant at the 10% level in any of the three models. Glaum et al. (2000) explored the exposure of German corporations to the USD and found a significant impact but they also stated that their results are unstable over time. In particular, they reported that especially when the currency pair was volatile, results were significant. During their sample period, the currency pair moved between 3.6 and 1.75 with large spikes and falls (CEIC 2023). This was not the case for the EUR/USD between the years 2010 to 2021, where the pair merely ranged between 1.45 and 1.05 (ECB 2023) explaining why the *EURUSD* coefficients are insignificant.

With all three models reporting F statistics significant at the 1% level, they are relevant overall. Altogether, the results lend statistical support for hypothesis 1 – ownership concentration and firm risk have a negative relationship.

Table 5. Effect of ownership concentration on firm risk

	(1)	(2)	(3)
#blockh	-0.562**		
	(0.231)		
%top1		-4.177***	
		(1.301)	
HerfTop10			-6.582***
			(1.715)
Age	-0.015***	-0.016***	-0.014***
	(0.004)	(0.005)	(0.004)
Size [a]	-89.500***	-96.7***	-95.500***
	(13.000)	(14.800)	(13.900)
Lev	1.248*	1.031*	0.999*
	(0.572)	(0.644)	(0.630)
EURUSD	5.598	6.059	7.563
	(25.726)	(25.693)	(26.233)
Constant	28.276	28.271	26.574
	(21.479)	(21.545)	(21.940)
Observations	860	860	860
F	16.24***	10.69***	9.41***
R2	0.055	0.0571	0.059

Notes: This table presents results from pooled OLS regressions based on eq. (1-3). Variables are defined as in Table 1. Driscoll and Kraay's (1998) robust standard errors in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. [a] Coefficient and SE given in E-06.

5.2. Regression results firm value

Table 6 shows the results of the pooled OLS regressions for the effect of ownership concentration on firm value (see equations 4–6). In all three regressions, firm value is the dependent variable.

In the first specification, the measure of ownership concentration is *#blockh* and *#blockh_sq*. Both the linear and squared variable are insignificant at the 10% level and even if they were, their economic impact would be very limited. Previous researchers who investigated the relationship between the number of blockholders and firm risk have not only focused on the role of the largest blockholder, as explored in model 5, but differentiated between the largest blockholder, mid-sized blockholders and created subsamples with no, one and more than one blockholders to find significant empirical evidence (e.g., Rossetto et al. 2023). The use of such subsamples may help in establishing significant results, but is beyond the scope of this article and thus not explored.

In the second specification, the measures of ownership concentration are *%top1* and *%top1_sq*, and in the third *HerfTop10* and *HerfTop10_sq*. The results for both specifications are significant and support the assumption of a non-linear relationship between firm value and ownership concentration.

Based on model 5, the coefficient for *%top1* (3.496**) indicates a positive linear relationship between *%top1* and *TobQ*. However, the coefficient for *%top1_sq* (-3.512*) indicates that as *%top1* increases, the effect on *TobQ* becomes negative at an increasing rate. Therefore, a turning point exists where the relationship between *%top1* and *TobQ* changes from positive to negative.

The same kind of relationship is also found for *HerfTop10.* The coefficient for *HerfTop10* (4.891***) is positive, and for *HerfTop10_sq* (-6.888***) negative. This suggests that at lower levels of *HerfTop10* a positive relationship with *TobQ* exists, which at some turning point becomes negative.

For both measures of ownership concentration (*%top1* and *HerfTop10*) the relationship with firm value is not a simple linear one. Rather, it is an inverted U-shape relationship where an increase in ownership concentration initially leads to an increase in firm value, but beyond a certain threshold, further increases in ownership concentration have a negative impact on firm value.

The control variable *Age* reports a negative coefficient significant at the 1% level in all models. This is in line with previous research which expects a negative relationship between firm age and value.

Table 6. Effect of ownership concentration on firm value

	(4)	(5)	(6)
#blockholders	0.140		
	(0.086)		
#blockholders_sq	-0.004		
	(0.016)		
% top #1		3.496**	
		(1.316)	
% top #1_sq		-3.512*	
		(1.757)	
Herfindahl Top10			4.891***
			(0.840)
Herfindahl Top10_sq			-6.888***
			(1.615)
Age	-0.004***	-0.003***	-0.003***
	(0.001)	(0.001)	(0.001)
Size [a]	-1.820**	0.750	0.645
	(0.661)	(1.120)	(0.890)
Lev	-0.209***	-0.178***	-0.165***
	(0.038)	(0.036)	(0.034)
EURUSD	2.599***	2.502***	2.340**
	(0.801)	(0.779)	(0.806)
Constant	-0.091	-0.353	-0.089
	(0.666)	(0.663)	(0.612)
Observations	888	888	888
F	79.02***	316.02***	230.55***
R2	0.066	0.084	0.095

Notes: This table presents results from pooled OLS regressions based on eq. (4–6). Variables are defined as in Table 1. Driscoll and Kraay's (1998) robust standard errors in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. [a] Coefficient and SE given in E-12.

Size does not report consistent coefficients among the three models and only in model 4 is *Size*'s coefficient significant ($p < 0.01$). One reason for this could be that because *Size* is measured in terms of market value of common equity which is also found in the nominator of *TobQ*, the results are exposed to mechanical correlation. Moreover, the true relation between firm size and value may be curvilinear, suggesting a quadratic functional form (Dang et al. 2018).

Lev is consistently associated with a negative effect on *TobQ* as in models 4–6, all coefficients are negative and significant at the 1% level. These results support research conducted by Fratini and Tettamanzi (2015).

Lastly, the effect of *EURUSD* on *TobQ* is significant for models 4-6 at the 1% level. Contrary to what has been expected for German export-oriented firms, the coefficients are all positive. This suggests that an increase of the value of EUR is associated with an increase in firm value. One factor explaining this relationship is that a significant share, i.e., more than one third, of German exports are made to the Euro Area (BMWi 2019). This lowers the exposure of German firms to the EUR/USD pair. Moreover, subsidiaries in foreign countries outside the Euro Area create costs denominated in USD. Therefore, German firms can also profit from a weaker USD.

Overall, all models are statistically significant, reporting high F-statistics ($p < 0.01$) and in particular models 5 and 6 support hypothesis 2c – a non-linear relationship between ownership concentration and firm value.

6. Robustness tests

Table 7 reports the estimates of the inverted U-shape relationship between ownership concentration (*%top1* and *HerfTop10*) and firm value. To test this curvilinear relationship, three steps outlined by Lind and Mehlum (2010) were followed. For the sake of traceability, the steps are outlined for *%top1* only; *HerfTop10* followed the same procedure.

First, the coefficients of the quadratic terms need to be significant and have a negative sign. This condition is satisfied ($\hat{\beta}_2 = -3.512$, $p < 0.05$). Second, the slope of the curve must be sufficiently steep both at the low end (i.e., X_L) and high end (i.e.,

X_H) of the data range. It is important that both slopes are steep enough to exclude the possibility of finding a relationship that is rather represented by an exponential or logarithmic function. The lower end of the data range is *%top1* = 0.005 and the higher end is *%top1* = 0.947. Using the equations $\hat{\beta}_1 + \hat{\beta}_2(X_L)$ and $\hat{\beta}_1 + \hat{\beta}_2(X_H)$, the slopes at X_L and X_H are found to be 3.464 ($p < 0.05$) and -3.155 ($p < 0.1$), respectively. Third, the turning (extremum) point must be within the data range. Using $-\hat{\beta}_1/(2\hat{\beta}_2)$, the extremum point is found at 0.498.

Furthermore, using "utest" in Stata to test the exact test of the presence of an inverse U-shaped relationship, a t-statistic of 1.56 significant at the 10% level could be found. To obtain further insight into the significance of the turning point, a 90% confidence interval was calculated using the Fieller method [0.444, 0.768].

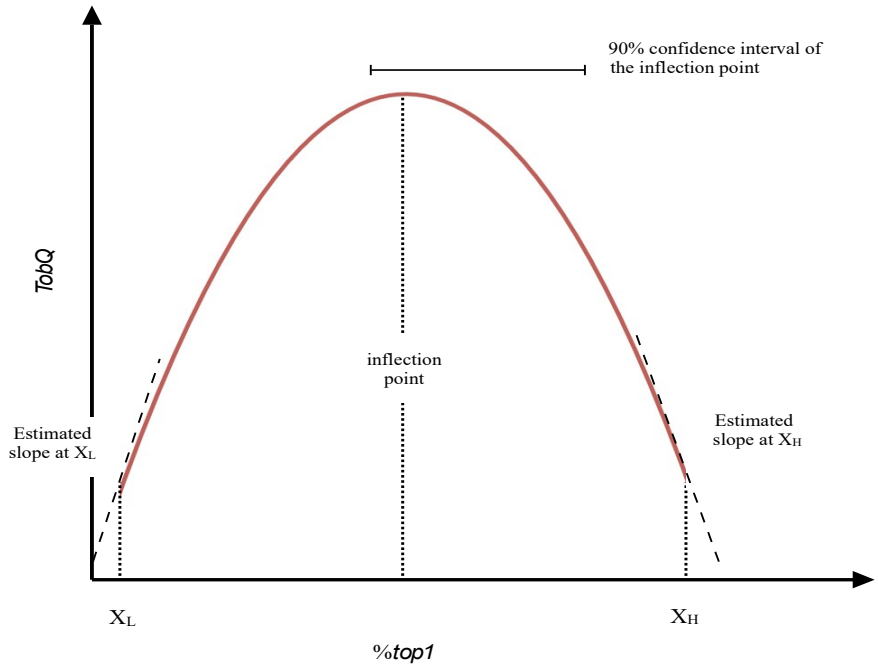
Based on values reported in Table 7, the graphical representations of the inverted U-shape relationship between *%top1* and *TobQ* and *HerfTop10* and *TobQ* are presented in Figure 2 and Figure 3, respectively. Note that in Figure 3, the estimated slope is not included as at the high end of the data range (X_L) for *HerfTop10*, the effect on *TobQ* is negative.

Table 7. Estimates of inverted U-shape relationship: ownership concentration and firm value

	%top1	**HerfTop10**
$\hat{\beta}_1$	3.496**	4.891***
$\hat{\beta}_2$	-3.512*	-6.888***
Slope at X_L	3.464	4.890
	(0.011)	(0.000)
Slope at X_H	-3.155	-7.459
	(0.073)	(0.002)
U test: t-statistic	1.56	3.58
	(0.073)	(0.002)
Extremum point	0.498	0.355
90% confidence interval, Fieller method	[0.444, 0.768]	[0.319, 0.435]

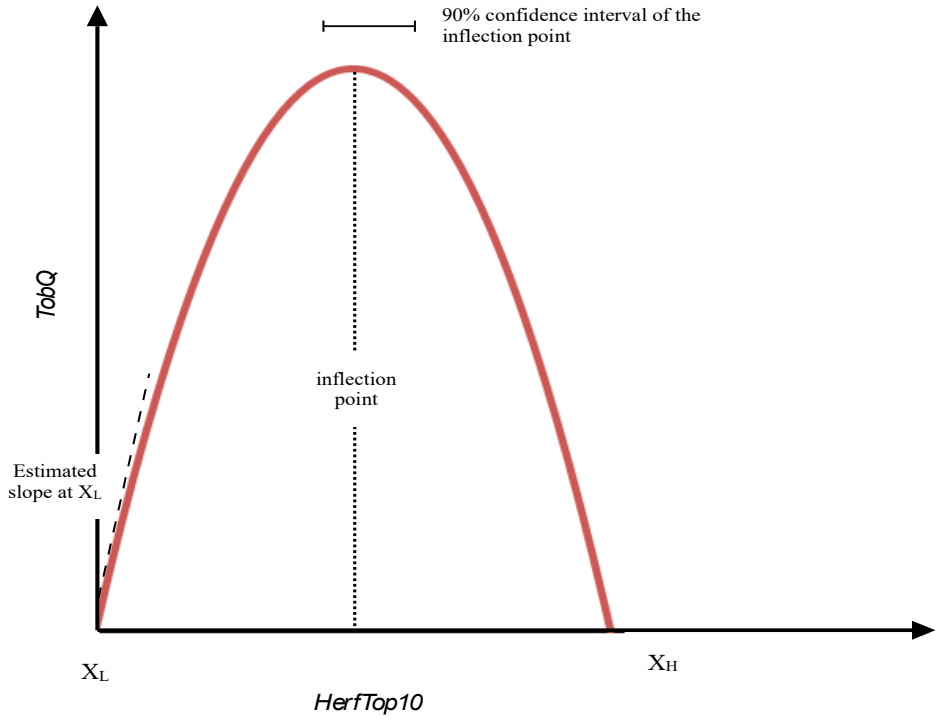
Notes: Variables are defined as in Table 1. P-values stated in parentheses. For *%top1* X_L = 0.005 and
X_H = 0.947. For *HerfTop10* X_L = 0.000 and X_H = 0.896. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Figure 2. Inverted U-shape relationship between *%top1* and *TobQ*



To confirm that the observed relationship is indeed quadratic, a cubic term (*%top1_cub* and *HerfTop10_cub*) was added to both regression models 5 and 6. Thereby, an S-shaped curve can be ruled out. Testing the regression with cubic terms, it was found that the coefficients for both *%top1* and *HerfTop10* turned insignificant at the 10% level and thus there is no support for an S-shaped relationship.

Figure 3. Inverted U-shape relationship between *HerfTop10* and *TobQ*



7. Discussion

The regression models that analysed the relationship between three different measures of ownership concentration and firm risk have confirmed both previous research and hypothesis 1. It has been found that in the German market, an increase in ownership concentration is negatively associated with firm risk. This is because a firm with higher ownership concentration is characterised by shareholders with larger stakes, who are more risk-averse. These large shareholders are more inclined to engage in monitoring and influence the agents' decision making, which is why agents choose less risky projects and investments. If they cannot successfully monitor, they can still influence managers' decisions through the threat of exit. It is important that these dynamics behind the effect of ownership concentration on firm risk have been established, as they similarly manifest in the creation of firm value.

In Germany ownership concentration is found to have a concave relationship with firm value; i.e., ownership concentration has a positive effect on firm value up to a certain point. Any rise in ownership concentration beyond that point has detrimental effects on firm value. Therefore, hypothesis 2c is supported. Combining the factors governing the effect of ownership concentration on firm risk with firm value can help explain the concave relationship established by the author.

As ownership concentration increases, on average, shareholders become more risk-averse and monitoring activity increases. This helps overcome the free-rider problem and agency costs can be reduced. This process has a positive effect on firm value. However, there is a turning point. At that turning point, a rise in ownership concentration decreases firm value. The reason is that from that point onwards, the marginal reduction in agency costs is lower than the marginal increase in foregone profit opportunities. Surpassing the turning point implies that principals become too risk-averse and their grip around agents becomes too tight. Consequently, agents are forced to take on projects and investments that are very low in risk but also low in return. When these agents are faced with highly promising, yet risky business opportunities, they cannot take them and potential positive net present value investments are foregone.

Next to monitoring as a means for large shareholders to control the decision process in a firm, they can make use of their threat of exit as a substitute, when monitoring is not possible. Because the threat of exit becomes stronger as ownership concentration rises, and hence the control of large shareholders becomes stronger, the threat of exit underlies the same process as the monitoring.

A study conducted by Hedge and Mishra (2017) exemplifies this risk-based approach to the creation of firm value. They found that mergers create value when risk-takers acquire risk-avoiding target firms. Such a risk-avoiding firm may be characterised by a high ownership concentration. When risk-takers acquire that firm, previous large shareholders lose their control on agents and new shareholders encourage them to take on profitable, but risky projects and thereby increasing firm value.

Burkart et al. (1997) introduced an additional topic that enhances the explanatory power of the concave relationship. They argue that a trade-off must be made between

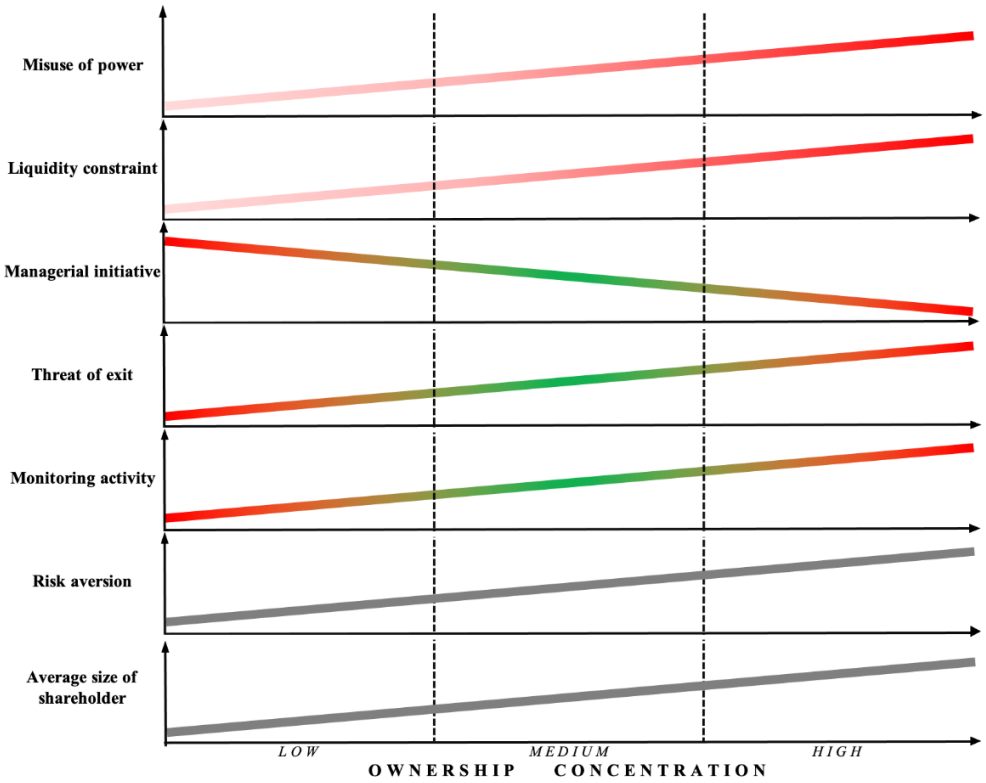
gains from monitoring and managerial initiative. In a firm where ownership concentration is low, shareholders do not engage in monitoring, managerial initiative tends to be higher. However, because interests between agents and principals are not aligned, and agents seek to maximise their private benefit, agency costs arise. When ownership concentration is high, shareholders extensively monitor agents, and a significantly lower initiative by the firm's management is expected. In both scenarios, high monitoring and low managerial initiative or low monitoring and high managerial initiative, firm value is not maximised.

Hence, as ownership concentration influences the risk-taking behaviour of shareholders which in turn affects the creation of firm value, it is important to take a risk-based approach when analysing the relationship between ownership concentration and firm value.

Apart from these risk dynamics, there are two factors that lead to the negative relationship between ownership concentration and firm value, but which become less prominent when a concave relationship between ownership concentration and firm value is present, instead of a linear one. One factor is that a higher ownership concentration is associated with the mis-use of power by large shareholders through the expropriation of smaller ones. The other factor is that stock liquidity is hampered when ownership concentration is high and few shareholders own large stakes the shares. Thereby, it becomes more difficult for market participants to produce information in the stock market and punish firm's management. Both factors negatively affect firm value especially when ownership concentration is high. However, these negative effects are less prominent when an inverted U-shape relationship is present, it predicts that more value is created when a firm has a medium degree of ownership concentration.

In sum, it follows that a medium ownership concentration is optimal for the creation of firm value (see Figure 4). This is because a medium ownership concentration balances the risk-taking behaviour of shareholders, finds a balanced trade-off between monitoring and managerial initiative, and weakens negative effects on firm value that arise when ownership concentration is high.

Figure 4. Summary of the factors behind the inverted U-shape relationship between ownership concentration and firm value



Notes: The slope of each factor should be interpreted as suggestive. The colour gradients represent the
effect of each factor on firm value (red = decrease in firm value; green = increase in firm value; darker
colour = stronger effect). Average size of shareholder and risk aversion have no effect on firm value
per se, but its implications do (grey = no effect).

8. Conclusion

In this paper, the effect of ownership concentration on firm risk and value has been examined. A higher degree of ownership concentration was hypothesised to be associated with a lower degree in risk, as larger shareholders are more risk-averse and influence agents' decision making through monitoring and threats of exit.

Furthermore, the literature on the relationship between ownership concentration and firm value has been inconclusive. Some studies suggest a positive linear relationship while others suggest a negative linear relationships or non-linear relationship. Therefore, three hypotheses were formulated to test which relationship best describes the data. Additionally, previous literature examined Anglo-Saxon countries with a market-based structure. Even though the German market was characterised by a network-like structure about 20 years ago, it has since developed into a more market-based structure due to the global convergence of government systems. Therefore, it is assumed that findings in the Anglo-Saxon market are applicable to the German market as well.

The hypotheses were empirically examined using data for the years 2010-2021 from 91 German firms listed in the DAX or MDAX. The analysis was conducted through a pooled OLS regression with ownership concentration measured in three different ways; the number of blockholders, the percentage owned by the largest shareholder, and the Herfindahl Index based on the ten largest shareholders. The results report a significant negative relationship between ownership concentration and firm risk. Additionally, a significant inverted U-shaped relationship was observed between ownership concentration and firm value. A medium ownership concentration is optimal as it balances the monitoring activity or threat of exit imposed by shareholders while it also weakens negative effects of high ownership concentration on firm value. Therefore, the hypothesis that the higher the ownership concentration, the lower firm risk and that the relationship between ownership concentration and firm risk is non-linear are supported. The results are robust to spatial and temporal dependence and are heteroscedasticity and autocorrelation-consistent. The analysis assumes that firm characteristics of highly capitalised German firms are similar, which supports the use of a pooled OLS regression instead of a fixed or random effects regression. Moreover, endogeneity concerns may exist as the regression models include a limited number of control variables.

This study contributes to the existing corporate governance literature in multiple ways. First, it presents new evidence on the relationships between ownership concentration, firm value and firm risk in a German market that is characterised by a market-based structure, as found in Anglo-Saxon countries. Second, the effect of

ownership concentration on firm value is analysed in a novel way by incorporating factors that influence the relationship between ownership concentration. This balanced approach explained the mechanisms of the significant U-shape relationship between ownership concentration and firm value.

There are important practical implications for managers, shareholders, and policy makers. Despite situation in which managers are tightly monitored by large shareholders, it is important for them to take on promising, yet risky investment opportunities and projects. Furthermore, shareholders with large stakes in a firm need to monitor to which degree they monitor managers and thereby influence the decision process towards their preferences. Lastly, German policy makers need to understand and carefully examine how the change in ownership structure of the German market affects the behaviour of shareholders and managers. The author hopes that future research on ownership concentration, firm risk and value, while considering changes in the ownership structure in Germany and beyond, will shed further light on these interrelated relationships.

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