Institutional Investor Networks and Firm Performance

by

Ryan Minasian

A thesis submitted to the Management Accounting Research Group
at the Philipps University of Marburg
for the degree of *Master of Science*
in Quantitative Accounting and Finance

Head of Research Group and Examiner: Prof. Dr. Marc Steffen Rapp
Supervisor: Andrew Reek

July 2022

Abstract

Alongside the rapid expansion of the largest institutional investors in recent decades, they are also coming closer to each other by holding more common shares. This paper elaborates the extent of addressed common ownership by measuring the importance and influential power of the investors using network centrality measures. Further, empirical evidence for an association between investor centrality and firm performance is provided that also withstands a set of robustness tests performed. Ultimately, reverse causality concerns are addressed by making use of likely exogenous effects to institutional ownership stemming from stock inclusions to the MSCI ACWI. The findings show that increasing institutional investor centrality may have some causal explanatory power for increasing firm performance.

Contents

List of Figures

List of Tables

1 Introduction

The way individual and institutional investors formed their investment strategies was revolutionized with the *portfolio selection model* published by Harry M. Markowitz in 1952, for which he was awarded the Nobel Memorial Prize in Economic Sciences in 1990. He concluded that while a single stock itself could be quite volatile, the volatility of a portfolio consisting of a variety of different stocks is likely to be substantially lower. As this theory has been increasingly applied in practice over the last decades, institutional investors have ensured that their returns are not solely dependent on the financial success of a single company by holding smaller stakes in multiple businesses. Both index funds and exchange-rated funds have immensely grown in popularity, and due to the simplicity and diversity that these funds provide, they also became an attractive option among individual investors. The logical consequence of this development is that more investors are spreading their assets and thus often hold shares of the same companies which creates indirect horizontal links within these companies based on their common shareholders' minority interests—a phenomenon known as *common ownership*.

According to the yearly joint study on the world's 500 largest asset managers (2021) from the Thinking Ahead Institute and Pensions & Investments, the total discretionary assets under management of all included asset managers in 2020 amounted to 119.5 trillion USD, with the top 20 managers holding 52.6 trillion USD. Over the last decade, the total assets of the top 500 asset managers increased by 85%, while the total assets of the top 20 managers doubled. Along with this enormous growth, the proportion of companies that are simultaneously held by multiple institutional investors is also increasing. In 1990, 17% of S&P500 firms were owned by a blockholder[1] that in the same time held a block of shares in a competitor. This quote increased to 81% by the end of 2015 (Lewellen and Lowry, 2021).

Although institutional investors generally hold minority interests significantly lower than 10% in publicly listed portfolio companies and thus move far below the threshold to control[2] corporate decisions, the extent of influence is usually much higher than the percentage of

[1] A firm's shareholder is generally defined as a blockholder if it holds at least 5% of its shares.

[2] Control is the possibility of exercising decisive influence on an undertaking, as defined by Article 3(2) of the COUNCIL REGULATION (EC) No 139/2004 of 20 January 2004 on the control of concentrations between undertakings (the EC Merger Regulation).

voting rights would initially lead one to assume. Besides of using their voting rights at annual shareholder meetings, which in the case of a low attendance rate increase in influence[3], there are two other methods institutional investors use to affect managerial decision making. Both of these methods are more challenging to quantify. The first of the two is proxy voting and direct engagement with the companies, also known as *voice* (McCahery et al., 2016; Appel et al., 2016). In the proxy voting and shareholder engagement FAQ on their official website, BlackRock, the largest institutional investor since 2009, confirms direct shareholder engagement as a key instrument and that they average 3,000 company engagements annually.[4] The other—more rigorous—method of exerting influence is the threat from actively managed funds to divest shares which, due to the signalling effect to other investors, could cause the share price to fall rapidly (McCahery et al., 2016; Gallagher et al., 2013). In his 2018 annual letter to CEOs[5], BlackRock's founder and CEO Laurence Fink states the following on this topic:

> *"In the $1.7 trillion in active funds we manage, BlackRock can choose to sell the securities of a company if we are doubtful about its strategic direction or long-term growth."*

Growing their portfolios and making use of the above mentioned mechanisms, institutional shareholders find themselves in more influential positions while at the same time they may come closer to each other. This paper aims to first evaluate these network positions—by examining the number of holding ties between institutional investors—in order to estimate the extent of common ownership. With this, we will then question the effect of common ownership on firm performance. The structure of this paper is as follows: Section 2 discusses the related literature and develops the hypothesis. Section 3 provides information on the data used, the methodology of this paper, as well as some descriptive statistics of the variables

[3] In 2015, the attendance at the shareholder meetings of DAX-30-listed companies was less than 55% (Monopolkommission, 2018).

[4] *"Engagement is not a single conversation. We have ongoing dialogue with companies to evaluate their business practices and explain our views over time. Engagement is a key mechanism for providing feedback or signaling concerns to companies about factors that affect long-term financial performance. Where we believe a company's governance or business practices fall short, we ask probing questions, explain our concerns and expectations and then allow time for a measured response."*
BlackRock's Proxy Voting and Shareholder Engagement FAQ
URL: https://www.blackrock.com/corporate/literature/fact-sheet/blk-responsible-investment-faq-global.pdf

[5] Larry Fink's Letter to CEOs
URL: https://www.blackrock.com/corporate/investor-relations/2018-larry-fink-ceo-letter

used. Section 4 presents the empirical findings. Section 5 inspects the robustness of these findings and Section 6 addresses potential endogeneity concerns. Section 7 concludes.

2 Literature Review and Hypotheses Development

The hypothesis—institutional investors positively influence firm performance—is justified by the fact that institutional shareholders use their often large holdings to actively influence corporate decisions, and while these monitoring and control activities involve costs, they pay off if the stock return exceeds the costs (Jensen and Meckling, 1976; Jensen, 1986). Institutional investors are often the largest shareholders in a company and therefore tend to be the most active when it comes to corporate intervention (Cornett et al., 2007; Smith, 1996). Shleifer and Vishny (1986) add that investor size plays an important role, concluding that investors with a greater percentage of ownership are more likely to want to intervene in managerial decisions. Lewellen and Lewellen (2022) estimate that in 2017, the average institutional holder gained 129,000 USD in annual management fees if a held stock increased by 1%.

In 2018, Azar et al. revealed a probable causal link between common ownership and anti-competitive effects in the U.S. domestic airline industry, reflected by rising route level prices. They measured common ownership concentration with the modified Herfindahl-Hirschmann Index (MHHI), more precisely, the version used by Salop and O'Brien (2000). As a natural experiment for instrumental variables estimation, they used BlackRock's aquisition of Barclays Global Investors[6] in 2009. It can be said that with this paper they triggered the Olympic starting gun, as many researchers (re-)entered the discussion about the extent and possible effects of common ownership. Early critique from Dennis et al. (2019), in which they show that the positive correlation between common ownership and ticket prices are caused by the market share component of the ownership measure, was claimed to be inaccurate by Schmalz (2021), where he states that Dennis et al. did not follow the data construction of Azar et al. and thus, that their statements cannot be related to the airline paper. Regarding research on the competitive effects of common ownership, many papers utilize concentration

[6]It is worth noting that at this time, BGI was the institutional investor with the highest amount of assets under management (1.5 trillion USD).

measures such as HHI, MHHI and various other modifications (Azar et al., 2016, 2018; Antón et al., 2018; Vives, 2020; Schmalz, 2018). Despite high concentration often being associated with lower competition, Philippon (2019) suggests that concentration may alternatively be the outcome of a process of intense competition, leading to few efficient firms earning higher profits. He also states that common concentration measures are static measures trying to capture competition, which is a dynamic process. To distinguish whether the measured concentration has a positive or negative effect on competition, one would need to embed dynamic measures, such as rank stability or market share volatility over time.

Prior research examining the effect of institutional ownership on firm performance does not show consistent results regarding the effect direction. Chaganti and Damanpour (1991) and Smith (1996) have found no statistically significant evidence of positive effects of institutional ownership on firm performance. On the other hand, other research shows positive correlation, with some of the studies also indicating a causal relationship. Cornett et al. (2007) confirm a positive relationship between institutional investor involvement—as measured by the percentage of institutional stock ownership—and operating cash flows returns. Michel et al. (2020) found that institutional ownership has a positive effect on a firm's operating performance in its initial years as a public company, while using reconstitutions of the Russel indices as an instrument to mitigate the concerns of endogeneity.[7] Bajo et al. (2020) utilize a model from graph theory and network analysis—*centrality*—and apply it in their research to capture the extent of common ownership. They find that more central institutional shareholders enhance firm value which they measure by Tobin's Q. To address endogeneity concerns, they use the 2003 mutual fund trading scandal—when several fund families were accused of insider trading—as an exogenous shock to the ownership network. The methodology of this paper is inspired by their approach, adding a modified variant of the degree centrality measure—the *relative degree centrality*. Empirical results will be challenged by conducting various robustness checks and further, an instrumental variables estimation model will be designed to confront potential concerns related to reverse causality. Therefore, additions (and deletions) of stocks to the MSCI All Country World Index are used as an exogenous source of variation in institutional ownership.

[7]Russel 1000/2000 indices reconstitutions are also used in Lewellen and Lowry (2021) as an instrumental variable for institutional ownership.

If higher network centrality of institutional investors has no explanatory power for the performance of firms which they have invested in, empirical results should support the null hypothesis:

> H0: *Common ownership, as measured by network centrality, has no positive effect on firm performance, captured by Tobin's Q.*

In the case that higher network centrality of institutional investors is one of the reasons for enhanced firm performance, the null hypothesis should be rejected and the alternative hypothesis should find support instead:

> H1: *Common ownership, as measured by network centrality, has a positive effect on firm performance, captured by Tobin's Q.*

3 Data

All empirical analyses and resulting statements in this paper refer to a sample of EU17 firms with yearly observations in the period of 2006 to 2020. The main dataset used for these analyses consists of merged information from three datasets. The first dataset contains annual lists of subsidiary names for each of the 34 included institutional investors, which are selected by collecting the 20 largest investors for each year, according to the yearly joint study on the world's 500 largest asset managers from Willis Towers Watson's Thinking Ahead Institute and Pensions & Investments. Information on subsidiaries are sourced from SEC form 10-K filings (only available for publicly listed companies in the US), annual reports or SEC form 13(f) filings. A detailed overview of sources used for each subsidiary list is reported in Appendix A.

This information then flows into the second dataset, the institutional holdings data. This data is sourced from SEC form 13(f) filings, which are made available in consolidated form by Thomson Reuters. In this step, the holdings data is limited to only those observations, where the investor names are successfully matched to an entry from the subsidiary lists. Thus, all observations in the holdings data can be attributed to the respective parent company of the investors in the network. Information on the third dataset will be provided in Section 3.2.

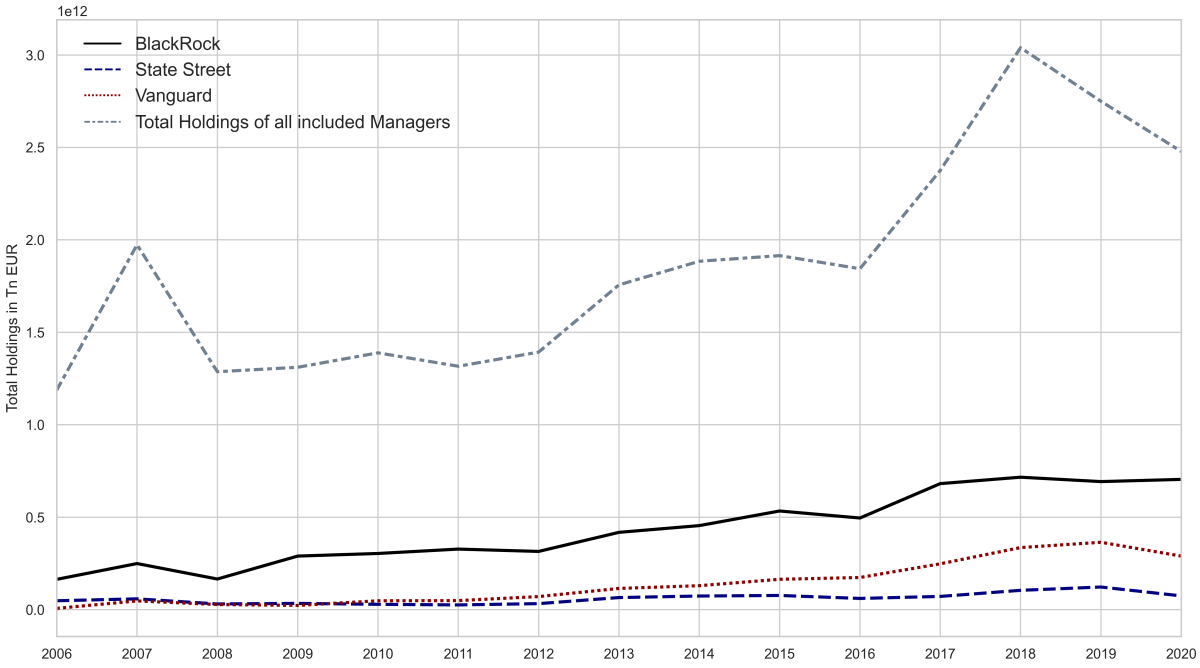

FIGURE 1. 13(F) HOLDINGS OF TOP INSTITUTIONAL INVESTORS

In addition to the general increase in total holdings shown in Figure 1, the relative proportion of total holdings from the "Big Three" (BlackRock, Vanguard and State Street) compared to those of all included managers has grown steadily over time. From 18.4% (BlackRock: 13.8%) in 2006, it increased to 43.1% (BlackRock: 28.4%) by the end of 2020.

In order to assess the reliability of the data used, Figure 2 compares the trend of the 13(f) holdings with the development obtained from Willis Towers Watson's top 500 report. Despite the overall similar tendency—showing a correlation coefficient of 0.84—there are some major differences which clarify why the trends are not congruent. Firstly, this paper's holdings data only contains information on companies in the EU17 area, whereas WTW's top 500 report has a worldwide scope. Secondly, the data used in this research relies on 13(f) filings, which only include "Section 13(f)" securities[8], compared to the top 500 report which takes all holdings into account. Lastly, the SEC only requires investors to submit the form 13(f), if they hold more than 100 million USD in securities, which could cause that some subsidiaries of institutional investors are not considered in the 13(f) holdings data.

[8]Section 13(f) securities are equity securities of a class described in Section 13(d)(1) of the Securities Exchange Act.

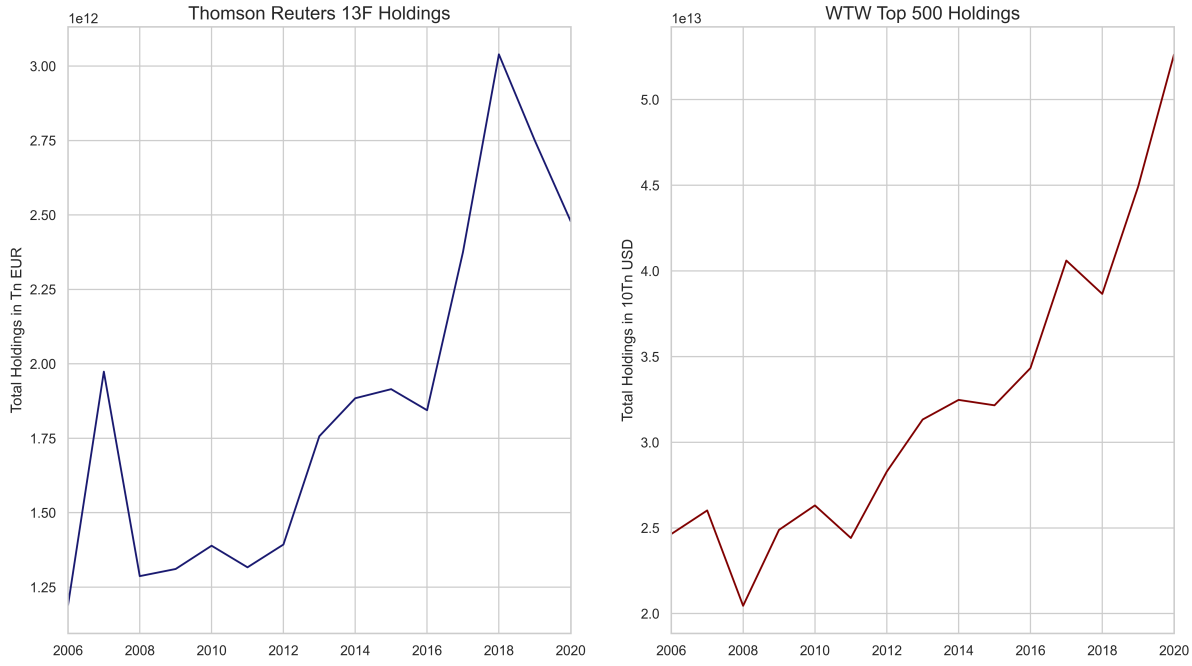

FIGURE 2. TOP 20 COMPARISON OF 13(F) HOLDINGS AND WTW TOP 500 REPORT HOLDINGS

3.1 Network Centrality Measures

In the academic field of network science, centrality measures are used to quantify power in terms of influence, prestige, or popularity of participants in a complex network. The intuitive concept that participants (often referred to as nodes in graph theory) in more central positions can exert greater influence is applied to the research question of this paper, where institutional investors represent nodes in a network.

When considering the institutional holdings dataset as a network, each investment observation is reflected by an institutional investor and a firm, and the tie between them. In this *bipartite* network—meaning that there are two different types of nodes (investors and firms)—the connections are directional but only in one way, as ownership always goes from the investor to the firm. Following the approach of Bajo et al. (2020), this bipartite network is transformed into a new, *one-mode* network, where interconnections are not between institutional investors and firms but only between the investors. These connections are valued in different ways depending on the centrality measure used.

Degree Centrality

As the most basic centrality measure in network science, degree centrality captures the number of connected neighbours of a node. In a one-mode network, it values each tie between two institutional investors utilizing a binary system. Formally expressed, the degree centrality for investor i is:

$$d_i^N = \frac{\sum_{i \neq j}^{N} x_{ij}}{N-1} \tag{1}$$

where N stands for the total number of institutional investors in the network. The binary variable x_{ij} values the connection between the investors and equals 1, if there is at least one firm in which investors i and j both hold a share, and equals 0, if they hold no common share. As the numerator of the equation is dependant on the size of the network, which may change over time, the expression will be normalized by N minus the connection to itself, thus $N-1$.

Due to its simplicity, degree centrality has been used for decades to identify powerful and influential nodes in a network (Saxena and Iyengar, 2020). However, there remains some information which cannot be extracted from this variable. First, the degree centrality only indicates whether there is a connection or not, giving no information on the strength of the connection. Thus, the case where two investors are connected by one common share is set equal to a connection based on holding a share in multiple common firms. Also, the ties are undirected and do not provide information about which of a pair of investors, linked through shares in common firms, is the more dominant.[9]

Relative Degree Centrality

To uncover more information about the extent of an investor's influence, the degree centrality variable is modified with the aim of evaluating each tie between an investor pair more precisely. Therefore, the structure of the formula for the relative degree centrality remains unchanged:

$$rd_i^N = \frac{\sum_{i \neq j}^{N} \hat{x}_{ij}}{N-1} \tag{2}$$

[9]In a simplified illustration, where investor a holds shares in a total of 1,000 firms and investor b holds shares in only one firm—assuming that they are holding shares in one common firm—the degree centrality values the connection for each investor as: $x_{ab} = x_{ba} = 1$.

with the changed parameter $\hat{x}_{ij}$ being defined as:

$$\hat{x}_{ij} := \frac{s_i \cap s_j}{s_j} \tag{3}$$

where s_i is defined as the total number of firms that investor i holds a share in. The connection of investors i and j is valued with the number of firms in which both investors hold an interest in as the numerator of the fraction. The denominator determines the direction of the tie, as when valuing the connectedness of i to j, the number of shared financial holdings is divided by the number of firms held by investor j. With this, the extent of connectedness takes a value between 0 and 1, indicating the strength of the tie. Comparing $\hat{x}_{ij}$ to $\hat{x}_{ji}$ gives information on who of the investor pair is the more dominant.[10]

Network Graphs

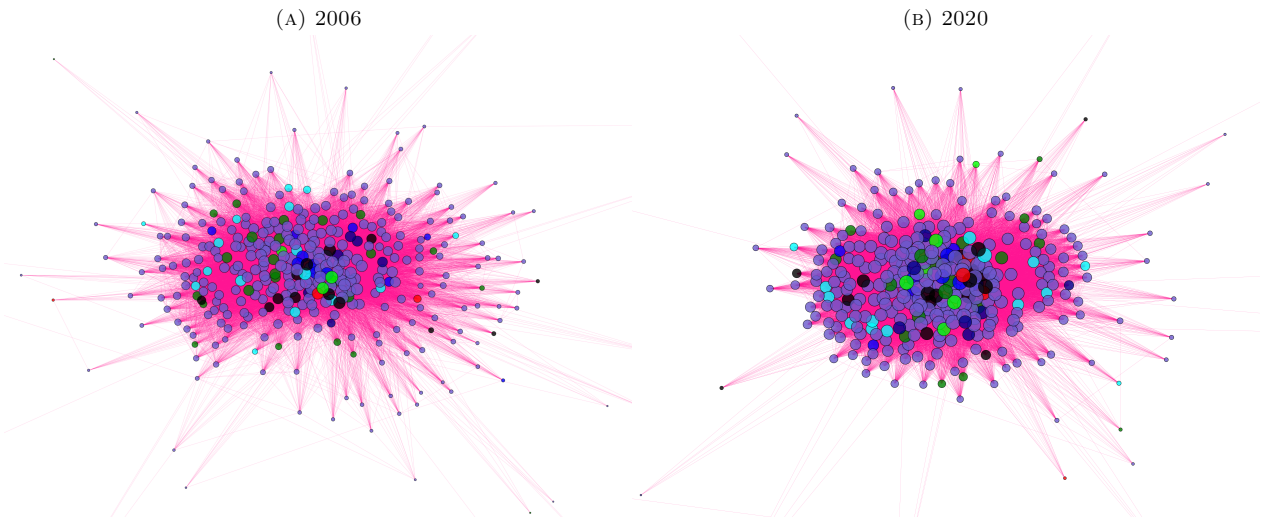

FIGURE 3. INSTITUTIONAL INVESTOR NETWORKS (DEGREE CENTRALITY): 2006 AND 2020

Note: This figure visualizes the network of institutional investors holding a share in the same firm (measured by degree centrality), where each node represents a subsidiary of an investor and the size of the nodes indicating the degree measure. For overview purposes, only the subsidiaries of five institutional investors were colored: BlackRock (black); Vanguard (red); State Street (blue); Capital Group (dark blue); Fidelity Investments (lime).

[10]In a simplified illustration, where investor a holds shares in a total of 1,000 firms and investor b holds shares in only one firm—assuming that they are holding shares in one common firm—the relative degree centrality values the connection for each investor as: $\hat{x}_{ab} = 1 \neq \hat{x}_{ba} = 0.001$.

The graph comparison illustrated in Figure 3 shows an increasing number of nodes and increasing node sizes, which means that the number of institutional investors (more precisely, their subsidiaries) as well as the average centrality values increased over time. Overall, it is noticeable that the network is more dense and that many investors are getting closer to a central position which implies that they have more ties than before.

(A) 2006 (B) 2020

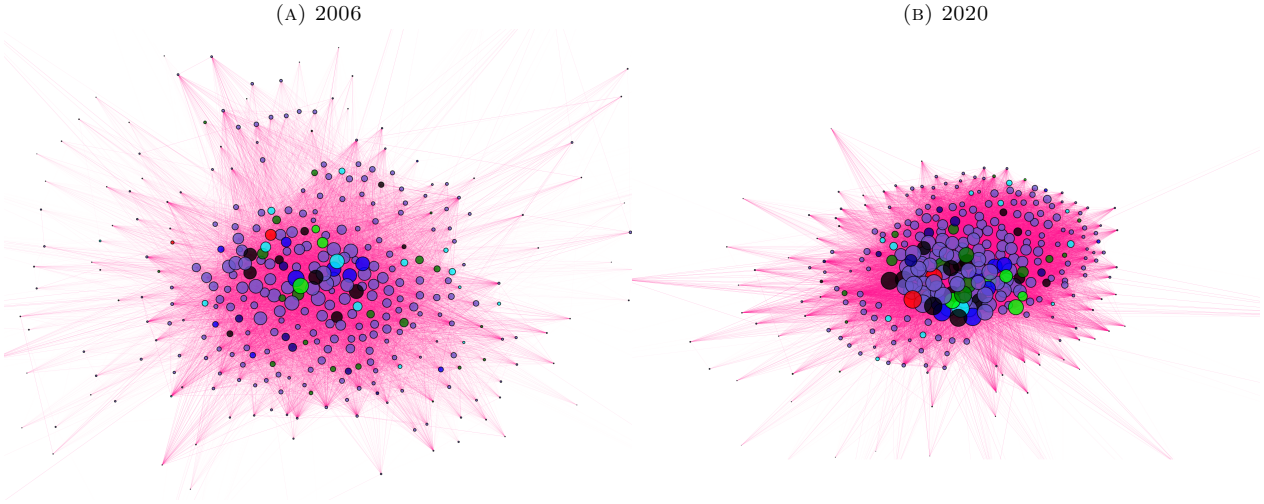

FIGURE 4. INSTITUTIONAL INVESTOR NETWORKS (RELATIVE DEGREE CENTRALITY): 2006 AND 2020

Note: This figure visualizes the network of institutional investors holding shares in the same firm (measured by relative degree centrality), where each node represents a subsidiary of an investor and the size of the nodes indicating the relative degree measure. For overview purposes, only the subsidiaries of five institutional investors were colored: BlackRock (black); Vanguard (red); State Street (blue); Capital Group (dark blue); Fidelity Investments (lime).

An even clearer development of the institutional investor networks becomes visible when using the relative degree centrality as the measure (Figure 4). Compared to the development in Figure 3, the relative degree centrality increased more significantly. This means that not only are more investors connected to each other, but that the connections have significantly increased in strength.

3.2 Descriptive Statistics and Control Variables

Table 1 confirms quantitatively what was visible in the network graphs. While the average degree centrality has increased by 31% from 2006 to 2020, the average relative degree centrality nearly doubled as it increased by 90%. Another indication is given by the devel-

opment of the standard deviations. The standard deviation of the relative degree measure has increased steadily over time (74% from 2006 to 2020) which could mean that, in terms of connectedness, the leading investors have extended their lead over the group average in the period under review.

Table 1. Overview of Institutional Ownership and Network Centrality

Year	*Inst held Firms*	*Inst Inv*	*Degree*	*Degree (Std Dev)*	*Relative Degree*	*Relative Degree (Std Dev)*	*Held by Big Three*	*Held by BlackRock*
2006	3210	410	0.428	0.258	0.112	0.153	1698	1273
2007	4025	433	0.451	0.268	0.133	0.187	2081	1711
2008	3789	440	0.445	0.269	0.131	0.184	2036	1630
2009	3477	438	0.444	0.268	0.132	0.181	1951	1531
2010	3216	462	0.436	0.266	0.126	0.184	1919	1586
2011	3021	449	0.446	0.267	0.133	0.188	1860	1569
2012	2922	446	0.413	0.263	0.123	0.186	1765	1539
2013	2967	439	0.437	0.266	0.133	0.201	1823	1612
2014	2953	421	0.495	0.270	0.148	0.208	1892	1709
2015	2923	413	0.519	0.272	0.159	0.219	1889	1680
2016	2909	426	0.536	0.271	0.169	0.226	1915	1698
2017	2841	429	0.531	0.269	0.172	0.230	1937	1781
2018	3695	433	0.560	0.274	0.178	0.234	2548	2376
2019	3394	427	0.558	0.275	0.184	0.241	2521	2235
2020	2595	373	0.560	0.276	0.213	0.266	1956	1778

Note: This table reports descriptive summary statistics for institutional ownership and network variables in the period 2006-2020 on holdings data level. *Inst held Firms* stands for the total number of unique firms held by an institutional investor. *Inst Inv* stands for the total number of all unique investors. Further, the total number of unique firms held by the *Big Three* (BlackRock/Vanguard/State Street) and *BlackRock* are reported. Mean values and standard deviations of the two main centrality measures used—*degree* and *relative degree*—are also included. It has to be mentioned that there is a quite significant drop in observations in the year 2020 which indicates a possible gap in completeness.

The descriptive statistics reported in Table 2 summarize the third and main data set used for this paper's analyses providing firm level accounting information. Besides Tobin's Q, which proxies firm performance and is to be explained, a number of accounting figures—known to also have explanatory power on firm performance—are included as control variables. Firm size is proxied by the natural logarithm of total assets and may have a negative influence on firm performance as larger firms tend to have fewer growth opportunities. Research and development to total assets as well as capital expenditures to total assets serve as proxies for recent and total investments. Asset intangibility controls for firm opaqueness as less transparent firms are expected to be lower in value. Return on assets proxies firm profitability

and leverage, as proxied by the debt ratio, controls for firm risk. Lastly, sales growth is used as a proxy for growth opportunities.

Table 2. Firm Level Descriptive Statistics

	N	Mean	Std Dev	Min	Max
Panel A—Firm Level Accounting Variables					
Tobin's Q	27,532	1.78	1.36	0.44	15.55
Firm Size	27,532	19.93	2.15	14.57	25.40
R&D	27,532	0.02	0.06	0.00	0.40
Intangibles	27,532	0.24	0.21	0.00	0.82
ROA	27,532	0.01	0.15	-1.13	0.34
Capex	27,532	0.04	0.04	0.00	0.36
Leverage	27,532	0.21	0.17	0.00	0.76
Sales Growth	24,670	0.11	0.48	-0.75	7.27
Panel B—Firm Level Ownership Variables					
Degree	27,532	0.10	0.13	0.00	0.99
Relative Degree	27,532	0.07	0.08	0.00	0.66
BlackRock Holdings	27,532	0.58	0.49	0.00	1.00
Big Three Holdings	27,532	0.66	0.47	0.00	1.00
Eigenvector	27,532	0.01	0.01	0.00	0.09

Note: This table shows descriptive summary statistics of the data set used for panel regression analysis. All variables from Panel A are winsorized at 1% level. More detailed information on the variable constructions are reported in Appendix B.

The three centrality measures are transformed to firm level by identifying the investors of the respective firm and summing their centrality measures, each weighted by the percentage share they hold in the firm.[11]

Further data cleaning is performed aiming to strengthen the validity of the analyses. The sample excludes banks, insurance companies and other financial firms (Standard Industrial Classification codes 6000-6799), public administration firms (9100-9729) as well as regulated utility firms (4900-4942). Also, firm observations with missing or negative values for total assets or net revenues are removed. Data in the period from 2006 to 2020 are used, with data back to 2000 used to proxy replacement costs for intangible capital (Section 5.3).

[11]In a simplified illustration, firm f is held only by investor 1 with 5% and investor 2 with 10% in year t. With the degree value for investor 1 being 0.5 and the degree for investor 2 being 0.2, the firm-level degree for firm f yields: $dc_{t,f} = (0.05 \cdot 0.5) + (0.2 \cdot 0.1) = 0.045$.

4 Baseline Regression Results

Table 3. Tobin's Q on Lagged Network Centrality Measures

	(1)	(2)	(3)	(4)	(5)	(6)
Degree	0.436***		0.536***			
	(0.000)		(0.000)			
Relative Degree		0.784***		0.916***		
		(0.000)		(0.000)		
BlackRock Holdings					0.161***	
					(0.000)	
Big Three Holdings						0.155***
						(0.000)
Firm Size			-0.173***	-0.174***	-0.184***	-0.182***
			(0.000)	(0.000)	(0.000)	(0.000)
R&D			1.175*	1.176*	1.140*	1.155*
			(0.088)	(0.087)	(0.097)	(0.093)
Intangibles			-0.628***	-0.626***	-0.623***	-0.622***
			(0.000)	(0.000)	(0.000)	(0.000)
ROA			0.873***	0.870***	0.859***	0.860***
			(0.000)	(0.000)	(0.000)	(0.000)
Capex			0.507**	0.502**	0.511**	0.514**
			(0.038)	(0.040)	(0.037)	(0.036)
Leverage			-0.320***	-0.317***	-0.296**	-0.302**
			(0.008)	(0.009)	(0.014)	(0.013)
Sales Growth			0.163***	0.162***	0.163***	0.164***
			(0.000)	(0.000)	(0.000)	(0.000)
Constant	1.998***	2.000***	5.478***	5.502***	5.667***	5.600***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	22,464	22,464	22,464	22,464	22,464	22,464
Adjusted R^2	0.067	0.067	0.106	0.107	0.107	0.107
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Note: This table reports unbalanced panel regressions of Tobin's Q on lagged network centrality measures and various firm controls. All variables are winsorized at 1% level, except for network measures. Network measures and firm controls are lagged by one year, except for sales growth. All models include firm and year fixed effects. Standard errors are clustered at firm level and robust to heteroskedasticity. P-values are in parentheses. *** p<0.01; ** p<0.05; * p<0.1.

Table 3 provides baseline results from various panel regression models, with all specifications reported in the notes. Economically justifiable, changes in ownership may take time to have

an impact on a firm's performance, which is why the ownership measures were lagged by one year in all models.

Models 1 and 2 regress Tobin's Q on the two network centrality variables—degree centrality and relative degree centrality. The first model shows a correlation between the degree measure and Tobin's Q with the coefficient being positive and highly statistically significant. Regarding economic significance, the model estimates a 0.1 increase in the degree value to enhance Tobin's Q by 0.0436—yielding to a 3.2% increase in performance for the median firm.[12] Similar results are obtained in the second model, in which the relative degree variable is used to explain investor centrality. Again, the coefficient is positive and highly statistically significant. A 0.1 change in relative degree is estimated to increase the performance for the median firm by 5.79%, which suggests higher economic significance for the relative degree variable.

Models 3 and 4 extend this by controlling for several firm characteristics. The positive correlation is also confirmed in these models with the centrality measures both still being highly statistically significant. Moreover, the economic significance of both measures increases when including control variables, which is consistent with findings of Bajo et al. (2020). The directions of coefficients of all control variables are in line with expectations (Section 3.2) and are consistent with observations conducted in the related literature.

Additionally, models 5 and 6 examine whether BlackRock or any of the "Big Three" as shareholders are associated with the firm's performance. For each holding dummy variable, the models find positive relationships to firm performance with high statistical significance. Although they show lower coefficients than the centrality measures in models 1-4, the economic significance is potentially higher. Model 5 estimates that BlackRock as a shareholder of a firm increases the firm's Tobin's Q by 0.161, which translates into a 11.9% increase in firm performance for the median firm.

Results from further analyses in Appendix C may support the possibility that ownership variation has delayed impact on firm performance. When regressing on contemporaneous centrality measures, the variables lose some statistical significance, but nevertheless show positive coefficients and significance with p-values of 6.9% for degree and 1.6% for relative degree. While still holding high statistical significance, the third and fourth models show

[12]Median firm's Tobin's Q: 1.35.

even higher economical significance for the contemporaneous versions of the dummy variables BlackRock and Big Three, which could mean that the investment decisions made by these three institutional investors send more immediate signalling effects compared to other investors in the network.

5 Robustness

In this section, three robustness tests are employed to further strengthen the validity of the findings. The first test examines the results of the analyses in Section 4 (Table 3) excluding firms from the United Kingdom as these represent the largest fraction of the sample (37.2%). In the second test, an alternative centrality measure—the *eigenvector*—is adopted to assess whether the results hold when using different measures. Finally, the third test re-evaluates the relationship between investor centrality and firm performance utilizing an alternative firm performance measure—the *Total Q*.

5.1 Exclusion of Firms from the United Kingdom

Following Bena et al. (2017), observations from the country with the largest fraction in the sample, which in this paper's sample is the United Kingdom, are excluded for the first robustness check. Table 4 reports that the coefficients of the centrality measures remain highly statistically significant and at the same time show increased economic significance. The directions of the control variables do not change, although the coefficient on the R&D variable is positive but statistically insignificant. The results of this test show that the findings based on the whole sample are robust to the exclusion of UK firms.

Table 4. Sample of non-UK Firms

	(1)	(2)	(3)	(4)	(5)	(6)
Degree	0.596***		0.588***			
	(0.000)		(0.000)			
Relative Degree		1.047***		1.010***		
		(0.000)		(0.000)		
BlackRock Holdings					0.102***	
					(0.004)	
Big Three Holdings						0.0869**
						(0.025)
Firm Size			-0.101**	-0.102**	-0.105**	-0.101**
			(0.024)	(0.022)	(0.020)	(0.025)
R&D			0.504	0.501	0.467	0.504
			(0.562)	(0.563)	(0.592)	(0.563)
Intangibles			-0.653***	-0.650***	-0.654***	-0.657***
			(0.001)	(0.001)	(0.001)	(0.001)
ROA			1.295***	1.292***	1.291***	1.297***
			(0.000)	(0.000)	(0.000)	(0.000)
Capex			0.666**	0.659**	0.656**	0.672**
			(0.043)	(0.045)	(0.048)	(0.043)
Leverage			-0.337**	-0.333*	-0.331*	-0.340**
			(0.048)	(0.050)	(0.053)	(0.047)
Sales Growth			0.218***	0.218***	0.219***	0.220***
			(0.000)	(0.000)	(0.000)	(0.000)
Constant	1.934***	1.937***	4.010***	4.049***	4.081***	3.989***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	14,147	14,147	14,147	14,147	14,147	14,147
Adjusted R^2	0.086	0.087	0.128	0.129	0.127	0.127
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Note: This table reports unbalanced panel regressions of Tobin's Q on lagged network centrality measures and various firm controls, excluding firms from the United Kingdom. All variables are winsorized at 1% level, except for network measures. Network measures and firm controls are lagged by one year, except for sales growth. All models include firm and year fixed effects. Standard errors are clustered at firm level and robust to heteroskedasticity. P-values are in parentheses. *** p<0.01; ** p<0.05; * p<0.1.

5.2 Alternative Centrality Measure—Eigenvector

The eigenvector centrality measure is a modified version of the degree centrality that weighs each connection by its relative importance in the network. Formally expressed, eigenvector

centrality for investor i is:

$$e_i^N = \frac{\lambda \sum_{i \neq j}^{N} x_{ij} e_j}{N-1} \tag{4}$$

where λ is a constant value of the largest eigenvalue of the adjacency matrix and the connection measure x_{ij} is weighted with the importance of investor j, e_j. Hence, fewer connections to highly connected investors contribute more to the eigenvector value than equal connections to less connected investors.

Table 5. Tobin's Q on Lagged Eigenvector Centrality

	(1)	(2)	(3)	(4)	(5)
Degree	0.536***				
	(0.000)				
Relative Degree		0.916***			
		(0.000)			
BlackRock Holdings			0.161***		
			(0.000)		
Big Three Holdings				0.155***	
				(0.000)	
Eigenvector					6.080***
					(0.000)
Constant	5.478***	5.502***	5.667***	5.600***	5.455***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	22,464	22,464	22,464	22,464	22,464
Adjusted R-squared	0.106	0.107	0.107	0.107	0.106
Control Variables	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes

Note: This table reports unbalanced panel regressions of Tobin's Q on lagged network centrality measures including the eigenvector centrality, and various firm controls. All variables are winsorized at 1% level, except for network measures. Network measures and firm controls are lagged by one year, except for sales growth. The coefficients of firm controls are not reported as they all retained their statistical significance and showed only minor changes regarding their economic significance. The full table is reported in Appendix D. All models include firm and year fixed effects. Standard errors are clustered at firm level and robust to heteroskedasticity. P-values are in parentheses. *** p<0.01; ** p<0.05; * p<0.1.

Table 5 contains the baseline results from Table 3 and is extended by the fifth model, which regresses Tobin's Q on the eigenvector centrality variable. Capturing investor centrality with the eigenvector variable does not change the components of the regression results as the coefficients of firm controls; the adjusted R^2 also remains stable. The eigenvector centrality

variable is also statistically significant at 1% level and although it shows a substantially larger coefficient compared to the other centrality measures, the economic significance is likely to be on a similar level, as the mean eigenvector value is ten times smaller than the mean degree value. The findings of this test show that the relationship between investor centrality and firm performance persists when using various centrality measures.

5.3 Alternative Performance Measure—Total Q

Following the approach of Bajo et al. (2020), this paper's third robustness test utilizes an alternative version of the Tobin's Q measure—the *Total Q* as defined by Peters and Taylor (2017). In contrast to the conventional Q measure, this modification takes intangible capital into account in addition to physical capital when normalizing the market value of the company. As the replacement costs of an entity's intangible capital cannot be directly extracted from its financial statements, this paper closely follows the proxy constructed by Peters and Taylor (2017). This measure is built by summing accumulations of R&D and SG&A expenses. Formally, these accumulations are computed as follows:

$$AccR\&D = (1 - \delta_{R\&D}) \cdot AccR\&D_{t-1} + R\&D_t \tag{5}$$

for accumulating R&D expenses and

$$AccSG\&A = (1 - \delta_{SG\&A}) \cdot AccSG\&A_{t-1} + 0.3 \cdot SG\&A_t \tag{6}$$

for the accumulation of SG&A expenses. The depreciation rate $\delta_{R\&D}$ is not industry specific but constant at 10%, as Peters and Taylor (2017) found same results for both approaches. For SG&A expenses, the depreciation rate is set at a constant 20%. Only 30% of SG&A expenses are considered as investments in intangible capital with the remaining 70% seen as operating costs that support current period's profits. Firm level accounting data going back to the year 2000 were used for these estimations with the assumption that the intangible capital stock in the first year started at 0.

Table 6. Total Q on Lagged Network Centrality Measures

	(1)	(2)	(3)	(4)
Degree	1.240			
	(0.112)			
Relative Degree		2.249**		
		(0.048)		
BlackRock Holdings			0.406**	
			(0.035)	
Big Three Holdings				0.318
				(0.177)
Firm Size	-1.137***	-1.139***	-1.161***	-1.145***
	(0.000)	(0.000)	(0.000)	(0.000)
R&D	-10.74**	-10.73**	-10.79**	-10.71**
	(0.035)	(0.035)	(0.034)	(0.035)
Intangibles	0.858	0.862	0.872	0.869
	(0.476)	(0.474)	(0.469)	(0.470)
ROA	4.458***	4.450***	4.438***	4.444***
	(0.000)	(0.000)	(0.000)	(0.000)
Capex	-5.108*	-5.129*	-5.030*	-5.002
	(0.090)	(0.089)	(0.099)	(0.101)
Leverage	-0.171	-0.166	-0.127	-0.148
	(0.793)	(0.799)	(0.845)	(0.820)
Sales Growth	1.266***	1.264***	1.269***	1.273***
	(0.000)	(0.000)	(0.000)	(0.000)
Constant	28.11***	28.15***	28.45***	28.16***
	(0.000)	(0.000)	(0.000)	(0.000)
Observations	13,425	13,425	13,425	13,425
Adjusted R-squared	0.065	0.065	0.065	0.064
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes

Note: This table reports unbalanced panel regressions of Total Q on lagged network centrality measures and various firm controls. All variables are winsorized at 1% level, except for network measures. Network measures and firm controls are lagged by one year, except for sales growth. All models include firm and year fixed effects. Standard errors are clustered at firm level and robust to heteroskedasticity. P-values are in parentheses. *** p<0.01; ** p<0.05; * p<0.1.

Results from Table 6 only partially confirm the baseline results. The degree centrality measure, when regressing Total Q, remains positive but loses its statistical significance. Also, not all coefficients of the included control variables conform to prior results. Some support still might be found with the relative degree centrality measure retaining a positive coefficient

and statistical significance at 5% level. However, further investigation would be necessary to evaluate these findings more accurately, as the inclusion of a proxy for intangible capital substantially separates the Total Q variable from Tobin's Q.

6 Endogeneity Concerns

The baseline results in Section 4 show an association between institutional investor centrality and firm performance that withstands most parts of robustness tests employed in Section 5 and thus increases in reliability. Nonetheless, this cannot be used to draw conclusions about causality as increasing firm performance could be the causal ingredient that attracts investors to invest in these firms—indicating *reverse causality*. To be able to debate this question, this paper implements an instrumental variables (IV) regression model using two-stage least squares (2SLS) estimations.

6.1 MSCI All Country World Index Inclusion as an Instrumental Variable

Selecting a valid instrumental variable for investor centrality that does not directly affect firm performance—hence is exogenous—is the most critical part of this approach. Different methods for instrumenting common ownership are to be found in the related literature. Azar et al. (2018) use changes to ownership structure due to the BlackRock-Barclays merger in 2009. Freeman (2019) and Bajo et al. (2020) use the mutual fund trading scandal in 2003 as an exogenous shock to ownership structure. Variations due to Russel 1000/2000/3000 index reconstitutions are used by Michel et al. (2020) and Lewellen and Lowry (2021) in their research on the U.S. market. By applying the last approach to European firms, this paper follows Bena et al. (2017), conducting a quasi-natural experiment that uses stock inclusions to the MSCI All Country World Index as an instrument for institutional investor centrality, with the assumption that investors are more likely to invest in international firms included in this index. The data containing the MSCI ACWI constitutions for the years under review are obtained directly from MSCI.[13]

[13]The MSCI data contained herein is the property of MSCI Inc. (MSCI). MSCI, its affiliates and its information providers make no warranties with respect to any such data. The MSCI data contained herein

6.2 IV Regression Results (2SLS)

In Table 7, the first stages regress the centrality measures on the binary variable *MSCI*, which takes the value of 1 if the firm is included in the MSCI ACWI index in a given year. In the second stages, the estimated centrality variables from first stage are used to regress Tobin's Q. Models 1-4 use degree as the centrality variable while models 5-8 use relative degree.

Table 7. Instrumental Variables (2SLS) Estimation of Tobin's Q and Network Centrality

	1st Stage Degree (1)	2nd Stage Tobin's Q (2)	1st Stage Degree (3)	2nd Stage Tobin's Q (4)	1st Stage Rel Degree (5)	2nd Stage Tobin's Q (6)	1st Stage Rel Degree (7)	2nd Stage Tobin's Q (8)
Degree*		11.45***		16.51***				
		(0.000)		(0.000)				
Relative Degree*						15.33***		20.86***
						(0.000)		(0.000)
MSCI	0.0339***		0.0262***		0.0253***		0.0208***	
	(0.000)		(0.000)		(0.000)		(0.000)	
Firm Size			0.0215***	-0.545***			0.0137***	-0.477***
			(0.000)	(0.000)			(0.000)	(0.000)
R&D			0.0300	0.654			0.0189	0.755
			(0.492)	(0.366)			(0.491)	(0.256)
Intangibles			-0.000521	-0.612***			-0.00165	-0.586***
			(0.965)	(0.004)			(0.828)	(0.002)
ROA			0.0335***	0.278			0.0232***	0.347*
			(0.001)	(0.225)			(0.000)	(0.074)
Capex			0.104***	-1.186*			0.0608***	-0.740
			(0.000)	(0.065)			(0.001)	(0.132)
Leverage			-0.0290***	0.204			-0.0200***	0.142
			(0.010)	(0.383)			(0.005)	(0.459)
Sales Growth			0.00591***	0.0573			0.00362***	0.0794**
			(0.001)	(0.177)			(0.002)	(0.026)
Observations	26,860	26,860	21,966	21,966	26,860	26,860	21,966	21,966
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F-statistic	56.21	40.40	35.75	16.99	68.36	48.83	37.59	22.98

Note: This table reports two-stage least squares regression analyses of Tobin's Q on degree centrality and relative degree centrality. The centrality measures are instrumented with a binary variable (*MSCI*) that takes the value of 1 if the firm is included in the MSCI All Country World Index in a given year. In the second stages, Degree* and Relative Degree* are estimated values from first stage regressions. All variables are winsorized at 1% level, except for network measures and firm controls are lagged by one year, except for sales growth. All models include firm and year fixed effects. Standard errors are clustered at firm level and robust to heteroskedasticity. P-values are in parentheses. *** p<0.01; ** p<0.05; * p<0.1.

As expected, all first stage regressions report positive correlation between *MSCI* and investor centrality that is highly statistically significant, also when including control variables. The

first model estimates a firm's inclusion to the MSCI index to increase its degree centrality by 0.0339, which is a 62% increase for the median firm. Model 5 even estimates a 72% increase in relative degree for the median firm.[14] The economic significance of *MSCI* decreases slightly when also controlling for the usual firm characteristics. Results of second stage regressions show that the investor centrality measures remain positively correlated with Tobin's Q in all constructed models, again with high statistical significance. The economic significance of both centrality measures is estimated to be significantly higher than the baseline results assumed, and it increases once firm controls are included. When testing the centrality variables for endogeneity, the null hypothesis, which assumes that the explanatory variables can be treated as exogenous, is rejected in all models. The F-statistics of all regression models are well above the value of 10, which is generally a first indicator that the instrument used is not weak. Moreover, all models withstand the weak identification test of Craig-Donald and also reject the null hypothesis in the Kleibergen-Paap underidentification test.

Table 8 expands the IV regression results by adding the eigenvector centrality variable and repeating all models using Total Q instead of Tobin's Q as a proxy for firm performance.

Table 8. Second Stage IV Regressions including Alternative Measures

	Tobin's Q (1)	Tobin's Q (2)	Tobin's Q (3)	Total Q (4)	Total Q (5)	Total Q (6)
Degree*	16.51***			64.48***		
	(0.000)			(0.009)		
Relative Degree*		20.86***			83.91***	
		(0.000)			(0.003)	
Eigenvector*			223.2***			852.8**
			(0.000)			(0.018)
Observations	21,966	21,966	21,966	13,094	13,094	13,094
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
F-statistic	16.99	22.98	14.02	7.530	8.573	6.858

Note: This table reports second stage IV regression results of Tobin's Q (Models 1-3) and Total Q (Models 4-6) on degree centrality, relative degree centrality, and eigenvector centrality. The centrality measures are instrumented with a binary variable (*MSCI*) that takes the value of 1 if the firm is included in the MSCI All Country World Index in a given year. Degree*, Relative Degree* and Eigenvector* are predicted values from first stage regressions. All variables are winsorized at 1% level, except for network measures and firm controls are lagged by one year, except for sales growth. All models include firm and year fixed effects. Standard errors are clustered at firm level and robust to heteroskedasticity. P-values are in parentheses.
*** p<0.01; ** p<0.05; * p<0.1.

[14]Median firm's degree value: 0.0550962; Median firm's relative degree value: 0.0350531.

The eigenvector measure also shows a positive and highly statistically significant relationship with Tobin's Q with the model also holding up against all mentioned postestimation tests. When Total Q is defined as the dependent variable, the coefficients of the centrality measures remain positive and highly statistically significant. Although the postestimation tests are passed in these models, the reported F-statistics fall below the commonly known threshold of 10 which could indicate the presence of weak instrumentation.

Ultimately, the results from the IV regression models support the theory that institutional investor centrality could have a positive causal effect on firm performance. Caution is required, however, as the results of these analyses are highly dependent on the appropriateness of the chosen instrument.

7 Conclusion

Institutional investors have steadily expanded their assets under management at a high pace over recent decades, which is likely to have further increased their influence on the economy. Based on EU17 firm-level data for the period 2006-2020, this paper aims to empirically elaborate possible effects of investor centrality on firm performance. Using various centrality metrics from graph and network analysis theory, it is first shown that as institutional investors have grown, the interconnectedness among them has also increased, as reflected by more and also stronger ties through holding minority interests in the same firms.

The baseline results of this paper confirm a highly statistically significant association between institutional investor centrality and firm performance. Moreover, substantial economic significance is found in all models constructed. These results also hold up to a series of robustness tests using alternative centrality measures and performing regressions with a subsample. Although finding some support when using the Total Q as an alternative proxy for firm performance, it should be emphasized that the estimation of firm performance in this study has been kept simple which leaves potential for future research with more sophisticated estimators.

This paper also provides empirical evidence that could support the alternative hypothesis that a higher network centrality of investors has positive causal effects on firm performance by implementing IV regression models. Specifically, likely exogenous increases in investor

centrality that follow the inclusion of stocks to the MSCI All Country World Index are used to explain increases in firm performance. However, it must be mentioned that since it is not unlikely that the inclusion of stocks in the MSCI ACWI also has a direct impact on firm performance, the instrument is presumably imperfect and the results should therefore be interpreted with caution.

Appendix A—Subsidiary Data Sources

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
AIG	EX21	EX21	EX21	EX21	EX21	EX21	EX21	13F	13F	EX21	13F	13F	AR	EX21	EX21
Allianz	13F	AR	13F	13F	13F	AR, 13F	13F	AR, 13F	13F	AR, 13F	13F	AR, 13F	13F	AR, 13F	13F
Aviva	13F	13F	13F	13F	13F	13F	13F	13F	13F	13F	13F	13F	13F	13F	13F
Axa S.A.	AR	AR	AR	AR	AR	AR	13F	AR, 13F	13F	AR, 13F	13F	13F	AR, 13F	13F, OTH	13F
Bank of America	EX21	EX21	EX21	EX21	EX21	EX21	EX21	13F	13F	EX21	13F	EX21	13F	EX21	EX21
Bank of New York Mellon	EX21	AR	EX21, 13F	EX21	EX21, 13F	EX21	EX21	EX21	EX21	EX21	EX21	EX21	EX21	EX21	EX21
Barclays	AR	EX21	EX21	AR	13F	EX21	13F	13F	13F	13F	13F	13F	13F	AR	13F
BlackRock	EX21, 13F	EX21	EX21, 13F	EX21	EX21, 13F	EX21	EX21	EX21	EX21	EX21	EX21	EX21	EX21	EX21	EX21
BNP Paribas	13F	AR	13F	AR	13F	13F	13F	13F	AR, 13F	13F	AR	13F	AR	AR	13F
Capital Group	13F	13F	13F	13F	13F	13F	13F	13F	13F	13F	13F	13F	13F	13F	13F
Credit Agricole/Amundi	13F	AR, 13F	13F	AR, 13F	AR, 13F	13F	13F	13F	13F	13F	13F	13F	13F	13F	13F
Credit Suisse	AR, 13F	13F	13F	13F	13F	13F	13F	13F	13F	13F	13F	13F	13F	13F	13F
Deutsche Bank	AR	AR	AR	AR	AR	AR	AR	AR	13F	AR	13F	AR	AR	AR	13F
Fidelity Investments 13F	13F	13F	13F	13F	13F	13F	13F	13F	13F	13F	13F	13F	13F	13F	13F
Franklin Templeton	EX21, 13F	EX21, 13F	EX21, 13F	EX21, 13F	AR	EX21	AR	AR	EX21	EX21	EX21	EX21	EX21	EX21	EX21
Goldman Sachs	EX21, 13F	EX21, AR, 13F	EX21, 13F	EX21, 13F	AR	EX21	EX21	EX21	EX21	EX21	EX21	EX21	EX21	EX21	EX21
HSBC	13F	AR	13F	13F	13F	AR	13F	AR	13F	AR	13F	13F	13F	AR, OTH	13F
ING Group	AR	AR	13F	13F	13F	AR	13F	13F	13F	AR	13F	AR	13F	AR	AR
Invesco	13F	EX21, 13F	EX21, 13F	EX21, 13F	EX21, 13F	EX21, 13F	EX21, 13F	13F	13F	13F	13F	13F	13F	EX21	EX21
JP Morgan Chase	EX21, 13F	EX21	EX21, 13F	EX21	EX21, 13F	AR	EX21, 13F	EX21	EX21	AR	EX21	EX21	EX21	EX21	EX21
Legal and General Group	13F	13F	13F	AR, 13F	13F	13F	13F	13F	13F, OTH	13F	13F	13F	13F	AR	13F
Legg Mason	EX21, 13F	EX21, 13F	EX21, 13F	AR, 13F	EX21	EX21	EX21	EX21	EX21	EX21	EX21	EX21	EX21	EX21	EX21
Morgan Stanley	EX21	EX21	EX21	EX21	EX21	EX21	13F	EX21	EX21	EX21	EX21	EX21	EX21, 13F	EX21	EX21
Natixis Investment Managers	13F	13F	13F	13F	13F	13F	13F	13F	AR	13F	13F	AR	13F	AR	13F
Nippon Life Insurance	13F	13F	13F	13F	13F	AR	13F	13F	AR	13F	13F	AR	13F	AR	AR
Northern Trust	EX21	EX21	EX21	EX21	EX21	EX21	EX21	EX21	EX21	EX21	EX21	EX21	EX21	EX21	EX21
Nuveen	EX21, 13F	13F	13F	13F	13F	13F	13F	13F	13F	13F	13F	13F	13F	13F	13F
Prudential	EX21	EX21	EX21	AR	EX21	EX21	EX21	EX21	EX21	EX21	EX21	EX21	EX21	EX21	EX21
State Street	EX21, 13F	EX21, AR, 13F	EX21, 13F	EX21, 13F	EX21, 13F	EX21	EX21, 13F	AR	EX21	EX21	EX21	EX21	AR	EX21	EX21
T Rowe Price	EX21	EX21	EX21	EX21	EX21	EX21	EX21	EX21	EX21	EX21	EX21	EX21	AR	EX21	EX21
UBS	13F	AR	13F	13F	13F	13F	13F	AR, 13F	AR	AR, 13F	AR, 13F	AR, 13F	AR	AR	AR, 13F
Vanguard	13F	13F	13F	13F	13F	13F	13F	13F	13F	13F	13F	13F	13F	13F	13F
Wellington Management	13F	13F	13F	13F	13F	13F	13F	13F	13F	13F	13F	13F	13F	13F, OTH	13F
Wells Fargo	EX21, 13F	EX21	EX21, 13F	EX21	EX21, 13F	EX21	EX21, 13F	EX21	EX21	EX21	EX21	EX21	EX21	EX21	EX21

Note:
Amundi was founded in 2010 by Credit Agricole and has since taken control of the asset management business, which is why the two companies are considered as one in this paper's analyses. In 2007, Bank of New York and Mellon Financial Corporation have merged to Bank of New York Mellon. The 2006 observations belong to the Mellon Financial Corporation, but were not considered separately in this paper's analyses.

13F: SEC 13(f) filing—284 reports collected
AR: Annual Report—88 reports collected
EX21: SEC Exhibit 21 of 10k-filing—200 reports collected
OTH: Other source (usually information from the investors' official websites)—4 reports collected

Appendix B—Variables Definitions

Variable	Definition
Panel A—Firm Level Accounting Variables	
Capex	Capital expenditures normalized by total assets.
Firm Size	Natural logarithm of total assets.
Intangibles	Intangible assets normalized by total assets.
Leverage	Total debts to total assets.
MSCI	Binary variable that takes the value of 1 if the firm is included in the MSCI All Country World Index.
R&D	Research and development expenses normalized by total assets.
ROA	Net income to total assets.
Sales Growth	Annual sales growth, formally: $SG = (S_t - S_{t-1})/S_{t-1}$.
Tobin's Q	Firm performance measure, formally: $Q^{tob} = (Market\ Cap + Total\ Liabilities)/Total\ Assets$.
Total Q	Alternative firm performance measure, formally: $Q^{tot} = (Market\ Cap + Total\ Debt - Current\ Assets)/(PPE + Replacement\ Costs\ for\ Intangible\ Capital)$. Detailed information on variable constructions to be found in Section 5.3.
Panel B—Firm Level Ownership Variables	
BlackRock Holdings	Binary variable that takes the value of 1 if the firm is held by BlackRock.
Big Three Holdings	Binary variable that takes the value of 1 if the firm is held by BlackRock, Vanguard or State Street.
Degree	Sum of weighted degree centrality values. Detailed information on variable constructions to be found in Section 3.1.
Eigenvector	Degree of connections to other well-connected investors. Detailed information on variable constructions to be found in Section 5.2.
Relative Degree	Sum of weighted relative degree centrality values. Detailed information on variable constructions to be found in Section 3.1.

Appendix C—Baseline Regression Results (Contemporaneous)

	(1)	(2)	(3)	(4)
Degree	0.203*			
	(0.069)			
Relative Degree		0.422**		
		(0.016)		
BlackRock Holdings			0.316***	
			(0.000)	
Big Three Holdings				0.311***
				(0.000)
Firm Size	-0.166***	-0.168***	-0.201***	-0.196***
	(0.000)	(0.000)	(0.000)	(0.000)
R&D	1.184*	1.182*	1.078	1.117*
	(0.088)	(0.088)	(0.111)	(0.099)
Intangibles	-0.632***	-0.632***	-0.603***	-0.599***
	(0.000)	(0.000)	(0.000)	(0.000)
ROA	0.856***	0.853***	0.820***	0.824***
	(0.000)	(0.000)	(0.000)	(0.000)
Capex	0.537**	0.532**	0.458*	0.509**
	(0.030)	(0.031)	(0.061)	(0.039)
Leverage	-0.314***	-0.311**	-0.260**	-0.272**
	(0.009)	(0.010)	(0.031)	(0.024)
Sales Growth	0.162***	0.162***	0.150***	0.152***
	(0.000)	(0.000)	(0.000)	(0.000)
Constant	5.357***	5.384***	5.878***	5.757***
	(0.000)	(0.000)	(0.000)	(0.000)
Observations	22,464	22,464	22,464	22,464
Adjusted R^2	0.104	0.104	0.119	0.116
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes

Note: This table reports unbalanced panel regressions of Tobin's Q on contemporaneous network centrality measures and various firm controls. All variables are winsorized at 1% level, except for network measures. Firm controls are lagged by one year, except for sales growth. All models include firm and year fixed effects. Standard errors are clustered at firm level and robust to heteroskedasticity. P-values are in parentheses.
*** p<0.01; ** p<0.05; * p<0.1.

Appendix D—Tobin's Q on Eigenvector (Full Report)

	(1)	(2)	(3)	(4)	(5)
Degree	0.536***				
	(0.000)				
Relative Degree		0.916***			
		(0.000)			
BlackRock Holdings			0.161***		
			(0.000)		
Big Three Holdings				0.155***	
				(0.000)	
Eigenvector					6.080***
					(0.000)
Firm Size	-0.173***	-0.174***	-0.184***	-0.182***	-0.172***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R&D	1.175*	1.176*	1.140*	1.155*	1.176*
	(0.088)	(0.087)	(0.097)	(0.093)	(0.088)
Intangibles	-0.628***	-0.626***	-0.623***	-0.622***	-0.629***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ROA	0.873***	0.870***	0.859***	0.860***	0.872***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Capex	0.507**	0.502**	0.511**	0.514**	0.508**
	(0.038)	(0.040)	(0.037)	(0.036)	(0.038)
Leverage	-0.320***	-0.317***	-0.296**	-0.302**	-0.321***
	(0.008)	(0.009)	(0.014)	(0.013)	(0.008)
Sales Growth	0.163***	0.162***	0.163***	0.164***	0.163***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	5.478***	5.502***	5.667***	5.600***	5.455***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	22,464	22,464	22,464	22,464	22,464
Adjusted R-squared	0.106	0.107	0.107	0.107	0.106
Firm FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes

Note: This table reports unbalanced panel regressions of Tobin's Q on lagged network centrality measures including the eigenvector centrality, and various firm controls. All variables are winsorized at 1% level, except for network measures. Network measures and firm controls are lagged by one year, except for sales growth. All models include firm and year fixed effects. Standard errors are clustered at firm level and robust to heteroskedasticity. P-values are in parentheses. *** p<0.01; ** p<0.05; * p<0.1.

References

Antón, M., Ederer, F., Giné, M. and Schmalz, M. C. (2018), 'Common ownership, competition, and top management incentives'.

Appel, I. R., Gormley, T. A. and Keim, D. B. (2016), 'Passive investors, not passive owners', *Journal of Financial Economics* **121**(1), 111–141.

Azar, J., Raina, S. and Schmalz, M. (2016), 'Ultimate ownership and bank competition'.

Azar, J., Schmalz, M. C. and Tecu, I. (2018), 'Anticompetitive effects of common ownership', *The Journal of Finance* **73**(4), 1513–1565.

Bajo, E., Croci, E. and Marinelli, N. (2020), 'Institutional investor networks and firm value', *Journal of Business Research* **112**, 65–80.

Bena, J., Ferreira, M. A., Matos, P. and Pires, P. (2017), 'Are foreign investors locusts? the long-term effects of foreign institutional ownership', *Journal of Financial Economics* **126**(1), 122–146.
URL: *https://www.sciencedirect.com/science/article/pii/S0304405X17301526*

Chaganti, R. and Damanpour, F. (1991), 'Institutional ownership, capital structure, and firm performance', *Strategic Management Journal* **12**(7), 479–491.
URL: *http://www.jstor.org/stable/2486521*

Cornett, M. M., Marcus, A. J., Saunders, A. and Tehranian, H. (2007), 'The impact of institutional ownership on corporate operating performance', *Journal of Banking & Finance* **31**(6), 1771–1794.

Dennis, P., Gerardi, K. S. and Schenone, C. (2019), Common Ownership Does Not Have Anti-Competitive Effects in the Airline Industry, FRB Atlanta Working Paper 2019-15, Federal Reserve Bank of Atlanta.
URL: *https://ideas.repec.org/p/fip/fedawp/2019-15.html*

Freeman, K. (2019), 'The effects of common ownership on customer-supplier relationships', *Kelley School of Business Research Paper* (16-84).

Gallagher, D. R., Gardner, P. A. and Swan, P. L. (2013), 'Governance through trading: Institutional swing trades and subsequent firm performance', *Journal of Financial and Quantitative Analysis* **48**(2), 427–458.

Jensen, M. C. (1986), 'Agency costs of free cash flow, corporate finance, and takeovers', *The American economic review* **76**(2), 323–329.

Jensen, M. C. and Meckling, W. H. (1976), 'Theory of the firm: Managerial behavior, agency costs and ownership structure', *Journal of financial economics* **3**(4), 305–360.

Lewellen, J. and Lewellen, K. (2022), 'Institutional investors and corporate governance: The incentive to be engaged', *The Journal of Finance* **77**(1), 213–264.
URL: *https://onlinelibrary.wiley.com/doi/abs/10.1111/jofi.13085*

Lewellen, K. and Lowry, M. (2021), 'Does common ownership really increase firm coordination?', *Journal of Financial Economics* **141**(1), 322–344.
URL: *https://www.sciencedirect.com/science/article/pii/S0304405X21000982*

McCahery, J. A., Sautner, Z. and Starks, L. T. (2016), 'Behind the scenes: The corporate governance preferences of institutional investors', *The Journal of Finance* **71**(6), 2905–2932.
URL: *http://www.jstor.org/stable/44155408*

Michel, A., Oded, J. and Shaked, I. (2020), 'Institutional investors and firm performance: Evidence from ipos', *The North American Journal of Economics and Finance* **51**(C), S1062940819300427.
URL: *https://EconPapers.repec.org/RePEc:eee:ecofin:v:51:y:2020:i:c:s1062940819300427*

Monopolkommission (2018), 'Excerpt from chapter ii of the xxii. biennial report of the monopolies commission ("competition 2018") in accordance with section 44 paragraph 1 sentence 1 of the german act against restraints of competition', *The Journal of Finance* **22**.

Peters, R. H. and Taylor, L. A. (2017), 'Intangible capital and the investment-q relation', *Journal of Financial Economics* **123**(2), 251–272.

Philippon, T. (2019), *2. Bad Concentration, Good Concentration*, Harvard University Press, pp. 25–44.
URL: *https://doi.org/10.4159/9780674243095-004*

Salop, S. and O'Brien, D. (2000), 'Competitive effects of partial ownership: Financial interest and corporate control', *Georgetown Law Faculty Publications and Other Works* **67**.

Saxena, A. and Iyengar, S. (2020), 'Centrality measures in complex networks: A survey'.

Schmalz, M. C. (2018), 'Common-ownership concentration and corporate conduct', *Annual Review of Financial Economics* **10**, 413–448.

Schmalz, M. C. (2021), 'Recent studies on common ownership, firm behavior, and market outcomes', *The Antitrust Bulletin* **66**(1), 12–38.

Shleifer, A. and Vishny, R. W. (1986), 'Large shareholders and corporate control', *Journal of political economy* **94**(3, Part 1), 461–488.

Smith, M. P. (1996), 'Shareholder activism by institutional investors: Evidence from calpers', *The journal of finance* **51**(1), 227–252.

Vives, X. (2020), 'Common ownership, market power, and innovation', *International Journal of Industrial Organization* **70**, 102528.
URL: *https://www.sciencedirect.com/science/article/pii/S0167718719300505*