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Institutional investor networks and firm value

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Abstract

This paper investigates the effect of active institutional investor networks on firm value. Using data on US institutional investors, we document that block-holdings from more central, active institutional investors enhance firm value more than those held by other investors. Our findings are consistent with the view that central institutional investors provide a certification benefit to the firm. On the contrary, we do not find evidence that the increase in value is due to monitoring, advisory, information cost, financing, or innovation effects. The documented effects are robust to alternative specifications of network centrality and to endogeneity concerns.

JEL Classification: G32; G34.

Keywords: Institutional Ownership, Firm value, Social Network, Blockholders.

1. Introduction

Over the last couple of decades, there has been a growing interest in the role of blockholders as well as in institutional ownership (Fitch, Harford and Tran, 2015; Edmans and Holderness, 2017). Blockholders, i.e. shareholders owning more than five percent of a company's equity, are common: 96 percent of US firms have blockholders, most of them are institutional investors, owning in aggregate 39 percent of common equity (Holderness, 2009).

Starting from Hirschman (1970), the financial literature has investigated the effect of blockholders on firm value, although neglecting the role of the network created by institutional investors holding stakes in the same firms.[1] However, the structure of this network influences the dynamics of information diffusion as well as the visibility of each investor's actions. As a result, the position of each institutional blockholder in the entire network is likely to serve as a proxy of its relative influence, prominence and prestige, and allows blockholders to be ranked according to their relative centrality. In this paper, we first assess the position of the institutional blockholder in the network of institutional investors by considering the number of blockholding ties with other institutional investors, i.e. the degree centrality (Borgatti, 2005).[2] Degree centrality is a positive measure, ranging from zero (if the institutional blockholder shows no connections with other active institutional investors),[3] to a maximum that is reached when the institutional investor is connected to all the other existing investors. For instance, in 2003, *Capital Research & Management* showed direct connections with 55 other institutional investors (i.e., a degree of 55) generated by common blockownership in about 40 target firms. Scaling the 55 connections by the maximum number of links that any investor can have (i.e.

[1] See Edmans and Holderness (2017) for a survey of the theory and evidence on the role of blockholders.
[2] In network analysis, degree centrality is defined as the number of direct connections that an actor has. Since we investigate institutional blockholders, each institutional blockholder is an actor in our network. The connection between two institutional investors is created when they hold equity stakes in the same company. Specifically, we deem a connection to exist between two institutional blockholders if each owned a block (at least 5%) in the same firm at the end of the year (i.e. blockholding tie).
[3] For example, *Longview Asset Management* that, in the year 2013, was not connected *via* blockholding ties to other institutional investors.

the number of institutional blockholders minus one) produces a normalized degree of 0.2 for *Capital Research & Management*. We then investigate the effect of institutional investor *centrality* on firm value,[4] as proxied by Tobin's Q. We focus our attention only on active institutional investors, as they actively decide which company they want to invest in and therefore their connections are not due to a mere replication of a benchmark index.

Why should a blockholding from a central active institutional investor be more value enhancing than participation from a less connected investor? Building on the widely-accepted principle that the position within the network creates different *status* or *reputation* (Davis and Robbins, 2004; Andres and Lehmann, 2013; Di Maggio, Franzoni, Kermani, and Sommavilla, 2019), we claim that the acquisition of a blockholding from a more central and thus more prestigious active institutional investor produces a *certification* benefit to the invested firm, similar to the one provided by outside directors with CEO positions in other firms (Fahlenbrach, Low and Stulz, 2010). Central institutional investors are, thanks to the ties created with other investors, at a crossroads of the information flow and their central position in the network allows them to reach a prominent and more visible position compared to other, more peripheral investors. As a result, when a central active institutional investor acquires a large stake in a firm, this serves as a signaling mechanism to certify the firm's quality. Our results support this view. In fact, we find that firms block-owned by more connected active institutional investors exhibit higher values (as measured by Tobin's Q). The effect is also economically important, as we document that one standard deviation increase in our centrality metric (*degree*) produces a rise in value for the median firm of between 4.05% and 5.27%.

Certification is hardly testable in a direct way, so empirically validating such a hypothesis is difficult. We address this concern by testing alternative explanations that could likewise justify the positive association between active institutional investor centrality and firm value

[4] We use institutional investor centrality to denote the degree centrality of the institutional investor in our network throughout the paper, with the only exception of Section 7.2 where alternative measures of centrality are employed.

(see also Fahlenbrach et al., 2010 for a similar strategy). Thanks to their numerous connections, central investors may (a) exercise their monitoring effort more effectively, being more easily able to contact and persuade other investors to either *vote* or *trade* in the same direction (*monitoring effect);* (b) extract information from other connected investors and help the firm to carry out value-enhancing strategies (*advisory effect*); (c) facilitate information diffusion throughout the network (and in turn among outside investors), thus reducing the cost of acquiring information about the firm (*information effect*); (d) improve access to external capital and lessen the relationships between investments and internal cash flows, thus creating value for the firm (*financing effect*); (e) facilitate business network creation and knowledge spillovers and further contribute to a firm's innovation activities (*innovation effect*). Using CEO turnover, entrenchment index, acquisitions, alternative measures of a firm's opaqueness, stock/debt net issues, investment-cash flow sensitivity, and R&D expenditures as testing grounds, we do not find evidence supporting any of the above value-creating channels.

Another legitimate concern is that institutional investor centrality may capture effects other than status and certification power. To alleviate this, our analysis also controls for a battery of these potential effects. First, an institutional investor may have several connections with other institutional investors merely because it invests in large companies, for example those belonging to the S&P500 index. Second, more central investors are also likely to be larger than average. Large institutional investors have indeed more assets under management, which translates into more stakes in listed companies and more ties to other investors. As a result, the size of the institutional investor–rather than its connectedness–may drive the results. Third, institutional investors with high network centrality are also likely to have invested in firms with multiple blockholders. Thus, a positive correlation between institutional investor centrality and blockownership dispersion should arise. Konijn, Kraussl and Lucas (2011) show that the blockownership dispersion is negatively associated to firm value, hence disentangling the effect of institutional investor centrality from that of ownership dispersion is undoubtedly critical. Finally, Faccio, Marchica and Mura (2011) and Ekholm and Maury (2014) empirically study the concentration of a stock in an investor's portfolio. More ownership relationships necessarily require a more diversified portfolio to maximize the likelihood of observing co-investments with other blockholders. Our results show that the positive relationship between firm value and institutional investor centrality is not due to these effects.

One might argue that firm performance may also affect blockholder centrality, generating a reverse causality problem. Indeed, if central, active institutional investors, thanks to their prominent role within the investor network and the resulting information advantage, invest mainly in companies with good performance, then the documented association could be due to performance affecting centrality, and not the other way around. To mitigate this endogeneity concern, like Anton and Polk (2014), Anton, Edemer, Gine, and Schmalz (2017), and Crane, Koch and Michenaud (2019), we use a natural experiment based on the 2003 mutual fund trading scandal. In September 2003, several fund families settled allegations of insider trading and the resulting scandal caused severe capital outflows for the implicated funds and a favorable spillover (i.e. unexpected inflows) to the non-involved institutional investors. In turn, the outflows forced the implicated funds to sell assets and decrease the likelihood of showing ownership connections to other investors. Hence, the scandal generated an exogenous variation in the network of active institutional investors. We exploit this scandal by running a two-stage least square regression analysis using as an instrument a binary variable that identifies the implicated institutional investors, for which we observe an exogenous change in the *degree* during the years of the scandal. We show that the documented relationship between firm value and investor centrality is robust to the IV approach.

Finally, we also provide some robustness checks. After controlling for director centrality (Larcker, So and Wang, 2013), alternative measures of centrality (*eigenvector* and *betweenness* as opposed to *degree*), replacing Tobin's Q with Total Q (Peters and Taylor, 2017), as well as controlling for a measure of common ownership (Backus, Conlon and Sinkinson, 2019) and isolating the *degree* of the active investors that first acquire the equity stake with respect to those that follow behind, the positive effect of blockholder centrality on firm value remains strongly significant.

While we are confident in our results, we caution that the lack of supporting evidence for the alternative hypotheses discussed above does not completely rule out the possibility that the association between firm value and investor centrality is driven by the certification hypothesis and not by other explanations that were not considered in this study. We attempt to mitigate this concern by being as thorough as possible and testing all the plausible alternative explanations. However, although we have tested (and rejected) all the most common theoretical motivations, we cannot exclude beyond any doubt that some other omitted channels are in place.

The paper offers three main contributions to the literature. First, this paper fits into a growing literature that investigates corporate financial phenomena using network centrality (e.g., Larcker et al., 2013; Bajo, Chemmanur, Simonyan, and Tehranian, 2016; Fracassi, 2017; Crane et al., 2019). In his study of the executive social network, Fracassi (2017) argues that centrally located companies are exposed to a wider set of information which can give them competitive advantages resulting in higher firm values. We extend this study to analyze another important social network that can affect firm performance: the institutional investor network. Crane et al. (2019) examine the effect of institutional networks on corporate governance, by using common equity ownership positions as a proxy of investor coordination. They observe that firm value responds negatively to liquidity shocks when clique ownership is high. While Crane et al. (2019) emphasize the coordination aspect of the institutional investor network, we focus on the certification role. In doing so, we advance prior literature by showing that the position of active institutional investors within the network of active institutions measures an important and, so far, unexplored facet of the relationship between ownership composition and firm value. Second, we document that the impact of centrality is associated with the certification that these investors provide to the firm. Shareholdings by central investors attenuate information frictions between the firm and the outside investors, provide positive signals to the market and in turn enhance firm value. This result complements Borochin and Yang (2017) who finds a reduction in firm misvaluation for companies with more dedicated investors. Third, while few studies have investigated the role of single attributes of institutional portfolios, we offer a comprehensive examination of a larger set of portfolio characteristics. Our results confirm that the composition of the institutional portfolio is equally critical to explaining the relationship between block-holdings and firm value.

The remainder of the paper is organized as follows. The next section presents the literature review. Section 3 describes our research methodology, introduces the centrality metrics and reports descriptive statistics. Section 4 presents our main findings. Section 5 aims at mitigating potential endogeneity concerns. Section 6 tests possible alternative channels through which investor centrality may affect firm value and Section 7 presents some robustness checks. Finally, Section 8 concludes.

2. Literature review and hypotheses development

2.1 Literature review

The extant literature provides conflicting predictions on whether closely held or diffuse ownership is better for firm value. The classical view is that concentrated ownership may enhance effective governance, as only large investors have monitoring (over the management) incentives and ways to intervene to correct value-destructive actions. However, many firms show an ownership structure with multiple blockholders (Faccio and Lang, 2002; Laeven and

Levine, 2007; Holderness, 2009). These blockholders can exert governance through two main mechanisms. The first is direct intervention within a firm, otherwise known as voice (Hirshman, 1970; Admati, Pfleiderer and Zechner, 1994; Kahn and Winton, 1998; Maug, 1998). This avenue passes through proposing shareholder proposals or voting against the directors. However, intervention can vary both in its observed impact on the firm and in the speed with which its success (or lack of) becomes apparent (Kahn and Winton, 1998). Empirically, Appel, Gormley and Keim (2016) report that passive institutional investors use their large voting blocks to exercise voice and exert influence, for example reducing the support for management proposals. Consistent with the observed changes in governance having a positive influence on firm value, they find that engagement by passive mutual funds also appears to improve firm's long-term performance. But, blockholders can also trade the firm's stocks. This second mechanism is known as exit or voting with your feet (Admati and Pfleiderer, 2009; Edmans, 2009; Edmans and Manso, 2011). If managers shirk, blockholders can react by selling their shares, therefore depressing the stock value (Gallagher, Gardner and Swan, 2013, and McCahery, Sautner and Starks, 2016). In order to be an effective mechanism of governance the blockholder does not have to necessarily sell its shares as the mere threat may induce the manager to maximize the firm's value. McCahery, Sautner and Starks (2016) resort to survey evidence to show that institutional investors employ exit as their main governance mechanism. Gallagher et al. (2013) confirms that institutional investors can exert governance by trading the firm's stocks. In particular, they show that order sequences submitted by institutional investors are associated with enhanced price informativeness and firm performance. Similarly, Kandel, Massa and Simonov (2011) present evidence that multiple small shareholders trading in the same direction produce a positive effect on firm value.

Edmans and Manso (2011) argue that the optimal number of blockholders depends on the tradeoff between intervention (voice) and trading (exit). The model predicts that blockholder structure impacts price efficiency and consequently firm value, and their power in exerting governance depends on microstructure factors such as liquidity and the blockholders' information advantage. Konjin et al. (2011) likewise (indirectly) investigate the optimal number of blockholders as they show that blockownership dispersion is negatively associated with firm value (as measured by Tobin's Q).

However, not all evidence points toward a positive effect of blockholding on firm value. Interestingly, blockholders may produce a negative effect on the company's value, strengthening rather than alleviating the agency costs (Shleifer and Vishny, 1997; Bhojraj and Sengupta, 2003; Edmans, 2014). Indeed, blockholders may extract private benefits (for instance, by forcing the firm to buy goods or services at inflated prices from other companies that they own) or their presence may simply reduce managerial initiative (Aghion and Tirole, 1997; Burkart, Gromb, and Panunzi, 1997) or stock liquidity (Bolton and von Thadden, 1998; Edmans, 2009). The incentive to collude or to monitor is also affected by the type of individual blockholder (Maury and Pajuste, 2005).

Edmans, Levit and Reilly (2019) argue that a common limitation of previous studies is that they neglect the portfolio composition of the blockholder. Many institutional investors hold blocks in multiple firms, and Backus et al. (2019) have documented a remarkable growth of common ownership incentives over the period 1980-2017.[5] He and Huang (2017) find evidence suggesting that cross-ownership by institutional blockholders offers strategic benefits to commonly held firms, in the form of product market collaboration, innovation and operating profitability. He, Huang and Zhao (2019) further suggest that when institutional shareholders have large ownership stakes in peer firms, companies benefit from an improvement in

[5] Recent literature has studied the effect of common ownership on product market competition and corporate governance with contrasting results (see for example Azar, Schmalz and Tecu (2018) and Dennis, Girardi, and Schenone (2018)).

governance as institutional investors are incentivized to play a more active monitoring role. This result complements the study by Matvos and Ostrovsky (2008) that analyses the effect of common ownership on the monitoring of acquisitions.[6]

This paper is also related to other studies investigating corporate financial phenomena through the concept of network centrality. In particular, Fracassi (2017) and Crane et al. (2019) also investigate the relation between centrality and performance measures. Fracassi (2017) considers the effects of social ties over corporate finance policy decisions and value, and shows that companies are indeed influenced in their policy decisions by their nearest social neighbors.[7] Crane et al. (2019) study the effect of investor connectedness through the network of institutional holdings on firm's corporate governance; however, they employ network theory to gauge the extent of their informal coordination (clique), rather than to identify key central actors in the overall network of institutional investors. They also find that in the event of a liquidity shock, firm value decreases more when ownership clique is high. Other papers also examine the importance of social networks. Godlewski, Sanditov and Burger-Helmchen (2012) show that banks located in the more central area of the syndicated loan network charge lower loan spreads. Analogously, Bajo et al. (2016) investigate the effect of lead manager centrality over a number of IPO phenomena. Kuhnen (2009), in a study based on the mutual fund industry, shows that directors tend to hire advisory firms with whom they had a past relationship, even though no detrimental effects are detected. Larcker et al. (2013) consider two firms connected if they share at least a common director and show that more connected firms earn significantly higher future excess returns. Finally, social ties and network analysis have also been applied to firm innovation. Schilling and Phelps (2007) study the impact of

[6] The effect of institutional common ownership has also been investigated in order to study the effect on return predictability and correlations. Gao, Moulton, and Ng (2017) evidence significant return predictability among economically unrelated stocks with mutual institutional ownership. Anton and Polk (2014) document excess stock comovement during the 2003 mutual fund trading scandal–which led to mutual fund outflows–characterized by common ownership. Similarly, Jotikasthira, Lundblad, and Ramadorai (2012) show that liquidity shocks to mutual funds trigger comovement between the markets they invest in.
[7] However, he focuses on the executive social network, rather than on institutional investors.

large-scale alliance networks on firm innovation. The results of this study show that firms embedded in alliance networks characterized by both high clustering and high reach have greater innovative output, as a result of the high information transmission capacity and the high quantity and diversity of information received.

2.2. Hypotheses development

In this paper, we postulate that the *status* associated with the network centrality of the institutional blockholders may offer a *certification* effect to the invested firm and, as a result, a greater market value. Alti and Sulaeman (2012) document the ability of institutional investors to certify the value of firm securities in contexts characterized by a high degree of asymmetric information. In fact, through trading, institutional investors, thanks to their superior ability to gather and process information, convey important information to the market. In this sense, the decision to acquire an important firm stake from an active institutional investor serves as a signaling mechanism to certify the firm value. However, it is also plausible to assume that the position that each investor has within the whole network of institutional blockholders produces a signal of a different intensity. Recent literature has documented that the position occupied within the network correlates with the status or reputation of the involved actors (see for example, Andres and Lehmann, 2013; Di Maggio et al., 2019). Indeed, the position of each institutional blockholder in the network may serve as a proxy of its relative influence, prominence and prestige, and correlate with their actions to be more or less visible through the network. Status is particularly important in cases where more direct evidence of quality is missing (Davis and Robbins, 2004). Institutional investor centrality, as an indicator of status, can thereby insulate a company from investor oversight.

Since the certification hypothesis is hardly testable in a direct way (see also Fahlenbrach et al., 2010; Alti and Sulaeman, 2012), we provide indirect evidence to support this effect by testing alternative explanations that could likewise justify the positive association between active institutional investor centrality and firm value.

First, previous studies provide empirical evidence that certain types of institutional investors tend to play a monitoring role (Kim, Kim, Mantecon and Song, 2019). Due to their privileged position in the network and the associated ease of information transmission, central institutional investors may also show greater monitoring ability. Thanks to the higher number of connected investors, the central institutional investor may more effectively discipline corporate managers, being able to more easily contact and persuade other investors to either vote or trade in the same direction (H1: *monitoring effect)*.

Second, exploiting the superior information set ensured by the network position, central investors may also assist the management in enhancing the firm's investment policy (H2: *advisory effect).* Being a good advisor depends critically on the information available (see, for example, Adams and Ferreira, 2007) and there is abundant evidence that institutional investors possess private information (Chemmanur, Shan and Gang, 2009) and that they engage in costly information production around important corporate events like SEOs (Chemmanur and Jiao, 2011). According to this view, central institutional investors may act as facilitators for the firm's investors, creating new business opportunities thanks to their networks of contacts with investors investing in other firms and providing more valuable advice to managers. Their role is somehow similar to that of foreign institutional investors in the cross-border takeover market examined by Ferreira, Massa and Matos (2010).

Third, Bajo et al. (2016) argue that a central IPO underwriter more easily disseminates information through the network and in turn to outside investors. Along the same line, a central institutional investor may facilitate information exchange with other connected investors and, in turn, with market analysts. Should this effect be in place, we may observe a lower cost of information acquisition for firms in which central investors participate (H3: *information cost effect*).

Fourth, we explore whether a network of investors may improve access to external capital and, thus, create value for the firm. We label this alternative explanation the *financing channel* (H4). In their model Chemmanur and Jiao (2011) provide an example of how institutional investors can reduce the costs of an equity issue. In fact, they document that SEOs with greater pre-offer net buying by institutional investors show higher institutional allocations, greater oversubscription, and lower SEO discounts. Central investors may induce other investors to follow them in buying the offer, lowering its cost. The presence of a financing advantage associated with an ownership network may also weaken the relationship between investments and internal cash flows.

Fifth, an ownership network may facilitate business network creation thus fostering business innovation. Previous literature has documented a relationship between institutional investors and innovation, where greater institutional ownership is associated with more innovation (Aghion, Van Reenen, and Zingales, 2013). In the same vein, Luong et al. (2017) show that foreign institutional ownership has a positive effect on firm innovation. Building on this insight, we investigate whether firms owned by more central institutional investors exhibit stronger innovation and R&D propensity. Central investors may act as a bridge for owned firms, facilitating knowledge spillovers and business network (H5: *innovation channel*).

3. Data and methodology

3.1. Network variables

The idea of network is a quite intuitive concept. A set of actors having mutual relationships constitutes a network. As possible examples, firms often exchange goods or services with other companies; banks mutually provide loans to other banks or, in syndication, to companies;

directors can sit on two (or more) boards of different firms. In all these cases the actors show several connections (or *ties*) to other actors. The set of actors and ties constitutes a network.

The simple observation of active institutional investors holding a block in multiple firms allows two sets of actors (the active institutional blockholders and the firms) and a tie between them to be identified when the institutional investors participate in the ownership structure. The resulting network is “bipartite”, or “two-mode” in network theory jargon, because there are two types of nodes (active institutional blockholders and firms) and only one directed link (from active institutional blockholders to firms), without a possible link back (from firms to active institutional blockholders). An example of this type of network is illustrated in Figure 1A. Bipartite networks are generally scarcely informative, and this is the reason why they are transformed into “projected” or “one-mode” networks. For the purpose of our investigation, we have projected the bipartite active institutional blockholder-firm network onto the institutional blockholder side, by using active institutional blockholders as *actors* and assigning a *tie* between two active institutional blockholders when at least one firm exists in which both have an equity stake (representing at least a 5% ownership). Note that while the original bipartite active institutional blockholder-firm network is directed, as relations originate from institutional blockholders and point to firms, the projected active institutional blockholder network is undirected. Figure 1B illustrates how the bipartite network is projected onto the set of active institutional blockholders to derive a one-mode network.

[INSERT FIGURE 1 ABOUT HERE]

The blockholding network is necessarily dynamic as new relations may be continuously created or dissolved. For this reason, we analyze the network of active institutional blockholders on an annual basis from 2001 to 2013. Institutional blockholder heterogeneity may be highlighted in terms of the position of each institutional blockholder in the network and this in turn may allow active institutional blockholders to be ranked according to their relative *centrality*. As active institutional blockholders form and maintain ownership relationships with each other, they weave a network of direct and indirect relationships. In sociology literature, the position that each actor occupies within the network serves as a proxy of their relative influence, prominence and prestige (Burt, 1980). Network analysis provides several indicators to assess the importance of a node *centrality*, capturing different aspects of its position (Borgatti, 2005).

In our analysis, we use *degree* centrality as the main proxy for investor centrality. Degree centrality counts the number of connections between an actor and the others. A blockholder which is more densely connected to other active institutional investors is likely to hold a more privileged position within the network of active institutional investors.

Formally, the degree (d_i) for actor i is:

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

where N is the total number of active institutional investors (nodes) in the network; x_{ij} is the element (i,j) in the adjacency matrix,[8] i is the row-indicator in the adjacency matrix corresponding to one active institutional blockholder and j is the column-indicator corresponding to another active institutional blockholder. If $x_{ij} = 1$ the two active institutional blockholders are blockholders in the same firm, if $x_{ij} = 0$ they do not hold a block in the same firm.

[8] An adjacency matrix X is defined as an N by N matrix (with N being the number of actors in the network); X_{ij} entries are equal to one if two actors have a link and zero otherwise. X_{ii} entries are set to zero. In an undirected network, Matrix X is symmetric.

The degree centrality measure, being dependent on the number of existing nodes in the network, makes it difficult to compare networks of different node-size. This may be a problem in time-series analysis as it creates a time-bias. In order to accommodate for this potential bias, we calculate the normalized bearable version of degree, using the total number of possible neighbors excluding self, *N-1*, as a normalized factor:

$$d_i^N = \frac{\sum_{j \neq i}^{N} x_{ij}}{(N-1)} \tag{2}$$

It follows that this indicator ranges from 0 to 1; the closer the degree centrality to 1, the more the active institutional blockholder is directly connected to the rest of the network. The degree centrality is essentially a local centrality measure. It only takes into consideration direct links of a node, its nearest neighbors, regardless of the position of the node in the network's structure. Figure 2 shows a graphical representation of the network of active institutional blockholders as measured in 2013. In this panel the size of nodes is proportional to the relative degree. In spite of the excessive number of nodes in the link-dimension, the resulting picture conveys some useful information about the presence of large sub-networks, as represented by nodes and ties of different colors. In each cluster, central blockholders show a remarkable number of direct ties (high degree) and few other indirect ones. This peculiar type of network structure creates, by construction, a high correlation among centrality measures.

[INSERT FIGURE 2 ABOUT HERE]

To uncover the effect of others we move from local centrality measures to global centrality measures, and in the robustness analysis we also employ two additional well-known measures of centrality: *eigenvector* centrality, which links the actor's centrality to the characteristics of the actor’s neighbors, and *betweenness* centrality, which describes how important an actor is in terms of connecting to other actors. *Eigenvector* centrality has the advantage of accounting for the network position of the nodes to which the actor is connected, giving more weight to connections to central nodes than to peripheral ones. In this sense, the *eigenvector* centrality may be thought of as a variation of *degree* centrality where each connection is weighted by its relative importance in the network, i.e. by its centrality. Formally, eigenvector centrality is calculated as:

$$e_i = \lambda \sum_{j \neq i}^{N} x_{ij} e_j \qquad (3)$$

where λ is a constant represented by the biggest eigenvalue of the adjacency matrix and *e* is the eigenvector centrality score (Bonacich, 1972, 1987). Further, we normalize *eigenvector* by dividing it by the maximum possible element value for an *N* actor network. In sociology literature, this measure is usually associated with a concept of popularity. Broadly speaking, being linked to other actors which are, in turn, connected to many others makes it easier for the node to become more visible within the network.

Betweenness centrality is likewise a global measure that depicts how well situated a node is in terms of the path that it lies on. It departs from the above concept of *degree* and *eigenvector* as it assigns a higher score to nodes that lie on a larger proportion of the shortest paths linking pairs of other nodes. Specifically, it can be defined as the ratio of the shortest paths between all the pairs of nodes in the network which pass through node *i* (deflated by the number of alternative shortest paths). Formally, *betweenness* centrality for actor *i* is:

$$b_i = \sum_{i \neq j \neq z} \frac{b_{jz}(i)}{b_{jz}} \qquad (4)$$

where $b_{jz}(i)$ is the total number of the shortest paths between actors j and z passing through i and b_{jz} is the total number of the shortest paths between nodes j and z. If the actor lies along every shortest path between any pair of other actors, the actor's *betweenness* will be at the maximum. On the contrary, if an actor is isolated or belongs to a fully connected network where every actor lies on the shortest paths between nodes, the actor's *betweenness* will be zero.

3.2 Institutional investor data

In our sample, the information on the equity holdings by active US institutional investors allows a network of relations to be constructed. We focus on active investors because our aim is to document whether investor centrality provides certification for the firm. Since passive funds maintain portfolio weights that are often closely aligned with the weights in their chosen benchmarks (Appel et al., 2016), their blockownership can hardly provide a certification benefit. To put it another way, passive investors do not select companies because they believe in their ability to generate value, but simply because they are part of a specific index. To create the network of active institutional investors, we rely on the investor classification data based on Bushee (1998, 2001) and Bushee and Noe (2000), which is available from Brian Bushee's website. This classification divides the universe of institutional investors into "dedicated", "quasi-indexer", and "transient". Transient investors display high portfolio turnover and focus on short-term trading profits; dedicated investors, on the other hand, are characterized by their interest in the long-term appreciation of shareholder wealth; finally, quasi-indexers use indexing or buy-and-hold strategies that are characterized by high diversification and low portfolio turnover. Following Borochin and Yang (2017), we consider dedicated and transient investors as active investors and include them in the analysis due to their proactive investment selection behavior. On the contrary, given their passive replicating investment strategy, we remove quasi-indexers from our sample.

We collect information on end-of-the-year institutional holdings of common stocks for the sample period 2001 to 2013 from the 13(F) filings available from the Thomson Reuters financial dataset.[9] Consistent with the financial literature, we employ the 5% stake threshold to define a blockholder. The observation of overlapping blockownership positions allows an active institutional investor network to be constructed. Information on institutional holdings from 13(f) are also relevant to deriving the portfolio characteristics of institutional blockholders. For each firm in which at least one institutional blockholder participates, we collect yearly financial data (from Compustat) and stock price data (from CRSP). After excluding all financial and utility firms from the sample, our final data set contains 21,658 firm-year observations in the time span 2001-2013.

3.3 Descriptive statistics

Table 1 provides an overview of the time evolution of institutional blockownership and network centrality.

[INSERT TABLE 1 ABOUT HERE]

Between 2001 and 2013 the institutional blockholder network has become more intensely populated as the number of active institutional blockholders has increased. More importantly, on average the centrality measures display a declining trend likely due to the structure of the

[9] Institutional investors with $100 million or more under management in exchange-traded or NASDAQ-quoted equity securities are required to file form 13F within 45 days of the end of the calendar quarter. Institutions are required to report all equity positions greater than either 10,000 shares or $200,000 in market value. Because 13F reporting is aggregated across different units within an institution, the number of institutions reflects the number of unrelated institutions buying or selling the security.

network. In fact, despite the increasing number of pair-wise links, the overall blockholding network becomes more fragmented in later sample years.

[INSERT TABLE 2 ABOUT HERE]

Table 2 reports descriptive statistics of our sample. Panel A describes the firm characteristics, while Panel B presents information on the blockownership dispersion as well as on the characteristics of the largest active blockholders and their portfolios. Starting from the firm characteristics, Table 2 first reports the Tobin's Q which we use in our analyses as a dependent variable and a proxy of firm performance: the average (median) Tobin's Q is 2.08 (1.57). We use the other variables reported in Panel A as control variables in our models. The description of the variable construction is reported in Appendix A. We take the total assets as a proxy of firm size (larger and more mature firms are expected to show fewer growing opportunities and hence lower value); the debt ratio (leverage increases firm risk but also may induce a discipline effect over the management); the return on assets (to measure the profitability of the firm); capital expenditure, R&D, property, plant and equipment over total assets (as proxies for the new and total investments); sales growth (as proxies for growth opportunities); the ratio of intangible asset over total asset (more asset intangibility might be associated with more firm opaqueness and lower value); the firm age; the stock market liquidity (as measured by the Amihud variable), the stock return volatility (as calculated by the standard deviation of returns) and inclusion in the S&P 500 Index. Additionally, Panel B reports several characteristics of the largest (in terms of shareholding) active blockholders along with information on their portfolio and blockownership dispersion. The first three variables are network centrality measures for the largest active blockholder.[10] Whilst the values of

[10] We also compute the *degree* and the other centrality metrics for the second and the third largest blockholder, as well as the average *degree* across the firm's blockholders. For the sake of space, we do not report them in this table as they are not included in the regression analyses we show in the paper.

eigenvector and the *betwenness* do not have an immediate economic interpretation, the level of *degree* is more an intuitive concept. The largest active blockholder shows a number of *ties* that are on average (median) 24 (15) percent of the maximum theoretical number of connections. Active blockholder dispersion is proxied by the *Herfindal* Index, which has a mean (median) value of 0.78 (1). The remaining variables are associated with the portfolio of the largest active institutional investors. On average, the first active blockholder owns 11 percent of the company's equity (*First own*) and manages funds worth $233 billion (*Inst size*).[11] Finally, its level of portfolio concentration in terms of the value of each company's stake (*Pft Herf*) is very low with an average of 0.03.

4. Results

Table 3 presents the result of a panel regression with firm and year fixed effects. The first model shows the effect of the *degree* centrality over the Tobin's Q. As expected, the coefficient is positive and highly statistically significant, suggesting that the presence of more connected active institutional investors is associated with larger firm value. Also, the economic significance is sizeable as one standard deviation increase in our centrality metric (*degree*) produces a 2.92 percent rise in firm value for the median firm.[12]

[INSERT TABLE 3 ABOUT HERE]

[11] While the amount of assets under management may appear large compared, for example, to Crane et al. (2019), it should be noted that this is an average value for the largest active institutional blockholder in the firm, which is likely to be larger than the typical institutional investor.

[12] A one standard deviation increase in degree generates a positive change of 0.0458 in the Tobin's Q. This increase is 2.92 percent of the median Tobin's Q (1.57).

This finding provides evidence about the positive association between the institutional investors' ability to establish numerous blockownership ties and an improvement in firm value as an effect–we argue–of the certification offered by more central institutions.

Model 2 adds a number of firm- and stock-specific standard control variables but the effect of *degree* centrality persists both in sign and statistical significance.[13] The signs of the control variables are all in line with previous findings: Tobin's Q is negatively associated with firm size, the level of the firm's opaqueness (asset intangibility), investments in PPE and positively associated with proxies of growth opportunities (capital expenditure, sales growth, and R&D), firm's operating performance (ROA), stock liquidity (Amihud, 2002) and the inclusion in the S&P 500 Index. [14]

So far, we have documented the positive association between institutional blockownership centrality and firm value, controlling for several firm characteristics. In the following models, we investigate if the documented evidence likewise holds even after having controlled for the composition of the blockownership structure.

First, the number of *ties* is likely to be correlated with the size of the funds managed by the institutional investors. Larger funds under management require, for diversification purposes, a broader set of targets in which to invest and, in turn, a larger number of co-investment relationships. As a result, *degree* centrality is likely to be correlated with the size of the investment company. In the third model of Table 3, we include the size of the funds under the

[13] In unreported robustness tests available from the authors upon request, we also include among the regressors the *degree* centrality of the second and third largest active institutional blockholder as well as the average *degree* across the firms' blockholders, without any appreciable change in the significance of the centrality measures (or in the control variables). The level of connectedness of the second largest institutional investor appears to be important, as it is positively associated with the firm's value, even if its impact is less meaningful than that of the largest investors. On the contrary, the statistical significance of the degree centrality for the third largest institutional investor is not above the standard requirements. The average *degree* maintains its positive and significant association with the Tobin's Q.

[14] Accounting variables in Table 3 are contemporaneous to Tobins' Q. However, using lagged explanatory variables produces no appreciable difference. Moreover, we also have regressed the change in Tobin's Q from year to year, as opposed to its level, but the high statistical significance of degree centrality persists. The results of these additional tests are available from the authors upon request.

management of the largest blockholder.[15] Larger institutional investors are indeed associated with a greater Tobin's Q as the *Inst size* coefficient is positive and highly statistically significant. Importantly, the explanatory power of the blockholder degree remains largely significant, denoting a role that goes above and beyond mere investor size. Second, larger connectedness might also be associated with blockholding dispersion. Multiple blockholders (greater dispersion) create a multitude of co-investment ties and hence higher connectedness. Thus, it could be argued that network centrality might somehow proxy for blockownership dispersion. As a proxy for blockownership concentration we likewise add the *Herfindal* index based on the value of the stakes (above 5%) owned by all the active institutional investors within the firm. However, the blockownership dispersion (concentration) of active institutional investors shows no statistically significant association with the firm value. Importantly, the inclusion of this dimension does not affect the significance of the *degree* centrality.[16] This result corroborates the idea that the degree captures an economic effect, which is unrelated to the composition of the blockownership structure.

The next model in Table 3 sheds some light on the role of the institutional investor portfolio composition on the firm value, along with providing robustness on the ability of the centrality measures to hold after controlling for such effects. Model 4 adds to the baseline regression the share owned by the largest blockholder (*First Own*) and a measure of portfolio concentration (*Ptf Herf*). The coefficient of *First Own* is negative and statistically significant, providing no support for the intuition that larger stakes incentivize blockholders to more closely monitor the firm. The negative coefficient might, on the other hand, be consistent with the assumption that the threat of *exit* becomes less credible if the stake size is excessively large, decreasing the

[15] To account for the positive correlation between institutional investor size and degree, we use as a proxy for the institutional investor size the residuals from a panel regression with firm and year fixed-effects, using the natural logarithm of the active institutional investor size as a dependent variable and the *degree* centrality as the only explanatory variable.

[16] Substituting the *Herfindal* index with the number of blockholders or the cumulative blockholding produces no appreciable differences. Results are available upon request.

bargaining power of the institutional investor (Edmans, 2009). The portfolio concentration (*Ptf Herf*) is positively associated with the Tobin's Q. This result supports the view that, everything else remaining constant, the broader the investment scope of the institutional investor, the less ability there is to produce a meaningful impact on firm performance.[17]

Overall, the economic significance of the centrality effect increases once we add control variables. Indeed, the increase in Tobin's Q for the median firm varies from 4.05 percent in model 2 to 5.27 percent in model 4. Consistent with the findings of Alti and Sulaeman (2012), our results suggest that the status associated with the network centrality of the institutional blockholders indeed offers a certification effect to the invested firm, resulting in a larger market value. Our results further support the positive role played by institutional investors (see for example, Appel, Gormley and Keim, 2016; and Borochin and Yang, 2017), while it is not consistent with the views that these blockholders either increase agency conflicts (Shleifer and Vishny, 1997; Bhojraj and Sengupta, 2003; Edmans, 2014) or negatively impact managerial initiative (Aghion and Tirole, 1997; Burkart, Gromb, and Panunzi, 1997).

5. Endogeneity concerns

The documented relationship between firm value and institutional investor centrality might be affected by reverse causality. To establish that our results are not due to firm performance influencing the investment choices of central institutional investors, and to identify the causal effect of investor centrality on firm value, we follow Anton and Polk (2014) and use the 2003 mutual fund scandal as a natural experiment. This scandal generated exogenous variation in the network of active institutional investors. In September 2003, several fund families received

[17] We also add *Managerial ownership* as a control related to ownership structure. The variable is computed as the percentage of total shares outstanding held by executives (net or gross of ESOs). Due to the large dropout caused by the inclusion of this control, which does not change our main results, we exclude this variable from reported analyses for the sake of space. Results are available from authors upon request.

notices of allegations of insider trading. Funds implicated in this scandal experienced dramatic outflows (24%) that continued up to the end of 2006. In contrast, funds that had not been implicated increased the managed assets by 12% (Kisin, 2011). As a result of the outflows generated by the scandal, implicated funds have been forced to reduce their shareholdings and, consequently, decrease the number of ownerships ties with other active institutional investors. Conversely, non-involved investors have been able to increase their portfolios, and likely their ties to other investors, as an effect of the larger amount of disposable financial resources. Hence, it is plausible that the 2003 mutual funds scandal has caused an exogenous variation in the number of ownership ties (investor *degree*). Following previous studies (Anton and Polk, 2014), we first identify the list of investors implicated in the scandal using four sources. The first is the list of mutual fund families that were tainted by the scandal published in McCabe (2009). Then, we cross-checked and completed this list by using Houge and Wellman (2005), Qian (2006), and Zitzewitz (2009) who also provided lists of firms that came under investigation for illegal trading practices. It is worth noting that while this shock affects only mutual funds, the two investor categories related to mutual funds, i.e. investment advisors and investment companies, represent the vast majority of our sample observations (more than 97%).

We create a dummy variable (*scandal*) that takes the value of one when two conditions are jointly met (and zero otherwise): a) at the time of the 2003 scandal the largest active institutional investor was involved in the scandal and b) the firm-year observation refers to the period 2003 – 2006. Since the effects on capital outflows did not continue after 2006, the former condition alone would not be able to capture the presumable change in network structure which occurred as a direct effect of the scandal.[18] We use this dummy variable as an instrument to capture the shock that creates exogenous variation in the investor *degree.* Finally,

[18] We identify 164 firms in our sample that at the time of the 2003 trading scandal had a scandal fund as the largest active institutional investor, for a total of 1,291 firm-year observations.

we run a 2SLS regression where, in the first stage, we regress the investor *degree* on the dummy *scandal* (and the whole set of control variables) and in the second stage the Tobin's Q on the fitted *degree* (from the first stage) along with the usual controls.

We argue that, while the dummy *scandal* should be negatively associated with the investor degree (relevance condition), there are limited economic motivations for it being correlated with the firm value (exclusion condition). As for the relevance condition, the mutual fund scandal has already been used as an exogenous shock to common ownership (Anton and Polk, 2014) and previous considerations support the idea that the number of ownership connections (*degree*) of the implicated (non involved) investors should decrease (increase) during the years of the scandal. As for the exclusion condition, it might be argued that the exit of the implicated institutional investors could exert a downward price pressure on the company's stocks and that this, in turn, should lower the firm value. Although this argument is legitimate, it is also plausible to expect that this deviation from the fundamental value should be temporary (mainly, during the years of the capital outflow) and able to be reabsorbed shortly after the end of the scandal period.

[INSERT TABLE 4 ABOUT HERE]

Table 4 reports the same baseline models reported in the previous table, here accounting for the 2SLS regression approach. In the first stage, in line with our expectations, the instrument (*scandal*) shows a negative and highly statistically significant relationship with the *degree*.[19] In all the models considered, the degree of the active institutional investors remains positive and highly statistically significant, confirming that the positive association between the investor centrality and firm value is robust to the endogeneity concern.

[19] Additionally, the relevance criterion is satisfied as the F-statistic of the weak instrument test is always above the critical values developed by Stock and Yogo (2005).

6. Certification effect and alternative hypotheses

Previous sections have shown the positive relationship between the centrality of the institutional blockholder and the firm value, which also holds after controlling for potential reverse causality concerns. As discussed throughout the paper, we put forward the hypothesis that higher valuations for firms block-owned by active institutional investors with high *degree* results from a certification effect offered by these central actors. Since a direct test for certification is hardly possible, we provide an indirect support to this hypothesis by excluding other possible channels. For this reason, in Section 2.2, we developed five alternative hypotheses that we aim to test in this Section. Specifically, we test whether a central active institutional blockownership impacts on firm value *via* better monitoring (H1), advisory activity (H2), reduction of information acquisition cost (H3), easing the firm's financing (H4) or fostering business innovation (H5). Due to the endogeneity concern, we only present the results of the second stage regressions (Table 5), after having instrumented the *degree* centrality with the scandal dummy.

As for the *monitoring effect* (H1), we use as dependent variables *Forced turnovers*[20] and the *Entrenchment index,*[21] while for *advisory effect* (H2) an *Acquisition dummy* and the *Total acquisition value*. Forced turnover is a common proxy for the effectiveness of board monitoring because the decision to fire a CEO after poor performance indicates whether the board acts as an independent monitor of management (see, for example, Guo and Masulis, 2015). The entrenchment index is negatively correlated with firm value (Bebchuk, Cohen and Ferrell, 2009). So, one way to unlock value for central institutional investors through enhanced

[20] Data for forced CEO turnovers cover the period 2001-2010 and are from Peters and Wagner (2014). The criteria for classifying a CEO turnover as forced are described in detail in Jenter and Kanaan (2015), and Peters and Wagner (2014). We thank Alexander Wagner for kindly providing us the forced turnover data.

[21] The index is based on Bebchuk et al. (2009). It considers six provisions: staggered boards, limits to shareholder amendments of bylaws, supermajority requirements for mergers, supermajority requirements for charter amendments, poison pills, and golden parachute arrangements. The index takes values from 0 to 6, based on the number of provisions that the company has in the given year. Higher values of the index indicate more entrenchment, and therefore poorer corporate governance.

monitoring is to remove the provisions that entrench managers. Concerning acquisitions, we create a binary variable taking a value of 1 if a firm executes at least one acquisition in a given year (*Acquisition dummy*). We also aggregate the deal values of the acquisitions carried out in a sample year, and scale them by the market capitalization of equity at the end of the previous year (*Total Acquisition Value*).[22] Acquisitions are usually large investment decisions that could exacerbate agency conflicts between managers and shareholders (Chen, Harford and Li, 2007). By increasing monitoring, central institutional investors could reduce the number of value-destroying acquisitions and, thanks to the superior information set, improve the quality of the deals that are carried out. Therefore, we expect our proxies of acquisition activity to be negatively related to investor centrality because of a pure monitoring argument. Collectively, we do not find evidence supporting the monitoring channel: none of the four variables are associated with the exogenous change in institutional investor centrality, once we control for the common determinants shown in the literature (*firm size*, *intangibles*, *leverage, sales growth, stock returns, standard deviation of stock returns,* and some specific variables in the acquisition regressions).

[INSERT TABLE 5 ABOUT HERE]

The analysis of the acquisition policy shown in Table 5 does not provide supporting evidence for the advisory channel either. The advisory role of institutional investors is associated with their ability to connect firms and reduce transaction costs and information asymmetry between bidder and targets. While this role is more pronounced for cross-border deals (Ferreira et al. 2010), it may also apply to domestic transactions. In fact, He and Huang

[22] To test these conjectures, we look at the acquisitions announced and completed by our sample firm over the period 2002-2014. We use the usual filters to identify acquisitions: 1) the bidding firm must own less than 50% before the deal and is seeking to own more than 90% after completion; 2) the deal has a value of at least $1 million; and 3) the relative size of the deal (deal value over market cap of the equity of the bidder) is at least 1%.

(2017) show that institutional cross-ownership of firms in the same industry facilitate coordination by enhancing information sharing among competing firms, resulting in collaborations in the product market and in acquisitions. However, Table 5 evidences no significant association between acquisition activity and the level of connectedness of the active institutional investors.

Leveraging on the conjecture that central blockholders may exert a positive influence *via* information dissemination and mitigation of firm opacity, thus reducing the cost of information acquisition for outside investors (H3), Table 5 reports the results of the regression between the *information cost index* (*IC*), *degree* and standard controls. IC is intended to measure an outsider's cost of acquiring information and is computed following Duchin, Matsusaka and Ozbas. (2010). [23] Similarly, we also regress alternative measures of a firm's opacity against the same set of variables. As there is little consensus about what the best proxies for a firm's opacity are, we follow Dahiya, Iannotta and Navone (2017) and use the *Amihud* illiquidity measure and the *Number of analysts* as these appear to be the most consistent metrics. As for the previous suggested channels, we are unable to reject the null hypothesis that our dependent variables are not associated with the instrumented *degree* of the active institutional investors.

Additionally, we test the last two postulated hypotheses: the financing (H4) and the innovation effects (H5). As for the former, we consider stock or debt issues (*Newequity/Newdebt*) and the investment-cash flow sensitivity (*CF sensitivity*).[24] As reported

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[23] Specifically, the index combines three separate measures on the availability, homogeneity, and accuracy of analysts' earnings forecasts: the number of analysts, the dispersion of analyst forecasts and the analyst forecast error, measured as the absolute difference between the mean analyst earnings forecast prior to a quarterly earnings announcement and the actual earnings forecasts. For further details on the computation of the index, see Duchin, Matsusaka and Ozbas (2010).

[24] We measure new equity issues, *Newequity*, as a dummy equal to 1 if the net stock issue for the firm in year *t* (that is the aggregate change in total equity in year *t*) is above 0.05. Net stock issue is computed as reported in Hirshleifer, Hsu and Li (2013). The new debt issue, *Newdebt*, is a dummy equal to 1 if the aggregate change in total debt is above 0.05. We consider "large" increases in equity and debt outstanding (above 5%) to avoid capturing small fluctuations in the equity and debt (for example, small increases in equity due to the exercise of stock options and stock plans for employees). A number of independent variables are motivated by the earlier study of Hovakimian and Hu (2016). They include some variables already used in our baseline regressions (Leverage, Firm Size, Stock Return, Market to book, R&D, ROA, PP&E) and newly computed variables: *Industry leverage* is computed as the median leverage for firms in the same industry using the 48 Fama-French industry classification; *NOCL* is net operating loss carryforwards scaled by total assets. All independent and control variables are measured as of the beginning of year *t*.

in Table 5, there is no statistically significant relationship between an investor's centrality and the issuing activities of firms. Therefore, our results do not support the view that the increase in firm value is driven by a central investor's ability to lessen credit rationing. In the same Table, we further test the financing channel by analyzing the cash flow sensitivity to investments for firms with more central institutional blockholders.[25] As mentioned above, if investor centrality helps a firm reduce the cost of external financing, we can expect investments to be less dependent on the internal cash flows. However, we do not document any statistical relationship.

Finally, we test the relationship between innovation propensity and institutional investor centrality. We proxy innovation propensity by *R&D* expenditures scaled by total assets. Following the literature on innovation (among others, Luong et al. 2017), we control for standard firm characteristics (Firm size, Firm age, Capex, PP&E, Leverage, ROA, Tobin's Q). Although the two-stage least square regressions show a positive association between degree centrality and innovation propensity, this is not statistically significant.

To conclude, we find no evidence that firms with more connected active institutional investors display more effective corporate governance, acquisition performance, lower information costs, easier financing or superior R&D investment propensity. We believe that these results provide ground to the hypothesis that higher firm valuations are indeed driven by the certification that more central active institutional investors provide through their blockholdings.

[25] Our dependent variable is the investment ratio calculated as the firm's fixed investment deflated by capital stock at the beginning of the year. The *Cash-flow ratio* is the firm's internal cash flow deflated by capital stock at the beginning of the year; the cash-flow ratio reflects whether a firm is able to generate enough cash to maintain investments or whether it may require external financing. We also add the interaction term between the *Cash flow ratio* and the *degree centrality* of the first largest institutional blockholder in order to investigate central investors ability to facilitate external financing, thus reducing sensitivity to internal cash. The set of control variables includes those commonly used in previous studies (see among others Hovakimian, 2009) such as Tobin's Q, Leverage, PP&E, Firm Size, Market-to-book, Sales growth, Firm age, Capex.

7. Robustness checks

In the following section, we provide five robustness checks that further validate our findings. First, we show that the importance of institutional investor centrality holds when we control for director centrality. Second, as the network centrality is gauged by different metrics, we show that our results are invariant to the measure used. Third, we document that the association between investor centrality and firm value holds when we replace Tobin's Q with Total Q (Peters and Taylor, 2017), which includes the intangible capital, and with industry-year fixed effects. Fourth, in order to dispel any doubt that the centrality overlaps with the concept of common ownership (Azar, Schmalz and Tecu, 2018; Backus et al., 2019; Dennis, Girardi, and Schenone, 2019), we document that the degree centrality remains highly significant after controlling for a measure of common ownership. Finally, in order to further provide support to the certification effect, we present a modified version of degree centrality aimed at identifying the active investor that first acquires a firm stake with respect to those that follow behind.

[INSERT TABLE 6 ABOUT HERE]

7.1 Director centrality

Recently, the directors' network has attracted lot of attention. For instance, Larcker et al. (2013) find that director centrality increases firm value. So, it could be argued that the relationship we document is the resulting effect of the indirect effect of director centrality (if director and investor centrality are indeed correlated). To rule out the possibility that our results are indeed driven by director centrality, we include the *degree* of the most central director, along with the investor connectedness and usual controls (Table 6, model 1).[26] The model in Table 6 (control

[26] We draw data for boards of directors from RiskMetrics. Due to the incomplete firm coverage (largest 1,500 US companies), the number of observations in the regressions is greatly reduced.

variables are not reported for the sake of space), which replicates models 7-8 in Table 4, suggests that our results are not driven by an indirect effect of the director centrality. Whilst investor centrality is always positive and significant, we do not find evidence that director degree affects firm value.

7.2 Alternative measures of centrality

We mentioned earlier that the *degree* is not the only centrality measures. *Eigenvector* and *betweenness* are other commonly alternative measures used in network studies. Although these measures capture a somehow different facet of centrality, where *eigenvector* tends to weight more those connections with highly connected investors and *betweenness* measures the ability to act as a bridge between otherwise unconnected investors, they similarly proxy the ability to act as information crossroads and offer an indication of the investor's *status* within the network. Table 6 shows the results of our IV specifications of Table 4 model 7-8 employing *eigenvector* (Model 2) and *betweenness* (Model 3). All the regression models confirm what was previously documented and show that the relationship between the position within the network of the institutional investor and firm value is not driven by the centrality metric we employ.

7.3 Alternative measures of Tobin's Q

As noted (Lewellen and Badrinath, 1997; Erickson and Whited, 2000 and 2006), the proxy of firm value (Tobin's Q), although widely established and accepted in the literature, is not free from possible measurement errors. While Erikson and Whited (2006) show that computing a more elaborated version of the proxy does not always bring significant improvements,[27] we

[27] Erikson and Whited (2006) write: Tobin's q is widely accepted as a proxy for an underlying "true" q, which is assumed to characterize a firm's incentive to invest. Researchers have developed numerous methods for computing q. This article assesses the measurement quality of different proxies for q. We adapt the measurement-error consistent estimators in Erickson and Whited (2002) to estimate the extent to which variation in true unobservable q explains variation in different proxies for q.

believe that providing further robustness is beneficial to reassure about the solidity of the paper's findings.

Among the several existing different algorithms for estimating Tobin's Q, we propose as a possible robustness, *Total Q* (Peters and Taylor, 2017).[28] As Peters and Taylor (2017) observe, the US economy has shifted towards service and technologically based industries. Intangible capital is of paramount importance and accounts for up to 34% of total capital (Corrado and Hulten, 2010). Differently from traditional measures of Tobin's Q, that focus only on physical assets, *Total Q* includes intangible capital, thus allowing this shift towards intangible assets to be accounted for. In replacing Tobin's Q with Total Q (model 4 of Table 6) as the dependent variable our main results are confirmed.

Additionally, as a further test to mitigate concern about the mismeasurement of Tobin's Q, we also replicate the analysis including industry-year fixed effects to control for unobserved heterogeneity at industry level. In unreported analysis,[29] we find that our results are invariant to these changes.

7.4 Centrality and common ownership

It might be argued that the degree centrality may capture or be highly correlated with common ownership (Azar et al., 2018; Backus et al., 2019; Dennis et al., 2019). While the two concepts are certainly conceptually related, they highlight different aspects. In fact, the common ownership literature has mostly emphasized the connections across firms and the resulting anticompetitive role in specific industries, while our measure of centrality is more focused on valuing the connections across investors and the subsequent effect on firm value. However, in

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We find most proxies for q are poor: careful algorithms for calculating q do little to improve measurement quality. Using elaborate algorithms, however, depletes the number of usable observations and possibly introduces sample selection bias.

[28] *Total Q* is computed as the firm's market value divided by the sum of its physical and intangible capital stocks. Like Lewellen and Badrinath (1997), *Total* Q measures the denominator of the ratio using the replacement cost of the assets.

[29] Results available upon request.

order to dissipate any possible doubt, we add to the baseline regression *Kappa*, a measure of common ownership used in Backus et al. (2019).[30] This measure captures the weight a firm puts on its rivals' profit in its maximization function. Following Rotemberg (1984), the firm wants to maximize the profits of its shareholders, whose portfolios may include equity stakes in other companies. Thus, rivals' profits enter the firm's maximization function because of common ownership. As Backus et al. (2019) argue, this profit weight can be interpreted as the value of a dollar of profits accruing to firm *i*, relative to a dollar of profits for firm *j*, in firm *j*'s profit maximization problem.[31]

The correlation between *Kappa* and *Degree* centrality is 0.4056 which supports the view that centrality and common ownership are indeed related as intuition may suggest. However, results (Table 6, Model 5) show that the effect of active institutional centrality is still confirmed once we control for common ownership. This level reassures that prior findings are not simply due to the omission of a measure of common ownership.

7.5 Leading active investors and followers

It might be argued that a centrality measure does not distinguish between an active investor that first moves, acquiring a stake in the firm's equity, with respect to other investors that merely follow, mimicking the action of a, presumably, more influential actor. To address this concern and to further corroborate the certification effect, we create a measure of the change in investor degree centrality (*Delta connections*) that relies on the concept of leading/following

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[30] We thank Micheal Sinkimson for kindly making this measure (https://sites.google.com/view/msinkinson/research/common-ownership-data) available to us.

[31] Their profit weight measure is an input in the modified Herfindhal Hirshman Index (MHHI) used in the common ownership literature (for example, Azar et al., 2018; Dennis et al., 2018). Differently from MHHI, the profit weight does not require the additional assumption that symmetric Cournot pricing is the relevant strategic game. Moreover, as Backus et al. (2019) point out, use of the MHHI index has been a source of controversy in the common ownership literature for two reasons. The first is its relationship to the now-defunct structure-conduct-performance (SCP) literature in industrial organization. Second, the computation of market shares introduces a market definition problem, as well as several other measurement problems (presence of foreign firms for example). For these reasons, Backus et al. (2019) suggest the implied profit weights to look at common ownership incentives.

investors. To this end, for every investor *j* with an equity block in firm *i*, we compute the change in the investor's degree between year *t-1* and *t* due to blockholding decisions of other institutional investors in companies other than firm *i* but already in the investor *j*'s portfolio.[32] Intuitively, *Delta connections* measures the gain in reputation and certification power that the active institutional investor receives as a result of other active institutional investors following behind.

Given that we measure changes in centrality as the algebraic sum of connections lost and gained over the year, our proxy for centrality can take negative values. Since we are interested in identifying the active investors that first move, we transform *Delta connections* into a binary variable taking the value of 1 if the change in centrality is positive. Table 6, Model 6 presents the results of the analysis where the Tobin's Q is regressed against *Delta connections* instead of the standard degree centrality. In the regression model, the statistical significance of *Delta connections* is below the 1% threshold, which confirms that firm value is positively associated with the centrality of the active investor, but even more so when the investor is a first mover. We interpret this insight as a further support for the certification hypothesis.

8. Conclusions

Despite a widespread presence of institutional blockholders in the US public market, their influence on firm performance is still largely debated. A number of scholars have brought several rationales explaining the channels through which blockholders can represent a good governance mechanism and consequently enhance firm value. However, numerous areas of this relationship are still empirically unclear.

[32] To alleviate the concern that firm *i* performance impacts the change in investor *j* degree centrality, for every firm *i*, we remove the connections that investor *j* gained or lost because of: 1) other investors' purchases/sales in firm *i*; 2) new purchases/sales by investor *j* in other firms. In this second case, our aim is to exclude possible wealth effects in the investor *j* portfolio due to firm *i* performance.

In this paper, we empirically test the effect of active institutional blockholder centrality on firm value. We look at the degree of connectedness established through overlapping blockholding positions with other active institutional investors. In order to gauge the level of connectedness we rely on the metrics used in the social network analysis to assess the centrality of each actor. Based on a sample of 21,658 US firm-year observations in the period 2001 to 2013, we document that the level of active institutional investor centrality is strongly and positively associated with firm value.

After finding no support for several alternative explanations (advisory effect, information cost effect, monitoring effect, financing effect, and innovation effect), we argue that central and more prestigious active institutional investors may serve as a certification provider for the invested company which, in turn, increases its value. Since there is not a direct test for certification, the lack of any evidence supporting alternative hypotheses is relevant for our purpose. However, we acknowledge that we cannot completely rule out that the effect we attribute to the certification is originated by some other untested channel that was not considered in our study and therefore we leave this question open for future research.

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Appendix A. Variables description

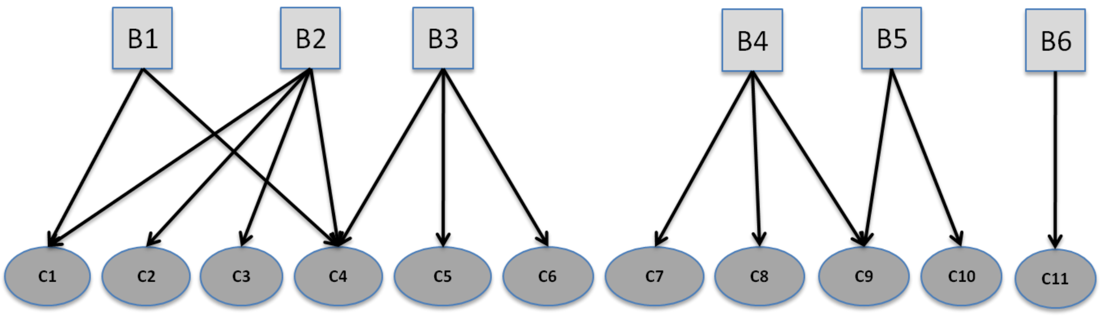
Variable	Description
Acquisition dummy	Dummy variable: it takes the value one if the firm makes at least one acquisition in year *t.*
Amihud	Amihud (2002) liquidity measure: annual average of daily $\|R_i\|$/(Volume * Price). $\|R_i\|$ is the daily return impact associated with one dollar of trading volume.
Betweenness	Betweenness centrality of the largest blockholder: the ratio of the shortest paths between all pairs of institutional blockholders in the network which pass through the largest institutional blockholder (deflated by the number of alternative shortest paths).
Capex	Capital expenditures scaled by total assets.
Cash Flow Ratio	Firm's internal cash flow deflated by capital stock at the beginning of the year.
Cash holding	Ratio of cash and short term investments to total assets.
Degree	Degree centrality of the largest blockholder: the number of ties with other institutional blockholders holding a block in the same firms. This measure is normalized by dividing it by the maximum number of connections (*N-1*).
Degree_dir	Degree centrality of the most central director: the number of ties (common board) with other directors. This measure is normalized by dividing it by the maximum number of connections (*N-1*).
Delta connections	Dummy variable: for each firm *i*, it takes the value of one if there is a positive change in the largest institutional blockholder *j*'s degree between year *t-1* and *t* due to blockholding decisions of other institutional investors in companies other than firm *i* but already in the investor *j*'s portfolio.
Eigenvector	Eigenvector centrality of the largest blockholder: the degree of connection with other well-connected institutional blockholders holding a block in the same firms. This measure is normalized by dividing it by the maximum possible eigenvector element value for an N actor network.
Entrenchment index	Calculated as in Bebchuk, Cohen, and Ferrell (2009), it takes a value from 0 to 6, based on the number of the following provisions that the company has in a given year: staggered boards, limits to shareholder amendments of the bylaws, supermajority requirements for mergers, supermajority requirements for charter amendments, poison pills, and golden parachute arrangements.
Firm age	Number of years since the firm first appears in CRSP.
Firm size	Log (total assets).
First own	Ownership stake of the largest institutional blockholder, in percent of shares outstanding.
Forced turnover	Dummy variable: it takes the value of one if the incumbent CEO is in office for the larger part of fiscal year t but no longer in fiscal year t+1, and the departure was involuntary.
Herfindhal	Blockholder dispersion – Herfindahl Index (scaled) calculated on the ownership stakes of all institutional blockholders in the firm.
Industry Leverage	Median leverage for firms with the same 48 Fama-Fama classification.
Information cost index	It represents how costly it is for outsiders to acquire information about the firm. It is calculated as in Duchin, Matsusaka and Ozbas (2010).
Inst Size	Log (total holdings reported in 13f filings) of the institutional blockholder.
Intangibles	Ratio of intangible assets to total assets.

Investment Ratio	Firm's fixed investment deflated by capital stock at the beginning of the year.
Kappa	It represents the weight a firm puts on its rivals' profit in its maximization function. It is calculated as in Backus, Conlon, Sinkinson (2019).
Leverage	Ratio of long-term debt to total assets.
Market to book	Ratio of the market value of equity to book value of equity.
Newdebt	Dummy variable: it takes the value of 1 if the aggregate change in total debt is above 0.05.
Newequity	Dummy variable: it takes the value of 1 if the net stock issue for the firm in year *t* is above 0.05. Net stock issue is the aggregate change in total equity in year *t* and is computed as reported in Hirshleifer, Hsu and Li (2013).
NOLC	Net operating loss carry forward to total assets.
Number of analysts	Number of analysts who posted forecasts about the firm in a given year.
Property, Plant and Equipment	Property, plant and equipment scaled by total assets.
Ptf Herf	Institutional portfolio dispersion: Herfindahl Index (scaled) based on the value of each stock-holding on the institutional portfolio.
R&D	R&D expenditure scaled by total assets.
ROA	Operating income before depreciation to total assets.
Sales growth	Annual sales growth (percent change in sale).
Std.Dev. returns	Standard deviation of daily returns over the calendar year.
Stock returns	Stock return over the calendar year.
SP	Dummy variable: it takes the value of one if the company is included in the S&P500 during the entire year.
Total Q	Total Q, defined as ratio of the market value of outstanding equity, plus book value of debt minus the firm's current assets to the sum of physical and intangible capital.
Tobin Q	Tobin's Q, defined as the ratio of book value of assets minus book value of equity plus market value of equity to book value of total assets.
Total acquisitions value	Total value of acquisitions made by firm *i* in year *t* standardized by the market value of the firm's equity at the beginning of the year.

Figure 1. Visual representation of networks

Construction of a projected network of active institutional blockholders. a) Bipartite network of active institutional blockholders (B1, B2, B3, B4, B5 and B6) and firms (C1, C2, C3, C4, C5, C6, C7, C8, C9, C10, C11). b) One-mode projection of the bipartite network onto the set of active institutional blockholders.

a)



b)

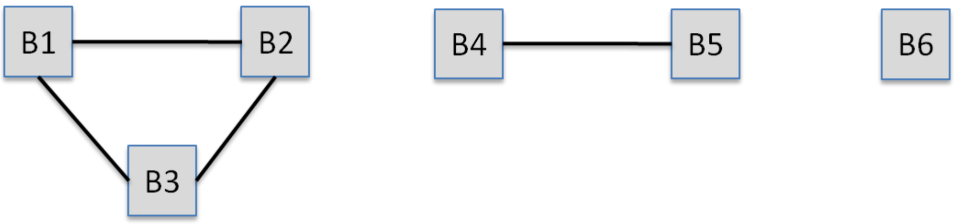


Figure 2. Institutional blockholder network visualization

This figure is the visualization of the network formed by active institutional investors holding a block in the same firm in 2013. Circle nodes on the graph represent active institutional blockholders. The node size scales with the degree measure (e.g., the number of ties with other active institutional blockholders holding blocks in the same firms), while the colours correspond to different clusters.

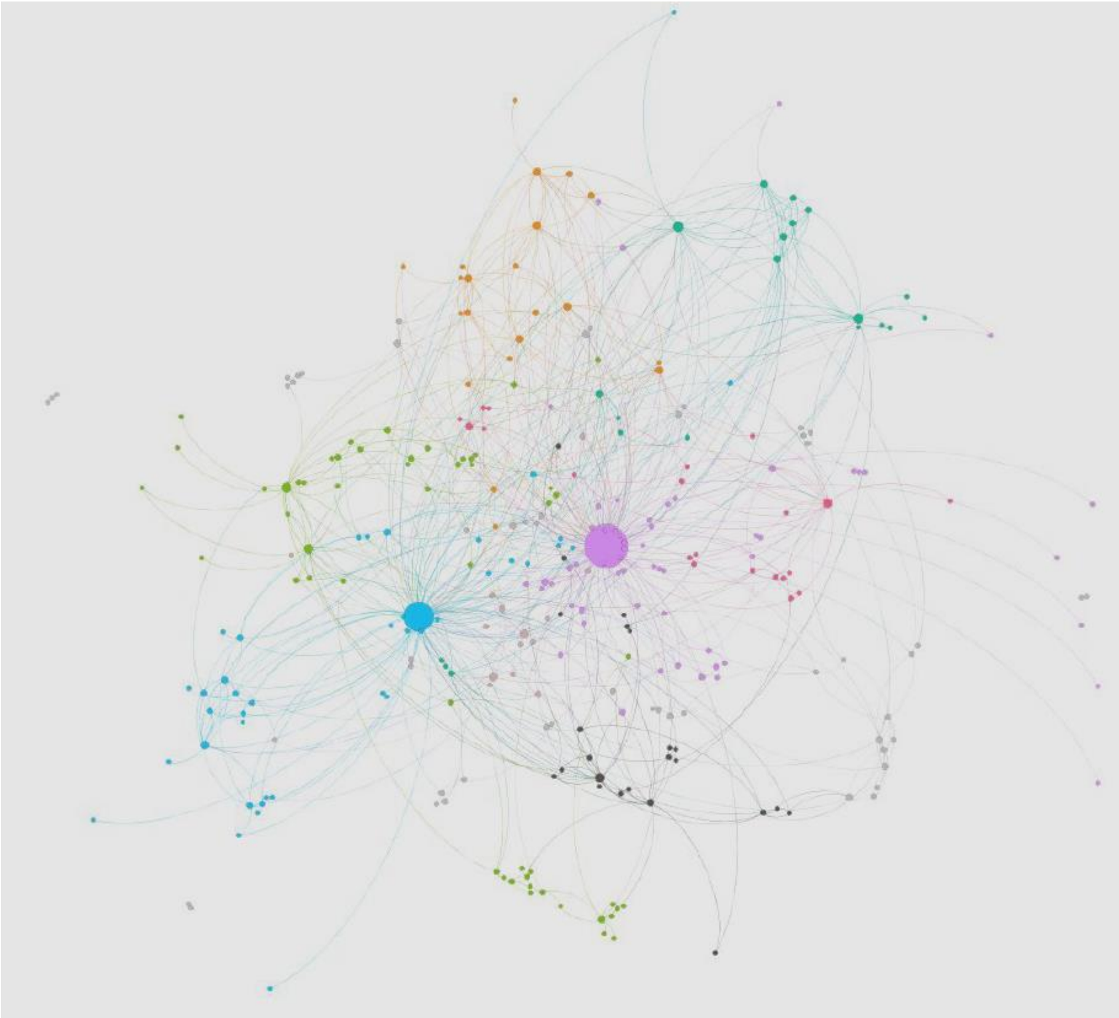


Table 1. Overview of institutional block-ownership and network centrality.

This table reports descriptive statistics for the evolution of institutional block-ownership and network centrality in the period 2001-2013. *Block-owned firms* is the overall number of firms that are participated by at least one active institutional blockholder in each year. *Institutional blockholders* is the number of active institutional investors holding at least one 5% equity stake. *Nblocks* is the average number of firms where each active institutional blockholder has a block. *Degree, eigenvector* and *betweenness* report the average of each centrality measure for the set of active institutional blockholders.

Year	*Block-owned firms*	*Institutional blockholders*	*Nblocks*	*Degree*	*Eigenvector*	*Betweenness*
2001	1509	272	13	0.0227	0.0342	0.0059
2002	1528	266	13	0.0242	0.0340	0.0061
2003	1514	264	14	0.0255	0.0365	0.0055
2004	1668	301	13	0.0217	0.0337	0.0055
2005	1750	338	13	0.0206	0.0330	0.0051
2006	1752	369	12	0.0197	0.03102	0.0047
2007	1830	451	11	0.0173	0.0283	0.0038
2008	1686	440	10	0.0145	0.0274	0.0040
2009	1758	362	14	0.0167	0.0312	0.0041
2010	1777	358	14	0.0163	0.0330	0.0042
2011	1707	377	12	0.0149	0.0311	0.0040
2012	1744	363	11	0.0149	0.0310	0.0046
2013	1435	375	8	0.0133	0.0292	0.0049

Table 2. Descriptive statistics

This table reports summary statistics for variables used in the study. These statistics are based on the data included in the regression analysis. All variables are winsorized at 1% level. Detailed variable definitions are in the Appendix.

	Panel A – Firm characteristics					
	N	Mean	Min	Max	Median	Sd
Tobin Q	21,615	2.08	0.58	11.25	1.57	1.53
Total Assets	21,649	2,142.07	2.15	92,934	476.67	6,015.02
Leverage	21,658	0.21	0	1	0.15	0.22
Capex	21,565	0.05	0	0.34	0.03	0.06
Intangibles	21,204	0.17	0	0.73	0.10	0.19
Sales growth	21,111	0.15	-0.75	3.44	0.08	0.48
Roa	20,415	0.07	-0.78	0.43	0.11	0.18
Firm age	20,461	17.00	0	80	13	16.01
R&D	19,599	0.06	0	0.62	0.01	0.11
Property, Plant and Equipment	20,457	0.23	0.00	0.89	0.16	0.22
Amihud	21,260	0.63	0.00	23.62	0.01	2.95
Std. Dev. returns	20,455	0.03	0.01	0.09	0.03	0.02
SP	21,658	0.10	0	1	0	0.29
	Panel B – Largest Blockholder characteristics					
	N	Mean	Min	Max	Median	Sd
Degree	21,658	0.24	0.00	0.59	0.15	0.21
Eigenvector	21,658	0.22	0.00	0.50	0.18	0.17
Betweenness	21,658	0.17	0.00	0.57	0.05	0.19
Herfindal	21,658	0.78	0.25	1	1	0.27
First own	21,658	0.11	0.05	0.45	0.09	0.06
Inst Size ($mil)	21,658	233,000	95,700	1,210,000	98,000	272,000
Ptf Herf	21,658	0.03	0.00	0.45	0.01	0.07

Table 3. Tobin's Q and network centrality of the largest active institutional blockholder

This Table reports the coefficients of unbalanced panel regressions of Tobin's Q on network centrality and other control variables. All our specifications include firm and year fixed effects. Detailed variable definitions are in the Appendix. All variables are winsorized at 1% level. Standard errors are in parentheses and are clustered at firm level. ***, ** and * denote significance at the 1, 5, and 10% level, respectively.

	(1)	(2)	(3)	(4)
Degree	0.218***	0.303***	0.306***	0.394***
	(0.059)	(0.055)	(0.055)	(0.057)
SP		0.990*	0.979*	0.977*
		(0.566)	(0.569)	(0.571)
Leverage		-0.065	-0.060	-0.053
		(0.111)	(0.111)	(0.111)
Capex		1.538***	1.536***	1.532***
		(0.302)	(0.301)	(0.302)
Intangibles		-1.179***	-1.177***	-1.177***
		0.139)	(0.139)	(0.138)
Firm size		-0.494***	-0.504***	-0.507***
		(0.047)	(0.047)	(0.047)
Sales growth		0.209***	0.208***	0.209***
		(0.037)	(0.037)	(0.037)
Roa		1.718***	1.703***	1.692***
		(0.212)	(0.212)	(0.212)
Firm Age		-0.004	-0.005	-0.005
		(0.027)	(0.026)	(0.026)
R&D		2.916***	2.897***	2.879***
		(0.523)	(0.527)	(0.526)
PP&E		-1.805***	-1.800***	-1.786***
		(0.219)	(0.219)	(0.218)
Amihud		-0.017***	-0.017***	-0.017***
		(0.004)	(0.004)	(0.004)
Std. Dev. returns		1.254	1.268	1.210
		(1.08)	(1.076)	(1.075)
Inst Size			0.033***	0.049***
			(0.009)	(0.010)
Herfindhal			0.032	0.031
			(0.034)	(0.035)
First own				-0.445**
				(0.226)
Ptf Herf				0.902***
				(0.251)
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Adjusted R^2	0.0921	0.2138	0.2151	0.2165
Observations	21,615	19,513	19,513	19,513

Table 4. 2SLS estimates of Tobin's Q and network centrality of the largest active institutional blockholder

This Table reports the coefficients of two-stage least square regression analysis. The instrumental variable is a binary variable (*scandal*) that takes the value of one when two conditions are jointly met (and zero otherwise): a) at the time of the 2003 trading scandal the largest active institutional investor of the firm is a scandal fund and b) for the period 2003 – 2006. In the second stage *Degree** is the predicted value of *Degree* from first stage regressions. All our specifications include firm and year fixed effects. Detailed variable definitions are in the Appendix. All variables are winsorized at 1% level. Robust standard errors are in parentheses. ***, ** and * denote significance at the 1, 5, and 10% level, respectively.

	First stage Degree (1)	Second stage Tobin Q (2)	First stage Degree (3)	Second stage Tobin Q (4)	First stage Degree (5)	Second stage Tobin Q (6)	First stage Degree (7)	Second stage Tobin Q (8)
*Degree**		3.464***		2.531***		2.706***		2.941***
		(0.863)		(0.743)		(0.766)		(0.809)
Scandal	-0.059***		-0.058***		-0.057***		-0.053***	
	(0.009)		(0.009)		(0.009)		(0.008)	
SP			-0.068*	1.130***	-0.070*	1.137***	-0.061*	1.121***
			(0.038)	(0.296)	(0.038)	(0.297)	(0.031)	(0.299)
Leverage			-0.026**	-0.005	-0.026**	0.006	-0.029***	0.025
			(0.012)	(0.096)	(0.012)	(0.097)	(0.011)	(0.097)
Capex			0.057	1.401***	0.062	1.377***	0.051	1.390***
			(0.048)	(0.282)	(0.048)	(0.287)	(0.045)	(0.289)
Intangibles			-0.010	-1.160***	-0.010	-1.155***	-0.005	-1.165***
			(0.019)	(0.116)	(0.019)	(0.118)	(0.018)	(0.116)
Firm size			0.040***	-0.581***	0.041***	-0.601***	0.040***	-0.608***
			(0.004)	(0.050)	(0.004)	(0.052)	(0.004)	(0.052)
Sales growth			0.004	0.201***	0.003	0.201***	0.001	0.205***
			(0.003)	(0.034)	(0.003)	(0.035)	(0.003)	(0.035)
Roa			0.012	1.693***	0.012	1.674***	0.022	1.636***
			(0.017)	(0.177)	(0.017)	(0.178)	(0.016)	(0.178)
Firm Age			0.013**	-0.032	0.013***	-0.036	0.010**	-0.030
			(0.005)	(0.024)	(0.005)	(0.024)	(0.004)	(0.023)
R&D			0.032	2.843***	0.033	2.817***	0.048	2.756***
			(0.039)	(0.455)	(0.039)	(0.456)	(0.036)	(0.452)
PP&E			-0.009	-1.783***	-0.010	-1.775***	-0.026	-1.720***
			(0.028)	(0.185)	(0.028)	(0.186)	(0.026)	(0.188)
Amihud			-0.001***	-0.014***	-0.002***	-0.013***	-0.001**	-0.013***
			(0.001)	(0.004)	(0.001)	(0.004)	(0.001)	(0.004)
Std. Dev. returns			-0.120	-1.492	-0.133	1.557	-0.040	1.281
			(0.145)	(1.042)	(0.146)	(1.052)	(0.140)	(1.050)
Inst Size					-0.003**	0.041***	-0.031***	0.129***
					(0.002)	(0.009)	(0.002)	(0.027)
Herfindhal					0.022***	-0.023	0.013**	-0.002
					(0.006)	(0.037)	(0.005)	(0.034)
First own							0.235***	-1.055***
							(0.036)	(0.292)
Ptf Herf							-1.475***	4.663***
							(0.041)	(1.217)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
F-statistic		39.167		37.599		34.498		39.718
Observations	20,702	20,702	18,772	18,772	18,772	18,772	18,772	18,772

Table 5. Value-creation channels. Column (1) reports the coefficients of the second stage from a two-stage probit regression where the dependent variable is the *Forced turnover*. Column (2) reports the coefficients of the second stage from a two-stage least square regressions for *BCF corporate governance index*. Column (3) reports the coefficients of the second stage from a two-stage probit regression where the dependent variable is a binary variable that takes the value one if the firm makes at least one acquisition in year *t* (*Acquisition dummy*). Column (4) reports the coefficients of the second stage from a two-stage tobit regression where the dependent variable is the *Total acquisitions value.* Columns (5)-(7) report the coefficients of the second-stage regressions from a two-stage least square regression analysis of the *Information cost index, Amihud's illiquidity ratio* and *Number of analysts*. The instrumental variable is a binary variable (*scandal*) that takes the value of one when two conditions are jointly met (and zero otherwise): a) at the time of the 2003 trading scandal the largest active institutional investor of the firm is a scandal fund and b) for the period 2003 – 2006. In the second stage Degree* is the predicted value of Degree from first stage regressions. Models (2)-(5)-(6)-(7) include firm and year fixed effects. Models (1)-(3)-(4) include fixed effects in the form of time dummies and industry dummies based on the 2-digit Standard Industrial Classification (SIC) code. Detailed variable definitions are in the Appendix. All variables are winsorized at the 1% level and are lagged in model (1). Robust standard errors are in parentheses.***, ** and * denote significance at the 1, 5, and 10% level, respectively.

	Panel A – Monitoring & advisoring				Panel B - Information		
	Forced turnover (1)	Entrenchment index (2)	Acquisition dummy (3)	Total acq.value (4)	Information cost index (5)	Amihud (6)	Number of analysts (7)
*Degree**	2.728	1.228	-1.175	-0.373	0.100	-0.406	-4.116
	(2.400)	(0.840)	(0.806)	(0.287)	(0.095)	(1.745)	(2.583)
Firm size	0.069	0.129***	0.176***	0.050***	-0.082***	-0.656***	3.315***
	(0.078)	(0.032)	(0.020)	(0.009)	(0.004)	(0.082)	(0.121)
Intangibles	0.274	0.070	0.638***	0.186***	-0.012	0.403**	-2.577***
	(0.387)	(0.125)	(0.080)	(0.024)	(0.012)	(0.178)	(0.328)
Leverage	0.089	-0.096	-0.401***	-0.097***	0.046***	0.729***	-0.719***
	(0.308)	(0.079)	(0.091)	(0.035)	(0.008)	(0.137)	(0.225)
Sales growth	-0.408**	-0.106***	0.077***	0.027***	0.006***	-0.071*	-0.323***
	(0.187)	(0.036)	(0.023)	(0.008)	(0.002)	(0.041)	(0.059)
Capex		-0.388			-0.182***	-2.703***	5.526***
		(0.325)			(0.027)	(0.496)	(0.800)
Amihud		-0.016			-0.000		-0.002
		(0.019)			(0.001)		(0.016)
Stock returns	-0.249						
	(0.156)						
Std. Dev. returns	11.348						
	(9.361)						
Cash holding			-0.153*	-0.074***			
			(0.078)	(0.027)			
Market to book			-0.000	-0.000			
			(0.000)	(0.000)			
SP					-0.104***	0.344**	5.228***
					(0.024)	(0.146)	(0.978)
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm		Yes			Yes	Yes	Yes
Industry	Yes		Yes	Yes			
F-statistic	76.853	26,741	37,717	37.717	40.193	39.471	40.193
Obs.	3,094	8,771	20,488	19,880	17,267	19,499	17,267

Table 5. Value-creation channels (continued). Columns (8)-(9) report the coefficients of the second stage from a two-stage probit regression where the dependent variable is a binary variable that takes the value one if the net stock/debt issue for the firm in year t is above 0.05. Column (10) reports the coefficients of the second stage from a two-stage least square regression for the *Investment-Cash Flow Sensisitivity.*Column (11) reports the coefficients of the second stage from a two-stage least

square regression for the *R&D expenditure*. The instrumental variable is a binary variable (*scandal*) that takes the value of one when two conditions are jointly met (and zero otherwise): a) at the time of the 2003 trading scandal the largest active institutional investor of the firm is a scandal fund and b) for the period 2003 – 2006. In the second stage Degree* is the predicted value of Degree from first stage regressions. Models (10)-(11) include firm and year fixed effects. Models (8)-(9) include fixed effects in the form of time dummies and industry dummies based on the 2-digit Standard Industrial Classification (SIC) code. Detailed variable definitions are in the Appendix. All variables are winsorized at 1% level and are lagged in models (8)-(9)-(11). Robust standard errors are in parentheses.***, ** and * denote significance at the 1, 5, and 10% level, respectively.

	Panel C – Financing & Innovation			
	Newequity (8)	Newdebt (9)	CF sensitivity (10)	R&D (11)
*Degree**	0.207	0.117	-0.002	0.041
	(1.215)	(0.996)	(0.243)	(0.043)
Leverage	0.970***	-2.089***	-0.111***	0.016
	(0.141)	(0.150)	(0.029)	(0.005)
Industry leverage	-1.207***	-0.701**		
	(0.385)	(0.304)		
R&D	1.391***	1.144***		
	(0.277)	(0.252)		
NOLC	0.032*	-0.023		
	(0.024)	(0.022)		
ROA	-1.626***	0.429**		-0.122***
	(0.209)	(0.192)		(0.009)
PP&E	-0.061	0.186	0.102***	0.021**
	(0.140)	(0.114)	(0.029)	(0.008)
Firm size	-0.056**	-0.076***	0.076***	-0.031***
	(0.027)	(0.022)	(0.002)	(0.003)
Market-to-book	0.006	0.007*	0.000	
	(0.004)	(0.004)	(0.000)	
Stock return	0.288***	0.038		
	(0.026)	(0.024)		
Tobin			0.066***	0.009***
			(0.005)	(0.001)
Cash Flow Ratio			-0.007***	
			(0.002)	
Degree Cash Flow*			0.009	
			(0.007)	
Sales growth			0.067***	
			(0.011)	
Firm age			-0.004*	0.000
			(0.013)	(0.000)
Capex				0.019
				(0.012)
Year	Yes	Yes	Yes	Yes
Firm			Yes	Yes
Industry	Yes	Yes		
F-statistic	12.173	33.523	19.425	16.513
Obs.	8,955	9,537	13,732	13,928

Table 6. Robustness analysis

Models 1-5 of this Table report the coefficients of the second-stage from a two-stage least square regression analysis of Tobin's Q on network centrality using additional control variables and alternative measures of centrality as well as an alternative proxy for Q (Total Q as in Peters and Taylor, 2017) and a measure of common ownership (Kappa as in Backus, Conlon, Sinkinson (2019). The instrumental variable is a binary variable (scandal) that takes the value of one when two conditions are jointly met (and zero otherwise): a) at the time of the 2003 trading scandal the largest active institutional investor of the firm is a scandal fund and b) for the period 2003 – 2006. In the second stage Degree*, Eigenvector* and Betweenness* are the predicted value of Degree, Eigenvector and Betweenness from first stage regressions. Model (6) reports the coefficients of unbalanced panel regressions of Tobin's Q on Delta connections and other control variables. All our specifications include firm and year fixed effects. The control variables, whose coefficients are not reported, are the same as those in model (4) of Table 3. Variable definitions are in the Appendix. All variables are winsorized at 1% level. Robust standard errors are in parentheses and are clustered at firm level in model (6). ***, ** and * denote significance at the 1, 5, and 10% level, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
*Degree**	4.810***			4.321***	2.916***	
	(2.162)			(1.070)	(0.829)	
Degree_dir	10.410					
	(25.818)					
*Eigenvector**		4.886***				
		(1.515)				
*Betweenness**			2.474***			
			(0.628)			
Kappa					-1.105	
					(0.808)	
Delta connections						0.070***
						(0.018)
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	8.078	24.539	61.098	40.413	41.584	
Adjusted R^2						0.2010
Observations	8,070	18,772	18,772	18,715	18,295	10,775