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by

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Abstract

Motivated by the centrality measures constructed in Larcker, So and Wang (2013), I affirm that board connectedness positively affect firm performance in Singapore, and even if we were to measure firm performance by Tobin's Q. The impact on firm performance persists over at least four years. Controlling for Corporate Governance using a proprietary database, the Singapore Corporate Governance Index, only the Eigenvector centrality under simple-weighted and hyperbolic-weighted projections survives the robustness test, suggesting that firstly, the local proxy of Corporate Governance based on OECD principles possibly controls for what is proxied by the Betweenness, Closeness and Degree centrality measures, and secondly, there is a strong case not to ignore multiple ties when projecting interlocking boards. The jury is hung on which weighting method is superior – the hyperbolic weighted projection has stronger results for return-on-assets while the simple weighted method has stronger results for Tobin's Q. These results collectively provide additional support that some Corporate Governance indices may already impute the effects of connected boards to a certain extent.

Using the methods for measuring social networks in interlocking boards as a basis, I extend the methodology to the space of ownership networks, a new endeavor since it considers the network distribution and connectedness of firm ownership, rather than focusing solely on the ultimate owners as has been the norm in the existing literature. Contrary to initial expectations, I find that simple methods, disregarding the directedness of the ownership linkages, are sufficient to yield strong results. This paper is the first to document that ownership centrality has a direct impact on corporate performance. Controlling for Corporate Governance using the Singapore Corporate Governance Index, I find that the results for Tobin's Q are fully explained away. However, the results for return-on-assets remain mostly undiluted, with Degree and Eigenvector more significant for the unity-weighted network, and Betweenness and Closeness more significant for the stake-weighted network, making the N-score composite centrality measure a suitable compromise. Composite centrality shows significant influence on firm return-on-assets in the short to medium term.

Keywords: Social Network, Ownership Centrality, Corporate Ownership, Board Centrality, Interlocking Directorates, Corporate Governance, Singapore Corporate Governance Index, SGX, Singapore

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This journey has been quite an exhilarating ride. I now bear personal testimony to and have a renewed heartfelt appreciation of the old African adage, that it takes a village to raise a child, for it would be arrogant and foolish to claim the successful birthing of this dissertation as the outcome of my efforts alone. Without the permission of external environment and favorable conditions and without the assistance of fortuitous fate, concocted opportunities and dumb luck, the completion of this work would have been impossible.

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Introduction

This dissertation investigates the effects of social linkages that span the corporate networks jungle. Herein, I attempt to dissect the qualitative nature of the web of social networks structures across firms in a quantitatively rigorous manner using a consistent diagnostic framework. I extensively apply specific measures originating from graph and network theory, known as the centrality scores, and uncover their corresponding effects on firms. This study uses the stocks listed in Singapore as a basis, and from the data of these firms, two distinct sets of networks for closer analysis were constructed.

The first part explores the effects of interlocking boardroom directorates, adding to the current literature by looking at the longer-term effects of board network ties. Studying the system as a bipartite network, I suggest that the traditional method of analysis is leaving out important information in transposing the network using Flat (unweighted) projections. I augment current studies by looking at how the well-studied framework of Corporate Governance overlaps with boardroom centralities.

The second part applies the methodology developed earlier on the network formed by firm owners, in a unique study of ownership centralities. Initially, the idea was to use more sophisticated network measures in dissecting the weighted and directed network of ownership links, but surprisingly, it turns out simple methods are sufficient to yield concrete robust results, proving among other things that the directionality of ownership is not vital in harvesting useful conclusions from the ownership network.

As in the proverbial story of the blind men and elephant, in this paper the two parts are like what two different blind men feel when they examine different body parts of the elephant – the nebulous ball of intricate relationships and linkages in the corporate network setting of firms listed on the Singapore Exchange is the elephant in the room. This dissertation attempts to put together two different views of the same elephant so that we can understand better the topology of social networks formed by firms and the impact these networks have on them.

Part 1. How many Ties that Bind – A Treatise on Connected Boards

Stripping away the extraneous flourishes, the primary thrust of this dissertation is the novel study on ownership centrality – to test the ways we can apply what we know about graph theory and network theory to capture the relationship between the firm and its shareholders concisely and succinctly. To do this for the United States would be challenging simply because of the enormity of the market - the ownership web can grow complicated very quickly. Hence, I commenced the research on a smaller scale, starting with Singapore[1]. Some would question if Singapore is a reliable test bed, especially in term of recent developments in network centrality. To assuage this concern, I will start by replicating past results of Board Centrality in the Singapore market. Hopefully, the results of the applicability of board centrality on firm performance would go some way in mitigating the apprehension of some skeptics in accepting that Singapore is a useful and relevant test case for testing the empirical relevance of ownership centrality.

Chapter 1.1 Literature Review

1.1.1 Board Connectedness

Besides a film, a play, and a song, the phrase "six degrees of separation" also inspired the formulation of the small world problem, which posits that all humans are connected to one another via six or fewer friends. This is probably the best known social network academic urban legend often attributable to social psychologist Stanley Milgram (Travers and Milgram (1967)). Since then, Sociologists, Economists, and researchers in Management, Accounting and

[1] Takes and Heemskerk (2016) found extremely similar board network topologies between countries, yet large differences when it comes to the relation between economic prominence indicators and firm centrality. In terms of centrality dominance, Singapore ranked 16 out of the 34 national networks studied, very near the median.

Corporate Finance have been studying fervently the impact of social networks on resource allocation, political influence, capital markets, Corporate Finance policies (Fracassi (2016)), labor markets (Chua (2011)), and firm performance.

In Corporate Finance, the common research focus is that of the interlocking boards, also known as connected boards or shared board directorates. The earliest papers tend to investigate how interlocking boards affect executive compensation and turnover (Hallock (1997), Fich and White (2003)), explore the theoretical reasons for this phenomenon (Fich and White (2005)) and the agency theory implications (Hillman and Dalziel (2003), Hallock (1999)).

This empirical paper builds on the strand of literature in Accounting and Corporate Finance that explores the effects of interlocking boards on firm performance. Larcker, et al. (2013) has shown that firms with central boards of directors earn superior risk-adjusted stock returns, better return-on-assets growth, and more positive analyst forecast errors. Their paper is one of the first papers that invoked centrality concepts from graph theory in the Corporate Finance literature space. Intuitively, high network centrality could proxy for the ability to effectively garner and harness private or timely information, expertise, new practices, and favors to create value for and manage risks of the firm. The result of Larcker, et al. (2013) is supported by evidence from the Netherlands (Feyen (2015)), but not in Italy (Croci and Grassi (2012)). Hence, as far as empirical evidence could suggest, it is not clear ex-ante whether firms with high boardroom centrality would have superior firm performance in Singapore.

On the theoretical front, it is also unclear whether we should predict a relationship between high board connectedness and better firm performance. The vast literature in sociology, economics, and finance acknowledges that there are both pros and cons to being highly central in a network. The plausible benefits of highly central boards can come from several channels. First and foremost, highly connected boards have access to more and better information, be it macroeconomic outlooks, idiosyncratic firm risks, industry trends, general market conditions, impending regulatory changes, or insider information. Better and timely access to information is crucial in formulating strategic decision and responses in the boardroom (Mizruchi (1996)). Better access to information would entail better access to innovations through the network, which will allow a highly central board to be an earlier beneficiary as far as diffusion of innovations and new practices are concerned (Shropshire (2010), Omer, Shelley and Tice (2016)). Innovations would include patents, governance best practices, new technologies, innovative financing schemes and compensation structures (Pennings (1980), Faleye, Kovacs and Venkateswaran (2014)). Adams and Ferreira (2007) go to the extent of suggesting that having a friendly board is an optimal choice for the firm, by enabling the board to strategize with management using their collective pool of knowledge and network. Second, highly central boards have better access to resources that may engender lower costs or enable economies of scale (Mol (2001)). Ties between borrower and lender result in larger loan amounts, lower interest rates, and less restrictive covenants (Engelberg, Gao and Parsons (2012)). More central boards enjoy lower bond yield spreads, and this advantage could conceivably translate into better firm performance (Chuluun, Prevost and Puthenpurackal (2014)). Third, social contacts of highly central boards will facilitate the search for new CEOs and directors (Engelberg, Gao and Parsons (2013)[2]), and strengthen ties with current or

[2] One of the earliest research on social networks in Corporate Finance by Engelberg, et al. (2013) mapped out various social linkages and found that an additional connection to an outside executive or director increases compensation by about $17,000 on average. They argued that this dimension

potential suppliers or customers (Hillman and Dalziel (2003)), or even facilitate more efficient mergers and acquisitions (Renneboog and Zhao (2014)). Fourth, highly central boards may be more powerful monitors who can veto management projects that do not enhance firm value (Kroszner and Strahan (2001), Hermalin and Weisbach (1998)). Fifth, firms that have political embeddedness in the boardroom reduce uncertainties and increase opportunities (Haveman, Jia, Shi and Wang (2017)) while also increasing shareholder value (Faccio (2006)) and increasing the chance of bailouts compared to unconnected firms (Faccio, Masulis and McConnell (2006))

On the flip-side, there are compelling reasons why high board centrality might be harmful to firm performance. First, highly central boards would be more susceptible to the spread of disinformation and ostensibly good innovations that might cause ruin in the medium to long term (Snyder, Priem and Levitas (2009), Connelly and Gangloff (2012)). One example is the dubious practice of options backdating, whose legitimacy seemed to be enhanced through boardroom interlocks (Bizjak, Lemmon and Whitby (2009), Brass, Butterfield and Skaggs (1998)). Second, firms with highly central CEOs may engage in empire-building and entrenchment practices at the expense of firm value. El-Khatib, Fogel and Jandik (2015) found that higher CEO centrality is detrimental for corporate outcomes, in this case, the erosion of value in the acquiring firm and combined entity in the highly connected CEO's more rampant pursuit of mergers and acquisitions. Highly central CEOs are not immune to abusing their power and influence to increase entrenchment and reap private benefits at the firm's expense, such as extracting

is not captured by extant corporate governance measures and that this is evidence that there is an efficient contracting explanation for CEO pay.

higher compensation from the firm (Brown, Gao, Lee, Stathopoulos and House (2009), Hwang and Kim (2009)), or appointing friends and sycophants as directors, thereby weakening board monitoring and neutering the purpose of independent board members (Fracassi and Tate (2012), Cohen, Frazzini and Malloy (2012)). Third, the highly central director may be a more effective decision maker, but limited bandwidth coupled with multiple directorships, a situation in firms known as "busy boards", has been shown in multiple studies to be detrimental to firm performance (Fich and Shivdasani (2006), Core, Holthausen and Larcker (1999), Adams, Hermalin and Weisbach (2008)).

On the flip-side of the flip-side, even though multiple directorships have been unequivocally frowned upon by the mainstream academia, evidence has been unearthed that there are certain situations when a busy board setup is beneficial. One such example by Field, Lowry and Mkrtchyan (2013) is the case of the IPO firm. The busy board conundrum is mentioned here as a useful analogy to the problems plaguing entities with high centralities; the busy board puzzle parallels the high centrality paradox. To understand busy boards, we need to recognize that Board serves both monitoring and advisory functions, and depending on the firm life cycle a busy board may or may not be favorable. Is there a high centrality paradox, where high centrality confers power, but absolute power has a tendency to corrupt?

The other complication on the theoretical front is that social networks are inherently complicated, a relationship may not necessarily increase communication and sharing. It is conceivable that increased contacts that board membership facilitates may cause some professional friendships to degenerate into hostile animosity, and the framework we construct does not allow for such nuanced interpretations. Every linkage we assume in our model is a positive link, whereas in reality, it may also indicate indifference, and or a less benign linkage involving backstabbing or dramatic politicking by frenemies.

In this paper, the network is restricted by the observable formal ties between firms formed by interlocking directors. We do not observe any social ties, nor other professional ties formed by shared work experience, nor any alumni ties to educational institutions. Our horizon of observation is also restricted to the set of boards of firms listed in Singapore. This is a problem inherent in all research involving social networks – it is impossible to capture the complete set of relationships between human agents, and studies that purport or attempt to do so may commit the opposite sin of over-reporting. For example, some studies assume a tie when two individuals study in the same education institution in an overlapping timespan. Personal anecdotal experience suggests that there are far more false positives under such a classification scheme than should be assumed. Encouraging results from some studies (Hwang and Kim (2009), Westphal, Boivie, Chng and Han (2006)) show that formal ties and informal ties are correlated and complementary, so in analyzing the most formalized ties in terms of boardroom membership I hope to also capture the impact of informal ties on firm performance. Furthermore, compared to other studies using hand-collected proprietary data, the S&P Capital IQ database used would be more reliable and could be more easily cross-verified.

Recent Corporate Finance papers that study the centrality of interlocking boards approach it from two different lenses. Most of the existing literature focuses on director interlocks and calculating the centralities of the directors (Feyen (2013), Omer, Shelley and Tice (2014)), including the CEO (El-Khatib, et al. (2015)). The firm centrality is then valued as an aggregated metric of the directors (Ang, Owen and Suchard (2017)) or used to compute some derivative measure (Hong (2015)). The other way to calculate this firm characteristic is to compute the firm centrality directly as a bipartite projection of the network of interlocking boards on its boards (Larcker, et al. (2013), Feyen (2013)). The latter is the approach this paper adopts.

Feyen (2013) employs board data in the Netherlands to disentangle two ostensibly different effects, that of interlocking board centrality and director centrality. Using the eigenvector centrality measure as the key measure, he found that high interlocking board centrality is beneficial for the firm, whereas firms with high director centrality had inferior stock returns. Moreover, he found that interlock ties only affect returns when they are active and that the access to value-enhancing resources decays rapidly after the dissolution of these ties. Unlike interlocking board directorates, the relevance of ties persists long after directors leave a board. This persistence effect is congruent with results by Gray and Nowland (2013) who, using data from Australia, found that both the breadth and depth (i.e. the number of prior years and the number of current directorships) of a new director's experience is valued by the capital markets.

I assess how well-connected firms are using four standard measures used in network theory. First, a board may be central if it is connected to more boards. Such a board is said to be high in Degree centrality (Proctor and Loomis (1951), Freeman (1978)), and can be thought of as having many sources and conduits of information and support. Second, a board may be central if it is connected to important boards, with the importance of a board defined as the number of important boards it is in-turn connected to. Such a board is said to be high in Eigenvector centrality (Bonacich (1972)), and can be thought of as having access to better quality information and resources. Third, a board may be central if it takes fewer steps to get to everyone else in the entire network, the primary idea behind "six degrees[3] of separation". Such a board is said to be high in Closeness centrality (Sabidussi (1966)), and can be thought of as having a faster speed in information access or dissemination to the rest of the network. Fourth, a board may be central if it straddles between other groups of boards. Such boards are said to be high in Betweenness centrality (Freeman (1978)), and are often thought of as the brokers or gatekeepers or chokepoints of information and resources. Finally, the N-score Composite centrality measure had its basis on principal component analysis and was first proposed by Larcker, et al. (2013). As could be inferred from its name, it is a summary statistic of the four centrality measures mentioned above.

Degree centrality is a local measure. Betweenness, Closeness and Eigenvector centralities are network measures, wherein a small change far away may impact a firm's Eigenvector centrality even though nothing changed in its immediate neighborhood. Betweenness and Closeness are somewhat non-intuitive in the way it is computed, in that it assumes information and resources flow solely in the shortest path connecting two firms, ignoring all other possible but longer paths. This appears to be an unrealistic assumption (Kedia and Rajgopal (2009)). What lends more intuitive sense are the newer measures of Flow-betweenness (Newman (2005)) and Flow-closeness (Stephenson and Zelen (1989)), where all the possible paths between two firms are considered in the computation of the final Flow-betweenness and Flow-closeness scores. The innovation these measures use is the analogy from the flow of electrical current between any two points in the network.

[3] An unfortunate conflation in terminology: "Degree" in "six degrees of separation" refer to closeness centrality, the inverse of which is the number of steps needed to reach everyone else in the network, which is a fundamentally different concept from degree centrality which measures the number of immediate neighbors.

Electricity does not flow only via the shortest path or only via the path of least resistance. It flows along all paths but in varying amounts inversely proportionate to the resistance along that path. This arguably is a more acceptable probabilistic model of information flow in the real world. However, very preliminary investigations yielded no concrete advantages of these new measures, and so the results are not reported in this paper. Similarly, Croci and Grassi (2012) also did not find significant differences in results between the Flow-betweenness and Betweenness measures.

One major thrust of this paper is to provide empirical support for a more widespread use of weighted projection methods. Existing literature in Corporate Finance by seminal papers such as Larcker, et al. (2013) ignore the number of interlocks. Some papers use weighted projections without justification (Croci and Grassi (2012)). This paper hopes to provide some empirical support to favor the use of weighted projection methodologies in future papers in Corporate Finance and Management dealing with social network theory. Intuitively, we are modeling the board interlocks as conduits for information flow and access to resources, as linkages for reciprocal favors. In that light, if two firms are linked by one shared director, and two other firms are linked by three directors, we should expect the link in the latter case to be stronger than the former. Preserving weightedness in projections allows us to model such expectations.

This paper complements Ang, et al. (2017) in that both papers study the impact of interlocking boards on firm performance in Singapore, but there are key differences in sample and methodologies. First, their sample covers both Hong Kong and Singapore, while this paper focuses only on Singapore. Second, they used a director projection of interlocking directorates while this paper uses the board projection. Third, their centrality variables are binary, above- or below-median, whereas this paper uses ordinal quintile variables. The results I obtain augment the results of their paper while setting up a basis of comparison for the second part of this dissertation.

In their studies, as robustness checks, Larcker, et al. (2013) controlled for some Corporate Governance factors, namely staggered board, poison pill, limits to special meeting, percentage of independent directors, CEO-Chairman duality, dual-class shares, and the G-index (Gompers, Ishii and Metrick (2003)). They found that the results for board centrality were not affected, suggesting that boardroom related governance characteristics are not driving the boardroom centrality results. These results do not reconcile fully with this paper, perhaps due to differences in Corporate Governance measures used.

1.1.2 Corporate Governance

Corporate governance refers to mechanisms concerned with the resolution of collective action problems among dispersed investors and the equitable reconciliation of conflicts of interest between various claim holders so as to maximize the value of the firm to its shareholders (Becht, Bolton and Röell (2003), Denis and McConnell (2003)). Arguably the first Corporate Governance paper to spark widespread interest in the subject, Gompers, et al. (2003) studied the impact of Corporate Governance on firm performance during the 1990s. They established a Governance Index constructed using an index of 24 anti-takeover provisions and showed that the "Democratic" portfolio with strongest shareholder rights protection outperformed the "Dictatorship" portfolio. They found that a long-Democracy-short-Dictatorship portfolio had positive abnormal returns. They also documented that firms with stronger shareholder rights had higher firm value, higher profits and sales growth, while concurrently having lower capital expenditures and making few acquisitions. Their ground-breaking work sparked off a wave of follow-up research on Corporate Governance.

Klapper and Love (2004) widened the research coverage to 495 firms across 25 emerging markets and 18 sectors, and they found a positive correlation between market value or operating performance and Corporate Governance. The relationship is accentuated for firms operating in weaker legal environments. They argued that firm-level governance is correlated with variables related to the extent of asymmetric information and contracting imperfections facing the firm, which they proxied with firm size and asset intangibility, while sales growth acted as a proxy for growth opportunities. The study by Durnev and Kim (2005) was similar in nature, covering 859 large firms in 27 countries. Cremers and Nair (2005) found that the market for corporate control (external governance) and shareholder activism (internal governance) interacts interestingly – firms with the highest level of takeover vulnerability outperform only when public pension fund (the block-holder) ownership is high as well.

Bebchuk, Cohen and Ferrell (2009) introduced the term, entrenchment index, into the vernacular of Corporate Governance research. This index is based on a subset of six out of 24 governance provisions developed by the Investor Responsibility Research Center (IRRC). Using Tobin's Q as a proxy for firm valuation, they found that higher entrenchment hurts U.S. firm values for the period 1990 to 2003.

Bhagat and Bolton (2008) found that firms with better governance[4] are

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[4] Corporate governance measured using the Gompers, et al. (2003) index, Bebchuk, et al. (2009) index, stock ownership of board members, and the separation of CEO-Chair.

significantly correlated with better operating performance contemporaneously and subsequently. However, contrary to earlier studies, the governance measures are found to be uncorrelated with subsequent stock market performance, especially when one considers the endogenous nature of the relationship between governance and stock market performance. They assert that corporate board ownership is a better measure of Corporate Governance.

In terms of international measures of Corporate Governance, in the wake of Gompers, et al. (2003), there have been multiple efforts to develop similar indices in other countries, such as Korea (Black, Jang and Kim (2006)), Russia (Black, Love and Rachinsky (2006)) and Singapore (Goh and Lee (2009)).

Chapter 1.2 Data and Methodology

Graph theory is the study of structures used to model relationships between objects, with objects represented as nodes or vertices, connected by edges or arcs. Network theory provides scaffolding to graph theory to study complex interacting systems so that we can study node attributes, edge directedness. In this paper, we will use results of these theories in parsing bipartite networks.

1.2.1 Bipartite Networks Projection

To the best of my knowledge, nearly all of the recent papers in Corporate Finance dealing with Social Network that used centrality, including Larcker, et al. (2013), El-Khatib, et al. (2015), Hong (2015), Ang, et al. (2017) used the same empirical framework to derive the network of boards or the network of directors. One exception is Croci and Grassi (2012) which employed the simple weighted projection method.

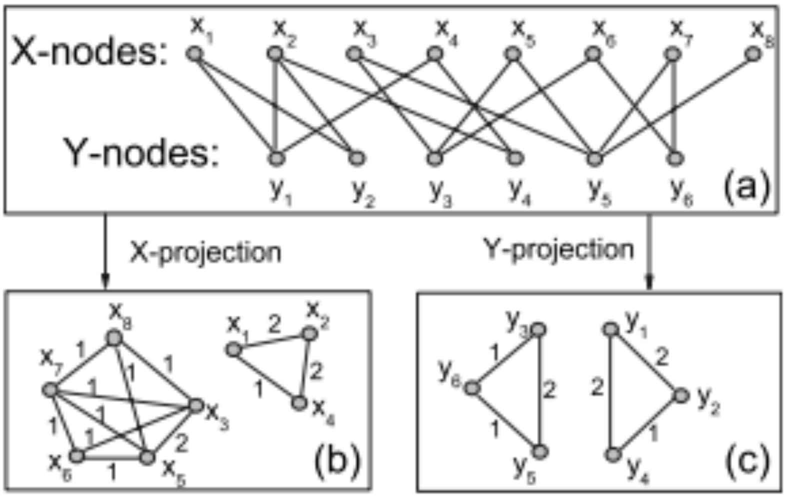
If they are building a network of boards, two boards are connected if they share one or more common directors. If they are building a network of directors (which may include CEOs in the final analysis), two directors are connected if they share one or more common boards. For lack of a better term, I will term this method of resolving connectedness the Flat projection.

An interlocking board network is made up of two types of nodes, the director node and the board/firm node. In graph terminology, this graph has two modes, and the resultant graph is the typical bipartite graph. There are established ways to deal with the transformation of the bipartite graph to the one-mode network which, I would argue, have an equal if not stronger theoretical basis than the current practice. I will explore two of these projection methods in this paper, the simple weighted projection and the collaboration based projection. However, before that, a little primer on the bipartite projection process is presented here for ease of reference.

1.2.1.1 Board and Director Projections from Interlocking Boards

Bipartite network projection is used widely to compress information about bipartite networks. Since the one-mode projection is always less informative than the original bipartite graph, an appropriate method for weighting network connections is crucial.

There is an extensive usage of bipartite network projections to convert information from the two-mode network to one-mode form. One of the best Figures depicting the relationship between bipartite networks and the monopartite counterparts I have come across is from Zhou, Ren, Medo and Zhang (2007), from which I reproduce the Figure below.



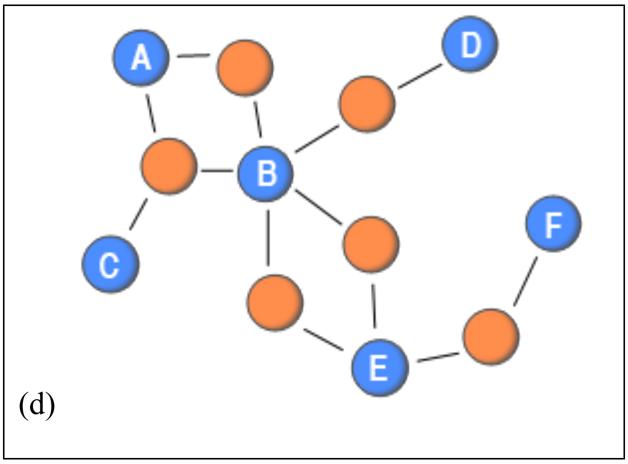
In this Figure, Box (a) depicts the bipartite network, which in our case would be the interlocking board network. X-nodes could be thought of as the Directors, and the Y-nodes could be thought of as the firms or boards. Box (b) shows the Director-projection, and Box (c) the Board-projection. The weights in the edges signify the number of common neighbors, using the simple weighted method, abbreviated as the Weighted projection in this paper.

Alternatively, we can assign a weight of one to all the projected edges. In Larcker, et al. (2013), two companies are linked if they share at least one board member; two companies are not linked if they do not share a board member. This treatment of common edges, used commonly in the Accounting and Finance literature, loses vital information in translation, and it is easy to might why we expect this simplistic projection method, which is called Flat projection in this paper, might be thought of as less effective to a weighted one. Nevertheless, researchers have been successful in generating many significant results using Flat projections, attesting to the relevance of this method, which plausibly could be more efficient.

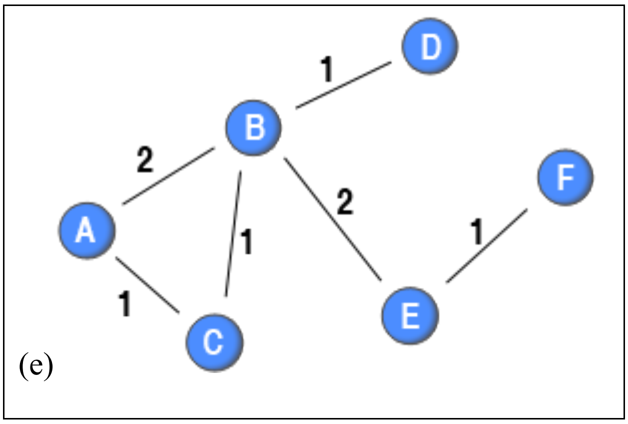
One notable point about graph components – in the Figure above, you can see that the number of components in Boxes (b) and (c) are equal. The one-mode networks are made up two smaller disconnected components. This is a general property of projections of bipartite networks, which you can confirm in this paper comparing our Board projection network in Panel 1.2B and Director projection network in Panel 1.2D. Note also that the components in Box (b) are unequal in node sizes, whereas the components have equal node sizes in Box (c).

1.2.1.2 Bipartite Projection Weighting Methods

As indicated earlier, different weighting methods have been proposed to best preserve the information from the projection procedure. To illustrate the differences, I borrow the excellent illustrations from Opsahl (2013).

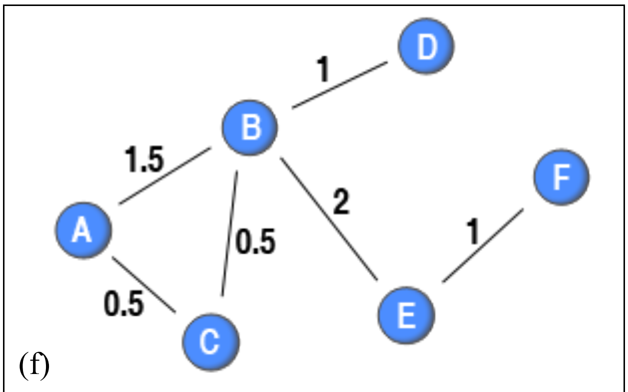


Box (d) shows a simple representation of a bipartite network in its raw form. Here, let shaded nodes be directors, and let the labeled nodes be boards or firms. In this case, firm A is linked to firm B via two common directors; firm B is linked to firm C via one common director. This relationship is summarized and depicted in Box (e).



Box (e) illustrates the simple weighting projection weighting methodology. This can be formalized as $w_{ij} = \sum_p 1$ where w_{ij} is the weight between node i and node j and p is the nodes of the other kind that connects nodes i and j. The astute will note that there is more than one way to summarize the weighting information.

Borrowing a famous economic concept, we may conceive that each additional connection will accrue to the firm less and less additional value, in a nod to the law of diminishing marginal utility. This idea is embodied in Hyperbolic weighting, or what is known as Collaboration weighting, a term derived from scientific paper collaboration networks as first described in Newman (2001). The basic idea behind this weighting scheme is that for the researchers and published papers bipartite network, the relationship between two authors who penned a paper together is stronger than two authors who penned a paper together with five other coauthors. The weights are formalized as $w_{ij} = \sum_p \frac{1}{N_p - 1}$ where N_p is the number of authors on paper p. See Box(f) for an illustration of the weighting consequent of applying this edge-weighting scheme.



(f)

In this dissertation, a thorough inquiry into the significance of the different weighting schemes is performed, with the unweighted case termed Flat projection, the simple weighted case termed Weighted projection, and the hyperbolic weighted case termed Collaboration projection.

1.2.2 Network Centrality

Once the projected networks are derived, the next step is to perform the centrality scores computation. In this section and this section alone, the convention of type-casting all centrality measures in ALLCAPS is adopted for improved typographical clarity.

The concept of connectedness is multi-dimensional. In graph theory, there are many measures that have been concocted, with each measuring a different aspect of centrality. There are four main measures that have been more popularly adopted in the Accounting and Finance literature, and they are DEGREE, CLOSENESS, BETWEENNESS, and EIGENVECTOR centralities. These are the same measures used in Larcker, et al. (2013) and El-Khatib, et al. (2015).

Perhaps the simplest centrality measure is DEGREE centrality. A node is said to have high DEGREE centrality if it has many direct connections to other nodes. This is the implicit measure used in the earliest social network studies like

Engelberg, et al. (2013). Let δ(i, j) denote an indicator that boards i and j share a director, for a given company i in a network. Then the DEGREE centrality of node i is as such:

$$DEGREE_i \equiv \sum_{j \neq i} \delta(i,j)$$

The CLOSENESS centrality measures the total shortest distance to all other nodes in the graph. A node has high CLOSENESS it is high when this total distance is low, and vice versa. Let l(i, j) be the number of steps in the shortest path between board i and board j, then we have:

$$CLOSENESS_i \equiv \frac{n-1}{\sum_{j \neq i} l(i,j)}$$

BETWEENNESS centrality measures the number of times a node lies on the shortest path between two other nodes. Let $P_i(k, j)$ denote the total number of shortest paths between node k and node j, and P(k, j) denote the total number of shortest paths between k and j.

$$BETWEENNESS_i \equiv \sum\nolimits_{j \neq i: i \notin \{k,j\}} \frac{P_i(k,j)/P(k,j)}{(n-1)(n-2)/2}$$

EIGENVECTOR centrality is a concept that is related to DEGREE centrality but which takes into account how important the direct linkages are, following the approach Bonacich (1972) outlined. This measure of influence measures a board's connectedness as well as the connectedness of its direct links and can be thought to be a measure of power and prestige. Let λ be the proportionality factor and $g_{ij}=1$ if firms i and j are linked.

$$\lambda \cdot CENTRALITY_i \equiv \sum\nolimits_j g_{ij} \cdot CENTRALITY_j$$

In vector form, a firm's EIGENVECTOR is obtained when we have:

$$\lambda \cdot EIGENVECTOR \equiv G \cdot EIGENVECTOR$$

Even though DEGREE, CLOSENESS, BETWEENNESS and EIGENVECTOR are commonly listed as network centrality measure, DEGREE is more of a local measure than a network measure, because it measures only the immediate neighborhood of the node. The other three measures of centralities, CLOSENESS, BETWEENNESS and EIGENVECTOR, are such that changes in one node or one link could have ripple effects affecting nodes far away. While this description may allude to the butterfly effect popularized in chaos theory, where a small change here causes large changes somewhere else, what we are describing here does not predicate on the initial conditions of the system as much as the structure of the network. Nonetheless, this work will employ the four measures which have secured a firm footing in recent Finance and Accounting literature. The other reason is that the preliminary testing of other measures, in particular, FLOW-BETWEENNESS and FLOW-CLOSENESS centralities as introduced in Newman (2005), have yet to bear fruit despite the initial theoretical appeal.

This paper uses the N-SCORE composite measure as first defined in Larcker, et al. (2013) which is an equally weighted average quintile rank in the four centrality measures. It was reported that N-Score has a supporting basis for principal component analysis of the four network measures. Hence this measure is replicated in this paper to evaluate its applicability in new tests.

$$N - SCORE \equiv Quint\left(\frac{1}{4}\big(Quint(DEGREE_i) + Quint(CLOSENESS_i) + Quint(BETWEENNESS) + Quint(EIGENVECTOR_i)\big)\right)$$

Different papers used slightly different ways to cleanse the centrality measures. Larcker, et al. (2013) first sorted the firms into size quintiles year by year, before assigning the centrality quintiles. This was done to minimize the mechanical correlation of increased centrality of a board whenever a director is added to the board. El-Khatib, et al. (2015) used percentiles of the centrality measures. Ang, et al. (2017) created dummy variables to separate centralities above the median from those below. Without loss of generality, I have chosen to proceed with ordering centrality scores into quintiles every year, an approach closest to Larcker, et al. (2013), except that quintiles are not presorted by firm size.

1.2.3 Board Composition

The primary source of data for Board information I used in this research is the S&P Capital IQ database. Through its web user interface, I hand-collected board composition data for the equities listed in Singapore.

One unique feature of the S&P Capital IQ board composition dataset is that board members of each company also include that of related boards, namely the supervisory board members, the management board members, and the board of directors for subsidiaries. This enables us to track loosely connected interlocking boards as one, as it is not inconceivable that members of these related boards must have more than a fair chance of establishing meaningful connections.

The S&P Capital IQ dataset collects extensive information on company key executives and board members. In this paper, I downloaded data on both the current and prior board members of the companies and amalgamated them to form the final dataset.

According to S&P Capital IQ, their data on people is collated from a spectrum of sources, which include Public filings, News, Company websites, Surveys (for public companies and private equity firms, Dun & Bradstreet. Also, their system also captures “thousands of press releases daily” to supplement their database for key executive moves and board appointments.

When Preferred Stock, ETFs, and Closed-End Funds were excluded from the search, and the data is sanitized, we are left with 1043 company entities with primary listings on the SGX.

Company Type	Total
Corporate Investment Arm	1
Private Company	291
Private Investment Firm	4
Public Company	698
Public Fund	22
Public Investment Firm	27
Grand Total	**1043**

The Table above shows the breakdown of the companies by the type as of the records in the Capital IQ database. Note that most of them (698) are Public Companies, as can be expected. The second largest pie are Private Companies, which represents those Public Companies which have been privatized.

Company Status	Total
Acquired	64
Liquidating	6
Operating	692
Operating Subsidiary	278
Out of Business	1
Reorganizing	2
Grand Total	**1043**

The Table above list the breakdown by the current status of the company in the database. Predictably the bulk of the companies is still in operation, with a substantial chunk being operating subsidiaries or acquired.

Finally, the Table below lists the companies by the most recent trade date, grouped by year. The numbers are the number of firms that are delisted or for whatever reasons no longer being listed on the Singapore Exchange. Note that delisted companies do not fall out of the sample to minimize the effects of survivorship bias.

Most Recent Trade Date in Year	Total
1999	1
2001	1
2002	6
2003	9
2004	36
2005	10
2006	20
2007	15
2008	28
2009	23
2010	33
2011	31
2012	28
2013	28
2014	39
2015	34
2016	701
Grand Total	**1043**

Of the list of 1043 firms listed on the SGX main and secondary boards, 14 of the firms had no information on their board members whatsoever, so there are only 1029 firms with board member information.

1.2.4 Singapore Corporate Governance Index

The Singapore Corporate Governance Index (SCGI) consists of 84 questions (including sub-questions) which are classified into five OECD Corporate Governance principles: rights of shareholders, equitable treatment of shareholders, the role of stakeholders, disclosure and transparency, and board responsibilities.

These questions were developed from the five OECD governance principles and modified to fit the Singapore context. They examine the Corporate Governance practices of the listed companies from the public shareholders' perceptive using information in the public domain. The data sources include annual reports, notices to call shareholder's meetings, general meeting minutes, company websites, analyst reports, proxy voting forms, and other sources.

For the rights of shareholders, they examine how shareholders can participate in major company decisions. For example, can shareholders ask questions in the Annual General Meetings (AGMs), and can shareholders nominate or remove directors? They also examine the amount of information disclosed in the notice to call AGMs and a company's anti-takeover defenses.

For the equitable treatment of shareholders, they examine whether the companies facilitate proxy voting by minority shareholders. They also include questions on the disclosure of insider trading.

For the role of stakeholders in Corporate Governance, they examine the company disclosure of employee benefits, welfare and long-term incentive schemes, and disclosure on environmental issues.

For disclosure and transparency, they assess the amount of information (financial and non-financial) disclosed in the company annual report and the company website, and investigate if the firms disclose a transparent ownership structure?

For board responsibilities, they assess the monitoring role of the board using questions on the board's activities, board composition and possible conflict of interest.

The scores for the five sub-indices are aggregated to derive the final index score.

I obtain proprietary data from the team behind the Singapore Corporate Governance Index, which developed a scorecard measure specific for the Singapore corporate landscape. According to Goh and Lee (2009), their database covers all SGX mainboard-listed companies, excluding exchange-traded funds, funds, secondary listings, structured products, real estate investment trusts and OTC for international securities listed overseas.

Most questions (61%) are strictly binary. For the other questions, they add a qualitative element to governance practices to assess the quantity and quality of information with a clear standard to identify good, fair or poor practices. For example, one of the questions asks "Among Board of directors, how many are independent directors[5]?" If the percentage of independent directors is above 50%, then the company will be classified as "good". If the percentage is below 33%, the company will get "poor". The companies where the percentage of independent directors ranges between 33% and 50% are ranked "fair". Each response is cross-checked for consistency and accuracy by different raters.

Each category carries a weighting: rights of shareholders (15%); equitable treatment of shareholders (10%); roles of stakeholders (15%); disclosure and transparency (20%); and board responsibilities and composition (40%). Major questions under each category and sub-questions under each major question are equally weighted. They then combine question scores into a sub-index for each category and combine sub-indices into an overall index. The sub- and overall index are rescaled from 0 (worst) to 100 (best).

The first two categories, which are assigned a total weight of 25%, are associated with minority shareholders' protection, which is crucial in Singapore market because of the prevalence of substantial block-holders. Information disclosure and board responsibilities, together carry a weight of 60%, are widely discussed topics in Corporate Governance practices. The role of stakeholder category carrying a weight of 15% is effectively corporate social responsibility which is becoming increasingly important.

[5] Unlike other developed markets, Singapore is slower in requiring independent directors of listed non-financial companies to be independent of controlling shareholders as well as management (Attig (2007)). According to the Code of Corporate Governance issued in 2001 and updated in 2005, independent director should have no relationship with the company, its related companies or its officers. In 2012, the Code of Corporate Governance was revised to state that independent directors should be independent of the management as well as 10% shareholders.

1.2.5 Firm Performance and Control Variables

1.2.5.1 Performance

The use of return-on-assets is the de-facto gold standard in measuring firm performance, and so I will also use in our investigation. It is trivial to point out it is used for purposes of easy comparability of the results of this paper with Larcker, et al. (2013).

Tobin's Q has become a ubiquitous measure of firm valuation, used by many papers in Corporate Finance (such as Demsetz and Lehn (1985), Morck, Shleifer and Vishny (1988), Porta, Lopez-de-Silanes, Shleifer and Vishny (2002)). On the other hand, there have been dissenting voices about the use, or rather, abuse, of this variable to assess firm performance. As pointed out in Dybvig and Warachka (2015), underinvestment increases rather than decreases Tobin's Q, which calls into question the validity of this firm performance proxy. Nonetheless, since this measure had been used so often, especially in the sub-field of Corporate Governance, it seems apt to utilize this proxy and note its response to the pivotal centrality variables of our research.

Tobin's Q is defined as the ratio of the market value of the firm's assets to the book value of the firm's assets. In this paper the calculation of Tobin's Q that was used approximates the market value of the firm's assets as the sum of two components, the market value of equity and the book value of liabilities.

1.2.5.2 Control Variables

A proper set of control variables is imperative to avoid omitted variable bias. To this end, we have chosen a curated list of variables using extant literature for guidance. The complete list of variables and their corresponding abbreviations used is tabulated in Table I.1.

The variables that were used include quick ratio, net sales, firm age, asset growth, leverage, the ratio of selling, general and administrative expenses to total assets, and the industry Herfindahl-Hirschman index.

Quick Ratio is a proxy for the liquidity level of the firm.

Net Sales, expressed in logarithm form, is used as a proxy for firm size.

We follow Jiraporn and Chintrakarn (2013) in designating Selling, general and administrative expenses, which is largely subject to managerial discretion, as a proxy for agency conflict between the managers and owners.

Leverage is used as a proxy for growth opportunities as in Lang, Ofek and Stulz (1996), and a proxy for business risk as in Hurdle (1974)

Asset growth is used as a proxy for financial stability (Beasley, Carcello, Hermanson and Lapides (2000)).

Firm age is a proxy for the maturity of the firm in terms of the firm's life-cycle (Dickinson (2011)).

The Herfindahl-Hirschman index of industry concentration is used as a proxy for the degree of imperfect competition, as noted in Lang and Stulz (1992). The index we used for this paper is constructed based on total assets of the firm.

There are no board variables used as controls explicitly in the regressions. Instead, I rely on the Singapore Corporate Governance Index to control for board variables in the robustness checks.

1.2.6 Endogeneity and Regression Methods

No research paper in Corporate Finance is complete without a discussion on endogeneity. This paper addresses the endogeneity problems in two main ways.

To rule out the problems of omitted variables, we have subjected the multivariate regressions to a curated list of firm control variables that have been shown to affect firm performance while avoiding the kitchen sink approach. In this respect, the potential problem of omitted variables is minimized.

This paper has taken a pragmatic approach to rule out reverse causality. Except for the very few cases where contemporaneous dependent variables are used and presented for comparison purposes, this paper typically uses look-ahead dependent variables. Most of the dependent variables are constructed on a one-year look-ahead basis.

As for Measurement Bias, nothing in this paper is directly hand collected and stored in a proprietary database. There may be gaps or error in the board membership data, especially the years-on-board variable which was relied on to form the network connections. Much of the information which must be hand or machine compiled by databases like Capital IQ may include measurement errors, but there is no reason to believe these are systemic. In any case since data error or omissions when reported to Capital IQ are corrected after factual counterchecks, we have good reasons to believe the integrity of the databases is improving over time.

Gormley and Matsa (2014) has shown that common research practices of using industry-demeaned (or industry-adjusted) dependent variables and adding the mean of the group's dependent variable to control for unobserved heterogeneity, tended to yield inconsistent estimates. Rather, the fixed effects estimator should be used instead.

Hence, following Gormley and Matsa (2014), the major regressions used in this paper controlled for fixed effects at the industry-year level, using Fama-French ten industries as referenced in Fama and French (1997). This is done to ensure there is at least a firm in each industry while at the same time not generating too many fixed effects that would reduce the power of the regression analyses.

The regressions in this paper uses clustering at the firm level for Standard Errors by default to control for heteroskedasticity and serial correlation within the panel. The firm variable is indicated in the regression tables by the abbreviation ecid (which stands for excel company id), a unique firm identifier used by the Capital IQ databases.

Chapter 1.3 Hypothesis Development

The first hypothesis is motivated by the idea that interlocking boards provide the conduits through which information and resources flow, and the most central boards are the ones who would benefit most from this network topology. The benefit that accrues to the firm would be evidenced in its corporate performance which we can observe via the accounting-based measure of return-on-assets, and the finance-based measure of Tobin's Q. The former is a direct extension of the results obtained in Larcker, et al. (2013) using a similar methodology.

H1: Firms with better-connected boards have better firm performance

The second idea is motivated by the idea that the effects of highly central boards show persistence empirically, which could be a result of highly central boards being exposed to more opportunities and resources to maintain their high centrality and therefore their firm performance. Alternatively, highly central boards may be more able to leverage their social capital and enjoy better access to other highly qualified directors to help maintain their high centrality and firm performance (Nicholson, Alexander and Kiel (2004)). In this respect, the second hypothesis attempts to answer the question on how persistent is the impact of today's connected boards on future firm performance in the one- to four-year medium-term window.

H2: Firms with better-connected boards have better firm performance in the medium term

The third hypothesis we test in this paper is that the slightly more sophisticated ways to project interlocking boards networks to the subset of board nodes should be used instead of the Flat projection method commonly documented in Corporate Finance papers on social network centrality. The theoretical motivation is to preserve information while dealing with board or director projections. The evidence we present in this paper provides empirical rationale.

H3: Simple Weighted and Hyperbolic Weighted Collaboration Weighting methods for interlocking board projections are superior to the Flat method

Chapter 1.4 Analysis and Results

1.4.1 Network Statistics

Table I.2 lists the Network Graph statistics for the interlocking board networks. In Panel I.2A, we can see that the number of interlocking boards in the networks is steadily growing in size over the years, from 181 boards in the year 1989 to a peak of 946 boards in the year 2014. This steady increase is likely due to augmented efforts in collecting more comprehensive board member data by Capital IQ, especially over the period 1989 to 2004. As noted earlier, these boards are boards of firms listed on the SGX mainboard and Catalist.

The number of boards would increasingly exceed the actual number of listed companies because Capital IQ maintains research on companies that may have been delisted but whose board member data is available to them via other means. For example, CapitaMalls Asia was delisted on July 22, 2014, but current board member data is still being collected on this entity. The CEO data is current because there is a new CEO after the delisting event. According to Capital IQ, "Mr. Juan Thong Leow, also known as Jason, has been the Chief Executive Officer of CapitaMalls Asia Limited since September 15, 2014." The financial data of delisted entities may not be available, in which case the firm will drop out of the sample set in the final regression analyses, but a considered decision is taken to include these firms in the computation of network centrality data.

Statistics presented in Panel I.2C and D are on the bipartite projection on the subset of Director nodes, a comparison counterpart to Panel I.2A and B respectively. They are presented to give the reader a better appreciation of the resultant projection on directors and how the topology of the network differs from the projection of connected boards. From Panels I.2A and C, it is observed that the ratio of the universe of directors to boards is 3-4 times.

A component is a subgraph in which the nodes are all connected directly or indirectly, and no nodes in the component are connected to any other outside nodes in the supergraph. Comparing Panels I.2B and D, we can see that the number of components every year is the same for the board and the director projection. Even though that is true, the director projection has more components of at least size 2, whereas the board projection has more singleton components. In both networks, the size of the largest component eclipses that of the second largest component, especially so after 1997.

From the director network, centralities of the directors, and therefore of the CEOs, can be computed, but these are not elaborated upon further in this dissertation.

1.4.2 Summary Statistics

In Table I.3, the summary statistics are presented. Panel I.3A reports the firm variables. In Panels I.3B, I.3C and I.3D, the network centrality metrics are presented, under the flat projection, weighted projection and collaboration projection respectively. Of the four centrality measures, the variables with suffix q are quintile variables, and they share similar distributions. The Betweenness, Closeness, and Eigenvector centrality measures are normalized in relation to the size of the network, a practice that is common to facilitate comparison across different networks (such as across different years). The degree centrality measure is not normalized because the unnormalized version has an intuitive and explicit in interpretation. Under the flat projection, the median board has direct connections (Fd) to 3 other boards. Under the weighted projection, we observe that the median firm has four linkages to (1 to 4) other boards. Under the Collaboration projection, the degree of the median firm is two.

1.4.3 Correlation Matrices

Table I.4 contains three Panels that show the Pearson correlation between the main firm variables and the Board network centrality variables. The network centralities under the different projection methods are understandably highly correlated and are omitted here for the sake of brevity.

Panel I.4A has the centrality measures calculated under the (unweighted) Flat projection, Panel I.4B has the centrality measures under the (simple) Weighted projection, and Panel I.4C has the centrality measures under the (hyperbolic weighted) Collaboration projection.

We can see the highly significant positive correlation between the one-year look ahead return-on-assets, and Degree and Composite N-score centralities, whereas for

Tobin's Q we observe that Closeness centrality has a significant but negative correlation with one-year look-ahead return-on-assets.

Looking at Panel I.4A, we see that among the Betweenness, Closeness, Degree and Eigenvector centralities, the highest correlation is the Betweenness-Degree pair at 0.77, while the lowest correlation pair is Closeness-Eigenvector at 0.21. In Larcker, et al. (2013), their highest correlated pair is also Betweenness-Degree at 0.898, and their lowest correlated pair is similarly Closeness-Eigenvector at 0.242.

1.4.4 Differences in Means

Before running the actual regressions, it is helpful to get a sense of the differences in means between the centralities with a test of differences in means of the key response variables return-on-assets and Tobin's Q, between centrality scores above and below the medians.

1.4.4.1 ROA

Panel I.5A presents the results for the differences in means of high and low centralities scores under (Unweighted) Flat projection. Looking at the t-tests for Betweenness, Closeness and Degree centralities are significant at the 1% level, while that for Eigenvector is significant at the 5% level. Furthermore, the firms with boards with centralities above the median all have higher return-on-assets compared to those below the median. The results are consistent with what the correlation analyses had earlier suggested. When the same tests are performed on centralities computed under the Simple Weighted and Collaboration Projections, the results are similar, except that the t-test Eigenvector centrality is highly significant at the 1% level instead.

1.4.4.2 Tobin's Q

On the same Panels described earlier (Panels I.5A, B and C) the results for Tobin's Q using the same differences in means methodology is presented in the second row after that of return-on-assets. As opposed to the clear and unambiguous results obtained for return-on-assets, the results for Tobin's Q are inconclusive, regardless of the projection method used. This is expected and in line with the results obtained using correlations in the earlier section.

1.4.5 Firm Performance and Board Centralities

1.4.5.1 ROA

Table I.6 has two panels showing the results of the regressions for firm performance and multiple board centrality measured obtained under the unweighted Flat projection method. As mentioned in the methodology section, we avoided using industry adjusted variables and proceeded with the approach of using fixed effects estimators instead, following Gormley and Matsa (2014).

Equations 1 to 5 of Panel I.6A are univariate regressions of the centrality measures. You can see that Betweenness, Closeness, Degree, Eigenvector and Composite N-score centralities all have highly significant positive coefficients, again corroborating with earlier results.

Equations 6 to 10 of Panel I.6A are multivariate regressions of return-on-assets and the various centrality measures. The coefficient values are all attenuated compared to the respective univariate regression cases, but they retain their significance at the 1% level (except degree centrality at 5%), as well as the positive direction of the effects on the response variable one-year ahead return-on-assets.

The results of the same regressions under the simple weighted projection and collaboration projection are similar to that obtained for flat projection and are not reported for the sake of brevity.

The strong results achieved mirrors what was obtained by Larcker, et al. (2013), because in their paper they were implicitly using a Flat projection of the bipartite network. What was unknown but established, is that similar results are obtained even if we used simple weighted projection or the hyperbolic weighted collaboration projection methods. These results also concur with those by Ang, et al. (2017).

Now that we established at the outset that the primary results or Larcker, et al. (2013) are applicable to the Singapore market, we are ready to branch out from this basis to extend the investigation to other interesting research questions, such as the applicability on the other key measure usually used in Corporate Finance literature, Tobin's Q.

1.4.5.2 Tobin's Q

Refer to Table I.6B for the results of the regressions of Tobin's Q on various measures of board centralities derived under the unweighted Flat projection.

Panel I.6B, equations 1 through 5 show the results of the univariate regressions of Tobin's Q on the individual board centralities measures. We can see that although the coefficients for the centrality measures are all positive, the results are insignificant. These results corroborate what was revealed earlier in the correlation analysis and the differences-in-means test.

Equations 6 to 10 of Panel I.6B show that multivariate regression gives us interesting results. A unit increase Betweenness centrality will increase Tobin's Q by 0.088 at the 1% significance level. Results for Closeness centrality, eigenvector centrality, and composite centrality are positive and significant at the 5% level.

Degree centrality has the weakest result at 10% level, but the coefficient is positive.

The results of the same regressions under the simple weighted projection and collaboration projection are similar to those obtained for flat projection and are not reported to avoid verbosity.

Collectively, these results point to the fact that the centrality measures may have a more direct impact on Tobin's Q than previously thought (since no papers have reported this link before).

1.4.6 Future Firm Performance and Composite Board Centralities

"What is the persistence of a firm's board centrality score?" is the direct question addressed in this section. What are the long-term effects of a board network? The related question is to ask what the half-life of a network is, to get an inkling of the rate of decay of effects of networks. I investigate these effects directly using the same regression methodology used in the previous section.

Taking guidance from Larcker, et al. (2013) who developed the composite N-Score centrality, we will use this measure to test the persistence of centralities of interlocking board networks. In their paper, they tested similar ideas, albeit using a pooled regression framework and using industry-adjusted variables which could have the problems of inconsistent standard errors as pointed out in Gormley and Matsa (2014).

Table I.7 has the regressions of future firm performance on composite board centralities under the Flat projection method.

1.4.6.1 ROA

Panel I.7A presents the results of regressions of contemporaneous and look-ahead return-on-assets on Composite N-score centralities obtained under a Flat projection.

In equation 1, we see that contemporaneous univariate regression is significant at the 5% level. In equation 2, we see that the contemporaneous multivariate regression is insignificant. These results are not surprising. Equations 3 and 4 are the same as Panel I.6A (5) and (10) and are presented here for ease of reference and comparison. Equations 5 and 6 show the 2-year look-ahead effect of N-score composite centrality on return-on-assets. Equations 7 and 8 show the same for 3-year look-ahead effect. Equations 9 and 10 show the 4-year look ahead effect.

For the look-ahead regressions (Equations 3 to 10), the coefficients for N-score composite centralities are all positive and significant at the 1% level, except for two-year look-ahead multivariate regression at 5%. The coefficients for the multivariate case are all attenuated compared to the univariate counterparts.

The results of the same regressions under the simple weighted projection and collaboration projection are similar to those obtained for flat projection and are not reported.

Feyen (2013) found that only active interlock connections matter in relation to stock valuations of firms, once the regressions control for past interlocks the results disappear, which is consistent with a resource allocation view of boards. This paper uses another angle, which investigates the persistence of effects of interlock networks. It is found that the effects of today's interlock persist for at least four years. The way to reconcile the ostensibly conflicting results is that while Feyen (2013) is structured like an event study with everything lined up at event time, this paper looks at how far we can peer into the future based on data today.

1.4.6.2 Tobin's Q

Panel I.7A presents the results of regressions of contemporaneous and look-ahead Tobin's Q on Composite N-score centralities obtained using a Flat projection.

Equations 1 and 2 are contemporaneous regressions for the univariate case and multivariate case respectively. The coefficients for composite board centrality are both positive at the 10% level. Equations 3 and 4 are reproduced from Panel I.6B (5) and (10) to facilitate comparisons and for easy referencing. Equations 5 and 6 show the 2-year look-ahead effect of N-score composite centrality on return-on-assets. Equations 7 and 8 show the same for 3-year look-ahead effect. Equations 9 and 10 show the 4-year look ahead effect.

For the look-ahead univariate regressions i.e. Panel I.7B (3), (5), (7), (9), are positive but insignificant, except for four-year look-ahead Tobin's Q showing up at 5% significance. However, all the multivariate regressions Panel I.7B (4), (6), (8), (10) have positive and highly significant coefficients for composite board centrality.

The results of the same regressions under the simple weighted projection and collaboration projection are similar to that obtained for flat projection and are not reported here since they do not add much value.

The results in Panel 1.7B all allude to the fact that interlock centralities may have a more lasting impact on firms' Tobin's Q than previously thought and reported.

Chapter 1.5 Robustness Checks

1.5.1 Corporate Governance and Board Centralities

In this section, we will explore the relationship uncovered in the earlier sections between the corporate performance variables (of return-on-assets and Tobin's Q), and centralities obtained under the unweighted Flat projection method of resolving interlocking board connections.

The two panels in Table I.8 contain the analyses on the subsample of firms with scores on the Singapore Corporate Governance Index (SCGI).

1.5.1.1 ROA and Centralities

Panel I.8A (1) to (5) should be read in conjunction with Panel I.6A as an extension of the results. When controlled for the Corporate Governance, it is observed that all the centrality variants lose their significance.

This is unexpected because this is not the results obtained by Larcker, et al. (2013) when they controlled for Governance factors in their tests and they still got strong positive results.

Our results also differ from Ang, et al. (2017), potentially because they used median dummies instead of quintiles for the centrality variables. Also, their study differs in that they include the Hong Kong market as well in their analyses.

There are at least two reasons to explain this phenomenon. First, the nature of firms listed on American and Singaporean stock markets are different such that SCGI explains board centralities whereas in the United States this is not the case. Second, the Corporate Governance measure used is different in type and potency from those used in Larcker, et al. (2013), and the SCGI overlaps more completely with centrality measures. While I used one consolidated variable to control for Corporate Governance, they used a lineup of variables instead for robustness testing, specifically the presence of a staggered board, the existence of poison pills and dual-class shares, whether the firm has limits to calling special meetings, the percent of independent directors, CEO-Chairman duality, and the shareholder rights governance index (G-index) of Gompers, et al. (2003).

1.5.1.2 Tobin's Q and Centralities

Panel I.8A (6) to (10) should be read in conjunction with Panel I.6B as an extension of the results.

Whereas the results disappeared for the regressions on return-on-assets, the results for Tobin's Q are only slightly better. Betweenness centrality and Composite N-score centrality both lost significance. Closeness centrality diminished in significance, moving from 5% to 10%. Degree centrality and Eigenvector centrality retain their significance level even when controlled for Corporate Governance.

1.5.1.3 Future ROA and Composite Centrality

Panel I.8B (1) to (5) should be read in conjunction with Panel I.7A as an extension of the results.

When controlled for Corporate Governance, all the centralities lost their significance in explaining look-ahead return-on-assets. This is unexpected, and a cursory conclusion might imply that centralities are controlling for the same things the SCGI captures in its index.

1.5.1.4 Future Tobin's Q and Composite Centrality

Panel I.8B (6) to (10) should be read in conjunction with Panel I.7B as an extension of the results.

When controlled for Corporate Governance, the centralities lose their ability to explain look-ahead Tobin's Q. This is expected now because of the earlier results obtained in Table I.8.

1.5.2 Weighted / Collaboration Projection on Firm Performance

Given the negative results obtained in Table I.8, where the significance of centralities in predicting firm performance all but vanishes when controlling for the

SCGI factor, I will repeat Table I.8, but using the Weighted and Collaboration projection methods for computing centralities. As noted earlier in the Methodology section, the theoretical basis for Weighted and Collaboration projection is stronger than for Flat projections, but results have not been reported because until now the Flat projection performed satisfactorily in the space explored by extant literature.

Table I.9 should be read in conjunction with Panel 1.8A as an extension of the results.

1.5.2.1 Weighted Board Centralities

Comparing Panel I.9A to Panel I.8A, we can see at a glance that under the simple weighted projection, eigenvector centrality shone through at the 1% significance level, for explaining both return-on-assets and Tobin's Q. That aside, all the coefficients on the other centralities are positive but insignificant. One exception is Weighted Betweenness centrality which reports the same coefficient magnitude and standard deviation and significance at the 10% level under both Flat and Weighted projections.

1.5.2.2 Collaboration Board Centralities

Comparing Panel I.9B to Panels I.8A and I.9A, we can see that Collaboration eigenvector centrality once again performs better than the other centrality measures in explaining return-on-assets.

For Tobin's Q, both Betweenness and Eigenvector centralities report significance at 5% level, with the N-score centrality significant at the 10% level.

1.5.3 Using Projection Eigenvector Centrality on Future Firm Performance

Looking at the results in Table I.9 in aggregate, it is unclear which projection method is empirically superior. Both seem to be valid alternatives, and both point to eigenvector centrality as the better choice for measuring centrality compared to Betweenness, Closeness, Degree and even N-score composite centrality, surprisingly.

With that in mind, this paper will extend the results in Table I.8 using eigenvector centrality instead of N-score composite centrality, for Flat, Weighted and Collaboration projections, presented in Panels I.10A, B and C respectively.

1.5.3.1 Flat Board Eigenvector Centralities

As expected, the Flat projection board eigenvector centralities were muted in their ability to explain firm performance. Comparing the results in Panel I.10A to Panel I.8B, we can conclude that Eigenvector factor performed better than the composite N-score factor which was insignificant in all of the regressions for look-ahead firm performance. In contrast, Eigenvector centrality at least managed to eke out a 5% significance for the one-year look ahead Tobin's Q and a 10% significance for four-year look-ahead Tobin's Q. Still, these are relatively weak results and is likely symptomatic of the deeper systemic issues with using the simplistic Flat projection.

1.5.3.2 Weighted Board Eigenvector Centralities

Panel I.10B show the results for Weighted Eigenvector centrality. The regressions for one-year and four-year look-ahead regressions on return-on-assets managed to clock a 5% significance, better than under the Flat projection case in Panel I.10A.

What's more promising is that the results of Tobin's Q, one-, two-, three-, and four-year look-ahead regressions managed a 1% significance level for Weighted Eigenvector centrality.

1.5.3.3 Collaboration Board Eigenvector Centralities

Panel I.10C show the results for Collaboration Eigenvector centrality. Comparing to Weighted projection in Panel I.10B, the results for return-on-assets are stronger, with a 1% significance for one- and four-year look ahead return-on-assets and lesser but still valid significance for the two- and three-year ones.

On the other hand, the Tobin's Q results under Collaboration projection are much weaker than under the Weighted Projection. A 1% significance is obtained only for four-year look-ahead Tobin's Q, while two-, three-, and four-year look-ahead Tobin's Q register significance at the 5% level.

Chapter 1.6 Conclusion

The results in this Part are consistent with boardroom connections providing information and resources and the benefits that accrue to the firms are discernable from both the return-on-assets as well as the Tobin's Q measures.

The effects to the firm of boardroom connections today have been shown to persist for at least four years on both return-on-assets and Tobin's Q.

One of the key contributions of this research is to highlight that the method of mapping the connected boards do matter, and to use the Flat projection is to leave money on the table insofar as information preservation of the network is concerned. It will be a worthwhile impact if the only one from this research is to highlight that it would be more accurate for future research to be based on weighted or collaboration network weighting projections instead.

As shown in the robustness tests, the simple weighted Eigenvector metrics performed better for predicting Tobin's Q in the one- to four-year look-ahead timeframe, while the hyperbolic weighted collaboration Eigenvector performed better for predicting future return-on-assets in the same timeframe. More tests may need to be done to determine the appropriate projection method and the associated interpretation at broader and deeper levels of analyses.

Eigenvector centrality was used exclusively in Feyen (2013), a perhaps incidental choice but nonetheless vindicated by the results of this dissertation. Even though at this moment I do not have an answer why Eigenvector centrality is superior, I like to think that this is because Eigenvector centrality is closely related to PageRank centrality, which is the algorithm that Google built its empire upon. There are two key differences that Eigenvector centrality has; firstly, it does not have a scaling factor, and secondly, PageRank is a left-hand eigenvector, because directionality of linkages is involved. With the computation of a single centrality score Google conquered the internet, and so it is little surprise that Eigenvector centrality can be an informative variable. The other probably more likely reason is that Betweenness, Closeness and Degree replicate information that is summarized in the SCGI.

Part 2. Follow the Money, Stupid! – A Treatise on Connected Owners

The second section deals with a new concept which I term "ownership centrality", borrowing from and extending similar concepts used in the evaluation of interlocking board centralities. Some papers dealing with ownership issues use variables such as ownership wedge and ownership dispersion to measure potential agency conflicts within the corporate entities. Other papers use various permutations of ownership dummies to proxy for ownership.

This section endeavors to uncover whether we can we extend the concept of centrality measures to the myriad web of interlocking and overlapping ownership stakes, to develop it as a credible and hopefully better proxy for measuring ownership and better identify potential ownership conflict of interests. As a proof of concept, I will focus this line of probing in the sandbox of the Singapore stock market.

The motivation of this line of research was met with much resistance from the outset. Unlike Interlocking Boards, which links firms through board relationships at the personal level, where we could proxy for informational exchange, resource allocation facilitation and stewardship consultations, the ownership network is more complicated. The web of ownership control is multimodal, it has companies owning companies, and sometimes the ownership is through a hierarchical pyramid to a penultimate family firm or person, sometimes complicated by cross-holdings, and the state may own firms too.

Another crucial obstacle is that the corporate ownership relationship is essentially one of cashflow rights, which should not influence the operations of the firm, and control rights, which is usually exercised only once a year at the Annual General Meeting, which is an orchestrated event where binary votes to approve resolutions are decided. Thus, the real operational control powers of the shareholders lie in the Board of Directors who represent the shareholders, so this line of reasoning speedily dismisses the relevance of ownership centrality, in favor of board centrality.

A third complication is that the ownership connection between the firms and their owners implies both directionality and weightedness in the relationship, which are concepts with standard treatment methods in graph and network theories, but the methods have yet to catch on in the Business research corpus, so there is no prior guidance on the best approach for this endeavor.

After much research into sophisticated methodology and advanced theory (and on the verge of giving up), this paper was saved by a niggling discomfort. Having done the board centrality computations, I made the serendipitous observation that the names of the current CEOs of Temasek Holdings (Ching, Ho) and Temasek International (Theng Kiat, Lee) did not feature in the list of Directors with high eigenvector centralities, or any of the other measured centralities for the matter. This eventually led to the breakthrough revelation that in fact the problem should be and could be couched in simpler terms, and using the same methods I have used in Part I could yield results. So even though when presented in the final form it may seem trivial in retrospect, it was absolutely non-intuitive ex-ante.

Having established how ownership centrality is useful, I endeavor to link up this concept with the prevailing knowledge base on Corporate Governance. Where and how does ownership centrality fit into the overall scheme of things, if at all? Do these centrality measures help enhance our current methods? I hope the results will be instructive in helping to guide developments and enhancements in future formulations of best practices in Corporate Governance. The hope is that within the scope of investigations of this paper we will derive a useful measure and understanding of ownership centrality.

The biggest value of this piece of research is to document its multiple attempts to model ownership centrality using cutting edge summary measures from network theory. Both the successful and the failed attempts will instruct future research as to whether my approach holds promise in describing complex corporate ownership phenomenon, and whether there is a meaningful impact of this novel measure on corporate outcomes.

Chapter 2.1 Literature Review

2.1.1 Firm Ownership

When we look at connected boards, we view the firm interlocks as conduits of information, support, and resources. The expectation is that a highly central firm would be able to harness and hoard information and gain better access to scarce resources thereby enhancing firm value. However, when we look at connected owners, the connections represent the cashflow rights of the owners from the firms, and control rights of the firm by the owners. Each ownership link represents the conduit through which cash and influence flow, albeit in opposite directions. In this sense, the relationship is bidirectional and could justify the usage of an undirected network. A highly central owner in this framework receives more cashflow and can exert much more influence, command and control than the less central owners.

The literature has accumulated significant evidence that boardroom connections drive corporate outcomes, but none yet for interlinked ownership connections in the social network sense. Notwithstanding, there are studies alluding to the strong linkages between strong ownership stakes and firm outcomes. Okhmatovskiy

(2010) asserted that governments not only regulate business activities but also become involved in the Corporate Governance of individual firms, not only through board memberships but also through ownership ties. Since the body of Corporate Finance literature has accepted and formalized the role of board centrality as a firm characteristic in determining corporate performance, it seems timely, and entirely logical, that ownership centrality should function as a viable firm characteristic as well.

In my opinion, one unique feature that allows our analyses to work is a feature of the database we use, which uses roll-up logic to unravel complicated ownership structures. Bebchuk, Kraakman and Triantis (2000) reconciled the phenomena of dispersed ownership against the reality of actual tight control by block-holders with what they termed controlling-minority structures used by block-holders to exert influence and control through three mechanisms – dual-class shares, stock pyramids, and cross-ownership ties. In Singapore, dual-class shares are not allowed and so can be ignored. As for pyramidal-holdings and cross-holdings, the web of ownership is unraveled at the database level using roll-up logic, so future researchers can access the same dataset for replication with little fuss and hassle.

A classic example of cross-holdings would be the Jardine Group. The Jardine Group is under the control of the Keswick brothers, whose combined stake of less than 10 percent in Jardine Matheson is amplified via complicated cross-holdings (Chan, Hameed and Lau (2003)). As of end-2014, the top 5 owners of Jardine Strategic Holdings Limited were Jardine Matheson Holdings Limited (66%), OppenheimerFunds Inc (2%), Franklin Resources Inc (2%), Schroder Investment Management (Singapore) Ltd (1%) and Norges Bank Investment Management (1%). The top 5 owners of Jardine Matheson Holdings Limited were, in descending order, 1947 Trust (11%), Adam Keswick (11%), Capital Research and Management Company (6%), Henry Keswick (3%) and Benjamin Keswick (3%). From this simple example, one can get a sense of how Capital IQ has unraveled the convoluted ownership loopbacks to aid understanding of the underlying ownership structures.

Roll-up logic also takes care of pyramidal holdings. Attig (2007) observed that presence of family pyramidal holding defuses any potential monitoring benefits of board attributes. Pyramidal holdings, for all intents and purposes, act like dual-class shares in helping leverage control power over and above actual ownership stakes held (Claessens, Djankov and Lang (2000)). For example, in 2014, the largest investor declared in the annual report of Olam International is Breedens Investments Pte Ltd (49%), followed by Citibank Nominees Singapore Pte Ltd (19%) and Aranda Investments Pte Ltd (9.36%). In fact, Breedens and Aranda are part of the pyramidal chain links through which Temasek Holdings exert ultimate ownership and control. If we look at what was reported as the owners of Olam on S&P Capital IQ, the top owner is Temasek Holdings (Private) Limited, with the stake of the intermediaries rolled-up to the ultimate parent. This standardization by Capital IQ facilitates our research greatly.

In this paper, we will use the four standard measures of centrality as we have used in the first part. All firms and owners, be it listed corporations, private firms, individuals, family trusts, are nodes in the ownership network. Every node is an economic agent. Nodes assume power when they are on more shortest paths connecting any other pair of nodes (Betweenness centrality), are closer to all other nodes (Closeness centrality), link to more nodes (Degree centrality), or link to nodes which are highly linked themselves (Eigenvector centrality). We also use the Composite N-score centrality which is a principal-components backed aggregated centrality score (Larcker, et al. (2013)).

Centrality now is a direct measure of the flow of money and an indirect measure of the ability to influence firms. The obvious way owners influence firms would be through the nomination and subsequent appointment of directors. Another way an owner would be able to influence the firm is if the shareholder is an insider, possibly in management. Even if the actual ownership stake may be small, the direct firm influence may be disproportionately big. Consistent with the idea that good network positions creates opportunities and reduces constraint, an economic actor with high ownership centrality would have more bargaining chips in negotiation and jostling for specific corporate outcomes (Hanneman and Riddle (2005)). Interestingly, a large stakeholder may have the incentive and resources to steer their firms as directors, but if they lack expertise, Feldman and Montgomery (2015) suggests that such directors might be ineffectual.

It is difficult to predict ex-ante the effect of high ownership centrality on firm performance, even if we adopt a pure ownership perspective on ownership centrality. The ownership lens would force us to invoke agency theory. When they formulated the theory of the firm, Jensen and Meckling (1976) put agency theory at the heart of their treatise. The agency conflicts that arise from the separation of ownership and control in organizations is one that was expounded by Fama and Jensen (1983). The tendency of principal-principal conflict would instigate expropriation of minority shareholders in favor of large shareholders (La Porta, Lopez-de-Silanes, Shleifer and Vishny (2000), Claessens, Fan, Djankov and Lang (1999)). However, diffuse ownership may exacerbate agency problems but also offer compensating benefits, so the net effect of concentrated ownership is not clear (Demsetz and Villalonga (2001)). In other cases though, family ownership, implying high ownership concentration, has shown to be an effective organizational structure that does not adversely affect minority shareholders (Anderson and Reeb (2003)). Okhmatovskiy (2010) found that firms with board and ownership ties to State-owned Enterprises are associated with higher profitability, but firms with direct ties to the government are not. Finally, there is a huge body of literature regarding the negative effects of excess control rights of the ultimate owner (Nenova (2003)). For instance, the cost of borrowing is higher for firms with large shareholders who have a divergence between their largest ultimate owner's control rights and cash-flow rights (Lin, Ma, Malatesta and Xuan (2011)). In conclusion, the literature is mixed as to whether concentrated ownership drives positive firm outcomes, and by extension, for ownership centrality, my prior expectations are not biased either way.

It is difficult also to predict ex-ante which measures of centrality best describes and predicts the relationship between ownership centrality and firm performance. This is because measures of centrality are highly dependent on the topology of the ownership network. For instance, in a line network of five nodes connected sequentially, the central node has the same Degree centrality as its neighbors but has higher Closeness and Betweenness centralities.

Because of the ability of ownership centrality to easily and quickly tease out the influence of various economic actors in a reliable and proportionate manner, a strongly related strand of literature this work would impact are those research looking at the battle between states and corporations – whether state involvement crowds out private investment (Choo and Wong (2006), Menon and Ng (2013), Van Thang and Freeman (2009)), and whether states embrace the capitalist system with the aim of promoting their political goals and furthering their political dominance

(Bremmer (2010)). In such studies, the influence of the state is routinely controlled for using dummy variables often depending on the stake of the state. Ownership Centrality provides an intuitive systemic mechanism to isolate the effects of the state viz-a-viz other economic agents, especially in countries where there is state dominance in the capital markets, such as Singapore and China. This new methodology would also apply to research looking at specifically the effects of Sovereign Wealth Funds on corporate or political outcomes (Dewenter, Han and Malatesta (2010)).

State ownership is often thought to be detrimental to corporate performance. Various explanations have been proposed. First, politicians may cause state-owned firms to employ excess labor inputs. Second, state-owned firms may be pressured to hire politically connected people rather than those best qualified to perform desired tasks. Third, state-owned firms forgo maximum profit in the pursuit of social and political objectives, such as wealth redistribution. Fourth, the residual cashflow claims of these state-owned firms are not readily transferable like the shares of a private corporation. State-owned firms have indeed been found to have lower accounting-based measures of performance (Dewenter and Malatesta (2001)). This “state liability” has been observed for State-owned enterprises who exhibit significant performance gaps in terms of profitability and efficiency compared to private firms (Lazzarini and Musacchio (2015)). However, in markets with emerging capital markets, the results are mixed. In Singapore for instance, Ang and Ding (2006) argues that in an emerging economy, the alternative to government control is often no governance. They found that Singaporean government-linked companies have higher valuations and better Corporate Governance. In China, a significant convex relation exists between state ownership and Tobin’s Q of partially privatized state-owned enterprises (Sun, Tong and Tong (2002), Wei, Xie and Zhang (2005), Tian and Estrin (2008)). The most understated benefit of state ownership could be insurance against black swan events, such as during recessions (Lazzarini and Musacchio (2015), Beuselinck, Cao, Deloof and Xia (2015)), or targeted attacks by short sellers (Wang (2014)).

Besides the state, the other large bloc of owners are the institution owners. These conglomerates and multi-national companies may or may not be linked to the state. Nonetheless, literature is awash with evidence of their impact on firms. Whether it is an active influence on CEO compensation (Hartzell and Starks (2003)), or passive influence by rebalancing their portfolios (Parrino, Sias and Starks (2003)), the impact of institution owners is not trivial. In fact, higher percentage stake held by institutions has been found to be associated with higher Tobin's Q (McConnell and Servaes (1990)), but different types of institutions have been found to have varying degrees of impact on firm performance, as can be expected. Firm performance is enhanced more by foreign and independent institutions compared to domestic ones and those perceived to be non-independent (Ferreira and Matos (2008)). Firm performance is enhanced by private pension fund ownership and undermined by activist fund ownership (Woidtke (2002)).

Similar to the argument that ownership centrality facilitates a quantitatively rigorous algorithmic way to isolate state ownership, the same would go for studies that need to invoke group institutional ownership (Claessens, Fan and Lang (2006), Carney, Gedajlovic, Heugens, Van Essen and Van Oosterhout (2011)) and corporate pyramids (Fan, Wong and Zhang (2013), Chang (2003), Malan, Salamudin and Ahmad (2012)).

2.1.2 Firm Ownership Network Topology

The traditional image of ownership of the modern corporation as perpetuated by Berle and Means (1932) is one that is with ownership of capital widely dispersed among small shareholders. However, La Porta, Lopez-de-Silanes and Shleifer (1999) tracked down the ownership structure of large corporations in 27 developed economies to identify the ultimate controlling shareholders and found the typical firm is more likely being controlled by family dynasties or the state, rather than widely dispersed ownership. Holderness, Kroszner and Sheehan (1999) uncovered the trend of higher managerial ownership which spiked from 13% in 1935 to 21% in 1995. Denis and Sarin (1999) dispelled another myth about the corporation; using a sample of 583 firms over the decade starting 1983, they documented that a sizable percentage of firms experience large changes in board composition and ownership structure in any given year. The changes appear to be correlated and permanent.

Using the most comprehensive dataset yet, Faccio and Lang (2002) pored through ultimate ownership and control records of 5,232 corporations in 13 Western European. They found that the typical firms are family-controlled or widely held. Their dataset proves to be very valuable is a widely reused in much subsequent research like Laeven and Levine (2008), who found that tradition focus on Corporate Finance on the 100% small shareholder firm or the one large blockholder firm misses out a huge class of ownership structure, that of multiple blockholders.

Phan and Yoshikawa (2004) examined the ownership structure for 271 companies listed on the SGX circa 1999-20000 and found that the median proportion of shares owned by block-holders is 63%, relatively high compared to Western economies. They note that this stands in stark contrast to countries like Japan and Germany. Banks do not directly own significant proportions of shares in

Singapore companies because they are not permitted to do so under the Banking Act of 1970.

Vitali, Glattfelder and Battiston (2011) is arguably the first paper to thoroughly investigate the architecture of the international corporate ownership network, along with the computation of the control held by each global player. Using the Orbis 2007 database, the paper mapped out corporate control in the year 2007 across the world, involving 37 million economic actors located in 194 countries and roughly 13 million directed and weighted ownership links. They found that transnational corporations form a giant bow-tie structure. Within this structure, a large portion of control flows to a small tightly-knit core of financial institutions. This is the general shape of the ownership network on the global scale, but the outcome of their analyses is mostly a (very complex) visualization effort. This paper attempts to map out a locality in this network and use it to see how it drives outcomes in Corporate Finance and Corporate Governance.

Chapter 2.2 Data and Methodology

2.2.1 Constructing the Ownership Network

The concepts of centrality listed in Part I could generally be applied to derive ownership centrality, but there are major differences in the network that bears highlighting, along with the specific treatment performed in this research.

First, the interlocking board of directors is a bipartite graph, where each node is either a director or a firm, and we could project the graph to either partition. The same does not apply to the ownership network graph. The starting nodes are all firms, but the owners could be other firms, or private firms, family firms, people, or even the state. There is no meaning in partitioning the graph into all its different modes, so in this sense all the nodes are equal; the nodes are all economic agents. There is no need for projection of the vertices as was done for the interlocking board.

Second, the ownership network has a natural weightedness edge attribute. As opposed to board relationships which have no easily quantifiable measure of strength in the relationship, the ownership stake in the firm, on the other hand, is conspicuously quantifiable in an accurate manner with ease, a piece of information which if disregarded might seem imprudent and unwise. And yet that was one of the approaches I have chosen to take. The philosophical retort is the well-worn aphorism that "not everything that matters can be measured, and not everything that is measured matters". The logical reason why the unweighted network might work is that small shareholders might have an outsized impact on corporate outcomes in comparison to larger shareholders. The typical small shareholders who appear on the radar of the database are possibly important insiders who have to declare even small stakes. Hence, the considered argument for the unweighted network is that it tends to err on in favor of the small stakeholders. In this paper, the unweighted ownership network is termed the unity-weighted network, to potentially disambiguate mentions of the unweighted interlocking board projections used in Part I which I have termed Flat projections. In the same line of thought, the weighted ownership network is termed stake-weighted ownership network to avoid confusion with the weighted board projection network used in Part I.

Third, in the interlocking boards framework, most of the board nodes are participating in the computation of centrality and involved in the final regressions, but not in the case of measuring ownership centrality. In the ownership network, a large majority of nodes are little more than placeholders whose absence will not allow us to derive accurate ownership centrality scores. These nodes are disregarded in the final analysis, since only the centrality scores of the firms are preserved and used in the analyses.

Lastly, a word about directedness in the ownership network. The ownership tie implies a certain flow of power, influence, and literal cash. Ownership of a firm implies a stake in the residual claim of the firm, and operationally this translates to literal cashflow such as in the case of dividend payouts. There are many documented ways of deriving centrality measures in the case where directedness is a feature of the graph, such as using hubs and authority as developed in Kleinberg (1999). The most famous example centrality algorithm, however, must be the PageRank algorithm, conceived by Brin and Page (1998), whose simplicity belies the elegance with which it distilled the essence of the very convoluted directed graph of hyperlinks and helped create one of the most valuable companies in the world. In our paper, we ignore directedness to no severe consequence. My conjecture as to why directedness could be safely ignored is because of roll-up logic at the database level, where eventual owners are identified almost immediately, making proper directional tracing of ownerships through convoluted ownership paths unimportant.

2.2.2 Firm Ownership Data

There is a plethora of company ownership information available in other databases, but they do not handle the combination of a list of companies and historical data as easily as S&P Capital IQ.

Formerly known as Spectrum, Thomson Reuters Insider Filing Data (Forms 3, 4, 5, and 144) goes back to 1978[6]. Unfortunately, Thomson Reuter's data from WRDS has data only for U.S. companies. Bloomberg is good for the ownership of single company analysis. Thomson One Worldscope has detailed ownership for worldwide companies but with restrictions on the number of companies that can be investigated at one time, and results often need significant reformatting. Fame is good for British and Irish companies, and Amadeus for large European companies.

S&P Capital IQ's detailed ownership data enables users to view a public company's latest shareholder base, historical ownership changes for up to five years, and insider transactions for up to two years. Ownership data is mainly sourced from annual reports and shareholder proxy statements. These documents are annual, so by its nature, the predominant share of ownership is going to be updated annually. A substantial shareowner needs to file a notification when the entity crosses a certain percentage of ownership.

In Singapore, the relevant legislation covering substantial shareholding disclosure are the Companies Act, the Securities and Futures Act, and the Business Trust Act. The legislation applies to all Singapore-listed corporations, REITs, and business trusts.

Substantial Holdings refers to interest in 5% or more of the voting shares or units. The reporting obligation kicks in upon becoming or ceasing to be a substantial shareholder or changes in percentage shareholdings at discrete levels of 1% within two business days of triggering event.

Interest can be direct or deemed. Interest is deemed when there is control or exercise rights of more than or equal to 20% through itself, its associates or together

[6] A cleansed version is available only back to 1986. Institutional (Form 13F) and 5 Percent Owner Databases go back to 1980; the Domestic Mutual Fund Database goes back to 1979

with associates. However, holding as bare trustee, holding by way of security in connection with a lending entered into in the ordinary course of business, and holding by reason of a prescribed office, are not deemed interests.

One peculiarity of the database is that Total Shares Outstanding can exceed 100% because reporting requirements for holdings data are not aligned with the financials reporting of shares outstanding. Below we provide further elucidation on the other unique characteristics of the S&P Capital IQ ownership database which bear mentioning.

A few documents may report shareholdings for a particular holder with actual holders or associated entities of it, which leads to a difference in the holdings available over the platform and that of source documents. S&P Capital IQ employs certain mechanism at the collection level that defines which holders could be considered as an Actual holder in cases where source document reports multiple holders for the same holdings.

One mechanism is “Roll-Up Logic”. In most of the cases, filings like Annual Reports or Exchange Announcements are inconsistent in different periods, meaning different entities in the same corporate family tree report for the same ownership positions in a public company. For example, a stock exchange filing may list JP Morgan (Suisse) SA as an owner, but an annual report may show similar shares with simply JP Morgan Chase & Company Inc. Often the ultimate parent of the owner reports for shares held by their subsidiaries. In case both the parent and child own, then the data vendor does not consistently get a break-down of the shares held by parent and subsidiary across periods. If all filings are kept at the actual reporting entity, then they would often end up counting the shares twice and duplicate ownership positions on the platform. Looking at the inconsistency in filings, S&P

Capital IQ devised a roll-up logic at backend that leverages the relationships amongst the entities in the same corporate family tree or vertical and shows the ultimate parent company as the owner of the shares.

In cases where reported holdings are given with some footnotes or additional information, S&P Capital IQ may perform certain adjustments based on the given footnotes at the collection level. Hence, a difference in reported holdings (without any adjustments done) given in the source document when compared to the platform (post adjusted holdings) is bound to happen. S&P Capital IQ makes all the necessary adjustments to keep the data in sync right from the history. These adjustments (add ups/deductions) could be of various nature, viz. based on given document, previously filled documents, additional information provided elsewhere, and so on.

S&P Capital IQ also performs consolidation of Direct and Indirect Positions when they come across the documents which report either the direct holdings or at times only indirect holdings or even family/trust holdings. While collecting the reported data, they try to ensure that the current holdings are in sync with previously collected holdings or are there any missing holdings available in other documents. Hence, consolidation of all these direct/indirect reported holdings needs to be done to show consistent data over the platform. Hence there would be a deviation between platform holdings and reported holdings in the document as holdings appearing over platform are the full holdings of a particular entity since it has been adjusted effectively.

2.2.3 Ownership Centrality

One constraint of ownership controls in standard Corporate Finance literature is that normally only the ultimate owner of the firm can be included in the regressions, regardless of the pattern of ownership. One advantage of using centrality to assess the impact of stakeholdings in companies is that not only the ultimate owner is assessed, but the distribution of owners is considered in the computation of the final centrality score of the firm.

As an example, I present in the Table below the list of entities with top stake-weighted Eigenvector centralities for the Year 2014. It can be observed that the top entities are not limited to Public Listed firms. In fact, the top entity is Temasek Holdings (Private) Limited, a state-owned holding company that is a sovereign wealth fund owned by the Government of Singapore.

List of Top 10 stake-weighted Eigenvector Centralities for 2014
Temasek Holdings (Private) Limited
Singapore Airlines Limited
Neptune Orient Lines Limited
Olam International Limited
Sembcorp Industries Ltd
SMRT Corporation Ltd
Singapore Telecommunications Limited
Singapore Technologies Engineering Ltd
SATS Ltd
CapitaLand Limited

Centrality scores are computed for all owner entities, regardless of whether they are actual persons, family trusts, publicly listed firms or private corporations. In this way, Temasek's high Eigenvector centrality would translate into higher eigenvector centrality scores for all entities that it owns, and through this mechanism, we have a proxy for the transmission of information, command, and control between all the entities in our ownership model.

Note that this result is peculiar to this ownership network and is not present in the network of interlocking boards. First, the Temasek board is not included as a board node because it is not listed. Second, the highest level of management, specifically the CEOs of Temasek Holdings and Temasek International, are not personally on the boards of Singapore listed companies. Temasek's presence must instead be felt through an army of nominated directors, who under the interlocking boards framework, are not algorithmically recognized as part of a super-entity.

The list for top 10 entities with highest unity-weighted Eigenvector centralities is shown below. Temasek is not on this list because in this list the magnitude of shareholdings is diluted to a binary relationship. A non-domestic entity, Prudential plc, appears on this list.

List of Top 10 unity-weighted Eigenvector Centralities for 2014
Keppel Corporation Limited
DBS Group Holdings Ltd
Singapore Telecommunications Limited
United Overseas Bank Limited
Prudential plc
CapitaLand Limited
Oversea Chinese Banking Corporation Limited
Global Logistic Properties Limited
Sembcorp Industries Ltd
ComfortDelGro Corporation Limited

According to listing rules of the SGX, complete ownership data is normally published except in the annual report, which would have a section listing the twenty largest shareholders, a section that is mostly cosmetic because it is commonly filled by brokerages under Nominee entities. The listing rules also mandate that in the annual report the names of the substantial shareholders and a breakdown of their direct and deemed interests be reported as shown in the company's Register of Substantial Shareholders. For deemed interests, the issuer must disclose how such interests are held or derived. The notifiable obligation for the substantial shareholder is typically 5%. In addition, since the Securities and Futures (Amendment) Act provides for disclosure of any interests in securities of a

Singapore incorporated company by its directors and whosoever irrespective of his corporate title, it is principally responsible for the management and conduct of business of that listed corporation. Hence through this way, our ownership network, especially under the unity-weighted case, would capture the influence of insider directors even though directors are not explicitly included.

2.2.4 Firm Performance and Control Variables

For the sake of completeness, a table of variable definitions is provided in Table II.A. Most of the variables used in Part II, in fact, overlaps significantly with those in Part I.

The only exception is the stake variable, which is the percentage shareholdings of the ultimate shareholder with the largest ownership stake. This variable is added as a control variable because the key independent variable tested in this Part have an understandably intricate relationship with the shareholdings of the ultimate owner and we want to disentangle these effects from the ownership centrality effects.

Chapter 2.3 Hypothesis Development

The first hypothesis of this part research is to test the idea that firms that are more central to the ownership network achieve better return-on-assets and Tobin's Q, using a simple interpretation of ownership without consideration to directionality. This hypothesis is based on the idea that the network of owners is also a network of influence and cashflow and is a good proxy for proxy for owners and their collective impact on multiple firms through their ties

H1: Firms with higher ownership centralities have better firm performance

The second hypothesis is that if H1 holds, such ownership effects should persist for the medium-term window of 2 to 4 years. This is an extension of the idea that while ownership distribution changes very frequently for a firm at the micro level, at the firm level huge changes to ownership centrality are less often observed and hence the impact of today's firm ownership centrality would impact the firm up to four years.

H2: Firms with higher ownership centralities have better firm performance in the medium term

The third hypothesis we test in this paper is that consideration of the weightedness of the ownership network is important yet unclear. On the one hand, a stake-weighted network would overstate the effects of large blockholders. On the other hand, a unity-weighted network would overstate the contribution of small shareholders. It is conceivable that we get varied results based on the type of network weighting scheme used. However, it is expected that a Stake-weighted network would dilute the effects of Degree centrality and its closely associated measure Eigenvector centrality.

H3: Stake-weighted ownership networks should yield stronger results for geodesic-based centrality measures like Betweenness and Closeness centrality, while Unity-weighted ownership network should yield better results for Degree centrality and its derivative Eigenvector centrality

Chapter 2.4 Analysis and Results

2.4.1 Network Statistics

Table II.2 shows the Ownership Network graph statistics. The sample period for ownership centrality of 11 years is shorter than that of Board connectedness because of data availability on Capital IQ.

Panel II.2A presents the general graph statistics. The number of nodes in the network graph for each year varies from a low of 3,400 in 2004 to 9,866 in 2014. Since Unity-weighted is shorthand for edge weights having a value of one for all edges, the graph size for the unity weighted case is equal to the number of edges in the graph. So, taking reference at the year 2004, the number of edges in the graph is 9,272 but the total sum of all edge weights, otherwise known as the graph size, is 1,486,092.

Panel II.2B presents the graph components. It is interesting to note the dispersion to form a sense of the graph topology. Note that singletons (graph components with one node) are omitted in the listing of components. It can be observed that there is as a rule a very large component, which is many orders of magnitude larger than the next largest component. This is a different topology compared to that of the board projection or the director projection graph networks. Inspecting the network closer would reveal that year 2004 was probably a year with insufficient data coverage as it stands out as having many islands in the network graph.

2.4.2 Summary Statistics

The summary statistics are presented in Table II.3.

Panel II.3A repeats most of what was discussed in Part I. A new control variable is added in this section, which is the percentage stake owned by the largest shareholder. As mentioned, within the Capital IQ database Total Shares Outstanding can exceed 100% because reporting requirements for holdings data are not aligned with the financials reporting of shares outstanding, and this would also affect the variable of the stake held by the largest shareholder.

Panel II.3B describes the descriptive statistics of the variables obtained from a unity-weighted ownership graph, and Panel II.3C presents the network variables obtained under a stake-weighted ownership network graph. The measures for Betweenness, Closeness, and Eigenvector have been normalized to the size of the graph for better comparability across graphs (different years). However, degree centrality has not been normalized, because the unadjusted degree is intuitive and easy to interpret.

2.4.3 Correlation Matrices

Table II.4 displays the Pearson correlation matrices between the main regression variables and the network centrality measures.

Panel II.4A is the table for Unity-weighted network centralities, while Panel II.4B is the counterpart for Stake-weighted network centralities. It is observed that all the centralities are positively correlated with one another, with the highest correlation between Degree centrality and N-score Composite centrality of 0.86 in the case of Unity-weighted, and Betweenness and N-score Composite centrality of 0.72 in the case of Stake-weighted.

The correlations between return-on-assets and Tobin's Q and the various centrality measures are unambiguously positive and significant. The only exception is Stake Eigenvector centrality, which shows insignificant correlation with return-on-assets.

2.4.4 Differences in Means

Table II.5 presents the differences in means of the ownership centrality measures in relation to the two main corporate performance measures used in this paper.

An examination of Panel II.5A shows that Betweenness under Unity-weighted networks has only a 10% significance for return-on-assets, while Closeness is insignificant. These results are not surprising considering that the correlational analysis for these two variables only has 5% significance while the other variables mostly had 1%. Besides these two cases, all the other centrality variables in Panel II.5A have significant t-tests that suggest higher centralities is associated strongly with higher corporate performance.

Panel II.5B show that all the stake-weighted derived centralities have significant t-tests for our firm performance response variables between the higher and lower centralities divided along the median. The only exception is stake-weighted eigenvector centrality, whose effect on return-on-assets is insignificant from zero, a result foreboded by the earlier correlation analysis.

2.4.5 Firm Performance and Ownership Centralities

Table II.6 presents the table of regressions for firm performance and various ownership centralities. It is split into four panels, with Panels II.6Ai and ii based on unity-weighted centrality measures and Panels II.6Bi and ii based on stake-weighted ones.

2.4.5.1 ROA on Unity-weighted Ownership Centralities

Panel II.6Ai presents the relationship between return-on-assets and ownership centralities derived under Unity-weighted networks.

Equations (1) to (5) are the univariate regressions, which show that all except closeness are positive and significant at the 1% level.

Equations (6) to (10) are the respective multivariate regressions. One control variable that is added to the lineup of firm controls is the stake held by the largest stakeholder of the firm, which is expected to have an impact on firm returns, and is added here to ensure that the effect of our new ownership centralities variable on firm performance is not duplicitous with the stake variable.

These results confirm the results obtained in the univariate regressions. The Betweenness and Degree coefficients are positive and highly significant at 1%, while eigenvector is positive and significant at 5%.

These highly promising and groundbreaking results prove that ownership centrality is a valid factor in the case of return-on-assets. It also raises some questions, such as the weakness of Closeness centrality factor, which is not anticipated.

2.4.5.2 Tobin's Q on Unity-weighted Ownership Centralities

Panel II.6Aii presents the relationship between Tobin's Q and ownership centralities derived under Unity-weighted networks.

For the univariate regressions, Equations (1) to (2), we observe that Betweenness and Closeness lose their significance compared to simple t-test result, and the significance is completely obliterated in the multivariate case in equations (6) and (7).

Degree, Eigenvector and Composite N-score centralities, on the other hand, show up as highly significant at 1% in the univariate regressions in equations (3) to (5), and the significance tapes slightly only in the multivariate case as seen in equations (9) and (10).

All the significant coefficients (and in fact, the insignificant coefficients too) are positive, which is the right direction of influence we expect of their impact on Tobin's Q.

These cursory results show that ownership centrality might be useful in prediction of Tobin's Q. However, Betweenness and Closeness does not seem to work, only Degree, Eigenvector, and N-score centralities do.

2.4.5.3 ROA on Stake-weighted Ownership Centralities

Panel II.6Bi presents the relationship between return-on-assets and ownership centralities derived under Stake-weighted networks.

Equations (1) to (5) show the univariate regressions, which all have positive and highly significant coefficients at 1% level, except for Eigenvector centrality. Upon including the set of control variables, we can see in equations (6) to (10) that Eigenvector centrality is still insignificant, while Degree centrality has lost its significance.

This last result is understandable, because among all the centralities that we have included in this study, the one that is most correlated with the percentage shareholdings of the ultimate owner would be stake weighted Degree centrality with a correlation of 0.53. It is therefore not surprising that Degree centrality becomes obsolete once we control for the ownership stake of the ultimate shareholder.

2.4.5.4 Tobin's Q on Stake-weighted Ownership Centralities

Panel II.6Bii presents the relationship between Tobin's Q and ownership centralities derived under Stake-weighted networks.

As with the differences-in-means test, the univariate regressions are promising, as reported in equations (1) to (5), with all the centrality coefficients being positive and significant at the 1% level. For multivariate regressions, as reported in equations (6) to (10), Closeness and N-score composite centrality retained their 1% significance. Degree and Eigenvector dropped to 5% significance. Betweenness dropped to 10% significance.

2.4.6 Future Firm Performance and Composite Ownership Centralities

Table II.7 presents the table of regressions for future firm performance and N-score composite ownership centralities. It is split into four panels, with Panels II.7Ai and ii based on unity-weighted centrality measures and Panels II.7Bi and ii based on stake-weighted ones.

The reason N-score centrality was chosen as the key centrality variable in this section is that after analyzing the results presented in Table II.6, it appears that the N-Score variant is the consistent performer of all the centrality variables used, whether in terms of return-on-assets or Tobin's Q.

2.4.6.1 Future ROA on Unity-weighted Ownership Centralities

Panel II.7Ai presents the relationship between future return-on-assets and composite N-score ownership centrality derived under Unity-weighted networks.

Note that all the centrality coefficients are positive. Equations (1) and (2) are for contemporaneous regressions presented for ease of comparison. Equations (3) to (10) are the look-ahead regressions. It can be noted that all the coefficients on the N-score centralities are highly significant at the 1% level whether it be the univariate or the multivariate regressions. The only regression showing 5% significance for the centrality coefficient is that for three-year look-ahead return-on-assets.

2.4.6.2 Future Tobin's Q on Unity-weighted Ownership Centralities

Panel II.7Aii presents the relationship between future Tobin's Q and composite N-score ownership centrality derived under Unity-weighted networks.

Note that all the centrality coefficients are positive. Equations (1) and (2) are for contemporaneous regressions presented for ease of comparison. Equations (3) to (10) are the look-ahead regressions. Equation (4) is the multivariate look-ahead Tobin's Q regression with the best result, which is what we saw in Panel II.6Aii (10). It appears that N-score centrality loses its explanatory powers when extended to time horizons longer than one year.

2.4.6.3 Future ROA on Stake-weighted Ownership Centralities

Panel II.7Bi presents the relationship between future return-on-assets and composite N-score ownership centrality derived under Stake-weighted networks.

Note that all the centrality coefficients are positive. When we compare the Stake weighted results here against the Unity-weighted results obtained in Panel II.7Ai, we can see that the results for Stake-weighted N-score centrality are stronger under the stake-weighted case.

2.4.6.4 Future Tobin's Q on Stake-weighted Ownership Centralities

Panel II.7Bii presents the relationship between future Tobin's Q and composite N-score ownership centrality derived under Stake-weighted networks.

Note once again that all the centrality coefficients are positive. When we compare the Stake weighted results here against the Unity-weighted results obtained in Panel II.7Aii, note that the results for look-ahead multivariate regressions are better or at least as good in the Stake-weighted case.

Chapter 2.5 Robustness Checks

Table II.8 does robustness checks on the regression results in the earlier chapter, by using the subsample of firms with SCGI scores. Panel II.8Ai presents the table of regressions for firm performance and ownership centralities based on unity-weighted centrality measures, controlled for Corporate Governance. Panel II.8Bi and ii presents the table of regressions for firm performance and ownership centralities based on stake-weighted centrality measures, controlled for Corporate Governance.

2.5.1 Corporate Governance and Unity-weighted Ownership Centralities

2.5.1.1 ROA and Unity-weighted Ownership Centralities

Panel II.8Ai (1) to (5) presents the relationship between return-on-assets and ownership centralities derived under Unity-weighted networks with Corporate Governance control and could be compared to Panel II.6Ai.

From the results, we can conclude that the general results are robust under controlling for Corporate Governance. Betweenness and Degree centralities retained their 1% significance, whereas Eigenvector and N-score centralities are slightly less significant, being at the 5% level.

2.5.1.2 Tobin's Q and Unity-weighted Ownership Centralities

Panel II.8Ai (6) to (10) presents the relationship between Tobin's Q and ownership centralities derived under Unity-weighted networks with Corporate Governance control and could be compared to Panel II.6Aii.

The results are unequivocal that none of the centrality measures are significant when Corporate Governance is accounted for. This result is unexpected, and imply that Corporate Governance scores from the SCGI control for the factors that centrality scores capture at least when in explaining variance in Tobin's Q.

2.5.1.3 Future ROA and Unity-weighted Composite Centrality

Panel II.8Aii (1) to (5) presents the relationship between return-on-assets and ownership centralities derived under Stake-weighted networks with Corporate

Governance control and could be compared to Panel II.7Ai.

It can be seen from equations (2) to (5) that N-score centrality is significant at the 5% level at least when accounting for the variance in look-ahead return-on-assets. The significance level of centrality coefficients for the one-year and two-year look-ahead cases dropped from the 1% level of significance to 5%.

2.5.1.4 Future Tobin's Q and Unity-weighted Composite Centrality

Panel II.8Aii (6) to (10) presents the relationship between Tobin's Q and ownership centralities derived under Stake-weighted networks with Corporate Governance control and could be compared to Panel II.7Aii.

Pursuant to the results of Panel II.8Ai (6) to (10), we see that the centrality measure has lost its explanatory linkage for all look-ahead Tobin's Q tested.

2.5.2 Corporate Governance and Stake-weighted Ownership Centralities

2.5.2.1 ROA and Stake-weighted Ownership Centralities

Panel II.8Bi (1) to (5) presents the relationship between future return-on-assets and composite N-score ownership centrality derived under Unity-weighted networks with Corporate Governance control and could be compared to Panel II.6Bi.

The direction and the significance of the coefficients on the centralities are unchanged, making this panel the one which best survives the Corporate Governance robustness check. Betweenness, Closeness and N-score composite centralities are positively significant at the 1% level.

2.5.2.2 Tobin's Q and Stake-weighted Ownership Centralities

Panel II.8Bi (6) to (10) presents the relationship between future Tobin's Q and composite N-score ownership centrality derived under Unity-weighted networks with Corporate Governance control and could be compared to Panel II.6Bii.

None of the coefficients are significant, meaning that stake-weighted centrality does not survive the Corporate Governance robustness test. This is in line with the earlier results achieved under the unity-weighted case.

2.5.2.3 Future ROA and Stake-weighted Composite Centrality

Panel II.8Bii (1) to (5) presents the relationship between future return-on-assets and composite N-score ownership centrality derived under Stake-weighted networks with Corporate Governance control and could be compared to Panel II.7Bi.

It can be noted that all the results for the look-ahead effects of stake-weighted composite centrality on return-on-assets survived the robustness checks and are positive and significant at the 1% level. The only exception is the two-year look-ahead, whose coefficient less significant, at the 10% level.

2.5.2.4 Future Tobin's Q and Stake-weighted Composite Centrality

Panel II.8Bii (6) to (10) presents the relationship between future Tobin's Q and composite N-score ownership centrality derived under Stake-weighted networks with Corporate Governance control and could be compared to Panel II.7Bii.

As expected by now, none of the stake-weighted composite centralities were significant for look-ahead Tobin's Q after controlling for Corporate Governance.

Chapter 2.6 Conclusion

This paper also provides a holistic view of how ownership centrality interact with classical Corporate Governance measures. Relying heavily on the prior Corporate Governance scorecard developed for the Singapore market by Goh and

Lee (2009), this paper showed that certain centrality measures may capture additional dimensions that are hitherto omitted from the scorecard approach used in classical Corporate Governance indices.

It is ground-breaking to report that ownership centralities are a valid method to analyze hitherto unanalyzed social network metrics of corporate ownership. The centrality measures get mixed results when controlled for Corporate Governance, and the most robust metric turns out to be the N-Score centrality measure defined in Larcker, et al. (2013), on the return-on-assets measure of Corporate Performance.

In reaching the conclusion that neither unity-weighted or stake-weighted is superior, I received some feedback that this conclusion is not satisfying and more should be done to crown a winner to guide future research towards a superior method. To this criticism, I would like to point to another star-crossed lover-pair of methodologies in Empirical Finance – the equally-weighted and value-weighted portfolio or index. It is taken for granted that both have their place for there are distinct advantages to both methods and one is not a subset of the other. In the same vein, I would like to suggest that future research be conducted into both unity and stake-weighted methods because they capture different dimensions of the ownership network.

In this paper, I ran a wide battery of tests to map out the terrain on ownership networks and its effects on corporate performance and governance. There is conceivably a great deal of future research that could be built on top of ownership networks. Firstly, the directedness of the network is something which has not been exploited. With a directed network, powerful network algorithms like PageRank (Brin and Page (1998)) could be performed. Second, the ownership centrality could be a more sophisticated way to replace traditional dummy ownership variables used like in the case of research in Singapore where Temasek dummy variable is invoked (Li (2016), Liu, Yap and Zhou (2016)). Stake-owned centrality may be a more intuitive and elegant way to achieve some of the same outcomes. Third, ownership centrality could be used as a variable, instrument or proxy to disentangle control rights versus cashflow rights of various owners. Using a proxy measure known as the Banzhaf Index, arguably we can further examine whether the control versus cashflow rights of the ultimate owner of the firm has any effects on firm performance. Fourth, it would be useful to extend the ownership database to include boards of private firms, where possible, and of public organizations. This would be important especially in the case of Singapore where the state has a larger than normal influence in the corporate world. A board member who is concurrently straddling government and corporate responsibilities is conceivably a valuable connection, a valuable link which is currently absent in the current dataset.

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Appendix for Part 1

Table I.1 ***Variable List***

Panel I.1A ***Board Network Variables***

Abbreviation	Variable Name	Description and Remarks
Fb	Flat Betweenness	Node Betweenness Centrality Score for Unweighted Flat Projection
Fc	Flat Closeness	Node Closeness Centrality Score for Unweighted Flat Projection
Fd	Flat Degree	Node Degree for Unweighted Flat Projection
Fe	Flat Eigenvector	Node Eigenvector Centrality Score for Unweighted Flat Projection
Fnq	Flat Composite (Quintile)	Quintile Composite Centrality Score for Unweighted Flat Projection
Fbq, Fcq, Fdq, Feq	Flat Centrality (Quintile)	Quintile for Betweenness, Closeness, Degree or Eigenvector centrality for Unweighted Flat Projection
Wb	Weighted Betweenness	Node Betweenness Centrality Score for Simple Weighted Projection
Wc	Weighted Closeness	Node Closeness Centrality Score for Simple Weighted Projection
Wd	Weighted Degree	Node Degree for Simple Weighted Projection
We	Weighted Eigenvector	Node Eigenvector Centrality Score for Simple Weighted Projection
Wnq	Weighted Composite (Quintile)	Quintile Composite Centrality Score for Simple Weighted Projection
Wbq, Wcq, Wdq, Weq	Weighted Centrality (Quintile)	Quintile for Betweenness, Closeness, Degree or Eigenvector centrality for Simple Weighted Projection
Cb	Collaboration Betweenness	Node Betweenness Centrality Score for Collaboration Projection
Cc	Collaboration Closeness	Node Closeness Centrality Score for Collaboration Projection
Cd	Collaboration Degree	Node Degree for Collaboration Projection
Ce	Collaboration Eigenvector	Node Eigenvector Centrality Score for Collaboration Projection
Cn	Collaboration Composite (Quintile)	Quintile Composite Centrality Score for Collaboration Projection
Cbq, Ccq, Cdq, Ceq	Collaboration Centrality (Quintile)	Quintile for Betweenness, Closeness, Degree or Eigenvector centrality for Collaboration Projection

Panel I.1B ***Firm Variables***

Abbreviation	Variable Name	Description and Remarks
roa, roa1, roa2, roa3, roa4	Return-on-assets	Return-on-assets of the firm. The suffix, if present, indicates the look-ahead number of years.
tq, tq1, tq2, tq3, tq4, tq5	Tobin's Q	Tobin's Q of the firm. The suffix, if present, indicates the look-ahead number of years.
quickratio	Quick Ratio	Contemporaneous quick ratio of the firm.
netsales	Net Sales	Net Sales (in log) of the firm in USD.
sgata	SG&A to Assets	Percentage of Selling, General and Admin expense over the total assets of the firm
leverage	Leverage	The leverage level of the firm, defined as the ratio of total debt over total assets
assetgrowth	Asset Growth	Asset growth rate of the firm
age	Firm Age	The age of the firm since its founding.
hhi_ta	Herfindahl-Hirschman Index	This measures industry concentration at the Fama-French 30 industry portfolio based on total assets.
ffi10		The Fama-French 10 Industry Portfolios, namely: 1. Consumer NonDurables 2. Consumer Durables 3. Manufacturing 4. Oil, Gas, and Coal Extraction and Products 5. Business Equipment 6. Telephone and Television Transmission 7. Wholesale, Retail, and Some Services (Laundries, Repair Shops) 8. Healthcare, Medical Equipment, and Drugs 9. Utilities 10. Other
scgi	Singapore Corporate Governance Index	Value weighted score of the firm on the Singapore Corporate Governance Index

Table I.2. ***Board Network Graph Statistics***

Panel I.2A. ***General Graph Statistics***

		Graph Size (Sum of all edge weights)		
Year	Nodes	CollabBoard	FlatBoard	WeightedBoard
1989	181	31	64	92
1990	201	37	68	101
1991	211	43	75	117
1992	230	52	105	149
1993	247	62	128	174
1994	275	70	141	189
1995	290	78	160	211
1996	319	83	164	217
1997	356	110	206	266
1998	383	130	239	305
1999	425	175	323	406
2000	480	244	472	567
2001	510	296	621	726
2002	547	388	864	1,007
2003	608	500	1,234	1,416
2004	698	630	1,606	1,815
2005	737	748	1,960	2,207
2006	789	834	2,191	2,469
2007	837	938	2,432	2,718
2008	864	962	2,510	2,795
2009	869	1,006	2,608	2,909
2010	894	1,046	2,662	2,969
2011	904	1,072	2,688	3,003
2012	922	1,104	2,706	3,056
2013	935	1,165	2,872	3,239
2014	946	1,176	2,824	3,180
2015	945	1,180	2,834	3,181
2016	942	1,134	2,602	2,948

Panel I.2B. ***Graph Components***

Year	#Components	Components (Singletons omited)
1989	154	[11, 5, 5, 4, 2, 2, 2, 2, 2, 2]
1990	171	[11, 5, 5, 4, 3, 2, 2, 2, 2, 2, 2, 2]
1991	177	[11, 6, 5, 5, 4, 2, 2, 2, 2, 2, 2, 2, 2]
1992	186	[15, 10, 5, 5, 4, 3, 2, 2, 2, 2, 2, 2, 2, 2]
1993	194	[19, 17, 5, 5, 3, 2, 2, 2, 2, 2, 2, 2, 2, 2]
1994	216	[20, 18, 8, 5, 3, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2]
1995	222	[23, 18, 8, 7, 4, 3, 3, 2, 2, 2, 2, 2, 2, 2, 2, 2]
1996	248	[23, 18, 8, 7, 5, 3, 3, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2]
1997	260	[32, 27, 8, 7, 4, 3, 3, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2]
1998	266	[65, 8, 7, 4, 4, 4, 4, 3, 3, 3, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2]
1999	267	[98, 15, 8, 8, 4, 4, 3, 3, 3, 3, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2]
2000	251	[170, 8, 6, 4, 4, 4, 4, 3, 3, 3, 3, 3, 3, 3, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2]
2001	234	[224, 8, 7, 6, 5, 5, 4, 3, 3, 3, 3, 3, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2]
2002	209	[317, 5, 5, 3, 3, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2]
2003	197	[392, 6, 4, 3, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2]
2004	192	[500, 3, 2, 2, 2, 2, 2]
2005	167	[564, 2, 2, 2, 2, 2, 2, 2]
2006	175	[607, 3, 3, 3, 2, 2]
2007	145	[681, 3, 3, 3, 2, 2, 2, 2, 2, 2]
2008	154	[701, 3, 3, 2, 2, 2, 2, 2, 2]
2009	128	[735, 3, 2, 2, 2, 2, 2]
2010	130	[752, 6, 3, 3, 2, 2, 2, 2]
2011	127	[762, 3, 3, 3, 3, 2, 2, 2, 2, 2, 2, 2, 2]
2012	121	[785, 3, 3, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2]
2013	111	[813, 3, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2]
2014	107	[825, 3, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2]
2015	110	[824, 3, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2]
2016	124	[807, 3, 3, 2, 2, 2, 2, 2, 2, 2, 2]

Panel I.2C. ***Director Projection Network Statistics***

		Graph Size (Sum of all edge weights)		
Year	Nodes	CollabDir	FlatDir	WeightedDir
1989	323	144	289	308
1990	370	170	345	369
1991	411	196	418	450
1992	457	224	501	535
1993	517	260	643	679
1994	618	312	881	920
1995	687	353	1,060	1,102
1996	773	394	1,207	1,254
1997	903	475	1,537	1,599
1998	990	533	1,753	1,821
1999	1,161	649	2,261	2,375
2000	1,389	808	3,013	3,146
2001	1,568	936	3,715	3,868
2002	1,851	1,146	5,048	5,274
2003	2,222	1,412	6,797	7,088
2004	2,656	1,720	8,761	9,090
2005	3,008	1,984	10,997	11,369
2006	3,326	2,200	12,716	13,138
2007	3,714	2,462	14,753	15,196
2008	3,862	2,557	15,069	15,503
2009	3,945	2,631	15,558	16,021
2010	4,135	2,748	16,692	17,157
2011	4,237	2,818	17,158	17,607
2012	4,384	2,916	18,038	18,551
2013	4,487	3,010	18,907	19,495
2014	4,603	3,072	19,258	19,827
2015	4,631	3,089	19,392	19,926
2016	4,533	3,003	18,323	18,870

Panel I.2D. ***Director Projection Network Graph Components***

Year	#Components	Components (Singletons omited)
1989	154	[20, 8, 8, 7, 6, 5, 5, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2]
1990	171	[21, 9, 9, 8, 7, 5, 5, 5, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2]
1991	177	[23, 13, 10, 9, 8, 7, 6, 5, 5, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2]
1992	186	[27, 14, 14, 11, 10, 7, 6, 6, 5, 5, 5, 5, 5, 5, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2]
1993	194	[43, 35, 11, 10, 7, 7, 6, 6, 6, 6, 5, 5, 5, 5, 5, 5, 5, 5, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2]
1994	216	[50, 41, 21, 15, 11, 8, 8, 7, 7, 7, 6, 6, 5, 5, 5, 5, 5, 5, 5, 5, 5, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2]
1995	222	[66, 46, 23, 21, 19, 11, 8, 8, 8, 7, 7, 6, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2]
1996	248	[68, 46, 24, 23, 22, 11, 10, 8, 8, 8, 7, 7, 6, 6, 6, 6, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2]
1997	260	[90, 84, 30, 26, 18, 12, 10, 10, 9, 8, 8, 7, 7, 7, 7, 7, 6, 6, 6, 6, 6, 6, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2]
1998	266	[190, 32, 27, 18, 15, 12, 11, 10, 10, 10, 9, 9, 8, 8, 8, 7, 7, 7, 7, 7, 6, 6, 6, 6, 6, 6, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2]
1999	267	[288, 67, 28, 28, 15, 12, 11, 11, 11, 10, 10, 9, 9, 9, 8, 8, 7, 7, 7, 7, 7, 6, 6, 6, 6, 6, 6, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2]
2000	251	[548, 31, 15, 15, 14, 13, 13, 12, 12, 12, 12, 12, 11, 11, 11, 10, 10, 9, 9, 9, 8, 8, 8, 7, 7, 7, 7, 6, 6, 6, 6, 6, 6, 6, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2]
2001	234	[757, 32, 22, 19, 18, 15, 14, 13, 13, 12, 12, 11, 11, 10, 10, 9, 9, 9, 9, 7, 7, 7, 7, 7, 6, 6, 6, 6, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2]
2002	209	[1184, 21, 18, 15, 13, 11, 11, 11, 9, 9, 8, 8, 7, 7, 7, 7, 7, 6, 6, 6, 6, 6, 6, 6, 6, 6, 6, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2]

Panel I.2D. ***Director Projection Network Graph Components (cont'd)***

Year	#Components	Components (Singletons omited)
2003	197	[1540, 22, 18, 16, 13, 11, 11, 10, 9, 9, 9, 8, 8, 8, 7, 7, 7, 7, 7, 7, 7, 7, 7, 6, 6, 6, 6, 6, 6, 6, 6, 6, 6, 6, 6, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2]
2004	192	[2011, 16, 16, 14, 13, 12, 11, 9, 8, 8, 8, 8, 8, 7, 7, 7, 7, 7, 7, 7, 7, 6, 6, 6, 6, 6, 6, 6, 6, 6, 6, 6, 6, 6, 5, 5, 5, 5, 5, 5, 5, 5, 5, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2]
2005	167	[2383, 18, 14, 13, 12, 12, 10, 9, 8, 8, 8, 8, 8, 8, 8, 8, 7, 7, 7, 7, 7, 7, 7, 7, 7, 7, 7, 7, 7, 7, 6, 6, 6, 6, 6, 6, 6, 6, 6, 6, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2]
2006	175	[2678, 19, 16, 14, 14, 13, 12, 11, 10, 9, 9, 8, 8, 8, 8, 7, 7, 7, 7, 7, 7, 7, 7, 7, 6, 6, 6, 6, 6, 6, 6, 6, 6, 6, 6, 6, 6, 6, 6, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2]
2007	145	[3135, 15, 15, 14, 14, 14, 13, 12, 12, 12, 10, 10, 9, 9, 9, 8, 8, 8, 7, 7, 7, 7, 7, 7, 7, 7, 7, 6, 6, 6, 6, 6, 6, 6, 6, 6, 6, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2]
2008	154	[3251, 15, 14, 14, 14, 13, 12, 11, 10, 9, 9, 8, 8, 8, 8, 8, 7, 7, 7, 7, 7, 7, 7, 7, 7, 7, 7, 6, 6, 6, 6, 6, 6, 6, 6, 6, 6, 6, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2]
2009	128	[3417, 15, 14, 14, 14, 13, 12, 11, 9, 9, 8, 8, 8, 8, 7, 7, 7, 7, 7, 7, 7, 7, 6, 6, 6, 6, 6, 6, 6, 6, 6, 6, 6, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2]
2010	130	[3579, 32, 15, 14, 13, 12, 9, 9, 8, 8, 8, 8, 8, 8, 7, 7, 7, 7, 7, 7, 7, 7, 7, 7, 7, 6, 6, 6, 6, 6, 6, 6, 6, 6, 6, 6, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2]
2011	127	[3658, 18, 14, 14, 13, 13, 13, 12, 11, 10, 9, 9, 9, 9, 8, 8, 8, 8, 7, 7, 7, 7, 7, 7, 7, 7, 7, 7, 7, 7, 7, 7, 6, 6, 6, 6, 6, 6, 6, 6, 6, 6, 6, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2]
2012	121	[3824, 14, 13, 13, 13, 12, 12, 11, 11, 11, 10, 10, 10, 10, 9, 9, 9, 9, 8, 8, 8, 8, 7, 7, 7, 7, 7, 7, 7, 7, 7, 6, 6, 6, 6, 6, 6, 6, 6, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2]
2013	111	[3978, 13, 13, 12, 11, 11, 10, 10, 10, 10, 9, 8, 8, 8, 8, 8, 8, 7, 7, 7, 7, 7, 7, 7, 7, 7, 6, 6, 6, 6, 6, 6, 6, 6, 6, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2]
2014	107	[4061, 14, 13, 13, 11, 11, 10, 10, 10, 9, 9, 9, 9, 9, 9, 8, 8, 8, 8, 8, 8, 8, 8, 7, 7, 7, 7, 7, 7, 7, 7, 7, 7, 7, 7, 6, 6, 6, 6, 6, 6, 6, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 2, 2, 2, 2, 2, 2, 2, 2]
2015	110	[4080, 13, 13, 11, 11, 11, 11, 11, 10, 9, 9, 9, 8, 8, 8, 8, 8, 8, 7, 7, 7, 7, 7, 7, 7, 7, 7, 7, 7, 7, 7, 6, 6, 6, 6, 6, 6, 6, 6, 6, 6, 6, 6, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 2, 2, 2, 2, 2, 2, 2]
2016	124	[3918, 14, 14, 13, 13, 11, 11, 10, 9, 9, 9, 9, 9, 8, 8, 8, 8, 8, 8, 8, 7, 7, 7, 7, 7, 7, 7, 7, 6, 6, 6, 6, 6, 6, 6, 6, 6, 6, 6, 6, 6, 6, 6, 6, 6, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 3, 3, 3, 3, 3, 3, 3, 3, 3, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2]

Table I.3. *Summary Statistics*

Panel I.3A. *Key Firm Variables*

	count	mean	sd	p10	p25	p50	p75	p90
roa1	11,483	2.204	14.773	-4.69	0.13	2.64	5.85	10.40
tq1	10,036	2.038	6.855	0.72	0.97	1.29	1.92	3.29
netsales	14,490	0.099	0.454	0.00	0.00	0.01	0.04	0.14
sgata	12,888	0.163	1.273	0.01	0.03	0.09	0.17	0.29
leverage	14,120	3.675	0.734	2.84	3.39	3.81	4.10	4.32
assetgrowth	8,535	2.695	1.483	0.96	1.91	2.76	3.56	4.31
quickratio	13,891	2.152	9.247	0.41	0.71	1.13	1.93	3.57
age	21,504	24.105	25.067	4.00	9.00	19.00	31.00	45.00
scgi	4,949	58.272	13.578	49.04	54.86	60.22	65.45	70.19
hhi_ta	24,208	0.233	0.185	0.06	0.11	0.19	0.28	0.44

Panel I.3B. *Unweighted Network Variables (Flat Projection)*

	count	mean	sd	p10	p25	p50	p75	p90
Fb	17,401	0.002	0.004	0.00	0.00	0.00	0.00	0.01
Fc	17,401	0.117	0.090	0.00	0.00	0.16	0.19	0.21
Fd	17,401	4.556	4.751	0.00	0.00	3.00	7.00	11.00
Fe	17,401	0.013	0.039	0.00	0.00	0.00	0.01	0.03
Fbq	17,401	2.451	1.624	1.00	1.00	1.00	4.00	5.00
Fcq	17,401	2.809	1.526	1.00	1.00	3.00	4.00	5.00
Fdq	17,401	2.707	1.506	1.00	1.00	3.00	4.00	5.00
Feq	17,401	2.811	1.526	1.00	1.00	3.00	4.00	5.00
Fnq	17,401	2.719	1.506	1.00	1.00	3.00	4.00	5.00

Panel I.3C. *Simple Weighted Network Variables (Weighted Projection)*

	count	mean	sd	p10	p25	p50	p75	p90
Wb	17,401	0.002	0.004	0.00	0.00	0.00	0.00	0.01
Wc	17,401	0.114	0.088	0.00	0.00	0.15	0.19	0.21
Wd	17,401	5.176	5.812	0.00	0.00	4.00	8.00	13.00
We	17,401	0.005	0.040	0.00	0.00	0.00	0.00	0.00
Wbq	17,401	2.531	1.618	1.00	1.00	2.00	4.00	5.00
Wcq	17,401	2.809	1.526	1.00	1.00	3.00	4.00	5.00
Wdq	17,401	2.720	1.519	1.00	1.00	3.00	4.00	5.00
Weq	17,401	2.810	1.526	1.00	1.00	3.00	4.00	5.00
Wnq	17,401	2.724	1.501	1.00	1.00	3.00	4.00	5.00

Panel I.3D. *Hyperbolic Weighted Network Variables (Collaboration Projection)*

	count	mean	sd	p10	p25	p50	p75	p90
Cb	17,401	0.003	0.007	0.00	0.00	0.00	0.00	0.01
Cc	17,401	0.361	0.300	0.00	0.00	0.40	0.63	0.75
Cd	17,401	1.876	1.847	0.00	0.00	2.00	3.00	4.00
Ce	17,401	0.004	0.041	0.00	0.00	0.00	0.00	0.00
Cbq	17,401	2.462	1.647	1.00	1.00	1.00	4.00	5.00
Ccq	17,401	2.810	1.526	1.00	1.00	3.00	4.00	5.00
Cdq	17,401	2.497	1.511	1.00	1.00	2.00	4.00	5.00
Ceq	17,401	2.809	1.525	1.00	1.00	3.00	4.00	5.00
Cnq	17,401	2.738	1.499	1.00	1.00	3.00	4.00	5.00

Table I.4. *Pearson Correlation Matrices*

Panel I.4A. *Correlation of Main Variables and Flat Projection Network Variables*

	roa1	tq1	netsales	sgata	leverage	assetgrowth	quickratio	age	scgi	hhi_ta	Fb	Fc	Fd	Fe	Fn
roa1	1.00														
tq1	0.08***	1.00													
	(0.00)														
netsales	0.03***	0.00	1.00												
	(0.01)	(0.79)													
sgata	-0.42***	0.06***	-0.01	1.00											
	(0.00)	(0.00)	(0.19)												
leverage	-0.12***	-0.03***	0.03***	0.20***	1.00										
	(0.00)	(0.00)	(0.00)	(0.00)											
assetgrowth	0.09***	0.03**	-0.08***	0.01	0.11***	1.00									
	(0.00)	(0.02)	(0.00)	(0.36)	(0.00)										
quickratio	-0.00	0.01	-0.02**	-0.01	-0.35***	-0.00	1.00								
	(0.75)	(0.21)	(0.01)	(0.22)	(0.00)	(0.83)									
age	0.01	-0.01	0.24***	-0.01	0.00	-0.18***	-0.01	1.00							
	(0.30)	(0.23)	(0.00)	(0.20)	(0.87)	(0.00)	(0.11)								
scgi	0.09***	0.01	0.14***	-0.11***	-0.01	-0.02	-0.03**	0.10***	1.00						
	(0.00)	(0.51)	(0.00)	(0.00)	(0.39)	(0.24)	(0.02)	(0.00)							
hhi_ta	0.01	0.04***	0.10***	0.01	-0.02*	-0.00	-0.00	0.07***	-0.02	1.00					
	(0.12)	(0.00)	(0.00)	(0.14)	(0.05)	(0.69)	(0.97)	(0.00)	(0.23)						
Fb	0.03***	-0.00	0.07***	-0.02	-0.03***	-0.07***	0.00	0.06***	0.12***	-0.05***	1.00				
	(0.01)	(0.64)	(0.00)	(0.10)	(0.00)	(0.00)	(0.63)	(0.00)	(0.00)	(0.00)					
Fc	-0.01	-0.03***	0.09***	-0.02**	-0.08***	-0.09***	0.03***	0.09***	0.14***	-0.15***	0.49***	1.00			
	(0.58)	(0.01)	(0.00)	(0.04)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)				
Fd	0.03***	-0.01	0.12***	-0.02***	-0.09***	-0.09***	0.02*	0.10***	0.15***	-0.09***	0.77***	0.74***	1.00		
	(0.01)	(0.60)	(0.00)	(0.01)	(0.00)	(0.00)	(0.05)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)			
Fe	0.02**	0.00	0.06***	-0.02**	-0.10***	-0.05***	0.01	0.04***	0.15***	0.01	0.30***	0.21***	0.50***	1.00	
	(0.04)	(0.68)	(0.00)	(0.04)	(0.00)	(0.00)	(0.14)	(0.00)	(0.00)	(0.33)	(0.00)	(0.00)	(0.00)		
Fn	0.04***	-0.01	0.12***	-0.03***	-0.07***	-0.10***	0.01	0.15***	0.17***	-0.07***	0.65***	0.71***	0.87***	0.41***	1.00
	(0.00)	(0.53)	(0.00)	(0.00)	(0.00)	(0.00)	(0.20)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	

p-values in parentheses
* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

Panel I.4B. *Correlation of Main Variables and Weighted Projection Network Variables*

	roa1	tq1	netsales	sgata	leverage	assetgrowth	quickratio	age	scgi	hhi_ta	Wb	Wc	Wd	We	Wn
roa1	1.00														
tq1	0.08***	1.00													
	(0.00)														
netsales	0.03***	0.00	1.00												
	(0.01)	(0.79)													
sgata	-0.42***	0.06***	-0.01	1.00											
	(0.00)	(0.00)	(0.19)												
leverage	-0.12***	-0.03***	0.03***	0.20***	1.00										
	(0.00)	(0.00)	(0.00)	(0.00)											
assetgrowth	0.09***	0.03**	-0.08***	0.01	0.11***	1.00									
	(0.00)	(0.02)	(0.00)	(0.36)	(0.00)										
quickratio	-0.00	0.01	-0.02**	-0.01	-0.35***	-0.00	1.00								
	(0.75)	(0.21)	(0.01)	(0.22)	(0.00)	(0.83)									
age	0.01	-0.01	0.24***	-0.01	0.00	-0.18***	-0.01	1.00							
	(0.30)	(0.23)	(0.00)	(0.20)	(0.87)	(0.00)	(0.11)								
scgi	0.09***	0.01	0.14***	-0.11***	-0.01	-0.02	-0.03**	0.10***	1.00						
	(0.00)	(0.51)	(0.00)	(0.00)	(0.39)	(0.24)	(0.02)	(0.00)							
hhi_ta	0.01	0.04***	0.10***	0.01	-0.02*	-0.00	-0.00	0.07***	-0.02	1.00					
	(0.12)	(0.00)	(0.00)	(0.14)	(0.05)	(0.69)	(0.97)	(0.00)	(0.23)						
Wb	0.03***	-0.00	0.07***	-0.01	-0.03***	-0.07***	0.00	0.06***	0.11***	-0.05***	1.00				
	(0.00)	(0.65)	(0.00)	(0.11)	(0.00)	(0.00)	(0.66)	(0.00)	(0.00)	(0.00)					
Wc	-0.01	-0.03***	0.08***	-0.02**	-0.08***	-0.08***	0.03***	0.08***	0.14***	-0.15***	0.49***	1.00			
	(0.51)	(0.01)	(0.00)	(0.05)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)				
Wd	0.03***	-0.00	0.27***	-0.02**	-0.10***	-0.10***	0.01	0.18***	0.13***	-0.07***	0.66***	0.66***	1.00		
	(0.00)	(0.92)	(0.00)	(0.01)	(0.00)	(0.00)	(0.22)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)			
We	0.01	0.01	0.30***	-0.01	-0.05***	-0.03**	0.00	0.17***	-0.02	0.02**	0.03***	0.01	0.36***	1.00	
	(0.15)	(0.45)	(0.00)	(0.55)	(0.00)	(0.02)	(0.99)	(0.00)	(0.23)	(0.02)	(0.00)	(0.47)	(0.00)		
Wn	0.04***	-0.01	0.15***	-0.03***	-0.07***	-0.10***	0.01	0.17***	0.18***	-0.07***	0.62***	0.70***	0.79***	0.15***	1.00
	(0.00)	(0.60)	(0.00)	(0.00)	(0.00)	(0.00)	(0.40)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	

p-values in parentheses
* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

Panel I.4C. *Correlation of Main Variables and Collaboration Projection Network Variables*

	roa1	tq1	netsales	sgata	leverage	assetgrowth	quickratio	age	scgi	hhi_ta	Cb	Cc	Cd	Ce	Cn
roa1	1.00														
tq1	0.08***	1.00													
	(0.00)														
netsales	0.03***	0.00	1.00												
	(0.01)	(0.79)													
sgata	-0.42***	0.06***	-0.01	1.00											
	(0.00)	(0.00)	(0.19)												
leverage	-0.12***	-0.03***	0.03***	0.20***	1.00										
	(0.00)	(0.00)	(0.00)	(0.00)											
assetgrowth	0.09***	0.03**	-0.08***	0.01	0.11***	1.00									
	(0.00)	(0.02)	(0.00)	(0.36)	(0.00)										
quickratio	-0.00	0.01	-0.02**	-0.01	-0.35***	-0.00	1.00								
	(0.75)	(0.21)	(0.01)	(0.22)	(0.00)	(0.83)									
age	0.01	-0.01	0.24***	-0.01	0.00	-0.18***	-0.01	1.00							
	(0.30)	(0.23)	(0.00)	(0.20)	(0.87)	(0.00)	(0.11)								
scgi	0.09***	0.01	0.14***	-0.11***	-0.01	-0.02	-0.03**	0.10***	1.00						
	(0.00)	(0.51)	(0.00)	(0.00)	(0.39)	(0.24)	(0.02)	(0.00)							
hhi_ta	0.01	0.04***	0.10***	0.01	-0.02*	-0.00	-0.00	0.07***	-0.02	1.00					
	(0.12)	(0.00)	(0.00)	(0.14)	(0.05)	(0.69)	(0.97)	(0.00)	(0.23)						
Cb	0.02*	-0.01	0.03***	-0.01	-0.03***	-0.06***	0.00	0.03***	0.06***	-0.02***	1.00				
	(0.08)	(0.51)	(0.00)	(0.20)	(0.00)	(0.00)	(0.73)	(0.00)	(0.00)	(0.01)					
Cc	-0.00	-0.02**	0.06***	-0.02**	-0.08***	-0.08***	0.03***	0.06***	0.11***	-0.14***	0.40***	1.00			
	(0.84)	(0.02)	(0.00)	(0.05)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)				
Cd	0.03***	-0.01	0.34***	-0.02***	-0.06***	-0.11***	0.01	0.23***	0.18***	-0.07***	0.37***	0.62***	1.00		
	(0.01)	(0.41)	(0.00)	(0.01)	(0.00)	(0.00)	(0.53)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)			
Ce	0.01	0.01	0.29***	-0.01	-0.04***	-0.02*	-0.01	0.14***	-0.03*	0.01	0.02***	0.01	0.32***	1.00	
	(0.29)	(0.58)	(0.00)	(0.57)	(0.00)	(0.08)	(0.49)	(0.00)	(0.05)	(0.43)	(0.00)	(0.32)	(0.00)		
Cn	0.04***	-0.01	0.15***	-0.03***	-0.06***	-0.10***	0.01	0.18***	0.18***	-0.07***	0.47***	0.70***	0.78***	0.13***	1.00
	(0.00)	(0.40)	(0.00)	(0.00)	(0.00)	(0.00)	(0.38)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	

p-values in parentheses
* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

Table I.5. *Differences in Means*

Panel I.5A. *T Tests of High and Low Centralities under Unweighted Flat Projection*

Fb	High Fb	Low Fb	Diff.	Std.Error	Obs.
roa1	2.2789	1.3705	-0.9084***	0.2816	10527
tq1	1.8561	2.0129	0.1568	0.1327	9488

Fc	High Fc	Low Fc	Diff.	Std.Error	Obs.
roa1	2.2061	1.3523	-0.8538***	0.2818	10527
tq1	1.9221	1.9531	0.0310	0.1333	9488

Fd	High Fd	Low Fd	Diff.	Std.Error	Obs.
roa1	2.3920	1.2175	-1.1745***	0.2812	10527
tq1	1.9771	1.8930	-0.0841	0.1327	9488

Fe	High Fe	Low Fe	Diff.	Std.Error	Obs.
roa1	2.1069	1.4692	-0.6377**	0.2817	10527
tq1	1.9388	1.9330	-0.0059	0.1332	9488

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

Panel I.5B. *T Tests of High and Low Centralities under Simple Weighted Projection*

Wb	High Wb	Low Wb	Diff.	Std.Error	Obs.
roa1	2.3636	1.2634	-1.1002***	0.2813	10527
tq1	1.8580	2.0153	0.1573	0.1327	9488

Wc	High Wc	Low Wc	Diff.	Std.Error	Obs.
roa1	2.1934	1.3672	-0.8262***	0.2818	10527
tq1	1.9343	1.9384	0.0041	0.1332	9488

Wd	High Wd	Low Wd	Diff.	Std.Error	Obs.
roa1	2.5117	1.0939	-1.4178***	0.2811	10527
tq1	1.9649	1.9054	-0.0595	0.1327	9488

We	High We	Low We	Diff.	Std.Error	Obs.
roa1	2.2625	1.3017	-0.9608***	0.2816	10527
tq1	1.9620	1.9054	-0.0566	0.1332	9488

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

Panel I.5C. *T Tests of High and Low Centralities under Hyperbolic Collaboration Projection*

Cb	High Cb	Low Cb	Diff.	Std.Error	Obs.
roa1	2.2973	1.3383	-0.9590***	0.2814	10527
tq1	1.8625	2.0084	0.1459	0.1327	9488

Cc	High Cc	Low Cc	Diff.	Std.Error	Obs.
roa1	2.1337	1.4366	-0.6972**	0.2818	10527
tq1	1.9280	1.9456	0.0176	0.1330	9488

Cd	High Cd	Low Cd	Diff.	Std.Error	Obs.
roa1	2.4798	1.3321	-1.1477***	0.2857	10527
tq1	1.9456	1.9291	-0.0165	0.1340	9488

Ce	High Ce	Low Ce	Diff.	Std.Error	Obs.
roa1	2.2703	1.2884	-0.9819***	0.2816	10527
tq1	1.9484	1.9213	-0.0270	0.1333	9488

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

Table I.6. *Firm Performance and Different Board Centralities*

Panel I.6A. *Return on assets and various (Unweighted) Flat Board Centralities*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	roa1	roa1	roa1	roa1	roa1	roa1	roa1	roa1	roa1	roa1
Fbq	0.551***					0.150***				
	(0.209)					(0.052)				
Fcq		0.447***					0.195***			
		(0.171)					(0.062)			
Fdq			0.486***					0.151**		
			(0.170)					(0.062)		
Feq				0.423**					0.181***	
				(0.168)					(0.060)	
Fnq					0.496***					0.172***
					(0.170)					(0.061)
netsales						0.147	0.135	0.126	0.125	0.131
						(0.119)	(0.113)	(0.117)	(0.115)	(0.116)
sgata						0.056	0.111	0.043	0.088	0.093
						(1.073)	(1.080)	(1.076)	(1.078)	(1.080)
leverage						0.490*	0.497*	0.498*	0.502*	0.495*
						(0.257)	(0.258)	(0.257)	(0.258)	(0.258)
assetgrowth						-0.184**	-0.178**	-0.182**	-0.179**	-0.180**
						(0.075)	(0.075)	(0.075)	(0.075)	(0.075)
quickratio						0.005	0.006	0.006	0.006	0.006
						(0.023)	(0.023)	(0.023)	(0.023)	(0.023)
age						0.010***	0.010***	0.010***	0.010***	0.010***
						(0.003)	(0.002)	(0.003)	(0.002)	(0.002)
hhi_ta						0.288	0.287	0.289	0.260	0.278
						(0.708)	(0.706)	(0.707)	(0.707)	(0.705)
roa						0.638***	0.639***	0.638***	0.639***	0.638***
						(0.046)	(0.046)	(0.046)	(0.046)	(0.046)
ffi10-Yr FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	10508	10508	10508	10508	10508	6129	6129	6129	6129	6129
adj. R^2	0.009	0.008	0.008	0.007	0.008	0.472	0.472	0.472	0.472	0.472
F	6.969	6.883	8.136	6.328	8.461	28.103	28.405	27.907	28.026	28.056
vce	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster
clustvar	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Panel I.6B. *Tobin's Q and (Unweighted Flat) Centralities*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	tq1	tq1	tq1	tq1	tq1	tq1	tq1	tq1	tq1	tq1
Fbq	0.026					0.088^{***}				
	(0.030)					(0.033)				
Fcq		0.007					0.114^{**}			
		(0.055)					(0.053)			
Fdq			0.009					0.097^{*}		
			(0.055)					(0.051)		
Feq				0.007					0.105^{**}	
				(0.054)					(0.053)	
Fnq					0.007					0.117^{**}
					(0.056)					(0.050)
netsales						0.124	0.117	0.110	0.111	0.113
						(0.088)	(0.084)	(0.087)	(0.086)	(0.084)
sgata						2.262^{***}	2.303^{***}	2.264^{***}	2.279^{***}	2.307^{***}
						(0.687)	(0.695)	(0.690)	(0.696)	(0.693)
leverage						-0.588^{***}	-0.587^{***}	-0.583^{***}	-0.583^{***}	-0.586^{***}
						(0.124)	(0.123)	(0.123)	(0.123)	(0.123)
assetgrowth						0.068^{**}	0.072^{**}	0.070^{**}	0.071^{**}	0.071^{**}
						(0.032)	(0.031)	(0.032)	(0.032)	(0.031)
quickratio						0.012	0.012	0.012	0.012	0.012
						(0.021)	(0.021)	(0.021)	(0.021)	(0.021)
age						-0.000	-0.000	-0.000	-0.000	-0.000
						(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
hhi_ta						0.911^{*}	0.910^{*}	0.915^{*}	0.897^{*}	0.906^{*}
						(0.478)	(0.478)	(0.479)	(0.480)	(0.478)
roa						0.117^{***}	0.117^{***}	0.117^{***}	0.118^{***}	0.117^{***}
						(0.025)	(0.025)	(0.025)	(0.025)	(0.025)
ffi10-Yr FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	9476	9476	9476	9476	9476	5413	5413	5413	5413	5413
adj. R^2	0.002	0.002	0.002	0.002	0.002	0.090	0.091	0.090	0.090	0.091
F	0.795	0.015	0.027	0.015	0.016	9.188	9.342	8.937	8.949	9.399
vce	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster
clustvar	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table I.7. *Future Firm Performance and Composite Board Centrality*

Panel I.7A. *Future Return on assets and Composite (Unweighted) Flat Board Centrality*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	roa	roa	roa1	roa1	roa2	roa2	roa3	roa3	roa4	roa4
Fnq	0.521**	-0.201	0.496***	0.172***	0.499***	0.225**	0.599***	0.474***	0.732***	0.551***
	(0.251)	(0.128)	(0.170)	(0.061)	(0.166)	(0.105)	(0.182)	(0.129)	(0.215)	(0.160)
netsales		0.785**		0.131		0.146		0.269		0.457*
		(0.358)		(0.116)		(0.197)		(0.251)		(0.267)
sgata		-5.209		0.093		-6.408		-7.464		0.341
		(5.287)		(1.080)		(3.956)		(4.929)		(1.859)
leverage		-2.405***		0.495*		0.667		0.104		0.560
		(0.651)		(0.258)		(0.500)		(0.379)		(0.543)
assetgrowth		0.743***		-0.180**		-0.623***		-0.746***		-0.495***
		(0.142)		(0.075)		(0.184)		(0.228)		(0.135)
quickratio		-0.114**		0.006		0.004		-0.072*		0.029
		(0.046)		(0.023)		(0.042)		(0.043)		(0.084)
age		-0.008		0.010***		0.023***		0.029***		0.023***
		(0.007)		(0.002)		(0.004)		(0.006)		(0.005)
hhi_ta		-1.009		0.278		2.246*		1.551		1.275
		(1.282)		(0.705)		(1.271)		(2.242)		(2.332)
roa				0.638***		0.777***		0.774***		0.286***
				(0.046)		(0.186)		(0.254)		(0.071)
ffi10-Yr FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	11749	6663	10508	6129	9558	5613	8674	5064	7802	4515
adj. R^2	0.000	0.083	0.008	0.472	0.005	0.409	0.000	0.315	-0.010	0.056
F	4.295	5.679	8.461	28.056	9.039	6.860	10.856	6.461	11.649	6.675
vce	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster
clustvar	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Panel I.7B. *Future Tobin's Q vs and Composite (Unweighted) Flat Board Centrality*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	tq	tq	tq1	tq1	tq2	tq2	tq3	tq3	tq4	tq4
Fnq	0.082^{*}	0.101^{*}	0.007	0.143^{***}	0.026	0.126^{***}	0.031	0.141^{***}	0.065^{**}	0.171^{***}
	(0.045)	(0.058)	(0.056)	(0.047)	(0.036)	(0.043)	(0.036)	(0.044)	(0.030)	(0.055)
netsales		0.212^{*}		0.112		0.100		0.096		0.104
		(0.126)		(0.080)		(0.078)		(0.085)		(0.088)
sgata		2.173^{***}		2.051^{***}		1.946^{***}		2.294^{***}		2.411^{***}
		(0.561)		(0.726)		(0.681)		(0.741)		(0.735)
leverage		-1.019^{***}		-0.511^{***}		-0.454^{***}		-0.525^{***}		-0.629^{***}
		(0.166)		(0.174)		(0.152)		(0.159)		(0.192)
assetgrowth		0.279^{***}		0.049		0.063^{*}		0.069		0.044
		(0.054)		(0.044)		(0.038)		(0.045)		(0.032)
quickratio		0.009		0.006		-0.006		-0.014		-0.008
		(0.025)		(0.017)		(0.013)		(0.011)		(0.017)
age		-0.000		0.000		0.001		0.002		0.002
		(0.002)		(0.001)		(0.001)		(0.002)		(0.002)
hhi_ta		0.791		0.476		0.486		0.577		0.718
		(0.547)		(0.470)		(0.554)		(0.617)		(0.740)
tq				0.277		0.225		0.175		0.123
				(0.170)		(0.147)		(0.122)		(0.091)
ffi10-Yr FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	9735	5663	9476	4865	8918	4398	8268	3930	7535	3454
adj. R^2	0.003	0.053	0.002	0.192	0.014	0.128	0.013	0.077	0.022	0.043
F	3.365	8.984	0.016	11.305	0.528	7.783	0.751	6.723	4.853	5.181
vce	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster
clustvar	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table I.8. *SCGI Subsample Analysis of Firm Performance and Board Centrality*

Panel I.8A. *SCGI Subsample: Firm Performance and various (Unweighted) Flat Board Centralities*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	roa1	roa1	roa1	roa1	roa1	tq1	tq1	tq1	tq1	tq1
Fbq	0.120^{*}					0.059				
	(0.071)					(0.046)				
Fcq		0.153					0.093^{*}			
		(0.104)					(0.053)			
Fdq			0.121					0.056^{*}		
			(0.083)					(0.032)		
Feq				0.096					0.065^{**}	
				(0.101)					(0.027)	
Fnq					0.098					0.088
					(0.103)					(0.056)
netsales	0.186	0.170	0.177	0.181	0.181	-0.046	-0.056	-0.050	-0.053	-0.057
	(0.114)	(0.117)	(0.116)	(0.120)	(0.120)	(0.078)	(0.081)	(0.077)	(0.077)	(0.083)
sgata	0.146	0.214	0.153	0.152	0.156	0.224	0.289	0.226	0.245	0.282
	(1.178)	(1.205)	(1.176)	(1.197)	(1.204)	(0.257)	(0.250)	(0.264)	(0.261)	(0.252)
leverage	1.018^{**}	1.013^{**}	1.015^{**}	1.019^{**}	1.014^{**}	0.046	0.040	0.046	0.045	0.044
	(0.445)	(0.447)	(0.445)	(0.444)	(0.446)	(0.066)	(0.066)	(0.066)	(0.066)	(0.066)
assetgrowth	-0.049	-0.046	-0.047	-0.047	-0.047	-0.120^{**}	-0.117^{**}	-0.119^{**}	-0.118^{**}	-0.117^{**}
	(0.104)	(0.105)	(0.105)	(0.106)	(0.106)	(0.058)	(0.056)	(0.057)	(0.057)	(0.056)
quickratio	0.069^{*}	0.068^{*}	0.068^{*}	0.068^{*}	0.068^{*}	-0.003	-0.003	-0.004	-0.003	-0.003
	(0.038)	(0.038)	(0.038)	(0.038)	(0.038)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
age	0.014^{***}	0.014^{***}	0.014^{***}	0.014^{***}	0.014^{***}	0.000	0.000	0.001	0.000	0.000
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
hhi_ta	-0.985	-1.041	-1.033	-1.057	-1.038	-0.040	-0.075	-0.066	-0.080	-0.064
	(1.034)	(1.023)	(1.026)	(1.024)	(1.026)	(0.388)	(0.380)	(0.382)	(0.380)	(0.383)
scgi	0.011	0.010	0.011	0.012	0.011	0.003	0.002	0.003	0.003	0.002
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.004)	(0.004)	(0.003)	(0.003)	(0.004)
roa	0.684^{***}	0.685^{***}	0.684^{***}	0.685^{***}	0.684^{***}					
	(0.040)	(0.040)	(0.040)	(0.040)	(0.040)					
tq						0.900^{***}	0.898^{***}	0.900^{***}	0.899^{***}	0.898^{***}
						(0.163)	(0.162)	(0.163)	(0.162)	(0.162)
ffi10-Yr FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	2688	2688	2688	2688	2688	2199	2199	2199	2199	2199
adj. R^2	0.530	0.530	0.529	0.529	0.529	0.286	0.287	0.286	0.286	0.287
F	49.153	50.567	49.456	51.230	49.973	30.547	31.294	29.316	28.885	31.446
vce	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster
clustvar	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Panel I.8B. *SCGI Subsample: Future Firm Performance and Composite (Unweighted) Flat Board Centrality*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	roa	roa1	roa2	roa3	roa4	tq	tq1	tq2	tq3	tq4
Fnq	-0.087	0.098	-0.190	-0.072	0.148	0.093^{**}	0.088	0.030	0.046	0.159
	(0.192)	(0.103)	(0.165)	(0.179)	(0.175)	(0.039)	(0.056)	(0.032)	(0.040)	(0.101)
netsales	0.742^{**}	0.181	0.083	0.127	0.719^{***}	0.245^{**}	-0.057	-0.045	-0.004	-0.019
	(0.358)	(0.120)	(0.212)	(0.221)	(0.251)	(0.104)	(0.083)	(0.067)	(0.053)	(0.077)
sgata	-13.426	0.156	-5.313	-6.577^{*}	0.713	1.755^{***}	0.282	0.416	0.889^{***}	1.667^{***}
	(10.207)	(1.204)	(3.236)	(3.884)	(1.871)	(0.480)	(0.252)	(0.283)	(0.320)	(0.560)
leverage	-3.212^{***}	1.014^{**}	1.442^{*}	0.933^{*}	1.158	-0.681^{***}	0.044	-0.001	-0.135	-0.364
	(1.167)	(0.446)	(0.817)	(0.558)	(0.773)	(0.150)	(0.066)	(0.073)	(0.121)	(0.261)
assetgrowth	0.303	-0.047	-0.569^{***}	-0.591^{***}	-0.290^{*}	0.184^{***}	-0.117^{**}	-0.034	-0.034	-0.059
	(0.259)	(0.106)	(0.170)	(0.185)	(0.157)	(0.039)	(0.056)	(0.048)	(0.070)	(0.060)
quickratio	-0.214^{**}	0.068^{*}	0.059	-0.020	0.084	0.009	-0.003	-0.007	-0.014	-0.008
	(0.094)	(0.038)	(0.049)	(0.051)	(0.117)	(0.023)	(0.006)	(0.005)	(0.011)	(0.020)
age	0.006	0.014^{***}	0.019^{***}	0.016^{**}	0.014^{**}	0.001	0.000	0.001	0.001	-0.000
	(0.009)	(0.003)	(0.007)	(0.008)	(0.005)	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)
hhi_ta	-2.232	-1.038	1.452	0.231	-0.641	0.636	-0.064	-0.070	-0.685	-0.523
	(1.494)	(1.026)	(2.036)	(3.731)	(2.365)	(0.571)	(0.383)	(0.729)	(0.864)	(1.501)
scgi	0.013	0.011	0.051^{***}	0.062^{***}	0.030^{*}	0.007	0.002	0.013^{**}	0.015^{**}	0.014^{**}
	(0.021)	(0.010)	(0.018)	(0.024)	(0.016)	(0.006)	(0.004)	(0.006)	(0.007)	(0.007)
roa		0.684^{***}	1.030^{***}	1.134^{***}	0.304^{***}					
		(0.040)	(0.242)	(0.315)	(0.105)					
tq							0.898^{***}	0.925^{***}	0.844^{***}	0.847^{***}
							(0.162)	(0.190)	(0.206)	(0.295)
ffi10-Yr FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	2799	2688	2591	2499	2021	2493	2199	2126	2037	1623
adj. R^2	0.101	0.529	0.529	0.468	0.048	0.107	0.287	0.261	0.208	0.134
F	1.826	49.973	6.639	6.880	5.783	6.053	31.446	15.841	12.155	6.414
vce	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster
clustvar	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table I.9. ***Weighted and Collaboration Centralities on Firm Performance (SCGI Subsample)***

Panel I.9A. *SCGI Subsample Analysis of Firm Performance and various (Simple) Weighted Board Centralities*

	(1) roa1	(2) roa1	(3) roa1	(4) roa1	(5) roa1	(6) tq1	(7) tq1	(8) tq1	(9) tq1	(10) tq1
Wbq	0.120*					0.065				
	(0.071)					(0.046)				
Wcq		0.116					0.089			
		(0.106)					(0.054)			
Wdq			0.093					0.040		
			(0.100)					(0.030)		
Weq				0.193**					0.080***	
				(0.094)					(0.026)	
Wnq					0.140					0.092
					(0.092)					(0.058)
netsales	0.196*	0.188	0.168	0.111	0.163	-0.041	-0.049	-0.053	-0.074	-0.063
	(0.112)	(0.117)	(0.128)	(0.121)	(0.118)	(0.075)	(0.079)	(0.078)	(0.079)	(0.085)
sgata	0.151	0.166	0.120	0.219	0.180	0.230	0.281	0.198	0.265	0.276
	(1.175)	(1.204)	(1.187)	(1.185)	(1.191)	(0.255)	(0.250)	(0.269)	(0.263)	(0.255)
leverage	1.013**	1.009**	1.018**	1.019**	1.013**	0.043	0.038	0.046	0.041	0.041
	(0.445)	(0.449)	(0.444)	(0.445)	(0.446)	(0.066)	(0.066)	(0.066)	(0.066)	(0.067)
assetgrowth	-0.049	-0.047	-0.047	-0.039	-0.044	-0.120**	-0.117**	-0.119**	-0.115**	-0.116**
	(0.104)	(0.105)	(0.106)	(0.106)	(0.105)	(0.058)	(0.056)	(0.057)	(0.057)	(0.056)
quickratio	0.068*	0.068*	0.068*	0.070*	0.069*	-0.003	-0.003	-0.004	-0.003	-0.003
	(0.038)	(0.038)	(0.038)	(0.038)	(0.038)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
age	0.014***	0.014***	0.014***	0.013***	0.014***	0.001	0.000	0.001	0.000	0.000
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
hhi_ta	-0.994	-1.038	-1.039	-1.050	-1.037	-0.040	-0.076	-0.066	-0.070	-0.068
	(1.032)	(1.025)	(1.027)	(1.025)	(1.025)	(0.387)	(0.381)	(0.381)	(0.379)	(0.383)
scgi	0.011	0.011	0.012	0.009	0.010	0.003	0.002	0.003	0.002	0.002
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.004)	(0.004)	(0.003)	(0.003)	(0.004)
roa	0.684***	0.685***	0.685***	0.685***	0.684***					
	(0.040)	(0.040)	(0.040)	(0.040)	(0.040)					
tq						0.900***	0.898***	0.901***	0.898***	0.898***
						(0.162)	(0.162)	(0.163)	(0.162)	(0.163)
ffi10-Yr FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	2688	2688	2688	2688	2688	2199	2199	2199	2199	2199
adj. R^2	0.529	0.529	0.529	0.530	0.530	0.286	0.287	0.286	0.286	0.287
F	49.077	50.677	50.757	51.197	49.991	30.152	31.386	28.025	29.235	33.129
vce	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster
clustvar	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Panel I.9B. *SCGI Subsample Analysis of Firm Performance and various (Hyperbolic Weighted) Collaboration Board Centralities*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	roa1	roa1	roa1	roa1	roa1	tq1	tq1	tq1	tq1	tq1
Cbq	0.084					0.029				
	(0.067)					(0.027)				
Ccq		0.050					0.066^{**}			
		(0.100)					(0.030)			
Cdq			0.108					0.024		
			(0.079)					(0.034)		
Ceq				0.234^{***}					0.071^{**}	
				(0.084)					(0.028)	
Cnq					0.128					0.052^{*}
					(0.087)					(0.031)
netsales	0.201^{*}	0.206^{*}	0.149	0.088	0.166	-0.039	-0.039	-0.048	-0.070	-0.052
	(0.113)	(0.116)	(0.124)	(0.114)	(0.117)	(0.074)	(0.073)	(0.078)	(0.077)	(0.076)
sgata	0.113	0.088	0.148	0.218	0.176	0.188	0.222	0.191	0.237	0.227
	(1.173)	(1.188)	(1.185)	(1.161)	(1.189)	(0.265)	(0.257)	(0.279)	(0.267)	(0.271)
leverage	1.017^{**}	1.015^{**}	1.015^{**}	1.019^{**}	1.014^{**}	0.046	0.045	0.044	0.041	0.043
	(0.445)	(0.446)	(0.446)	(0.445)	(0.446)	(0.066)	(0.066)	(0.067)	(0.067)	(0.067)
assetgrowth	-0.050	-0.049	-0.046	-0.037	-0.047	-0.120^{**}	-0.120^{**}	-0.119^{**}	-0.115^{**}	-0.119^{**}
	(0.105)	(0.105)	(0.105)	(0.105)	(0.105)	(0.058)	(0.058)	(0.057)	(0.057)	(0.057)
quickratio	0.068^{*}	0.068^{*}	0.068^{*}	0.068^{*}	0.069^{*}	-0.004	-0.003	-0.004	-0.004	-0.004
	(0.038)	(0.038)	(0.038)	(0.039)	(0.038)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
age	0.015^{***}	0.015^{***}	0.014^{***}	0.013^{***}	0.014^{***}	0.001	0.001	0.001	0.000	0.000
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
hhi_ta	-1.017	-1.044	-1.083	-1.067	-1.052	-0.060	-0.075	-0.077	-0.079	-0.073
	(1.028)	(1.026)	(1.024)	(1.025)	(1.024)	(0.382)	(0.378)	(0.373)	(0.379)	(0.379)
scgi	0.012	0.013	0.011	0.008	0.011	0.004	0.003	0.004	0.003	0.003
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
roa	0.684^{***}	0.685^{***}	0.684^{***}	0.684^{***}	0.684^{***}					
	(0.040)	(0.040)	(0.040)	(0.040)	(0.040)					
tq						0.902^{***}	0.901^{***}	0.901^{***}	0.899^{***}	0.900^{***}
						(0.162)	(0.161)	(0.164)	(0.163)	(0.163)
ffi10-Yr FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	2688	2688	2688	2688	2688	2199	2199	2199	2199	2199
adj. R^2	0.529	0.529	0.529	0.530	0.529	0.286	0.286	0.286	0.286	0.286
F	49.167	51.247	49.882	49.735	49.995	27.075	25.748	33.841	30.124	30.966
vce	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster
clustvar	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table I.10. *Flat, Weighted and Collaboration Eigenvector Centralities on Future Firm Performance (SCGI Subsample)*

Panel I.10A. *SCGI Subsample Analysis of Future Firm Performance and (Flat) Unweighted Eigenvector Board Centrality*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	roa	roa1	roa2	roa3	roa4	tq	tq1	tq2	tq3	tq4
Feq	-0.194	0.096	-0.247	-0.098	0.133	0.105**	0.065**	0.035	0.059	0.153*
	(0.232)	(0.101)	(0.183)	(0.175)	(0.173)	(0.041)	(0.027)	(0.029)	(0.038)	(0.092)
netsales	0.773**	0.181	0.100	0.134	0.728***	0.240**	-0.053	-0.047	-0.008	-0.016
	(0.370)	(0.120)	(0.214)	(0.223)	(0.251)	(0.103)	(0.077)	(0.066)	(0.053)	(0.075)
sgata	-13.537	0.152	-5.377*	-6.607*	0.699	1.760***	0.245	0.420	0.907***	1.667***
	(10.254)	(1.197)	(3.241)	(3.873)	(1.858)	(0.488)	(0.261)	(0.282)	(0.316)	(0.553)
leverage	-3.219***	1.019**	1.431*	0.928*	1.163	-0.678***	0.045	-0.000	-0.134	-0.358
	(1.171)	(0.444)	(0.811)	(0.556)	(0.770)	(0.150)	(0.066)	(0.073)	(0.121)	(0.258)
assetgrowth	0.299	-0.047	-0.570***	-0.591***	-0.290*	0.183***	-0.118**	-0.034	-0.034	-0.058
	(0.258)	(0.106)	(0.169)	(0.184)	(0.157)	(0.039)	(0.057)	(0.047)	(0.070)	(0.060)
quickratio	-0.216**	0.068*	0.058	-0.021	0.085	0.010	-0.003	-0.007	-0.014	-0.008
	(0.095)	(0.038)	(0.048)	(0.051)	(0.118)	(0.023)	(0.006)	(0.005)	(0.011)	(0.020)
age	0.007	0.014***	0.020***	0.016**	0.014**	0.001	0.000	0.001	0.001	-0.000
	(0.009)	(0.003)	(0.007)	(0.008)	(0.005)	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)
hhi_ta	-2.200	-1.057	1.490	0.246	-0.659	0.615	-0.080	-0.075	-0.694	-0.552
	(1.484)	(1.024)	(2.038)	(3.725)	(2.367)	(0.576)	(0.380)	(0.729)	(0.864)	(1.503)
scgi	0.015	0.012	0.052***	0.063***	0.031*	0.006	0.003	0.013**	0.014**	0.014**
	(0.021)	(0.010)	(0.018)	(0.024)	(0.016)	(0.006)	(0.003)	(0.006)	(0.007)	(0.007)
roa		0.685***	1.029***	1.134***	0.304***					
		(0.040)	(0.242)	(0.315)	(0.105)					
tq							0.899***	0.925***	0.843***	0.846***
							(0.162)	(0.190)	(0.206)	(0.295)
ffi10-Yr FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	2799	2688	2591	2499	2021	2493	2199	2126	2037	1623
adj. R^2	0.101	0.529	0.529	0.468	0.048	0.108	0.286	0.261	0.208	0.134
F	1.885	51.230	6.564	6.743	5.763	5.935	28.885	15.927	12.753	6.598
vce	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster
clustvar	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Panel I.10B. *SCGI Subsample Analysis of Future Firm Performance and (Simple) Weighted Eigenvector Board Centrality*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	roa	roa1	roa2	roa3	roa4	tq	tq1	tq2	tq3	tq4
Weq	-0.136	0.194**	0.119	0.229	0.394**	0.123***	0.080***	0.084***	0.139***	0.207***
	(0.221)	(0.094)	(0.127)	(0.142)	(0.161)	(0.044)	(0.026)	(0.031)	(0.041)	(0.064)
netsales	0.787**	0.110	-0.028	-0.006	0.544**	0.209**	-0.074	-0.076	-0.056	-0.080
	(0.382)	(0.121)	(0.205)	(0.218)	(0.239)	(0.099)	(0.079)	(0.071)	(0.063)	(0.085)
sgata	-13.450	0.220	-4.971	-6.275	0.997	1.768***	0.265	0.479*	1.013***	1.746***
	(10.217)	(1.185)	(3.221)	(3.868)	(1.853)	(0.489)	(0.263)	(0.276)	(0.323)	(0.553)
leverage	-3.214***	1.019**	1.444*	0.933*	1.168	-0.682***	0.041	-0.005	-0.142	-0.367
	(1.169)	(0.445)	(0.817)	(0.557)	(0.768)	(0.150)	(0.066)	(0.073)	(0.121)	(0.257)
assetgrowth	0.298	-0.039	-0.559***	-0.577***	-0.272*	0.187***	-0.115**	-0.030	-0.025	-0.046
	(0.259)	(0.106)	(0.170)	(0.185)	(0.158)	(0.039)	(0.057)	(0.048)	(0.070)	(0.059)
quickratio	-0.215**	0.070*	0.063	-0.017	0.090	0.010	-0.003	-0.006	-0.013	-0.007
	(0.095)	(0.038)	(0.049)	(0.051)	(0.118)	(0.023)	(0.006)	(0.005)	(0.011)	(0.020)
age	0.007	0.013***	0.018**	0.014*	0.012**	0.001	0.000	0.000	0.000	-0.001
	(0.009)	(0.003)	(0.007)	(0.008)	(0.006)	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)
hhi_ta	-2.225	-1.051	1.465	0.240	-0.724	0.625	-0.070	-0.070	-0.701	-0.582
	(1.488)	(1.025)	(2.025)	(3.718)	(2.351)	(0.572)	(0.379)	(0.733)	(0.870)	(1.516)
scgi	0.014	0.009	0.042**	0.054**	0.025	0.006	0.002	0.012**	0.012*	0.013**
	(0.021)	(0.010)	(0.018)	(0.023)	(0.016)	(0.005)	(0.003)	(0.005)	(0.007)	(0.006)
roa		0.685***	1.030***	1.135***	0.305***					
		(0.040)	(0.243)	(0.316)	(0.105)					
tq							0.898***	0.922***	0.838***	0.841***
							(0.162)	(0.189)	(0.205)	(0.292)
ffi10-Yr FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	2799	2688	2591	2499	2021	2493	2199	2126	2037	1623
adj. R^2	0.101	0.530	0.528	0.469	0.051	0.109	0.286	0.262	0.210	0.135
F	1.882	51.223	7.132	7.283	6.029	6.309	29.254	14.551	10.645	6.306
vce	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster
clustvar	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Panel I.10C. *SCGI Subsample Analysis of Future Firm Performance and (Hyperbolic Weighted) Collaboration Eigenvector Board Centrality*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	roa	roa1	roa2	roa3	roa4	tq	tq1	tq2	tq3	tq4
Ceq	-0.034	0.234***	0.232*	0.312**	0.463***	0.101***	0.071**	0.070**	0.113**	0.153***
	(0.173)	(0.084)	(0.126)	(0.157)	(0.151)	(0.038)	(0.028)	(0.035)	(0.045)	(0.058)
netsales	0.736**	0.088	-0.087	-0.049	0.503**	0.219**	-0.070	-0.070	-0.043	-0.051
	(0.359)	(0.114)	(0.202)	(0.210)	(0.231)	(0.101)	(0.077)	(0.069)	(0.058)	(0.074)
sgata	-13.356	0.218	-4.900	-6.243	0.977	1.734***	0.237	0.455*	0.959***	1.634***
	(10.147)	(1.161)	(3.207)	(3.894)	(1.857)	(0.479)	(0.267)	(0.276)	(0.313)	(0.522)
leverage	-3.213***	1.019**	1.446*	0.935*	1.175	-0.682***	0.041	-0.004	-0.141	-0.362
	(1.169)	(0.445)	(0.817)	(0.556)	(0.767)	(0.150)	(0.067)	(0.074)	(0.122)	(0.257)
assetgrowth	0.304	-0.037	-0.554***	-0.572***	-0.270*	0.186***	-0.115**	-0.030	-0.026	-0.050
	(0.259)	(0.105)	(0.170)	(0.185)	(0.155)	(0.039)	(0.057)	(0.048)	(0.072)	(0.060)
quickratio	-0.213**	0.068*	0.063	-0.018	0.087	0.008	-0.004	-0.007	-0.014	-0.010
	(0.093)	(0.039)	(0.049)	(0.051)	(0.118)	(0.023)	(0.006)	(0.005)	(0.011)	(0.020)
age	0.006	0.013***	0.017**	0.013*	0.011**	0.001	0.000	0.000	0.000	-0.001
	(0.009)	(0.003)	(0.007)	(0.008)	(0.005)	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)
hhi_ta	-2.226	-1.067	1.445	0.212	-0.762	0.620	-0.079	-0.076	-0.715	-0.579
	(1.494)	(1.025)	(2.023)	(3.719)	(2.351)	(0.572)	(0.379)	(0.734)	(0.869)	(1.509)
scgi	0.011	0.008	0.040**	0.053**	0.024	0.007	0.003	0.012**	0.014*	0.015**
	(0.021)	(0.010)	(0.018)	(0.023)	(0.016)	(0.006)	(0.003)	(0.006)	(0.007)	(0.007)
roa		0.684***	1.030***	1.134***	0.306***					
		(0.040)	(0.243)	(0.316)	(0.105)					
tq							0.899***	0.923***	0.840***	0.846***
							(0.163)	(0.191)	(0.207)	(0.296)
ffi10-Yr FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	2799	2688	2591	2499	2021	2493	2199	2126	2037	1623
adj. R^2	0.100	0.530	0.529	0.469	0.052	0.107	0.286	0.261	0.210	0.133
F	1.812	49.735	7.470	8.333	6.452	6.211	30.124	16.201	12.690	7.107
vce	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster
clustvar	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Appendix for Part 2

Table II.1 ***Variable List***

Panel II.1A ***Ownership Network Variables***

Abbreviation	Variable Name	Description and Remarks
Ub	Unity-weighted Betweenness	Node Betweenness Centrality Score for Unity-weighted
Uc	Unity-weighted Closeness	Node Closeness Centrality Score for Unity-weighted
Ud	Unity-weighted Degree	Node Degree for Unity-weighted
Ue	Unity-weighted Eigenvector	Node Eigenvector Centrality Score for Unity-weighted
Unq	Unity-weighted N-score Composite (Quintile)	Quintile Composite Centrality Score for Unity-weighted
Ubq, Ucq, Udq, Ueq	Unity-weighted Centrality (Quintile)	Quintile for Betweenness, Closeness, Degree or Eigenvector centrality for Unity-weighted Graph
Sb	Stake-weighted Betweenness	Node Betweenness Centrality Score for Stake-weighted
Sc	Stake-weighted Closeness	Node Closeness Centrality Score for Stake-weighted
Sd	Stake-weighted Degree	Node Degree for Stake-weighted
Se	Stake-weighted Eigenvector	Node Eigenvector Centrality Score for Stake-weighted
Snq	Stake-weighted N-score Composite (Quintile)	Quintile Composite Centrality Score for Stake-weighted
Sbq, Scq, Sdq, Seq	Stake-weighted Centrality (Quintile)	Quintile for Betweenness, Closeness, Degree or Eigenvector centrality for Stake-weighted Graph

Panel II.1B ***Firm Variables***

Abbreviation	Variable Name	Description and Remarks
roa, roa1, roa2, roa3, roa4	Return-on-assets	Return-on-assets of the firm. The suffix, if present, indicates the look-ahead number of years.
tq, tq1, tq2, tq3, tq4, tq5	Tobin's Q	Tobin's Q of the firm. The suffix, if present, indicates the look-ahead number of years.
quickratio	Quick Ratio	Contemporaneous quick ratio of the firm.
netsales	Net Sales	Net Sales (in log) of the firm in USD.
sgata	SG&A to Assets	Percentage of Selling, General and Admin expense over the total assets of the firm
leverage	Leverage	The leverage level of the firm, defined as the ratio of total debt over total assets
assetgrowth	Asset Growth	Asset growth rate of the firm
age	Firm Age	The age of the firm since its founding.
hhi_ta	Herfindahl-Hirschman Index	This measures industry concentration at the Fama-French 30 industry portfolio based on total assets.
ffi10		The Fama-French 10 Industry Portfolios, namely: 1. Consumer NonDurables 2. Consumer Durables 3. Manufacturing 4. Oil, Gas, and Coal Extraction and Products 5. Business Equipment 6. Telephone and Television Transmission 7. Wholesale, Retail, and Some Services (Laundries, Repair Shops) 8. Healthcare, Medical Equipment, and Drugs 9. Utilities 10. Other
scgi	Singapore Corporate Governance Index	Value weighted score of the firm on the Singapore Corporate Governance Index
stake	Stakeholdings	Percentage stakeholdings of largest ultimate shareholder

Table II.2. *Ownership Network Graph Statistics*

Panel II.2A. ***General Graph Statistics***

		Graph Size (Sum of all edge weights)	
Year	Nodes	Unity-Weighted	Stake-Weighted
2004	3400	9,272	1,486,092
2005	5362	13,477	2,929,515
2006	6039	15,789	3,357,875
2007	7092	19,522	3,934,515
2008	7943	21,053	4,530,633
2009	8217	21,322	4,201,324
2010	8647	22,613	4,446,758
2011	8775	22,528	4,547,808
2012	9081	23,662	4,771,725
2013	9322	24,018	4,888,937
2014	9866	24,048	5,195,111

Panel II.2B. ***Graph Components***

Year	#Components	Components (Singletons omited)
2004	66	[3074, 20, 20, 18, 10, 10, 9, 8, 8, 8, 7, 7, 7, 7, 7, 6, 6, 6, 6, 6, 5, 5, 5, 5, 5, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 4, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2]
2005	10	[5288, 18, 17, 14, 10, 4, 3, 3, 3, 2]
2006	7	[5983, 15, 13, 10, 10, 5, 3]
2007	9	[7030, 20, 13, 9, 6, 5, 5, 2, 2]
2008	7	[7896, 24, 9, 6, 3, 3, 2]
2009	8	[8179, 10, 8, 7, 5, 3, 3, 2]
2010	2	[8621, 26]
2011	5	[8739, 23, 7, 3, 3]
2012	8	[9029, 10, 10, 10, 9, 6, 4, 3]
2013	10	[9223, 22, 21, 20, 10, 7, 6, 6, 4, 3]
2014	14	[9784, 20, 10, 8, 7, 6, 5, 5, 4, 4, 4, 4, 3, 2]

Table II.3. *Summary Statistics*

Panel II.3A. *Key Firm Variables*

	count	mean	sd	p10	p25	p50	p75	p90
roa1	7,642	1.950	15.068	-4.86	-0.03	2.67	5.86	10.20
tq1	6,706	1.813	2.772	0.68	0.94	1.26	1.86	3.13
stake	5,983	37.418	21.045	11.51	21.63	34.97	52.33	65.91
netsales	8,559	0.109	0.499	0.00	0.01	0.02	0.04	0.14
sgata	8,239	0.181	1.576	0.01	0.04	0.09	0.18	0.30
leverage	8,471	3.651	0.746	2.79	3.35	3.80	4.08	4.30
assetgrowth	5,530	2.735	1.426	1.03	1.96	2.77	3.58	4.33
quickratio	8,468	2.278	11.169	0.42	0.72	1.16	2.02	3.81
age	9,910	26.025	24.573	5.00	11.00	21.00	33.00	46.00
scgi	4,949	58.272	13.578	49.04	54.86	60.22	65.45	70.19
hhi_ta	10,883	0.161	0.184	0.02	0.03	0.08	0.23	0.38

Panel II.3B. *Unity-Weighted Network Variables*

	count	mean	sd	p10	p25	p50	p75	p90
Ub	6,004	0.003	0.004	0.00	0.00	0.00	0.00	0.01
Uc	6,004	0.296	0.055	0.24	0.29	0.31	0.32	0.33
Ud	6,004	34.364	53.067	13.00	16.00	19.00	25.00	63.00
Ue	6,004	0.013	0.026	0.00	0.00	0.00	0.01	0.03
Ubq	6,004	2.997	1.414	1.00	2.00	3.00	4.00	5.00
Ucq	6,004	2.997	1.414	1.00	2.00	3.00	4.00	5.00
Udq	6,004	2.893	1.449	1.00	2.00	3.00	4.00	5.00
Ueq	6,004	2.997	1.414	1.00	2.00	3.00	4.00	5.00
Unq	6,004	2.862	1.390	1.00	2.00	3.00	4.00	5.00

Panel II.3C. *Stake-Weighted Network Statistics*

	count	mean	sd	p10	p25	p50	p75	p90
Sb	6,004	75.597	147.651	0.00	0.00	0.00	0.01	370.37
Sc	6,004	0.002	0.000	0.00	0.00	0.00	0.00	0.00
Sd	6,004	7335.280	3147.032	4126.00	6019.00	7459.50	8524.50	9499.00
Se	6,004	0.006	0.031	0.00	0.00	0.00	0.00	0.00
Sbq	6,004	2.997	1.415	1.00	2.00	3.00	4.00	5.00
Scq	6,004	2.764	1.146	1.00	2.00	3.00	4.00	4.00
Sdq	6,004	2.997	1.415	1.00	2.00	3.00	4.00	5.00
Seq	6,004	2.997	1.414	1.00	2.00	3.00	4.00	5.00
Snq	6,004	2.752	1.444	1.00	1.00	3.00	4.00	5.00

Table II.4. ***Pearson Correlation Matrices***

Panel II.4A. *Correlation of Main Variables and (Unity-Weighted) Centralities*

	roa1	tq1	stake	wedge	bzi	netsales	sgata	leverage	assetgrowth	quickratio	age	scgi	hhi_ta	Ub	Uc	Ud	Ue	Un
roa1	1.00																	
tq1	0.19^{***}	1.00																
	(0.00)																	
stake	0.10^{***}	0.07^{***}	1.00															
	(0.00)	(0.00)																
wedge	-0.02	-0.01	-0.47^{***}	1.00														
	(0.13)	(0.33)	(0.00)															
bzi	0.07^{***}	0.06^{***}	0.64^{***}	0.17^{***}	1.00													
	(0.00)	(0.00)	(0.00)	(0.00)														
netsales	0.03^{***}	0.03^{**}	0.02	-0.00	0.01	1.00												
	(0.01)	(0.04)	(0.11)	(0.98)	(0.47)													
sgata	-0.48^{***}	0.09^{***}	0.01	-0.01	-0.00	-0.01	1.00											
	(0.00)	(0.00)	(0.66)	(0.59)	(0.80)	(0.28)												
leverage	-0.16^{***}	-0.09^{***}	0.02	0.02	0.00	0.04^{***}	0.22^{***}	1.00										
	(0.00)	(0.00)	(0.25)	(0.25)	(0.78)	(0.00)	(0.00)											
assetgrowth	0.08^{***}	0.05^{***}	0.00	0.02	0.02	-0.07^{***}	-0.01	0.11^{***}	1.00									
	(0.00)	(0.00)	(0.83)	(0.24)	(0.32)	(0.00)	(0.57)	(0.00)										
quickratio	-0.00	0.04^{***}	-0.01	-0.01	-0.00	-0.02^{*}	-0.01	-0.33^{***}	-0.00	1.00								
	(0.93)	(0.00)	(0.67)	(0.48)	(0.97)	(0.07)	(0.38)	(0.00)	(0.79)									
age	0.02	-0.01	0.04^{***}	-0.00	0.02	0.26^{***}	-0.01	0.03^{***}	-0.18^{***}	-0.02	1.00							
	(0.20)	(0.53)	(0.00)	(0.81)	(0.24)	(0.00)	(0.36)	(0.00)	(0.00)	(0.10)								
scgi	0.09^{***}	0.01	-0.01	0.03^{*}	0.00	0.14^{***}	-0.11^{***}	-0.01	-0.02	-0.03^{**}	0.10^{***}	1.00						
	(0.00)	(0.51)	(0.63)	(0.06)	(0.84)	(0.00)	(0.00)	(0.39)	(0.24)	(0.02)	(0.00)							
hhi_ta	-0.02^{*}	-0.01	0.02	0.01	-0.00	0.14^{***}	0.01	-0.04^{***}	-0.05^{***}	0.01	0.05^{***}	0.12^{***}	1.00					
	(0.08)	(0.33)	(0.15)	(0.46)	(0.80)	(0.00)	(0.44)	(0.00)	(0.00)	(0.64)	(0.00)	(0.00)						
Ub	0.06^{***}	0.06^{***}	-0.09^{***}	-0.06^{***}	-0.12^{***}	0.45^{***}	-0.03^{**}	0.05^{***}	-0.06^{***}	-0.04^{***}	0.12^{***}	0.22^{***}	0.03^{***}	1.00				
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.05)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.01)					
Uc	0.07^{***}	-0.01	0.03^{**}	-0.24^{***}	-0.06^{***}	0.09^{***}	-0.05^{***}	-0.04^{***}	-0.12^{***}	-0.01	0.05^{***}	0.16^{***}	-0.02	0.13^{***}	1.00			
	(0.00)	(0.66)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.33)	(0.00)	(0.00)	(0.15)	(0.00)				
Ud	0.06^{***}	0.08^{***}	-0.07^{***}	-0.00	-0.05^{***}	0.69^{***}	-0.05^{***}	0.07^{***}	-0.08^{***}	-0.03^{**}	0.18^{***}	0.27^{***}	0.07^{***}	0.73^{***}	0.20^{***}	1.00		
	(0.00)	(0.00)	(0.00)	(0.76)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.04)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)			
Ue	0.07^{***}	0.09^{***}	-0.07^{***}	0.05^{***}	-0.02^{*}	0.61^{***}	-0.06^{***}	0.07^{***}	-0.07^{***}	-0.02^{*}	0.17^{***}	0.28^{***}	0.08^{***}	0.53^{***}	0.22^{***}	0.93^{***}	1.00	
	(0.00)	(0.00)	(0.00)	(0.00)	(0.07)	(0.00)	(0.00)	(0.00)	(0.00)	(0.07)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)		
Un	0.07^{***}	0.10^{***}	-0.09^{***}	-0.06^{***}	-0.10^{***}	0.31^{***}	-0.06^{***}	0.04^{***}	-0.09^{***}	-0.04^{***}	0.14^{***}	0.24^{***}	0.04^{***}	0.36^{***}	0.50^{***}	0.54^{***}	0.61^{***}	1.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	

p-values in parentheses
* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

Panel II.4B. *Correlation of Main Variables and (Stake-Weighted) Centralities*

	roa1	tq1	stake	wedge	bzi	netsales	sgata	leverage	assetgrowth	quickratio	age	scgi	hhi_ta	Sb	Sc	Sd	Se	Sn
roa1	1.00																	
tq1	0.19***	1.00																
	(0.00)																	
stake	0.10***	0.07***	1.00															
	(0.00)	(0.00)																
wedge	-0.02	-0.01	-0.47***	1.00														
	(0.13)	(0.33)	(0.00)															
bzi	0.07***	0.06***	0.64***	0.17***	1.00													
	(0.00)	(0.00)	(0.00)	(0.00)														
netsales	0.03***	0.03**	0.02	-0.00	0.01	1.00												
	(0.01)	(0.04)	(0.11)	(0.98)	(0.47)													
sgata	-0.48***	0.09***	0.01	-0.01	-0.00	-0.01	1.00											
	(0.00)	(0.00)	(0.66)	(0.59)	(0.80)	(0.28)												
leverage	-0.16***	-0.09***	0.02	0.02	0.00	0.04***	0.22***	1.00										
	(0.00)	(0.00)	(0.25)	(0.25)	(0.78)	(0.00)	(0.00)											
assetgrowth	0.08***	0.05***	0.00	0.02	0.02	-0.07***	-0.01	0.11***	1.00									
	(0.00)	(0.00)	(0.83)	(0.24)	(0.32)	(0.00)	(0.57)	(0.00)										
quickratio	-0.00	0.04***	-0.01	-0.01	-0.00	-0.02*	-0.01	-0.33***	-0.00	1.00								
	(0.93)	(0.00)	(0.67)	(0.48)	(0.97)	(0.07)	(0.38)	(0.00)	(0.79)									
age	0.02	-0.01	0.04***	-0.00	0.02	0.26***	-0.01	0.03***	-0.18***	-0.02	1.00							
	(0.20)	(0.53)	(0.00)	(0.81)	(0.24)	(0.00)	(0.36)	(0.00)	(0.00)	(0.10)								
scgi	0.09***	0.01	-0.01	0.03*	0.00	0.14***	-0.11***	-0.01	-0.02	-0.03**	0.10***	1.00						
	(0.00)	(0.51)	(0.63)	(0.06)	(0.84)	(0.00)	(0.00)	(0.39)	(0.24)	(0.02)	(0.00)							
hhi_ta	-0.02*	-0.01	0.02	0.01	-0.00	0.14***	0.01	-0.04***	-0.05***	0.01	0.05***	0.12***	1.00					
	(0.08)	(0.33)	(0.15)	(0.46)	(0.80)	(0.00)	(0.44)	(0.00)	(0.00)	(0.64)	(0.00)	(0.00)						
Sb	0.09***	0.10***	0.01	-0.00	0.01	0.45***	-0.07***	0.06***	-0.05***	-0.02*	0.16***	0.22***	0.06***	1.00				
	(0.00)	(0.00)	(0.40)	(0.96)	(0.43)	(0.00)	(0.00)	(0.00)	(0.00)	(0.09)	(0.00)	(0.00)	(0.00)					
Sc	0.10***	0.02*	0.07***	-0.14***	0.01	0.11***	-0.05***	-0.07***	-0.09***	-0.01	0.11***	0.15***	-0.04***	0.24***	1.00			
	(0.00)	(0.10)	(0.00)	(0.00)	(0.49)	(0.00)	(0.00)	(0.00)	(0.00)	(0.64)	(0.00)	(0.00)	(0.00)	(0.00)				
Sd	0.05***	0.04***	0.46***	-0.58***	0.04***	0.32***	-0.01	0.01	-0.03**	-0.04***	0.07***	0.09***	0.04***	0.16***	0.14***	1.00		
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.60)	(0.39)	(0.04)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)			
Se	0.04***	0.08***	0.11***	-0.03**	0.11***	0.31***	-0.02*	0.05***	-0.07***	-0.01	0.05***	0.23***	0.05***	0.33***	0.08***	0.22***	1.00	
	(0.01)	(0.00)	(0.00)	(0.03)	(0.00)	(0.00)	(0.09)	(0.00)	(0.00)	(0.30)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)		
Sn	0.12***	0.15***	0.20***	-0.26***	-0.02	0.33***	-0.05***	0.03**	-0.07***	-0.04***	0.17***	0.21***	0.04***	0.65***	0.45***	0.46***	0.29***	1.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.15)	(0.00)	(0.00)	(0.05)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	

p-values in parentheses
* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

Table II.5. *Differences in Means of Ownership Centralities*

Panel II.5A. *T Tests of High and Low (Unity-weighted) Centralities*

Ub	High Ub	Low Ub	Diff.	Std. Error	Obs.
roa1	2.0186	1.3083	-0.7103^{*}	0.3652	5514
tq1	1.7968	1.6040	-0.1927^{***}	0.0745	5052

Uc	High Uc	Low Uc	Diff.	Std. Error	Obs.
roa1	1.9448	1.3650	-0.5798	0.3654	5514
tq1	1.7980	1.5830	-0.2151^{***}	0.0748	5052

Ud	High Ud	Low Ud	Diff.	Std. Error	Obs.
roa1	2.3763	1.0450	-1.3313^{***}	0.3658	5514
tq1	1.9511	1.4571	-0.4939^{***}	0.0743	5052

Ue	High Ue	Low Ue	Diff.	Std. Error	Obs.
roa1	2.3333	1.0021	-1.3312^{***}	0.3649	5514
tq1	1.9405	1.4230	-0.5175^{***}	0.0744	5052

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

Panel II.5B. *T Tests of High and Low Stake-weighted Centralities*

Sb	High Sb	Low Sb	Diff.	Std. Error	Obs.
roa1	2.6110	0.7476	-1.8634^{***}	0.3645	5514
tq1	1.9184	1.4751	-0.4433^{***}	0.0743	5052

Sc	High Sc	Low Sc	Diff.	Std. Error	Obs.
roa1	2.9064	0.4848	-2.4217^{***}	0.3640	5514
tq1	2.0088	1.3608	-0.6480^{***}	0.0741	5052

Sd	High Sd	Low Sd	Diff.	Std. Error	Obs.
roa1	2.6648	0.6540	-2.0108^{***}	0.3643	5514
tq1	1.9606	1.4587	-0.5019^{***}	0.0743	5052

Se	High Se	Low Se	Diff.	Std. Error	Obs.
roa1	1.6189	1.7083	0.0895	0.3654	5514
tq1	1.8520	1.5353	-0.3167^{***}	0.0745	5052

* $p < 0.1$, ** $p < .05$, *** $p < 0.01$

Table II.6. _Firm Performance and Different Ownership Centralities_

Panel II.6Ai. *Return on assets and various (Unity-weighted) Ownership Centralities*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	roa1	roa1	roa1	roa1	roa1	roa1	roa1	roa1	roa1	roa1
Ubq	0.354***					0.224***				
	(0.133)					(0.057)				
Ucq		0.309					0.036			
		(0.270)					(0.065)			
Udq			0.707***					0.221***		
			(0.160)					(0.061)		
Ueq				0.814***					0.157**	
				(0.308)					(0.065)	
Unq					0.648***					0.187***
					(0.207)					(0.064)
netsales						0.038	0.101	-0.022	0.013	0.014
						(0.079)	(0.087)	(0.073)	(0.077)	(0.077)
sgata						0.263	0.228	0.397	0.434	0.459
						(0.822)	(0.850)	(0.814)	(0.794)	(0.810)
leverage						0.780**	0.798**	0.781**	0.781**	0.780**
						(0.383)	(0.386)	(0.383)	(0.380)	(0.383)
assetgrowth						-0.103	-0.119	-0.109	-0.114	-0.108
						(0.078)	(0.079)	(0.078)	(0.077)	(0.078)
quickratio						0.062	0.062	0.063	0.061	0.063
						(0.039)	(0.039)	(0.039)	(0.040)	(0.039)
age						0.011***	0.011***	0.010***	0.011***	0.011***
						(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
hhi_ta						-0.219	-0.119	-0.208	-0.174	-0.206
						(0.902)	(0.906)	(0.905)	(0.909)	(0.906)
stake						0.018***	0.016***	0.017***	0.016***	0.017***
						(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
roa						0.688***	0.689***	0.688***	0.688***	0.688***
						(0.032)	(0.032)	(0.032)	(0.032)	(0.032)
ffi10-Yr FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	5514	5514	5514	5514	5514	3538	3538	3538	3538	3538
adj. R^2	0.001	0.001	0.005	0.006	0.004	0.578	0.577	0.578	0.577	0.578
F	7.102	1.306	19.632	6.986	9.825	88.481	83.265	89.207	83.799	86.716
vce	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster
clustvar	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Panel II.6Aii. *Tobin's Q and various (Unity-weighted) Ownership Centralities*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	tq1	tq1	tq1	tq1	tq1	tq1	tq1	tq1	tq1	tq1
Ubq	0.081*					0.025				
	(0.047)					(0.041)				
Ucq		0.066*					0.073			
		(0.036)					(0.045)			
Udq			0.224***					0.087**		
			(0.061)					(0.036)		
Ueq				0.216***					0.138**	
				(0.053)					(0.068)	
Unq					0.182***					0.089**
					(0.050)					(0.037)
netsales						0.007	0.004	-0.031	-0.058	-0.024
						(0.033)	(0.032)	(0.031)	(0.051)	(0.032)
sgata						0.923**	1.068*	1.048**	1.195**	1.087**
						(0.469)	(0.552)	(0.495)	(0.571)	(0.521)
leverage						-0.146	-0.154	-0.162	-0.173	-0.162
						(0.114)	(0.122)	(0.117)	(0.129)	(0.120)
assetgrowth						-0.071*	-0.063*	-0.064*	-0.059*	-0.062*
						(0.039)	(0.035)	(0.038)	(0.034)	(0.037)
quickratio						-0.010**	-0.009**	-0.010**	-0.011**	-0.010**
						(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
age						0.000	0.000	-0.000	-0.000	-0.000
						(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
hhi_ta						0.344	0.327	0.318	0.301	0.317
						(0.458)	(0.436)	(0.450)	(0.429)	(0.445)
stake						0.006**	0.006**	0.006**	0.006**	0.006**
						(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
tq						0.667***	0.666***	0.661***	0.657***	0.662***
						(0.176)	(0.177)	(0.176)	(0.178)	(0.176)
ffi10-Yr FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	5051	5051	5051	5051	5051	3001	3001	3001	3001	3001
adj. R^2	-0.003	-0.004	0.010	0.007	0.004	0.290	0.291	0.291	0.293	0.291
F	2.980	3.334	13.508	16.638	12.974	25.924	28.347	34.187	35.386	33.166
vce	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster
clustvar	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Panel II.6Bi. *Return on assets and various Stake-weighted Ownership Centralities*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	roa1	roa1	roa1	roa1	roa1	roa1	roa1	roa1	roa1	roa1
Sbq	0.930^{***}					0.315^{***}				
	(0.190)					(0.069)				
Scq		1.542^{***}					0.322^{***}			
		(0.480)					(0.080)			
Sdq			0.784^{***}					0.113		
			(0.212)					(0.096)		
Seq				0.200					0.048	
				(0.226)					(0.058)	
Snq					1.149^{***}					0.260^{***}
					(0.249)					(0.061)
netsales						-0.071	0.005	0.075	0.085	-0.041
						(0.073)	(0.072)	(0.094)	(0.091)	(0.078)
sgata						0.449	0.487	0.100	0.210	0.447
						(0.802)	(0.787)	(0.816)	(0.829)	(0.814)
leverage						0.771^{**}	0.810^{**}	0.804^{**}	0.800^{**}	0.793^{**}
						(0.379)	(0.384)	(0.382)	(0.384)	(0.384)
assetgrowth						-0.103	-0.122	-0.124	-0.118	-0.108
						(0.076)	(0.077)	(0.077)	(0.077)	(0.078)
quickratio						0.064	0.061	0.063	0.062	0.064
						(0.040)	(0.040)	(0.039)	(0.040)	(0.040)
age						0.010^{***}	0.010^{***}	0.011^{***}	0.011^{***}	0.010^{***}
						(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
hhi_ta						-0.188	-0.086	-0.127	-0.138	-0.236
						(0.891)	(0.900)	(0.916)	(0.902)	(0.907)
stake						0.016^{***}	0.014^{***}	0.012^{*}	0.016^{***}	0.013^{***}
						(0.005)	(0.005)	(0.006)	(0.005)	(0.005)
roa						0.687^{***}	0.686^{***}	0.688^{***}	0.689^{***}	0.687^{***}
						(0.032)	(0.033)	(0.032)	(0.032)	(0.032)
ffi10-Yr FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	5514	5514	5514	5514	5514	3538	3538	3538	3538	3538
adj. R^2	0.009	0.016	0.007	0.000	0.014	0.579	0.579	0.577	0.577	0.579
F	24.035	10.306	13.657	0.789	21.356	91.539	84.618	83.114	82.540	84.194
vce	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster
clustvar	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Panel II.6Bii. *Tobin's Q and various Stake-weighted Ownership Centralities*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	tq1	tq1	tq1	tq1	tq1	tq1	tq1	tq1	tq1	tq1
Sbq	0.183***					0.050*				
	(0.048)					(0.030)				
Scq		0.293***					0.151***			
		(0.057)					(0.056)			
Sdq			0.178***					0.057**		
			(0.038)					(0.024)		
Seq				0.132***					0.096**	
				(0.045)					(0.039)	
Snq					0.260***					0.091***
					(0.057)					(0.033)
netsales						-0.012	-0.026	-0.004	-0.030	-0.034
						(0.028)	(0.034)	(0.035)	(0.037)	(0.029)
sgata						0.972**	1.106**	0.887*	1.018**	1.050**
						(0.477)	(0.517)	(0.466)	(0.501)	(0.493)
leverage						-0.151	-0.145	-0.141	-0.153	-0.153
						(0.116)	(0.116)	(0.117)	(0.119)	(0.117)
assetgrowth						-0.068*	-0.069*	-0.074**	-0.062*	-0.065*
						(0.039)	(0.037)	(0.037)	(0.035)	(0.038)
quickratio						-0.010**	-0.010**	-0.009**	-0.010**	-0.009**
						(0.005)	(0.005)	(0.005)	(0.004)	(0.005)
age						0.000	-0.000	0.000	0.000	-0.000
						(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
hhi_ta						0.344	0.380	0.342	0.300	0.315
						(0.446)	(0.447)	(0.442)	(0.436)	(0.444)
stake						0.006**	0.005**	0.004*	0.006**	0.004**
						(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
tq						0.665***	0.660***	0.667***	0.664***	0.660***
						(0.177)	(0.177)	(0.177)	(0.176)	(0.176)
ffi10-Yr FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	5051	5051	5051	5051	5051	3001	3001	3001	3001	3001
adj. R^2	0.005	0.010	0.004	-0.000	0.015	0.290	0.292	0.290	0.291	0.291
F	14.764	26.801	22.582	8.709	20.569	35.191	33.882	27.859	33.863	37.142
vce	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster
clustvar	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table II.7. *Future Firm Performance and Composite Ownership Centrality*

Panel II.7Ai. *Future Return on assets and Composite (Unity-weighted) Ownership Centrality*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	roa	roa	roa1	roa1	roa2	roa2	roa3	roa3	roa4	roa4
Unq	0.580^{***}	0.117	0.648^{***}	0.187^{***}	0.874^{***}	0.283^{***}	0.725^{***}	0.356^{**}	0.546^{***}	0.461^{***}
	(0.196)	(0.120)	(0.207)	(0.064)	(0.269)	(0.106)	(0.181)	(0.138)	(0.162)	(0.122)
netsales		0.523		0.014		-0.137		0.040		0.288
		(0.340)		(0.077)		(0.160)		(0.190)		(0.191)
sgata		-8.397		0.459		-6.539^{**}		-7.096^{**}		-0.311
		(7.635)		(0.810)		(2.966)		(3.179)		(1.677)
leverage		-2.856^{**}		0.780^{**}		1.470^{**}		0.625		0.509
		(1.129)		(0.383)		(0.710)		(0.560)		(0.768)
assetgrowth		0.488^{***}		-0.108		-0.629^{***}		-0.706^{***}		-0.563^{***}
		(0.170)		(0.078)		(0.154)		(0.182)		(0.174)
quickratio		-0.170^{**}		0.063		0.059		-0.030		0.077
		(0.086)		(0.039)		(0.049)		(0.046)		(0.106)
age		0.001		0.011^{***}		0.018^{***}		0.022^{***}		0.022^{***}
		(0.011)		(0.003)		(0.006)		(0.007)		(0.006)
hhi_ta		-1.939		-0.206		1.308		-1.770		-2.020
		(1.467)		(0.906)		(1.592)		(3.203)		(3.531)
stake		0.051^{***}		0.017^{***}		0.009		0.008		0.027^{***}
		(0.012)		(0.005)		(0.007)		(0.008)		(0.009)
roa				0.688^{***}		1.056^{***}		1.094^{***}		0.377^{***}
				(0.032)		(0.190)		(0.278)		(0.099)
ffi10-Yr FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	5593	3582	5514	3538	5451	3512	4816	3106	4201	2694
adj. R^2	0.016	0.082	0.004	0.578	0.001	0.547	-0.003	0.437	-0.007	0.047
F	8.740	3.946	9.825	86.716	10.545	12.137	16.052	6.710	11.404	7.044
vce	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster
clustvar	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Panel II.7Aii. *Future Tobin's Q and and Composite (Unity-weighted) Ownership Centrality*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	tq	tq	tq1	tq1	tq2	tq2	tq3	tq3	tq4	tq4
Unq	0.181***	0.253***	0.182***	0.089**	0.162***	0.075*	0.154***	0.091*	0.116**	0.073
	(0.050)	(0.079)	(0.050)	(0.037)	(0.054)	(0.038)	(0.049)	(0.054)	(0.053)	(0.056)
netsales		0.036		-0.024		0.001		0.001		0.042
		(0.082)		(0.032)		(0.036)		(0.050)		(0.058)
sgata		2.403***		1.087**		0.960**		1.061**		1.339**
		(0.707)		(0.521)		(0.407)		(0.485)		(0.620)
leverage		-0.851***		-0.162		-0.190		-0.279		-0.521*
		(0.194)		(0.120)		(0.116)		(0.189)		(0.287)
assetgrowth		0.256***		-0.062*		-0.016		-0.026		-0.055
		(0.055)		(0.037)		(0.034)		(0.068)		(0.038)
quickratio		-0.018*		-0.010**		-0.008		-0.017*		-0.025**
		(0.010)		(0.005)		(0.007)		(0.010)		(0.013)
age		0.003		-0.000		0.000		0.001		0.002
		(0.002)		(0.001)		(0.001)		(0.002)		(0.002)
hhi_ta		0.368		0.317		0.009		-0.183		-0.019
		(0.656)		(0.445)		(0.433)		(0.653)		(0.980)
stake		0.007**		0.006**		0.008***		0.009***		0.010***
		(0.004)		(0.002)		(0.003)		(0.003)		(0.003)
tq				0.662***		0.607***		0.516**		0.401**
				(0.176)		(0.166)		(0.202)		(0.191)
ffi10-Yr FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	5115	3269	5051	3001	4965	2948	4358	2601	3802	2250
adj. R^2	0.008	0.074	0.004	0.291	0.001	0.234	-0.003	0.147	-0.009	0.078
F	13.045	6.195	12.974	33.166	8.881	16.367	9.803	12.216	4.741	7.016
vce	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster
clustvar	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Panel II.7Bi. *Future Return on assets and Composite Stake-weighted Ownership Centrality*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	roa	roa	roa1	roa1	roa2	roa2	roa3	roa3	roa4	roa4
Snq	1.022^{***}	0.216^{*}	1.149^{***}	0.260^{***}	1.305^{***}	0.299^{***}	1.119^{***}	0.407^{***}	0.946^{***}	0.565^{***}
	(0.197)	(0.118)	(0.249)	(0.061)	(0.326)	(0.102)	(0.271)	(0.114)	(0.184)	(0.121)
netsales		0.457		-0.041		-0.165		-0.018		0.183
		(0.327)		(0.078)		(0.170)		(0.199)		(0.186)
sgata		-8.337		0.447		-6.670^{**}		-7.202^{**}		-0.328
		(7.616)		(0.814)		(2.966)		(3.183)		(1.659)
leverage		-2.845^{**}		0.793^{**}		1.494^{**}		0.659		0.579
		(1.129)		(0.384)		(0.714)		(0.558)		(0.768)
assetgrowth		0.490^{***}		-0.108		-0.633^{***}		-0.712^{***}		-0.568^{***}
		(0.169)		(0.078)		(0.154)		(0.181)		(0.174)
quickratio		-0.169^{*}		0.064		0.060		-0.028		0.086
		(0.086)		(0.040)		(0.048)		(0.045)		(0.106)
age		0.001		0.010^{***}		0.018^{***}		0.022^{***}		0.022^{***}
		(0.010)		(0.003)		(0.006)		(0.007)		(0.006)
hhi_ta		-1.981		-0.236		1.313		-1.786		-2.064
		(1.466)		(0.907)		(1.580)		(3.161)		(3.508)
stake		0.048^{***}		0.013^{***}		0.004		0.001		0.018^{**}
		(0.012)		(0.005)		(0.007)		(0.008)		(0.009)
roa				0.687^{***}		1.055^{***}		1.093^{***}		0.375^{***}
				(0.032)		(0.190)		(0.279)		(0.099)
ffi10-Yr FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	5593	3582	5514	3538	5451	3512	4816	3106	4201	2694
adj. R^2	0.027	0.082	0.014	0.579	0.009	0.547	0.003	0.438	-0.003	0.049
F	26.946	4.113	21.356	84.194	16.028	14.012	16.983	7.986	26.402	7.235
vce	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster
clustvar	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Panel II.7Bii. *Future Tobin's Q and and Composite Stake-weighted Ownership Centrality*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	tq	tq	tq1	tq1	tq2	tq2	tq3	tq3	tq4	tq4
Snq	0.248***	0.282***	0.260***	0.091***	0.239***	0.070*	0.220***	0.085*	0.195***	0.081
	(0.056)	(0.074)	(0.057)	(0.033)	(0.049)	(0.038)	(0.042)	(0.051)	(0.033)	(0.050)
netsales		-0.003		-0.034		-0.003		-0.005		0.029
		(0.076)		(0.029)		(0.036)		(0.050)		(0.060)
sgata		2.321***		1.050**		0.912**		1.004**		1.327**
		(0.668)		(0.493)		(0.397)		(0.456)		(0.601)
leverage		-0.825***		-0.153		-0.181		-0.269		-0.510*
		(0.188)		(0.117)		(0.115)		(0.185)		(0.286)
assetgrowth		0.249***		-0.065*		-0.019		-0.030		-0.057
		(0.055)		(0.038)		(0.035)		(0.067)		(0.041)
quickratio		-0.016*		-0.009**		-0.008		-0.017*		-0.024*
		(0.010)		(0.005)		(0.006)		(0.010)		(0.012)
age		0.002		-0.000		-0.000		0.001		0.002
		(0.002)		(0.001)		(0.001)		(0.002)		(0.002)
hhi_ta		0.367		0.315		0.018		-0.157		-0.019
		(0.650)		(0.444)		(0.424)		(0.637)		(0.943)
stake		0.003		0.004**		0.007**		0.007**		0.008**
		(0.004)		(0.002)		(0.003)		(0.003)		(0.003)
tq				0.660***		0.606***		0.515**		0.400**
				(0.176)		(0.168)		(0.204)		(0.195)
ffi10-Yr FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	5115	3269	5051	3001	4965	2948	4358	2601	3802	2250
adj. R^2	0.016	0.081	0.015	0.291	0.011	0.234	0.004	0.147	-0.002	0.078
F	19.401	6.678	20.569	37.142	23.593	20.541	27.974	17.007	34.236	8.455
vce	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster
clustvar	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table II.8. *SCGI Subsample Analysis of Firm Performance and Board Centrality*

Panel II.8Ai. *SCGI Subsample: Firm Performance and various (Unity-weighted) Ownership Centralities*

	(1) roa1	(2) roa1	(3) roa1	(4) roa1	(5) roa1	(6) tq1	(7) tq1	(8) tq1	(9) tq1	(10) tq1
Ubq	0.192***					-0.062				
	(0.074)					(0.088)				
Ucq		0.021					-0.014			
		(0.094)					(0.025)			
Udq			0.222***					-0.084		
			(0.080)					(0.098)		
Ueq				0.210**					0.008	
				(0.085)					(0.027)	
Unq					0.175**					-0.069
					(0.085)					(0.073)
netsales	0.105	0.203*	0.050	0.062	0.093	-0.019	-0.048	-0.000	-0.057	-0.013
	(0.098)	(0.111)	(0.098)	(0.104)	(0.103)	(0.046)	(0.079)	(0.032)	(0.079)	(0.042)
sgata	-0.786	-0.771	-0.594	-0.419	-0.541	0.001	-0.009	-0.103	0.045	-0.116
	(1.275)	(1.326)	(1.257)	(1.226)	(1.254)	(0.292)	(0.295)	(0.379)	(0.302)	(0.381)
leverage	0.956*	0.974*	0.954*	0.948*	0.956*	0.061	0.054	0.073	0.049	0.068
	(0.538)	(0.543)	(0.537)	(0.531)	(0.538)	(0.072)	(0.073)	(0.079)	(0.074)	(0.076)
assetgrowth	-0.042	-0.050	-0.044	-0.040	-0.040	-0.134*	-0.133**	-0.138*	-0.130**	-0.139*
	(0.112)	(0.115)	(0.112)	(0.110)	(0.112)	(0.069)	(0.064)	(0.073)	(0.064)	(0.073)
quickratio	0.076*	0.076*	0.077*	0.074*	0.076*	-0.005	-0.005	-0.005	-0.005	-0.005
	(0.045)	(0.045)	(0.045)	(0.045)	(0.045)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
age	0.012***	0.012***	0.011***	0.012***	0.012***	0.000	-0.000	0.000	-0.000	0.000
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
hhi_ta	-1.375	-1.283	-1.366	-1.359	-1.351	0.026	0.004	0.034	-0.005	0.026
	(1.273)	(1.267)	(1.275)	(1.274)	(1.274)	(0.464)	(0.433)	(0.457)	(0.429)	(0.450)
stake	0.017***	0.015***	0.017***	0.017***	0.017***	-0.001	-0.001	-0.001	-0.000	-0.001
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.003)	(0.002)	(0.003)	(0.002)	(0.003)
scgi	0.008	0.010	0.005	0.004	0.006	0.003	0.003	0.004	0.002	0.004
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.003)	(0.004)	(0.003)	(0.003)	(0.003)
roa	0.666***	0.667***	0.666***	0.666***	0.667***					
	(0.049)	(0.050)	(0.050)	(0.050)	(0.050)					
tq						0.990***	0.987***	0.998***	0.986***	0.994***
						(0.173)	(0.173)	(0.176)	(0.175)	(0.175)
ffi10-Yr FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	2245	2245	2245	2245	2245	1888	1888	1888	1888	1888
adj. R^2	0.532	0.531	0.533	0.532	0.532	0.283	0.283	0.284	0.283	0.284
F	31.888	31.082	33.509	31.843	32.373	24.410	24.622	21.603	28.790	22.857
vce	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster
clustvar	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Panel II.8Aii. *SCGI Subsample: Firm Performance and Composite (Unity-Weighted) Centrality*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	roa	roa1	roa2	roa3	roa4	tq	tq1	tq2	tq3	tq4
Unq	0.052	0.175**	0.324**	0.389**	0.441***	0.235***	-0.069	-0.068	-0.046	-0.090
	(0.145)	(0.085)	(0.134)	(0.166)	(0.150)	(0.062)	(0.073)	(0.071)	(0.033)	(0.070)
netsales	0.636*	0.093	-0.262	-0.155	0.346*	0.059	-0.013	-0.005	0.027	0.088
	(0.330)	(0.103)	(0.212)	(0.244)	(0.208)	(0.064)	(0.042)	(0.044)	(0.050)	(0.075)
sgata	-10.085	-0.541	-6.083*	-7.111*	0.929	1.945***	-0.116	0.148	0.595*	1.244**
	(11.337)	(1.254)	(3.188)	(3.822)	(1.837)	(0.596)	(0.381)	(0.344)	(0.339)	(0.523)
leverage	-3.329**	0.956*	1.795*	1.016	1.064	-0.709***	0.068	0.023	-0.149	-0.379
	(1.486)	(0.538)	(0.985)	(0.678)	(0.847)	(0.179)	(0.076)	(0.074)	(0.132)	(0.271)
assetgrowth	0.479***	-0.040	-0.570***	-0.562***	-0.270	0.208***	-0.139*	-0.054	-0.039	-0.089
	(0.177)	(0.112)	(0.160)	(0.188)	(0.171)	(0.046)	(0.073)	(0.044)	(0.073)	(0.059)
quickratio	-0.221**	0.076*	0.098*	0.010	0.100	-0.015**	-0.005	-0.008	-0.017	-0.023
	(0.106)	(0.045)	(0.053)	(0.054)	(0.122)	(0.007)	(0.004)	(0.006)	(0.012)	(0.018)
age	0.000	0.012***	0.015*	0.013	0.012**	0.002	0.000	-0.000	0.000	-0.001
	(0.012)	(0.003)	(0.008)	(0.009)	(0.006)	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)
hhi_ta	-2.450	-1.351	-0.452	-2.279	0.065	0.744	0.026	-0.412	-0.863	-0.736
	(1.785)	(1.274)	(1.854)	(3.457)	(2.221)	(0.711)	(0.450)	(0.664)	(0.772)	(1.500)
stake	0.038***	0.017***	0.014*	0.017*	0.033***	0.008***	-0.001	0.001	0.002	0.003
	(0.014)	(0.006)	(0.007)	(0.009)	(0.012)	(0.003)	(0.003)	(0.002)	(0.003)	(0.004)
scgi	0.010	0.006	0.023	0.040	0.021	0.007	0.004	0.015*	0.016*	0.018**
	(0.024)	(0.011)	(0.018)	(0.026)	(0.018)	(0.006)	(0.003)	(0.008)	(0.009)	(0.007)
roa		0.667***	1.101***	1.213***	0.309***					
		(0.050)	(0.232)	(0.308)	(0.118)					
tq							0.994***	1.002***	0.931***	0.943***
							(0.175)	(0.201)	(0.212)	(0.326)
ffi10-Yr FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	2265	2245	2238	2213	1801	2055	1888	1884	1847	1491
adj. R^2	0.091	0.532	0.568	0.498	0.051	0.102	0.284	0.263	0.218	0.138
F	2.836	32.373	6.730	5.820	5.079	6.281	22.857	14.312	12.338	6.734
vce	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster
clustvar	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Panel II.8Bi. *SCGI Subsample: Firm Performance and various Stake-weighted Ownership Centralities*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	roa1	roa1	roa1	roa1	roa1	tq1	tq1	tq1	tq1	tq1
Sbq	0.291^{***}					-0.081				
	(0.091)					(0.095)				
Scq		0.335^{***}					0.010			
		(0.102)					(0.027)			
Sdq			0.076					-0.028		
			(0.133)					(0.036)		
Seq				0.100					-0.014	
				(0.073)					(0.030)	
Snq					0.239^{***}					-0.070
					(0.082)					(0.084)
netsales	0.012	0.082	0.185^{*}	0.155	0.045	-0.001	-0.056	-0.042	-0.045	-0.009
	(0.102)	(0.096)	(0.109)	(0.111)	(0.104)	(0.032)	(0.073)	(0.067)	(0.066)	(0.035)
sgata	-0.578	-0.511	-0.851	-0.701	-0.547	-0.078	0.039	0.033	0.006	-0.095
	(1.247)	(1.216)	(1.270)	(1.278)	(1.266)	(0.355)	(0.296)	(0.272)	(0.306)	(0.382)
leverage	0.947^{*}	0.978^{*}	0.977^{*}	0.972^{*}	0.965^{*}	0.066	0.051	0.051	0.053	0.061
	(0.531)	(0.537)	(0.536)	(0.537)	(0.539)	(0.076)	(0.071)	(0.071)	(0.072)	(0.074)
assetgrowth	-0.042	-0.051	-0.052	-0.042	-0.040	-0.136^{*}	-0.130^{**}	-0.130^{**}	-0.132^{**}	-0.136^{*}
	(0.111)	(0.112)	(0.111)	(0.111)	(0.113)	(0.070)	(0.065)	(0.064)	(0.067)	(0.071)
quickratio	0.078^{*}	0.074	0.076^{*}	0.076^{*}	0.077^{*}	-0.005	-0.005	-0.005	-0.005	-0.005
	(0.045)	(0.045)	(0.045)	(0.046)	(0.045)	(0.004)	(0.004)	(0.004)	(0.004)	(0.005)
age	0.011^{***}	0.011^{***}	0.012^{***}	0.012^{***}	0.012^{***}	0.000	-0.000	-0.000	-0.000	0.000
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
hhi_ta	-1.316	-1.250	-1.289	-1.359	-1.390	0.013	0.001	0.001	0.009	0.028
	(1.261)	(1.258)	(1.277)	(1.263)	(1.278)	(0.442)	(0.437)	(0.440)	(0.439)	(0.453)
stake	0.016^{***}	0.014^{**}	0.013	0.016^{***}	0.013^{**}	-0.001	-0.000	0.000	-0.001	0.000
	(0.006)	(0.006)	(0.008)	(0.006)	(0.006)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
scgi	0.003	0.003	0.010	0.008	0.004	0.005	0.002	0.003	0.003	0.004
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
roa	0.666^{***}	0.665^{***}	0.667^{***}	0.667^{***}	0.666^{***}					
	(0.050)	(0.051)	(0.049)	(0.049)	(0.050)					
tq						0.994^{***}	0.986^{***}	0.988^{***}	0.988^{***}	0.996^{***}
						(0.173)	(0.173)	(0.173)	(0.174)	(0.175)
ffi10-Yr FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	2245	2245	2245	2245	2245	1888	1888	1888	1888	1888
adj. R^2	0.533	0.533	0.532	0.532	0.533	0.284	0.283	0.283	0.283	0.284
F	34.719	33.862	30.670	31.024	32.399	22.201	25.740	24.189	24.539	22.285
vce	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster
clustvar	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Panel II.8Bii. *SCGI Subsample: Firm Performance and Composite Stake-Weighted Centrality*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	roa	roa1	roa2	roa3	roa4	tq	tq1	tq2	tq3	tq4
Snq	0.172	0.239***	0.261*	0.449***	0.515***	0.240***	-0.070	-0.051	-0.036	-0.044
	(0.130)	(0.082)	(0.142)	(0.149)	(0.151)	(0.056)	(0.084)	(0.057)	(0.041)	(0.055)
netsales	0.551*	0.045	-0.226	-0.205	0.280	0.044	-0.009	-0.012	0.023	0.059
	(0.316)	(0.104)	(0.215)	(0.256)	(0.213)	(0.063)	(0.035)	(0.043)	(0.046)	(0.063)
sgata	-9.965	-0.547	-6.311*	-7.194*	0.950	1.864***	-0.095	0.205	0.631*	1.333**
	(11.324)	(1.266)	(3.235)	(3.865)	(1.811)	(0.563)	(0.382)	(0.324)	(0.328)	(0.523)
leverage	-3.329**	0.965*	1.819*	1.039	1.114	-0.687***	0.061	0.013	-0.155	-0.399
	(1.487)	(0.539)	(0.994)	(0.682)	(0.849)	(0.175)	(0.074)	(0.077)	(0.136)	(0.287)
assetgrowth	0.483***	-0.040	-0.579***	-0.566***	-0.274	0.201***	-0.136*	-0.050	-0.037	-0.082
	(0.178)	(0.113)	(0.160)	(0.188)	(0.172)	(0.045)	(0.071)	(0.047)	(0.075)	(0.062)
quickratio	-0.220**	0.077*	0.098*	0.010	0.109	-0.015**	-0.005	-0.008	-0.017	-0.024
	(0.106)	(0.045)	(0.052)	(0.053)	(0.122)	(0.007)	(0.005)	(0.006)	(0.012)	(0.018)
age	-0.000	0.012***	0.015*	0.012	0.012*	0.002	0.000	-0.000	0.000	-0.001
	(0.012)	(0.003)	(0.008)	(0.009)	(0.006)	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)
hhi_ta	-2.507	-1.390	-0.444	-2.315	0.032	0.737	0.028	-0.421	-0.874	-0.763
	(1.795)	(1.278)	(1.847)	(3.435)	(2.240)	(0.701)	(0.453)	(0.666)	(0.769)	(1.479)
stake	0.036***	0.013**	0.008	0.009	0.024**	0.003	0.000	0.003	0.003	0.004
	(0.013)	(0.006)	(0.007)	(0.009)	(0.011)	(0.003)	(0.002)	(0.002)	(0.003)	(0.004)
scgi	0.006	0.004	0.025	0.038	0.020	0.006	0.004	0.015*	0.016*	0.017**
	(0.023)	(0.011)	(0.019)	(0.026)	(0.018)	(0.006)	(0.003)	(0.007)	(0.009)	(0.008)
roa		0.666***	1.101***	1.212***	0.308***					
		(0.050)	(0.233)	(0.309)	(0.118)					
tq							0.996***	1.001***	0.931***	0.937***
							(0.175)	(0.203)	(0.216)	(0.330)
ffi10-Yr FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	2265	2245	2238	2213	1801	2055	1888	1884	1847	1491
adj. R^2	0.091	0.533	0.568	0.498	0.053	0.107	0.284	0.263	0.218	0.138
F	2.907	32.399	8.051	6.483	5.402	6.861	22.285	15.002	14.824	6.669
vce	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster	cluster
clustvar	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid	ecid

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$