Help or Hinderance? Boardroom Network Connectivity and Firm Performance

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Abstract

While boardroom networks should act as a conduit for resource sharing between firms, and so improve firm performance, recent evidence on the value of connected boards is limited and inconclusive. This study aims to provide additional evidence on the impact of board connectivity on firm performance by exploring Australian listed firms between 2001 and 2011. We employ four dimensions of connectivity; measuring the quantity, speed and quality of information flow and resource sharing, and a firms access to the best-connected boards. Additionally, we construct and test a factor of the four connectivity dimensions. Our findings show more connected boards have a negative impact on firm performance. The results remain consistent after controlling for different time periods, alternative model specifications and the inclusion of lagged variables. The results suggest that boardroom networks are not a value-enhancing tool for boards.

Keywords: Corporate Governance, Resource Dependence, Board of Directors, Social Networks, Centrality

JEL Codes: C33, G32, G34

1. Introduction

The prevailing literature has identified two primary roles for the board of directors; an agency role monitoring management, and as a provider of "human capital" resources. While much of the finance literature has focused on directors providing oversight for managers (Baysinger & Butler, 1985; Fama, 1980), resource dependency theory, based heavily in the management literature, contends that directors play a role in assisting managers by providing advice and counsel, expertise and connections (Hillman & Dalziel, 2003; Pfeffer & Salancik, 1978). Resource dependence theory therefore argues that board capital, such as skills, experiences, knowledge and connections, should add value to the firm.

One aspect of board capital that is yet to be fully examined is the role of board connectivity. Due to the extensive skillset directors require, the pool of qualified directors is limited. As a result, directors often appear on multiple boards, creating what is known as an interlock. Prior literature has established that interlocking boards facilitate flows of information, such as sharing experiences and mistakes (Davis, 1991; Haunschild, 1993); (Mizruchi, 1996; Useem, 1984), and can create beneficial relationships (Dooley, 1969; Houston et al., 2014), allow firms to trade favours (Engelberg et al., 2012) and negotiate better contractual arrangements (Mizruchi, 1996). However, interlocks may also result in firms circulating value-decreasing corporate practices (Bizjak et al., 2009), replicating mistakes (Mizruchi, 1996), or may weaken corporate governance (Fich & White, 2003). Additionally, interlocks could result in cartel behaviour, price collusion and reduced competition (Mizruchi, 1996) or firms may become overwhelmed with too much information (Chewning & Harrell, 1990; O'Reilly, 1980).

Studies looking at the impact of interlocks on firm performance generally find either no impact (Kiel and Nicholson, 2006) or a negative effect (Non & Franses, 2007; Santos et al., 2009). More recently studies have started to employ social network theory to explore board connections in a wider context. Social network theory argues that interlocking boards create a wider network of firms, allowing the flow of resources and information between distant firms (Wasserman & Faust, 1994) which the interlocking literature fails to consider. Firms in a larger network and those well positioned in terms of access to information should have access to more resources through the network (Hillman & Dalziel, 2003; Horton et al., 2012; Wasserman & Faust, 1994). However, while theory suggests that well-connected firms should benefit more, the empirical evidence to date is mixed. Some studies find a positive association between board connectivity and firm performance (Horton et al., 2012; Larcker et al., 2013), while others find a negative impact (Andres et al., 2013; Omer et al., 2013).

This study examines the effect of social network measures of board connectivity on firm performance in Australia. We use a sample of firms listed on the Australian Securities Exchange (ASX) between 2001 and

2011, resulting in 10,599 firm-year observations. We employ four measures of board connectivity drawn from the social network theory; *Degree*, *Closeness, Betweenness* and *Eigenvector*, which measure different aspects of firm connectivity. In addition, we employ principle component analysis (PCA) to derive a connectivity factor. Using regression analysis, we test the network connectivity measures against three commonly used firm performance measures; operating return on assets (hereafter referred to as *ROA*), Tobin's Q and total stock returns. Additionally, we consider both a contemporaneous relationship, and firm performance one-year ahead of connectivity.

When we consider the univariate relationship between board connectivity and firm performance we find positive relationships between connectivity and both *ROA* and total shareholder returns. However, after controlling for a number of other factors, the positive relationships completely reverse, producing a negative relationship between connectivity and firm performance, consistent with Omer et al. (2013) and Andres et al. (2013). Irrespective of the connectivity measure employed, board connectivity detrimentally impacts on firm performance. Additionally, we find that a connectivity factor created using PCA also shows board connectivity harms firm performance. The findings remain consistent despite testing different sub-periods and using alternative model specifications. Additionally, we test for potential reverse causality and find that rather than changes in connectedness driving changes in firm performance, it is firm performance that drives changes in the level of connectedness. Specifically, a positive change in the performance measures are associated with a subsequent increase in *Eigenvector* and a change in *ROA* and total stock returns is associated with a subsequent positive change in *Closeness* and *Aggregate Connectivity* respectively. The results show that more connected boards negatively impact on firm performance. Several possible explanations have been offered for this including firms receiving too much information to be efficiently processed, the introduction of value decreasing corporate practices or simply undermining board monitoring.

The remainder of this paper is structured as follows: Section 2 provides a discussion on the related board network literature commencing with evidence on interlocks and the resulting network flow, followed by board connectivity. Section 3 outlines the data, methodology and sample statistics, including a comprehensive description of the network measures employed. Section 4 presents a discussion of the empirical results, beginning with the main findings followed by robustness tests. Section 5 concludes the paper.

2. Literature Review and hypotheses development

2.1 The Role of the Board of Directors

While much of the finance literature has focused on the boards monitoring role, there is a growing focus on the broader role that boards have in the operating and strategic direction of the company (Hillman et al., 2009; Masulis et al., 2012). Directors are selected for the considerable skills, knowledge and expertise they bring to the role, which makes for a relatively limited pool of qualified individuals. As a result, board members may hold multiple directorships, creating interlocks between the boards of those companies. Directors holding multiple board seats therefore open up access to a wider pool of experiences, knowledge and connections which may add value to the firm.

An increasing body of literature examines interlocking relationships between firms. Board interlocks establish networks between firms that allow for the spread of information (Wasserman & Faust, 1994) allowing for firms to learn from others. For instance, Haunschild (1993) finds that interlocking boards are more likely to mimic the recent acquisition activities of the firms they are connected to. Further, Davis (1991) finds that the more ties a firm has to those that have adopted a poison pill clause, the more likely they are to adopt the practice themselves. As well as imitating corporate strategies, interlocked directors may also pass on the experiences and mistakes made by other firms (Mizruchi, 1996). CEO's interviewed in Useem (1984) contend that seats on other boards provide private information that executives can use in their own firm.

Additionally, multiple directorships also help to facilitate beneficial business relationships. Studies have found that firms connected to the banking and financial sector (Engelberg et al., 2012) or with political connections (Houston et al., 2014) have lower interest rates with fewer debt covenants, which improves shareholder value. Interlocks also assist with contract negotiations, as the social rapport between directors may result in quid-pro-quo behaviour (Mizruchi, 1996) and improve negiotations with suppliers of key inputs (Schoorman et al., 1981).

While the above benefits have been documented, other studies have identified issues with interlocks. For instance, interlocking boards may result in spreading value-decreasing corporate practices. For example, stock options backdating is rampant in firms with interlocking boards (Bizjak et al., 2009). Likewise, shared knowledge may also result in firms replicating mistakes in operating procedures or strategic decisions (Mizruchi, 1996), or imitating activities that give them a bad name, such as earnings management (Chiu et al., 2012). It may also be that interlocks undermines corporate governance. Fich and White (2003), for instance, find CEO pay tends to be higher and CEO turnover lower when the boards are "mutually

interlocked".[1] Additionally, firms may engage in cartel behaviour, colluding on price and reducing competition raising significant legal hazards which can severly reduce the value of the firm if discovered (Mizruchi, 1996).

Another issue that can arise is directors who hold too many board seats. Directors with a lot of directorships may be unproductive due to higher stress levels and limitations on the time a director can expend on each firm. This is referred to as "busyness"[2] and has been shown to result in worse monitoring and firm performance (Fich & Shivdasani, 2006). Additionally, highly connected boards may receive too much information. Unless firms are able to efficiently process the information they receive, the firms risk being overloaded (Swain & Haka, 2000). Moreover, too much information may distort a firm's ability to make good decisions critical to their forthcoming plans (Chewning & Harrell, 1990; O'Reilly, 1980).

Considerable literature has shown that interlocks between boards result in the flow of information, favours and experiences between the firms. Interlocks have been shown to have mixed impacts on firms, with both potentially positive or negative outcomes depending on the circumstances. However, the impact of connections on firm performance has not been well addressed.

2.1.1 Connectivity and Firm Performance

Recently, studies have begun to focus on the economic outcomes of corporate ties, finding a generally negative relationship between interlocks and firm performance. For instance, Kiel & Nicholson, (2006) investigate the impact of interlocks on stock returns in Australia and find no significant relationship. Non and Franses (2007) examine a sample of 101 large firms in the Netherlands between 1994 and 2004 and find that interlocks have a small negative effect on firm performance. Santos, Da Silveira, and Barros (2009) study the Brazilian market using a sample of firms for three years, 2001, 2003, and 2005, and find that Tobins-Q is negatively impacted by board interlocks. They do find however, that a small number of interlocks is beneficial with the optimal number around five connections. One issue with these studies is that they are primarily focused just on the direct connections between firms, and so fail to consider other dimensions of connectedness.

Social network theory argues that a firm that is directly connected to another firm is, by extension, also indirectly connected to each of the firms that they are directly connected to, establishing a broad network of firms. This allows for estimating and measuring a number of additional dimensions of connectivity which may impact firm value. Four measures commonly used in the social network literature include *Degree*, *Closeness*, *Betweenness* and *Eigenvector*. *Degree* measures the direct connections a firm has, essentially the number of interlocks, and proxies for the direct access to information a firm has. In contrast, *Closeness*,

[1] Mutually interlocked is defined as when a board has at least *two* directors who are also members of another firms board (Fich & White, 2003).
[2] "Busyness" is referred to by Fich and Shivdasani (2006) as an outside director who holds three or more directorships.

Betweenness and *Eigenvector* measure the indirect connections of a firm. *Closeness* estimates how central a board is within a network by looking at the distance between the firm and the rest of the firms in the network, measured by the shortest number of connections between two firms. More central firms have better quality and faster access to information. *Betweenness* measures the intermediate connections a board has, defined as being between two other firms. Intermediately linked firms have the potential to control the flow of information and resources between indirectly connected firms. *Eigenvector* measures the extent to which a firm has direct access to the best-connected boards by considering both the number and connectivity of it's connections. In our setting, a higher *Eigenvector* measure indicates better access to information and resources from highly connected boards.

The different dimensions of connectivity capture distinct yet interrelated aspects of a firm's connections and collectively demonstrate a firms overall position in the corporate network. To accurately estimate the impact of connectivity on firm performance, it is important to consider connectivity within a broader context.

2.1.2 Board Connectivity

To date, few studies have empirically investigated the effect of board connectivity on firm performance. Hochberg et al. (2007) were the first to apply social network measures within the finance context, finding that better connected venture capital firms have significantly better fund performance. Horton et al. (2012) also finds that better connected firms have improved firm performance, based on total stock returns, market to book ratios and return on assets, for London Stock Exchange listed firms. They also find that well-connected directors are compensated for the benefits that their better connections are perceived as providing. Larcker et al. (2013) examines a composite score based on the four connectivity measures in the US for both public and private companies. They find that more central (connected) firms earn superior characterstic-adjusted returns and have higher future growth in return on assets. Their findings are stronger for growth firms, and firms facing adverse circumstances which implies that these types of firms benefit more from board connectivity.

In contrast, Omer et al. (2013) examines firms in the US and find that the impact on return on assets and Tobin's Q depends on the connectivity measure, a positive relationship with *Degree* but negative relationships with *Closeness* and *Eigenvector*. Along similar lines, Andres et al. (2013) finds that German companies with well-connected boards (Degree and Eigenvector) perform worse. The authors also argue that the negative effect is driven by board connections undermining the monitoring role of directors. Given the conflicting evidence on the impact of board connectivity and firm performance, the value of well connected boards remains an open question. It is also intriguing that well connected directors are paid for their connections, yet it is not clear that those connections are value enhancing.

3. Methodology and Data

3.1 Network Construction and Measures

Directors on multiple boards act as information conduits between the boards. Additionally, the linkages of directors create more complex networks where boards can act as intermediaries between unconnected firms, creating indirect connections. These wider networks can be viewed within the framework of social network theory. An example of a simple board network is present in Figure 1. Within this example, Firm 5 has board members sitting on the other four companies boards and occupies the most central position, in terms of direct connections, and represents an intermediary for information flows between firms not directly connected, such as Firms 4 and 2. We employ four commonly used social network measures that measure different aspects of a firms position and centrality within the network. The first measure we employ is the number of direct connections a firm has, referred to as *Degree* in Freeman (1979), and which is a very similar measure to board interlocks as applied in previous studies (e.g. Non & Frances, 2007). *Degree* is defined as the number of unique direct connections between the board members of Firm *i* and all other firms, i.e.

$$C_{i,x}^{D} = \sum_{j=1}^{n-1} \delta(i,j), \quad j \neq i \tag{1}$$

Where $\delta(i,j)$ is a dummy variable that equals one if there is at least one director in common between Firms *i* and *j* and zero otherwise.[3] *Degree* measures information quantity and captures the potential for communication activity. A higher *Degree* score indicates a firm with more connections, and by extension more opportunities for the firm to exchange or acquire information (Freeman, 1979). To take into account differences in network size between years we divide *Degree* by (n – 1), where n is the number of firms in the network that year (Hochberg et al., 2007; Horton et al., 2012). *Degree* therefore represents the firms percentage of the total number of connections possible (Freeman, 1979).

The second measure we employ is *Closeness.* *Closeness* measures the quality of relationships a firm has by measuring the shortest distance between two firms. For instance, Figure 1 shows that while Firms 2 and 4 are not directly connected, indirect information channels exist via Firms 1, 3 and 5. As a result Firms 2 and 4 have two degrees of separation. Shorter distances allow for more timely information flows. We define *Closeness* as the sum of the inverse of the shortest distance between Firm *i* and all other firms in the network (Freeman, 1979) i.e.

[3] . We define a director as a director or an alternative director position held on the board of a firm for the majority of one year.

$$C_{i,\tau}^{C} = \sum_{j=1}^{n-1} d(i,j)^{-1}, \quad j \neq i \tag{2}$$

Where *n* is the total number of firms in the network and *d(i,j)* is the shortest distance between Firm *i* and Firm *j*. We deal with the issue of firms that are isolated from the main network, either forming small disconnected networks or being completely unconnected, by setting the distance between unconnected firms to 0 (Opsahl et al., (2010).[4] This measure is normalised by dividing by *(n-1)* representing the percentage of the maximum *Closeness* possible for a given Firm *i*.

The third measure we employ is *Betweenness*, which is designed to measure the volume of information passing through and potentially controlled by a given firm. Intuitively, a company sitting between two other companies is in a position to control and restrict the flow of information between those firms, such as withholding information on potential investment opportunities (Borgatti, 2005; Freeman, 1979). However, the more connections a firm has, the weaker the ability of other firms to restrict their flow of information. In Figure 1 for instance, Firm 5 is limited in its ability to restrict information flows between firms 2 and 4 because information can also flow via firms 1 and 3. Freeman (1979) explains that the potential control for a firm *i* who sits in between two other firms, is the probability that *i* falls on a randomly selected shortest path linking *(h,j)*. Let $g(h,j)$ be the number of shortest paths linking two boards, then the probability we observe in year *t* is:

$$B_{(h,i,j)\tau}^{B} = \frac{g(h,i,j)}{g(h,j)} \tag{3}$$

Where $g(h,j)$ is the maximum number of communication paths another board could be in a position to control. Therefore, the information passing between *(h,j)* can be completely controlled by *i when* $B_{(h,i,j),\tau}^{B}$ *=1*.The overall *Betweenness* of Firm *i* is the sum of the proportions of all the shortest paths linking two firms which pass through Firm *i*:

$$C_{i,\tau}^{B} = \sum_{h<}^{n-1} \sum_{j}^{n-1} B_{(h,i,j)\tau}^{B}, \quad where\ h \neq i \neq j \tag{4}$$

[4] For a more detailed discussion on the measurement of Closeness please refer to Freeman (1979) and Borgatti (2005). For a discussion on using the Freeman (1979) measure for disconnected networks, and the limitation of restricting the sample to the main component, refer to Omer et al (2013, p. 19 & 41).

N is the number of firms in the network and $B^{B}_{(h,i,j)}$ is defined as per Equation (3). Again, we normalise *Betweenness* by expressing it as the proportion of its maximum value possible in year *t*. The maximum value for $C^{B}_{i,t}$ is measured as $(n\text{^}2-3n+2)/2$ (Freeman, 1979). Accordingly, the relative *Betweenness* centrality in year t is:

$$C'^{B}_{i,t} = \frac{2(C^{B}_{i,t})}{n^2-3n+2} \tag{5}$$

Where $C^{B}_{i,t}$ is defined by equation (4) an *n* represents the number of boards in the network.

Our fourth measure is *Eigenvector* which captures the quality of the firms with which a firm is connected. Being directly connected to a highly connected firm increases a firms direct access to more information (Omer et al., 2013). *Eigenvector* is defined as the sum of Firm *i*'s first degree connections to all other firms (*δ(i,j)*) in the network, weighted by the connectedness of the firms to which it is connected to, i.e.

$$C^{E}_{i,t} = \frac{1}{\lambda}\sum_{j=1}^{n} \delta(i,j)\, C^{E}_{j,t}, \quad j \neq i \tag{6}$$

Where C^{E}_{t} is the *Eigenvector* score for a particular firm, $\delta(i,j)$ is defined at Equation (1), and λ is a constant, defined as the maximum possible eigenvector for the given network in year *t*. Connections to highly connected firms will increase a firms *Eigenvector* score more than connections to less connected firms. Theoretically, this power may enhance a firms prospects of obtaining beneficial informational resources.

3.2 Firm Performance Measures

To estimate firm performance, we use three commonly used measures of performance; return on assets, Tobin's Q and total stock returns. All three measures have been previously employed in studies of board connectivity and firm performance (Andres, 2008; Barnea & Guedj, 2007; Horton et al., 2012; Larcker et al., 2013).

Return on assets *(ROA)* measures the ability of a company to generate profit through efficient utilization of its assets. We define *ROA* as earnings before interest, taxes, depreciation and amortization (EBITDA) scaled by the average of book value total assets. Using the operating *ROA* reduces the impact of factors unrelated to performance like accounting decisions around depreciation (Anderson & Reeb, 2003). Tobin's Q has been extensively used to measure a firms' performance by expressing a ratio of the market valuation of a firm

over the book value of the firm. Specifically, we estimate Tobin's Q (*TQ*) as the aggregate market value of a firm's book value of short and long-term liabilities, the liquidation value of a firm's preferred stock that is outstanding, minority interests, and the firms market capitalisation measured at fiscal year-end, over its book value of total assets (Chung & Pruitt, 1994). Finally, we also measure annual shareholders return, using the adjusted closing price of the firm's security at the end of Decemeber and incorporating gross dividends, which we assume were reinvested at the closing price on the firms ex-dividend date (Core et al., 1999). We measure each of our firm performance measures both concurrently, one-year ahead and additionally include firm performance lagged a year to control for the possibility that past performance determines how a firm is connected.[5]

3.3 Empirical Design

We analyse the relationship between board connectivity and firm performance, by treating our data as an unbalanced panel and estimating a pooled ordinary least squares (OLS) model with year and industry dummies in the form:

$$FP_{i,\tau+t} = \alpha + \beta^1 C_{i,\tau}^{\varphi} + \sum_{k=1}^{\kappa} \delta^{\kappa} X_{i,\tau}^{\kappa} + \sum_{T=1}^{T} \psi^T Y_{\tau}^T + \sum_{\varkappa=1}^{\varkappa} \lambda^{\varkappa} I_i^{\varkappa} + \varepsilon_{i,\tau+t} \quad (7)$$

where $FP_{i,\tau+t}$ represents one of the proxies for firm performance, either in the current or following year, $C_{i,t}^{\varphi}$ represents one of the four measures of connectivity, $\boldsymbol{X}_{i,\tau}$ represents a vector of firm-level and corporate governance characteristics to control for observable factors, Y_{τ} and I_i are year and industry dummies respectively. Additionally, we cluster the standard errors by firm (Petersen, 2009).

We include a number of controls in our analysis. First, we include firm size, as large firms are typically more connected and perform better (Banz, 1981; Horton et al., 2012; Omer et al., 2013). We define size as the fiscal year-end market capitalisation (*MV*). Additionally, we also control for leverage which has been shown to play a role in motivating profit generation (Baker, 1973). We define leverage (*LEV*) as the book value of short and long-term debt divided by the book value of assets. Older firms are likely more established and potentially profitable. We measure firm age (*AGE*), as the number of years that a stock had been listed on the ASX, and control for firm experience (Barnea & Guedj, 2007; Core et al., 1999). To capture firm risk (similar to Core et al., 1999), we include the return volatility for a firm measured as the standard deviation of monthly stock returns from January to December (*RISK*).

[5] We also test firm performance out to *t+3*. The results are very similar to *t+1* and so are not reported for the sake of brevity.

We also control for various corporate governance characteristics known to be related to firm performance. We include a board size measure, defined as the total number of directors sitting on the board (Core et al., 1999), as larger boards may be less effective monitors (Yermack, 1996) and smaller boards may be less connected. Likewise, as busy directors may be ineffective monitors we also control for director busyness by creating a dummy variable (*BUSY*) which equals one if a board has over 50% of directors with three or more directorships in the same year (Andres et al., 2013; Fich & Shivdasani, 2006). Given recent evidence suggesting that having more independent (Fich, 2005; Horton et al., 2012; Rosenstein & Wyatt, 1990) and female directors (Adams & Ferreira, 2009) improves firm performance, we include a variable *OUT* which measures the percentage of outside directors and *FEM* which measures the percentage of female directors on a board. To capture the experience the board has in monitoring a firm, we control for tenure (*TEN*), defined as the average length of time the directors have served on the board (Horton et al., 2012) which is a proxy for management. Finally, we control for CEO duality with a dummy variable (*DUAL*) which equals 1 when the CEO is also the chairman and 0 otherwise.

To control for industry and time we create dummy variables using level 1 Industry Classification Benchmark codes and the year. To remove the effect of extreme outliers on the results, we winsorize *ROA, TSR MV*, *LEV*, and *RISK* at the 1st and 99th percentile and *TQ* at the 5th and 95th percentile.

3.4 Data

We address whether board connectivity has an effect on firm performance by examining firms listed on the Australian Stock Exchange between 2001 and 2011. Australia provides an interesting setting to explore the impact of connectivity on firm performance as it represents a well-developed market, with a strong regulatory regime, and similar market characteristics, culture and setting to the United States and the United Kingdom (where previous studies have been performed). Accordingly, Australia provides a sound setting for acquiring additional empirical evidence that can be compared to the current literature (Horton et al., 2012; Larcker et al., 2013; Omer et al., 2013).

We first construct boardroom networks consisting of our sample firms each year between 2001 and 2011. In constructing the network, we allow information to flow bi-directionally between connected firms. We then use each of our networks to calculate annual centrality measures for each firms' board of directors. Corporate governance data, including board characteristics and membership, are collected from Securities Industry Research Centre of Asia-Pacific (SIRCA) Corporate Governance Database. Accounting and stock market data are obtained from Thomson Reuters Datastream (DS). Our sample comprises 1355 unique ASX listed firms with 11,447 unique directors and 10,599 firm year observations. We use the directors board seats information from SIRCA to construct our network measures using the UCINET 6 package.

Panel A of Table 1 displays boardroom network characteristics for each sample year. On average there are 960 firms and 4,741 directors per year. We observe directors hold on average 1.25 boards seats per year, although this is declining from 1.3 in 2003 to 1.19 in 2011. We observe the maximum board seats held by a director is also declining, from 12 in 2001 to six in 2011. On average, about 70% of the companies in the sample were connected to the largest network, comparable with Larcker et al. (2013) who reports an annual average of 72% for US companies, although this percentage is also declining over time. The number of firms in isolated networks doubles over the sample period while the number of isolated firms (unconnected to any companies) increases slightly. The network characteristics therefore indicate that firms are becoming notably less connected, particularly following the Global Financial Crisis.

Panel B of Table 1 reports descriptive statistics for the centrality measures. Overall sample averages of *Degree*, *Closeness*, *Betweenness* and *Eigenvector* are 0.34%, 9.6%, 0.25% and 1.68% respectively. Of note, all bar *Closeness* are skewed, suggesting the means are driven by a few well connected firms. For *Closeness* we note that Australian firms are more closely connected than UK or US firms. Larcker et al. (2013) reports an overall closeness measure of 4.5% for US firms. Horton et al. (2012) considers the largest network for UK firms and reports a closeness measure of 8.7%, for the same measure we find a mean of 17.4%. Annual sample statistics of the centrality measures are presented in Panel C. We observe that both *Degree* and *Closeness* decline over the sample period, consistent with Omer et al. (2013) and Larker et al. (2013). However, *Betweenness* and *Eigenvector* display no obvious trends. The variation in trends suggest that these measures are capturing different aspects of connectivity and that some aspects of connectivity are declining over time.

[INSERT TABLE 1 HERE]

Table 2 presents descriptive and sample statistics of the firm performance measures. Panel A of Table 2 describes the distributional characteristics of firm performance at $t=0$. Overall, we observe a low average *ROA* of -5.9%, which is heavily skewed as shown by the median *ROA* being 4.3%. Shultz et al. (2013) also reports negative average *ROA* for Australian listed firms over a similar period. The overall sample average of 2.015 for *TQ* is rather high, interpreted as market value of assets being about two times that of the cost to replace those assets. Omer et al. (2013) by contrast reports an average of 1.82 for US listed firms. The average *TSR* is 17.1% compared with a median of just 2.9%, indicating a strong positive skew. We also observe considerable variation in the *TSR* with a standard deviation of 75.8%.

[INSERT TABLE 2 HERE]

Panel B shows the annual averages and medians (in parenthesis) of the sample. Average and median *ROA* is highest in 2004, although the average *ROA* is consistently negative over the sample period. In contrast the medians are consistently positive for all years. We observe a steady run up in average *TQ* to its highest level in 2007, however, following the GFC we see a marked decline in *TQ*. As expected, shareholder return is

extremely low in 2008 (-52.7% average), but recovers in 2009, increasing to an average of 79%. We deal with the skewness in *TQ* and *TSR* by taking the the natural log of *TQ*, and (1+*TSR*).

[INSERT TABLE 3 HERE]

In Table 3, distributions of firm and governance characteristics are reported. *MV* is significantly skewed to the right, with an average of $828.4 million and median of $64.79 million and considerable variation, a standard deviation of 2939.9 and an interquartile range between $14.41 million and $294.26 million. On average, firms are about 11 years old, with a median *AGE* of about 9.5 years. Average board size is 6.2 with 50% of boards consisting between 5 and 7 directors. On average, 17.8% of the firm assets are funded with interest bearing debt. Directors hold their positions for about 5 to 6 years, and a very small number of firms have female directors (upper quartile range is 0).

Following standard practice, we use the natural log of *MV* in regressions. To smooth out the skewed distributions of *AGE*, *LEV*, *BSIZE*, and *TEN*, we take the log of the variables for the regressions. Taking the logistic transformation of *AGE* is also consistent with previous studies (e.g. Larcker et al., 2013). Additionally, we take the log of (1+ *FEM*) (Wooldridge, 2009) to ensure observations with zero female board members are included in the analysis.

4. Results

4.1 Preliminary analysis

To investigate the relationship between connectivity and firm performance, we first estimate correlations between connectivity, current year firm performance and control variables. The estimates are presented in Table 4. The correlations show that each dimension of connectedness is correlated but not extremely highly. The strongest observations we observe are between *Degree* and the other three connectivity measures, ranging from 0.69 to 0.73. Correlations between *Closeness*, *Betweenness* and *Eigenvector* are weaker, between 0.45 and 0.5. The latter relationship suggests that closely connected firms are not necessarily well positioned to control information, or to access more information through connections to highly connected firms, and vice versa. Overall, we observe that *Degree*, which is almost identical to the interlocks measure used in early studies, is highly correlated with other dimensions of connectivity, but doesn't fully explain the other dimensions. Consideration of the wider dimensions may therefore provide additional insights.

In terms of firm performance, the correlations with the connectivity estimates are extremely weak with coefficients between 0.01 and 0.17 for the connectivity measures and *ROA* and *TSR*. Conversely, the relationship between *TQ* and connectivity is negative, although still between -0.08 and -0.03. These relationships do not indicate a strong association between connectivity and firm performance. We observe

strong relationships between connectivity, firm size and board size, with coefficients between 0.3 and 0.5. These are not surprising findings as larger firms generally have the ability to attract better, more connected directors and also, larger boards will tend to have higher connectivity.

[INSERT TABLE 4 HERE]

Next we investigate the relationship between firm performance and connectivity by sorting firms into portfolios based on their connectivity scores then compare the portfolio averages of our firm performance and connectivity measures. For each year between 2001 and 2011, firms were ranked by their score for each connectivity measure at each fiscal year-end and assigned to one of five portfolios, with low connectivity firms assigned to portfolio one and high connectivity firms to portfolio five. As a result, we form 20 portfolios in total (five quintile portfolios for four connectivity measures). We then test the significance of the differences in means between the firm performance measures of the high and low portfolios.

The results are displayed in Table 5. We see large differences in the connectivity measures between the highest and lowest quintiles. Of note however, we see average *Betweeness* of 0.0 for the bottom two quintiles, suggesting at least 40% of the sample is in no way able to control or assist the flow of information within the network. This suggests at least 40% of the sample are either isolated firms or are sitting on the very fringes of the network, tied by only one connection to the main network. Also, we observe large increases between Quintiles 4 and 5 for *Betweeness* and *Eigenvector*. In both cases this indicates that a relatively small number of firms are highly connected, either in strong positions to control the flow of information, or highly connected with other highly connected firms.

When we examine the mean firm performance measures by connectivity quintile we observe that there appears to be a positive relationship between *ROA* and the four measures of connectivity, but a negative relationship with Tobins Q. In both cases we observe strong significance when we compare the highest minus the lowest quintile returns. However, the results show that the worst(best) *ROA(TQ)* performance is actually in the Quintile 2. This may indicate that isolated firms, who make the majority of the bottom quintile in most years, perform slightly better in terms of operating performance, but worse when looking at market vaue to book assets, than those firms in smaller networks and the firms on the fringes of the main network. We also observe less clear cut patterns for the total stock returns. Specifically, for three of the four connectivity measures there is a significant negative relationship where Quintile 5 has on average lower returns than Quintile 1, *Betweeness* is insignificant. We also do not observe the hump-shaped pattern that was obvious in the *ROA* and *TQ* measures.

The univariate results, including the correlation coefficients and quintile analysis, suggest that there is evidence of a mixed relationship between connectivity and firm performance. There appears to be a positive relationship between *ROA* and connectivity, while *TQ* is lower for highly connected firms. However, the

significantly positive relationship between connectivity and firm size may be clouding the results. Therefore, we next conduct multivariate analysis.

[INSERT TABLE 5 HERE]

4.2 Multivariate Analysis

To investigate whether a firms positioning in the boardroom network is important for firm performance, we perform pooled OLS regressions where we regress three different firm performance measures against the four connectivity measures, using both current and one-year ahead firm performance measures. First we examine the linear relationship and estimate univariate regressions:

$$(FP_{i,\tau+t} = \alpha + \beta_1 C^{\varphi}_{i,\tau} + \varepsilon_{i,\tau+t}) \quad (8)$$

followed by estimating Equation (7):

$$FP_{i,\tau+t} = \alpha + \beta^1 C^{\varphi}_{i,\tau} + \sum_{k=1}^{\kappa} \delta^{\kappa} X^{\kappa}_{i,\tau} + \sum_{T=1}^{T} \psi^T Y^T_{\tau} + \sum_{\varkappa=1}^{\varkappa} \lambda^{\varkappa} I^{\varkappa}_{i} + \varepsilon_{i,\tau+t} \quad (7)$$

Tables 6, 7, 8 and 9 report the main results of the analysis. Overall, the results suggest that board connectivity is negatively associated with firm performance, consistent with the general findings of Omer et al. (2013) and the board interlocks literature (Non & Franses, 2007; Santos et al., 2009). This is unanticipated as the correlations, sorts, and univariate regressions generally suggest a positive relationship with *ROA* and *TSR*, although the findings for *TQ* are consistent.

Table 6 presents the results for the regression between *Degree* and firm performance. *Degree* is a measure of the quantity of direct information transfer, where a higher value represents more direct access to information in the network. Panel A, Table 6 reports the univariate results where we regress performance on *Degree*. We observe a positive and significant relationship between *Degree* and *ROA* and *TSR* for concurrent and one-year firm performance, consistent with Table 4. *TQ* shows a significant negative relationship, also consistent with Table 4. However, once we include control variables in Panel B, we observe that firms with more direct connections perform significantly worse. This relationship holds for both current and future performance, with the exception of one-year ahead market performance (*TSR*). The relationships are also economically significant. For instance, for current year *ROA* and *TQ* the *Degree* coefficient is *-7.66* and *-14.73* indicating that if a firm's *Degree* centrality increases by 1% of the maximum degree connectivity of the network, *ROA* decreases by -7.66% and *TQ* changes by -14.72% respectively, ceteris paribus. Overall, the results suggest that greater numbers of interlocks are harmful to firm performance irrespective of the measure employed. This is generally consistent with the interlock literature (see for example Non & Frances, 2007).

With regard to the control variables, we observe that larger firms are associated with higher accounting based performance measures and firm valuations for all event horizons. Interestingly, firm risk is associated with higher firm value (*TQ*) but lower *ROA* and total stock returns. High *TQ* firms are likely growth firms where the market impounds in higher unrealised future cash flows into the current prices, but firms current profitability is still low. Board size has a strong inverse relationship with current firm performance. This finding is consistent with Yermack (1996) who posits that larger boards are less effective for performance. However, we find younger firms make more efficient use of their assets, have higher market valuations to book values and better stock returns, possibly as younger firms have greater scope for growth and are in less mature industries (Delmar et al., 2003). Of the board structure characteristics, there is a strong association between average board tenure (*TEN*) and firm performance. Long-standing directors may bring benefits due to having more knowledge and expertise about the firm for monitoring purposes. However, *TEN* is negatively associated with *TQ* denoting that longstanding directors reduce valuation premiums in the current and subsequent years.

[INSERT TABLE 6 HERE]

Panel A of Table 7, reports the univariate results for *Closeness*, which again support the findings of the correlation coefficients in Table 4. We also observe, in Panel B of Table 7, once the controls are included the coefficients of *Closeness* are insignificant for *ROA* and one-year ahead *TSR* and are significantly negative for *TQ* and current *TSR*. The results in Table 7 support Omer et al. (2013) who find a board's connectedness, when measured by *Closeness*, appears to be detrimental to firm performance. Additionally, the results also indicate connectivity has a large impact on firm performance. For instance, the coefficient for *Closeness* on current year *TSR* is -0.33. Thus the results suggest that the more central to a network a firm is, the lower the firms performance.

[INSERT TABLE 7 HERE]

Panel A of Table 8 presents univariate regressions of firm performance on *Betweenness.* The results are consistent with the univariate results for *Degree* and *Closeness* and again, support the correlation coefficients in Table 4. Multivariate regressions of performance on *Betweenness* are displayed in Panel B of Table 8. Again, once we add controls the relationships are either negative or insignificant, with *ROA* switching from a positive relationship to a statistically significant negative relationship for both the current year and one-year ahead and current year *TQ* stays significantly negative. The *TSR* results become insignificant. Again, the coefficients denote an economically significant impact, with *ROA* decreasing by -2.11% when *Betweenness* increases by 0.01%.

[INSERT TABLE 8 HERE]

Finally, Table 9 reports the results for *Eigenvector (EIGEN).* Panel A of Table 9 displays univariate regressions, consistent with the previous findings, with the exception of current *TSR* where no significant

relationship is present. Panel B of Table 9 reports the results for testing the model defined in Equation 7, with *Eigenvector* as the connectivity variable. The coefficients for *Eigenvector* are all negative and significant at the 1% level for *ROA*, *TQ* and current year *TSR*, consistent with the previous findings. Firms with connections to highly connected firms do not benefit from the potential advantage of accessing more information, favours, or skill.

Thus far the results provide significant evidence that board connectivity is negatively associated with firm performance, both in the current year and in the one-year ahead results. While the four measures of connectivity measure different aspects of network access; either the number of connections, position in the network, ability to hinder or help information flows or the quality of connections, the results provide consistent evidence that board networks hinder firm performance. This is broadly supportive of Omer et al. (2013) and appears to suggest that board networks may undermine monitoring consistent with the argument of Andres et al. (2013). Having established a negative impact of four different types of network positions on firm performance, we question whether the collective effect of connections is in fact unbeneficial. This will identify whether there is a net benefit to being connected or not. For the analysis we pull out the common component in the four measures using principal component analysis (PCA).

[INSERT TABLE 9 HERE]

4.2.1 Analysis of the Overall Effect of Connectivity

The correlations in the preliminary analysis show that the four connectivity measures are interrelated yet distint from each other, capturing different dimensions of boardroom network connections. To investigate the overall effect of connectivity on firm performance, we create an overall connectivity factor based on the four connectivity dimensions using Principle Components Analysis.[6] This technique identifies the first common component within a set of variables with an eigenvalue greater than one. We use *Degree*, *Closeness*, *Betweenneess* and *Eigenvector* for the analysis, and create a combined measure of connectivity (*CONN*). Employing Equation (7) and replacing the individual connectivity measure with the principal component score (*CONN)*, we run OLS regressions of each firm performance. Table 10 presents the results of the analysis. Panel A provides univariate results displaying a strong, positive (negative) association between *ROA*, *TSR* (*TQ)* and *Aggregate Connectivity*. Panel B of Table 10 presents the results of the main model shown in Equation (7). The coefficient of *CONN* is negative and significantly related to each of the firm performance variables in the current year, and in the subsequent year, for all but *TSR*. This demonstrates that the collective impact of connectivity results in poorer performance for firms, but the impact on shareholder returns is only of concern in the current year

[6] The details for the principal components analysis and Cronbach's Alpha test of internal consistency of the measures are reported in Appendix I. Cronbach's Alpha is 0.85, which indicates the measures are reliable for the PCA.

[INSERT TABLE 10 HERE]

One caveat to the previous findings is that there may be a reverse causality issue whereby firm performance impacts the type of directors taken onto boards. For instance, a poor performing company may prefer to select well-connected directors for their board, with the expectation that the directors will bring economic benefits to the firm through their connections (Horton et al., 2012). Conversely, firms who are performing well, may attract well connected directors who prefer to sit on the boards of high performers due to the reputational advantage that comes from being associated with a good firm. We follow Horton et al. (2012) and include a lag of the firm performanc measure, $FP_{i,t-1}$, as an independent variable to control for firm performance impact form the board selection process and director preferences. Lagged dependant variables (LDV) can also be used as a proxy to capture any unobserved effects related to historical factors, where past outcomes persist and in part determine the future (Wooldridge, 2009).

Table 11 reports the results when we estimate the relationship between current firm performance and connectivity while controlling for past performance. The results confirm the significantly negative relationship between board connectivity and firm performance. In most cases the significance of the connectivity variable coefficients remain the same, with the exception of *Closeness* when regressed against *ROA* which becomes significantly negative, and *TQ* regressed on *Between* which loses significance. The results however do not suggest that past firm performance impacts the negative relationship between firm connectivity and firm performance we reported in earlier tests.

The coefficients for FP_{t-1} are significant and positive for both *ROA* and *TQ*, indicating a strong and persistent relationship exists for firm performance. The sign and significance of the control variables remain largely consistent. Of particular note, the results for the main model and dynamic model indicate a negative relationship between busy boards and firm performance. This finding is consistent with the emerging board busyness literature (Fich & Shivdasani, 2006) suggesting that multiple directorships restrict the board from performing their monitoring duties well. Finally inclusion of the LDV markedly improves the fit of the model based on the adjusted-R^2s, with the exception of the results for *TSR* which increases by only a small amount.

After controlling for past performance, board connectivity is still associated with poorer firm performance. The results indicate that more connected firms suffer valuation and performance consequences, both in accounting measures and market based measures. This suggests that connectivity either undermines monitoring more than it enables resource dependence, or that connectivity results in the transfer of either poor quality information or too much information for the board to deal with effectively.

[INSERT TABLE 11 HERE]

4.3 Robustness Tests

To ensure the robustness of the findings we conduct several additional tests including employing Fama MacBeth regressions instead of pooled OLS, testing for a structural break in the results due to the global financial crisis, and considering how changes in connectivity impact changes in firm performance.

4.3.1 Alternative Models

We first employ an alternate estimation method to ensure the results are not driven by the choice of model. The Fama-MacBeth (FMB) (1979) two stage method considers time effects and minimises within firm variance while capturing between firm characteristics. In the first stage we estimate a cross-sectional regression of firm performance on each of the connectivity measures for each year in our sample between 2001 and 2011. After estimating these regressions, we average each of the cross-sectional coefficients over the number of years in the sample.

Table 12 reports the results. In most cases, the results are consistent with the pooled OLS findings in Tables 6 to 11. Irrespective of the aspect of connectivity captured, more connected firms appear to perform worse, or at best, no better than less connected firms. Specifically, we observe negative and significant coefficients for *Degree*, *Closeness* and *Conn* regardless of the performance measure, and also for the relationship between *Betweenness* and *Eigenvector* with *ROA* and *TQ*. Additionally, the control variables remain consistent with the pooled OLS estimates with the exception of *TSR* on *AGE* which loses some significance, and *BUSY* appears to have a strong negative association with *TSR*. Overall, the different estimation method does not appear to impact the results.

[INSERT TABLE 12 HERE]

4.3.2 Structural Break Tests

Although the Australian economy suffered less impact from the global financial crisis (GFC) than other countries, we test whether the results are consistent, or conversely, affected by unobserved differences in the periods before and after the 2008 GFC. We split the sample into two separate periods; 2001 to 2007 and 2008 to 2011, and estimate OLS regressions using current firm performance[7] on the collective connectivity measure (*CONN*).

Table 13 presents the results for the sub-period regressions. Overall, the results are consistent across both periods for *TQ* with some loss in statistical significance for *ROA* in the 2008-2011 period. However, for *TSR*, there is no significant relationship with *CONN* in the post-GFC period. This is likely due to a smaller sample

[7] Robustness tests were also performed including lagged firm perfomance as a control and using future firm performance for the dependent variable. The results are similar to Table 12 and 13 thus to compensate for space, we do not tabulate.

size for the 2008-2011 regressions but could also indicate that connectivity played more of a role in the period before the GFC occured.

INSERT TABLE 13 HERE

4.4 Endogeneity

In Section 4.2 we employed Equation (7) including a lagged dependent variable, specifically the lag of the firm performance measure, to control for unobserved factors, firms' board selection process and director preferences, to ensure the robustness of the negative relationship between board connectedness and firm performance. While endogeneity does not appear to be a concern, we undertake additional testing to control for potential reverse causality. Specifically, network literature argues that if a company views connectivity as a beneficial governance mechanism, firms might increase connectivity by appointing more connected directors to a board to improve firm performance. An alternative interpretation might be that better performing firms are able to attract better quality, and therefore, more connected directors. To test for this, we look at changes in connectivity on changes in firm performance where we measure the difference in connectivity and firm performance measures between years t_0 and t_{-1}, and also $t_{-1} - t_{-2}$ for firm performance (Andres 2013; Yermack, 1996).[8] Following prior research, we include changes in control variables ($t_0 - t_{-1}$) that may also determine connectivity changes. We include the change in size ln(*MV*), market-to-book ln(*MTB*), firm risk (*RISK*) and board size ln(*BSIZE*) to control for the impact of changes in size, growth opportunities, risk of a firms' operations, and size of the board. Year and industry dummies are included with standard errors clustered by firm.

Table 14 provides the estimates of the change regressions. The results show no siginificant association between firm performance changes and the contemporanous changes in connectivity. However, there is weak evidence that changes in past performance increases connectivity, mostly limited to the *Eigenvector* coefficients. This suggests that better past performance improves the boards connections to better connected boards, possibly through the firms board members being selected onto other boards or attracting better quality new directors. Of the controls, we observe the expected positive relationship between changes in board size and changes in board connectivity and observe a positive relationship between changes in firm risk and the aggregate connectivity measure. Across all model specifications, these relationships are significant at the 1% level. None of the other variables show consistent significance.

Overall the results strongly dismiss evidence that connected boards add value to firms. While the resource dependency theory argues that connected directors bring valuable resources to the firm that managers can

[8] Andres (2013) employs changes in board centrality measures on stock returns, and Yermack (1996) looks at changes in board size on stock returns. I include the four firm performance measures used in this study for a more robust conclusion. Additional to the controls used in the previous studies, I control for board size and risk. A change in board size is expected to have an effect on connectivity and a positive change in risk may prompt firms to increase connections in search for a stronger resource base.

exploit to improve firm performance, we find no evidence that this is the case. Rather, we find that either connected board members are undermining the monitoring role of directors, that they are bringing in poor quality information or that they are bringing in too much information for the board to deal with. These results are robust to alternative estimation methods, time periods, the inclusion of past firm performance or estimating the results using change variables, where the relationship becomes broadly insignificant.

[INSERT TABLE 14 HERE]

5. Conclusion

Resource dependency theory asserts that the board provides managers with additional resources, such as connections, experience, inference and counsel, which can be used to drive firm performance (Hillman & Dalziel, 2003; Pfeffer & Salancik, 1978). By extension, companies can obtain external resources through connections to other boards (Wasserman & Faust, 1994). Therefore, well-connected directors have been argued as adding value by being more able to fulfil the resource dependency role. Prior research has established that information flows between firms through multiple dimensions of board connectivity, however the findings to date do not provide conlusive evidence on the economic effect of being well connected. We contribute to this literature stream using four social network measures that capture different aspects of a board's connectedness (Freeman, 1979; Borgatti, 2005; Opsahl et al., 2010), the quantity (*Degree*), quality and speed (*Closeness*) of information, the ability to control the network flow (*Betweenness*), and the power to access more information through connections with the best-connected firms (*Eigenvector*). The results suggest that board connectivity plays no beneficial role. In contrast, connectivity is a board capital characteristic that results in negative firm performance.

The main results suggest more direct connections (*Degree*), which should provide more opportunity for information transmission, hinder good firm performance. Similarly, closer connections (*Closeness*), and connections providing firms more opportunity to control information flow (*Betweenness*) also fail to be beneficial. The ability to access information through links to other well-connected boards (*Eigenvector*) also appears to be costly. Thus irrespective of the type of connectivity, board connectivity appears to be more costly than beneficial. We perform a number of robustness tests including controlling for past performance, employing additional models, splitting the sample in two periods before and after the GFC occured, and also test for a collective effect of connectivity on firm performance. The results remain relatively consistent. We include changes on changes regressions to test for potential endogeneity and find some support that firms change their level of connectedness in response to changes in performance. The findings suggest more research needs to be conducted exploring why connectivity has a negative effect on firm performance.

References

Adams, R. B., & Ferreira, D. (2009). Women in the boardroom and their impact on governance and performance. *Journal of Financial Economics, 94*(2), 291-309.

Anderson, R. C., & Reeb, D. M. (2003). Founding-family ownership and firm performance: evidence from the S&P 500. *The Journal of Finance, 58*(3), 1301-1327.

Andres, C. (2008). Large shareholders and firm performance—An empirical examination of founding-family ownership. *Journal of Corporate Finance, 14*(4), 431-445.

Andres, C., Bongard, I., & Lehmann, M. (2013). Is busy really busy? Board governance revisited. *Journal of Business Finance & Accounting, 40*(9-10), 1221-1246.

Baker, S. H. (1973). Risk, leverage and profitability: an industry analysis. *The Review of Economics and Statistics, 55*(4), 503-507.

Banz, R. W. (1981). The relationship between return and market value of common stocks. *Journal of Financial Economics, 9*(1), 3-18.

Barnea, A., & Guedj, I. (2007). Director networks and firm governance. *Unpublished Manuscript, University of Texas–Austin*.

Baysinger, B. D., & Butler, H. N. (1985). Corporate governance and the board of directors: Performance effects of changes in board composition. *Journal of Law, Economics, & Organization, 1*(1), 101-124.

Bizjak, J., Lemmon, M., & Whitby, R. (2009). Option backdating and board interlocks. *Review of Financial Studies, 22*(11), 4821-4847.

Borgatti, S. P. (2005). Centrality and network flow. *Social networks, 27*(1), 55-71.

Chewning, E. G. J. r., & Harrell, A. M. (1990). The effect of information load on decision makers' cue utilization levels and decision quality in a financial distress decision task. *Accounting, Organizations and Society, 15*(6), 527-542.

Chiu, P.-C., Teoh, S. H., & Tian, F. (2012). Board interlocks and earnings management contagion. *The Accounting Review, 88*(3), 915-944.

Chung, K. H., & Pruitt, S. W. (1994). A simple approximation of Tobin's q. *Financial Management, 23*(3), 70-74.

Core, J. E., Holthausen, R. W., & Larcker, D. F. (1999). Corporate governance, chief executive officer compensation, and firm performance. *Journal of Financial Economics, 51*(3), 371-406.

Davis, G. F. (1991). Agents without principles? The spread of the poison pill through the intercorporate network. *Administrative science quarterly, 36*(4), 583-613.

Delmar, F., Davidsson, P., & William, W. B. (2003). Arriving at the high-growth firm. *Journal of business venturing, 18(2),* 189-216.

Dooley, P. C. (1969). The interlocking directorate. *The American Economic Review, 59*(3), 314-323.

Engelberg, J., Gao, P., & Parsons, C. A. (2012). Friends with money. *Journal of Financial Economics, 103*(1), 169-188.

Fama, E. F. (1980). Agency Problems and the Theory of the Firm. *The Journal of Political Economy, 88*(2), 288-307.

Fich, E. M. (2005). Are Some Outside Directors Better than Others? Evidence from Director Appointments by Fortune 1000 Firms. *The Journal of Business, 78*(5), 1943-1972.

Fich, E. M., & Shivdasani, A. (2006). Are busy boards effective monitors? *The Journal of Finance, 61*(2), 689-724.

Fich, E. M., & White, L. J. (2003). CEO compensation and turnover: the effects of mutually interlocked boards. *Wake Forest Law Review, 38*(3), 935-960.

Freeman, L. C. (1979). Centrality in social networks conceptual clarification. *Social networks, 1*(3), 215-239.

Haunschild, P. R. (1993). Interorganizational imitation: The impact of interlocks on corporate acquisition activity. *Administrative science quarterly, 38*(4), 564-592.

Hillman, A. J., & Dalziel, T. (2003). Boards of directors and firm performance: Integrating agency and resource dependence perspectives. *Academy of Management Review, 28*(3), 383-396.

Hillman, A. J., Withers, M. C., & Collins, B. J. (2009). Resource dependence theory: A review. *Journal of Management*. doi: 10.1177/0149206309343469

Hochberg, Y. V., Ljungqvist, A., & Lu, Y. (2007). Whom you know matters: Venture capital networks and investment performance. *The Journal of Finance, 62*(1), 251-301.

Horton, J., Millo, Y., & Serafeim, G. (2012). Resources or power? Implications of social networks on compensation and firm performance. *Journal of Business Finance & Accounting, 39*(3-4), 399-426.

Houston, J. F., Jiang, L., Lin, C., & Ma, Y. (2014). Political Connections and the Cost of Bank Loans. *Journal of Accounting Research, 52*(1), 193-243.

Kiel, G. C., & Nicholson, G. J. (2006). Multiple Directorships and Corporate Performance in Australian Listed Companies. *Corporate Governance: An International Review, 14*(6), 530-546.

Larcker, D. F., So, E. C., & Wang, C. C. (2013). Boardroom centrality and firm performance. *Journal of Accounting and Economics, 55*(2-3), 225-250.

Masulis, R. W., Wang, C., & Xie, F. (2012). Globalizing the boardroom—The effects of foreign directors on corporate governance and firm performance. *Journal of Accounting and Economics, 53*(3), 527-554. doi: 10.1016/j.jacceco.2011.12.003

Mizruchi, M. S. (1996). What do interlocks do? An analysis, critique, and assessment of research on interlocking directorates. *Annual review of sociology, 22*(August), 271-298. doi: 10.1146/annurev.soc.22.1.271

Non, M., & Franses, P. (2007). Interlocking boards and firm performance: evidence from a new panel database. *Working Paper, Available at SSRN 978189*.

O'Reilly, C. A. (1980). Individuals and information overload in organizations: is more necessarily better? *Academy of Management Journal, 23*(4), 684-696.

Omer, T. C., Shelley, M. K., & Tice, F. M. (2013). When do well-connected directors affect firm performance? *Working Paper, Texas A&M University*.

Opsahl, T., Agneessens, F., & Skvoretz, J. (2010). Node centrality in weighted networks: Generalizing degree and shortest paths. *Social networks, 32*(3), 245-251. doi: 10.1016/j.socnet.2010.03.006

Petersen, M. A. (2009). Estimating standard errors in finance panel data sets: Comparing approaches. *Review of Financial Studies, 22*(1), 435-480.

Pfeffer, J., & Salancik, G. R. (1978). *The external control of organizations: A resource dependence perspective*. New York: Harper and Row.

Rosenstein, S., & Wyatt, J. G. (1990). Outside directors, board independence, and shareholder wealth. *Journal of Financial Economics, 26*(2), 175-191.

Santos, R., Da Silveira, A., & Barros, L. (2009). Board interlocking in Brazil: Directors' participation in multiple companies and its effect on firm value. *Working Paper, University of Sao Paulo, Available at SSRN 1018796*.

Schoorman, F. D., Bazerman, M. H., & Atkin, R. S. (1981). Interlocking directorates: A strategy for reducing environmental uncertainty. *Academy of Management Review, 6*(2), 243-251.

Swain, M. R., & Haka, S. (2000). Effects of information load on capital budgeting decisions. *Behavoural Research in Accounting, 12*, 171-199.

Useem, M. (1984). *The inner circle: Large corporations and the rise of business political activity in the US and UK*: Oxford University Press.

Wasserman, S., & Faust, K. (1994). *Social network analysis: Methods and applications* (Vol. 8): Cambridge University Press.

Wooldridge, J. M. (2009). *Introductory Econometrics* (4 ed.). Mason, USA: South-Western Cengage Learning.

Yermack, D. (1996). Higher market valuation of companies with a small board of directors. *Journal of Financial Economics, 40*(2), 185-211.

Appendix I

Principal Components Analysis

Aggregate Connectivity (CONN) is constructed by reducing the information in the four connectivity measures into a component which accounts for the most variation in the data as possible. This component is an uncorrelated linear combination of the four connectivity measures, identified by decomposing the correlation matrix of the connectivity measures *Degree, Closeness, Betweenness* and *Eigenvector* and taking the first component with a corresponding eigenvector that has eigenvalue greater than 1. The PCA results for eigenvalues show that the eigenvalue for the first component (2.76) is much larger than than the second component (0.56) and accounts for 69% of the total variance. This indicates that the connectivity measures are unidimensional.

PCA Output:

Number of observations: 10559

Number of Components with eigenvalue>1: 1

Trace: 4

Rho: 0.6912

Rotation: (unrotated = principal)

Component	Eigenvalue	Difference	Proportion	Cumulative
Comp1	*2.76463*	*2.20041*	*0.6912*	*0.6912*
Comp2	0.564221	0.0432384	0.1411	0.8322
Comp3	0.520983	0.370818	0.1302	0.9625
Comp4	0.150164	.	0.0375	1

Principal components (eigenvectors)

Variable	Comp1	Unexplained
DEGREE	0.5696	0.1029
CLOSE	0.4796	0.3641
BETWEEN	0.4783	0.3674
EIGEN	0.4655	0.4009

Cronbach's Apha Validity Test

To test the validity and reliability of the connectivity measures used to construct the measure *Conn*, we compute Cronbach's Alpha using standardized variables (mean 0, standard deviation 1).

Cronbach's Alpha output:

Test scale = mean(standardized items)

Item	Obs	Sign	item-test correlation	item-rest correlation	average interitem correlation	alpha
DEGREE	10559	+	0.9406	0.8831	0.4585	0.7175
CLOSE	10559	+	0.7968	0.6337	0.6175	0.8288
BETWEEN	10559	+	0.797	0.6341	0.6172	0.8287
EIGEN	10559	+	0.7803	0.6077	0.6357	0.8396
Test scale					*0.5822*	*0.8479*

Interitem correlations (obs=10559 in all pairs)

	DEGREE	*CLOSE*	*BETWEEN*	*EIGEN*
DEGREE	1			
CLOSE	0.7334	1		
BETWEEN	0.7039	0.4698	1	
EIGEN	0.6805	0.4378	0.468	1

The test score 0.8479 is greater than 0.80, therefore the variables used are considered to be statistically reliable.

Figure 1: Graph Illustration of Connected Boards

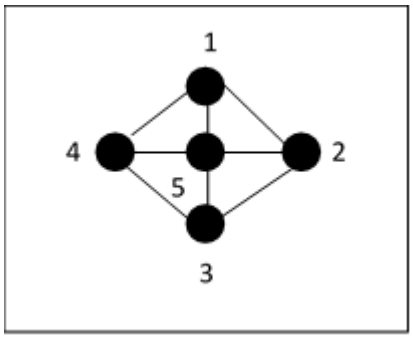
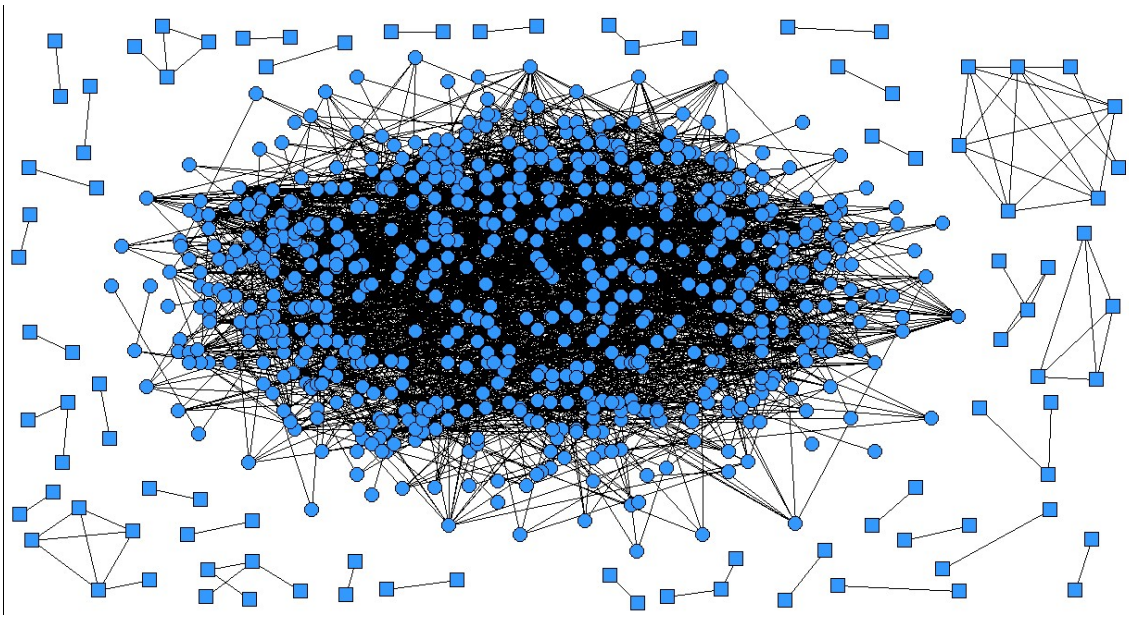


Figure 2: 2001 Aggregate Boardroom Network of Australian Listed Firms



Borgatti, S.P. (2002). *NetDraw: Graph Visualization Software.* Harvard: Analytic Technologies

Figure 2 presents a visual representation of the network of Australian listed firms in 2001. The figure demonstrates that Australia has a very significant main component, represented by the blue circles comprising 73.1% of the sample firms. These firms are all interconnected, where the firms on the fringes are less connected than those in the centre. The figure also contains a number of smaller networks, disconnected from the main component, represented by blue squares and ranging from two to eight firms. In total, 9.5% of the sample firms in 2001 are in such disconnected networks. The remaining 17.4% of firms, not shown in the figure, are isolates; firms with no directors in common with any other publicly listed board.

Table 1.
Sample and Descriptive Statistics of Boardroom Network Characteristics and Connectivity measures

Panel A: Boardroom network characteristics

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Total
N Firms	971	958	992	987	1,020	1,034	1,021	966	941	900	769	10,559
N Directors	4,884	4,838	4,835	4,746	4,887	5,021	5,093	4,808	4,633	4,459	3,943	52,147
N Directorates	6,199	6,179	6,283	6,062	6,219	6,361	6,346	5,917	5,654	5,392	4,673	65,285
Avg Directorships	1.27	1.28	1.30	1.28	1.27	1.27	1.25	1.23	1.22	1.21	1.19	1.25
Max Directorships	12	11	11	8	7	7	7	7	7	7	6	8.20
Max board size	21	18	19	20	16	17	17	16	17	16	17	17.4
Main (Largest)	73.1	74.1	74.5	72.2	71.8	72.7	70.0	65.2	65.1	64.7	57.6	69.5
Other components %	9.5	7.8	6.7	8.3	8.6	9.7	11.1	13.9	11.8	13.0	18.5	10.6
Isolated firms %	17.4	18.1	18.9	19.5	19.6	17.6	18.9	20.9	23.1	22.3	23.9	19.9

Panel B: Descriptive statistics of connectivity

	Mean	SD	P25	Median	P75	Skew	Obs
DEGREE	0.0034	0.0035	0.0010	0.0022	0.0050	1.647	10559
CLOSE	0.0957	0.0694	0.0013	0.1147	0.1495	-0.300	10599
BETWEEN	0.0025	0.0049	0.0000	0.0000	0.0030	3.9075	10599
EIGENVECTOR	0.0168	0.0424	0.000	0.0005	0.0101	4.3226	10599

Panel C: Sample averages (medians) of connectivity by year

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Total
DEGREE	0.0039	0.0040	0.0041	0.0037	0.0034	0.0033	0.0031	0.0030	0.0029	0.0028	0.0029	0.0034
	(0.0031)	(0.0031)	(0.0030)	(0.0030)	(0.0029)	(0.0019)	(0.0020)	(0.0021)	(0.0021)	(0.0022)	(0.0026)	(0.0022)
CLOSE	0.112	0.116	0.119	0.109	0.101	0.103	0.094	0.081	0.075	0.075	0.057	0.096
	(0.136)	(0.138)	(0.143)	(0.133)	(0.125)	(0.123)	(0.114)	(0.101)	(0.095)	(0.096)	(0.073)	(0.115)
BETWEEN	0.0025	0.0026	0.0025	0.0024	0.0026	0.0026	0.0025	0.0023	0.0027	0.0026	0.0026	0.00252
	(0.0002)	(0.0000)	(0.0003)	(0.0001)	(0.0002)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
EIGEN	0.0068	0.0194	0.0203	0.0170	0.0154	0.0164	0.0180	0.0173	0.0185	0.0184	0.0177	0.01682
	(0.0001)	(0.0013)	(0.0020)	(0.0007)	(0.0006)	(0.0007)	(0.0005)	(0.0003)	(0.0003)	(0.0006)	(0.0002)	(0.0005)

Presented here are various statistics for the sample of Australian listed firms from 2001 through 2011. Panel A displays annual network characteristics of the aggregate boardroom network. *Directors* include all directors and alternative directors. A directorship is defined here as a board position held by one director in the respective year. A component represents a subset of an entire network of a group of firms that are directly or indirectly connected. The main component is the largest group of firms directly or indirectly connected through shared directors. Isolated firms are those with no connections in the network. Panel B presents descriptive statistics for the connectivity measures *Degree*, *Closeness*, *Betweenness and Eigenvector* (see Equations (1), (2),(5) and (6) respectively in Section 3.1). *Degree* is defined as the number of first degree links from firm *i* to all other firms in the network; *Closeness* denotes the sum of the inversed shortest distances between firm *i* and all other directly and indirectly connected firms; and *Betweenness* is the number of times a firm occurs on the shortest path linking two other firms. All connectivity measures are normalised to represent the proportion of the maximum possible score of each measure. Panel D displays annual sample statistics of averages (medians) of the four centrality measures. All data are collected from Securities Industry Research Centre of Asia-Pacific (SIRCA) Corporate Governance Database.

Table 2.
Descriptive and Sample Statistics of Firm Performance

Panel A: Descriptive statistics of firm performance

	Mean	SD	Q25	Median	Q75	Skew	Obs
ROA	-0.059	0.409	-0.152	0.043	0.149	-2.179	10383
TQ	2.015	1.550	1.007	1.402	2.389	1.737	10214
TSR	0.171	0.758	-0.314	0.029	0.414	1.598	10201

Panel B: Sample averages (medians) of firm performance by year

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	TOTAL
ROA	-0.084	-0.084	-0.058	-0.024	-0.040	-0.044	-0.037	-0.058	-0.100	-0.071	-0.051	-0.059
	(0.040)	(0.024)	(0.053)	(0.064)	(0.061)	(0.057)	(0.054)	(0.037)	(0.005)	(0.039)	(0.036)	(0.043)
TQ	1.708	1.800	1.801	2.021	2.090	2.267	2.660	2.063	1.846	1.920	1.896	2.015
	(1.178)	(1.259)	(1.247)	(1.480)	(1.561)	(1.746)	(1.921)	(1.394)	(1.174)	(1.275)	(1.285)	(1.402)
TSR	-0.016	0.011	0.464	0.239	0.146	0.438	0.275	-0.527	0.790	0.184	-0.200	0.171
	(-0.050)	(-0.055)	(0.262)	(0.167)	(0.054)	(0.231)	(0.087)	(-0.597)	(0.493)	(0.001)	(-0.227)	(0.029)

Presented here are firm performance summary statistics of the sample of Australian listed firms from 2001 through 2011, Panel A provides descriptive statistics for each of the firm performance measures. *ROA* is measured as earnings before interest, tax, depreciation and amortization (EBITDA) scaled by the book value of average total assets; *TQ* is total liabilities + preferred stock + market capitalisation (fye) + minority interests / total assets; *TSR* represents the annual total stock return measured at calendar year-end including dividends. Panel B displays the sample averages (medians) of firm performance measures for each year. All measures are defined as per Panel A above. Accounting data are collected at fiscal year-end and measured in year *t*. All data are collected from Thomson Reuters Datastream.

Table 3.
Descriptive and Sample Statistics of Firm-Level and Governance Characteristics

Descriptive statistics of firm and governance characteristics							
	Mean	SD	P25	Median	P75	Skew	Obs
MV($M)	828.37	2939.9	14.41	64.79	294.26	6.05	10214
AGE(years)	10.92	7.71	5.46	9.53	14.54	1.22	10324
LEV	0.178	0.255	0.000	0.087	0.277	2.962	10468
RISK	0.610	0.330	0.320	0.542	0.818	1.042	10185
BSIZE	6.183	2.370	5.000	6.000	7.000	1.124	10599
%BUSY	0.143	0.181	0.000	0.100	0.250	1.445	10559
FEM	0.043	0.089	0.000	0.000	0.000	2.453	10555
OUT	0.386	0.301	0.000	0.400	0.625	0.056	9760
TEN(years)	6.033	3.745	3.289	5.149	7.788	1.371	10559
DUAL	0.072	0.259	0.000	0.000	0.000	3.350	10559

Presented here are descriptive statistics of firm-level and governance characteristics for the sample of Australian listed firms over 2001 through 2011. *MV* represents firm size, the market capitalisation measured at fiscal year-end expressed in millions (common shares outstanding*closing stock price); *LEV* is firm leverage, long + short term debt/total assets; *AGE* is firm age, the number of prior years the firm appears in Thompson Reuters Datastream; *RISK* represents firm risk, the firms' stock return volatility, measured as the standard deviation of the previous calendar year's monthly stock return; *BSIZE* represents board size, the total number of directors and alternative directors on the board; *%BUSY* is the ratio of the number of busy directors on the board to board size, where busy is defined as a director who holds 3 or more directorships in the respective year; *FEM* represents the ratio of female directors to board size; *OUT* represents the ratio of outsiders to board size where an outsider is defined as a director who is a non-executive and independent from the firm; *TEN* is the average tenure of the board, measured by the total number of years served by all current directors on the board divided by board size; *DUAL* is duality, which is a dummy variable that equals 1 if the CEO is chairman of the board, and 0 otherwise.

Table 4.
Pearson Pairwise Correlations

	ROA	*TQ*	*TSR*	*DEGREE*	*CLOSE*	*BETWEEN*	*EIGEN*	*MV*	*LEV*	*AGE*	*RISK*	*BSIZE*	*BUSY*	*FEM*	*OUT*	*TEN*	*DUAL*
ROA	1																
TQ	-0.265	1															
TSR	0.185	0.109	1														
DEGREE	0.140	-0.066	0.042	1													
CLOSE	0.163	-0.050	0.066	0.734	1												
BETWEEN	0.088	-0.032	0.030	0.709	0.474	1											
EIGEN	0.134	-0.076	0.015	0.693	0.452	0.479	1										
MV	0.403	0.124	0.138	0.483	0.424	0.355	0.439	1									
LEV	-0.005	-0.058	-0.065	0.077	0.065	0.054	0.077	0.086	1								
AGE	0.023	-0.105	-0.011	0.126	0.014	0.116	0.135	0.133	0.047	1							
RISK	-0.422	0.117	-0.039	-0.276	-0.300	-0.167	-0.243	-0.546	-0.071	-0.042	1						
BSIZE	0.170	-0.081	0.000	0.446	0.413	0.353	0.328	0.537	0.124	0.036	-0.303	1					
BUSY	0.026	-0.023	0.007	0.444	0.247	0.295	0.463	0.103	0.018	0.066	-0.064	-0.025	1				
FEM	0.102	-0.032	-0.002	0.165	0.149	0.119	0.329	0.212	0.042	0.028	-0.135	0.208	0.028	1			
OUT	0.140	0.001	0.023	0.198	0.137	0.184	0.196	0.378	0.071	0.159	-0.219	0.168	0.050	0.162	1		
TEN	0.239	-0.114	0.077	-0.002	-0.029	-0.017	0.218	0.172	0.057	0.351	-0.281	-0.111	0.019	0.052	0.143	1	
DUAL	-0.045	0.023	-0.008	-0.134	-0.139	-0.098	0.076	-0.102	-0.006	0.029	0.070	-0.118	-0.028	-0.016	-0.092	0.052	1.000

Provided here are Pearson pairwise correlation coefficients between the dependant variables *ROA*, *TQ*, *TSR* and independent variables used in Equation (7). The sample includes a total of 10599 firm-year observations of Australian listed firms over 2001 through 2011. Firms with missing observations are excluded from the tests. *DEGREE*, *CLOSE*, *BETWEEN* and *EIGEN* denote the connectivity measure *Degree*, *Closeness*, *Betweenness* and *Eigenvector* defined at Equations (1), (2), (5) and (6) respectively, in Section 3.1. Firm Performance measures and control variables are defined in Section 3.2. Accounting and corporate governance data are collected at fiscal year-end in year *t*. Accounting and stock market data are obtained from Thomson Reuters Datastream. Corporate governance data are collected from Securities Industry Research Centre of Asia-Pacific (SIRCA) Corporate Governance Database.

Table 5.
One-Year ahead Firm Performance across Quintiles of Connectivity

Panel A: Portfolios formed on *Degree*								
	Lo	2	3	4	Hi	Hi-Lo	T-Stat	
DEGREE	0.00005	0.00114	0.00243	0.00436	0.00899	0.00894	126.26	***
ROA	-0.089	-0.116	-0.088	-0.035	0.042	0.132	11.230	***
TQ	2.034	2.139	2.109	1.956	1.697	-0.336	-7.536	***
TSR	0.179	0.156	0.184	0.180	0.134	-0.044	-2.014	**
Obs	2117	2110	2109	2110	2113			
Panel B: Portfolios formed on *Closeness*								
	Lo	2	3	4	Hi	Hi-Lo	T-Stat	
CLOSE	0.00005	0.04839	0.11625	0.14153	0.17235	0.17230	294.54	***
ROA	-0.092	-0.176	-0.107	-0.003	0.097	0.189	17.860	***
TQ	2.047	2.308	2.090	1.837	1.647	-0.400	-9.162	***
TSR	0.174	0.172	0.200	0.163	0.124	-0.050	-2.408	**
Obs	2117	2110	2109	2110	2113			
Panel C: Portfolios formed on *Betweenness*								
	Lo	2	3	4	Hi	Hi-Lo	T-Stat	
BETWEEN	0.00000	0.00000	0.00024	0.00226	0.01010	0.01010	69.94	***
ROA	-0.092	-0.159	-0.016	-0.026	0.008	0.100	8.262	***
TQ	2.047	2.249	1.897	1.918	1.821	-0.226	-4.882	***
TSR	0.197	0.216	0.166	0.148	0.153	-0.044	-0.018	
Obs	2117	2110	2109	2110	2113			
Panel D: Portfolios formed on *Eigenvector*								
	Lo	2	3	4	Hi	Hi-Lo	T-Stat	
EIGEN	0.00000	0.00002	0.00086	0.00826	0.07493	0.07493	50.2856	***
ROA	-0.102	-0.163	-0.105	0.004	0.085	0.187	16.809	***
TQ	2.137	2.212	2.085	1.853	1.645	-0.492	-10.964	***
TSR	0.173	0.169	0.219	0.150	0.121	-0.052	-2.541	***
Obs	2117	2110	2109	2110	2113			

This table presents average firm performance measured in year *t+1 f*or quintiles of connectivity. The sample includes Australian listed firms for the period 2001 to 2011. Panels A, B, C and D provide the averages of firm performance measured for portfolios ranked by *Degree*, *Closeness*, *Betweenness* and *Eigenvector* respectively. Descriptions of the connectivity measures are provided in Section 3.1 and defined at Equations (1), (2), (5) and (6). Lo and Hi represent quintile portfolios of the least connected and most connected firms respectively. *ROA*, *TQ* and *TSR* denote firm performance and are described in Section 3.2. Differences in firm performance between the highest (5) and lowest (1) portfolios are tested for significance using the two sample unpaired mean comparison test assuming unequal variances.

Table 6.
Pooled OLS Regression Estimates of Firm Performance on Degree.

Panel A: Univariate regressions of firm performance on *Degree*

	ROA		*TQ*		*TSR*	
	(1) Current	(2) One-Year	(3) Current	(4) One-Year	(5) Current	(6) One-Year
DEGREE	15.537***	16.282***	-13.263***	-12.857***	8.486***	9.331***
	(9.070)	(9.732)	(-4.462)	(-4.248)	(5.298)	(5.689)
α	-0.112***	-0.112***	0.524***	0.508***	-0.076***	-0.077***
	(-9.052)	(-9.028)	(27.592)	(26.394)	(-8.094)	(-7.938)
Obs	10383	10017	10214	9904	10201	10411
R^2	0.018	0.012	0.005	0.005	0.002	0.002
p(F)	0	0	0	0	0	0

Panel B: Multivariate regression estimates of firm performance on *Degree*

	ROA		*TQ*		*TSR*	
	(1) Current	(2) One-Year	(3) Current	(4) One-Year	(5) Current	(6) One-Year
DEGREE	-7.658***	-6.515***	-14.728***	-8.223**	-4.536**	2.138
	(-3.596)	(-3.148)	(-3.850)	(-2.107)	(-2.094)	(0.915)
MV	0.059***	0.050***	0.129***	0.075***	0.074***	-0.004
	(14.54)	(12.08)	(17.88)	(9.92)	(17.95)	(-0.963)
LEV	-0.206***	-0.055	0.048	0.032	-0.291***	-0.180***
	(-3.815)	(-0.880)	(0.570)	(0.363)	(-8.358)	(-4.463)
AGE	-0.031***	-0.027***	-0.071***	-0.067***	-0.041***	-0.021**
	(-3.248)	(-2.784)	(-4.050)	(-3.698)	(-4.677)	(-2.074)
RISK	-0.233***	-0.213***	0.398***	0.308***	0.042	-0.165***
	(-10.323)	(-8.862)	(12.194)	(9.129)	(1.623)	(-6.208)
BSIZE	-0.045**	-0.013	-0.303***	-0.208***	-0.172***	-0.022
	(-2.212)	(-0.621)	(-8.737)	(-5.620)	(-7.881)	(-0.959)
BUSY	0.007	-0.011	-0.013	0.000	-0.083***	-0.019
	(0.344)	(-0.539)	(-0.317)	(0.010)	(-3.200)	(-0.691)
FEM	0.073	0.056	-0.096	-0.021	-0.124	0.198***
	(1.056)	(0.792)	(-0.648)	(-0.1347)	(-1.512)	(2.610)
OUT	0.000	0.029	-0.125***	-0.069*	-0.015	0.076***
	(-0.016)	(1.275)	(-3.313)	(-1.7364)	(-0.655)	(3.218)
TEN	0.083***	0.074***	-0.092***	-0.060***	0.065***	0.054***
	(7.104)	(5.856)	(-4.232)	(-2.6700)	(5.255)	(4.396)
DUAL	-0.025	-0.031	0.053	0.054	-0.030	-0.040
	(-0.946)	(-1.155)	(1.202)	(1.137)	(-1.308)	(-1.619)
α	-0.453***	-0.555***	-0.370***	-0.161	-0.985***	-0.041
	(-5.853)	(-6.716)	(-2.718)	(-1.190)	(-12.473)	(-0.477)
Obs	9154	8812	9202	8813	9206	9206
R^2	0.279	0.243	0.239	0.184	0.349	0.297
p(F)	0.000	0.000	0.000	0.000	0.000	0.000

Provided here are the main results for testing ***Hypothesis 1A.*** Pooled OLS regressions are estimated using an unbalanced sample of Australian firms listed between 2001 and 2011. Panel A reports univariate regression estimates of firm performance on *Degree*. *DEGREE* denotes the connectivity measure, defined at Equation (1) in Section 3.1. Panel B reports multivariate regression estimates of firm performance on *Degree* using the model defined at Equation (7).. *ROA, TQ* and *TSR* denote return on assets, Tobin's Q and total shareholder returns respectively and are described in Section 3.2. Control variables are described in Section 3.2. Time and industry effects are controlled for through dummy variables. Accounting and corporate governance data are collected at fiscal year-end. Accounting and stock market data are obtained from Thomson Reuters Datastream and Corporate governance data are collected from Securities Industry Research Centre of Asia-Pacific (SIRCA) Corporate Governance Database. T-statistics are displayed in parenthesis below each coefficient estimate and are based upon robust standard errors, clustered by firm. Significance levels are denoted by *, **, and *** for 10%, 5%, and 1% confidence levels, respectively.

Table 7.
Pooled OLS Regression Estimates of Firm Performance on Closeness

Panel A: Univariate regression estimates of firm performance on *Closeness*

	ROA		*TQ*		*TSR*	
	(1)	(2)	(3)	(4)	(5)	(6)
	Current	One-Year	Current	One-Year	Current	One-Year
CLOSE	0.925***	0.955***	-0.582***	-0.457***	0.648***	0.617***
	(9.811)	(10.044)	(-3.602)	(-2.792)	(7.027)	(6.594)
α	-0.147***	-0.148***	0.534***	0.508***	-0.109***	-0.104***
	(-9.920)	(-9.859)	(23.64)	(22.27)	(-9.276)	(-8.348)
Obs	10383	10017	10214	9904	10201	10411
R^2	0.025	0.027	0.004	0.002	0.004	0.004
p(F)	0.000	0.000	0.000	0.005	0.000	0.000

Panel B: Multivariate regression estimates of firm performance on *Closeness*

	ROA		*TQ*		*TSR*	
	(1)	(2)	(3)	(4)	(5)	(6)
	Current	One-Year	Current	One-Year	Current	One-Year
CLOSE	-0.131	-0.113	-0.600***	-0.378**	-0.330***	0.137
	(-1.432)	(-1.212)	(-3.552)	(-2.145)	(-3.034)	(1.167)
MV	0.056***	0.048***	0.127***	0.074***	0.075***	-0.004
	(13.87)	(11.43)	(18.04)	(10.03)	(18.23)	(-1.028)
LEV	-0.207***	-0.056	0.046	0.031	-0.292***	-0.179***
	(-3.812)	(-0.885)	(0.536)	(0.348)	(-8.412)	(-4.444)
AGE	-0.034***	-0.030***	-0.076***	-0.069***	-0.042***	-0.021**
	(-3.520)	(-3.038)	(-4.320)	(-3.838)	(-4.860)	(-2.037)
RISK	-0.233***	-0.213***	0.393***	0.305***	0.039	-0.164***
	(-10.331)	(-8.853)	(12.040)	(9.039)	(1.507)	(-6.156)
BSIZE	-0.059***	-0.025	-0.316***	-0.214***	-0.170***	-0.022
	(-3.061)	(-1.248)	(-9.237)	(-5.854)	(-8.007)	(-0.966)
BUSY	-0.030*	-0.042**	-0.065*	-0.026	-0.091***	-0.014
	(-1.652)	(-2.270)	(-1.648)	(-0.676)	(-3.842)	(-0.544)
FEM	0.065	0.049	-0.099	-0.023	-0.120	0.197***
	(0.940)	(0.692)	(-0.668)	(-0.145)	(-1.469)	(2.593)
OUT	-0.006	0.024	-0.129***	-0.070*	-0.013	0.076***
	(-0.271)	(1.073)	(-3.394)	(-1.768)	(-0.588)	(3.215)
TEN	0.084***	0.075***	-0.091***	-0.060***	0.064***	0.055***
	(7.155)	(5.911)	(-4.206)	(-2.670)	(5.220)	(4.404)
DUAL	-0.021	-0.028	0.052	0.052	-0.033	-0.039
	(-0.815)	(-1.053)	(1.171)	(1.099)	(-1.457)	(-1.561)
α	-0.406***	-0.410***	-0.324**	-0.126	-0.990***	-0.041
	(-5.285)	(-5.241)	(-2.404)	(-0.954)	(-12.775)	(-0.491)
Obs	9154	8812	9202	8813	9206	9206
R^2	0.277	0.242	0.238	0.184	0.350	0.297
p(F)	0.000	0.000	0.000	0.000	0.000	0.000

Provided here are the main results for testing ***Hypothesis 1B.*** Pooled OLS regressions are estimated using an unbalanced sample of Australian firms listed between 2001 and 2011. Panel A reports univariate regression estimates of firm performance on *Closeness*. *CLOSE* denotes the connectivity measure *Closeness*, defined at Equation (2) in Section 3.1. Panel B reports multivariate regression estimates of firm performance on *Closeness* using the model defined at Equation (7). *ROA, TQ* and *TSR* denote return on assets, Tobin's Q and total shareholder returns respectively and are described in Section 3.2. Control variables are described in Section 3.2. Time and industry effects are controlled for through dummy variables. Accounting and corporate governance data are collected at fiscal year-end. Accounting and stock market data are obtained from Thomson Reuters Datastream and Corporate governance data are collected from Securities Industry Research Centre of Asia-Pacific (SIRCA) Corporate Governance Database. T-statistics are displayed in parenthesis below each coefficient estimate and are based upon robust standard errors, clustered by firm. Significance levels are denoted by *, **, and *** for 10%, 5%, and 1% confidence levels, respectively.

Table 8.
Pooled OLS Regression Estimates of Firm Performance on Betweenness.

Panel A: Univariate regression estimates of firm performance on *Betweenness*

	ROA		*TQ*		*TSR*	
	(1)	(2)	(3)	(4)	(5)	(6)
	Current	One-Year	Current	One-Year	Current	One-Year
BETWEEN	6.279***	7.372***	-4.525**	-4.616**	4.267***	3.402***
	(5.363)	(6.900)	(-2.508)	(-2.536)	(3.285)	(2.713)
α	-0.075***	-0.076***	0.490***	0.476***	-0.058***	-0.054***
	(-7.397)	(-7.430)	(31.864)	(30.419)	(-7.266)	(-6.814)
Obs	10383	10017	10214	9904	10201	10411
Adj-R Sq	0.006	0.008	0.001	0.001	0.001	0.001
F Stat	28.77	47.61	6.29	6.43	10.79	7.36
p(F)	0.000	0.000	0.012	0.011	0.001	0.007

Panel B: Multivariate regression estimates of firm performance on *Betweenness*

	ROA		*TQ*		*TSR*	
	(1)	(2)	(3)	(4)	(5)	(6)
	Current	One-Year	Current	One-Year	Current	One-Year
BETWEEN	-2.002*	-2.112**	-4.061**	-0.995	-0.044	1.578
	(-1.844)	(-1.970)	(-2.323)	(-0.572)	(-0.038)	(1.134)
MV	0.056***	0.048***	0.124***	0.072***	0.072***	-0.004
	(14.27)	(11.83)	(17.89)	(9.85)	(17.71)	(-0.917)
LEV	-0.205***	-0.055	0.049	0.032	-0.291***	-0.180***
	(-3.801)	(-0.872)	(0.572)	(0.359)	(-8.348)	(-4.482)
AGE	-0.033***	-0.029***	-0.076***	-0.070***	-0.043***	-0.021**
	(-3.460)	(-2.959)	(-4.295)	(-3.869)	(-4.903)	(-2.074)
RISK	-0.232***	-0.212***	0.399***	0.308***	0.042	-0.165***
	(-10.274)	(-8.831)	(12.196)	(9.128)	(1.628)	(-6.214)
BSIZE	-0.057***	-0.022	-0.326***	-0.225***	-0.183***	-0.022
	(-2.947)	(-1.082)	(-9.605)	(-6.224)	(-8.632)	(-0.976)
BUSY	-0.026	-0.036**	-0.075*	-0.041	-0.108***	-0.015
	(-1.380)	(-1.978)	(-1.874)	(-1.043)	(-4.526)	(-0.607)
FEM	0.064	0.049	-0.112	-0.034	-0.132	0.199***
	(0.927)	(0.696)	(-0.759)	(-0.214)	(-1.598)	(2.623)
OUT	-0.005	0.025	-0.134***	-0.075*	-0.019	0.076***
	(-0.257)	(1.104)	(-3.545)	(-1.906)	(-0.857)	(3.216)
TEN	0.084***	0.075***	-0.090***	-0.059***	0.065***	0.054***
	(7.136)	(5.891)	(-4.160)	(-2.607)	(5.309)	(4.411)
DUAL	-0.020	-0.027	0.062	0.060	-0.026	-0.041
	(-0.764)	(-1.016)	(1.388)	(1.254)	(-1.148)	(-1.646)
α	-0.409***	-0.417***	-0.288**	-0.121	-0.947***	-0.043
	(-5.457)	(-5.448)	(-2.179)	(-0.907)	(-12.187)	(-0.510)
Obs	9154	8812	9202	8813	9206	9206
R^2	0.277	0.242	0.236	0.183	0.350	0.297
p(F)	0.000	0.000	0.000	0.000	0.000	0.000

Provided here are the main results for testing ***Hypothesis 1C.*** Pooled OLS regressions are estimated using an unbalanced sample of Australian firms listed between 2001 and 2011. Panel A reports univariate regression estimates of firm performance on *Betweenness*. *BETWEEN* denotes the connectivity measure *Betweenness*, defined at Equation (5) in Section 3.1. Panel B reports multivariate regression estimates of firm performance on *Betweenness* using the model defined at Equation (7). *ROA*, *TQ* and *TSR* denote return on assets, Tobin's Q and total shareholder returns respectively and are described in Section 3.2. Control variables are described in Section 3.2. Time and industry effects are controlled for through dummy variables. Accounting and corporate governance data are collected at fiscal year-end. Accounting and stock market data are obtained from Thomson Reuters Datastream and Corporate governance data are collected from Securities Industry Research Centre of Asia-Pacific (SIRCA) Corporate Governance Database. T-statistics are displayed in parenthesis below each coefficient estimate and are based upon robust standard errors, clustered by firm. Significance levels are denoted by *, **, and *** for 10%, 5%, and 1% confidence levels, respectively.

Table 9.
Pooled OLS Regression Estimates of Firm Performance on Eigenvector.

Panel A: Univariate regression estimates of firm performance on *Eigenvector*

	ROA		*TQ*		*TSR*	
	(1)	(2)	(3)	(4)	(5)	(6)
	Current	One-Year	Current	One-Year	Current	One-Year
EIGEN	1.165***	1.213***	-1.134***	-1.172***	0.224	0.379**
	(8.676)	(9.452)	(-5.713)	(-5.895)	-1.534	-2.44
α	-0.078***	-0.078***	0.498***	0.484***	-0.051***	-0.051***
	(-7.965)	(-7.822)	-33.464	-32.094	(-6.681)	(-6.823)
Obs	10383	10017	10214	9904	10201	10411
R^2	0.015	0.016	0.006	0.006	0.000	0.001
F Stat	75.28	89.33	32.64	34.75	2.35	5.95
p(F)	0.000	0.000	0.000	0.000	0.125	0.015

Panel B: Multivariate regression estimates of firm performance on *Eigenvector*

	ROA		*TQ*		*TSR*	
	(1)	(2)	(3)	(4)	(5)	(6)
	Current	One-Year	Current	One-Year	Current	One-Year
EIGEN	-0.570***	-0.406***	-1.339***	-0.765***	-0.832***	-0.010
	(-4.864)	(-3.794)	(-6.476)	(-3.611)	(-5.885)	(-0.056)
MV	0.059***	0.050***	0.130***	0.076***	0.077***	-0.003
	(14.70)	(12.07)	(18.44)	(10.20)	(18.51)	(-0.734)
LEV	-0.206***	-0.056	0.048	0.031	-0.291***	-0.179***
	(-3.827)	(-0.888)	(0.563)	(0.353)	(-8.370)	(-4.466)
AGE	-0.032***	-0.029***	-0.072***	-0.067***	-0.040***	-0.020**
	(-3.311)	(-2.886)	(-4.107)	(-3.721)	(-4.551)	(-1.996)
RISK	-0.231***	-0.211***	0.402***	0.310***	0.044*	-0.165***
	(-10.255)	(-8.809)	(12.305)	(9.195)	(1.711)	(-6.212)
BSIZE	-0.055***	-0.023	-0.320***	-0.217***	-0.171***	-0.016
	(-2.951)	(-1.179)	(-9.515)	(-6.099)	(-8.148)	(-0.738)
BUSY	-0.007	-0.027	-0.028	-0.007	-0.066***	-0.006
	(-0.401)	(-1.420)	(-0.716)	(-0.176)	(-2.771)	(-0.237)
FEM	0.085	0.062	-0.063	-0.003	-0.096	0.202***
	(1.225)	(0.881)	(-0.428)	(-0.017)	(-1.184)	(2.658)
OUT	-0.003	0.025	-0.129***	-0.071*	-0.012	0.078***
	(-0.158)	(1.119)	(-3.438)	(-1.794)	(-0.561)	(3.323)
TEN	0.084***	0.075***	-0.089***	-0.058***	0.065***	0.054***
	(7.189)	(5.936)	(-4.146)	(-2.614)	(5.341)	(4.378)
DUAL	-0.022	-0.028	0.057	0.056	-0.031	-0.042*
	(-0.840)	(-1.048)	(1.285)	(1.176)	(-1.377)	(-1.701)
α	-0.437***	-0.431***	-0.360***	-0.225	-1.018***	-0.020
	(-5.821)	(-5.621)	(-2.704)	(-1.622)	(-12.972)	(-0.249)
Obs	9154	8812	9202	8813	9206	9206
R^2	0.279	0.243	0.241	0.185	0.351	0.297
p(F)	0.000	0.000	0.000	0.000	0.000	0.000

Provided here are the main results for testing ***Hypothesis 1D.*** Pooled OLS regressions are estimated using an unbalanced sample of Australian firms listed between 2001 and 2011. Panel A reports univariate regression estimates of firm performance on *Eigenvector*. *EIGEN* denotes the connectivity measure *Eigenvector*, defined at Equation (6) in Section 3.1. Panel B reports multivariate regression estimates of firm performance on *Eigenvector* using the model defined at Equation (7). *ROA*, *TQ* and *TSR* denote return on assets, Tobin's Q and total shareholder returns respectively and are described in Section 3.2. Control variables are described in Section 3.2. Time and industry effects are controlled for through dummy variables. Accounting and corporate governance data are collected at fiscal year-end. Accounting and stock market data are obtained from Thomson Reuters Datastream and Corporate governance data are collected from Securities Industry Research Centre of Asia-Pacific (SIRCA) Corporate Governance Database. T-statistics are displayed in parenthesis below each coefficient estimate and are based upon robust standard errors, clustered by firm. Significance levels are denoted by *, **, and *** for 10%, 5%, and 1% confidence levels, respectively.

Table 10.
Pooled OLS Regression Estimates of Firm Performance on Aggregate Connectivity.

Panel A: Univariate regressions of firm performance on *Aggregate Connectivity*

	ROA		*TQ*		*TSR*	
	(1) Current	(2) One-Year	(3) Current	(4) One-Year	(5) Current	(6) One-Year
CONN	0.036***	0.038***	-0.029***	-0.027***	0.019***	0.02***
	(9.881)	(10.845)	(-4.565)	(-4.276)	(5.402)	(5.364)
α	-0.059***	-0.057***	0.479***	0.465***	-0.047***	-0.045***
	(-6.676)	(-6.432)	-34.677	-33.141	(-6.901)	(-6.720)
Obs	10383	10017	10214	9904	10201	10411
R Sq	0.021	0.025	0.006	0.005	0.002	0.002
p(F)	0.000	0.000	0.000	0.000	0.000	0.000

Panel B: Multivariate regression estimates of firm performance on *Aggregate Connectivity*

	ROA		*TQ*		*TSR*	
	(1) Current	(2) One-Year	(3) Current	(4) One-Year	(5) Current	(6) One-Year
CONN	-0.015***	-0.013***	-0.036***	-0.019**	-0.016***	0.005
	(-3.650)	(-3.216)	(-4.820)	(-2.529)	(-3.549)	(1.038)
MV	0.059***	0.050***	0.131***	0.076***	0.076***	-0.005
	(14.55)	(12.02)	(18.13)	(10.02)	(18.16)	(-1.016)
LEV	-0.206***	-0.055	0.048	0.032	-0.290***	-0.180***
	(-3.813)	(-0.879)	(0.573)	(0.362)	(-8.357)	(-4.462)
AGE	-0.031***	-0.028***	-0.071***	-0.067***	-0.040***	-0.021**
	(-3.301)	(-2.840)	(-4.041)	(-3.698)	(-4.604)	(-2.083)
RISK	-0.233***	-0.213***	0.398***	0.307***	0.042	-0.165***
	(-10.311)	(-8.858)	(12.210)	(9.128)	(1.609)	(-6.204)
BSIZE	-0.046**	-0.014	-0.297***	-0.206***	-0.165***	-0.023
	(-2.317)	(-0.702)	(-8.605)	(-5.593)	(-7.642)	(-0.996)
BUSY	-0.001	-0.018	-0.010	0.000	-0.071***	-0.019
	(-0.025)	(-0.917)	(-0.249)	(0.006)	(-2.817)	(-0.732)
FEM	0.078	0.060	-0.078	-0.012	-0.113	0.196**
	(1.124)	(0.845)	(-0.526)	(-0.078)	(-1.386)	(2.566)
OUT	0.000	0.028	-0.121***	-0.067*	-0.011	0.076***
	(-0.016)	(1.267)	(-3.214)	(-1.695)	(-0.501)	(3.193)
TEN	0.083***	0.074***	-0.092***	-0.060***	0.064***	0.055***
	(7.110)	(5.864)	(-4.256)	(-2.683)	(5.222)	(4.400)
DUAL	-0.025	-0.031	0.050	0.052	-0.033	-0.039
	(-0.948)	(-1.155)	(1.130)	(1.105)	(-1.439)	(-1.597)
α	-0.476***	-0.469***	-0.458***	-0.262*	-1.038***	0.007
	(-6.022)	(-5.879)	(-3.280)	(-1.845)	(-12.812)	(0.087)
Obs	9154	8812	9202	8813	9206	9206
R Sq	0.278	0.243	0.240	0.184	0.350	0.297
p(F)	0.000	0.000	0.000	0.000	0.000	0.000

Pooled OLS regressions are estimated using an unbalanced sample of Australian firms listed between 2001 and 2011. Panel A reports univariate regression estimates of firm performance on aggregate connectivity (*CONN*). *CONN* denotes the connectivity measure *Aggregate Connectivity*, constructed using PCA. Panel B reports multivariate regression estimates of firm performance on Aggregate *Connectivity* using the model defined at Equation (7). *ROA, TQ* and *TSR* denote return on assets, Tobin's Q and total shareholder returns respectively and are described in Section 3.2. Control variables are described in Section 3.2. Time and industry effects are controlled for through dummy variables. Accounting and corporate governance data are collected at fiscal year-end. Accounting and stock market data are obtained from Thomson Reuters Datastream and Corporate governance data are collected from Securities Industry Research Centre of Asia-Pacific (SIRCA) Corporate Governance Database. T-statistics are displayed in parenthesis below each coefficient estimate and are based upon robust standard errors, clustered by firm. Significance levels are denoted by *, **, and *** for 10%, 5%, and 1% confidence levels, respectively.

Table 11.
Dynamic Model: Pooled OLS Regression Estimates of Firm Performance on Connectivity

	ROA (1)	*TQ* (2)	*TSR* (3)	*ROA* (4)	*TQ* (5)	*TSR* (6)	*ROA* (7)	*TQ* (8)	*TSR* (9)	*ROA* (10)	*TQ* (11)	*TSR* (12)	*ROA* (13)	*TQ* (14)	*TSR* (15)
DEGREE	-4.204***	-6.313***	-4.817**												
	(-3.266)	(-3.449)	(-2.148)												
CLOSE				-0.151**	-0.326***	-0.322***									
				(-2.482)	(-3.892)	(-2.859)									
BETWEEN							-1.250*	-0.859	0.096						
							(-1.754)	(-0.858)	(0.082)						
EIGEN										-0.409***	-0.623***	-0.87***			
										(-4.987)	(-5.869)	(-5.860)			
CONN													(0.010)***	(0.016)***	(0.016)**
													(-3.991)	(-4.260)	(-3.469)
MV	0.035***	0.062***	0.076***	0.035***	0.062***	0.077***	0.034***	0.060***	0.074***	0.036***	0.063***	0.079***	0.036***	0.063***	0.078**
	(11.73)	(15.05)	(16.58)	(11.35)	(15.33)	(16.78)	(11.36)	(15.00)	(16.35)	-11.835	-15.479	-17.096	-11.818	-15.157	-16.722
LEV	-0.160***	0.078**	-0.306***	-0.160***	0.077**	-0.307***	-0.159***	0.078**	-0.306***	-0.16***	0.078**	-0.306***	-0.159***	0.078**	-0.305**
	(-4.633)	(2.042)	(-8.585)	(-4.634)	(2.006)	(-8.644)	(-4.621)	(2.044)	(-8.563)	(-4.640)	-2.033	(-8.604)	(-4.637)	-2.041	(-8.591)
AGE	-0.009	-0.026***	-0.039***	-0.010*	-0.027***	-0.040***	-0.010*	-0.028***	-0.041***	-0.009	-0.025***	-0.037***	-0.009	-0.025***	-0.038**
	(-1.517)	(-3.291)	(-3.760)	(-1.751)	(-3.538)	(-3.915)	(-1.723)	(-3.596)	(-3.997)	(-1.513)	(-3.279)	(-3.613)	(-1.499)	(-3.260)	(-3.687)
RISK	-0.094***	0.244***	0.046*	-0.095***	0.241***	0.043	-0.093***	0.244***	0.047*	-0.093***	0.246***	0.048*	-0.094***	0.244***	0.046*
	(-5.338)	(11.859)	(1.740)	(-5.381)	(11.711)	(1.617)	(-5.301)	(11.834)	(1.751)	(-5.280)	-11.944	-1.822	(-5.343)	-11.865	-1.722
BSIZE	-0.039***	-0.157***	-0.181***	-0.043***	-0.160***	-0.181***	-0.045***	-0.170***	-0.193***	-0.043***	-0.164***	-0.181***	-0.037**	-0.154***	-0.175**
	(-2.667)	(-8.627)	(-8.067)	(-3.068)	(-8.807)	(-8.247)	(-3.209)	(-9.489)	(-8.824)	(-3.136)	(-9.118)	(-8.346)	(-2.555)	(-8.512)	(-7.880)
BUSY	-0.001	-0.017	-0.089***	-0.017	-0.036*	-0.099***	-0.018	-0.048***	-0.117***	-0.003	-0.021	-0.072***	0.001	-0.015	-0.079**
	(-0.036)	(-0.841)	(-3.405)	(-1.302)	(-1.949)	(-4.129)	(-1.340)	(-2.596)	(-4.798)	(-0.246)	(-1.140)	(-3.003)	(0.049)	(-0.770)	(-3.091)
FEM	0.011	-0.041	-0.120	0.009	-0.040	-0.117	0.006	-0.050	-0.128	0.022	-0.024	-0.09	0.016	-0.032	-0.109
	(0.262)	(-0.666)	(-1.424)	(0.214)	(-0.654)	(-1.398)	(0.152)	(-0.811)	(-1.520)	-0.519	(-0.397)	(-1.076)	-0.383	(-0.530)	(-1.301)
OUT	-0.001	-0.048**	-0.012	-0.003	-0.048**	-0.011	-0.004	-0.053***	-0.017	-0.002	-0.049***	-0.01	0	-0.046**	-0.009
	(-0.108)	(-2.512)	(-0.514)	(-0.217)	(-2.521)	(-0.477)	(-0.298)	(-2.773)	(-0.718)	(-0.176)	(-2.598)	(-0.436)	(-0.027)	(-2.420)	(-0.382)
TEN	0.033***	-0.019**	0.064***	0.033***	-0.019**	0.064***	0.033***	-0.018*	0.065***	0.033***	-0.018*	0.065***	0.032***	-0.019**	0.063**
	(4.025)	(-1.989)	(4.971)	(4.042)	(-1.989)	(4.937)	(4.047)	(-1.887)	(5.025)	-4.118	(-1.886)	-5.061	-4.016	(-2.011)	-4.945
DUAL	-0.016	0.007	-0.037	-0.016	0.005	-0.040*	-0.014	0.012	-0.033	-0.015	0.009	-0.039*	-0.017	0.006	-0.04*
	(-0.920)	(0.386)	(-1.611)	(-0.911)	(0.273)	(-1.735)	(-0.782)	(0.627)	(-1.444)	(-0.870)	-0.468	(-1.684)	(-0.974)	-0.307	(-1.732)
FP_{t-1}	0.500***	0.671***	-0.024*	0.502***	0.671***	-0.025**	0.502***	0.672***	-0.023*	0.5***	0.67***	-0.028**	0.501***	0.67***	-0.026**
	(20.98)	(57.77)	(-1.909)	(20.97)	(57.68)	(-1.997)	(20.96)	(57.90)	(-1.798)	-20.896	-57.764	(-2.168)	-20.946	-57.532	(-2.019)
α	-0.251***	-0.453***	-0.749***	-0.235***	-0.428***	-0.737***	-0.228***	-0.422***	-0.713***	-0.251***	-0.476***	-0.797***	-0.277***	-0.491***	-0.798**
	(-5.100)	(-7.029)	(-8.865)	(-4.774)	(-6.839)	(-8.876)	(-4.759)	(-6.679)	(-8.539)	(-5.202)	(-7.239)	(-9.431)	(-5.448)	(-7.412)	(-9.204)
Obs	9041	8941	8846	9041	8941	8846	9041	8941	8846	9041	8941	8846	9041	8941	8846
R^2	0.456	0.603	0.346	0.456	0.604	0.346	0.455	0.603	0.346	0.456	0.604	0.348	0.456	0.604	0.346
p(F)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.00.00	0	0	0	0	0

This table presents pooled OLS regressions of firm performance on four measures of Connectivity and Aggregate Connectivity (*CONN*) employing Equation (7) and including a control for past performance. The sample consists of an unbalanced panel of Australian firms listed between 2001 and 2011. Connectivity measures are defined at Equations (1), (2), (5) and (6) in Section 3.1 and *CONN* is a collective measure of all four connectivity variables. Firm performance variables and control variables are as previously defined in Section 3.2. Time and industry effects are controlled for through dummy variables. Accounting and corporate governance data are collected at fiscal year-end. Accounting and stock market data are obtained from Thomson Reuters Datastream and Corporate governance data are collected from Securities Industry Research Centre of Asia-Pacific (SIRCA) Corporate Governance Database. T-statistics are displayed in parenthesis below each coefficient estimate and are based upon robust standard errors, clustered by firm. Significance levels are denoted by *, **, and *** for 10%, 5%, and 1% confidence levels, respectively.

Table 12.
Robustness Tests: Fama-MacBeth Regressions of Firm Performance on Connectivity

	ROA (1)	*TQ* (2)	*TSR* (3)	*ROA* (4)	*TQ* (5)	*TSR* (6)	*ROA* (7)	*TQ* (8)	*TSR* (9)	*ROA* (10)	*TQ* (11)	*TSR* (12)	*ROA* (13)	*TQ* (14)	*TSR* (15)
DEGREE	-7.34***	-15.907***	-4.817*												
	(-5.833)	(-5.255)	(-2.071)												
CLOSE				-0.147**	-0.563***	-0.298**									
				(-2.441)	(-4.293)	(-2.639)									
BETWEEN							-2.185***	-4.148***	-0.069						
							(-3.418)	(-3.804)	(-0.069)						
EIGEN										-0.616***	-1.276***	-0.431			
										(-6.872)	(-4.998)	(-1.296)			
CONN													-0.015***	-0.035***	-0.012**
													(-7.052)	(-5.423)	(-2.891)
MV	0.057***	0.131***	0.072***	0.055***	0.128***	0.073***	0.054***	0.126***	0.07***	0.057***	0.132***	0.072***	0.057***	0.132***	0.073***
	(16.64)	(15.00)	(4.95)	(16.51)	(15.13)	(5.30)	(14.89)	(15.51)	(5.01)	-14.543	-15.436	-4.594	-16.643	-14.877	-4.986
LEV	-0.195***	0.058	-0.314***	-0.196***	0.055	-0.315***	-0.195***	0.06	-0.314***	-0.196***	0.062	-0.314***	-0.195***	0.059	-0.313***
	(-7.412)	-0.653	(-	(-7.398)	-0.615	(-	(-7.355)	-0.678	(-	(-7.487)	-0.677	(-	(-7.411)	-0.657	(-
AGE	-0.031***	-0.076***	-0.042	-0.034***	-0.081***	-0.044*	-0.033***	-0.08***	-0.043*	-0.031***	-0.076***	-0.042*	-0.031***	-0.076***	-0.041
	(-8.505)	(-6.981)	(-1.809)	(-8.891)	(-7.848)	(-1.858)	(-8.450)	(-7.581)	(-1.833)	(-8.525)	(-6.696)	(-1.892)	(-8.558)	(-6.897)	(-1.785)
RISK	-0.242***	0.405***	0.016	-0.243***	0.4***	0.012	-0.241***	0.407***	0.017	-0.24***	0.407***	0.017	-0.242***	0.404***	0.016
	(-9.910)	-7.849	-0.205	(-9.766)	-7.84	-0.157	(-9.923)	-7.823	-0.208	(-9.992)	-7.878	-0.215	(-9.933)	-7.914	-0.196
BSIZE	-0.043***	-0.304***	-0.172***	-0.056***	-0.32***	-0.172***	-0.054***	-0.328***	-0.183***	-0.053***	-0.322***	-0.177***	-0.044***	-0.302***	-0.169***
	(-3.322)	(-	(-5.656)	(-4.573)	(-	(-5.088)	(-4.134)	(-	(-5.696)	(-4.120)	(-	(-6.304)	(-3.495)	(-	(-5.582)
BUSY	-0.003	0.015	-0.073**	-0.039***	-0.042	-0.081***	-0.036**	-0.049	-0.099***	-0.013	0.003	-0.078***	-0.01	0.014	-0.07***
	(-0.245)	(0.43)	(-2.948)	(-3.336)	(-1.441)	(-3.529)	(-2.774)	(-1.586)	(-3.820)	(-0.962)	(0.07)	(-3.188)	(-0.761)	(0.38)	(-3.202)
FEM	0.095**	-0.105	-0.117*	0.087**	-0.112	-0.112	0.083**	-0.122	-0.122*	0.105***	-0.074	-0.124**	0.099**	-0.091	-0.112*
	(3.09)	(-1.449)	(-1.907)	(2.82)	(-1.608)	(-1.713)	(2.89)	(-1.727)	(-1.861)	-3.343	(-0.969)	(-2.408)	(3.09)	(-1.228)	(-1.842)
OUT	-0.002	-0.126***	-0.011	-0.007	-0.132***	-0.011	-0.006	-0.137***	-0.015	-0.004	-0.133***	-0.013	-0.002	-0.124***	-0.01
	(-0.120)	(-5.795)	(-0.459)	(-0.382)	(-5.943)	(-0.488)	(-0.351)	(-6.016)	(-0.678)	(-0.216)	(-6.731)	(-0.590)	(-0.114)	(-5.882)	(-0.425)
TEN	0.083***	-0.1***	0.052***	0.084***	-0.099***	0.052***	0.084***	-0.098***	0.053***	0.085***	-0.097***	0.054***	0.083***	-0.1***	0.052***
	(10.24)	(-5.799)	(3.66)	(10.23)	(-5.847)	(3.79)	(10.27)	(-5.710)	(3.79)	-10.4	(-5.572)	-3.747	(10.25)	(-5.775)	-3.688
DUAL	-0.024*	0.041	-0.036	-0.022	0.042	-0.038	-0.02	0.05*	-0.033	-0.022	0.044	-0.037	-0.025*	0.039	-0.037
	(-1.966)	(1.61)	(-1.646)	(-1.715)	(1.73)	(-1.727)	(-1.619)	(1.962)	(-1.465)	(-1.759)	-1.792	(-1.627)	(-1.975)	(1.56)	(-1.680)
α	-0.445***	-0.357***	-0.618**	-0.404***	-0.29**	-0.604**	-0.412***	-0.286**	-0.585**	-0.448***	-0.364***	-0.613**	-0.469***	-0.427***	-0.646**
	(-7.601)	(-3.363)	(-2.969)	(-7.044)	(-3.031)	(-2.951)	(-6.754)	(-2.936)	(-2.832)	(-7.090)	(-3.614)	(-2.938)	(-7.993)	(-3.814)	(-3.073)
Obs	9154	9202	9206	9154	9202	9206	9154	9202	9206	9154	9202	9206	9154	9202	9206
R^2	0.293	0.232	0.154	0.291	0.231	0.155	0.291	0.229	0.154	0.293	0.233	0.157	0.292	0.233	0.155
p(F)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

This table contains Fama MacBeth (FMB) cross-sectional regressions of current firm performance measures on four measures of Connectivity and Aggregate Connectivity (*CONN*) employing Equation (7). The sample consists of an unbalanced panel of Australian listed firms from 2001 to 2011. The combined *CONN* measure is constructed using the common component of *Degree*, *Closeness*, *Beteweenness* and *Eigenvector* measures. All other variable descriptions are described in Section 3. Industry effects are controlled for through dummy variables. Accounting and stock market data are obtained from Thomson Reuters Datastream and Corporate governance data are collected from Securities Industry Research Centre of Asia-Pacific (SIRCA) Corporate Governance Database. T-statistics are displayed in parenthesis below each coefficient estimate, using FMB standard errors. Significance levels are denoted by *, **, and *** for 10%, 5%, and 1% confidence levels, respectively.

Table 13.
Break Test: OLS Regressions of Firm Performance on Connectivity

	ROA	*TQ*	*TSR*	*ROA*	*TQ*	*TSR*
	(1)	(2)	(3)	(4)	(5)	(6)
	2001-2007			2008-2011		
CONN	-0.017***	-0.032***	-0.02***	-0.011*	-0.048***	-0.009
	(-3.422)	(-3.573)	(-3.470)	(-1.895)	(-4.591)	(-1.331)
MV	0.056***	0.128***	0.078***	0.063***	0.143***	0.079***
	(11.630)	(14.885)	(13.754)	(10.982)	(14.544)	(11.838)
LEV	-0.181***	-0.134	-0.323***	-0.238***	0.319***	-0.269***
	(-2.832)	(-1.418)	(-7.487)	(-3.468)	(2.819)	(-4.660)
AGE	-0.034***	-0.083***	-0.05***	-0.025	-0.047*	-0.029*
	(-3.486)	(-4.258)	(-4.426)	(-1.599)	(-1.770)	(-1.895)
RISK	-0.244***	0.419***	0.033	-0.207***	0.352***	0.081*
	(-9.514)	(10.632)	(1.005)	(-5.708)	(6.992)	(1.879)
BSIZE	-0.033	-0.257***	-0.152***	-0.062**	-0.382***	-0.187***
	(-1.465)	(-6.621)	(-5.393)	(-2.105)	(-7.289)	(-5.404)
BUSY	0.012	-0.052	-0.079***	-0.037	0.158**	-0.046
	(0.525)	(-1.095)	(-2.747)	(-1.027)	(2.123)	(-0.943)
FEM	0.082	-0.206	-0.109	0.074	0.1	-0.136
	(0.963)	(-1.239)	(-1.085)	(0.825)	(0.501)	(-1.139)
OUT	0.018	-0.1**	-0.003	-0.035	-0.168***	-0.045
	(0.755)	(-2.487)	(-0.111)	(-0.980)	(-2.712)	(-1.138)
TEN	0.072***	-0.061**	0.063***	0.104***	-0.156***	0.064***
	(5.658)	(-2.498)	(4.156)	(5.348)	(-4.811)	(3.036)
DUAL	-0.029	0.064	-0.049*	-0.013	0.02	-0.001
	(-0.966)	(1.255)	(-1.671)	(-0.357)	(0.343)	(-0.020)
α	-0.428***	-0.594***	-0.827***	-0.459***	-0.471**	-0.905***
	(-5.007)	(-3.531)	(-8.761)	(-4.044)	(-2.429)	(-6.608)
Obs	5704	5741	5749	3450	3461	3457
R^2	0.2721	0.2446	0.1505	0.29	0.2352	0.4814
p(F)	0.000	0.000	0.000	0.000	0.000	0.000

Provided here are the results for the structural break tests. Pooled OLS regressions of current firm performance on the combined *Aggregate Connectivity* (*CONN*) measure are estimated using Equation (7). The sample consists of an unbalanced panel of Australian listed firms split into two separate periods: 2001 to 2007 and 2008 to 2011. The combined *CONN* measure is constructed using the common component of Degree, Closeness, Beteweenness and Eigenvector measures. All other variable descriptions are described in Section 3. Time and industry effects are controlled for through dummy variables. Accounting and stock market data are obtained from Thomson Reuters Datastream and Corporate governance data are collected from Securities Industry Research Centre of Asia-Pacific (SIRCA) Corporate Governance Database. T-statistics are displayed in parenthesis below each coefficient estimate and are based upon robust standard errors clustered by firm. Significance levels are denoted by *, **, and *** for 10%, 5%, and 1% confidence levels, respectively.

Table 14.
Pooled OLS Regressions of Changes in Connectivity on Changes in Firm Performance

	ΔDEG (1)	*ΔCLO* (2)	*ΔBET* (3)	*ΔEIG* (4)	*ΔCON* (5)	*ΔDEG* (6)	*ΔCLO* (7)	*ΔBET* (8)	*ΔEIG* (9)	*ΔCON* (10)	*ΔDEG* (11)	*ΔCLO* (12)	*ΔBET* (13)	*ΔEIG* (14)	*ΔCON* (15)
ΔROA_t	0.000	-0.002	0.000	-0.002	-0.054*										
	(0.818)	(-1.079)	(-0.958)	(-1.559)	(-1.674)										
ΔROA_{t-1}	0.000	0.003**	0.000	0.002*	0.026										
	(-0.690)	(1.966)	(-0.923)	(1.869)	(0.878)										
ΔTQ_t						0.000	-0.001	0.000	0.001	0.002					
						(0.432)	(-0.334)	(0.323)	(0.878)	(0.084)					
ΔTQ_{t-1}						0.000	0.000	0.000	0.002**	0.011					
						(0.614)	(-0.377)	(0.642)	(2.023)	(0.445)					
TSR_t											0.000	-0.002	0.000	0.001	-0.017
											(0.682)	(-1.614)	(0.581)	(1.300)	(-0.752)
TSR_{t-1}											0.000	0.001	0.000	0.004***	0.063***
											(0.873)	(1.214)	(1.110)	(6.224)	(3.412)
ΔMV_t	0.000	0.001	0.000	0.000	0.002	0.000	0.001	0.000	0.000	0.001	0.000	0.001	0.000	-0.002***	0.001
	(0.136)	(0.684)	(-0.260)	(-0.279)	(0.138)	(-0.111)	(0.911)	(-0.193)	(-0.907)	(0.045)	(0.152)	(0.632)	(-0.345)	(-3.959)	(0.045)
ΔMTB_t	0.000	0.000	0.000	0.000*	0.006	0.000	0.000	0.000	0.000	0.009	0.000	0.001	0.000*	0.000	0.009
	(1.275)	(-0.433)	(1.500)	(-1.649)	(0.509)	(1.251)	(-0.180)	(1.570)	(-1.503)	(0.673)	(1.567)	(0.776)	(1.874)	(-0.666)	(0.673)
$\Delta RISK_t$	0.000	0.000	0.000	0.001	1.129***	0.000	0.000	0.000	0.001	1.138***	0.000	0.000	0.000	0.002***	1.138***
	(0.516)	(0.203)	(1.100)	(1.605)	(20.460)	(0.718)	(0.254)	(1.018)	(1.306)	(20.330)	(0.031)	(0.135)	(0.835)	(2.622)	(20.330)
$\Delta BSIZE_t$	0.002***	0.040***	0.004***	0.011***	-0.009	0.002***	0.040***	0.004***	0.011***	-0.008	0.002***	0.040***	0.004***	0.011***	-0.008
	(22.50)	(16.37)	(14.18)	(7.45)	(-0.291)	(22.57)	(16.08)	(14.03)	(7.49)	(-0.246)	(22.85)	(16.34)	(14.38)	(7.57)	(-0.246)
α	0.000	-0.024***	0.000	-0.004	-0.227***	0.000**	-0.008***	0.000	0.000	-0.064	0.000*	-0.006**	0.001***	0.002	-0.064
	(1.409)	(-10.75)	(0.609)	(-1.085)	(-3.104)	(-1.972)	(-3.439)	(1.326)	(0.015)	(-0.893)	(-1.753)	(-2.514)	(2.649)	(0.505)	(-0.893)
Obs	8330	8330	8330	8330	8330	8234	8234	8234	8234	8234	8507	8507	8507	8507	8507
R^2	0.136	0.072	0.052	0.037	0.117	0.138	0.072	0.053	0.039	0.118	0.137	0.070	0.053	0.039	0.117
p(F)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

This table provides the results of pooled OLS regressions of changes in connectivity on changes in firm performance and several control variables. The sample contains Australian listed firms for the period 2001 to 2011. *DEG*, *CLO*, *BET*, and *EIG* are measures of board connectivity *Degree*, *Closeness*,*Betweenness*, *Eigenvector* defined at Equations (1), (2), (5), and (6) repectively. *CON* represents *Aggregate Connectivity*. Firm performance and control is measured by operating return on assets (*ROA*), natural log of Tobin's Q (*TQ*), and the natural log of 1+total stock returns (*TS)*. A change in connectivity is measured between the years *t* and *t-1*; a change in firm performance is the difference between years *t* and *t-1*, and *t-1* and *t-2*. Changes in control variables are measured between years *t* and *t-1* and include the change in size ln(*MV*), growth opportunities ln(*MTB*), firm risk (*RISK*) and board size ln(*BSIZE*). Time and industry effects are controlled for through dummy variables. Accounting and stock market data are obtained from Thomson Reuters Datastream and Corporate governance data are collected from Securities Industry Research Centre of Asia-Pacific (SIRCA) Corporate Governance Database. T-statistics are displayed in parenthesis below each coefficient estimate and are based upon robust standard errors clustered by firm. Significance levels are denoted by *, **, and *** for 10%, 5%, and 1% confidence levels, respectively.