

Andersen, Angela; Garel, Alexandre; Gilbert, Aaron; Tourani-Rad, Alireza

Article

Disentangling director attributes: Human capital versus social capital of directors

Journal of Risk and Financial Management

Provided in Cooperation with:

MDPI – Multidisciplinary Digital Publishing Institute, Basel

Suggested Citation: Andersen, Angela; Garel, Alexandre; Gilbert, Aaron; Tourani-Rad, Alireza (2022) : Disentangling director attributes: Human capital versus social capital of directors, Journal of Risk and Financial Management, ISSN 1911-8074, MDPI, Basel, Vol. 15, Iss. 8, pp. 1-21, <https://doi.org/10.3390/jrfm15080336>

This Version is available at:

<https://hdl.handle.net/10419/274858>

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.



<https://creativecommons.org/licenses/by/4.0/>

Article

Disentangling Director Attributes: Human Capital versus Social Capital of Directors

Angela Andersen ^{1,†}, Alexandre Garel ², Aaron Gilbert ^{3,*}  and Alireza Tourani-Rad ³¹ Deloitte New Zealand, Rotorua 3010, New Zealand; angeandersen@gmail.com² Finance Department, Audencia Business School, 44300 Nantes, France; agarel@audencia.com³ Finance Department, Faculty of Business, Economics and Law, Auckland University of Technology, Auckland 1010, New Zealand; atourani@aut.ac.nz

* Correspondence: agilbert@aut.ac.nz

† The views expressed in this paper are my own and do not necessarily reflect the views of my employer, Deloitte.

Abstract: This study seeks to disentangle the human capital and the social capital of directors to improve our understanding of the value that directors bring to their boardroom. Employing social network analysis (SNA) to measure the social capital of directors and using a unique and comprehensive sample of New Zealand publicly listed firms over the period of 2000–2015, we find a positive and significant relationship between the human capital and the social capital of directors, where the human capital appears to predict changes in social capital. We contend that the growing literature in the area of corporate finance and governance investigating the impact of characteristics of directors on corporate outcomes, need to take note of the complementary impact that social capital can have in addition to human capital.



Citation: Andersen, Angela, Alexandre Garel, Aaron Gilbert, and Alireza Tourani-Rad. 2022. Disentangling Director Attributes: Human Capital versus Social Capital of Directors. *Journal of Risk and Financial Management* 15: 336. <https://doi.org/10.3390/jrfm15080336>

Academic Editor: Ștefan Cristian Gherghina

Received: 1 June 2022

Accepted: 22 June 2022

Published: 29 July 2022

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.



Copyright: © 2022 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

Keywords: corporate governance; board of directors; social capital; social network analysis; human capital; board effectiveness

JEL Classification: C33; G32; G34

1. Introduction

“Human capital resides in individuals. Social capital resides in social relations.”
(OECD 2001).

The board of directors is an important component of the governance framework of a firm, and as such, has been the focus of numerous studies seeking to identify attributes of a high-quality board. In recent years, more studies have begun to consider the individual attributes of directors which may influence their contribution to the board, and by extension, their impact on firm value (Johnson et al. 2013). This literature suggests that the personal attributes a director brings to their board, known as *human capital*, are likely to impact on how successful they are as a director, with directors who have more experience, knowledge, and skills, fulfilling their roles more appropriately (Chen 2014; Fedaseyev et al. 2018; Fich 2005; Field and Mkrtchyan 2017; Gray and Nowland 2013; Johnson et al. 2013; Nicholson and Kiel 2004).

An attribute that has been of particular interest, beyond their personal qualities, is the connections that a director has within their group of peers, referred to as *social capital*. Social capital has been defined as a director's ability to access resources through their connections, including information (Burt 1992). The increasing intricacy of businesses necessitates an extensive range of expertise and experience that directors need (Van der Walt and Ingley 2003). This can make it hard for even a group of directors to provide all the required skills, knowledge, and experience personally, especially on smaller boards. One way to gain

additional knowledge and expertise is through social capital, i.e., by accessing the skills, knowledge, and experience of those directors they are connected to from sitting on the same boards of other firms. This suggests that directors who sit on multiple boards, connecting them to other directors, would be valuable for firms making them attractive directors.

Recently, researchers have begun to view social capital far more broadly than just the direct connections a director has from sitting on multiple boards, traditionally known as interlocks, which only considers direct connections a director has from sitting on multiple boards. Interlocks create networks of companies that can allow information and other experiences to be exchanged. For instance, firm B has a director who also sits on firm A's board, giving firm B access to the experiences and knowledge of firm A. More recently, researchers have begun to focus on the wider networks formed by the indirect connections among directors sitting on multiple boards. For instance, if another director on firm B sits on the board of firm C, the interlock literature would not recognize A and C as being connected. However, it can be argued that there is an indirect connection between firms A and C via firm B. The idea of indirect connections raises the possibility that social capital brings greater access to resources than was recognized under the literature on interlocks.

However, it is important that the concept of *social capital* is distinguished from a director's human capital. Human capital generally refers to the value of people's personal attributes such as their skills, experience, and knowledge acquired from current and past positions, training, and education (Becker 1993). Admittedly, while these two types of capital are distinct, they are highly interrelated (Coleman 1988; Nyberg and Wright 2015). For instance, a director with a larger network of social connections will be in a position to develop greater human capital as they will likely be offered more opportunities to build experience. Similarly, a director with a highly desirable set of professional skills and prior experience is more likely to be offered additional board seats resulting in greater social capital. The interrelation also suggests that the number of directorships one holds is an indication of a director's personal qualities, namely, their human capital, while also indicating the level of a director's social capital. It is therefore important to employ measures of social capital that can separate human from social capital. In this study, we investigate the interrelationship between the two types of capital and show that they are distinct from each other. We argue that in empirical studies both sets of directors' attributes should be taken into consideration, something that has not always occurred in the extant literature.

We measure social capital using social network analysis (SNA) as suggested by (Wasserman and Faust 1994). More specifically, SNA argues that there are four common social network attributes that can be measured based on the network of indirect connections among, in our setting, directors. These are: degree, closeness, betweenness, and eigenvector. Each measure represents a different dimension of connectivity, including the number of direct connections, the centrality of a person within the network, a person's ability to acquire and restrict information, and the quality of their connections. Based on these four measures of connectivity, we create a composite measure of connectivity using principal component analysis (PCA). Next, we create a unique "human capital index" comprised of nine personal attributes of directors based on the extant literature, including director experience, qualifications, industry specific knowledge, and past positions, among others.

Using our two measures of social and human capital and conducting both univariate and multivariate regression analysis, we observe a positive and significant relationship between the two types of capital where changes in human capital appears to predict changes in social capital. After conducting several robustness tests, including first-difference regressions, and logit regressions to account for potential endogeneity problems, our main findings remain unchanged. Overall, we observe that human capital predicts social capital. We conclude that the growing literature in the corporate finance and governance area must control for both types of capital when investigating the impact of social capital or human capital of directors.

The rest of the study is structured as follows. Section 2 provides a background of the literature and expands particularly on the relationship between human capital and social capital. Section 3 provides a description of the data, social capital measures, and the human capital index used in this study. Section 4 first presents univariate analyses that determine the human capital differences between a high and low connected director and next presents the multivariate results we use to test the relationship between human capital and social capital. In Section 5, we carry out a number of robustness tests, and Section 6 concludes the study.

2. Literature Review and Human and Social Capital Determinants

As a result of the blended line between human and social capital and the increased attention being placed on the value of directors' attributes, it is important to investigate whether there is a relationship between human capital and social capital. One concern is that if human and social capital are interlinked, then identifying the value of social capital requires that we suitably control for human capital and appropriately measure social capital. Initially, studies of social capital focused on board interlocks, the connections between companies created by having mutual directors on each company's board. However, Fama and Jensen (1983) argue that high human capital directors are in high demand, making them more likely to sit on multiple boards, an argument supported by a considerable amount of literature (see among others Fich and Shivdasani 2007; Ahn et al. 2010; Cashman et al. 2012; Field et al. 2013). As a result, it is empirically difficult to separate human and social capital when using interlocks to proxy for social capital. More recently, studies have utilized social network analysis to measure wider connectivity, allowing us to distinguish between human and social capital more easily.

Another issue in the literature is that studies that posit a particular view on the impact of social capital have only partially controlled for human capital (Akbas et al. 2016; Andres et al. 2013; Barnea and Guedj 2007; Larcker et al. 2013; Omer et al. 2014). Omer et al. (2014), for instance, appear to control for the board level human capital using outside CEOs on a board and directors sitting on other boards in the same industry. Andres et al. (2013) control for director busyness in a study on the connectivity of German firms. To date, the most comprehensive attempts to control for human capital are by Horton et al. (2012) and Cashman et al. (2013). Horton et al. (2012) find that social capital is positively associated with firm performance and director compensation in the United Kingdom. With regards to human capital, they control for board experience and director education. Horton et al. (2012) posit a strong argument that human capital is a crucial factor to account for when investigating board connectivity and, that its exclusion may bias findings on the importance of connectivity. On the contrary, Cashman et al. (2013) find that it is the social capital that is more important than the human capital for gaining additional board seats in the United States.

Our review of theory and prior literature suggests that there is a strong interrelationship between human capital and social capital, which we will examine in our empirical analysis. To do so, we first discuss how human capital and social capital are determined in our study.

2.1. Social Capital

Early studies of director and board social capital focused on the issue of interlocks; the direct connections formed by a director sitting on other companies' boards. More recently, studies have started to acknowledge that social capital and connectivity is multifaceted and that more encompassing measures are required. For instance, Bailey et al. (2018) explore social connectedness between countries based on Facebook links, just one of a number of studies exploring social media links. In this study we use another method that has only recently been employed for studying board connectivity, social network analysis (Wasserman and Faust 1994). SNA has the advantage of incorporating prior literature that focuses only on the direct connections between boards based on the number

of boards a director sat on (the SNA component degree is equivalent to the definition of interlocks) as well as taking a wider view of connectivity. Specifically, SNA goes beyond the direct connections to consider factors such as the quality of a director's connections (being linked to more connected directors brings access to greater resources). SNA is therefore a more suitable proxy of social capital than the simple multiple directorship measure. SNA is particularly suitable for use in studying director connectivity as it focuses on the connections that will bring the most value to the firm, connections to other directors who possess relevant skills and experiences.

Applying SNA to board connectivity relies on constructing the director network for each year. The director network collects all the board positions that all the directors hold and uses that information to identify pathways between companies based on shared directors. Companies with more connections to other companies are placed more centrally in the network and therefore have more access to additional resources and information. From the director network we calculate four common social network measures that capture different aspects of connectivity: degree (Nieminen 1974), closeness (Sabadussi 1966), betweenness (Freeman 1978), and eigenvector (Bonacich 1972, 1987).

The first measure, degree (denoted hereafter as “*DEG*”), is the number of direct connections of a director (Freeman 1978; Nieminen 1974). *DEG* is measured as the number of unique direct connections between director *i* and all other directors: *j*, i.e.,

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

where $\delta(i, j)$ is a dummy variable that equals one if directors *i* and *j* sit on one or more of the same boards, and zero otherwise. *DEG* measures the direct information shared between two directors that a board can access (Freeman 1978). A higher *DEG* score indicates a director with many direct connections to other directors, and hence more opportunities to exchange or acquire information. To take into account differences in network size from changes in the number of listed firms and board size, we normalize *DEG* by dividing C_{it}^D by $(n - 1)$, where *n* is the number of directors in the network in the corresponding year (Hochberg et al. 2007; Horton et al. 2012). Normalizing the scores by $n - 1$ bounds *DEG* between 0 and 1, which can be interpreted as a director's proportion of the maximum direct connections possible within the network. This measure can be compared between years (Freeman 1978).

The second measure employed is closeness (denoted hereafter as “*CLO*”) (Freeman 1978; Sabidussi 1966). *CLO* measures the distance between a director and every other director they are connected to. In line with Freeman (1978), *CLO* is defined as the sum of the inverse of the shortest distance between director *i* and all other directors in the network:

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

where *n* is the total number of directors in the network and $d(i, j)$ is the shortest distance between director *i* and director *j*. We set the distance between disconnected directors to 0. Effectively, this overcomes the issue of excluding directors from the analysis who are not connected at all or are connected to smaller satellite networks, but not to the main network (Opsahl et al. 2010). A higher closeness score represents a director with closer connections that enable quicker and more readily available information and resource exchange. *CLO* is normalized by dividing by $(n - 1)$ representing the percentage of the maximum *CLO* possible for a given director *i*.

The third measure, betweenness (denoted hereafter as “*BET*”) (Freeman 1978), measures how well-situated the director is for connecting other directors to each other and the ability to potentially control the exchange of information and resources (Borgatti 2005; Freeman 1978). Freeman (1978) constructs the *BET* measure to represent the probability that

director i is positioned on a randomly selected shortest path that links two directors (h, j) . By doing so, BET considers the likelihood of information being circumvented through other channels to capture the probability of director i successfully controlling the information flow, i.e.,

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

where $g(h, j)$ is the maximum number of communication paths another director could be in a position to control. Therefore, the information passing between directors (h, j) can be completely controlled by director i when there are no other directors between directors (h, j) , such that $B_{(h,i,j)t}^B = 1$. To measure the overall BET of director i , we follow Freeman (1978) and take the sum of the proportions of all the shortest paths linking two directors which pass through director i :

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

where n is the number of directors in the network and $B_{(h,i,j)}^B$ is defined as per Equation (3). We normalize BET by expressing it as the proportion of its maximum value possible in year t . The maximum value for C_{it}^B is essentially the most central point a director can sit, that being $(n^2 - 3n + 2)/2$ (Freeman 1978). The final measure is the relative BET centrality of director i in year t which is:

$$C'_{it}^B = \frac{2(C_{it}^B)}{n^2 - 3n + 2}, \quad (5)$$

where C_{it}^B is defined by Equation (4) and n represents the number of directors in the network.

The fourth measure is eigenvector (denoted hereafter as “ EIG ”) (Bonacich 1972), which expands on the degree measure and is typically interpreted as capturing the power and prestige of a director’s connections. Specifically, EIG combines a director’s DEG score with their direct connections’ DEG scores. EIG is defined as the sum of director i ’s first-degree connections to all other directors $(\delta(i, j))$ in the network, weighted by the EIG of the directors to which director i is connected to, i.e.,

$$C_{it}^E = \frac{1}{\lambda} \sum_{j=1}^n \delta(i, j) C_{jt}^E, \quad j \neq i, \quad (6)$$

where C_{it}^E is the EIG score for a particular director i , $\delta(i, j)$ is defined in Equation (1), and λ is a constant, defined as the maximum possible eigenvector for a given network in year t . Connections to a highly connected director will increase a director’s EIG score more than connections to less connected directors. A high EIG director has faster and increased access to information and resources which should increase their value on a board.

Finally, we employ principal components analysis to create an aggregate connectivity score, (hereafter referred to as “ AGG ”). This method has commonly been used to account for the multidimensionality of social capital and examines several indicators simultaneously (Cashman et al. 2013; Larcker et al. 2013; Omer et al. 2014). This is done by extracting the common variance in the four network measures: degree (DEG), betweenness (BET), closeness (CLO), and eigenvector (EIG). We employ this measure as our main variable of interest as it represents the overall connectivity of a director across all four dimensions, while simplifying the analysis. Unreported testing shows that the results for AGG are similar to the results for the four individual connectivity measures. Appendix B contains details of the construction of the connectivity factor. The first component explains over 55% of the overall variation and has a Cronbach alpha of 0.723 indicating that the connectivity factor is statistically reliable.

2.2. Human Capital

We next construct our human capital index by scoring directors between 0 and 2 on nine attributes. The scores are summed to form our human capital index (*HCI*), which has a maximum possible value of 18. The nine attributes we employ have been drawn from the director attribute literature. The first attribute is education, where we use a director's highest qualification, as a proxy for their level of education (Shuller 2001). We assign a director 2 if their highest level of education is a postgraduate degree, 1 for an undergraduate degree, and 0 for no degree.

The next attribute is director experience based on the number of years a director has served on publicly listed boards (Gray and Nowland 2013). A director scores 2 if they have four or more years' experience, 1 for one to three years' experience, and 0 for one year or no experience, similar to the approach of Gray and Nowland (2013). A director in their first year on a board is assumed to have little board experience, and thus may not contribute strongly to a board, while a director with more than three years has served a full term as a director (three-year terms are normal in most countries), experiencing a full range of board activities.

We also consider a director's expertise. Directors of large firms, as they are more complex, more publicly visible, and prestigious, are more likely to have dealt with a wide range of corporate issues (Cashman et al. 2013; Ferris et al. 2003), creating a set of transferrable skills (Cashman et al. 2013; Ferris et al. 2003). This attribute is measured by classifying directors based on the size of the firms a director currently serves, specifically the director of an NZX10 (top 10 listed firms) is assigned a 2, 1 for an NZX50 (top 50 listed firms), and 0 otherwise.

CEOs are seen as bringing valuable skills and experiences to boards (El-Khatib et al. 2015; Fracassi and Tate 2012), although current CEOs are often constrained by their current time commitments. We consider a director's CEO experience, assigning a director with CEO experience at a public firm a 2, 1 for CEO experience at a private firm, and 0 for no CEO experience. CEOs of publicly listed firms have additional relevant experience compared to one of a private firm, because of dealing with additional responsibilities such as those relating to listing rules, and continuous disclosure rules. Individuals who have been CEOs for less than one year, and have no other prior CEO experience, are assigned a 0 as they have yet to build up a significant of managerial skill.

International experience is an important attribute of the board to adequately deal with today's globalized business environment. We classify directors based on whether they have had international exposure; predominantly through sales, or having worked abroad (Herrmann and Datta 2005; Chen 2014; Johnson et al. 2013; Volonté and Gantenbein 2014). We assign directors a score of 2 if they have international experience and 0 otherwise.

We also consider a director's exposure to M&A deals based on the cumulative number of deals a director has been involved with. We assign a director a score of 2 if they have been involved with three or more deals, 1 for directors involved with one or two deals, and 0 for directors with no deal experience.

Directors with either financial or legal acumen are attractive potential directors given that boards require members with these skills (Adams et al. 2018; Equilar 2016; Spencer Stuart 2017). We consider a director to have financial acumen if their main or secondary career is in the accounting or banking fields, or if they are a financial expert (see Appendix A for variable definitions). Directors who are or have been lawyers are deemed to have legal acumen. We assign a director a score of 2 if they have both financial and legal acumen, 1 for either financial or legal acumen, and 0 if they have no financial or legal acumen.

Professional directors, who are typically individuals who have retired from successful careers and as such have the time and ability to commit to directorships, may make attractive directors (Jahan 2018; Larcker and Miles 2011; Wells and Mueller 2014). We assign a director a score of 2 if they classify as a professional director and 0 otherwise.

Finally, we consider a director's industry experience based on the range of industries they have worked in. Using the industry classification benchmark level one coding system, we assign a director a score of 0.2 for each of the 10 ICB industries they have substantial experience in, thus a director with 5 industries receives a score of 1.

In the next section, we will provide detailed statistics on each component of the social and human capital measures.

3. Data, Variables, and Descriptive Statistics

Our sample is drawn from the New Zealand Stock Exchange (NZX) listed companies covering over a sixteen-year period from 2000 to 2015. New Zealand offers an interesting setting to undertake this study because it is a smaller market with fewer directors, which allows us to hand-collect in-depth information on directors, offering a comprehensive understanding of the relationship between human capital and social capital. Our data is derived from multiple sources. Each year, we identify the directors on the boards of the listed companies primarily using the companies register of the Ministry of Business Innovation and Employment provided by Information Logistics Company Limited. After having identified our sample of directors, we hand-collect information on companies' directors from annual reports and appointment announcements, supplemented by web sources including LinkedIn, Bloomberg, and the National Business Review. Mergers and acquisitions data is obtained from Bloomberg. The sample includes 279 unique firms, 2432 unique directors, and 12,211 director-year observations. All variables used in the analysis are described in Appendix A.

Table 1 presents descriptive statistics for the variables used in this study. Panel A presents the connectivity measures *DEG*, *CLO*, *BET*, and *EIG*, expressed as the percentage of the maximum possible value per year, and the factor of the four individual connectivity measures' *AGG*. These values measure a director's social capital. Overall, sample averages of *DEG*, *CLO*, *BET*, *EIG*, and *AGG* are 0.89%, 10.15%, 0.26%, 1.25%, and 0%, respectively. Based on *DEG*, the average director is directly connected to 0.89% of the other directors. As we can observe from the table, *DEG*, *BET*, and *EIG* all demonstrate a positive skew, indicating that a small number of highly connected directors have greatly increased the mean level of connectivity measures. This can also be seen in the p75 statistics for these three variables which are very low values or 0 for the first 75% of the sample, with the final 25% scoring markedly higher. *CLO* demonstrates a negative skew, with disconnected or isolated directors pulling the mean closeness score below the median. We focus on the connectivity factor, *AGG*, in the analysis because we are interested in the overall connectedness of directors.

Panel B presents director characteristics and human capital measures. The typical director (based on the median values) is 56 years old, has over 5 years of cumulative board experience, holds just one directorship of a publicly listed company, and is based in New Zealand. Only 15% of directors in our sample sit on multiple boards. Women account for 9% of directors; 70% of our sample has a tertiary qualification; 9% are directors of an NZX10 company; 40% are directors of an NZX50 company. Prior CEOs held 41% of the directorships, and 26% are held by current CEOs (either for public or private companies). Forty-four percent of the sample have international experience, and on average, directors have been involved with 2.13 merger and acquisition (M&A) deals. We also consider the professional experience of directors, and find that general executives are most common, followed by financial experts, and 11% are professional directors. In terms of industry experience, the average director has gained experience in 1.45 out of 10 ICB industries. Specifically, 45% of the sample have banking and finance experience, and 41% have consumer goods and services experience, while other industry experience is considerably less common.

In addition to the human capital attributes above, we also control for gender (denoted as "FEM") and place of residence (denoted as "NZ") of directors. Globally, there have been

efforts to increase the number of female directors (Terjesen et al. 2009; Vinnicombe et al. 2008). As such, these characteristics are important to control for in this study.

Table 1. Descriptive statistics of director human capital and social capital variables.

<i>Panel A: Director Connectivity Measures</i>					
	Mean	Median	SD	P25	P75
DEG	0.0089	0.0078	0.0051	0.0062	0.0105
CLO	0.1015	0.1274	0.0696	0.0099	0.1556
BET	0.0026	0.0000	0.0101	0.0000	0.0000
EIG	0.0125	0.0001	0.0497	0.0000	0.0025
AGG	0.0000	−0.2635	1.4929	−0.9105	0.2697
<i>Panel B: Director Characteristics and Human Capital</i>					
	Mean	Median	SD	P25	P75
Female (0/1)	0.0875	0.0000	0.2826	0.0000	0.0000
Age (years)	56.2443	56.0000	9.4518	50.0000	63.0000
New Zealand (0/1)	0.7038	1.0000	0.4566	0.0000	1.0000
Undergraduate (0/1)	0.3548	0.0000	0.4785	0.0000	1.0000
Postgraduate (0/1)	0.3470	0.0000	0.4760	0.0000	1.0000
No Degree (0/1)	0.2982	0.0000	0.4575	0.0000	1.0000
Director Experience (years)	6.5321	5.0000	6.5685	2.0000	10.0000
Directorships (N)	1.2125	1.0000	0.5742	1.0000	1.0000
Directorships (2+) (0/1)	0.1521	0.0000	0.3591	0.0000	0.0000
NZX10 (0/1)	0.0909	0.0000	0.2875	0.0000	0.0000
NZX50 (0/1)	0.3951	0.0000	0.4889	0.0000	1.0000
Prior CEO Experience (0/1)	0.4088	0.0000	0.4916	0.0000	1.0000
Current CEO (listed) (0/1)	0.1413	0.0000	0.3483	0.0000	0.0000
Current CEO (non-listed) (0/1)	0.1172	0.0000	0.3217	0.0000	0.0000
International Experience (0/1)	0.4445	0.0000	0.4969	0.0000	1.0000
M&A Experience (N deals)	2.1300	0.0000	5.4599	0.0000	2.0000
<i>Professional Expertise (0/1)</i>					
Accountant	0.1803	0.0000	0.3845	0.0000	0.0000
Banker	0.1560	0.0000	0.3629	0.0000	0.0000
Consultant	0.0949	0.0000	0.2931	0.0000	0.0000
Financial Expert	0.2363	0.0000	0.4248	0.0000	0.0000
General Executive	0.3161	0.0000	0.4650	0.0000	1.0000
Lawyer	0.0736	0.0000	0.2612	0.0000	0.0000
Prof Director	0.1078	0.0000	0.3101	0.0000	0.0000
<i>Industry Experience</i>					
Banking and Finance (0/1)	0.4465	0.0000	0.4971	0.0000	1.0000
Consumer Goods and Services (0/1)	0.4120	0.0000	0.4922	0.0000	1.0000
Industry Experience (N)	1.4866	1.0000	0.9017	1.0000	2.0000

This table presents descriptive statistics for the human capital and social capital variables for a sample of 12,211 director-year observation of directors of NZX listed companies between 2000 and 2015. Panel A reports descriptive statistics for the four centrality measures; degree (DEG), closeness (CLO), betweenness (BET), eigenvector (EIG), and the PCA factor (AGG). Female is a dummy variable that equals 1 if a director is a woman. Age is the age of the director in the sample year. New Zealand is a dummy variable if the director was domiciled in New Zealand, Undergraduate, Postgraduate, and No Degree are dummy variables based on the highest qualification of a director. Director experience is the cumulative number of years of director experience a director has, Directorships (N) is the number of current directorships a director has. Directorships (2+) is a dummy variable if a director has more than two current directorships. NZX10 and NZX50 are dummy variables if the firms a director sits on are currently part of the NZX 10 or NZX 50 market indices. Prior CEO, Current CEO (listed) and Current CEO (unlisted) are dummy variables based on a director's past or current experience as a CEO. International Experience is a dummy variable if a director has worked abroad. M&A Experience measures the number of deals a director has experienced as a director. Professional Expertise are a series of dummy variables if the director has held or holds a position in the relevant profession. Banking and Finance and Consumer Goods and Services are dummy variables that equal 1 if the director has experience in that industry while Industry Experience (N) measures the number of different ICB industries a director has experience in. More detail regarding the variable definition can be found in Appendix A.

Table 2 presents correlation coefficients between the variables employed in our study. As expected, we see reasonably strong positive correlations among the connectivity measures *DEG*, *CLO*, *BET*, and *EIG*, although the correlations are low enough to suggest that the four individual connectivity measures are measuring different aspects of connectivity. *AGG* has a strong correlation with the individual components, ranging between 0.9 and 0.6. The correlation between *HCI* and *AGG* is 0.3, indicating a moderately strong positive relationship between human capital and connectivity. As discussed above, the number of directorships (*DIR*) is highly correlated with *AGG* (0.69). We also observe that *DIR* is positively related to *HCI*, indicating that high human capital directors are more likely to hold multiple directorships. To ensure that multicollinearity is not an issue given the strong correlations between some variables, we generate variance inflation factors. None exceed 2.03, well below the maximum accepted value of 10 (Midi et al. 2010).

Table 2. Pearson pairwise correlations.

	AGG	DEG	CLO	BET	EIG	HCI	FEM	NZ
DEG	0.90							
CLO	0.67	0.46						
BET	0.78	0.69	0.31					
EIG	0.60	0.44	0.27	0.20				
HCI	0.30	0.32	0.21	0.25	0.06			
FEM	0.02	0.03	0.01	0.02	0.00	0.00		
NZ	0.07	−0.02	0.10	0.13	0.00	−0.16	−0.03	
DIR	0.69	0.72	0.30	0.76	0.16	0.28	0.02	0.16

This table reports Pearson pairwise correlations for the variables employed in the empirical analyses. Degree (*DEG*), closeness (*CLO*), betweenness (*BET*), and eigenvector (*EIG*) are the four social network analysis connectivity factors while *AGG* is the PCA factor (*AGG*). *FEM* is a dummy variable that equals 1 if a director is a woman, *NZ* is a dummy if the director is domiciled in New Zealand, and *DIR* is the number of current directorships the director holds at listed firms in NZ.

4. Empirical Findings

Univariate Analysis

We first examine the relationship between social capital and human capital by comparing differences in the average human capital of the top and bottom 25% of directors each year based on their aggregate connectivity score (*AGG*). We tested for significance in the differences using a *t*-test and reported the results in Table 3. The results show significant differences in the human capital attributes of the most and least connected directors. Specifically, high-connectivity directors are older than low-connectivity directors, 56.9 vs. 55.6 years old, are more likely to have a tertiary qualification, 75% vs. 66%, and are more likely to have prior experience as a CEO, but less likely to be a current CEO. This finding regarding CEOs is consistent with Larcker and Miles' (2011) who find that CEOs are highly sought after for board positions, but find that the time commitments of the CEO role limits their contribution as a director. High-connectivity directors also sit on more boards, 1.72 vs. 1.02. We also observe a marked difference in director experience with a much higher average number of years on boards for high-connectivity directors, 7 vs. 5.6 years. The number of M&A deals a highly connected director has been involved with is on average, at least three times that of a low connectivity director. Low-connectivity directors are also more likely to be directors of smaller firms, with only 11% sitting on an NZX50 company, and zero on an NZX10 company. Interestingly, 10% of high-connectivity directors are women, which is 3% higher compared to low-connectivity directors, potentially signalling that female directors are more likely to sit on boards with more connections, or that they generally sit on multiple boards.

Looking at professional careers, high-connectivity directors are more likely to be accountants, financial experts, and professional directors (who hold on average 1.6 board seats). The high connectivity of professional directors is consistent with these directors typically being retired and therefore having the time to sit on multiple boards. High-

connectivity directors are also more likely to have experience in a greater number of industries, 1.62 vs. 1.34. These results clearly suggest that certain human capital attributes of directors are related to their level of social capital.

Table 3. Attributes of high-connected versus low-connected directors.

Variable	AGG p75 = 1 (High)	AGG p25 = 1 (Low)	Mean Difference (High–Low)	T/Z Stat	
Observations	3052	3054			
Female	10%	7%	3%	(3.50)	***
Age	56.9	55.6	1.3	(4.25)	***
New Zealand	72%	74%	−2%	(−1.74)	*
Undergraduate	39%	34%	5%	(4.06)	***
Postgraduate	36%	32%	4%	(3.85)	***
No Degree	24%	34%	−10%	(−8.31)	***
Director Experience	7.04	5.60	1.44	(9.43)	***
Directorships	1.72	1.02	0.70	(41.74)	***
NZX10	20%	0%	20%	(27.65)	***
NZX50	65%	11%	54%	(45.14)	***
Prior CEO Experience	43%	38%	5%	(4.24)	***
Current CEO (listed)	10%	16%	−6%	(−6.40)	***
Current CEO (non-listed)	9%	14%	−5%	(−5.74)	***
International Experience	45%	44%	1%	(0.54)	—
M&A Experience	3.52	0.74	2.78	(21.01)	***
Industry Experience	1.62	1.34	0.28	(10.47)	***
Professional Expertise					
Accountant	21%	16%	5%	(5.35)	***
Banker	14%	16%	−2%	(−2.41)	**
Consultant	7%	11%	−4%	(−5.20)	***
Financial Expert	28%	20%	8%	(7.15)	***
General Executive	30%	34%	−4%	(−4.02)	***
Lawyer	8%	8%	0%	(−1.22)	—
Prof Director	21%	6%	15%	(17.23)	***

This table reports the human capital and other attributes for directors in the top 25% connectivity quantile versus directors in the bottom 25% connectivity quantile. Each year, directors are sorted into four quantiles based on their measure of AGG. Directors in the top 25th percentile are in the high group and directors in the bottom 25th percentile are in the low group. The second to last column of the table reports the average differences in the attributes between the high versus low connected directors, followed by the statistical significance based on a two-tailed two-sample t/z-test with unequal variances. AGG is the PCA connectivity factor. Female is a dummy variable that equals 1 if a director is a woman. Age is the age of the director in the sample year. New Zealand is a dummy if the director was domiciled in New Zealand, Undergraduate, Postgraduate and No Degree are dummy variables based on the highest qualification of a director. Director experience is the cumulative number of years of director experience a director has, Directorships is the number of current directorships a director has. NZX10 and NZX50 are dummy variables if the firms a director sits on are currently part of the NZX 10 or NZX 50 market indices. Prior CEO, Current CEO (listed) and Current CEO (unlisted) are dummy variables based on a director's past or current experience as a CEO. International Experience is a dummy variable if a director has worked abroad. M&A Experience measures the number of deals a director has experienced as a director. Professional Expertise are a series of dummy variables if the director has held or holds a position in the relevant profession. More detail regarding the variable definition can be found in Appendix A. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

We next undertake univariate analysis of the relationship between AGG, the variable of interest, and HCI, which measures director human capital. The sample directors are ranked by their AGG measure and then sorted into quartiles. In panel A of Table 4, we report the average estimates of HCI and DIR for each quartile. The first important result is that HCI monotonically increases across the social capital quartiles. Specifically, we observe statistically significant increases of 0.81 between the first and second quartiles, 0.40 between the second and third quartiles, and 0.99 between the third and fourth quartiles. Overall, we observe a 2.19 increase in HCI between the high and low quartile. This indicates a strong relationship between an increase in social capital and an increase in human capital. To put the results into perspective, the difference of 2.19 between the high and low quartile is

nearly a full standard deviation of the *HCI*. We also find similar patterns between *AGG* and *DIR* with the exception that there is not a significant difference in the average number of directorships between quartiles 2 and 3. Around 85% of the director observations only hold one directorship, thus there is not a substantial amount of variation in the lower quartiles. Nevertheless, the results do suggest that the number of directorships is positively related to connectivity and should be included in regressions.

Table 4. Univariate analysis.

<i>Panel A: Univariate Test of the Relationship between Connectivity (AGG), Human Capital and Director Characteristics</i>								
Variable	Quartiles				Mean Difference (High–Low)			
	Low	2	3	High	2—Low (T Stat)	3—2 (T Stat)	High—3 (T Stat)	(High–Low) (T Stat)
Observations	3054	3052	3053	3052				
HCI	5.03	5.84	6.23	7.22	0.81 *** (13.25)	0.40 *** (6.12)	0.99 *** (14.30)	2.19 *** (33.46)
DIR	1.02	1.05	1.05	1.72	0.03 *** (5.30)	0.00 (0.10)	0.67 ** (1.72)	0.70 *** (41.74)
<i>Panel B: Univariate Tests of Human Capital (HCI) Differences between Directors Grouped by Characteristics</i>								
	Obs	0	Obs	1	Mean Difference		T Stat	
NZ	3617	6.73	8594	5.81	−0.93	***	(−18.17)	
FEM	11,142	6.08	1069	6.05	−0.04		(0.43)	
New Director	10,710	6.38	1501	3.92	−2.46	***	(−41.68)	

This table presents a univariate analysis of director attributes for the relationship between human capital and connectivity. Each year, directors are sorted into four quartiles based on their measure of *AGG*. The high group includes directors who are in the top 25th percentile of *AGG*, while the low group includes directors who are in the bottom 25th percentile of *AGG*. *AGG* is the PCA connectivity factor. *HCI* is the human capital index score of directors, *DIR* is the number of directorships a director holds. Female is a dummy variable that equals 1 if a director is a woman. New Zealand is a dummy if the director was domiciled in New Zealand, New Director is a dummy variable if this is the first year that a director has held a public company directorship. The difference in the average *HCI* measures between quartile groups are tested for significance using the two-tailed two-sample *t*-test with unequal variances. ** $p < 0.05$, *** $p < 0.01$.

Panel B of Table 4 reports the averages of *HCI* by country of residence, gender, and new directors. We observe that directors who live in NZ have less human capital than overseas-based directors. This appears to suggest that increasing the director pool by appointing more foreign directors can facilitate boards with more skills, knowledge, and expertise. We find there is no significant difference in relevant human capital between men and women. This finding supports the study of Singh, Terjesen, and Vinnicombe et al.'s (2008), who suggest that new women directors of UK FTSE 100 firms have less board experience, CEO/COO experience, but are more likely to be better educated and have international experience. Our findings suggest that while women may have lower attributes in some areas, they are offset by being stronger in other attributes. We find that new directors have less human capital, which is what we should expect. New directors typically have not had the opportunity to gain much experience on NZ boards given that they have only obtained their first public board appointment.

5. Multivariate Analysis

5.1. Main Regression Analysis

We observe thus far, a significantly positive relationship between human capital and social capital. To further test this relationship, we estimate the following ordinary least square (OLS) model:

$$AGG_{it} = \alpha + \beta_1 HCI_{it} + \beta_2 FEM_{it} + \beta_3 NZ_{it} + \beta_4 DIR_{it} + \sum_{y=1}^Y \theta_y Year_{yt} + \varepsilon_{it} \quad (7)$$

where AGG_{it} is our measure of connectivity, HCI_{it} represents the index for director i in year t 's human capital, FEM_{it} is a dummy variable that equals one if the director is a female, in year t , and zero if a male, NZ_{it} is a dummy variable that equals one if the director resides in New Zealand, in year t , and zero otherwise, DIR_{it} represents the number of directorships held by director i in year t , and $Year_{yt}$ is a set of year dummies to control for time-series trends. Robust standard errors ε_{it} are clustered at the director level (Petersen 2009) assumed to be I.I.D. over directors and time.

We estimate the regressions with DIR in some specifications to test the robustness of the relationship. The correlation coefficients in Table 4 indicate that DIR has a positive relationship with HCI and AGG , thus we expect that including DIR will significantly reduce the explanatory power of HCI in regressions. We only include director age (AGE) in some specifications as reliable information on director age is missing for approximately 39% of the sample, consistent with previous studies (Cashman et al. 2012).

We present the OLS results in Table 5. Overall, the directions of the relationships broadly agree with the correlations in Table 2. Column 1 of Table 6 includes HCI , FEM , and NZ as explanatory variables. We observe that the coefficient on HCI is positive and significant at the 1% level. The positive association between human capital and connectivity suggests that directors with more human capital are also better connected. The coefficient suggests that a director at the 75th percentile of HCI (7.5) achieves an AGG score that is 0.63 higher than a director at the 25th percentile of HCI (4.20).¹ The coefficients on FEM and NZ are positive and significant, suggesting that women and directors who live in New Zealand are better connected than men and directors who live overseas. This evidence demonstrates a positive relationship between human capital and social capital. Directors with more skills, experience, and knowledge typically have more board connectivity. Achieving a greater level of connectivity can be achieved by directors being appointed to boards that are located at the center of the board network, multiple boards, or larger boards, and directors may earn these appointments because of the demand for their human capital.

Table 5. OLS regressions for the relationship between human and social capital.

	1	2	3	4	5
	AGG	AGG	AGG	AGG	AGG
	OLS	OLS	OLS	FE	FE
Constant	−0.920 *** (−9.24)	−2.025 *** (−19.19)	−2.659 *** (−12.99)	−0.979 ** (−2.44)	−2.060 *** (−7.91)
HCI	0.191 *** (12.69)	0.070 *** (7.77)	0.085 *** (7.85)	0.194 *** (10.10)	0.056 *** (5.39)
FEM	0.216 ** (2.31)	0.103 (1.38)	0.163 * (1.79)	0.000 (.)	0.000 (.)
NZ	0.419 *** (6.76)	−0.038 (−0.80)	0.038 (0.64)	0.803 (1.43)	0.290 (0.83)
DIR		1.700 *** (18.41)	1.688 *** (17.80)		1.652 *** (21.68)
AGE			0.001 (0.24)		
Observations	12,211	12,211	7400	12,211	12,211
R2	0.126	0.498	0.554	0.110	0.484
F Stat	17.93	44.41	36.91	14.85	48.27
p(F)	0.000	0.000	0.000	0.000	0.000
Year fixed effects	Y	Y	Y	Y	Y

This table presents results for OLS regressions where each observation represents a director for a given year between 2000 and 2015. The dependent variable, AGG , is the PCA connectivity factor. HCI is the human capital index score for a director, FEM is a dummy variable that equals 1 if a director is a woman. NZ is a dummy if the director was domiciled in New Zealand, DIR is the number of directorships for a director. Age is the age of a director in the sample year. The t -statistics are reported in parentheses below coefficients and are based upon robust standard errors clustered at the director level. Year dummies are included but not shown. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Column 2 of Table 5 provides the results after including *DIR* as a control variable. We observe a strong positive association between *DIR* and *AGG*, suggesting that a director who is appointed to an additional board increases their *AGG* score by around 1.7 points (just over 1 standard deviation). This result is expected as more board positions provide more access to other directors and therefore result in higher connectivity and greater social capital. More directorships also increase the opportunity to control information in the network (measured by betweenness, which requires serving on at least 2 boards). The coefficient on *HCI* is still positive and significant but loses some explanatory power, although we observe a marked increase in the *r*-square compared with column 1. This evidence suggests that greater connectivity is positively related to human capital after controlling for the number of boards a director sits on.

Table 6. First difference OLS regressions.

	1	3	5
	ΔAGG	ΔAGG_{t+1}	ΔHCI_{t+1}
	OLS	OLS	OLS
Constant	−0.226 *** (−4.95)	−0.404 *** (−3.61)	0.529 *** (9.47)
ΔHCI	0.062 *** (3.59)	0.101 ** (2.24)	
ΔAGG			−0.001 (−0.05)
ΔNZ	0.210 (0.51)	0.404 (1.35)	0.330 *** (3.03)
ΔDIR	1.674 *** (20.46)	−0.443 *** (−4.84)	0.084 (1.36)
Observations	2229	1120	1120
R ²	0.583	0.044	0.037
F Stat	75.35	5.97	7.56
p(F)	0.000	0.000	0.000
Year fixed effects	Y	Y	Y

This table presents results for OLS regressions where each observation represents a director for a given year between 2000 and 2015. The dependent variable is the three-year change in *AGG*. Specifically, we calculate the change in variables between 2003 and 2000, 2006 and 2003, 2009 and 2006, 2012 and 2009 and 2015 and 2012. ΔAGG , is the change in PCA connectivity factor. ΔHCI is the change in the human capital index score of the director, *FEM* is a dummy variable that equals 1 if the director is a woman. ΔNZ is the change in the dummy of the director being domiciled in New Zealand, ΔDIR is the change in the number of directorships of the director. The *t*-statistics are reported in parentheses below the coefficient and are based upon robust standard errors clustered at the director level. Year dummies are included but not shown. ** $p < 0.05$, *** $p < 0.01$.

Column 3 of Table 5 includes *AGE* as a control variable. We include the age of directors because older directors could have been provided more opportunities to be on boards and age is commonly employed as a measure of experience. As this data is not consistently available, it reduces the number of observations by around 39%. The coefficient on *AGE* is insignificant suggesting that age has no meaningful impact on connectivity. An explanation for our result could be that the *HCI* variable does a good job at picking up the relevant human capital attributes of directors, eliminating the relevance of age as an observed factor of director experience.

Columns 4 and 5 of Table 5 introduce fixed effects to control for time-invariant individual director attributes, such as innate ability (Verbeek 2012). The results again show consistently significant positive coefficients for *HCI*, supporting our main findings and indicating a strong relationship between human and social capital after controlling for year and director fixed effects. We also find that the number of directorships (*DIR*) also remains positive and significant.

5.2. Robustness Tests

To ensure the validity of our findings, we undertake a series of robustness tests including addressing potential endogeneity issues. There are two main sources of potential endogeneity in our study; omitted variables that may influence both human and social capital, and simultaneity whereby social capital is driven by human capital, but also influences human capital. Simultaneity is an obvious concern in our study as high human capital directors make more attractive directors and thus they sit on multiple boards, but equally, a well-connected director who is on multiple boards will add to their human capital via extra knowledge and experience.

5.2.1. First Differences Regression

To address endogeneity, we begin by rerunning our regressions using first differences. To do so, we examine whether changes in human capital affect contemporaneous and future changes in connectivity or changes in connectivity affect future changes in human capital, or both happen.

We begin by taking observations for every third year to allow for enough variation in the human capital and connectivity measures which change slowly over time (see [Wintoki et al. \(2012\)](#) for a discussion on time-invariant variables). Specifically, we calculate the change in *AGG* and the independent variables between 2000 and 2003, 2003 and 2006, 2006 and 2009, 2009 and 2012, and 2012 and 2015. The reduced sample includes 4500 director-year observations and 2229 changes. The average change in *AGG* is -0.13 with a median of -0.05 and standard deviation of 1.36 . This suggests that changes in connectivity, on average, have been negative. This result is consistent with boards increasing the number of independent board members over time, resulting in fewer directors sitting on multiple boards. The average change in *HCI* is 0.77 with a median of 1 and a standard deviation of 1.04 , suggesting that changes in human capital have on average been positive and more consistent than connectivity. We estimate the following model:

$$\Delta AGG_{it-(t-3)} = \beta_1 \Delta HCI_{it-(t-3)} + \beta_2 \Delta NZ_{it-(t-3)} + \beta_3 \Delta DIR_{it-(t-3)} + \sum_{y=1}^Y \theta_y Year_{yt} + u_{it} \quad (8)$$

where $\Delta AGG_{it-(t-3)}$ is the change in connectivity, $\Delta HCI_{it-(t-3)}$ is the change in human capital, and $\Delta NZ_{it-(t-3)}$ is the change in the director's place of residence, which can be one of three values, -1 , 0 , or 1 . $\Delta DIR_{it-(t-3)}$ is the change in the number of directorships held by a director. Finally, we include year dummies $Year_{yt}$ to control for the time fixed effects on changes in connectivity. We exclude *FEM* from the regression as it does not change over the sample period.

Table 6 presents the OLS estimates for Equation (2), where column 1 presents contemporaneous changes of *AGG* on *HCI*. The coefficients on *HCI* are positive and significant after controlling for *DIR*. These results suggest that current changes in human capital are positively related to current changes in director connectivity. Specifically, the results in column 1 indicate that increasing human capital by one point over a three-year period also increases their level of connectivity by 0.062 . Column 2 provides the results for the impact of a current change in *HCI* on future changes in *AGG* which again shows a positive and significant coefficient. The results in column 2 indicate that when directors increase their human capital by one point over a three-year period, they achieve an increase in *AGG* of 0.101 in the next period. The coefficient on *HCI* is also larger compared to that in column 1. Overall, the evidence supports a causal relationship where an increase in human capital leads to an increase in connectivity. Column 3 investigates the relationship between changes in connectivity on future changes in human capital. The results are insignificant, suggesting that increases in connectivity have limited effects on human capital. This result also suggests that we do not have a simultaneity issue but also reinforces the need to control for human capital when examining the impact of social capital.

5.2.2. Logit Regression

We next test the robustness of our main results by estimating logit regressions to test whether greater levels of human capital increase the likelihood of a director being highly connected. Specifically, we investigate whether the likelihood of being in the 75th quantile of AGG is influenced by human capital. The following logit regression equation is estimated:

$$\ln \left(\frac{P(AGG_{it}^{Q75} = 1)}{1 - P(AGG_{it}^{Q75} = 1)} \right) = \alpha + \beta_1 HCI_{it} + \beta_2 FEM_{it} + \beta_3 NZ_{it} + \beta_4 DIR + \sum_{y=1}^Y \theta_y Year_{yt} + \varepsilon_{it} \quad (9)$$

where P is the probability of director i in year t being in the 75th quantile. The dependent variable is coded as one if director i in year t is in the top 25th percentile of AGG and 0 otherwise; HCI_{it} represents the human capital index for director i in year t and all other variables are consistent with Equation (1). Robust standard errors ε_{it} are clustered at the director level (Petersen 2009).

Table 7 reports the results of the logit model regressions. As logit regression coefficients are typically reported in log-odds units, which are hard to interpret, we report odds ratios which represent the change in the odds of being highly connected arising from a one-unit change in HCI , with 1 representing no change. The overall evidence in Table 7 supports our previous findings that there is a strong causal relationship between human and social capital. In both specifications we observe an odds ratio significantly higher than 1, ranging between 1.317 and 1.155. These findings indicate that a director with an HCI score of 1 point higher, has between a 15% and 32% chance of being a high-connected director. Of the control variables, female directors are between 37% and 52% more likely to be highly connected; unsurprisingly, directors with more directorships are extremely more likely to be better connected. Overall, the findings support the main analysis, predicting a positive relationship between human capital and social capital.

Table 7. Logit regressions for the relationship between human capital and social capital—top 25%.

	1	2
	AGG ^{Q75}	AGG ^{Q75}
	LOGIT	LOGIT
Constant	0.022 *** (−18.25)	0.003 *** (−21.12)
HCI	1.317 *** (14.08)	1.155 *** (6.89)
FEM	1.520 *** (2.81)	1.369 * (1.86)
NZ	1.505 *** (4.17)	0.745 ** (−2.53)
DIR		13.945 *** (14.58)
Observations	12,211	12,211
Pseudo R2	0.104	0.286
Log	−6155	−4903
Wald Chi2	397.7	457.9
p(F)	0.000	0.000
Year fixed effects	Y	Y

This table presents results for logit regressions where each observation represents a director for a given year between 2000 and 2015. The dependent variable equals one if a director is in the top 25% quantile of AGG at time t , and zero otherwise. Odds ratios are reported representing the likelihood of a change in the dependent variable arising from a one-unit change in the independent variable. AGG, is the PCA connectivity factor. HCI is the human capital index score of the director, FEM is a dummy variable that equals 1 if the director is a woman. NZ is a dummy if the director was domiciled in New Zealand, DIR is the number of directorships of the director. Z-statistics, displayed in parenthesis below each odds ratio estimate, are based upon robust standard errors clustered at the director level. Year dummies are included but not shown. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

6. Conclusions

In this study, we attempt to disentangle two important components of board of directors, human capital and social capital, to investigate whether they are associated. Prior studies have noted the need to consider the value of social capital and human capital concurrently, since they are inter-related. However, studies looking at the value of social capital have tended to either exclude human capital measures or only consider a few aspects of human capital. We explore this issue more deeply by constructing a comprehensive index that represents the human capital of a director based on personal attributes identified in prior literature. To measure social capital, we employ social network analysis to compute four commonly employed connectivity measures which we aggregate into a single score based on principal components analysis. This aggregate connectivity measure estimates the value of a director's social capital. We conduct a battery of tests to investigate the association between human capital and social and find consistent evidence of a significant positive relationship between two types of capital. We find that a higher level of human capital increases current and future connectivity and thus social capital. We also provide evidence that this relationship runs in only one direction, whereby changes in social capital do not predict changes in future human capital. Our results remain unchanged after conducting multiple robustness tests.

Our results have important implications for several groups. A number of studies have considered the value of social capital for firms, but to date the results have been mixed with some studies finding positive impacts from social capital and others negative. It is important to note though that few studies adequately control for human capital, either employing a few select human capital controls or not controlling for it at all. This may explain the conflict in findings, there we contend that the human capital of directors must be appropriately controlled for in empirical studies considering the value of directors' social capital for boards. Our findings are also likely to be of interest to firms, shareholders, and regulators. Given that boards have a critical role to play from a corporate governance perspective and also in creating firm value, understanding the attributes that make effective directors and boards is of great interest. Our findings suggest that the prior evidence on the value of social capital may need to be re-examined and therefore may alter what we consider to be the most desirable attributes of directors.

Our research suggests additional lines of future research. We establish that human and social capital are interrelated and therefore need to be jointly considered. This suggests that we should reconsider the prior research on the value of social capital to see if adequately controlling for human capital results in a more consistent picture on whether social capital creates value. It is also worth noting that in our study we limit our director network to only publicly listed companies. It would be of interest to study the social connectivity and human capital of the boards of smaller and private companies, though such information may prove to be difficult to acquire.

Author Contributions: Conceptualisation, A.A., A.G. (Alexandre Garel), A.G. (Aaron Gilbert), and A.T.-R.; Investigation, A.A.; Formal Analysis, A.A., A.G. (Aaron Gilbert), and A.T.-R.; Writing—Original Draft, A.A., A.G. (Alexandre Garel), A.G. (Aaron Gilbert), and A.T.-R.; Writing—Review and Editing, A.A., A.G. (Aaron Gilbert) and A.T.-R. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A. Description of Variables

Variable	Type	Definition
Social Capital Measures		
Degree (DEG)	Continuous, Ratio	Number of unique direct connections for director <i>i</i> to all other <i>j</i> directors in the network at FYE, scaled by $n - 1$ (n = total directors in network).
Closeness (CLO)	Continuous, Ratio	Sum of the inverse of the shortest distance between director <i>i</i> and all other directly and indirectly connected <i>j</i> directors in the network at FYE, scaled by its maximum possible value $n-11$ (n = total directors in network).
Betweenness (BET)	Continuous, Ratio	Sum of the proportions of all the shortest paths linking two directors which pass through director <i>i</i> at FYE, scaled by its maximum possible value $((n^2 - 3n + 2)/2)$.
Eigenvector (EIG)	Continuous, Ratio	Sum of director <i>i</i> 's first-degree connections to all other directors in the network, weighted by the connectedness of the directors to which it is connected to.
Aggregate Connectivity (AGG)	Continuous, Interval	Principal component analysis of degree, closeness, betweenness, and eigenvector to reduce the dimensions into one principal factor of social capital.
Human Capital Index		
HCI	Count, Discrete	Self-constructed index consisting of 9 different human capital attributes. The individual categories form a human capital index which has a maximum possible value of 18.
Director Characteristics		
Age	Count, Discrete	Directors' age in years.
Female (FEM)	Dichotomous	Dummy variable equal to one if the director is a female.
New Zealand (NZ)	Dichotomous	Dummy variable equal to one if the director is an NZ citizen/resides in NZ.
Education		
Undergraduate	Dichotomous	Dummy variable equal to one if the director's highest degree is a bachelor's degree or LLB.
Postgraduate	Dichotomous	Dummy variable equal to one if the director's highest degree is a postgraduate-level qualification including honors, JD, postgraduate cert/dip, masters, MBA, and PhD.
No Degree	Dichotomous	Dummy variable equal to one if no degree qualifications (minimum degree level is a bachelor's degree).
Director Experience		
Director Experience	Count, Discrete	Number of prior years' experience as a director of firms in NZ database (years counted concurrently).
Directorships (DIR)	Count, Discrete	Number of current directorships the director holds at listed firms in NZ.
Director Expertise		
NZX10	Dichotomous	Dummy variable equal to one if a director at an NZX10 firm, zero otherwise. NZX firm is defined as one that has been part of the index at any time during the respective year.

Variable	Type	Definition
NZX50	Dichotomous	Dummy variable equal to one if a director at an NZX50 firm, zero otherwise. NZX firm is defined as one that has been part of the index at any time during the respective year.
CEO Experience		
Prior CEO Experience	Dichotomous	Dummy variable equal to one if the director has been a CEO of a listed or non-listed firm either in NZ or abroad, in prior years. Note that a director with prior CEO experience may still be a current CEO.
Current CEO (listed)	Dichotomous	Dummy variable equal to one if (if information given) director is currently a CEO of an NZ listed firm, or another listed firm abroad.
Current CEO (non-listed)	Dichotomous	Dummy variable equal to one if (if information given) director is currently a CEO of another non-listed firm.
Other Significant Experience		
International Experience	Dichotomous	Dummy variable equal to 1 if the director had international exposure (sales), who lived or worked abroad, or who is a foreigner. Foreigners exclude those who have lived in NZ for most of their life.
M&A Experience	Count, Discrete	Cumulative number of completed deals a director has been associated with for the sample of NZ firms between 1993 and the respective year. Deals include directing firms that have acquired, sold, or were the target.
Professional Expertise		
Accountant	Dichotomous	Dummy variable equal to one if the director's occupation is classified as an accountant or financial controller (experience as a CA, CPA, CFO).
Banker	Dichotomous	Dummy variable equal to one if the director's occupation is classified as a banker (experience as an investment banker, commercial banker, fund manager, stockbroker, finance industry experience, CFA).
Consultant	Dichotomous	Dummy variable equal to one if the director's occupation is classified as a consultant (management, IT, marketing, strategy, industry-specific).
General Executive	Dichotomous	Dummy variable equal to one if the director's occupation is classified as a general executive/businessperson (not classified into another occupation group).
Financial Expert	Dichotomous	Dummy variable equal to one if the director has any of the following qualifications: CA, ACA, CMA, CPA, CFA/CSA.
Lawyer	Dichotomous	Dummy variable equal to one if the director's occupation is classified as a lawyer (experience as a practicing lawyer).
Prof Director	Dichotomous	Dummy variable equal to one if the director is identified as a professional director (often a retiree or corporate governance expert).
Industry Experience		
Banking	Dichotomous	Dummy variable equal to 1 if the director has significant experience with a banking/savings/loan firm (GIC code 04/ICB Code 8300).
Basic Materials	Dichotomous	Dummy variable equal to 1 if the director has significant experience in the basic materials industry, including mining, chemicals, and forestry (GIC code 02/ICB code 7000).
Consumer Goods	Dichotomous	Dummy variable equal to 1 if the director has significant experience in the consumer goods industry (ICB Code 3000).

Variable	Type	Definition
Consumer Services	Dichotomous	Dummy variable equal to 1 if the director has significant experience in the consumer services industry (ICB Codes 5000).
Finance	Dichotomous	Dummy variable equal to 1 if the director has significant experience with a financial or insurance firm, including banks, insurance, or real estate firms and other financial firms (GIC codes 05 and 06/ICB Codes 8500 and 8700).
Health	Dichotomous	Dummy variable equal to 1 if the director has significant experience in the health industry (ICB Code 4000).
Industrial	Dichotomous	Dummy variable equal to 1 if the director has significant experience with an industrial /transportation firm (GIC code 01 and 03/ICB Code 2000).
Oil and Gas	Dichotomous	Dummy variable equal to 1 if the director has significant experience in the oil and gas industry (ICB Code 0001).
Technology	Dichotomous	Dummy variable equal to 1 if the director has significant experience in the technology industry (ICB Code 9000).
Telecommunications	Dichotomous	Dummy variable equal to 1 if the director has significant experience in the telecommunications industry (ICB Code 6000).
Utilities	Dichotomous	Dummy variable equal to 1 if the director has significant experience in the utility industry (GIC code 02/ICB code 7000).
Industry Experience	Count, Discrete	Cumulative number of ICB industries a director has significant experience in. The total number of industries equals 10: banking and finance, basic materials, consumer goods, consumer services, health, industrial, oil and gas, technology, telecommunications, and utilities.

Appendix B. Principal Component Analysis of Centrality Measures

Panel A: Principal Component Analysis

	Component 1	Component 2	Component 3	Component 4
DEG	0.605	−0.144	−0.168	−0.765
CLO	0.450	0.114	0.875	0.142
BET	0.519	−0.559	−0.288	0.579
EIG	0.403	0.809	−0.352	0.244
Eigenvalue	2.229	0.819	0.698	0.254
Variance explained %	55.72	20.49	17.45	6.34
Cumulative %	55.72	76.21	93.66	100

Panel B: Cronbach's Alpha Validity Test

	Item-test correlation	Item-rest correlation	Average inter-item correlation	Alpha
DEG	0.876	0.744	0.263	0.517
CLO	0.692	0.441	0.444	0.706
BET	0.744	0.520	0.393	0.660
EIG	0.648	0.377	0.488	0.741
Test scale = mean (standardized items)			0.397	0.723
Observations				12,211

This table presents principal component analysis (PCA) for the social capital measures employed. Panel A reports the PCA for the centrality measures. PCA creates four new uncorrelated components, 1–4. Component 1 has the greatest eigenvalue of 2.229 as it captures the most variation in the centrality measures (variance explained = 55.72%). This component therefore extracts the most important information and similarity in the data (Abdi and Williams 2010). We use this component as our social capital measure, aggregate connectivity (AGG). Components 2–4 have eigenvalues under 1, suggesting that the loss of information is low excluding these vectors. Panel B reports the Cronbach's (1951) "The Alpha Validity Test" statistics for the validity of the first principal component (component 1), used to create AGG. The test scale of 0.723 for AGG is within the acceptable range of 0.70–0.95 (Bland and Altman 1997; Tavakol and Dennick 2011), suggesting that AGG is statistically reliable.

Note

- ¹ We calculate the increase in connectivity by the difference between *HCI* at the 75th and 25th percentile multiplied by the coefficient on *HCI*: $(7.5 - 4.2) \times 0.191 = 0.6303$.

References

- Abdi, Herve, and Lynne J. Williams. 2010. Principle Component Analysis. *Wiley Interdisciplinary Reviews: Computational Statistics* 2: 433–59. [CrossRef]
- Adams, Renee, Ali Akyol, and Patrick Verwijmeren. 2018. Director skill sets. *Journal of Financial Economics* 130: 642–62. [CrossRef]
- Ahn, Seoungpil, Pornsit Jiraporn, and Young Sang Kim. 2010. Multiple directorships and acquirer returns. *Journal of Banking & Finance* 34: 2011–26.
- Akbas, Ferhat, Felix Meschke, and M. Babajide Wintoki. 2016. Director networks and informed traders. *Journal of Accounting and Economics* 62: 1–23. [CrossRef]
- Andres, Christian, Inga Bongard, and Mirco Lehmann. 2013. Is busy really busy? Board governance revisited. *Journal of Business Finance & Accounting* 40: 1221–46.
- Bailey, Michael, Rachel Cao, Theresa Kuchler, Johannes Stroebel, and Arlene Wong. 2018. Social connectedness: Measurement, determinants, and effects. *Journal of Economic Perspectives* 3: 259–80. [CrossRef]
- Barnea, Amir, and Ilan Guedj. 2007. *Sympathetic Boards: Director Networks and Firm Governance*. Austin: University of Texas at Austin, Unpublished Manuscript.
- Becker, Gary S. 1993. *Human Capital*. Chicago: University of Chicago Press.
- Bland, J. Martin, and Douglas G. Altman. 1997. Statistics notes: Cronbach's alpha. *BMJ* 314: 572. [CrossRef]
- Bonacich, Phillip. 1972. Factoring and weighting approaches to status scores and clique identification. *Journal of Mathematical Sociology* 2: 113–20. [CrossRef]
- Bonacich, Phillip. 1987. Power and Centrality: A Family of Measures. *American Journal of Sociology* 92: 1170–82. [CrossRef]
- Borgatti, Stephen P. 2005. Centrality and network flow. *Social Networks* 27: 55–71. [CrossRef]
- Burt, Ronald S. 1992. *Structural Holes*. Cambridge: Harvard University Press.
- Cashman, George D., Stuart L. Gillan, and Chulhee Jun. 2012. Going overboard? On busy directors and firm value. *Journal of Banking & Finance* 36: 3248–59.
- Cashman, George D., Stuart L. Gillan, and Ryan J. Whitby. 2013. Human and social capital in the labor market for directors. In *Advances in Financial Economics*. Bingley: Emerald Group Publishing Limited, vol. 16.
- Chen, Hsiang-Lan. 2014. Independent Directors Human Capital and Firm Internationalization. *Asian Economic and Financial Review* 4: 1378–88.
- Coleman, James S. 1988. Social capital in the creation of human capital. *American Journal of Sociology* 94: S95–S120. [CrossRef]
- Cronbach, Lee. 1951. Coefficient alpha and the internal structure of tests. *Psychometrika* 16: 297–334. [CrossRef]
- El-Khatib, Rwan, Kathy Fogel, and Tomas Jandik. 2015. CEO network centrality and merger performance. *Journal of Financial Economics* 116: 349–82. [CrossRef]
- Equilar. 2016. The top 20 board skills in the S&P 500. Available online: <http://www.equilar.com/blogs/bi/12--07-2016-the-top-20-board-skills-in-the-s&p-500.html> (accessed on 20 December 2016).
- Fama, Eugene F., and Michael C. Jensen. 1983. Separation of ownership and control. *Journal of Law and Economics* 26: 301–25. [CrossRef]
- Fedaseyeu, Viktor, James S. Linck, and Hannes F. Wagner. 2018. Do qualifications matter? New evidence on board functions and director compensation. *Journal of Corporate Finance* 48: 816–39. [CrossRef]
- Ferris, Stephen P., Murali Jagannathan, and Adam C. Pritchard. 2003. Too busy to mind the business? Monitoring by directors with multiple board appointments. *The Journal of Finance* 58: 1087–111. [CrossRef]
- Fich, Eliezer M. 2005. Are Some Outside Directors Better than Others? Evidence from Director Appointments by Fortune 1000 Firms. *The Journal of Business* 78: 1943–72. [CrossRef]
- Fich, Eliezer M., and Anil Shivdasani. 2007. Financial fraud, director reputation, and shareholder wealth. *Journal of Financial Economics* 86: 306–36. [CrossRef]
- Field, Laura Casares, and Anahit Mkrtchyan. 2017. The effect of director experience on acquisition performance. *Journal of Financial Economics* 123: 488–511. [CrossRef]
- Field, Laura Casares, Michelle Lowry, and Anahit Mkrtchyan. 2013. Are busy boards detrimental? *Journal of Financial Economics* 109: 63–82. [CrossRef]
- Fracassi, Cesare, and Geoffrey Tate. 2012. External networking and internal firm governance. *The Journal of Finance* 67: 153–94. [CrossRef]
- Freeman, Linton C. 1978. Centrality in social networks conceptual clarification. *Social Networks* 1: 215–39. [CrossRef]
- Gray, Stephen, and John Nowland. 2013. Is prior director experience valuable? *Accounting & Finance* 53: 643–66.
- Herrmann, Pol, and Deepak K. Datta. 2005. Relationships between Top Management Team Characteristics and International Diversification: An Empirical Investigation. *British Journal of Management* 16: 69–78. [CrossRef]
- Hochberg, Yael V., Alexander Ljungqvist, and Yang Lu. 2007. Whom you know matters: Venture capital networks and investment performance. *The Journal of Finance* 62: 251–301. [CrossRef]

- Horton, Joanne, Yuval Millo, and George Serafeim. 2012. Resources or power? Implications of social networks on compensation and firm performance. *Journal of Business Finance & Accounting* 39: 399–426.
- Jahan, Mosammet Asma. 2018. An Empirical Study on Multiple Corporate Directorships in New Zealand: A New Interpretation of Selected Governance Theories. Ph.D. thesis, Victoria University of Wellington, Wellington, New Zealand. Available online: <http://hdl.handle.net/10063/6971> (accessed on 1 March 2019).
- Johnson, Scott G., Karen Schnatterly, and Aaron D. Hill. 2013. Board composition beyond independence social capital, human capital, and demographics. *Journal of Management* 39: 232–62. [\[CrossRef\]](#)
- Larcker, David F., and Stephen A. Miles. 2011. *Corporate Board of Directors Survey*. Los Angeles: Heidrick & Struggles and Stanford University.
- Larcker, David F., Eric C. So, and Charles C. Y. Wang. 2013. Boardroom centrality and firm performance. *Journal of Accounting and Economics* 55: 225–50. [\[CrossRef\]](#)
- Midi, Habshah, Saroje K. Sarkar, and Sohail Rana. 2010. Collinearity diagnostics of binary logistic regression model. *Journal of Interdisciplinary Mathematics* 13: 253–67. [\[CrossRef\]](#)
- Nicholson, Gavin J., and Geoffrey C. Kiel. 2004. A framework for diagnosing board effectiveness. *Corporate Governance: An International Review* 12: 442–60. [\[CrossRef\]](#)
- Nieminen, Juhani. 1974. On the centrality in a graph. *Scandinavian Journal of Psychology* 15: 332–66. [\[CrossRef\]](#) [\[PubMed\]](#)
- Nyberg, Anthony J., and Patrick M. Wright. 2015. 50 years of human capital research: Assessing what we know, exploring where we go. *Academy of Management Perspectives* 29: 287–95. [\[CrossRef\]](#)
- OECD. 2001. *The Well-Being of Nations: The Role of Human and Social Capital*. Paris: OECD.
- Omer, Thomas C., Marjorie K. Shelley, and Frances M. Tice. 2014. Do Well-connected directors affect firm value? *Journal of Applied Finance* 24: 17–32.
- Opsahl, Tore, Filip Agneessens, and John Skvoretz. 2010. Node centrality in weighted networks: Generalising degree and shortest paths. *Social Networks* 32: 245–51. [\[CrossRef\]](#)
- Petersen, Mitchell. 2009. Estimating standard errors in finance panel data sets: Comparing approaches. *The Review of Financial Studies* 22: 435–80. [\[CrossRef\]](#)
- Sabidussi, Gert. 1966. The centrality index of a graph. *Psychometrika* 31: 581–603. [\[CrossRef\]](#)
- Shuller, Tom. 2001. The complementary roles of human and social capital. *Canadian Journal of Policy Research* 2: 18–24.
- Spencer Stuart. 2017. *Spencer Stuart U.S. Board Index*. New York: Spencer Stuart.
- Tavakol, Mohsen, and Reg Dennick. 2011. Making sense of Cronbach's alpha. *International Journal of Medical Education* 2: 53. [\[CrossRef\]](#) [\[PubMed\]](#)
- Terjesen, Siri, Ruth Sealy, and Val Singh. 2009. Women Directors on Corporate Boards: A Review and Research Agenda. *Corporate Governance: An International Review* 17: 320–37. [\[CrossRef\]](#)
- Van der Walt, Nicholas T., and Coral B. Ingley. 2003. Board Dynamics and the Influence of Professional Background, Gender and Ethnic Diversity of Directors. *Corporate Governance: An International Review* 11: 218–34. [\[CrossRef\]](#)
- Verbeek, Marno. 2012. *A Guide to Modern Econometrics*, 4th ed. West Sussex: John Wiley & Sons.
- Vinnicombe, Susan, Val Singh, Ronald J. Burke, Diana Bilimoria, and Morten Huse. 2008. *Women on Corporate Boards of Directors: International Research and Practice*. Cheltenham: Edward Elgar Publishing Limited.
- Volonté, Christophe, and Pascal Gantenbein. 2014. Directors' human capital, firm strategy, and firm performance. *Journal of Management & Governance* 20: 1–31. [\[CrossRef\]](#)
- Wasserman, Stanley, and Katherine Faust. 1994. *Social Network Analysis: Methods and Applications*. Cambridge: Cambridge University Press, vol. 8.
- Wells, Philippa, and Jens Mueller. 2014. Boards of directors in New Zealand: What do they reveal about governance? *International Journal of Business and Globalisation* 12: 334–57. [\[CrossRef\]](#)
- Wintoki, M. Babajide, James S. Linck, and Jeffry M. Netter. 2012. Endogeneity and the dynamics of internal corporate governance. *Journal of Financial Economics* 105: 581–606. [\[CrossRef\]](#)