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Locating women board members in gendered director networks

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Abstract

Purpose – Despite the extensive study of director interlocks very little is known about gendered director networks. Boards of directors are primarily male; globally, only 5-20 per cent of directors are women and change is described as glacially slow. The extent to which women directors are central to the network, or pushed to the margins, is unknown. Using the tools of social network analysis we extract the components of three director networks, a global and two national networks and locate the women directors. The paper aims to examine the persistence of director networks over time to determine whether gender related differences – apart from size – contribute to the apparent resistance to change.

Design/methodology/approach – The paper uses a longitudinal approach, comparing director networks on a global network scale (2004 and 2007 *Fortune* Global 200) and a national one (2004 and 2007 New Zealand Stock Exchange) with the iconic 1999 *Fortune* US 1000 dataset. After extracting the largest connected component, the female directors are separated out. From the 2004 and 2007 data director turnover is calculated to determine the stability of the networks.

Findings – Female directors are more likely to be found in the largest connected component of the mixed gender network, indicating that they are not marginalised. Despite high turnover rates, director networks are stable over time which may manifest as resistance to change.

Originality/value – The structure of gendered director networks is unknown and the location of women directors in the network components has not been considered in board diversity research. The results point to an underlying gender equity in all director networks. A new theoretical approach, glass network theory, has implications for boardroom diversity interventions.

Keywords Women directors, Network diversity, Glass ceiling, Gender, New Zealand

Paper type Research paper

1. Introduction

Globally, only 5-20 per cent of directors of substantial organisations are women (Vinnicombe *et al.*, 2008). While this gender imbalance is increasingly under challenge in Western countries, as notions of gender equity and equal employment opportunities become the norm, the ratio has remained remarkably constant despite 30 years of affirmative action (Joy, 2008; Hawarden and Stablein, 2008; Ross-Smith and Bridge, 2008; Shilton *et al.*, 2010). Progress has been described as "glacially slow" (Bellar *et al.*, 2004) and "glacial at best" (Ross-Smith and Bridge, 2008). Only where quotas have been introduced, in countries such as Norway and Spain, is board equity being achieved (Seierstad and Opsahl, 2011; de Anca, 2008; Huse, 2007).

Women directors have also been the subject of research for over 30 years (McGregor and Fountaine, 2006; Vinnicombe, 2011; Vinnicombe *et al.*, 2008), but in their recent comprehensive review, Terjesen *et al.* (2009) find much of the Women on Boards (WOB) research descriptive in nature and lacking in theory. However, there is considerable data: the numbers of women directors on listed stock exchanges have been globally tracked since the early 1990s through regular national censuses and by organisations such as Catalyst (Burke and Mattis, 2000; Vinnicombe *et al.*, 2008). This data, largely in the form of raw numbers, does little to explain the dynamic and interrelated nature of director

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interactions or the role that gender may play. In this paper, we introduce social network analysis as a useful tool for Woman on Boards research, presenting one facet of an attempt to explain the slow rate of change, known as glass network theory (GNT) (Hawarden, 2010). Social network analysis, the core methodology of GNT, lends itself to longitudinal research as shown here and can be used to track the effectiveness of diversity interventions.

We wish to lay the foundations for a theoretical approach to the analysis of gendered director networks based on advances in complex network theory. We term this the "glass network", in analogy to the ubiquitous metaphor of the glass ceiling, which Baxter and Wright (2000, p. 71) suggest is "one of the most compelling metaphors for analyzing inequalities between men and women in the workplace". Although invisible to the participants, we suggest that director networks have a specific structure that can be revealed through social network analysis. This methodology will also establish whether the structure of male and female director networks are similar or different and whether these constitute inequalities. The distribution of directors by sex in director networks needs to be established before the "gendered" functioning of director networks can be meaningfully discussed. Unlike the glass ceiling, which is viewed as a solid barrier, in glass networks the gender barriers are conceptualised as transparent and semi-permeable, allowing a small, but constant proportion of women into boardrooms. Single seat women directors are linked into director networks largely through male colleagues, while the few women who have multiple directorships actively participate in the creation of the network components. In particular, we are interested in investigating the hypothesis that women are not sidelined despite their small numbers, but are present throughout the network components and are more likely to be found in the largest component. This supposition underpins the evidence that more women are found on the boards of bigger and more successful companies which have larger boards (Carter *et al.*, 2003; Farrell and Hersch, 2005; Nguyen and Faff, 2007). Directors of these companies are more likely to be connected to each other through multiple board appointments forming a large linked network component (Battiston and Catanzaro, 2004).

We consider earlier research into director links or interlocks and suggest that this research has been revitalised by recasting interlocks as a type of network link that impacts individual and company actions and outcomes. With the development of social network analysis tools (Scott, 2000), the influence of director networks on company performance has been a focus of research but director gender has been ignored (Böhler *et al.*, 2010). In the WOB literature board diversity has been related to company performance and sustainability, but director networks have been ignored (Farrell and Hersch, 2005; Galbreath, 2011; Nguyen and Faff, 2007; Reddy *et al.*, 2011). This paper introduces social network concepts into board diversity research thus bridging the gap between these two research streams. Before the relationship to company performance can be considered, the structure of gendered board networks needs to be established. The distribution and location of women directors in director networks at a global, national or local level may reflect a specific form of network which determines the possible pathways of action and influence with varying effects on the performance of companies which operate at these three levels.

We begin by discussing why there is research interest in directors who sit around multiple board room tables together, before introducing the network graph, the mathematical model that underpins social network analysis. Following this, we describe

our methodology for identifying and extracting the network components and locating the women directors within them. We examine three director networks, one global and two national that vary in size and location, namely an iconic American dataset, the Fortune Global 200 network and the network of the directors of the 200 companies listed on the New Zealand Stock Exchange (NZX). In presenting the results of this first social network analysis of mixed gender corporate boards, gender serves as an analytical tool revealing the formerly invisible structure of director networks. We also consider director turnover rates by gender in relation to network stability and its persistence as an observable structure over time.

2. Director interlock research

Researchers have long considered that the holding of multiple directorships establishes channels of power and, by driving corporate performance, determines the shape of the business landscape (Davis, 1996; Davis *et al.*, 2003; Mizruchi, 1996). Sitting together around a boardroom table creates a link or interlock between two directors, with more links being created when directors invite co-directors to take up vacancies on other boards. Interlocking seats are seen to facilitate political cohesion amongst corporate elites or "inner circles" (Useem, 1984), and encourage the flow of valuable information on business practices across multiple companies on multiple topics (Tan and Keong, 2006). With business interests spanning communities and countries, linked director networks can exist at local, regional, national and global levels (Kono *et al.*, 1998).

In both small and large national economies, there have been concerns of undue influence through board interlocks, with director and company interlocks being the subject of a number of studies, reflecting an interest by economists and management scholars in company control, potential conflicts of interest, hegemony of financial institutions and competitiveness (Alexander *et al.*, 1994; Firth, 1987; Murray, 2001; Roy *et al.*, 1994; Walker and Borrowdale, 1994). However, high levels of director interlocks can also be seen as desirable collusion to increase sector size to promote international competitiveness (Firth, 1987). Alternatively, in a small economy such as that of New Zealand, decreases in the numbers of directors, seats and companies and reduced interlocks observed by Roy *et al.* (1994), were regarded as undesirable, concentrating control in a small group of companies, with insurance companies dominating the interlock pattern. These descriptive papers focusing on concerns of political or economic control did report on the distribution of multiple directorships, but lacked a theory and methodology to extract and observe the network structure that such multiple directorships create.

3. Director networks – terminology, formation, location and stability

3.1 Network terminology

There is a large amount of research into social networks, part of the field of complex networks. A short explanation of the critical concepts is given here. Mathematically, networks are represented as a "graphs", consisting of a set of vertices or nodes, with links or edges between them signifying some connection between the nodes. The power of this mathematical abstraction is that a great many things can be represented and compared in this way, using the same underlying algorithms and analytical tools (Barabási and Bonabeau, 2003; Buchanan, 2002; Scott, 2000). In this paper, in common with many others (Battiston *et al.*, 2003; Conyon and Muldoon, 2006; Kogut and Walker, 2001; Newman, 2002, 2003b) we identify individual directors as nodes, and then

place edges between any pair of directors who sit on a board together. In GNT terms, directors who sit on more than one board are referred to as connector directors as they link other directors and companies together. While there are variations on the general graph theme to include directed edges (equivalent to one-way streets) and weights on the edges, we ignore that here. Battiston and Catanzaro (2004) have used weights on edges to signify that two directors sit on more than one board together and find such "lobbies" a macroscopic phenomenon relevant to decision-making dynamics. Alexander (2003), using the term "redundancy", examined the levels of multiple common boards in both company and director networks over a 20 year period, reporting little change to company redundancy but greater interpersonal connectivity. In WOB research the problem is compounded as lobby directors can consist of single gender or mixed gender pairs, triplets, etc. This paper deals with the problem of lobbies by dichotomising the link between directors, so that there is just one edge between any pair and all edges have a weight equal to one.

When a graph is visualised it can often be seen that it is not completely connected but consists of a number of components, usually a large component and many smaller ones (Newman *et al.*, 2006). Starting with a random director and following edges, there will be some subset of the directors whom cannot be reached. This causes problems for computing the distances between nodes in a graph, since there are a number of pairs of nodes where there is no path between them. For this reason, network analysis tends to consider only the largest component of the graph, which is the biggest piece of the graph such that it is possible to reach every node in the piece by following some path. As is well described elsewhere, it is a property of complex networks (including director networks) that there will be such a large component, and it will represent a significant proportion of the entire graph (Battiston and Catanzaro, 2004; Callaway *et al.*, 2001). It is also possible to create sub-networks of the director network by using specific director attributes, such as gender or presence in the network at two points in time to include or exclude directors and others linked to them. For example, we could extract the male-only or female-only networks from a larger mixed gender network. In this study, we investigate a mixed gender sub-network which we term "continuing directors", being a sub-set of directors present in both 2004 and 2007 on the boards investigated.

3.2 The location of female directors in director networks

Three options are possible for the location of women directors in director networks. These are: first, female directors are evenly distributed through the network components second, they are marginalised in the unconnected components or third, they are concentrated in the largest component. Given the known configuration of large and small director network components (Battiston and Catanzaro, 2004), the first option is unlikely. Taking the second option, if business women are seen as marginalised in an economy and peripheral on boards of directors, who appoint them with reluctance, then it can be hypothesised that the few women directors in the network will be found on the periphery of the director network in the smaller unconnected components. If women are marginalised in director networks then board appointment opportunities for women directors will be less easily obtained, a self-perpetuating factor that may be contributing to the static gender balance.

However, GNT predicts the third option, which suggests that women directors are more likely to be found in the largest component. Larger companies are likely to be clustered in the large component as they have larger boards (Burke, 2000) and more

directors with multiple seats (Newman, 2002, 2003a). Women directors tend to be found in larger companies with larger boards, often as the token woman (Carter *et al.*, 2003; Farrell and Hersch, 2005; Nguyen and Faff, 2007).

GNT also emphasizes the role of connector directors who have more than one board appointment in the resulting network structure. This paper considers the extent to which women connector directors are found in director networks and their distribution in the network components because the manner in which directors gain additional board appointments determines the shape of the resulting network. The prevalent method of recruiting directors is through "shoulder tapping" or personal invitations to known colleagues and acquaintances, usually by the chairperson (Conyon and Mallin, 1997). "Homophily", which is a preference for the similar, and "salience", or a preference for characteristics that are notable and relevant drives the "patterns of social mixing" in director networks (Hillman *et al.*, 2002; Newman, 2003a, b). In network terminology nodes that already have links are preferred over nodes that do not have links, a concept known as "preferential attachment" (Barabási, 2003; Strogatz, 2001). Shoulder tapping is, therefore, viewed as a form of preferential attachment that is used to explain the dominance of a small group of nodes or directors in the network leading to the formation of the largest connected component.

In the boardroom the preference for white males limits the number of board appointments available to the pool of aspiring directors who are women or members of minority groups. These preferences serve to create and reinforce the prevailing gender proportions observed in director networks. Hillman *et al.* (2002) examined the intersection of differences in race and gender with "diversity of expertise", or differences in occupation, education and experience. They viewed multiple board seats as a resource representing an increase in the number of external linkages directors provide to their boards. These linkages may act to "reduce uncertainty by linking the firm with environmental contingencies and further reducing transaction costs when dealing with these external elements" (Hillman *et al.*, 2002, p. 751).

Their prediction that women and racial minorities holding multiple seats will show differences in joining patterns was supported, as women and minorities with two seats join subsequent boards at a faster rate than do white males. However, the number of boards on which they already sat is an important factor in their rate of joining subsequent boards. Their prediction that female and African-American directors will more likely serve on multiple boards than white male directors was not supported. Hawarden (2010) re-worked their reported data from the viewpoint of GNT, finding support for their hypothesis and evidence that director networks adapt to the pressure to add more female and minority directors by adding them faster than white males once they already have substantive board experience. GNT suggests that, where there is pressure for affirmative action, boards will respond by appointing more female directors who already have a substantive board appointment. As these will be larger companies with bigger boards forming the largest network component, more women connector directors will be found in the largest component.

As director networks are dynamic entities, the movement of directors into, through and out of director networks must also be taken into account. Limited research shows that there are high levels of turnover in director networks. Davis *et al.* (2003) found this to be 95 per cent in 17 years. Male and female director turnover is unknown although some research such as the Cranfield FTSE 100 report series (Sealy *et al.*, 2007, 2008) does

monitor new board appointments and distinguish between female directors who have previously had a FTSE 100 board appointment. For example, in 2008 of the 16 new female appointees 25 per cent had previously held FTSE 100 seats. Recent research has shown that once a stable state is reached, both natural and social networks are robust and change-resistant, despite continually changing inputs and outputs, in this instance, new directors being appointed and older directors retiring (Newman, 2002; Newman *et al.*, 2006). This is a valuable attribute in power grids or the internet, but a problematical one when affirmative action interventions attempt to increase the numbers of women directors. If director networks exhibit little change over time, gender ratios may similarly stay constant, shedding or adding directors in the same proportion as economies expand or contract. This same research has also suggested that director networks like other complex networks are similar in structure irrespective of the location, scale or size of the network, called self-similarity or scale-free. Although these theoretical concepts are not discussed in this paper they did influence the data selection which included director networks of different sizes and scale, namely a global network, a very large US network and a small national network.

3.3 Hypotheses

We present three hypotheses that arise from GNT which we examine in this paper:

H1. Women directors are more likely to be found in the largest connected component and not randomly distributed through the network components.

H2. Continuing women directors are more likely to be found in the largest connected component over time, and not randomly distributed through the network components.

H3. The ratio of male to female connector directors' seats or directorships in the largest connected components of the mixed gender networks is equal to the total ratio of gendered seats.

4. Methodology

The three networks selected are an American director network dataset that has iconic status in network research but has not previously been analysed by gender; a global network of 200 companies; and the much smaller national network of New Zealand directors that consists of a comparable number of companies. Earlier longitudinal research (Davis *et al.*, 2003) set a benchmark with a dataset of approximately 200 companies. To determine director gender similar methods to Hillman *et al.* (2002) were followed. The datasets were hand-coded by research assistants based on their knowledge of gendered first names. When a gender neutral name, initials or unusual name was encountered this was highlighted for further checking and validation. Web sites listing boys and girls names were also consulted, as was the internet profile of the directors in the databases used. In order not to overstate the number of women directors in a network, a conservative approach was followed and the default of male assigned in the very few instances where gender could not be determined. UCINET (Borgatti *et al.*, 2002), the popular social network analysis software, was the tool we used to determine the network links between directors in a one mode analysis where company links are ignored and each link assigned a weight of 1. From these director-director links the largest component is extracted. This analysis gives a list of names of directors in each component which can be used to sort the directors

into corresponding groups in the original two mode (company by director) matrices in Microsoft SQL or Microsoft Excel format. Simple addition and cross-casting produces the totals required for the input data in the further statistical analysis. As the data are categorical data, χ^2 analysis with Yates correction and one degree of freedom was selected to test the female director location hypothesis in the largest connected component for all directors and the continuing directors.

The three networks analysed were as follow.

4.1 The 1999 United States Fortune 1000 director dataset

The 1999 Fortune US 1000 director dataset is the iconic dataset of director network analysis and has been used by a number of network researchers (Battiston and Catanzaro, 2004; Battiston *et al.*, 2003; Davis *et al.*, 2003; Newman, 2002, 2003a; Newman and Park, 2003; Newman *et al.*, 2001), but has not previously been used in gender research. It acted as a validating dataset. The data were captured into a Microsoft SQL database and a number of stored procedures written to remove duplicates and then extract files in the DL format required by UCINET (Borgatti *et al.*, 2002). Validating procedures reduced the number of companies from 967 to 916, the number of director seats to 10,098 seats and the number of directors to 7,644. Validation followed similar steps to those reported by Davis *et al.* (2003). If directors with similar names could not be shown to be a single director with multiple seats, the default action was to leave them as two individuals, thereby reducing the number of linked directors. This is an older dataset but given the slow rate of change in board diversity over the first decade of the twenty-first century, may still approximate the network configuration in 2011. Analysing a more current US Fortune 1000 dataset is an obvious future research project.

4.2 Fortune 200 Global director datasets

The 2004 and 2007 Fortune Global 200 director datasets were derived from the detailed male and female director information of the Top 200 global boards ranked by *Fortune* magazine and studied by the Corporate Women Directors International organisation (CWDI) (2004, 2007) Report. The global companies in the 2004 dataset were ranked by *Fortune* magazine according to global revenue in 2004 and were current on 30 June 2004. The companies in the 2007 dataset were ranked by *Fortune* magazine according to global revenue in 2006 and were current on 31 March 2007. The 2004 and 2007 Fortune Global 200 datasets were already gender coded, but this was validated where possible. The appendices containing the detailed director information were found to have proofreading errors and director totals did not always agree with totals in the text. Data were verified by an internet company search and corrected figures used. A two mode (company by director) matrix was created in Microsoft Excel.

4.3 New Zealand Stock Exchange director datasets

Two datasets spanning 2004 and 2007 were constructed, permitting a longitudinal analysis of the gendered New Zealand director network. The raw NZX datasets were obtained from the stock exchange administration in January 2004 and January 2007, respectively. Only the main board companies were analysed, but comprised the full number of companies on the stock exchange for each year. This consisted of 184 companies in 2004 and 185 in 2007. A two mode (company by director) matrix was created in Microsoft Excel.

4.4 Longitudinal datasets

To construct longitudinal datasets, directors who were present in both the 2004 and 2007 datasets for the Fortune 200 and NZX were identified. Director names were matched and sorted, which allows the continuation rate of directors to be established by comparing the percentage of the continuing directors to the numbers of directors in the full network. A two mode (company by director) matrix was created in Microsoft Excel for each of the datasets at the two points in time. This analysis differs from Davis *et al.* (2003), who analysed a panel of 195 firms that were still in existence 17 years later while the number and identities of the directors at each of three points in time varied. Three years is a short period of time to measure change in board diversity and these analyses should be repeated to cover the 2010 and 2013 movements.

5. Results

Table I provides summary statistics for the five networks analysed. It can be seen that female directors are found in low levels (11 per cent or below) in all networks. The mean number of seats per director was just over one for the Fortune 200 and NZX, meaning that most directors have just one seat and the percentage of female seats

	1999 Fortune US 1000	2004 Fortune Global 200	2007 Fortune Global 200	2004 NZX	2007 NZX
No. of companies	916	200	200	184	185
Average board size	8.3	13.6	13.8	6.4	5.8
No. of directors	7,644	2,479	2,538	965	899
Male directors (%)	6,985	2,223	2,263	908	832
	(91.4)	(89.7)	(89.2)	(95.1)	(92.5)
Female directors (%)	659	256	275	57	67
	(8.6)	(10.3)	(10.8)	(5.9)	(7.5)
Gender ratio	10.6	8.6	8.2	16	12.4
No. of seats	10,090	2,725	2,754	1,176	1,059
Mean seats	1.4	1.1	1.1	1.2	1.2
No. of male seats (%)	9,141	2,439	2,446	1,106	985
	(90.6)	(89.5)	(88.8)	(94.0)	(93.0)
No. of female seats (%)	949	286	308	70	74
	(9.4)	(10.5)	(11.2)	(6.0)	(7.0)
No. of connector directors (%)	1,608	198	190	144	117
	(23.0)	(8.9)	(8.4)	(15.9)	(14.1)
No. of male connector directors (%)	1,432	170	160	133	110
	(89.1)	(85.9)	(84.2)	(92.4)	(94.0)
No. of female connector directors (%)	176	28	30	11	7
	(10.9)	(14.1)	(15.8)	(7.6)	(6.0)
Largest connected component only					
No. of directors	6,705	1,573	1,562	633	445
	(87.7)	(63.5)	(62.3)	(66.2)	(49.6)
Number of connector directors (%)	1,595	185	181	130	96
	(23.8)	(11.8)	(11.6)	(20.5)	(21.6)
Male single seat directors (%)	76.7	88.4	88.9	79.1	78.2
Male connector directors (%)	23.3	11.6	11.1	20.9	21.8
Female single seat directors (%)	71.1	87.2	86.6	84.9	81.1
Female connector directors (%)	28.9	12.8	13.4	15.1	18.9

Table I. Descriptive statistics for the mixed gender 1999 Fortune US 1000, 2004 and 2007 Fortune Global 200, 2004 and 2007 NZX director networks

closely followed the director percentages. 23 per cent of directors in the Fortune 1000 network are connector directors having more than one board appointment, with the NZX having an average of 15.0 per cent, considerably more that the average of 8.7 per cent in the Fortune Global 200. The lower value for this latter figure may reflect the logistics of global travel reducing multiple board appointments. Connector directors are critical to the formation of the network and indeed in some analyses the single seat directors can be ignored as irrelevant.

Table II reports statistics for the two networks where we have two sample points: 2004 and 2007 data for the Fortune 200 and NZX and compared the directors present at both points in time, the continuing directors. About 1,384 Fortune Global 200 directors (out of an average of 2,508 directors) and 476 NZX directors (out of an average of 932 directors) were present in 2004 and 2007. Directors may have resigned from a board in the 2004 data but are still included being appointed to another board in the 2007 data. A few companies also completely changed their boards in this three year period, the net effect of these movements being a reduction in the number of companies.

Table II shows the high level of director turnover in both networks: over the three year time span between the two surveys an average of 44.9 per cent of Fortune Global 200 and 48.9 per cent of NZX directors had been replaced. In the Fortune Global 200 network, the continuing male director turnover was 10 per cent higher than the female continuing director turnover, with an average turnover rate of 44.8 per cent for males and 36.3 per cent for females. It was the reverse in the NZX network with female continuing directors showing a higher average turnover rate of 59.4 per cent compared

	2004 Fortune Global 200	2007 Fortune Global 200	2004 NZX	2007 NZX
No. of companies	195	193	159	167
No. of continuing directors	1,384	476		
Male continuing directors (%)	1,215	451		
	(87.8)	(94.7)		
Female continuing directors (%)	169	25		
	(12.2)	(5.3)		
Gender ratio	7.1	18 .0		
No. of seats	1,582	1,557	653	621
Mean seats	1.1	1.1	1.4	1.3
	194	194	36	33
	(12.3)	(12.5)	(5.5)	(5.3)
Number of connector directors (%)	85	75		
	(6.1)	(15.8)		
Male connector directors (%)	70	72		
	(82.4)	(96.0)		
Female connector directors (%)	15	3		
	(17.6)	(4.0)		
Percentage of total director continuation rate (% turnover rate)	55.8	54.5	49.3	52.9
	(44.2)	(45.5)	(50.7)	(47.1)
Percentage of male director continuation rate (% turnover rate)	54.7	53.7	49.7	54.2
	(45.3)	(46.3)	(50.3)	(45.8)
Percentage of female director continuation rate (% turnover rate)	66.0	61.5	43.9	37.3
	(34.0)	(38.5)	(56.1)	(62.7)

Table II.
Descriptive statistics for the continuing directors in the 2004 and 2007 networks for the Fortune Global 200 and NZX

to 48.1 per cent for male continuing directors. From Table II, the percentages of the continuing connector directors did not differ markedly from the total connector directors (6.1 per cent Fortune Global 200 continuing connector directors as compared to the average total connector directors of 8.6 per cent; 15.8 per cent NZX continuing connector directors as compared to the average total connector directors of 15.0 per cent). Despite high turnover, individual connector directors must gain other board appointments at an equal rate or single seat directors gain a second seat, giving the network the observed stability.

There does seem to be slight evidence for a preference for women with more than one seat, since the percentages of female connectors directors are 2-4 per cent higher than in the whole population. Table I shows that the percentage of female directors compared to female connector directors in the Fortune 1000 is 8.6 per cent to 10.9 per cent; an average of 10.5 to 14.9 per cent in the Fortune Global 200; and an average of 6.7-6.8 per cent in the NZX. From Table II, the female continuing connector director percentage for the Fortune Global 200 is 17.6 per cent compared to the 14.9 per cent average for all female connector directors while the 4 per cent NZX female continuing director figure is lower than the average of 6.8 per cent for all female connector directors. The international women directors, once appointed, tended to be there for the long haul in greater numbers, while reduced numbers in the NZX data probably reflects turnover in a small sample. When the female connector directors for the largest connected component are considered, these percentages increase markedly (10.9-28.9 per cent for the Fortune 1000, average 6.8-17.0 per cent for the NZX) except for the Fortune 200 companies, which drop from an average of 14.9-13.1 per cent. This suggests a higher proportion of token women directors in international companies and is reflected in the lower percentages of connector directors.

The location of women directors in the network components can be ascertained from Tables III and IV. The null hypothesis (*H1*) that male and female directors are found in the largest connected component in the same ratio as the total gender ratio for the director network is rejected for the 1999 Fortune US 1000 directors with a x^2-value of 5.9, significant at $p < 0.05$ and the 2004 and 2007 Fortune Global 200 directors with x^2 values of 20.4 and 33.7, significant at $p < 0.001$. Examination of Tables III and IV indicates that the ratio of men to women directors in the largest connected components of these two networks is significantly less than the total gender ratio, indicating that more women directors are to be found in the largest connected components than

	1999 Fortune US 1000			2004 Fortune Global 200			2007 Fortune Global 200		
	Male (%)	Female (%)	Gender ratio	Male (%)	Female (%)	Gender ratio	Male (%)	Female (%)	Gender ratio
Total	6,985	659	10.6	2,223	256	8.6	2,263	275	8.2
Largest connected component	6,107 (87.4)	598 (90.7)	10.2	1,377 (62)	196 (76.6)	7.0	1,366 (60.4)	216 (78.5)	6.3
Remainder unconnected components	878 (12.6)	61 (9.3)	14.4	846 (38)	60 (23.4)	14.0	897 (39.6)	59 (21.5)	15.2
x^2		5.9*			20.4**			33.7**	

Note: Significance at: $^{*}p < 0.05$ and $^{**}p < 0.001$ with Yates correction for one degree of freedom

Table III. Director component analysis by gender for 1999 Fortune US 1000, 2004 and 2007 Fortune Global 200

in the unconnected components. For the NZX data the null hypothesis was accepted, although this may be a function of the small size of the network and the contraction of the number of directors in the NZX between 2004 and 2007.

In the continuing director networks, the χ^2 results given in Table V show that the null hypothesis (*H2*) that male and female directors are found in the largest connected component in the same ratio as the total gender ratio for the director network was similarly rejected for the 2004 and 2007 Fortune Global 200 directors. It was also rejected for the 2004 NZX network with a values of 6.0 with $p < 0.05$, but accepted for the 2007 NZX network of continuing directors.

The location of female connector directors can be ascertained from Table VI. As significant data were found in the largest connected component, this analysis was repeated for the full seat count (which included the directors in the unconnected components) to determine if this pattern applied to the networks as a whole. The null hypothesis (*H3*) is rejected for the 1999 Fortune US 1000 directors. This has a x^2-value of 23.6 significant for $p < 0.001$ with Yates correction and one degree of freedom. However, the null hypothesis was accepted for the Fortune Global 200 and NZX director networks. This indicates that as early as 1999 US female directors with two or more seats in the largest connected component of the Fortune 1000 director network were preferred over male directors for additional board appointments. This was not a significant trend in the global director network or the smaller network of New Zealand. The null hypothesis is also rejected for the total network of 1999 Fortune US 1000 directors with a x^2-value of 34.3 significant for $p < 0.001$ and the 2007 Fortune Global 200 network with a x^2-value of 8.5 for $p < 0.01$ with Yates correction and two degrees of freedom. It was accepted for the 2004 Fortune Global 200 and NZX director networks.

Table IV.
Director component analysis by gender for 2004 and 2007 NZX

	2004 NZX directors			2007 NZX directors		
	Male (%)	Female (%)	Gender ratio	Male (%)	Female (%)	Gender ratio
Total	908	57	16.0	832	67	12.4
Largest connected component (%)	597 (65.8)	42 (73.2)	14.0	409 (49.2)	37 (55.2)	11.0
Remainder unconnected components (%)	311 (34.2)	15 (26.8)	20.7	423 (50.8)	30 (44.8)	14.1
x^2		1.19			0.65	

Table V.
Director component analysis by gender for the 2004 and 2007 Fortune Global 200 and NZX continuing directors

	2004 Fortune Global 200		2007 Fortune Global 200		2004 NZX		2007 NZX	
	Male	Female	Male	Female	Male	Female	Male	Female
Total	1,215	169	1,215	169	452	24	452	24
Largest connected component (%)	701 (57.7)	119 (70.4)	738 (60.7)	131 (77.5)	295 (65.3)	22 (91.7)	238 (52.6)	13 (54.2)
Remainder unconnected components (%)	514 (42.3)	50 (29.6)	477 (39.3)	38 (22.5)	157 (34.7)	2 (8.3)	213 (47.1)	11 (45.8)
x^2		9.4*		17.2***		6.0**		0.0

Note: Significance at: $^{*}p < 0.01$, $^{**}p < 0.05$ and $^{***}p < 0.001$ with Yates correction for one degree of freedom

Table VI. χ^2 analysis of connector directors with 2 + seats to single seat directors in the total networks and the largest connected components only for 1999 Fortune US 1000; and the 2004 and 2007 Fortune Global 200; and 2004 and 2007 NZX, including the 2004 and 2007 continuing directors of these networks

	1999 Fortune US 1000		*2004 Fortune Global 200*		*2007 Fortune Global 200*		*2004 NZX*		*2007 NZX*	
Total network seats	*Male*	*Female*	*Male*	*Female*	*Male*	*Female*	*Male*	*Female*	*Male*	*Female*
Single seats	5,553	483	2,053	228	2,103	304	775	46	722	60
2 + seats	3,588	466	386	58	343	63	331	24	261	16
x^2	34.3**		3.4		8.5*		0.4		0.8	
Largest components seats										
Single seats	4,685	425	1,217	171	1,214	187	472	30	319	30
2 + seats	3,563	457	365	52	326	61	315	24	217	16
x^2	23.6**		0.0		1.2		0.2		0.4	
	Continuing 2004 Fortune Global 200		*Continuing 2007 Fortune Global 200*		*Continuing 2004 NZX*		*Continuing 2007 NZX*			
Largest components seats	*Male*	*Female*	*Male*	*Female*	*Male*	*Female*	*Male*	*Female*		
Single seats	579	100	618	110	196	13	160	9		
2 + Seats	283	39	260	45	260	20	198	11		
x^2	0.53		0.0		0.16		0.0			

Note: Significance at: $^*p < 0.01$ and $^{**}p < 0.001$ with Yates correction and one degree of freedom

These findings support early evidence that female connector directors with two or more seats are being preferred for board appointments in the Fortune US 1000 companies. This preference is a possible emerging trend in the Fortune Global 200 as a whole and in the largest connected component, but it is absent in the NZX networks, indicating that diversity interventions are not having an impact on New Zealand listed companies.

The results support GNT by showing that a preference for women directors with two or more seats is emerging in some director networks. This trend is shown in both the largest connected component and the network as a whole, which may indicate a response to diversity interventions where the director networks are responding by appointing more women directors, but prefer to appoint the known women directors who already have a seat on a substantial board.

6. Discussion and conclusions

Low levels of women directors have been observed as a persistent pattern over many years in director data from listed stock exchanges. There has been a tacit assumption that director networks are amorphous entities, which this study questions by undertaking the first investigation of gendered director networks. We have investigated three networks of directors at a national and global level, two of them a two time points three years apart. By extracting network components and using gender as an analytical tool, the location and role of women directors as connector directors (who have more than one simultaneous board appointment) has been determined. The study has found the same low percentages of women directors reported elsewhere, but we have also found that – despite high levels of director turnover with approximately 50 per cent of directors replaced between 2004 and 2007 – the percentage of women directors remains remarkably constant. Although consisting of a similar number of companies to the NZX, the Fortune Global 200 network has nearly double the percentage of women directors. This may be due to the larger board size: an average of 13.7 members compared to 6.1 for NZX boards. Although the gross WOB data is reflecting slow increases in the numbers of women directors, these changes cannot be attributed to diversity interventions unless factors such as board size are held constant. Comparisons across countries are consequently also difficult. The study has found that continuing women directors, particularly in international networks, show less turnover and may be more motivated to retain prestigious international appointments.

This study also highlights the role of the connector director in the network, with differing gender percentages within this group when compared to the total network or the largest connected component. The ability of women connector directors to secure the small proportion of multiple seats available to them suggests that overlooked differences may exist between them and single seat directors. Connector directors of both genders may share these characteristics, which may relate to competence, leadership abilities and other enabling factors. In future research, male and female connector directors should be distinguished from their single seat colleagues.

The results we have presented give support to the glass network hypothesis that women directors (including the female continuing directors) are found in the largest connected component. Those women who are appointed to boards, whether as single seat directors (the vast majority), or as a small proportion of connector directors, are not marginalised in director networks. They have the same opportunities for interaction with influential connector directors as well as access to network resources.

However, network size and the possibility of effective affirmative action enhancing this tendency for women directors to be located in the largest connected component must also be considered as explanations for the obtained results. Company size, as measured by financial results or ranking such as the criteria used in the Fortune analyses, is also related to board diversity. As the Fortune Global 200 data show, larger companies (which have bigger boards) have more women directors.

These findings have implications for diversity interventions and future research. Director networks have been shown to resemble other networks in their component structure, which includes a large dominant component and multiple smaller components. Even though this structure is a "glass network" and invisible to the participants, network researchers such as Strogatz (2003, p. 237) suggest that "Whenever nonlinear elements are hooked together in gigantic webs, the wiring diagram has to matter. It's a basic principle. Structure always affects function". The extent to which the structure of director networks influences the participants is an area requiring further exploration. As a methodology social network analysis is a robust quantitative tool for mapping and analysing director networks from the readily available data in the public domain. Only with this tool can the connected components of a director or company network be extracted for use in further research. For example, a hypothesis that needs investigating is:

> What is the relationship between board diversity (gender or another attribute) and the performance of companies in the largest connected component of a company network compared to the unconnected components?

Social network analysis is tool that lends itself to longitudinal studies as shown here and can be used to track affirmative action interventions before and after the proposed changes as well as monitor distinctions between single and multi-seat directors. This study is limited by the short time period selected and the small size of the networks considered. Further research is needed to track a wide variety of national networks as well as the large regional networks of the USA and Europe. Analysis of emerging Asian, Indian and Arab director networks where board diversity is not yet on the agenda may reveal the same low ratio of unrecognised women directors, probably family appointments, in the largest component. Tracking national director networks in countries considering changes in diversity legislation such as France or Australia, would validate the predictive power of GNT. Direction and clarity can be provided in the contentious area of female board representation by the quantitative tools of social network analysis as the results are neutral, readily replicable and capable of graphic representation. Affirmative action interventions, such as the Norwegian board diversity legislation, took place without a deliberate programme to monitor the effects of social change and ameliorate deleterious effects. GNT predicts that a class of elite women directors, the beneficiaries of the network forces of preferential attachment will arise where there is pressure to increase WOB. Known as "golden skirts", a group of female connector directors has emerged in Norway with what are regarded as "excessive" board appointments contrary to the intention of the legislation which was gender equity amongst single seat directors (Seierstad and Opsahl, 2011). In addition to providing monitoring tools, GNT provides a theoretical explanation for the observed results from social change programmes, accounts for the lack of success with board diversity initiatives and suggests directions for future research.

The lack of women in director networks cannot be explained by the location of women directors in the networks, as this seems to be a level playing field with women over-represented in the largest connected component. Women directors must be differentiated into sub-groups for a clear picture to emerge of which women are getting board appointments. This paper suggests that categorisation into national and international, connected or unconnected components and single or multiple directorships are useful groupings for differentiation. Diversity interventions can, therefore, be directed at increasing the numbers of women in different categories using different strategies. For example, connector directors who are already known in a director network may be able to pick and choose less risky board appointments, while single seat directors may be setting themselves up for failure by accepting any appointment offered them. A general strategy to increase women directors as a whole may not be as effective as a more targeted approach.

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