

**Moving in Higher Circles: Exploratory Social Network Analysis on Corporate Interlocks of Women Directors in South Africa, 1994 – 2018.**

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**Abstract (148/150 words)**

National policies aimed at altering board gender composition have yielded mixed results globally. Social network analysis (SNA) of board interlocks using longitudinal data provides a robust tool for policymakers to evaluate the effectiveness of such policy changes. However, access to national longitudinal data, including both listed and unlisted companies, is rare. We utilise such data from the South African Companies and Intellectual Property Commission registry to describe how policy changes reconfigure network structures. We extracted data from listed and unlisted companies that have achieved a critical mass of three or more women directors, yielding 84,186 company observations. Employing SNA, we differentiated between active firm interlocks and their evolution following four periods of policy change in South Africa. This study elucidates policy-induced structural shifts in the firm networks of women board members and offers discourse on the direction of future board gender diversity policy implementations in South Africa.

**Keywords:** Critical Mass Theory, Corporate Networks, Interlocking Directorates, Social Network Analysis, South Africa, Women Directors

**Track:** Gender in Management

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## **Literature Review**

### ***1. Introduction***

Board gender diversity has gained increasing importance in contemporary corporate governance policy and has been a significant area of research interest since the late 1980s, owing to both the ethical and economic benefits of incorporating women as a previously underrepresented group (Reddy and Jadhav, 2023). One of the mechanisms to increase board gender diversity has been the use of policies encompassing “legal, regulatory, and institutional framework for corporate governance” (OECD 2023). Policy interventions have yielded mixed results, with women making up only one-third of board members in only 20 out of 50 countries and “only four jurisdictions had at least 40% of each gender at board level (France, Iceland, New Zealand and Norway)” (Denis, 2022, p. 6). Since board directorships not only serve shareholder interests but also aim to sustainably and strategically govern a company, directorships are powerful positions. Policy interventions aim to give women access to these powerful positions. However, the onboarding of a single woman director may not translate into diverse or influential decision-making on a board. Elizabeth Kanter’s critical mass theory suggests that stereotype pressure is placed on minority members unless there is a critical mass of them. Once critical mass is reached, minority members are treated as individuals without the burden of the social stigma attached to their gender (Kanter, 1977). In support of the presence of multiple women on a board, towards women directors’ increased level of influence and voice, typically, thirty per cent or three or more women constitute a critical mass on a board (Joecks *et al.*, 2013).

Furthering the imperative of influence, the centralisation of women directors in networks of directors, and the linkages they provide between companies, advances our understanding of the strength of women directors' influence beyond a single board. In other words, even if three women serve on a board, without roles on other boards or in director networks, they are seen as peripheral and less influential in a national or international company network. Interlocking directorships and interlocking companies, derived from Social Network Analysis (SNA), go beyond counting the number of boards that women directors serve on, indicating “extent and spread” of board member and company links and influence (Öberg, 2020, p. 53). Therefore, understanding the characteristics of the interlock network within national company data helps determine if women's board representation is tokenism, favouritism, or a genuine advancement of their power and influence. Tracking board and company interlocks over time, alongside key national policy changes, reveals both the inherent patterns of influence and the effectiveness of policy interventions.

### ***2. Policy Changes Affecting Board Gender Diversity in South Africa***

Globally, six types of policy intervention are noted, namely, gender quota laws, voluntary targets, recommendations in corporate governance codes, including self-regulatory arrangements, listing requirements, disclosure requirements (Kirsch, 2021; Denis, 2022), and other statutes. Additional intervention types, such as contractual undertakings, voluntary or industry commitments, and business practices (OECD 2023), are not included as policy interventions in this paper due to a lack of access to such information on a national basis. Kirsch (2018, p. 346) contends that national regulations are shaped by a country's specific “institutional and cultural background, international developments and the interests of key actors.” South Africa’s notorious history, resulting in a progressive constitution based on human rights, presents an interesting context in which to investigate the effectiveness of policy

interventions towards women's board representation. The preamble of the constitution outlines the advancement of human rights, including non-sexism (Hassim, 2018). South Africa follows a unitary board structure where the Chief Executive Officer and the Chief Financial Officer have seats, but all other board positions are filled by non-executive board members. The King Governance Code suggests that boards should be largely composed of outsiders. There is also no employee representation on South African boards. Oftentimes, the fastest way to increase the onboarding of women directors is through the implementation of a mandated policy. The objective of such a policy is not only to increase the number of women on boards and in senior management positions linked to board representation but also to avoid groupthink that may ensue due to a lack of diversity (OECD, 2023).

South Africa deploys the following policy interventions:

#### ***A. Statutes***

Broad-Based Black Economic Empowerment Act

- **Broad-Based Black Economic Empowerment Act of 2003** – defined “Black people” to include women and outlined strategies to empower Black people, including women, in the economy. Required the creation of codes of good practice for transformation charters in various sectors, allowing the Minister to distinguish between Black men and Black women in these codes and targets.

Companies Act

- **Companies Act No 71 of 2008** – Mandated that profit companies (except state-owned ones) have at least 50% of directors and alternate directors elected by shareholders, potentially creating opportunities for women. Outlined the process of electing directors, emphasizing an election system based on individual candidacy and a majority vote. Established eligibility and disqualification criteria for directors and prescribed officers, contributing to a more accountable and equitable selection process. Required certain companies to have a social and ethics committee responsible for ensuring compliance with employment equity and BBBEE legislation.

#### ***B. Soft laws (recommendations in corporate governance codes, including self-regulatory arrangements)***

King Governance Codes

- **King Report on Corporate Governance (1994)** – The first King Report recommended implementation by July 1996. It addressed affirmative action and encouraged the participation of historically disadvantaged groups, including women, in corporate governance, while discouraging "tokenism."
- **King Report on Corporate Governance (2002)** – Emphasised board diversity, including gender, and acknowledged challenges women faced in leadership roles. Recommended specific measures to improve women's access to executive-level positions.
- **King Report on Corporate Governance (2009)** – Recommended that all boards consider their size, diversity, and demographics, including race and gender, to ensure effectiveness. Stressed the independence of non-executive directors on all issues, including diversity and employment equity.

- **King Report on Corporate Governance (2016)** – Recommended diversity, including race and gender, in the composition of the governing body and set targets for representation. Encouraged a majority of non-executive members, most of whom should be independent, potentially benefiting women by mitigating the influence of existing power structures.

### ***C. Listing requirements***

Although there is more than one securities exchange in South Africa, the Johannesburg Securities Exchange (JSE) is the largest and most influential on the African continent.

### ***D. Targets and quotas***

The constitution of South Africa does not allow for quotas but instead provides for targets. The difference between quotas and targets lies in quotas being a fixed and mandatory, and targets being voluntary (Bosch, van der Linde, and Barit, 2020). Also, quotas have a rigid percentage that should be achieved whilst targets are realistically determined (Bosch, van der Linde, and Barit, 2020).

The King Governance Codes were introduced as soft law in South Africa in 1994 to create standardised corporate governance guidelines in a post-apartheid economy (Armstrong, 1995). Though these governance policies were initially aimed at all companies listed on the JSE, large public entities, large financial institutions, as well as large unlisted companies (companies with shareholder equity of 50 000 000 rand or more), all unlisted companies were encouraged to adhere to these guidelines. Furthermore, national policies in the form of statutes such as the Broad-based Black Economic Empowerment Act (2003) and the Companies Act (2008) aimed to target the integration of previously underrepresented groups into the economy.

## ***3. Theoretical Foundations underpinning Gender Board Diversity***

In the South African corporate landscape, Critical Mass Theory offers a compelling lens through which to understand the influence of women directors. While the appointment of a single woman to a board may be symbolically significant, it often lacks the structural power to shift decision-making dynamics. Kanter (1977) argued that a critical mass, typically three or more women, is necessary to move beyond tokenism and enable substantive participation. This is particularly relevant in South Africa, where women remain underrepresented on boards despite comprising over half the population. Research by Willows and van der Linde (2016) found that increased female representation on boards of JSE-listed firms was statistically associated with improved governance and performance, reinforcing the idea that critical mass enhances the benefits of diversity. However, as Zajiji *et al.* (2021) note, numeric representation alone is insufficient to dismantle deep-seated gendered dynamics. South African women directors often face an “(in)visibility vortex,” where their presence is acknowledged but their influence remains constrained unless supported by inclusive leadership and deliberate cultural shifts.

Resource Dependency Theory adds another dimension by framing women directors as conduits of valuable external resources. According to Pfeffer and Salancik (2003), boards serve as bridges between the firm and its environment, and directors bring access to information, legitimacy, and networks. In South Africa, women who serve on multiple boards, particularly as independent directors, can facilitate inter-organisational collaboration and knowledge transfer (Kabir *et al.*, 2023). These cross-board linkages are especially critical in a context where formal gender quotas are absent, and progress relies on voluntary targets and stakeholder

pressure. The networks formed by women directors can enhance strategic adaptability, especially in response to policy shifts or socio-economic challenges. Moreover, these networks help build a pipeline of future female leaders, reinforcing the long-term sustainability of gender diversity efforts.

#### ***4. Social Network Analysis in Interlocking Directorate Research***

Social Network Analysis (SNA) is a valuable methodology used to examine the relationships and structures within networks, particularly in the context of interlocking directorates. By mapping connections at the meso-level, between individuals (micro) and firms (macro), SNA sheds light on how group dynamics, resource access, and influence circulate within corporate governance structures (Gamper, 2022). Several foundational theories deepen our understanding of these dynamics, especially when applied to gender diversity on boards.

One such theory is the Small World Network Theory, which asserts that most nodes in a network can connect through a few intermediaries, facilitating efficient communication and information flow (Budrikis, 2023). When applied to gender-diverse corporate boards, this theory reveals how women directors, once they are integrated, can serve as vital links between distant or siloed network clusters. In boards with a critical mass of female representation (often defined as three or more members), women are better positioned to participate in these small-world structures, increasing both their visibility and influence (Torchia *et al.*, 2011). Their presence can enhance network connectivity, strengthening overall decision-making processes.

Complementing this is the Strength of Weak Ties Theory, proposed by Granovetter (1973), which suggests that weak ties, connections that are more casual or distant, can actually provide access to novel information and external opportunities. For women trying to enter historically male-dominated boardrooms, such weak ties often serve as a strategic entry point. These connections may not be deep initially, but can bridge otherwise disconnected parts of a network, opening pathways to innovation and inclusion. Importantly, when women on boards achieve a critical mass, these weak ties can evolve into more stable, centralised relationships that enhance their impact, moving them from the periphery to the core of governance networks (Kanter, 1977).

Structural Hole Theory, developed by Burt (1992), adds another layer of relevance. It emphasises the advantages held by actors who bridge “holes” or gaps in a network, enabling them to control the flow of information between segregated groups. Women directors, especially when in the minority, can play this role by connecting male-dominated board clusters to more diverse and external perspectives (Bilimoria and Huse, 1997). Their positions as brokers not only increase their strategic value but also help break down entrenched norms within the network. As boards diversify and women reach a critical mass, their ability to collectively span structural holes becomes more prominent, leading to stronger collaboration and greater influence over strategic decisions (Terjesen *et al.*, 2009).

All these theories intersect meaningfully with Critical Mass Theory, which posits that a minority group must reach a certain threshold, typically three individuals or 30% representation, to exert consistent and meaningful influence (Kanter, 1977; Torchia *et al.*, 2011). In the context of corporate boards, reaching this threshold transforms women from symbolic tokens into active participants. It also strengthens their positions within network structures, amplifying their ability to access resources, bridge clusters, and catalyse collective

action (Joecks *et al.*, 2013). Boards that meet or exceed this threshold have been shown to perform better and engage in more effective governance, especially when addressing strategic and ethical issues (Lefley and Janeček, 2024).

### **5. Social Network Analysis in Practice**

Network-level statistics in SNA provide insights into the overall structure and connectivity of a network. An important network-level measure is the density score, which represents the proportion of observed connections relative to the total possible connections in a network. A higher density suggests greater interconnectedness, supposedly facilitating faster information flow and stronger social cohesion (Wasserman and Faust, 1994). Another essential set of network metrics includes centrality measures, which identify influential nodes within a network, often related to power dynamics within the network. Degree centrality counts the number of direct connections a node has, indicating its immediate influence, i.e. finding the most influential director or firm within a network due to the frequency of connectivity (Freeman, 1979). Betweenness centrality measures how often a node appears on the shortest paths between other nodes, again, highlighting its role as a bridge in information flow. Closeness centrality assesses how quickly a node can reach all others in the network through the analysis of the shortest path between nodes, reflecting its accessibility. Lastly, Eigenvector centrality, an extension of degree centrality, considers not only the number of connections but also their importance, emphasising nodes connected to other well-connected nodes (Bonacich, 1987; Borgatti *et al.*, 2018). By leveraging these metrics, social network analysis helps in understanding social influence, information diffusion, and community formation in various contexts, from online networks to organisational settings (Mäkinen *et al.*, 2019).

Subgraph-level statistics in SNA provide insight into the local structures within a network, revealing patterns of interaction and connectivity among smaller sets of nodes. This is particularly important if there are large numbers of nodes not participating in the central network. The dyad census examines pairs of nodes and classifies them as mutual (bidirectional ties), asymmetric (one-directional ties), or null (no ties) (Wasserman and Faust, 1994). The triad census extends this to sets of three nodes, which categorises them into sixteen possible configurations based on tie presence and direction, such as closed triads (strong indicators of cohesion) or open triads (potential for tie formation) (Holland and Leinhardt, 1970). Beyond these small structures, cliques represent maximally connected subgroups where every node shares a direct tie with all others, indicating strong local connectivity (Scott, 2000). More relaxed variations include n-cliques and k-cores, which allow for indirect connections within a substructure (Seidman, 1983). Components are maximal connected subgraphs, where each node can reach any other within the subgraph, and they help identify cohesive subnetworks within a larger social system (Newman, 2010). Isolates are nodes with no connections, representing socially disconnected actors who may lack access to network resources or influence (Borgatti *et al.*, 2018). Analysing these subgraph-level structures aids in understanding network cohesion, social capital distribution, and the potential for information diffusion within a network.

Node-level statistics in SNA quantify firm nodes' roles and influence within a network. Degree distribution describes the frequency of nodes with a given number of connections (degree), offering insights into the network's structure and whether it follows a scale-free pattern with a few highly connected hubs or a more uniform distribution (Barabási and Albert, 1999). Another key measure known as brokerage scores, assesses how well a node connects otherwise disconnected groups, highlighting its potential for information flow and structural influence (Burt, 1992). High brokerage scores indicate nodes that bridge structural holes, enabling access

to diverse information and greater control over communication. Together, degree distribution and brokerage scores provide a comprehensive understanding of connectivity and influence within a network, essential for applications in marketing, epidemiology, and organisational studies (Freeman, 1977). These scores become essential in analysing the effect of attributes associated with the actors and how they impact the positioning and influence of an actor within a network.

## **Research Aim**

We set out to examine the structural network effects of nationally implemented board policy changes in South African firms (combined listed and unlisted) with boards that have achieved a critical mass of women directors over the past 25 years. We hypothesise that boards that have achieved a critical mass of women directors will show significant differences in the structure of company and director networks following each policy change, as these boards tend to have increased influence by women directors at the decision-making level.

## **Methodology**

### ***Policy Cluster Identification***

Initially, the yearly periods of interest were determined around the onset of the board policies previously described. Thereafter, we aimed to isolate data that represented at least one year of pre- and post-policy implementation to identify immediate and lagged changes to the firm networks. This resulted in the identification of yearly clusters of interest.

#### **Cluster 1: 1994, 1995, 1996, 1997**

- **Policy Introduction: King Report on Corporate Governance (1994)**

**Date of implementation:** November 1994

#### **Cluster 2: 2002, 2003, 2004, 2005**

- **Policy Introduction: King Report on Corporate Governance (2002)**

**Date of implementation:** 1<sup>st</sup> of March 2002

- **Broad-Based Black Economic Empowerment Act of 2003**

**Date of implementation:** 1<sup>st</sup> of August 2002

#### **Cluster 3: 2008, 2009, 2010, 2011**

- **Policy Introduction: King Report on Corporate Governance (2009)**

**Date of implementation:** 1<sup>st</sup> of March 2010

- **Companies Act No. 71 of 2008**

**Date of implementation:** 1<sup>st</sup> of May 2011

#### **Cluster 4: 2016, 2017, 2018, 2019**

- **Policy Introduction: King Report on Corporate Governance (2016)**

**Date of implementation:** 1<sup>st</sup> of April 2017

**Cluster 4:** 2016, 2017, 2018, 2019

### ***Data Source***

The datasets utilised in this study were sourced from the national business registry database, the Companies and Intellectual Property Commission (CIPC) South Africa, through a formal research partnership established between the CIPC and Stellenbosch University (Stellenbosch Business School).

### ***Dataset Preparation***

The full CIPC dataset (containing all listed and unlisted firms and their associated directors registered in South Africa from 1800 to 2022) was cleaned and transformed in MSSQL Server 2018 and compiled into individual datasets composed of all firms with three or more newly appointed and existing women directors within a specified year. The three firm types used in this study are Pty (Ltd) (private, unlisted firms), Ltd (listed firms), and State-Owned Companies (SOC). Women directors were identified through the sex-assigning digits present on their South African identification numbers. Lastly, this dataset was scanned for individuals who held two or more directorships within the dataset, as these are the individuals who form the links between firms to create yearly edge lists. Furthermore, firm type was obtained in a secondary attribute dataset for the network visualisations.

### ***Social Network Analysis (SNA) Methods***

These two-mode firm-director datasets were transformed into one-mode firm-firm adjacency matrices. We then computed global network-level, subgraph-level, and node-level statistics. We then created a dictionary for the firm types represented in our dataset, allowing for their depiction in the visualisation using colour (Pty (Ltd) = black, Ltd = green and SOC = red). The node-level statistics were also incorporated into the visualisation to inform the centrality of firms through the size of the node. The edge weights were determined and colour-coded to infer the number of shared directors between firms (1 shared director = light grey, 2 shared directors = burnt orange, 3 shared directors = yellow, 4 or more shared directors = blue). These steps were achieved using the pandas, numpy, pyvis and networkx packages in Python.

## Results and Discussion

### *Cluster 1: King Report on Corporate Governance 1994 (1994, 1995, 1996, 1997)*

**Table 1: Firm-Firm Network Analysis of Cluster One**

|                                                                  | 1994   | 1995   | 1996   | 1997   |
|------------------------------------------------------------------|--------|--------|--------|--------|
| <i>Nodes (Firms)</i>                                             | 77     | 102    | 136    | 209    |
| <i>Edges (Links between firms due to shared women directors)</i> | 144    | 196    | 324    | 335    |
| <i>Pty (Ltd)</i>                                                 | 73     | 99     | 133    | 201    |
| <i>SOC</i>                                                       | 1      | 1      | 2      | 3      |
| <i>Ltd</i>                                                       | 3      | 2      | 1      | 5      |
| <b>Network-Level Statistics</b>                                  |        |        |        |        |
| <i>Density</i>                                                   | 0.0492 | 0.0381 | 0.0353 | 0.0154 |
| <i>Transitivity</i>                                              | 0.9988 | 0.9994 | 0.9847 | 0.9379 |
| <i>Degree Centrality)</i>                                        | 3.7403 | 3.8431 | 4.7647 | 3.2057 |
| <i>Closeness Centrality</i>                                      | 0.0493 | 0.0381 | 0.0377 | 0.0198 |
| <i>Betweenness Centrality</i>                                    | 0.0000 | 0.0000 | 0.0002 | 0.0003 |
| <i>Eigenvector Centrality</i>                                    | 0.0344 | 0.0259 | 0.0195 | 0.0116 |
| <i>Symmetry</i>                                                  | TRUE   | TRUE   | TRUE   | TRUE   |
| <b>Subgraph-Level Statistics</b>                                 |        |        |        |        |
| <i>Dyad Census</i>                                               | 144    | 192    | 324    | 335    |
| <i>Triad Census</i>                                              | 288    | 528    | 1011   | 680    |
| <i>Cliques (n=&gt;3)</i>                                         | 10     | 9      | 17     | 34     |
| <i>Components</i>                                                | 24     | 35     | 37     | 62     |
| <i>Largest Component Size</i>                                    | 12     | 15     | 18     | 32     |
| <i>Isolates</i>                                                  | 881    | 975    | 1274   | 1789   |

The first yearly cluster (1994, 1995, 1996, 1997) represented the years likely to be directly affected by the introduction of the first King Code (1994). Following the introduction, the boards in South Africa were encouraged to adhere to these recommendations by July 1996. As seen in **Table 1**, in 1994, a total of 77 firms that achieved critical mass (with directors that shared at least two directorships) were extracted. This number rose to 209 network-participating firms by the end of this clustered period, indicating a near tripling of firms with three or more women directors (a percentage growth of 26.95%). Edges were calculated to determine the relation of firms with themselves and their association to other firms on the basis of shared directors. Network-level statistics provide critical insights into the structure and dynamics of the global one-mode networks (either firm-firm or director-director interactions extracted from a two-mode network), such as interlocking directorates, where directors serve on multiple corporate boards.

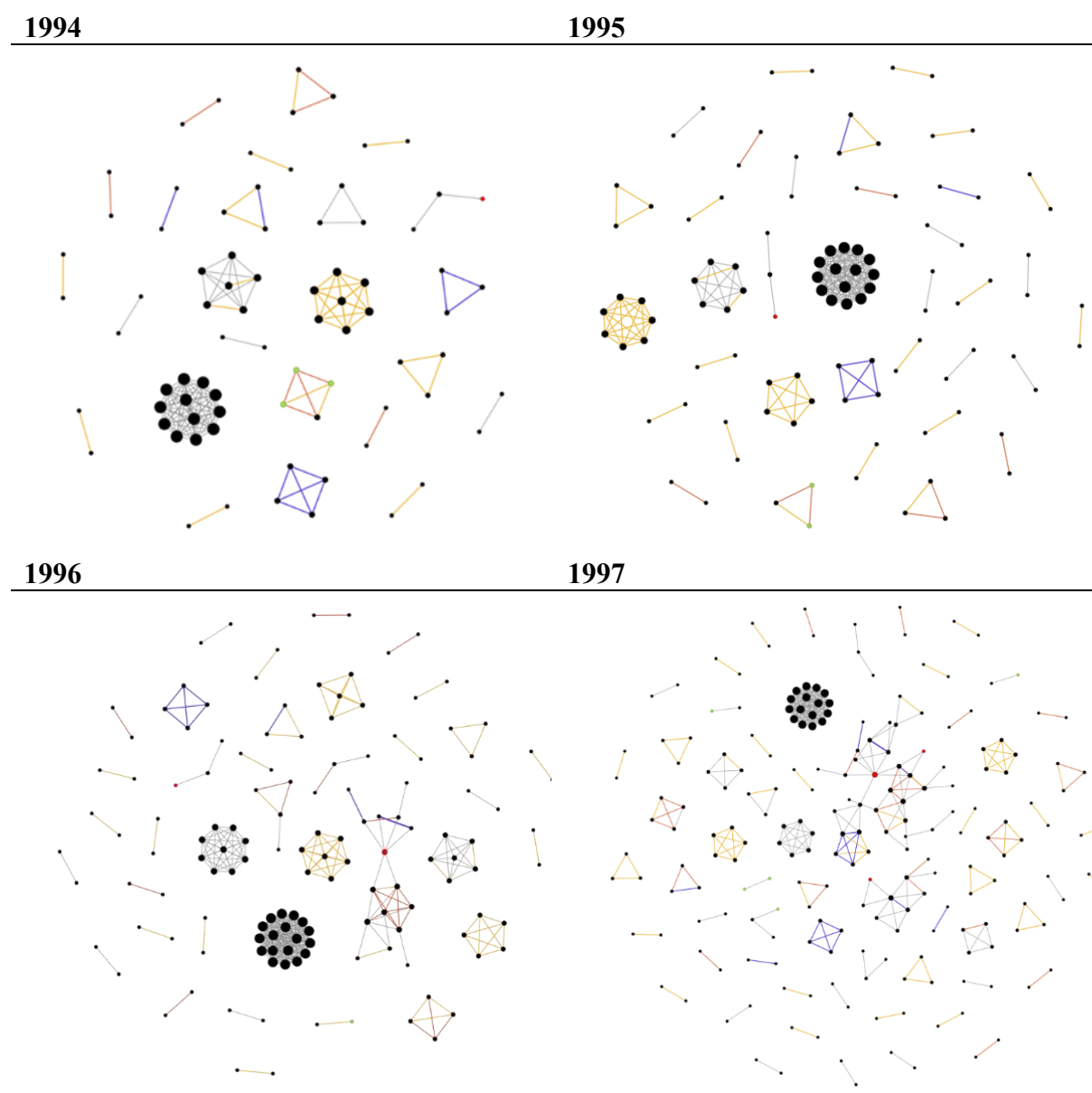
Density measures the proportion of observed connections to possible connections, reflecting how interconnected the network is (Wasserman and Faust, 1994). Density measures of the global firm-to-firm network indicated that the firms in 1994 depicted a higher degree of density than the subsequent three years. The decreased density of the networks highlights that many of the newly introduced directors were onboarded at peripheral firms instead of firms that were part of the dense network cluster, causing a deeper fragmentation of the firm network. This

could have been supported by the increased introduction of new women directors by the soft deadline (mid-1996) set by policymakers. This was further corroborated by the decrease in transitivity in 1996 and, especially, 1997. Transitivity is the tendency of nodes to form closed triangles, indicating clustering and potential elite cohesion (Newman, 2003). These results suggest there is a peripheral widening of director participation.

Degree centrality, including indegree (number of incoming ties), highlights directors with high visibility, while closeness centrality measures access to the entire network, signifying information efficiency (Freeman, 1979). Low degree centrality scores were seen across the four years, with the largest increase in 1996 and a decrease to its lowest value (3.2057) in the final year of the cluster. This could indicate that, due to directors joining peripheral firms, the measure of influence through degree was weakened in existing firm-firm clusters. Betweenness centrality identifies the nodes/firms that act as intermediaries, controlling information flow (Burt, 1992). Although there is evidence of network fragmentation between firms, the increase in the number of firms achieving critical mass increases the propensity or chance of firms becoming connected, hence the increase in betweenness centrality in 1997. Eigenvector centrality captures influence by considering not just direct ties but also the importance of indirectly connected nodes (Bonacich, 1987). A decrease in eigenvector centrality over time in a firm-firm network suggests a decline in a firm's influence within the overall network, as is seen in these results. Symmetry measures the reciprocity of ties, indicating the balance of power among directors. As this was analysed as an undirected network, the networks for each of the years were symmetrical. Together, these metrics reveal governance structures, influence distribution, and potential power concentrations in corporate networks.

Subgraph-level statistics provide insights into the microstructures of a one-mode network, such as a firm-firm network, where firms are connected based on shared board memberships. Dyads (two connected nodes) reveal direct relationships between firms, indicating direct collaboration or influence (Wasserman and Faust, 1994). The number of firms with a tie to another firm was seen to double pre- and post-policy introduction; however, this was seen alongside a near tripling (77 to 209 firms), indicating that tie formation did not increase but followed a linear growth level. This possibly highlights the lack of influence in already established firms in the appointment of women directors to neighbouring firms. Triads (three-node structures) can indicate brokerage or cohesion, with closed triads suggesting tightly connected director groups and open triads highlighting potential gatekeeping roles (Granovetter, 1973). The triad census calculated in this study identifies all potential triadic components, not just firms that are directly linked to one another (i.e. both open and closed triad structures).

Cliques, or fully connected subgroups, represent elite clusters of firms that frequently serve together, often signifying power concentration (Scott, 2000). A count of cliques with at least three or more connected firms signified no change in the first two years and a gradual increase over the following two years. Finally, isolates, or firms with women directors with no connections to other firms, may reflect marginalisation or independent firms (Barnes, 2012). 1994 and 1995 results indicated that 91.96% of total firms were isolated from other 'critical mass' firms. This decreased to 90.35% in 1996 and 89.54% in 1997. It's possible that adhering to a newer board diversity policy slightly increases a firm's propensity to share a director with another firm. This is a typical advantage of network formation as it reduces uncertainty and improves decision-making.



**Figure 1: Social Network Visualisations of Cluster One**

Due to the sparsity in critical mass firms with shared women directors, we were able to visualise the formation of network structures preceding and following the implementation of the King Report Code 1994 (**Figure 1**). The largest connected component steadily expanded from 12 firms in 1994 to 32 firms in 1997, reflecting an increasing tendency toward inter-firm linkage through shared women directors. Concurrently, the total number of components more than doubled, growing from 24 to 62, indicating that while larger clusters were forming, many smaller isolated groups persisted within the network. In 1994, we see a distinct cluster of highly centralised firms that remain disjointed from other firms throughout the period. It's possible that firms within this cluster were either industry-specific or relied on knowledge sharing with trusted women directors only. Firm-type composition shifted markedly during this period: privately held companies (Pty Ltd) increased substantially from 73 in 1994 to 201 in 1997, suggesting growing private sector engagement in board diversity, whereas state-owned companies (SOCs) and public limited companies (Ltd) remained marginal in number.

Examining edge weight distributions, which represent the number of shared directors between pairs of firms, reveals that edges with one shared director dominated throughout, comprising approximately 60-70% of all edges. This predominance of singly shared directors indicates that most inter-firm connections were relatively weak ties. However, moderate-weight edges (weights of 3 or 4) also maintained a significant share, collectively accounting for roughly 20-35% of ties, and rare but stronger ties (weights of 5 and 8) emerged by 1997, indicating the formation of more robust collaborative linkages (Borgatti and Halgin, 2011). These evolving patterns suggest a strengthening network cohesion likely influenced by the governance emphasis of King Code I, fostering greater board interlocks among firms (Roberts *et al.*, 2017).

***Cluster 2: King Report on Corporate Governance 2002 and Broad-Based Black Economic Empowerment Act of 2003 (2002, 2003, 2004, 2005)***

**Table 2: Firm-Firm Network Analysis of Cluster Two**

|                                                                  | 2002   | 2003   | 2004    | 2005    |
|------------------------------------------------------------------|--------|--------|---------|---------|
| <b>Nodes (Firms achieving critical mass)</b>                     | 651    | 729    | 842     | 1197    |
| <b>Edges (Links between firms due to shared women directors)</b> | 2502   | 2348   | 4732    | 10745   |
| <b>Pty(Ltd)</b>                                                  | 602    | 685    | 799     | 1142    |
| <b>SOCs</b>                                                      | 9      | 7      | 9       | 11      |
| <b>Ltd</b>                                                       | 40     | 37     | 34      | 44      |
| <b>Network-Level Statistics</b>                                  |        |        |         |         |
| <b>Density</b>                                                   | 0.0118 | 0.0088 | 0.0134  | 0.0150  |
| <b>Transitivity</b>                                              | 0.9857 | 0.9574 | 0.9828  | 0.9927  |
| <b>Degree Centrality</b>                                         | 7.6866 | 6.4417 | 11.2399 | 17.9532 |
| <b>Closeness Centrality</b>                                      | 0.0167 | 0.0293 | 0.0263  | 0.0257  |
| <b>Betweenness Centrality</b>                                    | 0.0004 | 0.0016 | 0.0016  | 0.0005  |
| <b>Eigenvector Centrality</b>                                    | 0.0111 | 0.0087 | 0.0100  | 0.0089  |
| <b>Symmetry</b>                                                  | TRUE   | TRUE   | TRUE    | TRUE    |
| <b>Subgraph-Level Statistics</b>                                 |        |        |         |         |
| <b>Dyad Census</b>                                               | 2502   | 2348   | 4732    | 10745   |
| <b>Triad Census</b>                                              | 24727  | 14534  | 72909   | 287533  |
| <b>Cliques (n=&gt;3)</b>                                         | 104    | 114    | 131     | 151     |
| <b>Components</b>                                                | 129    | 145    | 151     | 206     |
| <b>Largest Component Size</b>                                    | 136    | 310    | 367     | 410     |
| <b>Isolates</b>                                                  | 4197   | 4394   | 4996    | 6260    |

**Table 2** represents the firm-firm network analysis in the second clustering following the introduction of two separate policies aimed at board diversity at the gender and racial level. The first year of the cluster identifies 4848 firms that have achieved critical mass. We observe an increase in these firms over the following three years (resulting in a final n=7457), where

we see a larger increase in connected firms (as observed in cluster 1), indicated by a connected firm percentage growth of 35.23%.

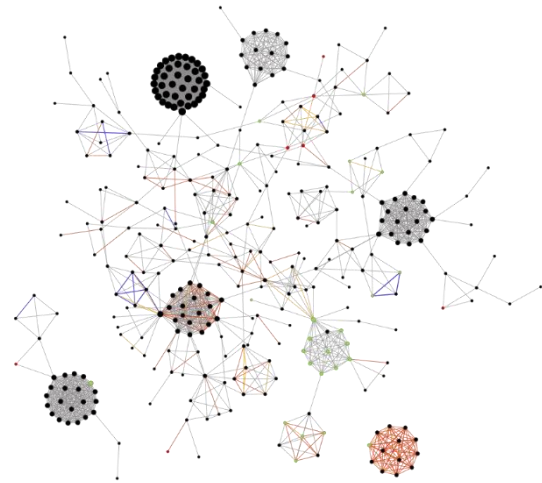
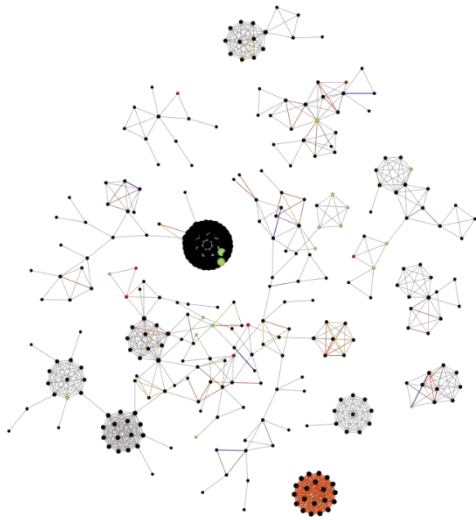
Network-level statistics that were performed to identify the nature of the relationships between director-connected firms suggested an initial decrease in density from 2002 to 2003, thereby increasing steadily up to 2005. This indicates that initially, shared directors were newly appointed at disconnected firms, but thereafter, network-involved firms showed an increased propensity to share directors with other firms. This could be due to the introduction of established directors as opposed to increasing the number of new directors on boards to comply with the policy in a risk-averse manner (Raddant and Takahashi, 2020). This is also highlighted and supported by the higher transitivity score in 2005, indicating a move towards forming cohesion through board interlocks. Degree centrality scores indicated relatively minimum variance across the four years, with a slight decrease over the 2002 and 2003 period. However, 2004 and 2005 indicated a dramatic increase. This indicates that there was a positive net gain in the number of connections between the total critical firms in 2005. Women who sit on multiple boards are found to reduce external uncertainty and increase firm performance, even when compared to their male counterparts in the United States of America. Hence, these interlocks behave as a channelling tool of advantageous and unique knowledge transfer (O'Hagan, 2017). These results support the narrative of an increase in shared boards, which could be due to self-serving mechanisms that increase power, enhance information access or industry control following institution-level policy. Betweenness centrality increased in 2003 and 2004, indicating a network restructuring where previously peripheral firms are becoming more central to information flow. With directors connecting previously unlinked firms, they facilitate unique strategic opportunities, such as partnerships or resource sharing, allowing for a bridging of 'structural holes' present in the network. However, Eigenvector centrality had decreased significantly, specifically in 2003 (0.0087) and 2005 (0.0089), which suggests interlocks forming around other firms may reduce the relative importance of previously dominant players.

Subgraph-level statistics were performed to identify the clustering of firms through shared board memberships following changes in director appointments in each year. The dyadic census indicated a compounding effect on the number of dyads formed in 2005 compared to previous years, highlighting the appointment of directors to firms close to other firms that were more connected. This was also corroborated by the increase in triadic instances within the network, which could lead to the formation of more cliques. The number of cliques (a clustering of three or more firms with shared directors) showed an increase in the final year ( $n=151$ ). This could potentially be due to short-term lag effects that underlie sudden changes to the network structure (Gimeno *et al*, 2022). Also, in listed companies, often a director with multiple board memberships forms elite cohesion where their trusted expertise is seen as beneficial and risk-averse, while also holding a higher degree of influence in corporate governance (Benton, 2021). This particular effect may be evident in unlisted firms when faced with uncertainty. It is possible that because the B-BBEE Act is aimed at all companies (as opposed to the King Code, which targeted listed or large unlisted firms) that we see larger variations in network statistics in 2005.

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**2002****2003**

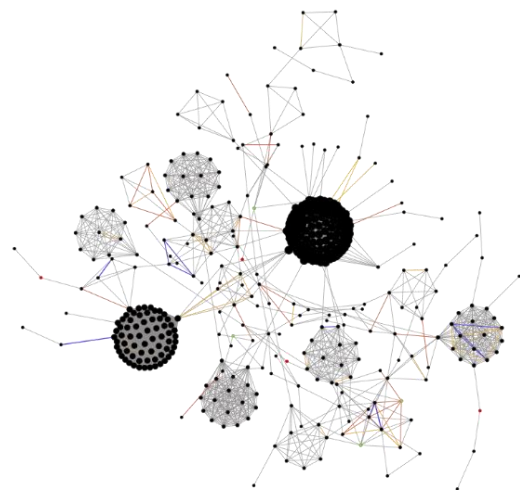
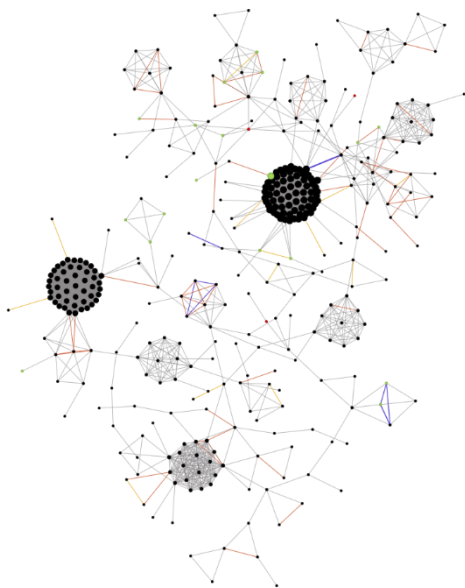
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**2004****2005**

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**Figure 2: Social Network Visualisations of Cluster Two**

From 2002 to 2005, the network of women directors across South African firms demonstrated significant expansion and evolving connectivity during the period marked by King Code II and the implementation of the Broad-Based Black Economic Empowerment (B-BBEE) framework (**Figure 2**). The largest component size grew substantially from 136 firms in 2002 to 410 firms in 2005, reflecting a rapidly consolidating core of interconnected firms that shared women directors, likely driven by intensified governance reforms and diversity mandates (Moyo and Yeros, 2005). Meanwhile, the number of network components also rose from 129 to 206, indicating that although the main cluster expanded, fragmentation persisted with multiple smaller isolated groups. Over this period, we witness a slow growth in clustered, centralised

firms with the number of shared directors (edge weights) decreasing over time, indicating a trend towards deeper network formation through single shared directorships only. Firm type composition shifted markedly as private companies (Pty Ltd) increased notably from 602 to 1,142, emphasising a surge in private sector engagement with female directorships, whereas SOC and Ltds showed only minimal changes in numbers. Analysis of edge weight distributions, representing the number of shared directors between pairs of firms, reveals that edges with a weight of one overwhelmingly dominated throughout the period, accounting for over 84% and climbing to nearly 96% by 2005. This indicates that most firm connections were characterised by single shared directors, reflecting relatively weak inter-firm linkages. Edges with higher weights (two or more shared directors) diminished proportionally, suggesting limited formation of stronger ties despite growing network size. ). This was also seen in a study observing the appointment of directors following a board gender and racial quota in Australia (Wright *et al*, 2023). These patterns point to a network in transition, where policy-driven pressures facilitated increased female board presence, but the consolidation of dense, multi-director connections remained nascent, underscoring ongoing challenges in achieving integrated governance networks (Habib and Welch, 2013).

### ***Cluster 3: King Report on Corporate Governance 2009 (2008, 2009, 2010, 2011)***

**Table 3: Firm-Firm Network Analysis of Cluster Three**

|                                                                         | <b>2008</b> | <b>2009</b> | <b>2010</b> | <b>2011</b> |
|-------------------------------------------------------------------------|-------------|-------------|-------------|-------------|
| <b><i>Nodes (Firms)</i></b>                                             | 2658        | 2744        | 2642        | 2553        |
| <b><i>Edges (Links between firms due to shared women directors)</i></b> | 7850        | 8037        | 9169        | 11237       |
| <b><i>Pty (Ltd)</i></b>                                                 | 2541        | 2615        | 2530        | 2452        |
| <b><i>SOC</i></b>                                                       | 31          | 33          | 31          | 28          |
| <b><i>Ltd</i></b>                                                       | 86          | 96          | 81          | 73          |
| <b><i>Network-Level Statistics</i></b>                                  |             |             |             |             |
| <b><i>Density</i></b>                                                   | 0.0022      | 0.0021      | 0.0026      | 0.0034      |
| <b><i>Transitivity</i></b>                                              | 0.8330      | 0.8413      | 0.9022      | 0.9411      |
| <b><i>Degree Centrality</i></b>                                         | 5.9067      | 5.8579      | 6.9410      | 8.8030      |
| <b><i>Closeness Centrality</i></b>                                      | 0.0469      | 0.0425      | 0.0487      | 0.0475      |
| <b><i>Betweenness Centrality</i></b>                                    | 0.0007      | 0.0006      | 0.0008      | 0.0007      |
| <b><i>Eigenvector Centrality</i></b>                                    | 0.0017      | 0.0024      | 0.0025      | 0.0026      |
| <b><i>Symmetry</i></b>                                                  | TRUE        | TRUE        | TRUE        | TRUE        |
| <b><i>Subgraph-Level Statistics</i></b>                                 |             |             |             |             |
| <b><i>Dyad Census</i></b>                                               | 7850        | 8037        | 9169        | 11237       |
| <b><i>Triad Census</i></b>                                              | 37940       | 42393       | 76129       | 11206       |
| <b><i>Cliques (n=&gt;3)</i></b>                                         | 602         | 637         | 585         | 514         |
| <b><i>Components</i></b>                                                | 393         | 418         | 387         | 383         |
| <b><i>Largest Component Size</i></b>                                    | 1493        | 1448        | 1521        | 1402        |
| <b><i>Isolates</i></b>                                                  | 14296       | 14935       | 14851       | 15880       |

Between 2008 and 2011, the network of women directors across South African firms that had reached a critical mass showed meaningful structural shifts, particularly in the number of

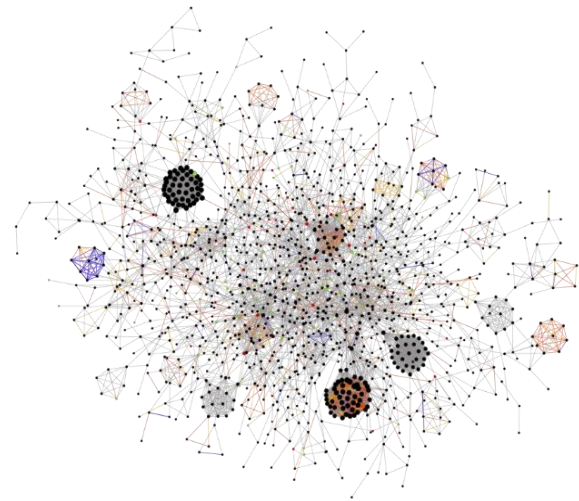
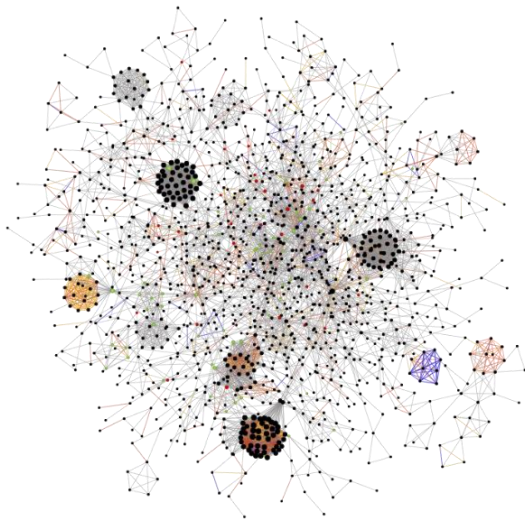
connected firms and isolates, as seen in **Table 3**. The number of firms remained relatively stable, with a slight decline from 2,658 in 2008 to 2,553 in 2011. However, the number of connections between these firms, which reflect shared women directors, increased substantially from 7,850 in 2008 to 11,237 in 2011. This indicates a growing trend of women serving on multiple boards, thereby linking firms more densely over time. Notably, the number of isolates, directors who sit on only one board, increased from 14,296 in 2008 to 15,880 in 2011. This rise in isolates suggests that while some women directors were highly connected and instrumental in bridging firms, a significant portion remained confined to single-board appointments, highlighting persistent barriers to broader network integration despite policy efforts (Sealy and Singh, 2010).

Examining network-level statistics reveals that the connectivity and cohesiveness of the network improved during this period, which may be partially attributed to the introduction of the 2009 King Code (King III), which emphasised integrated reporting and governance accountability, indirectly encouraging greater female participation and cross-board collaboration (IoDSA, 2009). Network density rose from 0.0022 in 2008 to 0.0034 in 2011, signifying a higher proportion of actual ties among possible connections. Transitivity, which reflects the likelihood that two firms connected to the same director are also connected to each other, increased markedly from 0.8330 to 0.9411, suggesting a more tightly knit network structure. Degree centrality, representing the average number of ties per firm, increased from 5.91 to 8.80, indicating that firms were increasingly sharing directors and thus becoming more central to the network. Although closeness and betweenness centralities remained relatively stable, eigenvector centrality, which captures a firm's influence based on connections to other highly connected firms, rose slightly, emphasising the emergence of more influential firms within the network. Collectively, these changes suggest that policy frameworks like King III potentially contributed to creating a more integrated and influential network of women directors. Additionally, the Companies Act of 2008, which emphasised improved accountability and governance structures, likely reinforced these trends by formalising expectations for more inclusive and transparent board practices (Republic of South Africa, 2008). This legislative push may have further motivated firms to diversify their boards and connect more actively within the evolving director network.

At the subgraph level, further notable changes can be observed. Dyad and triad counts, which represent two- and three-firm collaborations, both increased significantly. Dyads rose from 7,850 to 11,237, and triads from 37,940 to 112,060, reflecting deeper and more complex sub-network formations. The number of cliques of size three or more decreased from 602 to 514, suggesting a move away from tightly clustered small groups toward broader, more interconnected configurations. While the number of components (disconnected subgroups) decreased slightly, the size of the largest connected component remained large, though it declined marginally from 1,493 to 1,402. These patterns point to a dynamic restructuring of women's director networks post-King III, promoting broader integration but also indicating that full consolidation was yet to be achieved (Adams and Kirchmaier, 2016).

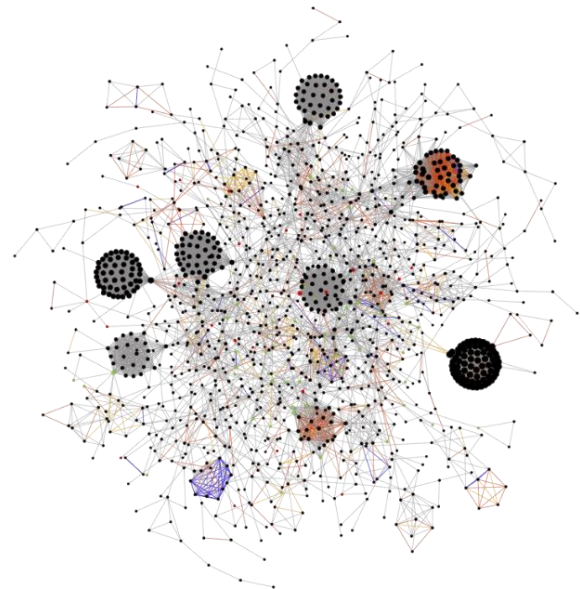
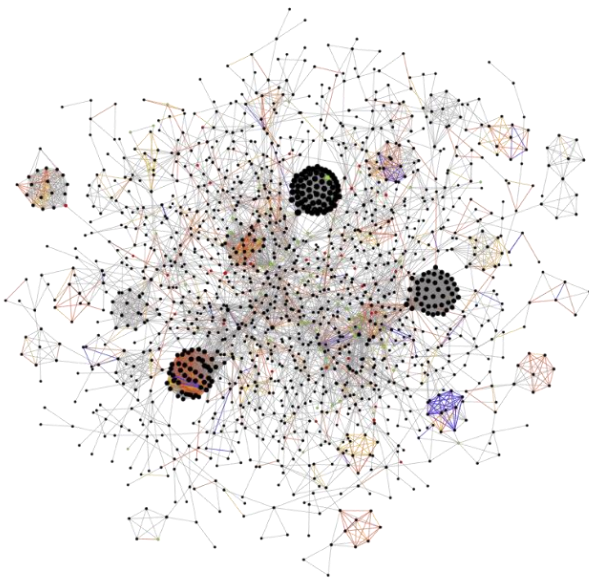
2008

2009



2010

2011



**Figure 3: Social Network Visualisations of Cluster Three**

The network of women directors across South African firms exhibited notable structural changes coinciding with the introduction of King Code III and the Companies Act of 2008, both of which emphasised improved governance and board diversity (**Figure 3**). The largest connected component remained substantial throughout this period, fluctuating slightly but

maintaining a strong core presence with sizes of 1,493 in 2008, 1,448 in 2009, peaking at 1,521 in 2010, and slightly declining to 1,402 in 2011. This sustained size reflects a resilient and interconnected cluster of firms sharing women directors, highlighting increasing board interlocks during this era of governance reform. The firm composition was dominated by Pty Ltds, which consistently numbered around 2,500 firms each year, while SOC and Lts remained far fewer, indicating the private sector as the primary locus of women director activity. Analysis of edge weights, which measure the number of shared directors between firm pairs, shows a clear trend towards weaker ties predominating the network. Edges with weight one, indicating a single shared director, grew from 72.13% in 2008 to 83.72% in 2011, underscoring an increasing prevalence of minimal inter-firm connections. Higher-weight edges, representing stronger board overlap, declined proportionally over time; for instance, weight-three edges fell from 8.93% to 4.65%. This suggests that while the network expanded, its cohesion weakened as firms shared fewer directors per connection, potentially reflecting firms' cautious approach to board interlocks amidst evolving regulatory environments (Larcker, Richardson, and Tuna, 2007).

#### ***Cluster 4: King Report on Corporate Governance 2016 (2016, 2017, 2018, 2019)***

**Table 4: Firm-Firm Network Analysis of Cluster Four**

|                                                                         | <b>2016</b> | <b>2017</b> | <b>2018</b> | <b>2019</b> |
|-------------------------------------------------------------------------|-------------|-------------|-------------|-------------|
| <b><i>Nodes (Firms)</i></b>                                             | 4628        | 5926        | 6585        | 7195        |
| <b><i>Edges (Links between firms due to shared women directors)</i></b> | 5473        | 7270        | 7336        | 9711        |
| <b><i>Pty(Ltd)</i></b>                                                  | 4499        | 5767        | 6407        | 7018        |
| <b><i>SOC</i></b>                                                       | 38          | 30          | 33          | 30          |
| <b><i>Ltd</i></b>                                                       | 91          | 119         | 145         | 147         |
| <b><i>Network-Level Statistics</i></b>                                  |             |             |             |             |
| <b><i>Density</i></b>                                                   | 0.0005      | 0.0004      | 0.0003      | 0.0004      |
| <b><i>Transitivity</i></b>                                              | 0.7889      | 0.7988      | 0.7267      | 0.9252      |
| <b><i>Degree Centrality</i></b>                                         | 2.3652      | 2.4536      | 2.2281      | 2.6994      |
| <b><i>Closeness Centrality</i></b>                                      | 0.0027      | 0.0031      | 0.0032      | 0.0027      |
| <b><i>Betweenness Centrality</i></b>                                    | 0.0000      | 0.0000      | 0.0000      | 0.0000      |
| <b><i>Eigenvector Centrality</i></b>                                    | 0.0008      | 0.0007      | 0.0007      | 0.0011      |
| <b><i>Symmetry</i></b>                                                  | TRUE        | TRUE        | TRUE        | TRUE        |
| <b><i>Subgraph-Level Statistics</i></b>                                 |             |             |             |             |
| <b><i>Dyad Census</i></b>                                               | 5473        | 7270        | 7336        | 9711        |
| <b><i>Triad Census</i></b>                                              | 6316        | 10777       | 7702        | 39946       |
| <b><i>Cliques (n=&gt;3)</i></b>                                         | 561         | 698         | 767         | 845         |
| <b><i>Components</i></b>                                                | 1499        | 1932        | 2198        | 2359        |
| <b><i>Largest Component Size</i></b>                                    | 649         | 896         | 989         | 1052        |
| <b><i>Isolates</i></b>                                                  | 57232       | 68974       | 75541       | 80253       |

The number of firms (nodes) grew significantly from 4,628 in 2016 to 7,195 in 2019, as seen in **Table 4**, reflecting both economic expansion and a broadening corporate landscape in South

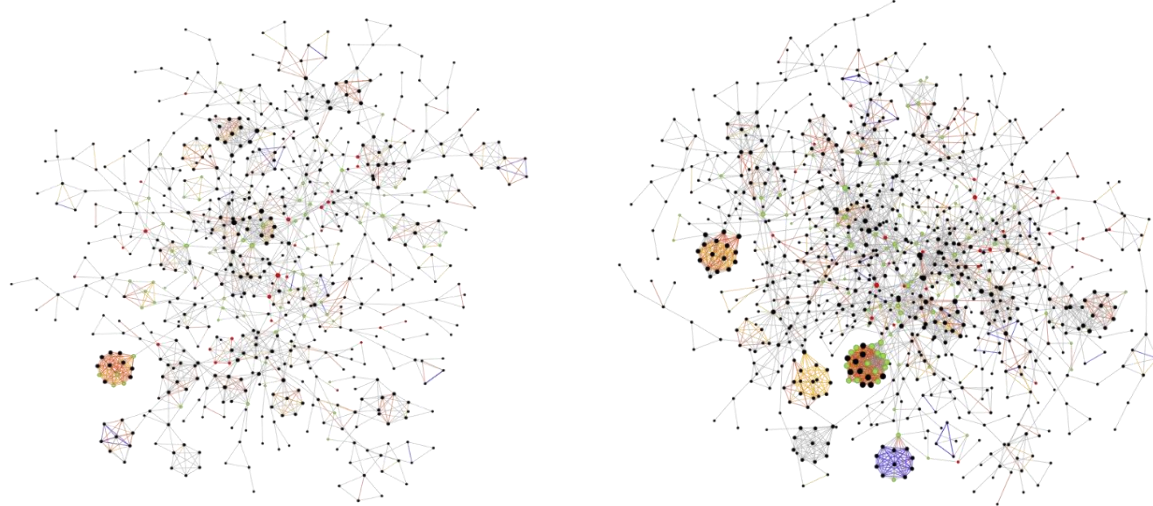
Africa during this period (Ntim, 2016). However, while the number of edges (representing shared women directors) also rose from 5,473 to 9,711, it did not keep pace with the rapid increase in nodes. As a result, the number of isolates, or directors serving only on single boards, surged dramatically from 57,232 to 80,253. This suggests that although more women were entering boardrooms, many did so in isolated capacities without developing cross-board connections. These figures highlight the ongoing challenges of achieving true integration and influence for women directors, despite nominal increases in representation (Kang *et al.*, 2020).

At the network level, the statistics illustrate a shifting but still fragmented structure. Network density declined from 0.0005 to 0.0004 over the period, underscoring the sparse connectivity among firms as the network expanded. Nevertheless, transitivity increased substantially from 0.7889 in 2016 to 0.9252 in 2019, suggesting that where connections did exist, they were more likely to form tightly knit clusters. Degree centrality, representing the average number of connections per firm, rose modestly from 2.37 to 2.70, indicating a slight increase in individual firms' participation in the network. Meanwhile, closeness and eigenvector centralities remained low and stable, emphasising the peripheral nature of most firms and the absence of dominant, highly central firms. Betweenness centrality stayed at zero, highlighting the lack of intermediary "bridge" firms connecting different parts of the network. These patterns may be partially explained by post-2008 global economic shocks and local economic fluctuations, which impacted corporate governance practices and risk appetites in South Africa (Adegbite *et al.*, 2012). The gradual economic recovery may have encouraged cautious expansion of women's roles rather than widespread integration.

Subgraph-level metrics provide further evidence of evolving but uneven connectivity. Dyads increased from 5,473 to 9,711, and triads grew sharply from 6,316 to 39,946 by 2019, signalling the development of more local substructures despite overall network sparsity. The number of cliques with three or more firms also rose steadily from 561 to 845, indicating a growing number of small, tightly connected groups. Interestingly, the number of components (disconnected subgroups) rose from 1,499 to 2,359, and the largest component only expanded from 649 to 1,052, suggesting that while more micro-communities were forming, the network as a whole remained fragmented. The surge in isolates supports this picture, demonstrating that many women directors were included in governance structures but remained siloed. These dynamics illustrate that although policy changes like King IV continued to promote gender diversity on boards, broader economic conditions and firm-level strategies played a critical role in shaping the structure and inclusivity of women directors' networks (Post and Byron, 2015).

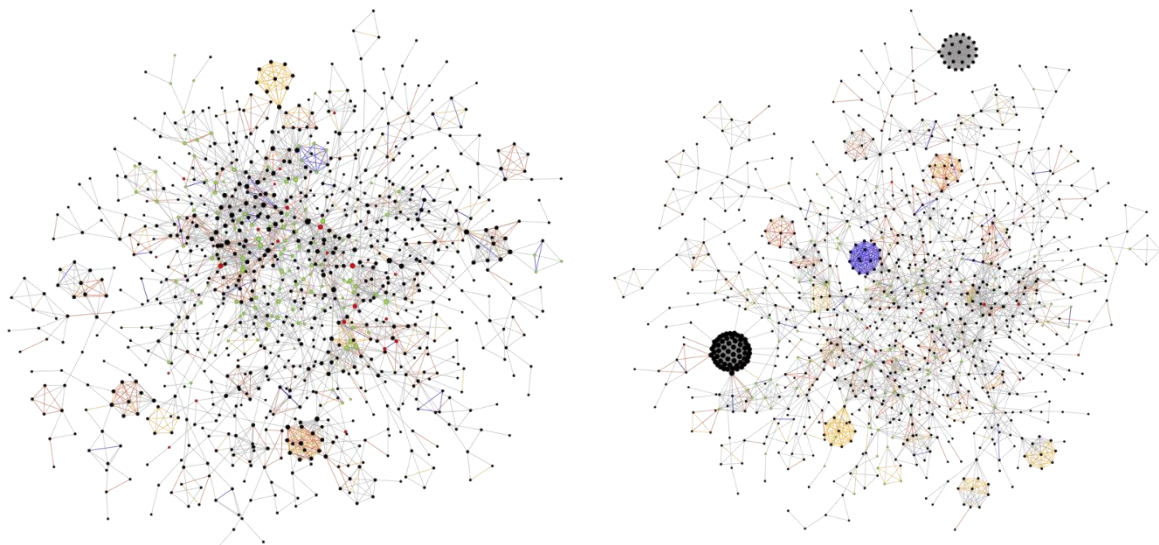
2016

2017



2018

2019



**Figure 4: Social Network Visualisations of Cluster Four**

The South African women director networks observed in Cluster 4 (**Figure 4**) underwent interesting changes that coincided with the introduction of King Code IV, which emphasised integrated thinking and strengthened stakeholder inclusivity. The largest connected component expanded from 649 firms in 2016 to 1,052 firms in 2019, highlighting a gradual consolidation of firms into larger, more cohesive clusters of shared women directors. Furthermore, we see

the resurgence of a highly connected, centralised cluster in 2019, indicating the return to risk-averse onboarding. However, the total number of components also increased sharply, rising from 1,499 to 2,359, indicating growing fragmentation alongside core growth. Firm type composition trends showed a dominant presence of Pty Ltd, which increased from 4,499 to 7,018, suggesting that private sector firms increasingly embraced female directorships during this governance-driven period. SOCs and Ltds remained small in number but exhibited slight growth, reflecting a slow diversification beyond private entities. Examining edge weights, edges with one weight consistently dominated, growing from 66.11% in 2016 to 70.12% in 2019, signifying that most inter-firm ties remained weak. Moderate-weight edges (weights two and three) accounted for around 25-28% across these years, while stronger ties (weights four and above) remained marginal. These patterns suggest that although King IV inspired wider inclusion and emphasised transparency, firms favoured broad but shallow networks rather than deeply interconnected board interlocks, which could potentially increase indirect access to industry, financial or regional resources (Hillman et al., 2007; Du Toit, 2017). Overall, these shifts reflect an evolving landscape where policy-driven diversity efforts created expansive but relatively loose governance networks rather than dense, high-overlap structures.

## **Conclusion**

Our results indicate that the number of women directors that are appointed in firms with critical mass increases, but also that there is increased formation of firm-firm ties through shared board memberships, as well as new appointments that have no links to other firms following the introduction of a nationally implemented board gender diversity policy. This trend was specifically seen in the third cluster, circa King Code III and B-BBEE implementations. Our data may show that, overall, firms in South Africa may be open to appointing women board members, but highly central firms may have been more risk-averse in appointment decision-making when racial quotas were introduced, highlighted by the significant increase in peripheral firm-firm ties following the implementation of the BEE Act (2003). Understanding the influence of soft laws and their impact on intersectional inclusion at the corporate governance level becomes imperative.

A critical limitation of our analysis lies in the fact that our data lacks racial information on all the women directors, as well as consistent regional and industrial classification of firms to highlight whether significant differences occur within social, regional or industrial subgroups. Further development of this paper would include the analysis of the node-level statistical effects of nodal attribution data and how they impact the evolution of the network structures. This would include the age of the company, directors' ages and length of directorship (newly appointed versus existing memberships). Furthermore, we would like to compare these women director networks to men director networks in companies achieving critical mass and companies not achieving critical mass to determine whether there is a significant difference in network metrics following the introduction of new board policy recommendations.

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