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Changes in Norwegian ASA Board Networks

- Gender Balance Law and Firm Exit between 2000 and 2010

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ABSTRACT

This paper explores characteristics of Norwegian ASA board networks from 2000 to 2010, to better understand the consequences of new regulations in gender equality introduced in the period, and the financial crisis unfolding in the period. These latter exogenous shocks are bound to give repercussions that change the board structures, and hence inter-firm relations over time. During the period, the number of ASA firms was roughly halved. The evidence shows that, in spite of this, 2/3 of all ASA firms are connected through common directors. Additionally, I find that the networks change over time in terms of how firms connect through shared directorship. By 2010, there is an elite of directors, both male and female, occupying powerful positions in the network in terms of accessing information.

SAMMENDRAG

Denne oppgaven undersøker hva som karakteriserer norske ASA-selskapers nettverk i perioden fra 2000 til 2010. Analysen bidrar med å gi innsikt i hvilke konsekvenser kjønnskvoteringsloven og finanskrisen har hatt for selskapers nettverk. Kjønnskvoteringsloven og finanskrisen er to eksogene sjokk som har endret styresammensetningen og i så måte endret forholdene bedrifter har til hverandre. Jeg finner at 2/3 av alle ASA-selskaper er forbundet gjennom at de deler ett eller flere styremedlemmer med andre selskaper. Videre finner jeg at nettverket endrer seg over tid hvis man ser på hvilken selskaper som er forbundet på grunn av delte styremedlemmer. I tillegg finnes det en elite av styremedlemmer, både kvinner og menn, som har sentrale posisjoner i nettverket.

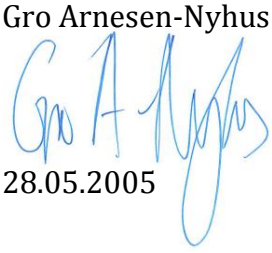
PREFACE

This thesis is written as part of my master degree in Economics and Administration. The past five months have for me been an exciting journey which have given me the opportunity to conduct an in-depth study of network ties amongst board. Additionally, through this thesis I have had the to enhance my English. The idea to study network relations in governance structures came to me after I had spent hours on LinkedIn visiting other people's profiles and seen that people I knew also knew others I knew without me being aware.

I have been lucky to meet an open-minded tutor supporting the idea to utilizing social network analysis on governance issues. I would like to take this opportunity to sincerely thank my tutor and coach, Øystein Strøm, for his guidance and input both on academic aspects as well as my personal development.

I am eternally grateful to have family and friends supporting me. For the hours spent discussing the Norwegian directorship networks I wish to thank my father, Tor Arnesen. I also thank Lars Moastuen and Marthe Pernille Hernæs for spending time proofread my thesis.

Gro Arnesen-Nyhus



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CONTENTS

1 INTRODUCTION

This paper studies Norwegian Allmennaksjeselskap (hereafter referred to as ASA[1]) inter-firm network by shared directors from 2000 to 2010. Norway is the first country in the world legislating a gender law, requiring 40% gender representation on the board of directors, hence placing Norway in the forefront on gender equality in the boardroom. This law acts as a natural experiment for other countries to look at when debating equality in the business world. In 2008 when the financial crisis struck, many companies were forced to make changes (some rendered bankrupt). These changes probably reached the boardrooms as well. The new gender balance law and the unfolding financial crisis, act as two exogenous shocks for the board environment.

Gender representation, as stated in the proposition no.97 of 2002-2003 (Regeringen 2002), is considered important to the contribution of gender equality, wider power distribution and utilisation of existing knowledge and resources in society as a whole. A study conducted by Adams and Ferreira (2009) on companies in USA, show that gender-diverse boards allocate more effort to monitoring. Staubo (2010) finds that the increase in female directors due to the gender law have left boards being more independent than before. However, Seierstad and Opsahl (2011) conclude that the private sector is not convinced by the arguments in the proposition since the female ratio has not increased beyond 40 percent nor has the female fraction of chair positions increased. The gender law has resulted in a need for reshuffling of the directorship network to meet the legislation. However, to this point, one does not know what effect this reshuffling has had to the directorship network.

Other studies related to governance structures have found multiple directorships to be preferred for both firm performance (Bøhren and Strøm, 2010) and acquisition of information (Grønmo and Løyning, 2003). Director independence is considered essential in conducting sufficient monitoring and in being an advisory body to the executive management, particularly the CEO. Indeed, multiple directors must be balanced against representing multiple interests when serving as board members for different firms.

[1] similar to public limited companies

This study will add to the literature by describing, visualising and characterising the inter-firm board of directors' networks in an environment dominated by 1) mandatory and soft laws influencing established best practice in terms of board structure and 2) the financial crisis immediate ripple effect to board structure and inter-firm connections. This network study primarily focuses on how firms are connected through common directors and not individual member characteristics in the network.

Utilizing social network analysis as a methodical angle is a fairly recent approach when looking at and understanding how multiple directorships produce connections and spread information between firms. Keep in mind, however, that the formal ties between board of directors is not the only way information is shared with a company, informal ties is also an important information "highway". The same can be seen for formal ties outside of ASA boards, e.g. AS boards. However, this study is limited to formal ties by ASA board directorship. Network analysis is conducted partly by extracting centrality measurements, more specifically, the so-called degree, closeness, betweenness and eigenvector (see chapter 4.2.1.4).

I find that there is an inter-firm network of ASA firms connecting 2/3 of all firms throughout the period. A few male, and as the decade progresses, an almost comparable number of female directors, hold prominent positions in this network. If anything the "boys' club" has been joined by the "golden skirts". The average age of directors has increased, however the average age for female directors is five years younger than their male peers by 2010. Firms that have stayed in the database during the eleven year period have higher centrality scores compared to other firms at the end of the period. These firms, however, do not stick together as one might expect, but are spread throughout the network.

The thesis proceeds as follows: a brief overview of available literature on the subject in chapter 2. Then, chapter 3 presents the institutional background and hypothesis before chapter 4 provides information about methodology followed by chapter 5 presenting the data and its characteristics. Results of the analysis can be found in chapter 6 and a additional evidence is presented in chapter 7. Finally, results and conclusions are presented in chapter 8.

1.1 NETWORK STUDY

Social networks can take many forms and may be studied for different purposes. Figure 1 shows two different random networks and gives the reader an idea of what a network can look like. The figure to the left is a one-mode network where circles can represent people, organizations etc. and the lines shows the connections between them. The figure to the right is a two-mode network where the circles represent two types of categories. For example, black circles can be boards (event) and white circles represent directors (actor), and this is known as an affiliation network. Based on network relations information flow etc. within the network can be studied.

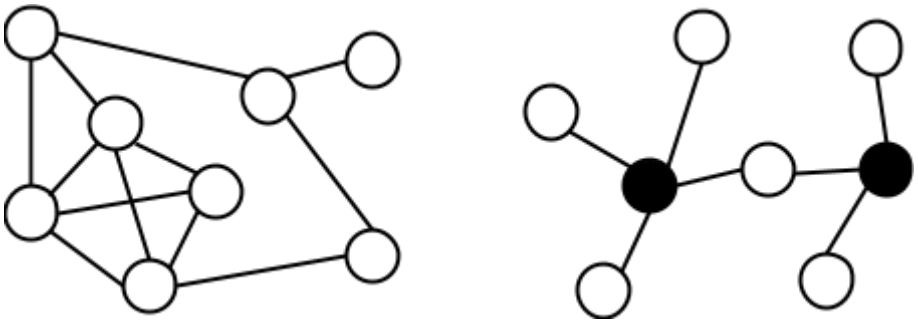

FIGURE 1 - RANDOM NETWORK SAMPLE FOR ILLUSTRATION PURPOSES.
RIGHT FIGURE: ONE-MODE NETWORK AND LEFT FIGURE: TWO-MODE NETWORK.

2 LITERATURE REVIEW

The Gender Balance Law (GBL) came as an exogenous shock in 2006 and is consequently a natural experiment situation on what was already established to be the best practice for firms (Ahern and Dittmar, 2010).

Bøhren and Staubo (2014) find that, compared to other more flexible alternatives, the mandatory approach to gender balance is a costly way to regulate firm boards. Many firms choose to exit ASA as their organizational form to avoid the legislation in general. One repercussion of choosing AS over ASA is less transparency, hence less information is shared. Bøhren and Staubo also find that the exiting firms are commonly characterised as being small, young, successful companies, not family owned, with few female directors or strong owners.

Ahern and Dittmar (2010) find that the GBL has a negative impact on firm value based on the idea that the board is selected to maximize value. However, they find that firm value did not decline due to the new members, but rather due to young age and lack of high-level work experience. On average, all firms had to change 30 percent of their board of directors to meet the requirements. This led to a change in board characteristics including age, gender and experience. Hence, GBL led to less optimal boards, which in turn gave weaker firm performance. Ahern and Dittmar (2010) also find that a) board members with previous CEO experience or professional board members increase firm value and b) older board members increase value. The cost of this forced legislation is borne by the firm's shareholders.

Bøhren and Strøm (2010) find that boards have higher firm value creation when gender diversity is low. They have evidence to suggest that the absence of employee directors is favourable to firm value. The authors additionally find that directors with strong links to other boards create more value for its owners and that multiple directorships are beneficial for value creation. Utilizing information centrality, they find that the value of the firm is higher when directors have wide networks through board memberships in other firms.

Seierstad and Opsahl (2011) address the effects of gender balance law as an exogenous shock with collected data of ASA-firms from 2002 to 2009. Applying betweenness

centrality, they reject a hypothesis on equality between gender and conclude that the influence has, after the law was fully effective, been concentrated on a few individual directors. Advocates of the gender balance law have claimed that the law would lead to a more desirable equality distribution. However, Seierstad & Opsahl (2011) report that the opposite is in fact the case. Additionally, the authors conclude that the private sector is not convinced by the argument behind the law since the female ratio of directorships has not increased beyond the mandatory 40 percent nor has the fraction of female holding chair positions increased.

Grønmo and Løyning (2003) conduct a qualitative longitudinal study of Norwegian boards and report that holding multiple directorship[2] is considered to be a valuable way of acquiring and sharing knowledge and experience. Moreover, they argue that these directors have more influence than their non-multiple director colleagues. A respondent stated that as CEO one should hold board membership outside ones firm to *"get new impulses"*. The majority of respondents recognise that network has become increasingly important to conduct successful business in a rapidly changing environment. The study is in line with what social network analyses seek to show.

Conyon and Muldoon (2006) is a network-study utilizing data from USA, UK and German boards to investigate whether boards are more *"clubby"* than what would be expected purely by random graph modelling. They find that this is not the case and that board networks in the corporate world are no more *"pronounced"* than what one would expect by chance. In addition, they find evidence to suggest that directors who sit on several boards appear to do so in the company of others who also sit on several boards[3].

Granovetter (1973) is a seminal paper within the study of networks introducing the term *"the strength of weak ties"*. The paper is concerned with how information spreads throughout a network and asserts that the weak ties are as equally important as the strong ties. Weak ties can work as bridges between groups of people who otherwise would be disconnected. There is a subtle point made by Granovetter: strong ties between mutual friends can be broken almost without consequence for information

[2] Grønmo & Løyning (2003) refer to such directors as prominent directors.

flow within the friends' network. Bridges are almost always formed from weak links - thus weak links may be of higher importance than strong links because they act as the crucial information ties that stitch subgroups in the social network together. An additional point is that weak ties do not only connect to another person, but to another group of people.

A key point as to why weak ties are more fertile is that information will spread throughout larger number of people and always to someone new. In the case where one only shares information with strong ties, chances are the information will come back around, hence loop, and then stop. In the case of the board and firm networks this is an interesting observation which will be looked further into later by focusing on betweenness centrality, clustering and other centrality measures.

3 THEORY AND HYPOTHESES

Focusing on relationships between firms, connected by shared directors, the underlying assumption is that common directors amongst boards are an important factor in the information flow between corporations. Thus, an analysis of the network created and maintained between boards as a function of shared membership should shed light on inter-firm board community formation. This again should be of importance to the understanding of the context for the work done by the boards of directors in corporate governance processes.

In Norway, there is an ongoing debate on whether directorship networks are dominated by an elite of people whom all are connected. These elites, the argument goes, have mostly been male dominated, referred to as the *"boys club"* [4], before the gender balance law, however now supplemented by a league female director referred to as *"golden skirts"* post enforcement (Seierstad and Opsahl, 2006). Based on this, it is not unthinkable that the firm network consists of one large cluster/component where all firms are connected. Multiple directorship is considered an important success factor for value creation (Grønmo and Løyning, 2006; Bøhren and Strøm, 2010). This leads to the first hypothesis:

Hypothesis 1. The majority of ASA firms are connected on board level by multiple representations in directorship and CEO relations.

Social Network Analysis is applied to explore the ASA networks in the period 2000 to 2010. This period is characterised by two exogenous shocks transforming the context for ASA board; GBL and the financial crises of 2008. Over the sample period there is a 44% decrease in number of ASA firms. Consequently, one might expect that the network will have changed over the decade. With this in mind, hypothesis two is:

Hypothesis 2. The massive reduction of ASA firms has led to significant changes in the inter-firm network structure.

[4] See 3.2.1 for description.

Corporate governance[5] involves, according to OECD principles of corporate governance:

> "*... a set of relationships between a company's management, it's board, it's shareholders and other stakeholders. Corporate governance also provides the structure through which the objectives of the company are set, and the means of attaining those objectives and monitoring performance are determined.*" OECD (2004, p.14)

Goergen (2012) underlines that:

> *"The board of directors is the ultimate governing body within the corporation. It's role, and in particular the role of non-executive directors on the board, is to look after the interests of all the shareholders as well as sometimes those of other stakeholders ..."*

Limited literature on inter-firm network by shared directors including social network analysis and visualisation seem to exist. Some Norwegian studies address the effects of the *"gender bender"* regulation enforced in the period studied here. Seierstad and Opsahl (2010) apply social network analysis to study the effect of women entering the boards in the period May 2002 to August 2009 and conclude that the *"gender bender"* regulation has *"created a small elite of female directors"*. Hypothesis 3 is:

Hypothesis 3. The effect of the major recruitment of female board members has caused a pool of female directorships with a privileged position in information flow between firm boards, forming clusters.

This study will add to the literature by describing and visualising the inter-firm board of directors networks by social network analysis. It will also reveal some central characteristics of these networks. The specific causes driving the transformation of the networks throughout the decade is not the topic for this study, beyond recording the immediate effects of the major exogenous shocks represented by the GBL and the financial crises.

[5]Alternative definition by Shleifer and Vishny (1997) is less concerned with the stakeholders: *"the way in which suppliers of finance to corporations assure themselves of getting a return on their investment"*

Following is a review of regulations concerning directorship and theory on social network analysis.

3.1 ALLMENNAKSJESELSKAP (ASA) AND AKSJESELSKAP (AS)

Two types of regulative arrangements give firms limited liability, namely Aksjeselskap and Allmennaksjeselskap, roughly private limited firm and public limited firm. The latter form was introduced in 1996 as a response to the European Union legislation regarding corporate law. The owner(s) of a firm can choose *ad lib* to be organised as ASA or AS, but the two are subservient to different regulations.

Among the characteristics that separate the two, the number of shareholders as well as shareholder protection is highlighted. An ASA is generally more diffusely owned, as ASA is the only institutionalization of a firm that can obtain equity through the general public and be listed on the stock exchange. Because of this, ASA have more comprehensive provisions for reporting and transparency than AS. In general ASA firms have more transparency requirements than AS.

Additional regulations for an ASA is a minimum of 1 million NOK in equity of which maximum 50 % can be shares without the right to vote or other types of limitations compared to common stocks. It is mandatory to conduct an annual general meeting.

The gender quota law of 2006 only applies to ASA firms. The board of directors must consist of a minimum of three members in which both genders must be represented. In Norway the CEO cannot be a member of the board of directors within the same firm. All stocks must be registered in The Norwegian Central Securities Depository (Verdipapirsentralen, 2014).

3.2 REGULATION AFFECTING ASA

Most nations, including Norway, have regulations to secure that both shareholders and stakeholders are included in a firm's corporate governance structure. Since 2006, the regulations include mandatory gender balance. In addition to mandatory legislations, firms are also advised to embrace the Norwegian recommendation for code of conduct (The Norwegian Code of Practice for Corporate Governance - NCGB). The Norwegian

code of conduct is based on the publication of "Cadbury committee" (1992) report, OECD (2004) and Sarbanes-Oxley Act (2002). In the following section, a review of mandatory and code of conduct focussing on issues relating to board of directors.

3.2.1 MANDATORY LEGISLATIONS

The gender balance law became effective in 2006, with an acclimatisation period of two years for existing firms making it mandatory for all by 2008.

In February 2002, the conservative party Minister of Trade and Industry, Ansgar Gabrielsen, announced through the media that he wanted a change in the Norwegian board of directors network. He claimed to be "sick and tired of the boys club" (VG nett 2014) and urged all Norwegian firms, both AS and ASA, to execute a more gender equal policy when electing their board of directors. Gabrielsen also stated that he was willing to legislate a new bill to see this through if firms did not act on the encouragement voluntarily.

This is how Norway came to be the first country to have a law demanding gender balance in the boardroom. Gabrielsen and the government based this decision on arguments that a gender quota requirement would contribute to a wider gender equality in society as a whole. Additionally, it would contribute to a positive decentralisation of power and a recruitment of new competence into the world of ASA boards. Successors within the government supported Gabrielsen's statements further adding that it will contribute to more democracy and even enhanced value creation for companies. This paper will not discuss the political side of this law, but look at how this contributed to the development of inter-firm relations through the eyes of social network analysis.

Proposition no.97 2002-2003 is the formal announcement of GBL that was set into motion January 1st 2006. ASA firms registered before 2006 had two years transition period and thus the legislation was mandatory for all ASA by 2008. The gender balance was not at 40%, for women, until 2008 and nor has it increased after.

The proposition states that AS not will be affected by the law because Norwegian AS often are small, family-owned firms. In addition to ASA firms, the gender balance policy

also applies to state-owned firms, specifically: statsaksjeselskap (public sector corporation), statsallmennaksjeselskap (public limited liability state-owned company) and statsforetak (state corporation).

Norwegian public limited liability companies act (Lov om Allmennaksjeselskaper - LOV-1997-06-13-45. Lovdata, 2014) states that if the firm has three board members, both genders must be represented. If the firm has four or five board members, the board is required to have at least two representatives of each gender and so on. Table 1 shows the required gender representation.

Board members	Gender representation
3	1
4-5	2
6-8	3
9	4
>9	40%

TABLE 1 - REQUIRED GENDER REPRESENTATION ACCORDING TO BOARD SIZE.

GBL has a direct effect on the board and enforce firms to assess what is considered the appropriate size of the board for the firm. Either the firm can choose to replace existing directors or they can increase board size to keep their directors. Therefore, I expect a change in board size over the sample period which leads to the next hypotheses:

Hypothesis 4. The effect of the major recruitment of female board members has partly been absorbed by increasing the size of boards.

3.2.2 CODE OF CONDUCT

The Norwegian Code of Practice for Corporate Governance (2013) - is issued yearly by Norwegian Corporate Governance Board (in Norwegian "Norsk utvalg for eierstyring og selskapsledelse - NUES" [6]). The purpose is to review guidelines and code of conduct for

[6]A cooperation of organizations publish the code: Aksjonærforeningen i Norge, Den norske Revisorforening (The Norwegian Institute of Public Accountants), Eierforum, Finans Norge (Finance Norway), Norske finansanalytikeres Forening (The Norwegian society for finance analysts), Næringslivets Hovedorganisasjon (Confederation of Norwegian Enterprise), Oslo Børs (Oslo Stock Exchange),

Norwegian firms relating to corporate governance. NCGB is not law, but a *"comply or explain"* type of guide on 15 aspects relating to governance structure - ref. NGCB (2013, p.13) often called *"soft law".*

Referring to the Public Companies Act and repeatedly highlighted in NCGB, the duties of the board of directors are pivotal:

> *"The Public Companies Act stipulates that the board of directors has the ultimate responsibility for the management at the company and for supervising its day-to-day management and activities in general"* (NCGB, 2013, p.37).

The function of the board according to the code of NCGB are extensive. It includes e.g. ensuring that the company implements sound corporate governance, defining the company's basic corporate values and formulating ethical guidelines and guidelines for corporate social responsibility. It also includes the responsibility to make strategic decisions within the overall scope of the company's business as defined by its owners, establish a clear and predictable dividend policy and decide on the company's share capital.

Independence is a highly regarded value in NGCB. Operationalization of independence of board members is widely discussed in the OECD principles of corporate governance. It also shows that practice and interpretation of independence vary across countries. In the final deliberations of the report, OECD underlines the value of independence in board structures:

> *"Independent board members can contribute significantly to the decision-making of the board. They can bring an objective view to the evaluation of the performance of the board and management. In addition, they can play an important role in areas where the interests of management, the company and its shareholders may diverge such as executive remuneration, succession planning, changes of corporate control, take-over defences, large acquisitions and the audit function. In order for them to play this key role, it is desirable that boards declare who they consider to*

Pensjonskasseforeningen (The Norwegian Association of Pension Funds) and Verdipapirfondenes Forening (Norwegian Fund and Asset Management Association).

be independent and the criterion for this judgement". (OECD, 2004, p.64f)

Independence is considered vital, to management board, shareholders and auditors. The independence of the board of directors is underlined repeatedly in NCGB, e.g.

> *"The composition of the board of directors should ensure that it can operate independently of any special interests"* (NCGB, 2013, p.31).
>
> *"The company should operate guidelines to ensure that members of the board of directors and executive personnel notify the board if they have any material direct or indirect interest in any transaction entered into by the company"* (NGCB, 2013, p.18).

Relating to the main topic of this thesis, Social Network Analysis is about dependencies in inter-firm relations where board members are bridges or potential brokers between firms. This though, is not without complications and to some extent may be in conflict with the code.

Independence in the NCGB code is mostly defined in relation to the executive management and "*material business contact*", as well as "*independent of the company's main shareholder(s)*" (NGCB, 2013, p.18). Independence is difficult to define, as can be seen from this extensive quote:

> "*In general terms, a member of the board of directors may be defined as independent when the individual in question has no business, family or other relationships that might be assumed to affect his or her views and decisions. It is difficult to provide an exhaustive summary of all the matters that might affect the independence of a member of the board. When evaluating whether a member of the board is independent of the company's executive management or its main business connections, attention should be paid to ensuring, inter alia, that the individual:*
>
> - *has not been employed by the company (or group where appropriate) in a senior position at any time in the last five years*
> - *does not receive any remuneration from the company other than the regular fee as a board member (does not apply to payments from a company pension)*
> - *does not have, or represent, business relationships with the company*

- *is not entitled to any fees as a board member that are dependent on the company's performance or to any share options*
- *does not have any cross-relationships with executive personnel, other members of the board of directors or other shareholder elected representatives*
- *has not at any time in the last three years been a partner or employee of the accounting firm that currently audits the company.*

The criteria listed above may also be relevant to determining whether a member of the board of directors is independent of the company's main shareholder(s). Such evaluation should then be carried out on the basis of the board member's relationship with the main shareholder(s) not the company. The rationale for placing such emphasis on the independence of the board of directors is to ensure that the interests of shareholders in general are properly represented" (NCGB, 2013, p.33).

The influence of social networks as a factor of independence is not directly included or addressed in the NCGB (2013) code, nor in the OECD (2004) report. However, the importance of social networks in board performance and functions is addressed in research. In their article Carpenter and Westphal (2001) examine how external network ties determine a board's ability to contribute to the strategic decision making process. They conclude that the strategic context of social network ties, not simply the number of ties, is an important influence on corporate governance.

Inter-firm ties by board members may be ties between firms within the same industry or across industries. Westphal, Seidel, and Stewart (2001) find that *"firms that have board network ties to firms in other industries that imitate their competitors' business strategy are likely to imitate their own competitors' business strategy, as well as their competitors' acquisition activity and compensation policy"*. This indicates that information shared through a tie in the firm board, their directors, could indeed lead to competitors having valuable insight into a given firm. Hence, a firm should be concerned with and be strategic regarding their common directors, both to protect and acquire valuable information.

Westpahal et. al (2001) shows that information flows through inter-firm networks by

board members represented on several boards. They also show that the information in question may be of importance in a firm's strategic decisions. It does not show that the highly regarded independence is compromised. However, given the potential function of the information flow, the ties in question here have a potential to compromise independence. The potential is of more interest than e.g. simple friendship ties or even family ties, as inter-firm representation by board members implies that he or she has "two hats", while this is not the case in simple friendship ties.

Based on this discussion on independence and the literature review there are reasons to assert that present regulations are insufficiently concerned with networking[7]. And it is even the case that the ones that are ref. The Norwegian Code of Practice of Corporate Governance [8] seem to disfavour networking.

An additional initiative of securing independence is by honouring the tenure recommendations. Directorship tenure is recommended by NCGB as follow:

> *"While the legislation permits a term of office for members of the board of directors of up to four years, this Code of Practice recommends that the term of office should not exceed two years. The situation in respect of both the company's requirements and the demands of independence can change over the course of a two-year period ….. Recruitment of members of the board should be phased so that the entire board is not replaced at the same time."*

Tenure recommendations combined with the possibility that firms must replace male with female directors could lead to a change in board members age towards being younger as the "old boys club" becomes smaller. This leads to the following hypothesis:

Hypothesis 5. The effect of the major recruitment of female board members has caused a pool of board members lowering the average age.

[7] Networking: "Creating a group of acquaintances and associates and keeping it active through regular communication for mutual benefit", based on a givers mentality. See Businessdictionary.com
[8] Read more about this in chapter Theory, page 10.

In addition to hypothesis 1-5 this study will look into how firms that are present in all eleven years in the dataset, referred to as *survivors*, are positioned in the network. The following two hypotheses will be considered:

Hypothesis 6. *Survivors* tend to have a more privileged information position in the inter-firm network.

Hypothesis 7. *Survivors* tend to be more connected to other surviving firms than other firms.

4 METHODOLOGY

This chapter gives an introduction to applied concepts and terminology from social network analysis (SNA).

Social network analysis has emerged as an interdisciplinary research field. The theoretical foundation is a merger of social theory and application, mathematical, statistical and computing methodology (Wasserman and Faust, 1994 p.10). Social network analysis has emerged as a powerful methodological tool alongside statistics and focuses on ties, e.g. people, groups of people and organizations. The main goal of social network analysis is detecting and interpreting patterns of social ties among actors (Nooy, Mrvar, and Batagelj, 2011).

The branch of mathematics called graph theory is applied to define the concepts used. A graph is a set of vertices or nodes and a set of lines, or edges, between pairs of vertices. A network consists of a graph and information on the edges or vertices. A network is a map of the relationships (ties or edges) between a set of objects (nodes or vertices) (Kadushin 2012, p.14). There are more ways of naming the same networks due to the fact that SNA is an interdisciplinary research field. Table 2 gives an overview of this.

Dots	Lines	Discipline
Vertices	Edges	Mathematics
Nodes	Links	Computer Science
Sites	Bonds	Physics
Actor	Ties, relations	Social Science

TABLE 2 - TERMINOLOGY USED IN NETWORK ANALYSIS

The edges can represent different connections between the nodes as shown in Figure 2. The important point is that an edge is a relation in a certain respect or capacity, e.g. friendship, lender/borrower relation, board member etc.

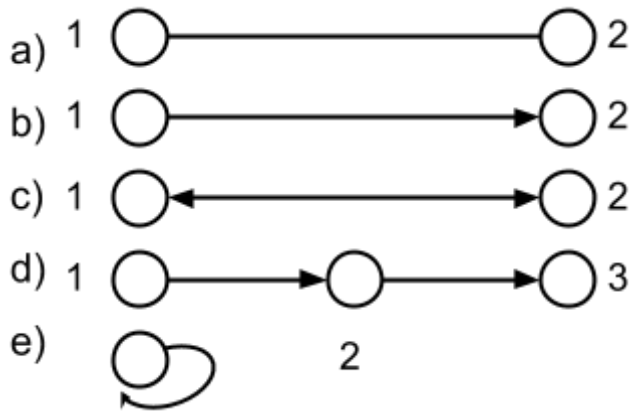

FIGURE 2 - UNDIRECTED AND DIRECTED POSSIBLE NETWORK RELATIONS

If the vertex has no connection to other nodes in the network this is represented by a loop, as shown in Figure 2e). As we will see from the network analysis this might be the case for some firms, meaning the firm has no ties to other firms by common directors.

Figure 2a) represent a relationship that is a mutual connection between the two parties. An example is two friends, or simply two customers in the same supermarket at the same time, other than that it does not say anything about their relation to one another.

Figure 2b) represents a directional relationship where in this case we can say that e.g. 2 is a borrower from 1, or 2 is 1's daughter. In the case of a firm this relation can show who reports to whom. Relationship 2b) can be said to be asymmetric which brings us to 2c).

Figure 2c) relationship is symmetric and can represent two people,1 and 2, that like each other or two colleagues in a firm. Depending on the network 2c) might be different from 2a) if there is a third option in the value of the tie.

When a relationship contains more than two nodes, regardless of their directionality, it is called a multiplex relationship. This is the case for Figure 2d). As we can see a relationship exists between 1 and 3 through 2, an intermediary node. The directions indicates that the relations are not reciprocal. If this were to represent a firm structure we can immediately see who reports to whom. A network contains of a number of nodes which are all connected through one another. In the case of 2d) we can say that 1 is connected to 3 by two steps. If person 1 also knows person 3 directly the connection

would look like Figure 3 and is called a sociogram[9]. Here all three nodes are directly connected and since the edges are symmetric, this is a balanced or transitive network.

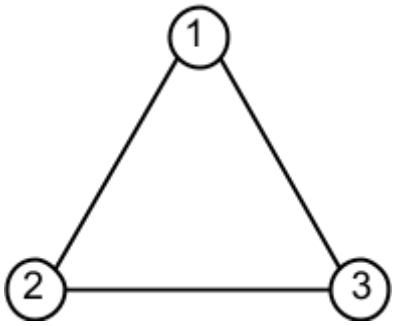

FIGURE 3 - MULTIPLEX RELATIONSHIPS

In this example, it is easy to see the connections and analyse its characteristics of the network, however, this is not as easy when the network expands. When working with network data many analysts prefer to work algebraically. The same goes for generating networks using software[10]. Figure 3 is represented in matrix form in Table 3 and is called The Adjacency Matrix. Figure 3 is an undirected network, and the accompanying matrix shown below defines how nodes are related to each other:

	Node 1	Node 2	Node 3
Node 1	0	1	1
Node 2	1	0	1
Node 3	1	1	0

TABLE 3 - ADJACENCY MATRIX

In a complete network all nodes are connected with each other. In the latter matrix, edge values would have the value 1 (or any other relevant value but zero). However, in real life networks this is rarely the case and the matrix is therefore said to be a sparse matrix meaning there will be more zeroes than other values.

The affiliation network as it is analysed in this thesis is a simple undirected graph, it does not contain multiple edges or ties between an actor and a given event.

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[9] This definition was presented by Jacob Moreno (1953) which is by many claimed to be the founder of modern network studies, cited in Kadushin, 2012.

[10] Such as NodeXL, Pajak or similar.

4.1.1.1 SINGLE MODE AND TWO-MODE NETWORKS

In a one-mode network there is only one category (or mode) of nodes, e.g. people being friends or not. In this case any node can be connected to any other node in the network.

In a two-mode network there are two categories (or modes) of nodes e.g. members and organizations. In this case all edges are between the two different modes and not between e.g. people. For this reason, two-mode networks are referred to affiliation networks (Wasserman & Faust, 1994 p.31). By definition an affiliation network consists of at least two sets of vertices (such that affiliation networks connects vertices from one set to vertices of another set). In this thesis there are two sets of vertices, thus it is a two-mode or bipartite network. One set is called actors, the other events. The vertices that represent actors are in this case directors and CEOs. The other mode represent a set of events to which the actors belong, in this case the firm boards.

Affiliations connect directors or CEOs (actors) to boards of firms (events). Since an affiliation does not connect actors to actors and events to events, at least not directly, the Adjacency Matrix will for a two-mode network look different according to events they are connected to.

	Firm X	Firm Y	Firm Z
Board member 1	1	1	0
Board member 2	1	0	0
Board member 3	1	1	1

TABLE 4 - TWO-MODE ADJACENCY MATRIX

As seen from Table 4, the Matrix now gives information about two things, namely actors and events. Board member 1 is represented on two boards and therefore firm A and B is formally connected. Board member 2 only has one directorship. Board member three on the other hand has three directorships.

With these basics established I move on to the measuring of centrality which can be done both for the actors and the events as well as for the network as a whole.

4.2 MEASURING NETWORKS

Most network measures are defined for the structure of one-mode networks, and then applied with necessary additional conditions to two-mode networks. The analytical strategy applied reduces two-mode networks to two one-mode networks, an agent network (board members) and an events network (firms). Specific social network analysis is performed on event and actors networks separately in this study. Accordingly, various relevant network measures will be defined relating to one-mode networks.

Board members cannot have more than one tie to a given board, meaning that they have only one type of relation to the board, namely as board member. The membership might have different qualities: member, chairman or deputy chairman of the board.

CEOs are also included in the network analysis, obviously not as board members[11], but as executive directors. This is a logical addition when the goal is to study formalised information flow channels between firms. It is important to notice though, that according to regulations by law, CEOs cannot have the status as board member in his/her own firm.

4.2.1 ONE-MODE NETWORKS

4.2.1.1 PARTITION

A partition of a network is a classification of the vertices in the network such that each vertex is assigned to one class. An example is the board member role or gender. These are discrete properties. Partitions split a network into parts, and can be used to reduce networks. One reduction in this network could be the network of all female board members.

4.2.1.2 VECTORS

Partitions assign discrete values to vertices or nodes. Vectors may be used to assign continuous values to vertices. This could, as an example, be the age of a board member.

[11] As Norway practice a two-tier system, which prohibits the CEO to sit on the board of directors.

4.2.1.3 COHESIVE SUBGROUPS

Social networks usually contain pockets of people who *"stick together"* (Nooy et al, 2005 p.71). These are called cohesive subgroups. Various measures are applied to identify cohesive subgroups.

- *Path:* a walk in which no vertex in between the first and last vertex (of the walk) occurs more than once. Geodesic is the shortest path between two vertices.
- *Distance:* the distance from one vertex to another is the length of the geodesic between them.
- *Density:* the number of edges in a network expressed as the proportion of the maximum possible number of edges in the network.
- *Completeness:* A complete network is a network with maximum density (all possible ties are drawn).
- *Degree:* the number of edges a node has.
- *Adjacent nodes:* two nodes are adjacent if they are connected with an edge.
- *Components:* Components are connected parts of networks. Defining components in undirected networks require introduction of some new concepts:
    - A (undirected) network is connected if there is a path along edges for each pair of vertices where any vertex along the path is only visited once.
    - A component is a connected sub-network.
    - In an undirected network components are isolated from each other.
    - The giant component (GC) is the component in the network with the most number of vertices attached.
- *Communities:* Modularity is often used in optimization methods for detecting community structure in networks. A network is said to have "community structure" if the nodes of the network can be grouped into sets of nodes such that each set of nodes is densely connected internally. In applying a modularity analysis it is interesting to see if and how the giant component has a community structure, and how the structure has developed from 2001 to 2010. Modularity is one measure of the structure of networks or graphs. The idea is to measure the strength of division of a network into modules (also called communities or clusters). Networks with high modularity have dense connections between the

nodes within modules but sparse connections between nodes in different modules.

- *Louvain* modularity detection (included in the Pajek software package) is a frequently applied approach. The general idea of the Louvain method is to start out with a partition in which each node is in its own a community. The method is then a greedy optimization method in iterative steps. In greedy optimization, the concept of “cover” is applied. A subset A' of the set (the community) A is said to cover the set (the community) B if and only if every vertex in B is connected to at least one vertex of A’. The algorithm keeps track of which vertices are covered by what community. In iterative steps, a greedy criterion applies a procedure whereby a vertex of A is selected that covers the largest number of uncovered vertices of B and so on until no improvement is achieved in the next iterative run of the procedure. Thus, the Louvain optimization is performed in two steps. First, the method looks for "small" communities by optimizing modularity locally. Second, it aggregates nodes belonging to the same community and builds a new network whose nodes are the communities. These steps are repeated iteratively until a maximum of modularity is attained and a hierarchy of communities is produced.

4.2.1.4 BROKERAGE

This study is about information flow in institutionalised structures, exchange between actors in boards under the normative conditions expressed in NCBE. The network is a representation of a social structure that should help in explaining or analysing the diffusion of information in a formal structure. In analysing the social structure it is of interest to find vertices that have a more central position in the information exchange than others. These are known as centrality measures and definitions are taken from Jackson (2008) and Nooy et al. (2011, p.399):

- Degree
    - Degree centrality of a vertex is its degree.
    - Degree centralization of a network is the variation in the degrees of vertices divided by the maximum degree variation that is possible in the network of the same size.

- Closeness
    - Closeness centrality of a vertex is the number of other vertices divided by the sum of all distances between the vertex and all others. It is a measure of how long it will take to spread information from a given vertex to all other vertices and is measured by analysing the shortest path to all others.
    - Closeness centralization is the variation in the closeness centrality of vertices divided by the maximum variation in closeness centrality scores possible in a network of the same size.
- Betweenness
    - Betweenness centrality of a vertex is the proportion of all paths between pair of other vertices that include this vertex. Betweenness centrality tells us how important a node is in terms of connecting other vertices.
    - Betweenness centralization is the variation in the closeness centrality of vertices divided by the maximum variation in closeness centrality scores possible in the network of the same size.
- Eigenvector
    - Eigenvector centrality of a vertex is the extent to which it is linked to vertices with high eigenvector centrality. Eigenvector centrality is a neighbour's characteristics indication on how important, central or influential a node's neighbours are.

4.2.2 TWO-MODE NETWORKS

Having introduced various measures relating to one-mode networks, adjustments necessary to analyse two-mode networks must be discussed. In analysing two-mode networks it is important to distinguish between actors and events, because measures derived from simple networks have different meanings for actors and events. Things can get quite complicated when analysing two-mode networks. According to Nooy et al (2011), the solution commonly used is to transform two-mode networks into two one-mode networks that can be analysed with standard techniques. A couple of terms has to be introduced when two-mode networks are transformed to two one-mode networks – e.g. one network consisting of actors (board members) and one consisting of events (firm boards). In the case of deriving a one-mode network of events, firm boards in our

case, lines are drawn between events that share actors (board members). This has two consequences:

- Since firm boards or events can share more than one actor or board member, we can get multiple lines between the same two nodes. Multiple lines can be replaced by a single line with an attached value, e.g. 3 if 2 firms share 2 directors. This is called a valued network, which in the example has a line multiplicity of 3. Such valued networks are not used in this study.
- Events, or firm boards, may have board members they share with no other event. In that case the node has a loop with a line multiplicity equal to the number of board members the event does not share with any other event. Such loops are removed in this study.

5 DATA AND DESCRIPTIVE STATISTICS

5.1 SAMPLE SELECTION

Data for this study is collected from The Brønnøysund Register Centre (BRC, 2014)[12]. BRC is a government body under the Norwegian Ministry of Trade and Industry, and consists of several different national registers.

This network study is limited to Norwegian ASA firms both listed and non-listed on the Oslo Stock Exchange. Both financial and non-financial firms are included in the study. Furthermore, the sample period is limited to years 2000-2010. It consists of information about board of directors and CEOs for a total of 1068 firms and 7803 unique names. Both directors and CEO birth years are included as well as their role on the board (chair, deputy chair or member).

As this dataset is confined to ASA boards, it represents a subset of, probably a more, comprehensive directorship network than what extends to for example AS. Consequently, firms that in this study seem to have no shared directors might have connections to other ASAs through an intermediate AS.

5.2 DATA PROCESSING

Information from BRC is processed in Microsoft Excel[13] to prepare data for social network analysis software. Mainly, this part consists of changing codes from text to numbers. For example, the role of individual board members was labelled *"leader"* or *"member"* and this is transformed into numbers so that one equals to leader and so on.

For practical reasons, board member names have been anonymised using a number coding system of four numbers. Individual members are not the focus in this thesis but rather the network structures and how firms are connected.

Additionally, the dataset did not contain gender information for any of the directors. This has been generated using publicly available name list for men and women. Where

[12] In Norwegian called Brønnøysundregisteret
[13] http://office.microsoft.com/nb-no/excel/

the firm information is incomplete, it has simply been marked 9999 indicating that the information is missing. Missing data (2001=30 firms, 2004= 29 firms, 2006= 15 firms, 2008=12 firms and 2010= 5 firms) is removed when generating network images and central measurements. This missing information is not suspected to bias the overall sample.

The dataset is partly described for all years in the period and partly for a selection of years (2001, 2004, 2006, 2008 and 2010). The selection of years is done with reference to implementation of GBL and the financial crisis. Part of the analysis consist of studying community for firms (event network) in years 2001 and 2010. 2001 is chosen because the number of ASAs was at its peak this year. 2010 is chosen due to being the final year of the dataset. Between 2001 and 2010 the effects of GBL and probably also the financial crisis has played out and a new normal had been established, at least concerning board structure.

5.3 SOCIAL NETWORK ANALYSIS SOFTWARE PROGRAMS

The network analysis is conducted by using Pajek and NodeXL[14].

5.3.1 NODE XL

NodeXL is a template for Microsoft Excel that is used for visualisation of the network as a whole (two-mode network), mainly to illustrate how gender balance has developed through the dataset period[15].

5.3.2 PAJEK

Pajek[16] enables analysis of large networks with thousands of vertices in both one- and two-mode networks. It holds the ability to transfer two-mode into one-mode networks which has been utilized to extract centrality measurements. All exploration of giant components for the chosen years is done in Pajek. For definition of giant component see

[14] Both open-source software programs

[15] http://nodexl.codeplex.com/

[16] http://pajek.imfm.si/doku.php

4.2.1.3. Additionally, the surviving firms and gender centrality scores are explored with Pajek. Model graphs are created from this software as well.

Pajek is applied to detect Louvain community as described earlier. Nooy et al (2011) decision tree for the analysis of cohesive subgroups has worked as guidance throughout the analysis period of this study. Referring to Appendix 1.

5.4 CHARACTERISTICS

General characteristics about the sample selection is described below. Table 5 gives an overview of the numbers of ASAs and the reduction over time.

Year	Number of ASA's	Δ number of ASA in %
2000	603	100,0 %
2001	631	104,6 %
2002	601	99,7 %
2003	556	92,2 %
2004	523	86,7 %
2005	495	82,1 %
2006	506	83,9 %
2007	484	80,3 %
2008	415	68,8 %
2009	362	60,0 %
2010	339	56,2 %
		Relative to 2001

TABLE 5 - DEVELOPMENT IN NUMBER OF FIRMS IN THE DATASET

As seen from Table 5, the number of ASAs have been almost halved between 2000 and 2010. Although the rate of reduction seems to be constant over time, the most prominent reduction occurred between 2006 and 2007 when 11.5 % of the firms exited. The GBL was by 2007 effective for new firms and the transition period for existing firms ended a year later in 2008. By 2008 all firms had de facto complied. Between 2008-2009 and 2009-2010 there is a continued decrease in the number of ASA of 8.8 % and 3.8 % respectively, and therefore there is no reason to assume that this reduction is attributable to GBL. Thus, it seems plausible to assume that there are other circumstances causing this decrease - such as the financial crisis. I will not speculate

upon this as the data material does not give sufficient information. Due to the massive reduction, some firms have a short tenure in the dataset. Figure 4 shows the distribution of firms in relation to how many years' they are present in the database.

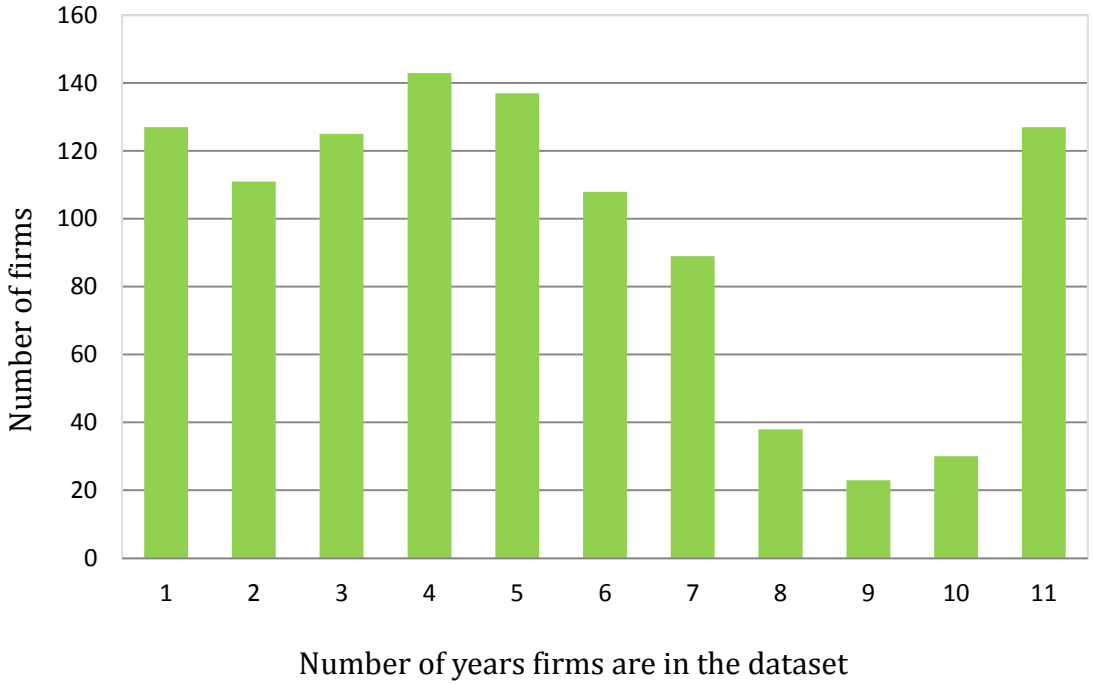


FIGURE 4 - NUMBER OF YEARS IN DATASET FOR TOTALLY 1068 FIRMS

As shown in the Figure 4 above, four years is the most frequent number of years firms are in the database, followed by five years. Figure 4 does not show which year's firms are in the database, nor will this be studied further in this paper. 127 firms have eleven years duration in the dataset and these firms will in the following be referred to as *"survivors"*. Survivor centrality is relevant for hypothesis 6 and 7. Despite the decrease in ASA the female fraction has increased substantially due to GBL as shown in the Figure 5.

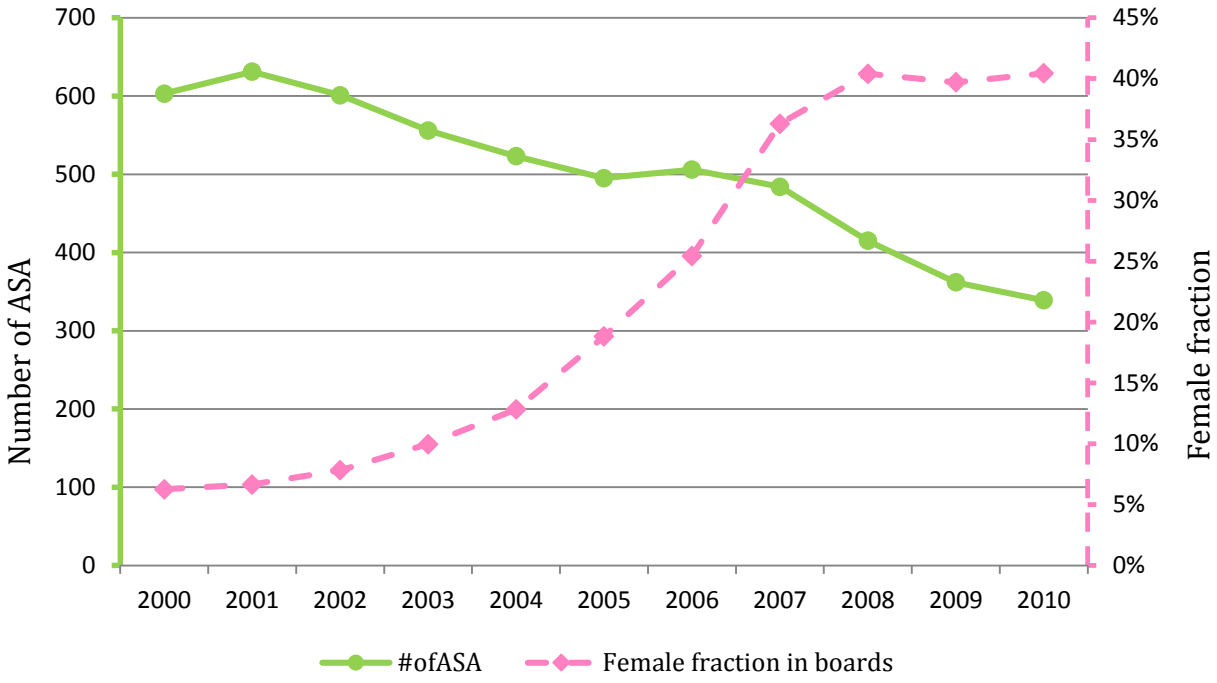


FIGURE 5 - YEARLY DEVELOPMENT IN NUMBER OF ASA AND FEMALE FRACTION

The solid line in Figure 5 (relating to right vertical axes), represents the decrease in number of ASA. The decreasing trend stagnates between 2004 and 2007 however, it continues to decreases after 2007. Female fraction increase over time, however, this trend ends abruptly in 2008 when the 40% representation requirement is reached. This might indicate that there is no willingness to go beyond the minimum requirement. That goes against the reasoning behind advocates of GBL as discussed earlier, but is in line with Seierstad and Opsahl (2006).

Figure 5 shows the fraction of female board members of the total available directorship positions in ASA firms. Edling et al. (2012) find that by 2005, 87 % of firms in their sample had at least one female director. However, as seen for Figure 5, in 2005 female directors in total only amounts to ≈20 % of all available director positions, and consequently the GBL was enforced. Figure 6 gives an overview of board size in the dataset.

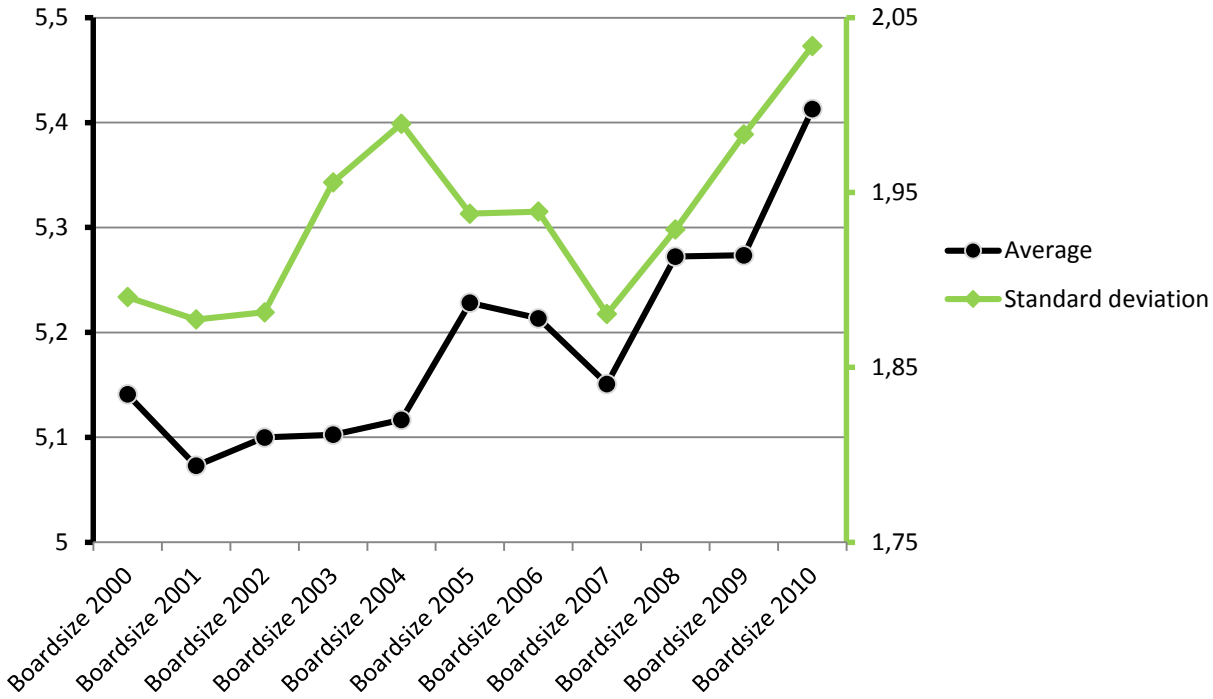


FIGURE 6 - AVERAGE BOARD SIZE

Average board size does not fluctuate much over the total period but stays within 5 and 5.5 board members. However, standard deviation as well as average board size increases yearly from 2007 and onwards. This means that we observe an increase in variation in board size for ASA firms and average board size increases. This could indicate that instead of replacing male directors with female, firms that remain an ASA chose to increase the board size to keep a larger fraction of male directors on the board by *"adding"* women until the GBL quota is filled. Remembering how firms that exited had few female directors (Bøhren and Staubo, 2012), this is a possible action taken by firms.

Moving on to age distribution, Figure 7, represents age distribution by year.

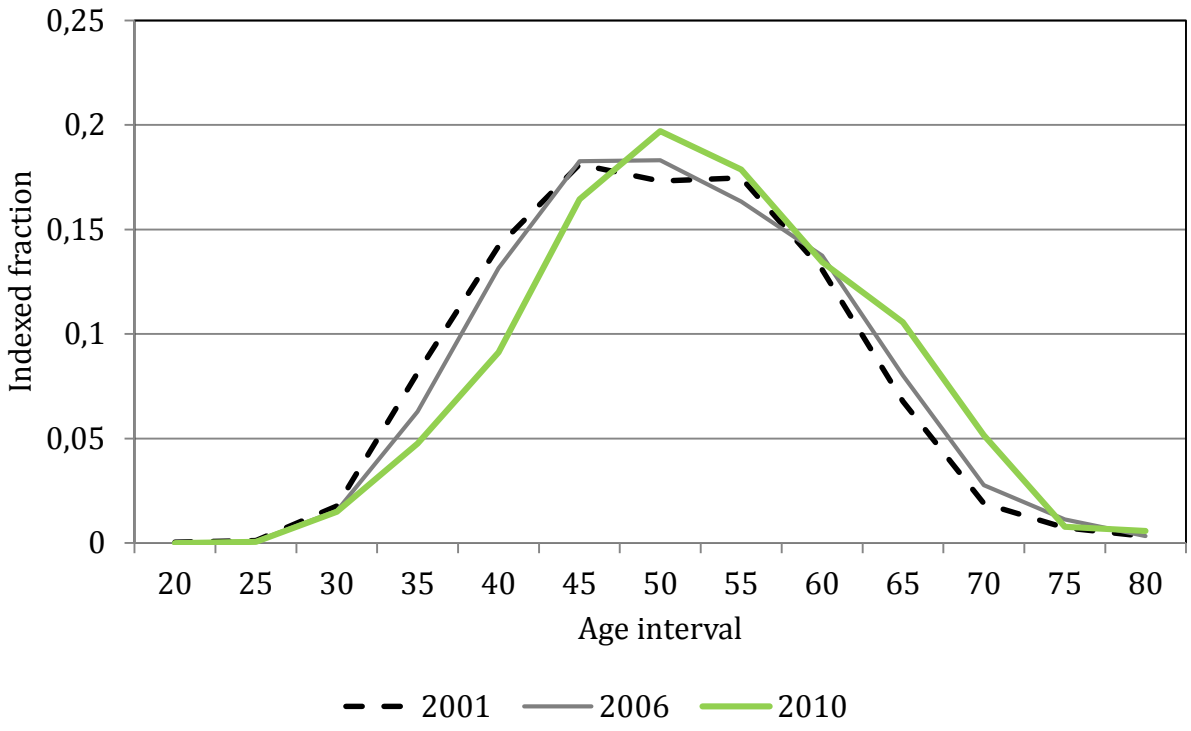


FIGURE 7 - INDEXED AGE DISTRIBUTION

There is a clear shift in age distribution towards board members being older. Especially, the interval 65-70 and onwards experience a steady holding of directorships which also seem to increase over time. Knowing that the total number of board seats decreases[17], it is clear that the older are the ones to keep their directorship(s). In the dataset, young people extending to approximately 40 years of age are more frequently the drop-outs. Hence, overall there is a shift in age on board members towards being older. The observation is consistent with previous literature, which states that directors with CEO/CFO or similar experience increase in firm value (Ahren and Dittmar, 2010). In absence of GBL it is likely to assume that firms had both young and old directors so that the older ones could educate the younger on conducting sufficient monitoring and advising. A possible long-term effect of the GBL is that young women get educated on the directorship role to a lager extent than their male colleagues, hence leaving a smaller pool of competent male directors in the future.

The above figure is created from all director seats. Sorting directorship by gender, as

[17] as they do over time because of the decrease in ASA

done in Figure 8 (below), the latter trend is prominent.

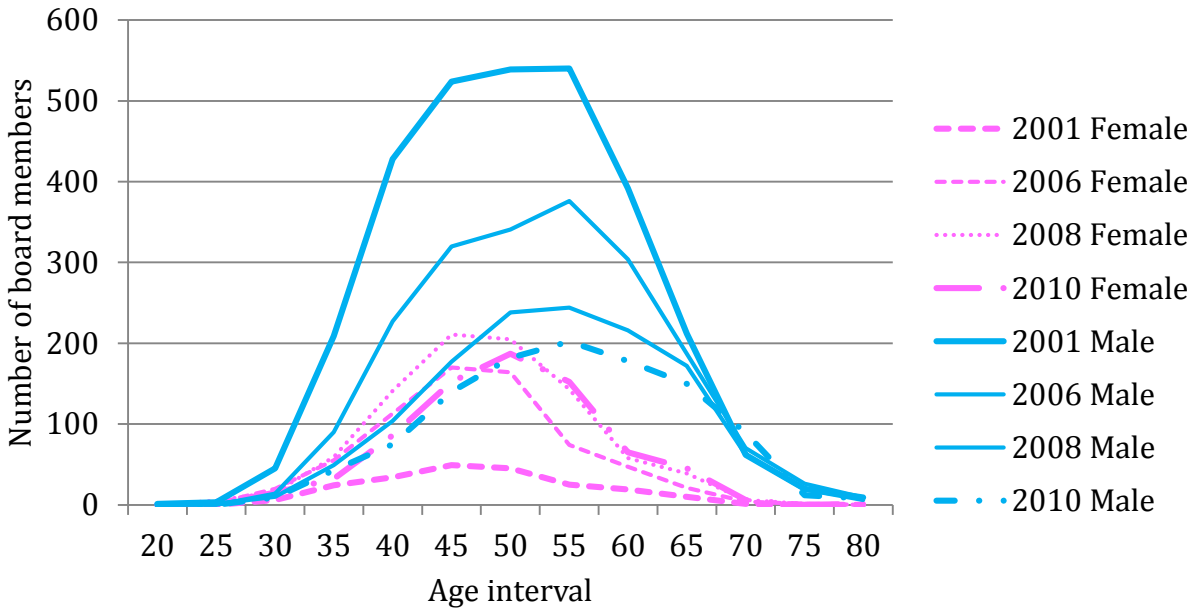


FIGURE 8 - DEVELOPMENT IN AGE ISTRIBUTION BY GENDER

The decrease in sub-fifty aged male directorships is remarkable. Male directors of 65 and above keep a steady amount of board positions while men under 50 are the ones to be elected away. In the female distribution, an initial period with recruitment of relatively younger females extending to 2008 is seen. Post 2008, a similar *"correction"* of female board member age is seen towards older individuals. This late adjustment is, as one can see, in line with the male directorship age preference. This might be an indication of the fact that after the transition period ended and the situation normalised, there was a natural selection of female board member probably based on experience and age as with male board members. As the gender/age development is different especially with consideration to number of directors in the database, it is natural to examine both genders in the analysis.

Figure 9 presents women holding chair roles in the board and CEO role.

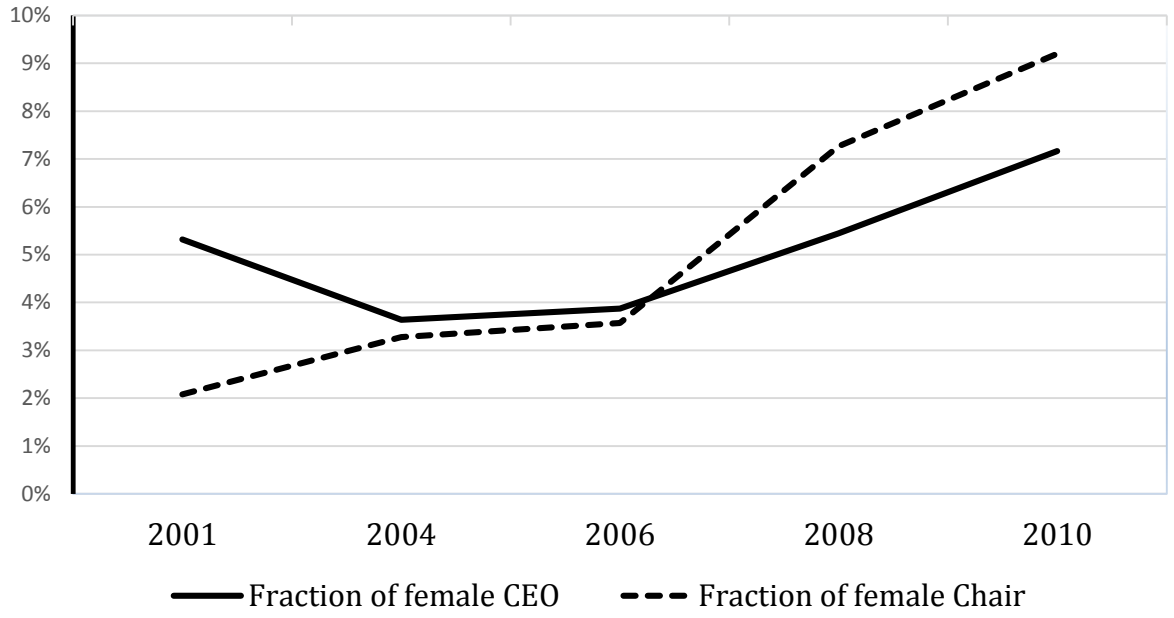


FIGURE 9 - FEMALE FRACTION OF CEO AND CHAIR POSITIONS

Looking at female holding chair roles in boards there is an increase from 2% to 9% throughout the decade, hence 350%. Females CEOs experience a small decrease before increasing in line with chair role. However, for either, it is far from the 40% gender representation.

On the following page (Figure 10) is an illustration of the networks, in two-mode, as they develop through the decade. Two features are to be noticed. 1) Female fraction increases and 2) Networks become sparse as firms exit. By 2010, the network contained directorships distributed with roughly 40% female and 60% male fraction.

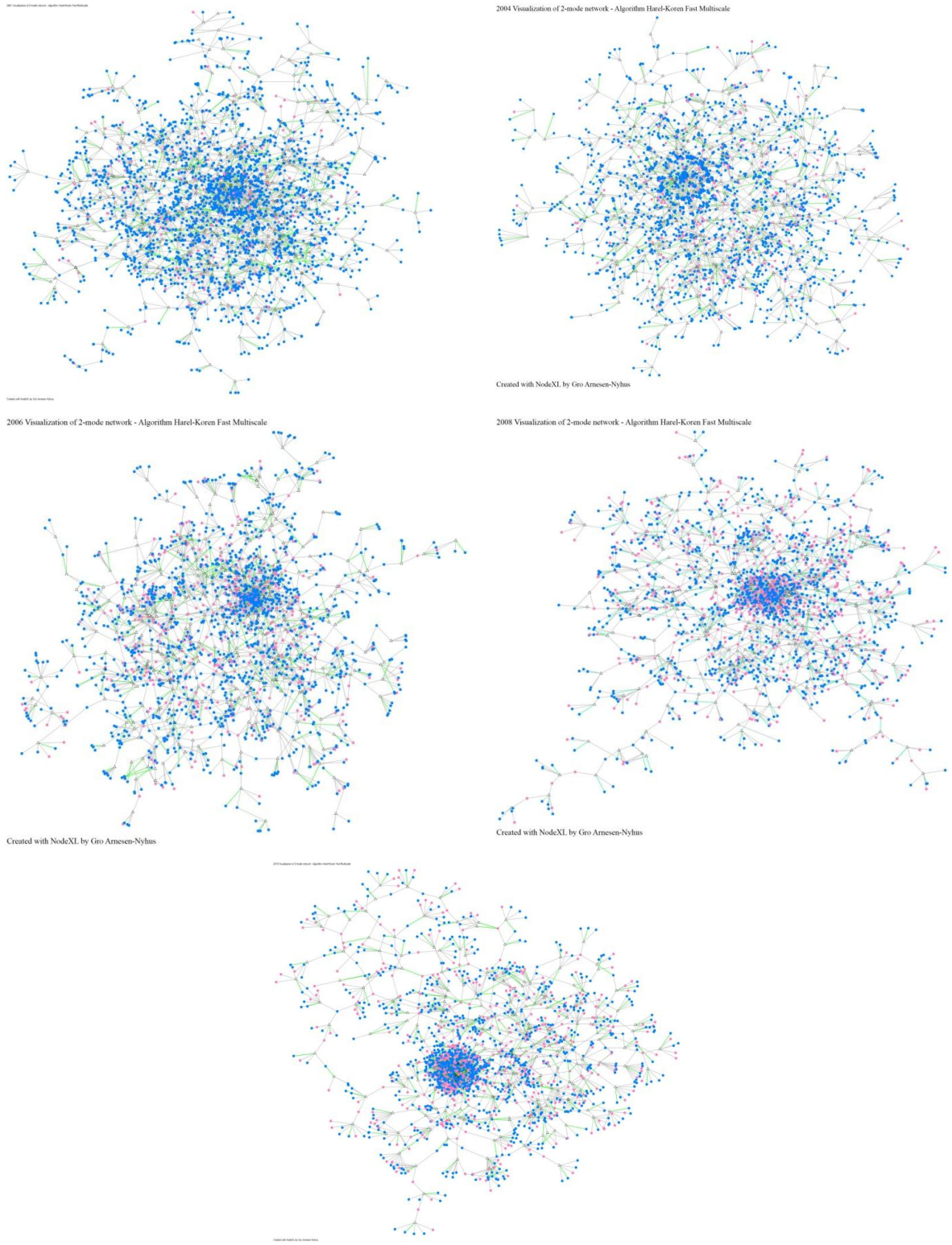


FIGURE 10 - VISUALIZATION OF TWO–MODE NETWORK IN 2001,2003,2006,2008 AND 2010. MADE IN NODEXL WITH ALGORITHM HAREL-KOREN FAST MULTISCALE. EVENTS (FIRMS) ARE SHOWN BY TRIANGLES, BLACK BEEING SURVIVORS AND WHITE OTHER FIRMS. ACTORS (BOARD MEMBERS) SHOWN AS BLUE FOR MALE AND PINK FOR FEMALE. GREEN EDGES INDICATING THAT ACTOR IS IN FACT A CEO NOT BOARD MEMBER.

The illustrations above do not, however, reveal the component structures in the networks. For this purpose, Pajek is powerful tool. The entailing figure illustrates this for the 2010 network. Apart for 2010 being a more sparse network, the component structure is similar to preceding years. Figure 11 shows clearly that the network consists of:

- A large number of boards with no inter-firm relations (the lower part of the illustration). These firms do not share any board member with other ASA firms in 2010. Apart from this characteristic we do not know more about the board composition. One interesting observation however is that 33 of 119 of these firms, which have no shared board members with other ASA firms, are *survivors*. There is reason to believe that these firms are part of networks which consist of firms with other organizational forms such as AS or similar.

- A handful of inter-firm relations with between 2-4 firms (upper right corner). This group has 14 *survivors* and 23 other firms. It is not inconceivable that survivors have contributed to innovation leading to new firms. This is mentioned more as a curiosity than for any other purpose. The very upper right network shows 4 firms which are all connected by one board member who is also a woman. This is also the case for six of the other *"mini-networks"* in this group.

- A giant component that consistently covers roughly ⅔ of ASA firm boards (upper left). It is more difficult to visually inspect this component from Figure 11.

Moving on, I use the giant component to extract centrality measures. For the remaining years, the component structure is presented and summarized in Table 6 below.

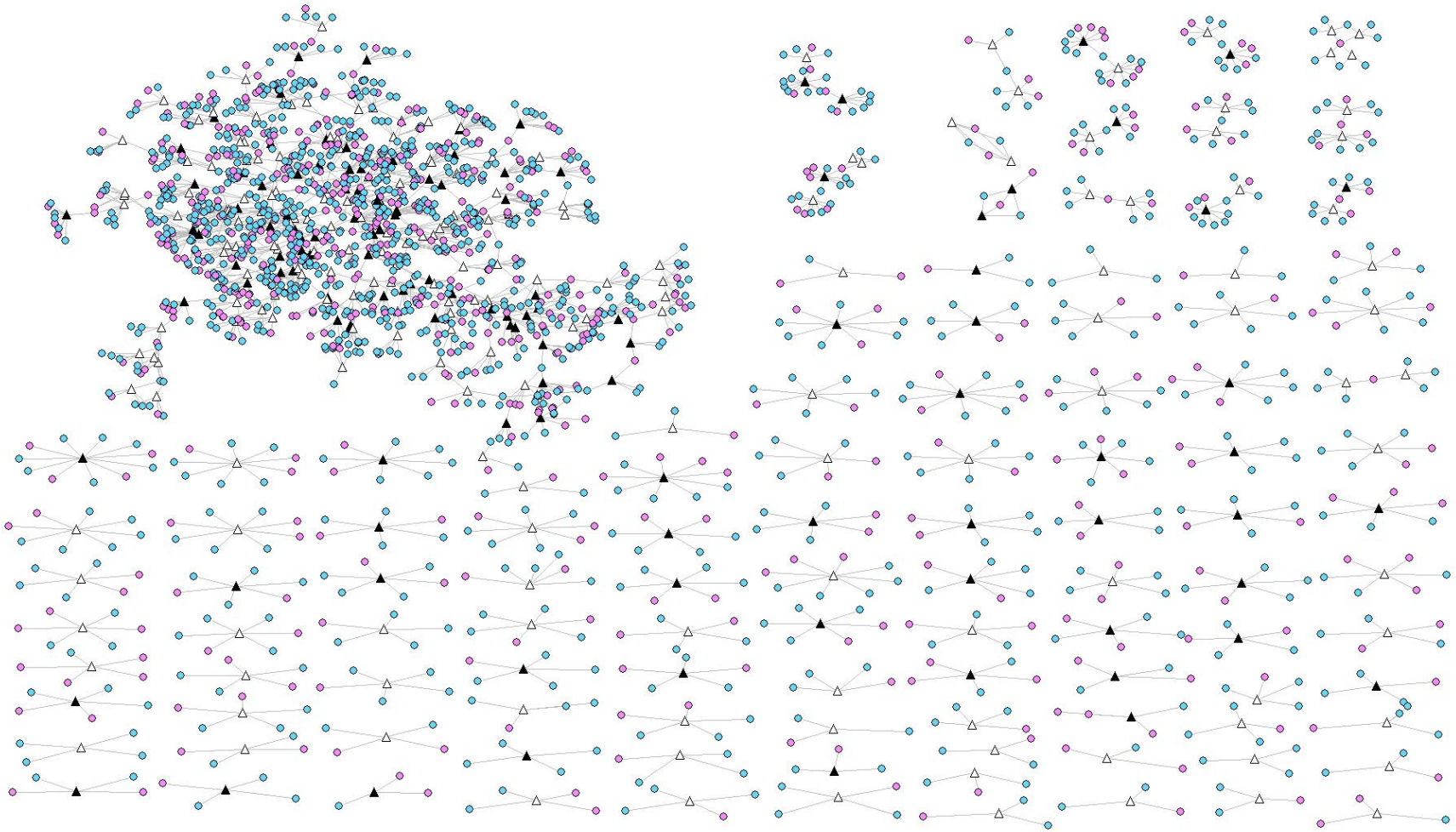


FIGURE 11 –NETWORK VISUALIZATION FOR 2010 OF SEPARATE COMPONENTS.

CREATED IN PAJEK UTILIZING KAMADA-KAWAI ALGORITHM. THE GIANT COMPONENT (UPPER LEFT) COVERS 62% OF THE FIRMS FOR 2010. TRIANGLES REPRESENT FIRMS WHERE BLACK IS SURVIVORS AND WHITE ARE OTHER FIRMS. BLUE NODES ARE MALE BOARD MEMBERS AND PINK ARE FEMALE.

6 RESULTS

Up to this point the study has describes how network analysis may be used to understand and reveal network structures in Norwegian ASA board by looking at both director (actors) and firms (events) connections. The number of ASAs decreases by almost 50% throughout the decade and 127 firms are present all sample years. The female fraction was at 40% by 2008 and has not increased later. Mean board size between 2000 and 2010 is five directors, however, the standard deviation increase in the later years. The age of directors has gone toward male directors being, on average, older and female directors on average five years younger than their male colleagues.

Following, is a presentation of results, divided into two parts, event/firm network and actor network/directorship-CEO network. The analysis is followed by model graph analysis and lastly concluding remarks.

6.1 EVENT NETWORK

As seen in Pajek visualisation (Figure 11) on event network in 2010 there is a giant component, a collection of smaller network components and finally firms with no inter-firm connections (hence, these firms count as a component each). Table 6 shows how nodes in the giant component is distributes through the years.

Year	Number of firms	Number of components	Number of nodes in GC	Fraction of nodes in GC
2001	630	147	441 nodes	70 %
2004	521	145	329 nodes	63 %
2006	505	147	316 nodes	63 %
2008	414	134	252 nodes	61 %
2010	338	111	208 nodes	62 %

TABLE 6 - NUMBER OF FIRMS IN TOTAL AND FRACTION IN GIANT COMPONENT

There are some noticeable points in Table 6 above. The network in 2010 has decreased to half since 2001, but the fraction of nodes in the giant component remains the same post

2004. This means that nodes (firms) are dispersed in all parts of the total network and there seems to be no local preference from where the decrease is more prominent than elsewhere in the network. Being inside or outside the giant component seems to have no obvious effect on exit strategies.

Hypothesis 1 asserts that the Norwegian ASA network consists of one giant component where the majority of firms are connected through directorships and CEO relations. Hypothesis 2 is concerned with the reduction in number of ASAs leading to structural changes in the network. Table 6 shows that the network consists of a giant component with roughly 2/3 of all nodes and 1/3 of nodes in the network outside this giant component. It also reveals that this distribution of nodes is approximately constant over the years with $\approx$ 62 % of the nodes in the giant component. Based on this, hypothesis 1 is confirmed as the majority of firms are connected through directorships and CEO relations. The same cannot be said for hypothesis 2 since the distribution of nodes is similar throughout the decade. The network does not become structurally different, at least not judged by the visual network structure as illustrated in Figure 11. Hypothesis 2 in relation to network structure seems from a superficial inspection to be similar between 2000 and 2010. Chapter 7 will provide an in-depth analysis of the network structure.

After studying ASA firms and their network connections through formal inter-board representation, it is logical to focus on the giant component as they are the ones to actually being part of the board membership network in Norway. Other firms, as seen in Figure 11, are part of micro-networks or have no network at all and hence are not relevant to the network-information perspective chosen. Following is centrality measures for the giant component.

When studying affiliation networks the centrality measures may have different meanings. Therefore, centrality measures are extracted in line with Faust (1997) paper on *"Centrality in affiliation networks"*. The author finds that it is important to have centrality measures for both actors and events. Extracting and comparing degree, closeness and eigenvector centrality is straightforward according to Faust. However, for betweenness this is not directly applicable between actors and events. In short, the difference in betweenness and

eigenvector centrality in a bipartite graph is that betweenness gives actors belonging to one event zero in centrality score while eigenvector gives those same actors a non-zero score. This shows how one must be cautious in comparing actor and event network in search for overlaps. Table 7 presents centrality measures for the giant component.

Year	2001	2004	2006	2008	2010
All degree centralization	0,0327	0,0278	0,0439	0,0516	0,0497
Development relative to 2001*	1,0	0,9	1,3	1,6	1,5
Degree centrality					
Mean	4,6893	3,9635	4,2278	4,1508	3,8173
Standard deviation	3,1646	2,6746	2,9605	3,1233	2,4991
Development*	1,0	0,8	0,9	0,9	0,8
All closeness centralization	0,1699	0,1415	0,1593	0,1492	0,1448
Development relative to 2001*	1,0	0,8	0,9	0,9	0,9
Closeness centrality					
Mean	0,1828	0,1798	0,1798	0,1926	0,1846
Standard deviation	0,0288	0,0314	0,0315	0,0348	0,0326
All betweenness centralization	0,0848	0,0836	0,1573	0,1259	0,16
Development relative to 2001*	1,0	1,0	1,9	1,5	1,9
Betweenness centrality					
Mean	0,0105	0,0145	0,0151	0,0176	0,0224
Standard deviation	0,0162	0,0195	0,0226	0,0272	0,0317
Eigenvector centrality					
Mean	0,0081	0,0079	0,01	0,0176	0,0098
Standard deviation	0,0469	0,0546	0,0554	0,0605	0,0686

TABLE 7 - CENTRALITY SCORES FOR GIANT COMPONENT *INDEXED 2001 MULTIPLIED WITH 0,1

Degree centrality is a measure of how connected a node is, and centralisation how connected the network as such is. The mean, as well as the standard deviation, is lower in 2010 than in 2001, while it fluctuates some in the intermediate years. This indicates that nodes in the giant component become less connected through the period, probably, or partly at least, due to the decrease in the number of nodes. Fewer nodes (firm boards) means a potential for fewer edges (inter-board connections), hence potentially a reduction

in the achievable mean values of degree centrality. The degree centralization of the giant component is fairly low, but increase with a factor of 1.5 during the period. Being a measure of the variation in centrality scores for the vertices (firm boards) this means that variation is fairly low but increasing. Degree centrality, however, can be deceiving, because it is a purely local measure.

The second measure of centrality in the table is closeness centrality for the individual nodes and closeness centralization for the giant component as a whole. A node is considered important if relatively close to all other nodes, and closeness is based on the inverse of the distance of each node to every other node in the network. Mean values of closeness centrality remains more or less the same, with a slight increase in standard deviation. Closeness centrality is in itself low, meaning that across the giant component as a whole there is not much variation in closeness. Closeness centrality decreases moderately with a factor of 0.85, indicating that information flow in the network as a whole becomes more demanding (the geodesic increases). Closeness centralization does not indicate if more nodes get a more prominent position in relaying information in the network.

A node (firm board) that lies on paths of information can control information flow, and is thus more important than a node that does not. Betweenness centrality counts the number of shortest paths between two nodes passing through a given intermediate node. Interestingly enough, mean betweenness centrality increase with more than a factor 2, as does standard deviation. The variation in betweenness centralization increases with a factor 1.9. This indicates that the relative number of nodes (firm boards) in the giant component that act as gatekeepers in the information flow increases, as do the variation between nodes (firm boards) - all in all the information flow becomes more structured through a given set of walks in the network. This may be seen as a consequence of decrease of the network size, while retaining the same overall structure.

Eigenvector centrality is a measure dependent on neighbour characteristics, and indicates how important, central or influential a node's neighbours are. Throughout the decade, this score is fairly stable with an exception of 2010 where it is higher and the standard deviation is lower than the year before.

To sum up the structural changes in the giant component: The number of nodes are being cut to about a half in the period, but the structure remains remarkably stable with a smaller adjustment towards fewer and more prominent information paths in the giant component of the network.

6.1.1 SURVIVORS

There are 79 *survivors* in the giant component in 2010. However, only 69 of these surviving firms was also in the giant component in 2001. In the following centrality scores are extracted for both.

The analysis show that there is no evidence to suggest that surviving firms are connected to other surviving firms to a lager extent than to other firms in the network, howere they ar slightly more central in terms on betweenness centrality by 2010 (Table 8).

Table 8 holds a comparison of the development in *survivors* and other firms in regard to centrality measures. *Survivors* have somewhat higher centrality measures by the end of 2010 relative to other firms in the giant component.

Centrality		2001 All Survivors	2001 Survivors GC 2001 and 2010	2001 Other firms	2010 All Survivors	2010 Survivors GC 2001 and 2010	2010 Other firms
Degree	Mean	4,6699	4,6877	4,6953	4,1013	4,1594	3,6434
	Std	3,3560	2,9604	3,1139	2,5349	2,5183	2,4805
Closeness	Mean	0,1856	0,1861	0,1820	0,1883	0,1855	0,1824
	Std	0,0295	0,0310	0,0287	0,0328	0,0303	0,0328
Betweenness	Mean	0,0131	0,0130**	0,0097	0,0251	0,0271**	0,0207
	Std	0,0191	0,0161	0,0152	0,0329	0,0338	0,0311
Eigenvector	Mean	0,0020	0,0004	0,0099	0,0206	0,0236	0,0031
	Std	0,0168	0,0024	0,0527	0,1052	0,1123	0,0283

TABLE 8 - CENTRALITY SCORES IN GIANT COMPONENT DIVIDED INTO SURVIVORS AND OTHER FIRMS
** P<0.01 (TWO-TAILED INDEPENDENT SAMPLE T-TEST)

Table 8 show that both survivors and other firms share more or less same centrality measures in 2001. However, by 2010 this is no longer the case; the survivors now have higher values overall. Eigenvector centrality is as mentioned a neighbours' characteristics that indicates how important, central or influential a node's neighbours are. In 2001 the survivors have a lower eigenvector score compared to other firms. Notice however how the situation has changed by 2010. Now the *survivors* have higher eigenvector score compared to other firms, but also a higher standard deviation.

Conducting t-test in excel reveals that there a few significant measures. Independent sample t-test, both survivors and other firms have non-significant values, apart from degree and betweenness for other firms. This is not pursued further but rather I look at the *survivors* who are in the giant component in 2001 and 2010. A paired-sample t-test to evaluate the change in centrality measures reveals that the only statistical significant change is for betweenness scores in survivors present in giant component in both 2001 and 2010. This show that there is a statistically significant increase in betweenness scores from 2001 (Mean= 0.0130, SD=0.0161) to 2010 (Mean= 0.0271, SD=0.0338), t (68) = -3.42, p <

0.01 (two-tailed). The mean increase in betweenness centrality is 0.0141 with a 95% confidence interval ranging from -0.02 to -0.01. The eta squared statistics (0.14) indicates a large effect size (Pallant, 2010 p.243).

This indicated that the network development with its exogenous shocks have left survivors to be part of strong influential and highly informed communities. With this knowledge, hypothesis 6; surviving firms have a more privileged information position in the network by 2010, is confirmed.

6.1.2 COMMUNITY STRUCTURES

For 2001 (Figure 13) and 2010 (Figure 14) a network illustration of firms with vertex according to betweenness centrality is extracted. Remembering how the number of ASAs decrease throughout the decade this is shown much clearer with network analysis.

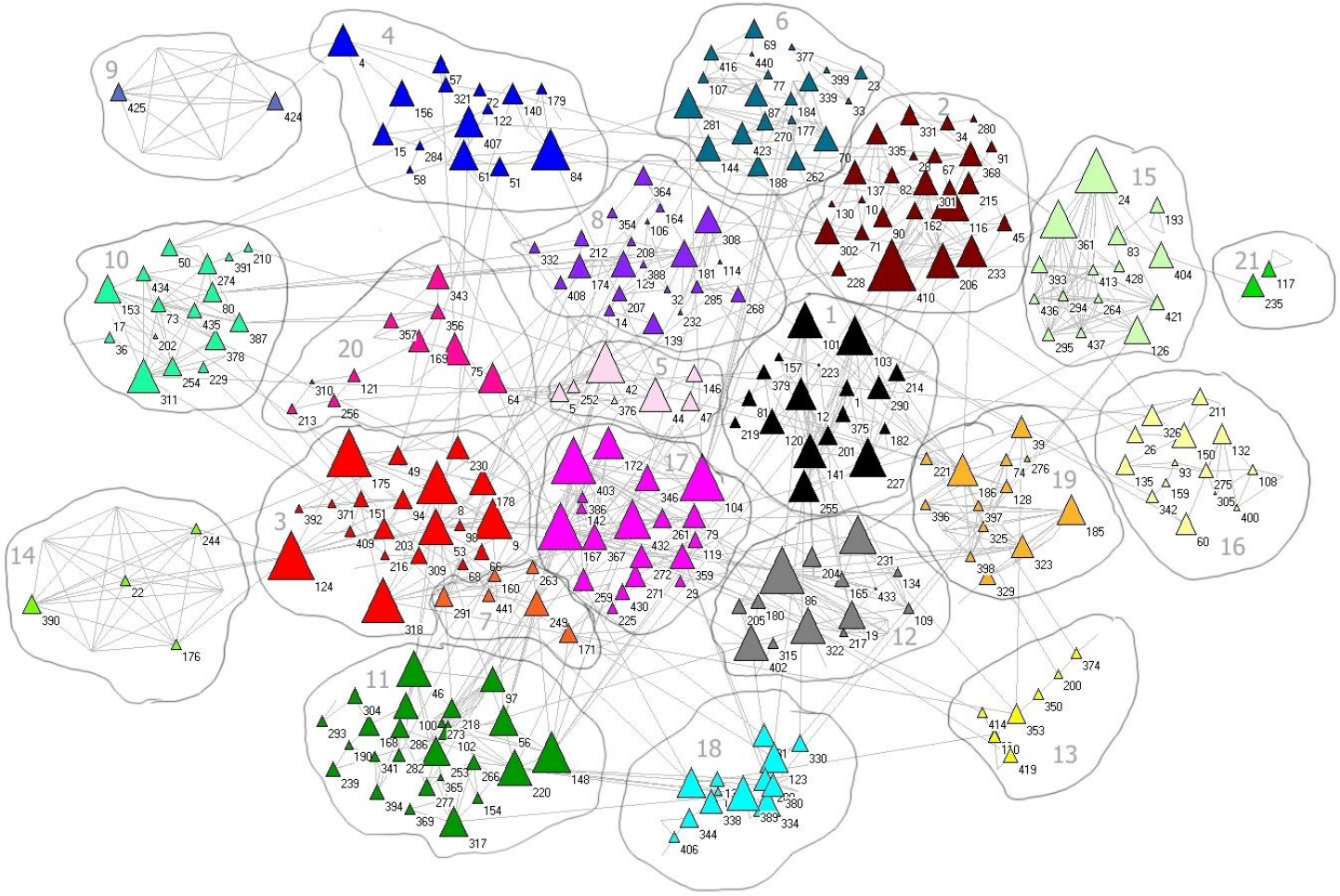


FIGURE 12 - 2001 COMMUNITY STRUCTURE IN GIANT COMPONENT.

CREATED IN PAJEK WITH LOUVIAN COMMUNITY ALGORYTHM. VERTEX SIZE ACCORDING TO BETWEENNESS CENTRALITY.

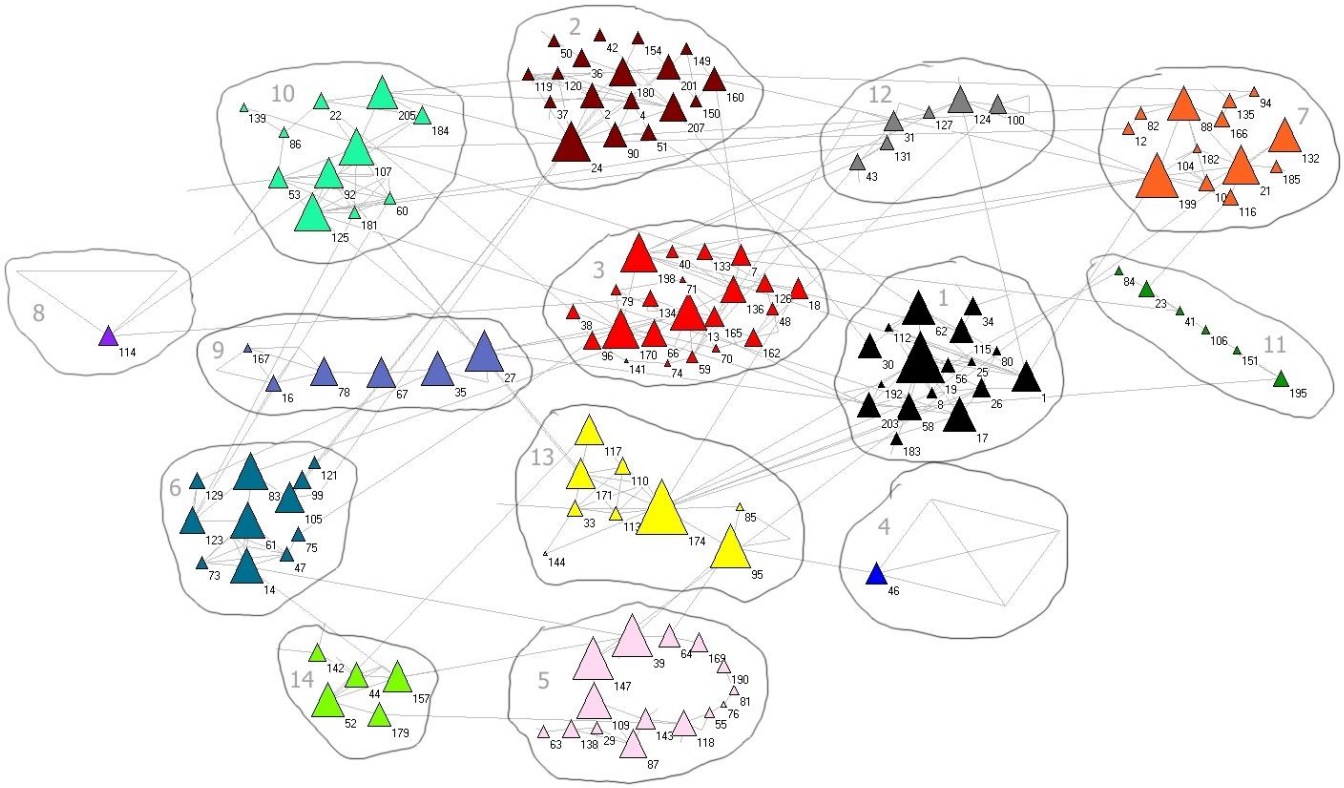


FIGURE 13 - 2010 COMMUNITY STRUCTURE IN GIANT COMPONENT

CREATED IN PAJEK WITH LOUVIAN COMMUNITY ALGORYTHM. VERTEX SIZE ACCORDING TO BETWEENNESS CENTRALITY.

The 2001 network contained 21 communities more specifically referred to Loviant communities[18]. Vertex size is defined by the firm's betweenness centrality in giant component. Table 10 shows each community's biggest vertex in 2001, for a full table see Appendix 3.

Component	Highest betweenness vertex	Total firms in component
1	Håg (103)	32
2	Privatbanken (410)	39
3	Schibsted (124)	30
4	Aker Kværner (84)	22
5	Arendal Fossekompani (42)	11
6	Prosafe (281)	31
7	Genomar (249)	11
8	Norse Energy Corp (308)	29
9	Oslo Børs (425)	7
10	Whitecliff (311)	20
11	Tusenfryd (148)	40
12	Atea (86)	24
13	Axxessit (353)	10
14	Akershus Formueforvaltning (390)	8
15	Investra (24)	23
16	Vmetro (150)	16
17	Bjørge (104)	29
18	Inaq (389)	19
19	Marineprovider (186)	19
20	Storebrand (75)	21

TABLE 9 - 2001 HIGH BETWEENNES FIRMS IN COMMUNITY STRUCTIRE.
GREY INDICATED THAT THIS FIRM IS THE ONLY FIRM IN 2010 WITH HIGHEST BETWEENNESS CENTRALITY STATUS

Moving on to how the network looks in 2010 it is clear that there are fewer communities and vertices in total. For a full table of firms in 2010 see appendix 4. To understand more

[18] When creating this network, standard settings in Pajek is used.

about how the network has developed with the exogenous shocks Table 11 compares how survivors have changed their network relations over time.

Com 2001	Vertex 2001	Firm name	Com2010	Vertex 2010
3	66	Norsk Hydro	1	30
4	407	Telenor	1	115
5	5	Gyldendal	1	1
5	42	Arendals Fossekompani	1	19
5	54	Fondsfinans	1	25
5	376	Fondsfinans Kapitalforvaltning	1	112
6	155	Kongsberg Gruppen	1	62
10	202	Ekornes	1	80
11	56	Glamox	1	26
19	74	Petroleum Geo-Services	1	34
1	81	Veidekke	2	36
2	10	Eltek	2	4
3	8	Eksportfinans	2	2
3	53	Norske Skogindustrier	2	24
6	88	Aktieselskabet Borgestad	2	37
8	129	Edb Business Partner	2	51
9	424	Oslo Børs Holding	2	119
9	425	Oslo Børs	2	120
11	100	Scana Industrier	2	42
11	234	Opera Software	2	90
20	127	Farstad Shipping	2	50
1	118	Akva Group	3	48
2	91	Dno	3	38
2	280	Petrolia	3	96
3	9	Norgesgruppen	3	3
3	94	Statoil	3	40
8	181	Aktiv Kapital	3	71
12	163	Aker Biomarine	3	66
13	20	Wicom | Ignis	3	7
16	197	Marine Harvest	3	79
16	342	Ulstein Group	3	108
7	11	Bonheur	4	5
7	111	Ganger Rolf	4	45
7	283	Fred Olsen Energy	4	97
3	230	Cermaq	5	87
3	309	Kebony	5	101
8	158	Fearnley Fonds	5	63
15	192	Guard Systems	5	77

16	93	Green Reefers	5	39
16	159	Solstad Offshore	5	64
20	64	Rieber & Søn	5	29
20	343	Global Geo Services	5	109
3	152	Kongsberg Automotive	6	61
3	178	Biotec	6	69
8	212	Bionor Pharma	6	83
17	112	Marine Farms	6	47
19	38	Abg Sundal Collier Norge	6	11
19	185	Abg Sundal Collier	6	73
6	59	Hardanger Sunnhordlandske Dampskipsselskap	7	28
7	43	Eidsiva Rederi	7	21
13	414	Cappit	7	116
16	211	Nordic Semiconductor	7	82
16	260	Tgs Nopec Geophysical Company	7	93
19	39	Apptix	7	12
19	323	Acta Holding	7	104
4	57	Hafslund	9	27
15	193	Norsk Tillitsmann	9	78
20	75	Storebrand	9	35
20	169	Finansbanken	9	67
2	45	Blom	10	22
2	337	Itera	10	107
6	149	Ecuanor	10	60
12	226	Data Respons	10	86
11	46	Orkla	11	23
11	97	Tomra Systems	11	41
11	218	Photocure	11	84
11	336	Komplett	11	106
1	101	Tandberg Data	12	43
2	67	Vital Forsikring	12	31
2	368	Dnb Holding	12	111
8	308	Norse Energy Corp.	12	100
17	119	Tts Group	12	49
3	68	Bn Bank	13	32
6	69	Hurtigruten	13	33
10	387	Imarex	13	113
19	221	Eitzen Maritime Services	13	85
20	356	Norsk Oppgjørssentral	13	110
6	184	Domstein	14	72
16	108	Austevoll Havfiske	14	44
16	132	Dof	14	52

TABLE 10 - FIRMS BOTH IN 2001 AND 2010 WITH COMMUNITY DETECTION

From this analysis, both Figure 13 and 14 and also Table 10, we see that the connections between firms change over the decade. Table 10 shows that some firms are connected throughout the period and hence their part of the same communities, but there are also firms that change their connections.

There are especially two communities that are interesting when considering development of networks:

- Community 1 in the 2010 network had 11 firms in 2001 and has 4 firms in the same community in 2010. The only firm to keep the highest betweenness in its giant component over ten years is in community 1, namely Arendal Fossekompani.
- Community 2 seems to be a new network consisting of firms from different 2001 communities, 1, 2,3,6,8,9,11 and 20. How this has happen is not known by this surface study of communities.

Apart from communities 1 and 2 in 2010, the other communities consist of new *"clusters"* with firms from different 2001 communities. For example, community 3 consists of two firms from 2001 community 2, 3 and 16. Similar can be said for community 11 that had 40 firms in 2001 who by 2010 this community have 7 firms in which 4 remains from the 2001 community.

As the latter describes, there is a change in the event network and hypothesis 2 is confirmed. The reduction in the number of ASAs seem to have led to significant changes in the inter-firm network structure. Therefore, hypothesis 2 is kept when relating to the individual firms but not to the network structure as a whole.

6.2 ACTOR NETWORK AND GENDER DIVERSITY

As we know GBL has changed the network for directorship in ASA firms. Mean betweenness centrality for female directors is by 2010 1.45 times the size for male directors when directors without betweenness centrality (hence =0) is removed. This shows that female directors in the giant component more frequently have brokerage positions by multiple directorship in the network than male directors. That being true,

female betweenness centrality also has a higher standard deviation. Appendix 2 contains the top and bottom 20 female eigenvector scores in giant component and as this shows the score is highly irregular explaining this standard deviation. Table 9 give a overwiev of the gender diversity status for the year 2010 in relation to all chosen centrality measures.

Centrality measures divided by gender in GC	Female	Male	*Female >0*	*Male >0*
Degree centrality				
Mean	9,0358**	7,7268**		
Standard deviation	5,6070	3,8656		
Closeness centrality				
Mean	0,1624	0,1627		
Standard deviation	0,0263	0,0250		
Betweenness centrality				
Mean	0,0077**	0,0034**	0,0320	0,0220
Standard deviation	0,0225	0,0131	0,0367	0,0267
Eigenvector centrality				
Mean	0,0088	0,0085		
Standard deviation	0,0274	0,0293		
Number of actors	363	754	87	116
Gender balance in GC	32,5 %	67,5 %		

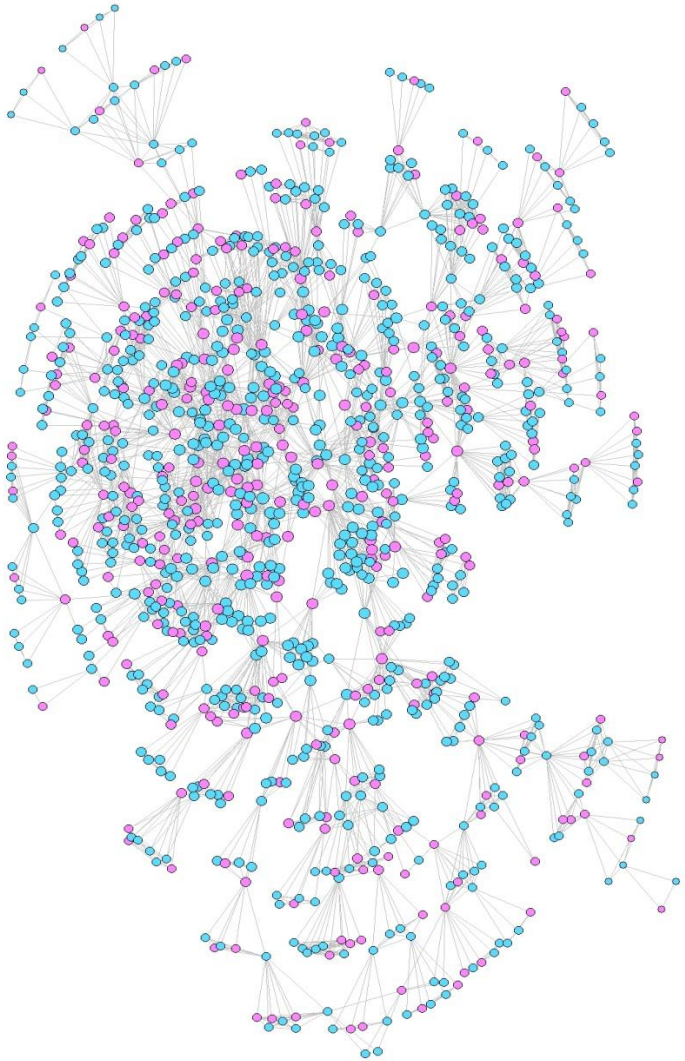
TABLE 11 - CENTRALITY FOR GENDER-DIVERSITY IN GIANT COMPONENT 2010
** P<0.01 (TWO-TAILED INDEPENDENT SAMPLE T-TEST)

An independent sample t-test (equal variance not assumed) to compare the change in centrality measures by gender reveals that two centrality measures is statistical significant, namely degree and betweenness.

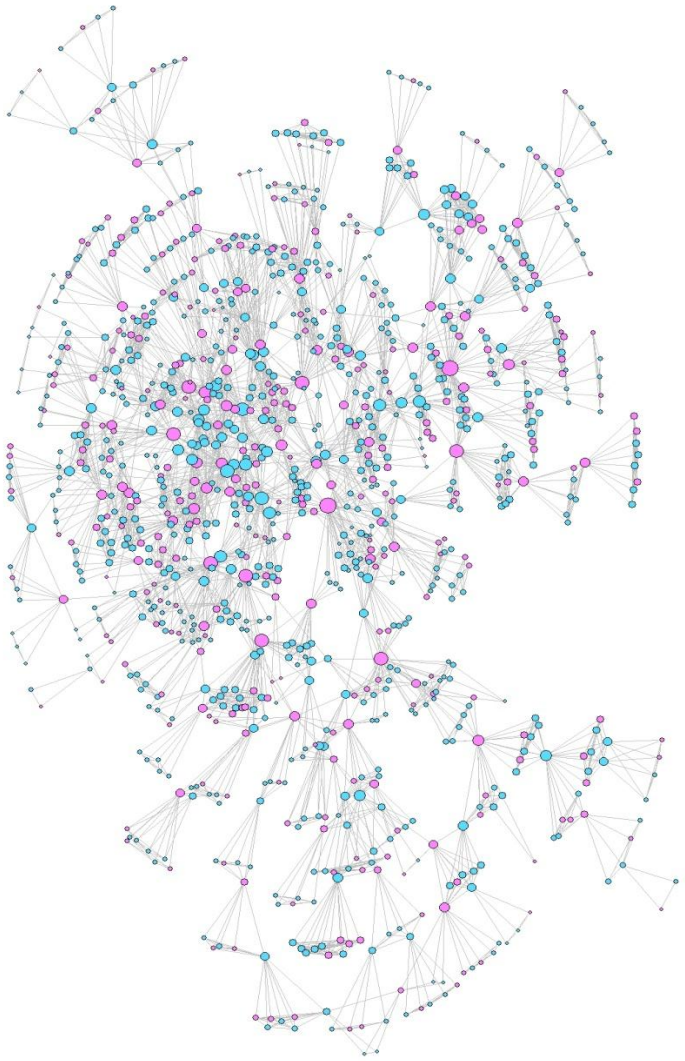
Degree centrality show that there is a statistically significant difference between male and female directors in 2010. There is a significant difference in scores for female (Mean= 9.0358, SD=5.6070) and male (Mean= 7.7268, SD=3.8656); t (534.7) = -4.085 , $p < 0.01$ (two-tailed). The magnitude of the difference in the means (mean difference = 1.309, 95% CI: 1,97 to 0.69. The eta squared statistics (0.03) indicates a small effect attributable to gender (Pallant, 2010 p. 243).

Betweenness centrality show that there is a statistically significant difference between male and female directors in 2010. There is a significant difference in scores for female (Mean= 0.0077, SD=0.0225) and male (Mean= 0.0034, SD=0.0131); t (483.5) = -3.336 , p < 0.01 (two-tailed). The magnitude of the difference in the means (mean difference = 0.0043, 95% CI: -0.068 to -0.002. The eta squared statistics (0.022) indicates a small effect on gender.

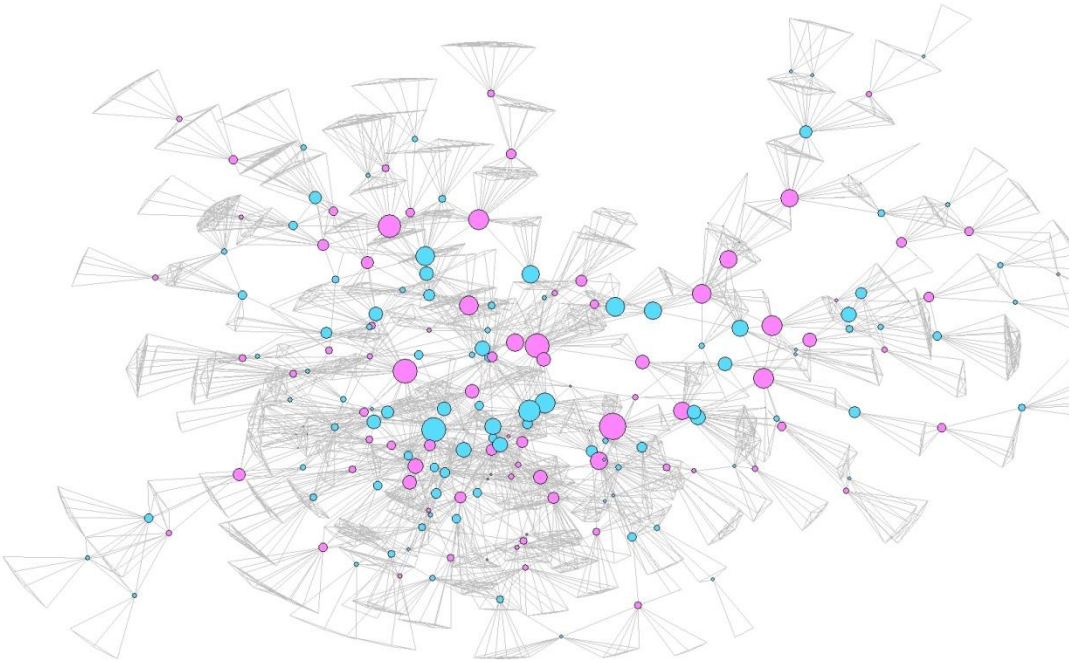
The betweenness score may be interpreted as the *"golden skirts"* reported by Seierstad and Opsahl (2011). Figure 14 is a visualisation of directors in the giant component with vertex size according to centrality status. A big vertex indicates that the person has a high centrality. For instance, the more boards one sits on the higher betweenness one has. As seen in Figure 14 (below) there is a handful of women holding the dominant vertex size, however as seen in table 11 giant component consists of 42.1% female and 57.1% male directors. Additionally only 24% (female) and 15.4% (male) actually have a betweenness centrality, the remaining only have one directorship.



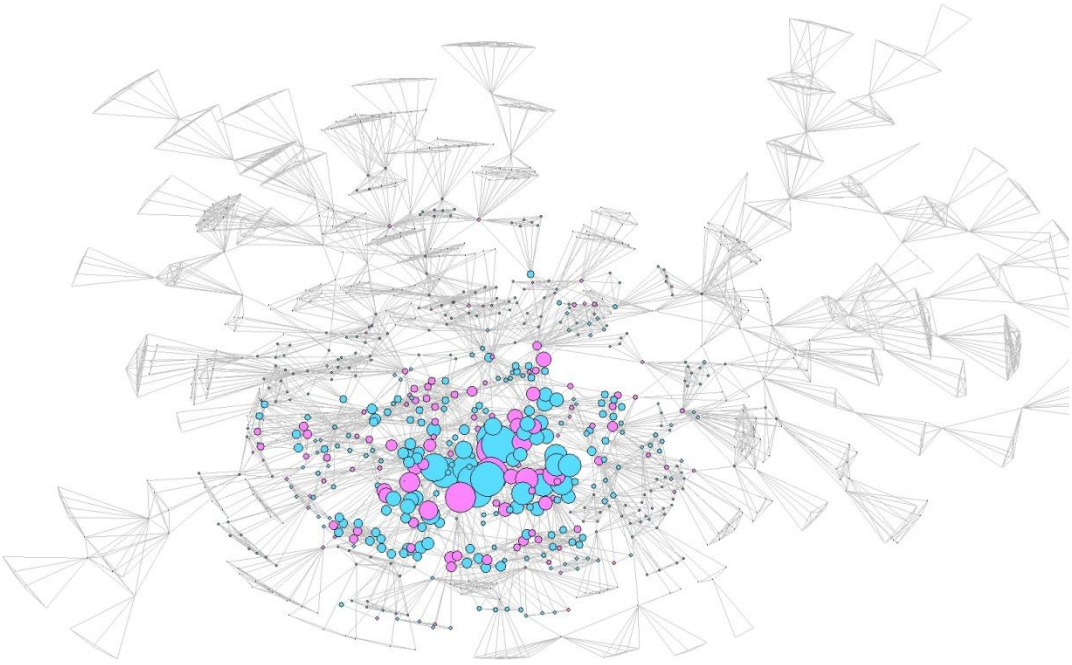
Closeness centrality (by size) and gender (by color)



All **degree** centrality (by size) and gender (by color)



Betweenness centrality (by size) and gender (by color)



Eigenvector centrality (by size) and gender (by color)

FIGURE 14 – ACTOR NETWORK IN 2010 SHOWING CENTRALITY MEASURES AS VERTEX SIZE AND GENDER.

It becomes clear how betweenness and eigenvector centrality weighs actors relations differently. In betweenness centrality female directors dominate the network structure. In eigenvector centrality it is more unclear, however, we know from Table 11 that the male has a slightly higher score. Based on betweenness centrality there is reason to believe that there are female directors in the network who hold privileged positions in information flows between firms (hypothesis 3). This analysis however is not sufficient to reveal which female directors these are or how they are positioned compared to male directors beyond the visual inspection and the centrality measures.

7 ADDITIONAL EVIDENCE

The purpose of this chapter is conduct an in-depth analysis of the network structure.

> *"A statistical network model is a mathematical description of a collection of possible networks and a probability distribution on this set"* (Nooy et al, 2011).

Model networks (graphs) are mathematical representations introduced in an attempt to describe and understand real systems. These graphs are based on statistical network models with some basic rules assigning probabilities to links between any set of nodes and are useful in community detection, where they may act as null models. Model graphs have no community structure, and may therefore be used to test the outcome of various community detection algorithms. Model graphs are also of interest in characterizing the type of network as such. If a real network can be shown to have features that resemble a given graph model this could be a basis for reasoning about and looking for features in the real network.

So far this study has been limited to analysing real world networks. A main purpose of SNA is to detect and interpret community structures within networks (as shown in previous sections). When doing so, separating patterns that are purely random or accidental from patterns that are meaningful is central. By comparing real world networks with selected model graphs two interesting questions may be asked:

- Does the real world network have characteristics that resemble a given type of random model graph?
- If yes, do other characteristics of the real world network appear more often than expected by chance for this type of model graph?

Conyon and Muldoon (2006) find that Germany, UK and USA boards are similar to small world graph based on data from 2001, 2002 and 2003. Notice that this is based on the giant component, not on the network as a whole. Edling et.al. (2012) study Scandinavian board networks (both director and firm) from 1990 to 2005 and find that to some extent the networks can be characterised as small world networks however *"this only holds true for*

the network of Danish firms". Norwegian (and Swedish) changes towards having less pronounced small-world resemblances.

Pajek is used to generate various model graphs where number of nodes and edges from the real world network of 2010 is applied as input. This makes it possible to use Pajek as a *"laboratory"* and compare a model graph with a real world network of the same size and assess which graph model the network resembles the most. The real world network (for 2010 as seen in Figure 11) is compared with three well known graph models:

- Random graph (Bernoulli/Poisson) where input is the number of nodes and edges, and edge attachment to a node is not dependent on whether the node has other edges attached. In terms of behaviour, this would be a situation where the number of relations a firm has to other firms by shared board membership, is distributed purely by chance. That would be a case where firms are indifferent to what other firms they are related to by shared board memberships among its board of directors. Social networks are normally more clustered than a Bernoulli/Poisson model graph, as indicated by the clustering coefficient, as will be shown; this is the case in this study too.
- Small world graph: Input is the number of nodes, and a tendency to have more links to neighbour nodes than to other nodes. Then one endpoint of a small portion of locally connected nodes are placed outside the well-connected nodes, creating links between locally well connected nodes. The implicit behavioural interpretation is that actors tend to cluster in neighbourhoods, and that links to other neighbourhood clusters often are few (however important in relation to information, refer to the discussion on the strength of weak ties in the literature review). Translating this to the real world network, if it is small world, one should expect a clustering or community structure with strong local clusters and a few but important links between them. This could mirror a situation where new board members are more often recruited from the immediate neighbourhood understood as intermediate circles of trusted individual, creating a number of stable communities over time.

- Scale free graphs are network growth models constructing a random graph by adding vertices and one or more lines, one at the time. The model is a preferential attachment model where the probability that a vertex is selected is proportional to its degree[19]. In terms of behaviour this is the *"rich-get-richer"* type of network, where a smaller number of vertices have a higher degree and new-comers prefer to attach to those with success/higher degree. In terms of the firm network, this would mean the existence of a few high degree firms and a clustering around them. Of course, an actor can only hold so many board positions, limiting how skewed the real world network of corporate boards can become. Still, the phenomenon should be significant and visible.

Parameters used to compare model graphs with the real world network:

- Clustering coefficient which is the proportion of all two-paths in the network that is closed. This can be interpreted as a situation where two nodes also have a third node in common. Clustering is expected smaller in random graphs.
- Size of the giant component. Often found in real world social networks.
- The distribution of vertex degrees.
- Average degree.
- Average path length.
- Diameter which is often relatively small in real world social networks.

In all chosen graphs (Random, Small world and Scale free) the comparison is comprised of both the whole real event network, loops removed, and a follow up of more specific comparative analysis of the giant component. Comparison is done by two approaches: (1) a visual inspection and comparison of the graph model with the real world network, and (2) comparing by the set of parameters above.

[19] One limitation in this model is that it assumes that a vertex stays in the network throughout the growth process. This is not the case if we should compare our real world network as it historically develops in the dataset. For the study of the network any one year this is not problematic.

Figures 15-18 below shows the real world network compared with three model graphs (with 338 nodes and 761 edges). All graphs are visualized in Pajek with Kamada-Kawai algorithm /separate components.

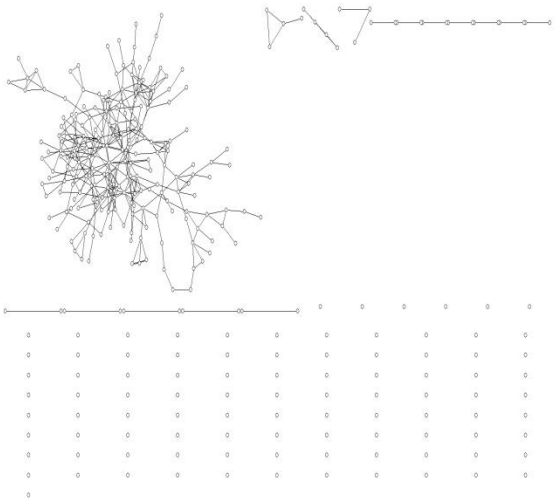


FIGURE 15 - REAL WORLD EVENT NETWORK 2010 WITH 62 % OF NODES IN GIANT COMPONENT

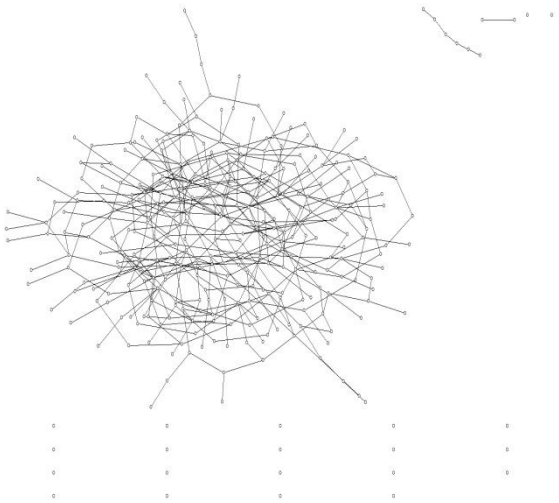


FIGURE 16 – RANDOM MODEL GRAPH WITH 91,4 % OF NODES IN GIANT COMPONENT

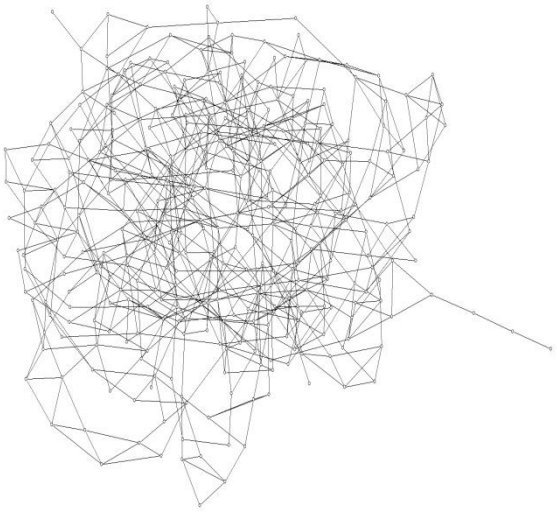


FIGURE 17 - SMALL WORLD GRAPH WITH 100 % OF NODES IN ONE COMPONENT

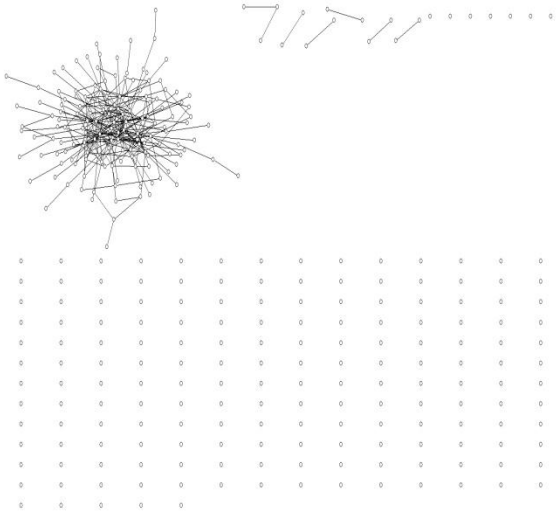


FIGURE 18 - SCALE FREE MODEL GRAPH WITH 51 % OF NODES IN GIANT COMPONENT

(1) A purely visual inspection of the various graphs compared with the 2010 event network shows more familiar features with a scale free model graph, than any of the other model graphs when including the whole ASA network as shown earlier in the paper, ref. Figure 11.

(2) To compare the real world graph with the various model graph parameters it requires nodes to be connected, hence the giant component. For the Random model graph and the Small world graph a revised version with of 208 nodes and 397 lines is created, in line with real world network of 2010. The only exception is the Scale free network. It is called scale free because it more or less retains its structure as it varies in size. This again means that a giant component in a scale free network with fewer nodes than what is contained in the GC in the real world network should still be a good enough for the comparison intended here. Table 12 shows characteristics of the various network.

		Model graphs with the same size as the network in 2010		
	Real world network in 2010	Random graph	Small world graph	Scale free graph
Giant component	63 %	97,6 %	100 %	52,7 %
Vertex distribution	Figure 15	Figure 16	Figure 17	Figure 18
Average degree	2,49 (full network) 3,82 (GC)	2,83	4	2,59(full network) 4,37 (GC)
Diameter	15 (GC)	7	13	7
Clustering coef.*	0,43 (GC)	0,03	0,28	0,13
Aver. Path length/Cluster coefficient	13,04	1906	19,2	26,31

*Watts-Strogatz Clustering Coefficient.

TABLE 12 – REAL WORLD AND MODEL GRAPHS

8 CONCLUSIONS

This thesis is concerned with understanding Norwegian ASA firm governance structures by describing, visualising and characterising inter-firm board of directors networks by applying social network analysis. This study holds several findings:

Firstly, a network of connected firms exists and this network component connects roughly 2/3 of all ASA firms. The relative size of this component (giant component) has remained unchanged throughout the decade, in spite of firms entering and exiting the ASA domain and in spite of an overall reduction in the number of ASA firm to roughly a half. The network contained, by 2010, a large fraction of female directors as regulated by law. However, after complying with the 40% requirement there has not been any increase in the female fraction. A few, both male and female, directors in the giant component actor network hold central positions in the network according to various centrality measures, especially betweenness and eigenvector centrality. There are a few female directors holding highly prominent position in the network, which very well might be the *"golden skirts"*. This goes against the reasoning behind advocates of GBL as discussed earlier, especially decentralization of power, but is thus in line with Seierstad and Opsahl (2006).

Secondly, average board size is in 2000 and 2010 five directors, however the standard deviation increases throughout the decade, especially from 2007 and onwards. Firms have exited to avoid the legislation, inter alia due to having no or few female directors (Bøhren and Staubo, 2012; 2014).

Thirdly, board of directors becomes on average older by 2010. This development is constant throughout the decade, however somewhat more aggressive in the late years. This is believed to be a direct consequence of the GBL as male directors are replaced with female directors. When looking at gender separately it is interesting to find that 65+ male directors seem to hold their directorships regardless of this exogenous shock. The reason for this is not addressed in this study. It might be explained by findings from Ahern and Dittmar (2010) that directors creating firm value have CEO, DFO or similar experience, and are therefore older by default. Ferris et. al. (2003) find that multiple directors usually are

older. The female directors are on average significantly younger than male, and contribute to the total average age being +/- 50 years. To sum this up, female directors are significantly younger (> 5 years) than male directors by 2010.

Fourthly, firms that have survived as ASA firms throughout 2000 to 2010 have especially two characteristics. 1) *Survivors* tend to have higher centrality measures in the networks they are part of and 2) *Survivors* have not stuck together but are dispersed throughout the network.

Finally, the firm network resembles more a scale free graph than a small world graph, and not at all a random graph. Scale free graphs are often referred to as *"the rich get richer"* or *"success breeds success"*, indicating that a few firms will have a central position in networks and may thrive on being in a favourable position having access to information flows.

The importance of networks is reported to be of significance when concerned with value creation. Bøhren and Strøm (2010) find that firm value increases with multiple directorship and strong links to other boards, hence networking. Grønmo and Løyning (2003) find that network is considered increasingly important. A word of caution in interpreting the meaning and impact of ties is in place, Carpenter and Westphal (2001), pinpoint that the number of ties is secondary to the importance or quality of ties.

Previous literature has expressed concern with GBL leading to less optimal board composition, for various reasons. This study shows that even though the network becomes sparser over the decade, leaving firms with fewer connections to other firm, the firm network structure as a whole has in no way been disrupted. Based on the latter papers and this research, there is reason to conclude that the mandatory regulations and code of conduct are hardly concerned with potential dependence/independence issues in networking. To the extent networks or effects on networks from regulations are considered, for example in NCGB, it implies less network with reference to independence.

Much is still to be studied in terms of network analysis of board structures in Norway, and indeed generally.

This study has mainly focused on the inter-firm ties created through multiple directorships. There is little doubt that inter-firm relations is a significant and important part of the board of directorship network. Pursuing the discussion about an elite of people densely connected, a study examining directors with high centrality scores in the ASA network would probably produce new interesting findings. Another next step could be to include AS boards to get a better understanding of how firms interact and are connected. Additionally, it would be interesting to analyse a sample of firms with high centrality scores in regard to their financial performance. *"The rich get richer"*, but are they also the once to get rich?

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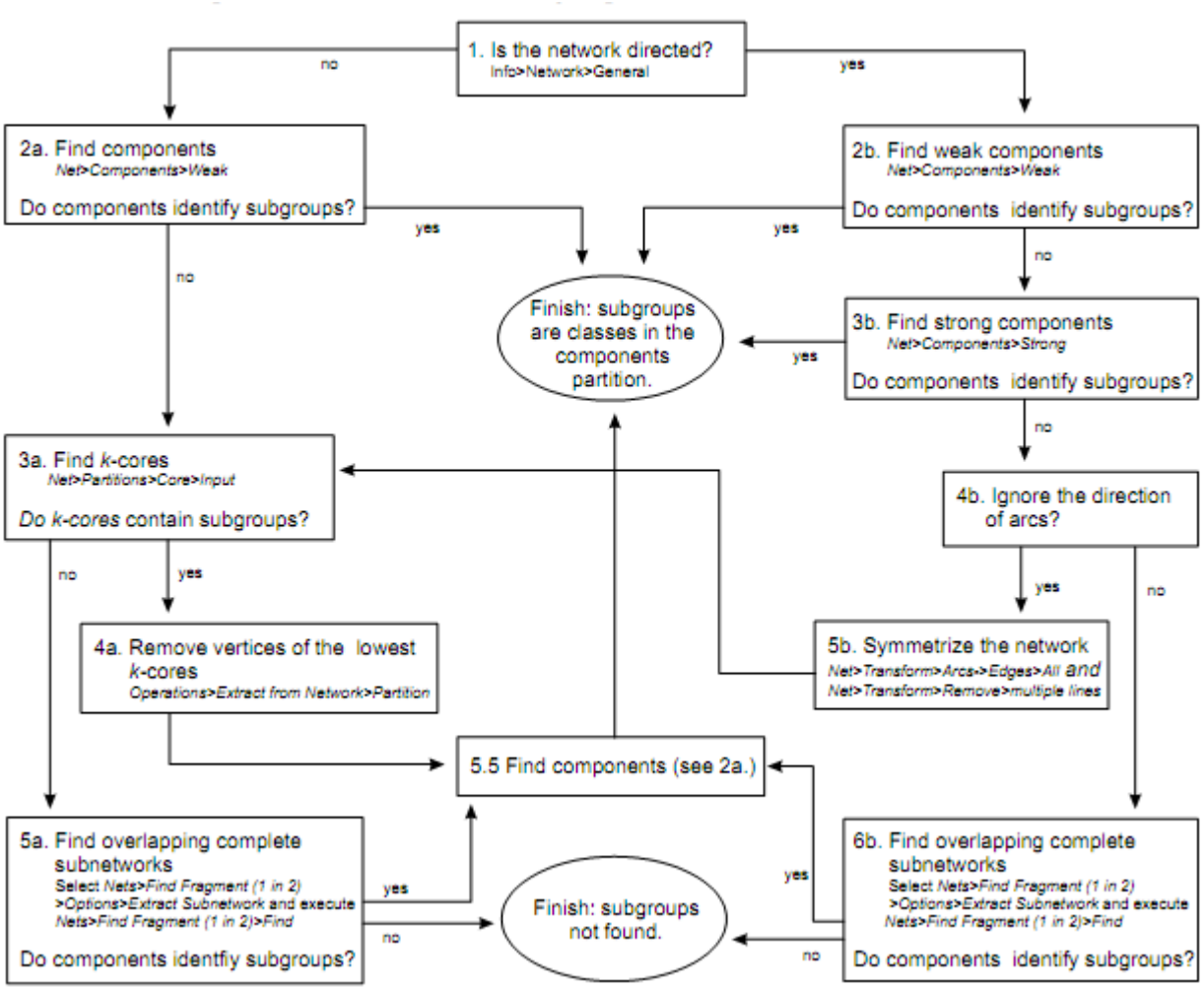
APPENDIX

Appendix 1: Nooy et al (2011) decision tree guide for analysis of cohesive subgroups



Appendix 2: 20 Top and low female eigenvector scores in the giant component.

Top 20	Lower 20
0,2869	1,28E-07
0,2237	1,28E-07
0,2233	1,11E-07
0,1242	1,11E-07
0,1242	1,11E-07
0,1020	8,91E-08
0,0996	8,47E-08
0,0923	8,47E-08
0,0690	8,38E-08
0,0641	8,38E-08
0,0620	7,57E-08
0,0620	7,57E-08
0,0564	4,08E-08
0,0564	3,54E-08
0,0564	3,54E-08
0,0549	2,87E-08
0,0545	2,19E-08
0,0520	2,19E-08
0,0447	1,01E-08
0,0447	9,58E-10

Appendix 3: Firms in Figure 13

2001 Giant component communety network

Community	Organization no	Firm name	Vertex no
1	810090812	Adresseavisen	1
1	814520242	Namsos Trafikkselskap	6
1	835925072	Norman	12
1	879213142	Igroup	30
1	917103801	Veidekke	81
1	926022504	Norsk Lotteridrift	95
1	928661881	Tandberg Data	101
1	928902749	Håg	103
1	931693670	Akva Group	118
1	933174697	Adra Match	120
1	936796702	Visma	141
1	945724846	Comuniq	157
1	960640632	Geo Drilling	182
1	963795572	Scandinavian Customized Prosthesis	196
1	964922292	Exense	201
1	966639199	Cogen	214
1	968348655	Nettaxess	219
1	969059401	Tech Partner	222
1	970601538	Segmentor	223
1	970997636	Smart Club	224
1	971506121	Meditron	227
1	976614089	Probitas	255
1	976896246	Sport & Spill	267
1	978644945	First Services	290
1	978707807	Creditsafe Holding	292
1	979403909	Buytele	306
1	980858073	Visma Business	352
1	981125592	Inmeta	360
1	981603117	Norsk Lotteridrift	375
1	981648803	Delphi Smb Ii	379
1	981910273	Start Network	384
1	982844576	Visma Services	418
2	810506482	Den Norske Bank	2
2	824545022	Eltek	10
2	876862522	Hansa Borg Bryggerier	28
2	882076202	Holberg Aktiv Forvaltning	34
2	910686909	Blom	45

2	911772191	Fosen	55
2	914782007	Vital Forsikring	67
2	915315577	Raufoss	71
2	916819927	Torghatten	76
2	917330557	Widerøes Flyveselskap	82
2	921482957	Leif Høegh & Co.	90
2	921526121	Dno	91
2	921533349	Ivarans Rederi	92
2	926739166	Odim Hitec	96
2	928274624	Rica Eiendom	99
2	930776793	Belships	115
2	931402900	Det Søndenfjelds-Norske Dampskibsselskab	116
2	934849930	Nordic Water Supply	130
2	936270409	Sensonor	137
2	948633841	Abn Amro Forvaltning	162
2	963071426	Vensafe	191
2	965395830	Handicare	206
2	966770198	Corrocean	215
2	971590629	Alfred Berg Industrifinans Aktiv Forvaltning	228
2	974519496	Industrifinans Boligeiendom	233
2	976683048	Precon	257
2	976853938	Trico Supply	265
2	976929284	Cambi	269
2	977321484	Petrolia	280
2	979292473	Industrifinans Næringseiendom	301
2	979297165	Offshore Heavy Transport	302
2	979734344	Industrifinans Eiendom Baltikum	320
2	980053865	Se Labels	331
2	980170225	Mustad Industrier Forvaltning	335
2	980250547	Itera	337
2	981122089	Sector Asset Management	358
2	981165462	Key Asset Management Norge	362
2	981276957	Dnb Holding	368
2	982582709	Privatbanken	410
3	810969652	Fokus Bank	3
3	816521432	Eksportfinans	8
3	819731322	Norgesgruppen	9
3	837041732	Fesil	13
3	864936792	Bolig- Og Næringskreditt	21
3	911044110	Christiania Bank Og Kreditkasse	49
3	911750961	Norske Skogindustrier	53
3	914778271	Norsk Hydro	66
3	914864445	Bn Bank	68

3	923609016	Statoil	94
3	927733056	Norgros	98
3	933739384	Schibsted	124
3	933783405	Medinor	125
3	935007356	Ncl Holding	131
3	937237502	Axis-Shield	143
3	941735169	Toten Økonomiservice	151
3	942593821	Kongsberg Automotive	152
3	957558208	Luxo	175
3	959033560	Biotec	178
3	965336796	Norsk Medisinaldepot	203
3	966991887	Promeks	216
3	971647949	Cermaq	230
3	979165285	Byggma	296
3	979446276	Kebony	309
3	979561296	Terra Fonds	313
3	979661274	Consorte Group	318
3	981400216	Laycan	370
3	981413156	Dyno Nobel	371
3	982246822	Dyno Nobel Holding	392
3	982579201	Terra Aktiv Forvaltning	409
4	811176702	Sas Norge	4
4	837457122	Stepstone	15
4	910102532	Aker Rgi Holding	41
4	911382008	Elkem	51
4	912230252	Hafslund	57
4	912359999	Helly Hansen	58
4	913661346	Kverneland	61
4	915470572	Romsdals Fellesbank	72
4	918883908	Aker Kværner	84
4	929449991	Simrad Optronics	105
4	933478963	Technor	122
4	936647774	Avantor	140
4	944536949	Nera	156
4	959942013	Aker Maritime	179
4	975860078	Pol Nordic Group	237
4	975898679	Aker Geo	238
4	976553209	Mefjorden	248
4	977466482	Helly Hansen Holding	284
4	979751621	Havila Supply	321
4	981445449	Farmersfield	373
4	982281024	Bravida	395
4	982463718	Telenor	407

5	812206222	Gyldendal	5
5	875778722	Synnøve Finden	27
5	910261525	Arendals Fossekompani	42
5	910517694	Bergesen D.Y.	44
5	910763644	Braathens	47
5	911752271	Fondsfinans	54
5	938702675	Af Gruppen	146
5	939595449	System Sikkerhet	147
5	976574958	Powel	252
5	981635647	Fondsfinans Kapitalforvaltning	376
5	982796598	Fondsfinans Aktiv Forvaltning	415
6	815832272	Oslo Reinsurance Company	7
6	868234202	Amfi Eiendom	23
6	881933632	Rema Eiendom Vest	33
6	912423921	Hardanger Sunnhordlandske Dampskipsselskap	59
6	914904633	Hurtigruten	69
6	915293999	Revheim Eiendom	70
6	916882173	Troms Fylkes Dampskibsselskap	77
6	920407048	Allianse	87
6	920639674	Aktieselskabet Borgestad	88
6	920775543	Eye-Share	89
6	929897404	Solvang	107
6	935738709	Oceanor - Oceanographic Company Of Norway	133
6	937905645	Gresvig	144
6	940376645	Ecuanor	149
6	943753709	Kongsberg Gruppen	155
6	958839014	Hydralift	177
6	960756932	Domstein	184
6	962073182	Steen & Strøm	188
6	976769643	Ocean Rig	262
6	976931335	Data Design System	270
6	977356059	Prosafe	281
6	980344215	Viking Fotball	339
6	980667081	Bærum Lufthavn	345
6	981645685	Rema Eiendom Øst	377
6	981889355	Allianse Provider	383
6	982292646	Rema Eiendom Sør	399
6	982813085	Nor Cargo	416
6	983238769	Sinvest	423
6	983298664	Enwa	426
6	983298702	Oceanor Holding	427
6	984016522	Nord Norges Dampskipsselskap	440
7	830357432	Bonheur	11

7	910411616	Eidsiva Rederi	43
7	930357618	Ganger Rolf	111
7	947224700	Scanbio	160
7	954676072	Loki	171
7	976559975	Genomar	249
7	976841220	Fjord Seafood	263
7	977388287	Fred Olsen Energy	283
7	978650449	Axiti	291
7	979179278	Sikon Øst	297
7	984037740	Scanbio Holding	441
8	837088852	Otrum Electronics | Otrum	14
8	881173662	Pop Media	32
8	929621417	Bizylink	106
8	930728209	Awilco	114
8	934382404	Edb Business Partner	129
8	936304818	Gjensidige Nor Equities	139
8	945757647	Fearnley Fonds	158
8	950766441	Ceetron	164
8	956753104	Superoffice	174
8	960545397	Aktiv Kapital	181
8	965522441	Cicero Forlag	207
8	965646019	Component Software Group	208
8	966033967	Bionor Pharma	212
8	974392453	Vålerenga Fotball	232
8	976388348	Omnitree Norge	246
8	976562879	Computerhouse	250
8	976683420	Infocus	258
8	976910907	Tordenskjold	268
8	977483883	Team Shipping	285
8	979416830	Euro Fleet	307
8	979441002	Norse Energy Corp.	308
8	979498748	Wireless Reading Systems	312
8	980067645	Voss Of Norway	332
8	980740358	Gjensidige Nor Kapital- Forvaltning	347
8	981046846	Dropzone	354
8	981052722	Intellinet	355
8	981230566	Helpinhand	364
8	982003008	Pointbreaker	388
8	982578337	Office Line	408
9	838583512	Pareto Private Equity	16
9	956632374	Pareto Securities	173
9	977287677	Pareto Forvaltning	278
9	978643825	Garde Aktiv Forvaltning	289

9	979203527	Pluss Aktiv Forvaltning	299
9	983268617	Oslo Børs Holding	424
9	983268633	Oslo Børs	425
10	851567372	Norsk Kjøkkeninvest	17
10	882420302	Officeshop Holding	36
10	911178664	Det Stavangerske Dampskibsselskab	50
10	915693016	Winder	73
10	917019215	Unitor	80
10	942674465	Jøtul	153
10	948446103	Evercom Network	161
10	964976430	Ekornes	202
10	965662952	Nasdaq Omx Oslo	210
10	971592311	Scanwafer	229
10	976605713	Kitron	254
10	977241774	I M Skaugen	274
10	979498667	Whitecliff	311
10	979967837	Euronordic Kapitalforvaltning	327
10	980758214	Cognition Ventures	349
10	981646398	Benefit Network	378
10	981999460	Imarex	387
10	982232015	Broadband Mobile	391
10	983670032	Sagatex Holding	434
10	983670067	Dale Of Norway Holding	435
11	851634142	Crystal Production	18
11	910747711	Orkla	46
11	910985949	Båtservice Holding	48
11	912007782	Glamox	56
11	914348803	Moelven Industrier	62
11	914769922	Goodtech	65
11	920165931	Kristiansand Dyrepark	85
11	927124238	Tomra Systems	97
11	928613941	Scana Industrier	100
11	928661970	Tandberg	102
11	936046967	Lister	136
11	940352738	Tusenfryd	148
11	943545634	Omnia	154
11	953114828	Smedvig	168
11	954046451	Pride	170
11	962989659	Roxar	190
11	964266980	S Gruppen	198
11	965650776	Ideas	209
11	967598593	Photocure	218
11	968591878	Klean	220

11	974529459	Opera Software	234
11	975259307	Natumin Pharma	236
11	976145178	Safetel	239
11	976568133	Airworks	251
11	976584201	Network Electronics	253
11	976855396	Industrifinans Smb Ii	266
11	977234913	Tandberg Television	273
11	977250544	Organic Power	277
11	977385733	Lillestrøm Fotball	282
11	977499372	Norshell	286
11	979111576	Fredrikstad Fotballklubb Sport	293
11	979199325	Navion	298
11	979364857	Interconsult	304
11	979650116	Industrifinans Smb Iii	317
11	980213250	Komplett	336
11	980413993	Infovital	341
11	981232585	Storebrand International Private Equity	365
11	981363876	Statoil Kapitalforvaltning	369
11	982279143	Coastshell	394
11	982822645	Storebrand International Private Equity Ii	417
12	855721902	Ementor Financial Systems | Tietoenator Financial Solutions	19
12	882332772	Telenor Kapitalforvaltning	35
12	920237126	Atea	86
12	930150363	Ementor	109
12	935891949	Software Innovation	134
12	950293225	Aker Biomarine	163
12	951337242	Eterra	165
12	960102215	Polydisplay	180
12	962951155	Western Bulk Shipping	189
12	965361413	Netcom	204
12	965390049	Caretaker	205
12	967372668	Hands	217
12	971125756	Data Respons	226
12	974341840	Sospita	231
12	976358465	Customax	245
12	977301939	Nordic Restaurant Group	279
12	977511542	Novatech	287
12	979605501	Nethouse	314
12	979620292	Neomed Innovation	315
12	979812345	Start-Fondet	322
12	980747026	Western Bulk	348
12	981260147	Nordika Asset Management	366

12	982376084	Telenor Venture Ii	402
12	983640753	Ementor	433
13	858905192	Wicom | Ignis	20
13	930256331	Industriinvestor	110
13	963498586	Robia	194
13	964843503	Innovation	200
13	980832562	Adaptive Media	350
13	980913120	Axxessit	353
13	981482581	Reiten & Co	374
13	982769221	Cappit	414
13	982893496	Konftel Invest	419
13	983835783	Reiten & Co Asset Management	438
14	866918112	Formuesforvaltning Drammen	22
14	958143087	Formuesforvaltning Rådgivende Økonomer	176
14	962040659	Formuesforvaltning Hurum Og Follo	187
14	963733690	Formuesforvaltning Oppland Og Hedmark	195
14	976320034	Formuesforvaltning Oseberg	244
14	982168716	Akershus Formuesforvaltning	390
14	982431239	Formuesforvaltning Asker Og Bærum	405
14	982763118	Formuesforvaltning Oslo	412
15	871004862	Investra	24
15	871093482	Opticom	25
15	883077172	Serve	37
15	883886852	Carnegie Fondsforsikring	40
15	917991014	Choice Hotels Scandinavia	83
15	933921875	A. Sundvall	126
15	963299850	Guard Systems	192
15	963342624	Norsk Tillitsmann	193
15	976307879	Carnegie Forvaltning	243
15	976846923	Idex	264
15	979115350	Fastweb	294
15	979158831	Fast Search & Transfer	295
15	979356560	Mørdre Sportsnett	303
15	979694407	Aon Grieg Investor	319
15	981142977	Smartcall	361
15	981201825	Thin Film Electronics	363
15	982250625	Concept Esolutions	393
15	982410614	Home Invest	404
15	982769043	Rosa Media	413
15	983052754	Fastweb	421
15	983336027	Bluewater Insurance	428
15	983789579	Rosaindex	436
15	983789595	Vanadis Internett	437

16	871579792	Banqsoft	26
16	912685144	Hjellegjerde	60
16	922493626	Green Reefers	93
16	929975200	Austevoll Havfiske	108
16	935349230	Dof	132
16	935956560	Actinor Shipping	135
16	941576184	Vmetro	150
16	945883294	Solstad Offshore	159
16	964118191	Marine Harvest	197
16	966011726	Nordic Semiconductor	211
16	976695372	Tgs Nopec Geophysical Company	260
16	977246156	Odra Industries	275
16	979403194	Pacpro Norge	305
16	979881703	Profdoc	326
16	980489876	Ulstein Group	342
16	982321514	Pan Pelagic	400
17	877241602	Frontier Drilling	29
17	911382296	Elkjøp	52
17	916979436	Thrane Gruppen	79
17	929118200	Bjørge	104
17	930501778	Marine Farms	112
17	932142104	Tts Group	119
17	936947220	Orkla Finans	142
17	938318999	Enskilda Securities	145
17	951863750	Applied Plasma Physics	166
17	952751190	Norsk Vekst	167
17	955706137	Efd - Elva Fritz Dusseldorf	172
17	971005564	H&Q Norden Corporate	225
17	976160630	Bryggen Finans Fonds	240
17	976685881	X.Hlp Technologies	259
17	976721454	Enitel	261
17	977037093	Birdstep Technology	271
17	977097878	Advanced News Networking Systems	272
17	980408361	Golfaxess	340
17	980684342	Sense Communications International	346
17	980855376	Factor Insurance Group	351
17	981123190	Egroup	359
17	981263790	Orkla Finans Kapitalforvaltning	367
17	981928180	Fondsnett	385
17	981956087	Multibrand	386
17	982321522	Pan Marine	401
17	982377528	Norsk Vekst Forvaltning	403
17	983466133	H&Q Norden Fondsmeglerforretning	430

17	983466141	Norden Corporate	431
17	983521592	Bankia Bank	432
18	880109162	Dnb Asset Management	31
18	914526647	Narvesen	63
18	930673730	Reitan Medinvest	113
18	933485447	Sponsor Service	123
18	936301436	Epocket Solutions	138
18	964620970	Procorp	199
18	976205308	Eiendomsnett Norge	242
18	977572266	Norgesinvestor Verdi	288
18	980050491	Easy Park	330
18	980159833	Ppn	334
18	980300609	Allegro Finans	338
18	980645487	First Securities	344
18	981695461	Norgesinvestor Verdi Ii	380
18	981875605	Haavi Lie-Nielsen Rønnov Asset Management	382
18	982152313	Inaq Invest	389
18	982431352	Sparebank 1 Aktiv Forvaltning	406
18	982699355	Sparebank 1 Nord-Norge Forvaltning	411
18	983054560	Sr-Forvaltning	422
18	983992765	Universal Fonds Oslo	439
19	883603362	Abg Sundal Collier Norge	38
19	883742192	Apptix	39
19	916235291	Petroleum Geo-Services	74
19	934254813	Kenor	128
19	961095026	Abg Sundal Collier	185
19	961301238	Marineprovider	186
19	969031140	Eitzen Maritime Services	221
19	976518373	Norlandia Holding	247
19	977249287	Telecomputing	276
19	979626878	Acta Asset Management	316
19	979867654	Acta Holding	323
19	979871376	Sundal Collier & Co	324
19	979871384	Acta	325
19	980050211	Sundal Collier Institusjonell Forvaltning	329
19	980095614	Sundal Collier Fondsforvaltning	333
19	982286891	Acta Bank	396
19	982286913	Acta Online	397
19	982288223	Acta Fondsforsikring	398
19	983354378	Lysaker Maritime	429
20	914709628	Rieber & Søn	64
20	916300484	Storebrand	75
20	933321118	Finansbanken Aktiv Invest	121

20	934021592	Farstad Shipping	127
20	953299216	Finansbanken	169
20	960755316	Storebrand Kapitalforvaltning	183
20	966458429	Finansbanken Index	213
20	976645146	Delphi Aktiv Forvaltning	256
20	979287534	Norex Group Norway Petroleum	300
20	979490097	Delphi Investor Service	310
20	979980876	Continuum Resources International As	328
20	980585522	Global Geo Services	343
20	981119487	Norsk Oppgjørssentral	356
20	981119509	Nos	357
20	981708504	Xeron	381
20	982948010	Kaupthing Markets	420
21	916950381	Andvord Tybring-Gjedde	78
21	931456237	S-U Soft	117
21	974986140	Hugin	235
21	976201590	Folin	241
21	981435729	Su Intersoft	372

Appendix 4: Firms in figure 14

2010 Giant component communety network

Community	Organization no	Firm name	Vertex no
1	812206222	Gyldendal	1
1	863769132	Markedskraft	8
1	864234232	Norway Royal Salmon	9
1	891797702	North Energy	17
1	910261525	Arendals Fossekompani	19
1	911752271	Fondsfinans	25
1	912007782	Glamox	26
1	914778271	Norsk Hydro	30
1	916235291	Petroleum Geo-Services	34
1	936656013	Medistim	56
1	938803595	Cecon	58
1	943753709	Kongsberg Gruppen	62
1	955514262	R.S. Platou	68
1	964976430	Ekornes	80
1	981635647	Fondsfinans Kapitalforvaltning	112
1	982463718	Telenor	115
1	988228397	Aker American Shipping	145
1	988843016	Arrow Seismic	155
1	989961225	Nortechs Fpso	173
1	990031479	A-Com Norge	175
1	990874050	Zoncolan	183
1	991697918	Rainpower	192
1	995216604	Wilh. Wilhelmsen	203
1	995277905	Wilh. Wilhelmsen Holding	204
2	816521432	Eksportfinans	2
2	824545022	Eltek	4
2	911750961	Norske Skogindustrier	24
2	917103801	Veidekke	36
2	920639674	Aktieselskabet Borgestad	37
2	928613941	Scana Industrier	42
2	934021592	Farstad Shipping	50
2	934382404	Edb Business Partner	51
2	974529459	Opera Software	90
2	983268617	Oslo Børs Holding	119
2	983268633	Oslo Børs	120
2	983892876	Faktor Eiendom	122
2	985140421	Verdipapirsentralen	130
2	986922113	Ability Group	140
2	988603228	Storebrand Institusjonell Investor	149

2	988603252	Storebrand Privat Investor	150
2	988737798	Block Watne Gruppen	154
2	989183001	Storebrand Optimã‰R	160
2	989275089	Dnb Nor Eiendomsinvest I	161
2	990216924	Oslo Clearing	176
2	990530297	Fornebu Utvikling	180
2	991853545	Storebrand Infrastruktur	194
2	992516178	Borgestad Industries	197
2	994901281	Union Eiendomsinvest Norge	201
2	995216531	Bridge Energy	202
2	995568217	Gjensidige Forsikring	207
3	819731322	Norgesgruppen	3
3	858905192	Wicom | Ignis	7
3	886581432	Aker	13
3	895465232	Morpol	18
3	921526121	Dno	38
3	923609016	Statoil	40
3	931693670	Akva Group	48
3	937917376	Nussir	57
3	938992185	Hexagon Composites	59
3	950293225	Aker Biomarine	66
3	960514718	Salmar	70
3	960545397	Aktiv Kapital	71
3	961360560	Sølvtrans Holding	74
3	964118191	Marine Harvest	79
3	977321484	Petrolia	96
3	980489876	Ulstein Group	108
3	984487819	Reservoir Exploration Technology	126
3	985573913	Via Travel Group	133
3	986221530	Aker Asset Management	134
3	986392858	Aker Seafoods	136
3	986529551	Aker Kværner	137
3	987727713	Petromena	141
3	989061879	Aker Contracting Fp	156
3	989284339	Rem Offshore	162
3	989628615	Aker Floating Production	165
3	989795848	Aker Exploration	170
3	991125175	Arctic Securities	188
3	991851526	Aker Philadelphia Shipyard	193
3	992614145	Polaris Media	198
4	830357432	Bonheur	5
4	930357618	Ganger Rolf	45
4	930366323	Fred. Olsen Production	46

4	977388287	Fred Olsen Energy	97
5	845278822	Altinex	6
5	882757692	Wilson	10
5	914709628	Rieber & Søn	29
5	922493626	Green Reefers	39
5	936310974	Carnegie	55
5	945757647	Fearnley Fonds	63
5	945883294	Solstad Offshore	64
5	963191383	Read	76
5	963299850	Guard Systems	77
5	965920358	Norwegian Air Shuttle	81
5	971647949	Cermaq	87
5	979446276	Kebony	101
5	980585522	Global Geo Services	109
5	983218180	Sevan Marine	118
5	986558926	Scanarc	138
5	987989297	Norwegian Energy Company	143
5	988257133	Bank2	147
5	989776002	Mpu Offshore Lift	169
5	989910272	Sevan Drilling	172
5	991097481	Fearnley Finans Eiendom	187
5	991281924	Norwegian Finans Holding	190
6	883603362	Abg Sundal Collier Norge	11
6	886582412	Aqua Bio Technology	14
6	910301268	Asker Og Bærums Budstikke	20
6	930501778	Marine Farms	47
6	935590221	Bb Finans	54
6	942593821	Kongsberg Automotive	61
6	959033560	Biotec	69
6	961095026	Abg Sundal Collier	73
6	962007465	Independent Oil & Resources	75
6	966033967	Bionor Pharma	83
6	979380593	Algeta	99
6	979938799	Diagenic	105
6	983733506	Clavis Pharma	121
6	984186614	Codfarmers	123
6	985012059	Navamedic	129
6	990357242	Probio	178
6	992470763	Spectrum	196
7	883742192	Apptix	12
7	910411616	Eidsiva Rederi	21
7	912423921	Hardanger Sunnhordlandske Dampskipsselskap	28
7	966011726	Nordic Semiconductor	82

7	972417513	Mamut	88
7	976695372	Tgs Nopec Geophysical Company	93
7	977258561	Renewable Energy Corporation	94
7	979683103	Rosenlund	103
7	979867654	Acta Holding	104
7	982769221	Cappit	116
7	985279721	Protector Forsikring	132
7	986228608	Yara International	135
7	989734229	Maracc - Marine Accurate Well	166
7	990295697	Comrod Communication	177
7	990727007	Storm Real Estate	182
7	990919321	Nordic Heavy Lift	185
7	994035975	Arena Group	199
8	888571302	Contract Co Alfa	15
8	982000564	Aker Drilling	114
8	988571326	Contract Co Beta	148
9	890687792	Aberdeen Eiendomsfond Asia	16
9	912230252	Hafslund	27
9	916300484	Storebrand	35
9	953299216	Finansbanken	67
9	963342624	Norsk Tillitsmann	78
9	988664839	Höegh Capital Management	152
9	988671258	Aberdeen Eiendomsfond Norge Ii	153
9	989180797	Aberdeen Asset Management Corporate	159
9	989761390	Aberdeen Eiendomsfond Norden/Baltikum	167
9	995532921	Statoil Fuel & Retail	206
10	910686909	Blom	22
10	935487242	Q-Free	53
10	940376645	Ecuanor	60
10	971125756	Data Respons	86
10	976094875	Crew Minerals	92
10	979543883	Dips	102
10	980250547	Itera	107
10	984277016	Hafslund Infratek	125
10	986759808	Norman	139
10	989112007	Fara	158
10	989623362	Gjensidige Investeringsrådgivning	164
10	990565791	Copeinca	181
10	990906475	Pareto Bank	184
10	995359774	Saga Tankers	205
11	910747711	Orkla	23
11	927124238	Tomra Systems	41
11	967598593	Photocure	84

11	980213250	Komplett	106
11	988622036	Norwegian Property	151
11	990947619	Global Rig Company	186
11	992090480	Dnb Nor Privat Shippinginvestor I	195
12	914782007	Vital Forsikring	31
12	928661881	Tandberg Data	43
12	932142104	Tts Group	49
12	974442167	Bouvet	89
12	977473799	Car	98
12	979441002	Norse Energy Corp.	100
12	981276957	Dnb Holding	111
12	984195486	Electromagnetic Geoservices	124
12	984851006	Dnb Nor Bank	127
12	984861060	Dolphin Group	128
12	985206732	Client Computing Europe	131
12	989307606	Aladdin Oil & Gas Company	163
12	994051067	Panoro Energy	200
13	914864445	Bn Bank	32
13	914904633	Hurtigruten	33
13	969031140	Eitzen Maritime Services	85
13	977311632	Camillo Eitzen & Co	95
13	981119487	Norsk Oppgjørssentral	110
13	981999460	Imarex	113
13	982985110	Fish Pool	117
13	988217867	Concedo	144
13	988247006	Interoil Exploration And Production	146
13	989816128	International Maritime Exchange	171
13	989990500	Eitzen Chemical	174
13	991674446	Netconnect	191
14	929975200	Austevoll Havfiske	44
14	935349230	Dof	52
14	946598038	Grieg Seafood	65
14	960756932	Domstein	72
14	975350940	Lerøy Seafood Group	91
14	987974532	Gc Rieber Shipping	142
14	989094823	Norway Pelagic	157
14	989761846	Ability Drilling	168
14	990512663	Dof Installer	179
14	991279539	Bergen Group	189
14	995632233	Armada Seismic	208