Did Norway's board gender quota reduce firm value?*

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Abstract

At the end of 2005, Norway gave public limited liability companies one of two choices: within two years, form a gender-balanced board or face liquidation. For the typical firm, this meant replacing one male director with a female, a marginal change in board composition by most standards. However, in a widely quoted study, Ahern and Dittmar (2012) conclude that the quota law caused a large loss in the market values of firms listed on the Oslo Stock Exchange (OSE). Implementing a more robust empirical methodology, we reverse this conclusion: the quota law did not cause a statistically significant change in the market values of OSE-listed firms. We also document the rise of female director network power in the post-quota era.

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The forced addition of new female directors on boards led to value losses of upwards of 20% for the firms with [no previous female members]...[The] value losses are persistent across time."
—Ahern and Dittmar (2012)

1 Introduction

In December of 2005, when 15% of the directors of Norwegian-domiciled public limited companies ("ASA firms") were female, the Norwegian government mandated gender-balanced boards—or face forced liquidation. ASA firms were given two years to recompose their boards so that 40% of the directors were from each gender. This pioneering social experiment has attracted substantial international attention among researchers as well as government agencies and public policy makers. Various forms of board gender quotas have since been adopted by Italy, Belgium, the Netherlands, Iceland, Spain, France and Germany. Today, women on average make up 18% of boards in the European Union (EU), and the European Commission has proposed a 40% EU-wide quota.

The main purpose of this paper is to test whether the gender quota—by constraining the free choice of board gender composition—reduced firm value. Passage of the quota law created a "natural" corporate governance experiment. When board structures are formed voluntarily, latent firm characteristics simultaneously drive optimal board characteristics and firm value. As a result, cross-sectional regressions of firm value on board characteristics identify equilibrium correlations but not the direction of causality. The exogenous nature of the mandatory quota event helps resolve this endogeneity problem. Moreover, the universal application of the quota to all Norwegian ASA firms suggests that the imposition of the gender quota should indeed show up in firm value unless this change is truly value neutral.

Ahern and Dittmar (2012), in the first study to examine the valuation effects of the Norwegian gender quota, conclude that it dramatically reduced firm value (above quote). A consistent interpretation is that board composition matter for firm value, and that the supply of qualified female directors is severely limited—forcing many ASA firms to put low-quality female directors on their boards. If this interpretation is correct, it also supports the notion that the pervasive male domination on boards seen around the world reflects economic efficiency as opposed to board entry restrictions enforced by an "old boys" network.

However, considering the generally weak link between board composition and economic performance established by governance research (Adams, Hermalin, and Weisbach, 2010), and the relatively modest change in directors required to comply with the law, the large negative valuation effect reported by Ahern and Dittmar (2012) is surprising to say the least. The typical firm had to replace a single male with a female director on a five-director board (as it turned out, firms chose not to change their board size).

It seems unlikely that this marginal change should have a material effect on firms' investment policies and therefore on firm performance and market values. Further to this point, equity ownership in Norway was (and still is) highly concentrated—the largest shareholder owning about 30% of the voting shares of ASA firms on average—which suggests that boards face substantial shareholder monitoring. Simply put, the notion that the typical incoming "rookie" female director was in a position to strongly influence both the entire board and the large shareholder in a value-reducing direction seems farfetched.

With this in mind, we revisit the value implication of the quota law. Ahern and Dittmar (2012) draw their main empirical support from an event study that produces significantly negative abnormal stock returns to OSE-listed Norwegian companies on February 22, 2002, and which is more negative for firms with zero female directors. We reverse their event-study conclusion after making two simple innovations. The first is to add foreign firms listed on the OSE as a comparison or "placebo" sample. The board gender quota is an amendment to Norwegian corporate law and so foreign companies are not subject to the quota.[1] As it turns out, the foreign OSE-listed companies also experienced significantly negative abnormal stock returns on February 22, 2002, and of a similar magnitude as the Norwegian companies. This strongly suggests that the negative market reaction reflects news unrelated to the quota law.

Second, we introduce a news event ignored by earlier studies but which provides significant power to test whether the gender quota law had a negative valuation impact. On December 9, 2005, it was announced for the first time that the quota law would include a liquidation penalty for noncompliance. This change came as a surprise as only a few days earlier, the Prime Minister had talked publicly about imposing reasonable monetary fines for non-compliance—far from anything

[1] Also, the OSE listing requirements do not include a gender balance restriction.

like a liquidation penalty.[2] The December 9, 2005 news announcement removed any residual uncertainty about the implementation of the gender quota law. Importantly, OSE-listed companies (Norwegian or foreign) did *not* experience statistically significant abnormal stock returns in response to this event.

We round off the event-study anlysis by presenting results of cross-sectional regressions with the announcement-induced abnormal return as dependent variable. These regressions summarily fail to produce a significant slope coefficient on a variable measuring the shortfall of female directors relative to the 40% quota requirement. The regressions, which control for industry sector fixed effect, also do not indicate that firms with no female directors experience greater abnormal returns that other OSE-listed Norwegian companies. In sum, we cannot reject the hypothesis that news of the quota law had zero effect on the market values of Norwegian OSE-listed companies.

We then turn to the instrumental variable (IV) test of Ahern and Dittmar (2012), in which they examine whether firms with a greater shortfall of female directors in 2002 have lower Tobin's Q in future years. They use the pre-quota fraction female directors interacted with future year fixed effects to instrument exogenous variation in voluntary female appointments. While this approach is innovative, their conclusions drawn from the IV test are troublesome. Perhaps most important, as we also show here, their instrument does not have a significant effect on Tobin's Q until 2008. Since all uncertainty about the quota law was resolved by the end of 2005, the quota law also cannot have impacted market values after 2005. Thus, their IV test atcually rejects the hypothesis that the quota law negatively impacted firm values.

However, this is not the inference drawn by Ahern and Dittmar (2012). Instead, they assert that "the negative impact of the quota on firm value persists over time" and further that "The persistence in the value loss suggests that declines in firm value are not simply temporary overreactions by the stock market. Instead, the imposition of the quota appears to have affected the fundamentals of Norwegian firms" (p 31). It is not clear what the authors base this statement on. However, what *is* clear is that, in 2007-2008, the market values of OSE-listed firms dropped significantly as a result of the financial crisis. We therefore argue that the instrumented shortfall of female directors in 2008 picks up an effect of the financial crisis.

[2] The decision to impose the severe penalty reflected the government's frustration with ASA firms' failure to voluntarily adopt gender balanced boards up to that point: in 2005 only 15% of ASA directors were female on average.

Finally, Ahern and Dittmar (2012) show that the fraction of female directors in 2002, which supposedly captures involuntary addition of female directors, had a *positive* effect on the market-to-book value in 2006 for supposedly "placebo" firms in Sweden, Denmark and Finland—while a zero effect for Norwegian companies. In other words, the instrument affects the placebo sample but not the treatment sample! Ahern and Dittmar (2012) suggest from this that "firms in Scandinavia may have responded to the Norwegian quota in anticipation of a similar quota in their own country" (p 31). However, a more consistent interpretation is that the instrumented fraction of female directors in 2002 captures something else than the Norwegian quota law—in effect casting doubt on the instrument itself. In sum, we conclude that the Tobin's Q analysis also fail to support the hypothesis that the quota law reduced the market valuations of OSE-listed companies.

Our paper is relevant also for recent studies that do not directly measure valuation effects of the quota law but appear to have been greatly influenced by the main conclusoin of Ahern and Dittmar (2012). For example, Bøhren and Staubo (2013a,b) suggest that firms may have switched legal form (away from ASA) to avoid negative effects of the quota law, and that the increase in independent directors caused by the gender quota may have shifted board deliberations away from strategic considerations towards excessive (i.e. costly) "policing" of management. Matsa and Miller (2013) further find that Norwegian quota firms experience an increase in labor costs and a decline in operating profits compared to matched control firms.

On the other hand, Dale-Olsen and Verner (2013) fail to find any significant difference between Norwegian public and private firms in the development of return on assets, operating revenues or costs over the sample period. Moreover, Bertrand, Black, Jensen, and Lleras-Muney (2014) report that female board members are substantially more qualified post-reform than their female predecessors and document a higher representation of female top executives following the law. The message from our analysis is clear: whatever the change in post-quota firm behavior, it should not be motivated by an assumption that the law led to a significant destruction of firm value in the first place.

Moreover, our paper also contributes to a growing literature on director network power. Our analysis includes a compilation of director networks used to measure director "power" using all public and private corporations in Norway (more than 175,000 firms in total). Much like Bøhren and Strøm (2010), our network analysis uses the concept of network centrality (explained in the

Appendix) and provides a meaningful definition of the power of a "busy" director, and which we show correlates with firm value.[3]

The rest of the paper is organized as follows. Section 2 reviews existing research on gender diversity, board monitoring and director network power more generally. This serves as a useful backdrop for our own analysis. Section 3 provides a data description, including our measure of director network power, we we use in the subsequent analysis. Section 4 provides our discussion of firm-value effects of the quota law. In Section 5, we ask whether firms changed their legal form from ASA to AS because of the law. Section 6 concludes the paper.

2 Gender diversity, director power and firm value

2.1 Are female directors better monitors?

There is some evidence—anecdotic in Scandinavia but more systematic based on US firms—that female directors are willing to "rock the boat" in the boardroom. Consider first what happened in Statoil and HQ Bank—two high-profile whistle-blower cases which are instructive for the ongoing debate over the decision power of female directors in Scandinavia:

Statoil: In 2002, the nine directors of Statoil, Norway's partly state-owned oil company, became aware that the company had bribed an Iranian consultancy firm (Horton Investments) in order to secure oil contracts. The directors split into two camps on how to deal with this illegal act. One camp, led by the Chairman of the board, wanted to "manage" the flow of information to outside investors in the hope of protecting key company officers and directors. The other camp, however, argued that shareholders would be better off with a full and immediate disclosure. This camp was strongly influenced by two young and newly appointed female directors, one with a PhD in laser physics and the other with a Dartmouth MBA degree. The female camp won, and both the chairman and the chief executive officer (CEO) were eventually forced to leave the company.[4]

HQ Bank: In April 2010, a woman with a PhD in finance joined the board of HQ Bank, a Swedish niche bank for wealthy individuals. She was explicitly hired to perform risk management

[3]Bøhren and Strøm (2010), Horton, Millo, and Serafeim (2012), Larcker, So, and Wang (2013), Fogel and Morck (2014), and Masulis and Mobbs (2014) all provide evidence that firms may benefit from having relatively powerful directors on their boards.

[4]Statoil was found guilty of corruption by Norwegian courts in 2004, and the company settled a lawsuit by U.S. authorities in 2006, admitting to having paid bribes.

at the board level. She proceeded to perform an assessment of the bank's derivatives portfolio and informed the other directors in the May 2010 board meeting that the HQ portfolio was substantially overvalued. She demanded that the firm's trading portfolios be revalued and the stock market informed. However, the board's majority declined to follow her request and she resigned.[5] Three months later, HQ's bank license was revoked and the firm was forced to liquidate. According to Sweden's Financial Supervisory Authority, the bank had been severely undercapitalized since 2008, systematically overvaluing its trading portfolio and reporting its financial positions inaccurately.

These two cases highlight the complexity of the likely economic effects of mandating female director quotas. The operative words here are "independent", "female" and "mandated". The debate has two opposing sides. Proponents of quotas point to the growing evidence that young and well-educated female directors with few ties to the firm or its board members tend to show the independence needed to act as effective monitors and corporate governance advocates. This notion—clearly supported by the Statoil and HQ cases—is also supported by systematic research. For example, Adams and Ferreira (2009) find that gender-diverse boards allocate more effort to monitoring, both in terms of better attendance records and that female directors are more likely to join audit, nominating and corporate governance committees. Gender diverse boards are also more likely to fire the CEO when the firm performs poorly.

Moreover, Schwartz-Ziv (2013) finds that boards with at least three female directors present in the meeting are twice as likely to request additional information or updates from management and to take initiatives, such as proposing actions to undertake. That is, boards with a critical mass of women are more active in their board work, consistent with more efficient monitoring. Importantly, at the individual level, both men and women are more active in these meetings. Female directors, however, tend to take actions pertaining to supervisory issues, while male directors are more likely to take actions related to managerial issues. Research further supports the notion that director independence is valuable more generally: CEO turnover is more sensitive to firm performance in companies with relatively small boards and a high fraction of independent directors (Adams, Hermalin, and Weisbach, 2010).

It is also possible for mandatory gender quotas to reduce firm value, however. There are two

[5] The Chairman of HQ later explained her abrupt departure after serving on the board for less than two months with a "lack of nerves" to stay on the board (*Svenska Dagbladet*, August 30, 2010).

types of arguments. First, female directors without business experience may swing board governance activity towards excessive monitoring relative to time spent advising the CEO on business strategy. For example, as modeled by Adams and Ferreira (2007), a strictly monitored CEO may be reluctant to share information with the board.[6] That is, the free reign of female monitors may threaten the internal cohesion and efficiency of an existing male director network. The second type of argument holds that the number of qualified female directors may be in short supply. Under this argument, forcing boards to appoint the few available qualified female directors may simply result in a group of male directors ("golden shirts") being replaced by another female director club ("golden skirts"). Who is to say one club is better than the other?

Several studies have documented a positive relationship between the fraction of female board members and firm performance (Carter, Simkins, and Simpson, 2003; Erhardt, Werbel, and Shrader, 2003; Catalyst, 2004; Suisse, 2012; Liu and Xie, 2013; Schwartz-Ziv, 2013; Reuters, 2013). As indicated in the introduction, underlying firm characteristics likely simultaneously determine the optimal composition of the board and firm performance. It is possible that profitable firms are more likely to appoint female board members and women tend to accept directorships in profitable firms.[7] That notwithstanding, Adams, Gray, and Nowland (2011) find a positive stock price reaction for Australian firms that announce the appointment of female directors.[8] Overall, the evidence suggests that female directors may improve governance when appointed for their own merits.

2.2 Director power and firm value

Powerful directors can provide important connections and hence be valuable for the firm. For example, former politicians may help increase sales to the government (Agrawal and Knoeber, 2001), and there is some evidence of a positive announcement effect of the appointment of politically connected directors (Goldman, Rocholl, and So, 2009). Moreover, directors with prior investment

[6] Following various corporate governance scandals around the turn of the century, boards appear to spend more time monitoring managers. With detailed minutes of board meetings and board-committee meetings, Schwartz-Ziv and Weisbach (2013) show that boards spend most of their time discussing issues of a supervisory nature.

[7] It may not be the gender itself that is critical, but the resulting heterogeneity of directors that bring different perspectives to the table. See, for example, Oxelheim and Randoy (2003) for the value of international directors and Fogel and Morck (2014) for the value of powerful independent directors. Fahlenbrach, Low, and Stulz (2010) show that the stock market values the first outside CEO director but not additional outside CEO directors.

[8] Al Farrell and Hersch (2005) document an insignificant stock-market reaction to announcements of female director appointments in US firms. See also Kang and Charoenwong (2010) for a study of female directors appointed to Singaporean firms.

banking experience may be better able to identify suitable target firms for acquisition (Huang, Jiang, Lie, and Yang, 2014; Guner, Malmendier, and Tate, 2008). Also, firms tend to have lower loan spreads and fewer covenants if their directors have personal connections to bank officials (Engelberg, Gao, and Parsons, 2012). The value of powerful directors is supported by evidence that powerful boards are associated with higher Tobin's Q (Bøhren and Strøm, 2010; Horton, Millo, and Serafeim, 2012) and return on assets (Larcker, So, and Wang, 2013), and Fogel and Morck (2014) report negative announcement returns on the death of a powerful outside director.

If female directors have smaller networks than male directors, the forced replacement of male board members may have a negative impact on firm value. Below, we provide direct evidence on the impact of the quota on board power, and study the effects of the rising power of female directors.

3 Sample firms and director networks

Norway uses the dual corporate classification system of the European Union (EU) in which all limited liability companies are classified either as "public" (ASA) or "private" (AS). The law only regulates ASA firms. Note that the definition of"public" does *not* necessarily mean that the firm is listed on a stock exchange, and many ASA firms are not. Only ASA firms may undertake a public equity offering and be publicly traded. The ASA legal form also comes with stricter disclosure and financial reporting standards, including adhering to International Financial Reporting Standard (IFRS) rather than the simpler Norwegian GAAP followed by AS firms.

3.1 Sample of ASA and Large AS firms

The data are from the Accounting Database at the Norwegian School of Economics (organized by Aksel Mjös). The database covers all firms in Norway, beginning in 1992. Our sample period is 1998 through to 2011, which are the years for which we also have detailed data on boards. As shown in Table 1, the population of AS companies (Panel A) averages 487 per year over the sample period, while the number of AS averages about forty times as many: 174,129. For both ASA and AS firms, we restrict this population to what we call *ultimate firm*: either a stand-alone firm with no divisions or the mother of a conglomerate identified as the entity that files the conglomerate's consolidated financial account. The average annual number of ultimate firms is 395 ASA and 133,172 AS.

Furthermore, we impose multiple accounting data availability requirements. These include non-missing information on sales, book assets (and requiring assets $\geq$ working capital), long-term assets, current assets, book equity, long-term debt, current debt, and the number of employees. This produces our final sample of ASA firms, which averages 373 per year over the sample period. For AS firms, however, we further reduce the sample to the top 10^{th} percentile of AS firms sorted on total revenue. As shown in the last column of Table 1 Panel B, these "Large AS" average 12,289 firms per year.

Figure 1 shows the frequency distribution of the Large AS firms when sorted into deciles using ASA firms to identify the size breakpoints. In Panel A, we define the decile breakpoints using the total revenue of each of our sample of ASA firms, and then allocate the Large AS companies into each decile. As shown, the majority of our Large AS sample firms fall in the 4^{th} decile and, interestingly, the figure implies that our Large AS firms are of about the same revenue-size as the median ultimate ASA company. Furthermore, the figure shows that Large AS firms are of similar size as the median ASA also when counting the number of employees (Panel C). Only when when we sort on book value of total assets is our sample of Large AS firms small relative to the median ASA (Panel B).

Table 2 shows summary statistics for the ASA firms split into listed (Panel A) and nonlisted (Panel B). As shown in column (2), the share of female directors increased substantially over the sample period as the quota law was implemented. Both listed and unlisted ASA firms saw an increase from 2-3% in 1998 to 40+% in 2011. Both groups of firms also saw an increase in the proportion of female board chairs, from around 1% to about 10% in 2011. Notice also, in column (4), the substantial increase in the percentage female CEOs of unlisted ASA from 1% to 11% in 2011, while the percentage female CEOs are virtually unchanged over the sample period for listed ASA companies. Table 2 also shows that the typical listed ASA has greater revenue and assets than the typical unlisted ASA, with a particularly small median unlisted ASA size.[9] We return to this difference below when we discuss the incentives for nonlisted ASA firms to convert back to AS. Table 3 reports the same summary statistics as in Table 2 but for our sample of Large AS—all of which are unlisted. While there is some increase in the percentage female directors, female chair,

[9]All accounting values are first converted to USD using the annual average exchange rate with NOK from the Norwegian Central Bank, and then converted to 2011 USD using the annual average consumer price index from Statistics Norway.

and female CEOs, the increase is much smaller than for ASA companies, which were subject to the gender quota.

Finally, Table 4 shows the allocation of ASA and Very Large AS firms across major sectors of the Norwegian economy.[10] The sectors with the greatest overall representation in our sample are wholesale/retail (36% of the firm years), construction (22%) and other services (15%). Listed ASA tend to dominate in shipping, telecom and manufacturing, while unlisted ASA firms are dominant in finance and other services. Large AS firms are most prevalent in wholesale/retail and in construction, which are also the largest sectors of the sample of Very Large AS firms.

3.2 The absolute change in female directors was modest

Ahern and Dittmar (2012) argue that the large negative market impact that they estimate is in proportion to the "massive reorganization of corporate boards imposed by the quota" (p 32). Indeed, as a *percentage* of board size, the impact of the quota looks substantial. When the quota of 40% was mandated with sanctions in December 2005, the average share of female directors on regulated firms was only 16%. As shown in Panel A of Figure 2, the quota brought an increase in female representation of on average a whopping 24%.

However, a much less dramatic image emerges when we look at the change in the absolute number of female directors. The average firm achieved compliance with the quota by adding just one female director, as shown in Panel B of Figure 2. That is, when the law was mandated the average firm had one female director and, after compliance with the quota, the average firm had two female directors. Average board size remains unchanged at five directors from 1998 to 2011, and overall compliance was therefore achieved by exchanging one male director with a female. This swap of one director for another represents a decidedly modest change to the average firm's board composition.

[10] The sample period covers two reforms of the industry classification system: Standard industrial classification 1994 (SIC1994) was in effect from from 1994-01-01 to 2001-12-31, SIC2002 was in effect from 2002-01-01 to 2008-12-31, and SIC2007 was in effect from 2009-01-01. Each classification consists of a 5-digit sector code. We use SIC2002 up to 2008, and SIC2007 from 2009. The two classification standards link 5-digit sector codes. Sector groups are constructed to be consistent across both SIC2002 and SIC2007.

3.3 Measuring director power using network centrality

Director networks contain information about director reputation and power that can be summarized using characteristics of the network alone. Four common measures of network centrality are *Degree*, *Eigenvector*, *Closeness*, and *Betweeness* (Wasserman and Faust, 1994). All four are described in detail in the Appendix. Degree centrality counts the number of network connections for each director, while eigenvector centrality also takes into account the importance of the connections in terms of the eigenvalue size. PageRank centrality, which we use below, is a slight modification of eigenvector centrality to networks that contain disconnected subgroups.[11]

Each year, we construct the network of all directors and CEOs on our sample firms (ASA and Large AS). Given the large number of firms, the resulting annual networks are also large. For example, in 2011 the total network consists of 37,248 unique individuals that hold the 53,169 directorships and CEO positions in our sample firms. From these annual networks of individuals, we then compute an annually updated network centrality score for each individual (PageRank). Each year we divide each individual's centrality score by the maximum score that year to create a number from zero to one—where a greater value implies greater power.

Table 5 reports descriptive statistics on this power measure at the firm level: each year and for each firm we find the average powerfulness across all directors on the board, and across male and female directors separately. Not surprisingly, average female director power is below male director power in each year. However, female power is increasing throughout the sample period, approaching that of male power. In 1998, average male power was 61% higher than average female power on ASA boards, while by 2011, average male power was only 4% higher than mean female power on ASA boards. On AS boards, the gap between mean female and male power is smaller initially compared to ASA boards. In 1998, average male power was 30% higher than mean female power on AS boards. By 2011, average male power was 13% higher than average female power on AS boards.

[11] Closeness and betweenness assume that the relevant connections in a graph are only the shortest paths between pairs of directors. Closeness is the sum of the lengths of these shortest paths, from one director to each of all the other directors in the network. Betweenness counts the number of the shortest paths, between all other pairs of directors, that a director is on. Of these four common centrality measures, eigenvector centrality best captures the power that an individual director wields in a network constructed from interlocking directorships. Moreover, to ensure a centrality measure per director in the case of disconnected sub-groups of firms, we therefore apply the PageRank algoritm to calculate each director's network centrality.[12]

Table 6 compares female and male power each year, separately for ASA and AS, on boards where there is at least one representative for each gender. In 1988, average female power was strictly greater than male power for 17.0% of the ASA firms with both male and female directors. By 2011, this ratio had increased to 40.1% . Interestingly, this rise in female power is associated with a significant increase in the percentage of firms with with at least one female director that holds five or more directorships ("golden skirt"), which rises from 0.8% in 1998 to 23.7% in 2011. This rise of female power coincides with a reduction of the percentage "golden shirt" male directors from 59% in 1998 to 35% in 2011. For AS firms, however, female power is generally low, and increases only slightly throughout the sample period.

4 Did the gender quota reduce firm value?

To identify a causal relationship between the quota and firm value, in this section we perform two different but complementary approaches. The first is an "event study" where we isolate the stock price effect of quota-related news announcements. This approach provides a relatively precise estimate of the price impact (if any) of the unanticipated portion of quota news. The second approach, less precise but also popular in the extant literature, regresses Tobin's Q on prequota female board representation (an instrument for the number of new female directors the quota forces the firm to hire), ownership structure, and our measure of director network power.

Recall first the time-line for the adoption of the quota law. The law, which requires Norwegian ASA firms (both listed and unlisted) to have at least 40% women among their shareholder-elected directors, became effective in January 2006. A first version of the law was adopted in November of 2003. However, this first version did not penalize non-compliance and, probably as a result, voluntary compliance did not occur: the fraction female directors barely budged from seven percent in 2002 to fifteen percent in early 2005—far below the 40% target. The non-compliance triggered the final quota law with its provision for forced liquidation, passed in December of 2005. By April 2008 all Norwegian ASA firms had complied.

4.1 Price reaction to quota law news events

In this section, we estimate abnormal stock returns on key announcement dates over the quota's legislative period. As the quota covers Norwegian-domiciled ASA firms only, we use foreign firms listed on Oslo Stock Exchange (OSE) as our control group. We test whether the announcement-returns differs from zero and whether they differ between domestic and foreign listed companies. We begin by forming two equal-weighted portfolios consisting of domestic and foreign OSE-listed companies, respectively. We then estimate seven conditional daily abnormal stock return parameters $AR_k,\ k = 1, ..., 7$ simultaneously using the following return generating process:

$$r_t^e = \alpha + \sum_{k=1}^{7} AR_k d_{k,t} + \beta_1 W_{t+1}^e + \beta_2 W_t^e + \beta_3 W_{t-1}^e + \varepsilon_t, \tag{1}$$

where r_t^e is the daily portfolio excess return. This excess return is computed as the difference in log closing prices minus the one-day Norwegian interbank offered rate (NIBOR).[13] W^e is the excess return on the Morgan Stanley Composite world stock market index (MSCI) onverted to NOK using the daily NOK/USD exchange rate. The regression model includes lead $(t+1)$ and lagged $(t-1)$ values of the market index in order to account for potential serial correlation arising from non-synchronous trading (Scholes and Williams, 1977).

Table 7 lists ten dates during the years from the proposal to the passage and ultimate compliance of the Norway's gender quota law. We use seven of these dates as our event days, and estimate the parameters AR_k over the 3-day window (-1,0,1) for each event.[14] The variable $d_{k,t}$ in Eq. (1) is therefore a dummy variable which takes on a value of one on each trading day in the k^{th} 3-day event window and zero otherwise. As a result, the event parameter AR_k is the average daily abnormal return over the three-day window, and $3AR_k$ is the three-day cumulative abnormal return over event window k. The regression period starts 1-Oct-1998—one year before the first date in Table 7—and it ends on the trading day just after the last date in the table (13-Dec-2009). To be included in the portfolio for event window k, a firm must have return observations on all days in window k and also have at least 100 return observations in the year preceding the event window (from day -6 to -255).

[13] If a closing price is missing, we use the average of the bid-ask spread. All prices are adjusted for split/revers split and dividends.

[14] The seven event dates excludes Spring of 2003, January 1 2006, and January 1 2008 shown in Table 7.

What is the most important event date in table 7? Ahern and Dittmar (2012) focus on February 22, 2002 in their event study analysis. However, December 9, 2005 is clearly more potent in terms of identifying adverse market reaction to the quota law. The reason is as follows: on February 22, 2002, the Minister of Trade and Industry declares in an interview with a national newspaper that he is "tired" of male directors dominating boards and that he supports a board gender quota. However, as was widely understood at the time, his commitment to imposing a quota law remained weak. He in fact confirmed this himself the following day (February 23, 2002) when he reverses his February 22 statement in an interview in the daily national financial newspaper *Dagens Næringsliv* (the most widely read daily financial newspaper in Norway).

Now consider the December 9, 2005, event date. Prior to this date, in December of 2005, only 15% of ASA directors were female on average. This despite the Norwegian government's attempts for years to get ASA firms to voluntarily adopt gender-balanced boards. The government, obviously frustrated by this outcome, now for the first time decides to mandate sanctions to the quota, which is announced on December 9. Even more important, the severe penalty for non-compliance—forced liquidation—came as a major surprise without prior notification. In fact, public statements by the Prime Minister only a few days earlier had suggested that the sanctions would consist of reasonable monetary fines only. For the first time, on December 9, 2005, it becomes clear to the market that all firms would have to comply—or get liquidated.

Table 8 shows the estimation results for regression model (1). Column (1) - (3) uses the contemporaneous world market index only as a risk control, while columns (4) - (6) uses the full model with the lead and lagged market index. Abnormal stock returns are statistically indistinguishable from zero in almost all event windows, and in particular for the key event date of December 9, 2005. There is no evidence that the market reacted to the surprise news that the quota law would include a liquidation penalty.

Table 9 show that this conclusion is robust to expanding the risk model in Eq. (1) with additional risk factors, as follows:

$$r_t^e = \alpha + \sum_{k=1}^{7} AR_k d_{k,t} + \beta_1 W_{t+1}^e + \beta_2 W_t^e + \beta_3 W_{t-1}^e + \beta_4 HML_t + \beta_5 SMB_t + \beta_6 MOM_t + \varepsilon_t, \quad (2)$$

where HML and SMB are the two Fama-French factors (Fama and French, 1992) and MOM is the

Carhart momentum factor Carhart (1997). Each of these additional risk factors are calculated using the universe of OSE stocks only, and they are available from the web-page of Bernt A. Odegaard at the University of Stavanger.

As Table 8 and 9 also show, the market reaction on event date February 22, 2002—the singular focus of Ahern and Dittmar (2012)—is negative and significant. However, notice that on this date, the portfolio of foreign companies listed on the OSE also experience a significant price decline of a similar magnitude. Moreover, as shown by the long-short portfolio (long in ASA firms and short in foreign firms listed on the OSE), both Table 8 and Table 9 show that the difference between the abnormal return to the two types of firms is indistinguishable from zero. Since foreign firms are not subject to the quota law, the negative abnormal returns to both Norwegian ASA and foreign listed companies likely reflect some other news affecting these two groups of companies firms equally and should not be confused with an effect of the gender quota.

Ahern and Dittmar (2012) report negative and significant abnormal stock returns of -2.57% for their total sample of Norwegian ASA over the five-day window [-2,+2] relative to February 22, 2002. This five-day estimate compares to our statistically significant three-day abnormal return of 3x(-0,7)=-2.1% in column (1) of Table 8. However, they do not also estimate the contemporaneous abnormal returns to foreign companies listed on the OSE, which is likely why they associate this abnormal return with the quota law.

Given our larger sample, we also replicate their event study methodology in Table 10.[15] They define abnormal return to OSE-listed companies as the total return minus the return to a sample of US-listed companies operating in a similar industry as the Norwegian listed firms. Industry classifications are from the Global Industry Classification Standard (GICS), and they use US market data from CRSP and Norwegian market data from Compustat Global. In terms of our Eq. (1), their approach is to use the US industry portfolio return as a single risk factor with a beta of one.

Panel A of Table 10 simply reproduces their findings, including the last column which shows the significant difference in abnormal returns to firms with zero female directors and firms with some female directors prior to the quota law (in 2002). Panel B shows that this significance is tenuous: it is driven by three sample firms with estimated abnormal stock returns greater than

[15]We thank Kenneth Ahern for supplying us with the names of the firms used in the Ahern and Dittmar (2012) sample.

20%. Moreover, Panel C shows that when we reduce their event window from five to the more common three days (-1,+1), the significance of the difference disappears even for the full sample. Overall, these results provide little if any support for the proposition that the quota law affected firms with no female directors differently than firms with sone females, also when we use the basic Ahern and Dittmar (2012) event study methodology.

Finally, Table 11 further supports our conclusion from Table 8 that the quota law had statistically zero valuation effects for OSE-listed companies. The table reports parameter estimates in cross-sectional regressions with the individual firm's abnormal return parameter estimate AR as dependent variable. The first seven columns correspond to each of the seven event windows, while in column (8) the dependent variable is the abnormal return summed over all seven events.

On the right-hand side we include three explanatory variables. *Shortfall female director* is the number of additional female directors the firm must hire to comply with the quota law. It is computed as Max(0,quota - share female directors at end of most recent fiscal year), where quota is the share of women required by the law (in 1998 quota = 25%, else 40%). *Board size* is the total number of shareholder representatives on the board at the end of the most recent fiscal year relative to each announcement date. *Ownership concentration* is the share owned by the largest shareholder at the end of the most recent fiscal year relative to each announcement date (ownership data are from 2001, and ownership concentration variable in columns (1) and (2) are valued in 2001). In column (8), the explanatory variables are from 2002.

In Table 11, the slope coefficient for *Shortfall female director* is statistically insignificant across all eight event windows. This strongly rejects the hypothesis that the short-fall of female directors prior to the quota law affects firm value.[16] Our conclusion contrasts in particular with that of Ahern and Dittmar (2012), who conclude that the quota law reduced firm value based on their abnormal estimate around 22-Feb-2002 (and which is similar to our estimate in column (1) of Table 8. Again, whatever negative news reached the market on 22-Feb-2002, our analysis shows that the same news affected equally foreign firms listed on the OSE and who are not subject to the quota law.

[16]This conclusion is unchanged after replacing *Shortfall female director* with a dummy variable taking on a value of one if the firm does not have a female directors at the time of the announcement.

4.2 The quota legislation and Tobin's Q

The event study presented in the previous section provides the most powerful test for immediate valuation effects of the quota law. In this section, we follow Ahern and Dittmar (2012) and ask whether the year-2002 variation in female board representation is related to subsequent changes in Tobin's Q. While the scope for the quota law to affect firm value is limited in time to the end of 2005 (when the liquidation penalty was introduced), we follow the example of Ahern and Dittmar (2012) and also project the shortfall in female directors until year 2009, as shown in Table 12.

Panel A of Table 12 shows the results of the second-stage in a two-stage IV estimation, and where the first stage is in Panel C. The second-stage regression in Panel A is:

$$Q_{i,t} = \alpha + \beta \text{Percent female directors}_{i,t} + \theta_i + \tau_t + \epsilon_{i,t}, \tag{3}$$

where i indexes firms and t indexes time, $Q_{i,t}$ is Tobin's Q, and θ_i and τ_t are firm and year fixed effects, respectively. The first stage regression in Panel C involves regressing the year-2002 percent female directors on year dummies, interactions of year dummies and the 2002 percent female directors, and firm fixed effects. Then this regression is used to instrument the percent female directors in the second step.

The inclusion of firm fixed effects makes this equivalent to a "diff-in-diff" analysis where the reported coefficients involving the 2002 percent female directors represent the *change* in the percent female directors from 2002 required to comply with the quota. Firms had until the end of 2007 to comply and, as the year-dummy coefficient in the last column in Panel B shows, the average percent female directors in year 2007 had grown to 36% (a few firms waited until 2008 to fulfil the 40% quota).[17]

The key result in Table 12 is the statistically insignificant slope coefficient in Panel A for year 2005. This coefficient reflects the correlation between the percent shortfall female directors and Tobin's Q for the years 2003-2005. Recall that this is the period where implementation of the quota law was uncertain. Thus, this is also the *only* period where, in a rational market, the quota law could affect firm values. The statistically insignificant slope coefficient for 2005 in Panel A therefore

[17] The law requires gender equality and with, say, a six-member board, 40% is 2.4 persons. The 38% female directors in 2008 (after all firms had complied) reflects the non-divisibility (integer) problem.

unambiguously rejects the hypothesis that the quota law affected firm values (through Tobin's Q).

Our Table 12 differs from that of Ahern and Dittmar (2012) Table IV in that we show how the slope coefficient in the first stage (Panel A) evolves as we extend the time horizon year by year from 2005 through 2009. We do this because Ahern and Dittmar (2012) report one single time horizon only, through 2009. As shown in our table as well, for the 2009 time horizon, the slope coefficient is negative and significant. While the sample sizes are identical (603 firm years), our coefficient estimate is -1.4, while theirs is -1.9. This difference is driven by the fact that we adjust Tobin's Q with the industry median among Norwegian companies, while Ahern and Dittmar (2012) uses the median of US industries.

Ahern and Dittmar (2012) interpret their significant slope coefficient estimate as evidence that "the negative impact of the quota on firm value persists over time", and further that "The instrumental variables estimates suggest that the forced addition of new female directors on boards led to value losses of upwards of 20% for the firms with large constraints". Moreover, "The persistence in the value loss suggests that declines in firm value are not simply temporary overreactions by the stock market. Instead, the imposition of the quota appears to have affected the fundamentals of Norwegian firms" (p 31).[18]

However, our multiple horizon estimates for the slope coefficient shows that their interpretation is essentially wrong. As discussed above, the slope coefficient for 2005—where the law arguably might have had an effect—is insignificant. Moreover, our table shows that the significance of the 2009 slope is driven by the years 2008 and 2009 (where the two stars indicate 5% level of significance). However, this effect almost certainly reflect the negative impact of the financial crisis on firm values—it cannot come from the quota law. In fact, while not shown here, a simple time series plot of the market values of the sample firms shows a steady increase in market values of listed ASA firms until 2008, after which market values drop significantly.

Finally, there is one additional piece of evidence in Ahern and Dittmar (2012) that warrants a comment here. The reduced-form estimates in Panel B of their Table IV show that the fraction

[18]They justify the large negative effect of the law as follows: "We recognize that these magnitudes may appear large and are therefore conservative in our interpretation. However, it should not be forgotten how substantial is the change in board composition. These firms are undergoing a massive reorganization of their shareholder representatives, where over 30% of the members of their board of directors are changing, on average" (p 32). As we demonstrated in Section 3 above, the change required by the quota law may seem "massive" in percentage term, but in fact only exchanges one male for one female director.

of female directors in 2002 had a positive effect on the market-to-book value in 2006 for firms in Sweden, Denmark and Finland—*before* there were any effect on Norwegian ASA firms. Ahern and Dittmar (2012) interprets this as suggesting that "firms in Scandinavia may have responded to the Norwegian quota in anticipation of a similar quota in their own country" (p 31). A much more plausible explanation is, of course, that the reduced form regression captures something other than the Norwegian quota law. More importantly, the significant effect of the instrument on firms in the other Scandinavian countries, which were included to form a "placebo" sample for the treated Norwegian firms, casts serious doubts on the validity of the instrument itself.

5 Conversions from ASA to AS

Recall that only ASA firms are subject to the quota law. Moreover, with its stricter corporate governance and reporting requirements, the legal form ASA imposes higher costs on the firm than the AS legal form. One would therefore expect some firms to switch from ASA to AS, depending on the evolution of these costs as well as the cost of the gender quota law.

Nygaard (2011) and Bøhren and Staubo (2013b) find that the number of Norwegian ASA has dropped steadily since it peaked in 2001. This decline has several reasons, including financial firms leaving the ASA legal form. By law, financial firms were required to be ASA until this requirement was relaxed in 2007. Moreover, some ASA disappear to to bankruptcy and after becoming a target of an acquisition. he remaining decline is due to ASA firms switching to the AS legal form. Importantly, most of these conversions are by nonlisted ASA firms—not listed ASA firms—witching legal form. Bøhren and Staubo (2013b) find that firms switching from ASA to AS are relatively small, young and profitable, with concentrated ownership and few, if any, women on the board. That is, for non-listed ASA, there is an association between the share of female directors and conversion to AS. Bøhren and Staubo (2013b) propose that these firms took action and switched legal form in order to avoid a value-reducing change of their boards forced by the quota.

With its stricter corporate governance and reporting requirements, the legal form ASA imposes higher costs on the firm than the legal form AS does. Given the higher corporate governance standards and costs associated with being an ASA—and independent of the quota law—non-listed companies should generally prefer the AS to the ASA legal form. An interesting question is why any (non-financial) firm selects the ASA legal form without a public listing. One potential explanation is the introduction of IFRS in 2005. The additional reporting imposed by IFRS on ASA firms may have induced non-listed ASAs to convert to AS. Another possible explanation for the peak in the number of non-listed ASA in 2000/2001 is that many firms converted to ASA during the second half of the 1990s in preparation for an initial public offering (IPO). However, after the burst of the internet bubble, these firms may have decided to stay private and subsequently converted back to AS.[19] Thus, one interpretation of the findings of Bøhren and Staubo (2013b) is that small, young, and profitable firms may have shied away from IFRS and done fine without external capital from the public equity markets.

Table 13 reports the number of firms in our sample that each year converted from ASA to AS from 2000 to 2009. A converting firm is a firms that is registered as ASA in the current year and then registered as AS the following year, and must therefore be in our sample in both years. The table excludes firms in the financial sector (until 2007, financial firms were required to be ASA). Moreover, firms that drop out due to bankruptcy or being acquired are eliminated. In Table 13, a total of 27 listed ASA firms convert to AS from 2000 to 2009, an average of three firms per year. Moreover, 68 non-listed ASA convert to AS, an average of seven firms per year. Thus. the conversion rate is of an oprder of magnitude higher for non-listed ASA than for listed ASA firms.

Table **??** shows probits estimates of the determinants of the conversion decision for our sample. The estimation uses a non-converting comparison group created by matching each converting firm observation to the five closest non-converting ASA firms in our sample in the current year. Matching is performed using propensity scores based on four firm characteristics: revenue, book value of total assets, sector and listing status. All explanatory variables are valued in the current year. The model in column (1) has only a single explanatory variable—the share of female directors—which is insignificant. Thus, there is no association between the share of female directors and the decision to convert from ASA to AS, across all converting ASA. The model in column (2) shows that there is also no relationship with the share of female directors when we control for the listing status of the ASA firm.

However, as shown in models (3) and (4), our measures of director network power significantly

[19] In the US, the average annual number of IPOs was four times higher in the 1990s compared to the 2000s (440 vs. 100 IPOs per year). See Jay Ritter's webpage `http://bear.warrington.ufl.edu/ritter/ipodata.htm`.

affects the conversion decision. Firms with more powerful boards are more likely to convert. Interestingly, boards with more powerful female directors are also more likely to convert. This effect of board power on conversion is robust to the inclusion of several firm level control variables and sector and year fixed effects.

The results in Table **??** adds to the conversion decision evidence in Bøhren and Staubo (2013b) who also use the 2000-2009 sample period. They find that the percentage female directors also affect the conversion decision, which we do not. They use a wider definition of a converting firm in that they include subsidiaries and conversion activity due to the types of mergers and acquisitions excluded here, whic yields a total of 217 converting firms (compared to the 95 converting firms that we identify). Moreover, they use a panel estimation in which the dependent variable equals 1 if the firm converted as some point from 2000 to 2009, else zero. In contrast, our estimation in Table Bøhren and Staubo (2013b) a firm that converts enters only once once in our estimation, and we compare this firm to matched non-converting firms. It is unclear to what extent these differences in estimation methodology are responsible for the difference in inference concerning the role of female directors in the conversion decision.

6 Conclusion

The world watched closely as Norway in January 2006 pioneered a gender quota law for boards. Under the threat of forced liquidation, the law mandates that each gender must each occupy at least 40% of the board seats in all domestic public limited liability companies. Several nations and the EU itself soon followed suit, perhaps reflecting a common social political agenda. There is little doubt that the quota law has empowered women—we provide unambiguous evidence of a rising female director network in Norway. However, the question of whether this rise is also accompanied by greater firm values has proven more controversial. This paper provides the most comprehensive empirical analysis of this issue to date, and we conclude that the Norwegian quota law most likely had a neutral effect on the market values of firms listed on the Oslo Stock Exchange.

Our conclusion reverses the widely quoted study of Ahern and Dittmar (2012), which concludes that the Norwegian quota law had substantial negative valuation effects on Norwegian listed firms—a loss of market value of upwards of 20% for firms with no female directors prior to the quota law was introduced. A negative valuation effect is expected if the pre-quota low percentage of female directors reflects limited supply of qualified female directors, forcing some firms to hire female directors of relatively low quality. Thus, the results in Ahern and Dittmar (2012) supports the notion that the pervasive pre-quota male domination of boards were driven by economic efficiency rather than by an "old-boys" network blocking qualified females from becoming directors.

However, as we discuss above, the very notion that this law should have severe negative valuation effects strains credulity. Passage of the law led the typical five-member board to replace a single independent male director with a female (firms did not actually expand board size). Moreover, equity ownership in Norway was (and still is) highly concentrated, with the largest shareholder owning about 30% of the voting shares on average—suggesting that boards face substantial shareholder monitoring. For this single male-female director exchange to result in large negative valuation effect, the incoming female director must have exercised outsize influence on the board and large shareholder—and in a value-reducing direction to boot. All this in a country long known for its tradition of gender equality (so the quota law was less surprising to male directors) and that is ranked by the United Nations as one of the least corrupt societies in the world (so individual directors ted to independent minded).

We show that the conclusions of Ahern and Dittmar (2012) is driven by a combination of a restrictive sample selection and estimation methodology. While we use foreign companies listed on the Oslo Stock Exchange as a control sample (as these firms are not subject to the Norwegian law), Ahern and Dittmar (2012) use foreign firms listed in the US and on other Scandinavian stock exchanges to measure a "placebo" effect of the quota law. While we show that the difference in valuation effects of the law between Norwegian and foreign firms on the OSE is statistically insignificant, Ahern and Dittmar (2012) find that Norwegian firms with zero prior female directors suffer relative to their control firms. However, the latter evidence is largely driven by the change in Tobin's Q in year 2008—two years after the passage of the law and when the financial crisis hit all western countries. Thus, we conclude from much the same basic empirical approach as that of Ahern and Dittmar (2012) that the law did not materially affect firm values.

All studies of board structure and performance are plagued by endogeneity issues. We no more than Ahern and Dittmar (2012) claim to have fully resolved these with the instrumental variable and diff-in-diff approach. However, our evidence of insignificant short- and long-term valuation effects is consistent with a growing extant literature studying the effects of gender quota laws more generally, and in which female directors are shown to be relatively consistent monitors of top management. Moreover, female directors appears in many studies to be both better educated and more willing to “rock the boat” relative to their male counterparts. If so, the rise of female director networks may well have a positive long-run effect on firm value.

Interestingly, Bertrand, Black, Jensen, and Lleras-Muney (2014) observe that while female board members have substantially higher education and income after the gender quota than their female predecessors, they find no corresponding change in the qualifications of male directors. Moreover, the gender pay gap in earnings within boards drops significantly after the quota, indicating that the reform may have had a positive impact on the overall quality of the board. whether this rise in board quality is also associated with higher firm value remains, however, to be seen.

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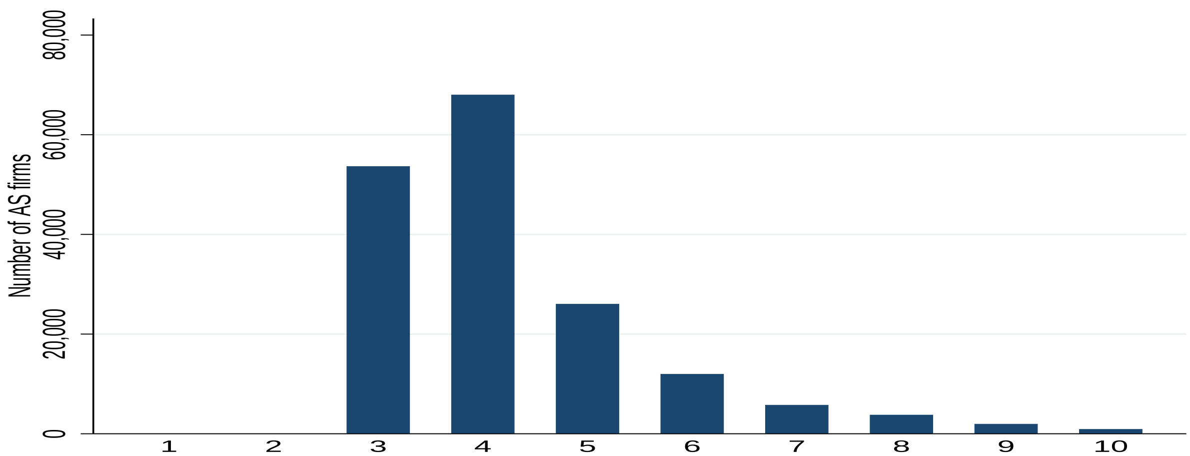
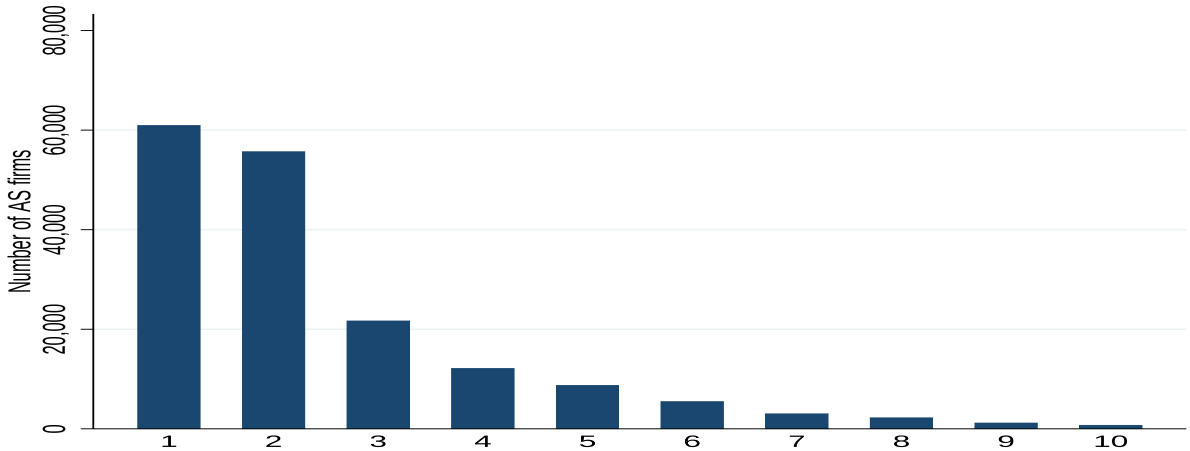
Figure 1
Size frequency of Large AS firms with ASA decile breakpoints

The horizontal axis consists of size deciles where the breakpoints are defined using the sample of ASA ultimate firms (decile 1 is lowest value). The sample of Large AS firms are then allocated into their respective size decile. In Panel A, size is defined using total revenue, in Panel B it is total assets, and in Panel B number of employees, respectively.

Panel A: Revenue



Panel B: Assets



Panel C: Number of employees

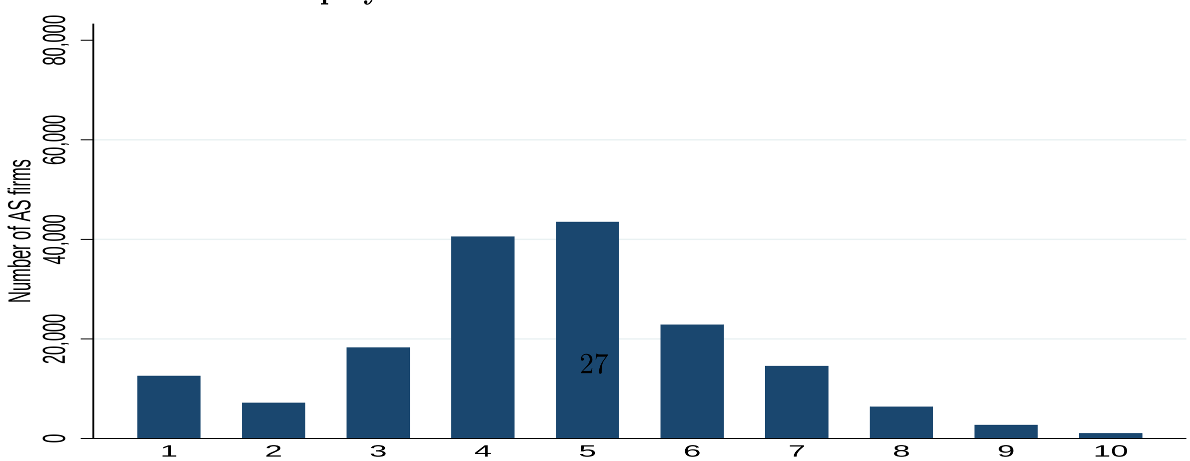


Figure 2
Female directors, all ASA, 1998-2011

Panel A shows the average percentage share of female directors, across all ASA. Panel B plots the average board size and the average number of female directors, across all ASA. Only directors represenating shareholders included.

Panel A: Share female directors

Panel B: Number of female directors

Table 1
Sample of Norwegian-domiciled ASA and AS companies, 1998-2011

The firm population and accounting data is from the Accounting Database at the Norwegian School of Economics. The ASA legal form is necessary for the firm to be publicly traded—but not all ASA firms are listed on a stock exchange. If a firm reports both company and consolidated accounts, we use the consolidated accounts. *Ultimate firms* are stand-alone or consolidated Norwegian-domiciled companies (excluding subsidiaries). The sample data checks require non-missing accounting information on: Sales, Assets, Long-term Assets, Current Assets, Book Equity, Long-Term Debt, Current Debt, and the Number of Employees. Moreover, it is required that Assets $\geq$ working Capital.

Sample year	Total population (no filter) (1)	Population of ultimate firms (2)	Ultimate firms without missing revenue data (3)	Ultimate firms after all data checks (4)	Large AS (top 10^{th} revenue percentile) (5)
A: Public limited liability companies (ASA)					
1998	442	394	391	391	
1999	510	443	431	430	
2000	575	478	477	475	
2001	594	475	467	465	
2002	559	451	440	439	
2003	682	529	407	406	
2004	665	491	386	386	
2005	461	349	348	347	
2006	480	370	357	355	
2007	467	377	375	374	
2008	401	340	334	334	
2009	348	295	285	284	
2010	331	273	273	272	
2011	299	258	258	257	
Mean	487	395	374	373	
B: Private limited liability companies (AS)					
1998	127021	107377	105893	104361	10437
1999	137753	115513	108830	106883	10689
2000	136132	111401	111215	109320	10933
2001	138834	112027	111661	110020	11002
2002	140467	113581	112840	111304	11132
2003	216649	175167	114881	113380	11338
2004	214073	168582	115920	114679	11469
2005	151887	108464	108367	107190	10719
2006	174734	133637	133637	132421	13246
2007	191453	139562	139562	138173	13820
2008	198125	145306	145305	143756	14376
2009	199898	143146	143146	141548	14156
2010	201633	142657	142657	141121	14114
2011	209140	147988	147988	146077	14608
Mean	174129	133172	124422	122874	12289

Table 2
Director and accounting statistics for sample of listed and unlisted ASA firms

This table splits the total sample of ultimate ASA firms into listed (Panel A) and unlisted (Panel B) companies. *Female Dir.* is the average percentage of female directors elected by shareholders; *Female Chair* is the average percentage of firms with a female board chairman; . *Female CEO* is the average percentage of firms with a female CEO. *Empl.* is the total (consolidated) number of employees. Revenue (*Rev.*) and *Assets* are in million 2011 USD. All accounting values are first converted to USD using the annual average exchange rate with NOK from the Norwegian Central Bank, and then converted to 2011 USD using the annual average consumer price index from Statistics Norway.

Sample		Female	Female	Female	Mean			Median		
year	*N*	Dir.	Chair	CEO	Rev.	Assets	Empl.	Rev.	Assets	Empl.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
A: ASA companies listed on the Oslo Stock Exchange										
1998	170	3.46	1.86	3.11	560	1029	643	92	141	130
1999	170	3.60	1.23	1.85	532	1354	687	80	152	112
2000	174	4.59	1.23	1.84	472	1237	677	58	122	116
2001	164	4.97	0.65	3.87	683	1427	799	70	134	133
2002	155	6.50	1.36	3.40	795	1676	711	79	115	141
2003	143	9.87	2.22	2.22	896	2097	755	69	113	89
2004	149	14.28	2.01	2.01	1075	2181	679	75	122	89
2005	166	21.96	1.81	1.20	1142	1531	568	68	160	102
2006	161	28.87	1.86	2.48	1367	3200	649	75	205	96
2007	192	39.99	2.62	2.08	1269	3440	514	83	249	77
2008	185	42.25	3.24	2.70	1439	2377	559	154	364	89
2009	163	42.36	3.70	3.68	1216	2153	603	133	268	77
2010	162	42.44	6.17	3.09	1387	4332	632	139	287	95
2011	157	42.98	9.55	3.82	1800	5154	703	148	294	90
B: ASA companies not publicly traded										
1998	221	1.99	0.48	1.43	82	315	119	5	9	11
1999	260	2.54	1.23	2.06	55	95	82	4	8	10
2000	301	3.01	0.35	2.49	58	123	100	3	7	9
2001	301	3.89	1.06	6.03	71	126	108	3	7	12
2002	284	4.48	1.50	3.80	121	639	158	4	8	13
2003	263	4.62	2.47	5.42	97	451	164	5	9	12
2004	237	5.91	2.53	3.00	111	949	196	6	13	11
2005	181	10.49	2.22	3.35	125	1498	255	6	13	9
2006	194	19.49	4.17	4.74	99	1733	224	4	14	8
2007	182	32.90	7.69	5.56	121	2224	234	4	21	9
2008	149	39.77	8.78	7.64	172	3508	165	5	37	8
2009	121	39.80	10.00	11.21	189	3996	359	9	42	10
2010	110	40.10	10.91	10.28	258	4287	361	9	42	10
2011	100	41.48	10.00	11.34	299	4226	346	11	44	11

Table 3
Director and accounting statistics for sample of Large AS firms (all unlisted)

Panel A of this table uses the total sample of Large AS firms, while Panel B presents the summary statistics for the subsample of 373 AS firms with the largest revenue (as shown in Panel A of Table 1, 373 is the average annual number of ASA firms in our sample). *Female Dir.* is the average percentage of female directors elected by shareholders; *Female Chair* is the average percentage of firms with a female board chairman; . *Female CEO* is the average percentage of firms with a female CEO. *Empl.* is the total (consolidated) number of employees. Revenue (*Rev.*) and *Assets* are in million 2011 USD. All accounting values are first converted to USD using the annual average exchange rate with NOK from the Norwegian Central Bank, and then converted to 2011 USD using the annual average consumer price index from Statistics Norway.

Sample		Female	Female	Female	Mean			Median		
year	N	Dir.	Chair	CEO	Rev.	Assets	Empl.	Rev.	Assets	Empl.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1998	10437	9.30	4.72	4.87	25	24	53	6	3	19
1999	10689	9.47	4.71	5.00	22	25	50	5	2	17
2000	10933	9.51	4.80	5.51	19	21	48	4	2	17
2001	11002	9.98	5.06	5.76	16	19	45	4	2	16
2002	11132	10.29	5.35	6.04	19	25	47	5	2	16
2003	11338	10.61	5.60	6.03	21	24	44	5	2	16
2004	11469	11.13	5.96	6.76	23	29	43	6	2	16
2005	10719	12.29	6.74	7.60	26	33	45	5	2	14
2006	13246	12.32	6.73	7.69	25	33	40	5	2	13
2007	13820	12.43	6.93	8.00	30	45	43	6	3	14
2008	14376	12.22	7.08	8.32	38	55	46	6	3	13
2009	14156	12.76	7.62	8.94	30	51	41	5	2	13
2010	14114	13.11	7.70	9.55	28	49	42	5	2	13
2011	14608	13.04	7.79	9.71	33	56	42	5	2	13

Table 4
Percent of sample firm-years represented by by major economic sectors in Norway

The table reports the share of firm-years in each sector group for the sample of listed and non-listed ASA firms in 2, and for Large and Very Large AS companies in Table 3. The sample period covers two reforms of the industry classification system: Standard industrial classification 1994 (SIC1994) was in effect from from 1994-01-01 to 2001-12-31, SIC2002 was in effect from 2002-01-01 to 2008-12-31, and SIC2007 was in effect from 2009-01-01. Each classification consists of a 5-digit sector code. We use SIC2002 up to 2008, and SIC2007 from 2009. The two classification standards link 5-digit sector codes. Sector groups are constructed to be consistent across both SIC2002 and SIC2007.

Economic	ASA firms		AS firms		All
sector	Listed ASA	Non-listed ASA	Large	Very Large	firm-years
Agriculture	2.69%	3.51%	2.84%	1.59%	2.85%
Offshore/Shipping	24.80	8.50	2.86	13.06	3.23
Transport	1.54	1.21	4.21	3.62	4.13
Manufacturing	15.89	9.97	10.39	16.06	10.46
Telecom/IT/Tech	19.11	14.46	3.03	3.62	3.41
Electricity	1.24	1.36	0.91	6.29	0.92
Construction	6.27	6.76	22.39	14.77	21.94
Wholesale/Retail	5.96	8.99	36.50	21.78	35.68
Finance	4.81	22.73	2.47	4.39	2.81
Other services	17.70	22.51	14.41	14.83	14.57
Sum	100%	100%	100%	100%	100%

Table 5
The rise of female director network power in Norway, 1998-2011

The table reports the annual mean and median director network power for the entire board and for male and female directors as well as for the CEO. Network power is calculated each year as follows: (1) A network centrality score (PageRank) is calculated for each director and CEO on all ASA and Large AS firms in the sample (see the Appendix for calculation of PageRank). (2) The centrality score is scaled by dividing by the maximum score that year to create a number between zero to one, where higher values indicate greater network power. (3) Compute the average network power score across all directors on the board of a given firm, as well as separately across the male and female directors.

	Board		Male director		Female director		CEO		No. of
Year	Mean	Median	Mean	Median	Mean	Median	Mean	Median	Firms
A: ASA firms									
1998	0.185	0.172	0.187	0.173	0.116	0.099	0.134	0.105	371
1999	0.173	0.158	0.174	0.159	0.116	0.096	0.126	0.102	406
2000	0.168	0.156	0.170	0.157	0.117	0.103	0.123	0.101	446
2001	0.189	0.173	0.191	0.176	0.145	0.120	0.146	0.120	438
2002	0.204	0.187	0.205	0.187	0.182	0.140	0.153	0.128	414
2003	0.200	0.190	0.202	0.191	0.185	0.164	0.153	0.125	379
2004	0.231	0.215	0.237	0.216	0.195	0.179	0.174	0.145	386
2005	0.209	0.195	0.216	0.197	0.186	0.149	0.163	0.136	347
2006	0.205	0.192	0.212	0.194	0.195	0.152	0.157	0.131	354
2007	0.231	0.210	0.239	0.218	0.222	0.183	0.173	0.133	374
2008	0.203	0.188	0.207	0.188	0.198	0.161	0.157	0.128	334
2009	0.235	0.222	0.243	0.228	0.221	0.184	0.178	0.144	283
2010	0.196	0.185	0.209	0.187	0.180	0.159	0.151	0.120	272
2011	0.220	0.211	0.225	0.203	0.216	0.187	0.159	0.130	257
All years	0.202	0.187	0.206	0.188	0.194	0.161	0.152	0.123	5061
B: Large AS firms									
1998	0.124	0.105	0.127	0.105	0.098	0.105	0.108	0.105	8350
1999	0.119	0.102	0.121	0.102	0.098	0.102	0.103	0.102	8395
2000	0.120	0.104	0.122	0.104	0.098	0.104	0.104	0.104	8545
2001	0.136	0.121	0.139	0.121	0.115	0.121	0.122	0.121	8515
2002	0.147	0.131	0.150	0.131	0.126	0.131	0.132	0.131	8576
2003	0.148	0.131	0.151	0.131	0.127	0.131	0.133	0.131	8731
2004	0.167	0.147	0.171	0.147	0.143	0.147	0.150	0.147	9488
2005	0.151	0.136	0.154	0.136	0.135	0.136	0.139	0.136	8883
2006	0.153	0.137	0.155	0.137	0.136	0.137	0.140	0.137	10851
2007	0.172	0.150	0.175	0.150	0.152	0.150	0.155	0.150	11484
2008	0.149	0.132	0.151	0.132	0.134	0.132	0.134	0.132	11887
2009	0.174	0.154	0.177	0.154	0.156	0.154	0.157	0.154	11635
2010	0.144	0.129	0.147	0.129	0.131	0.129	0.132	0.129	11547
2011	0.158	0.140	0.161	0.140	0.143	0.140	0.144	0.140	11904
All years	0.149	0.138	0.152	0.140	0.132	0.131	0.134	0.131	138791

Table 6
Male versus female director power in ASA and AS firms

The table lists the percentage of the sample where average female director power exceeds male power, and the percent of the firms with at least one golden director (defined as holding five board seats or more), classified by gender. Average female power includes only the firms that have both male and female directors.

	ASA			AS		
Year	Female power > Male power	Percentage of firms w. golden shirt	Percentage of firms w. golden skirt	Female power > Male power	Percentage of firms w. golden shirt	Percentage of firms w. golden skirt
1998	17.0%	59.3%	0.8%	4.6%	16.5%	0.1%
1999	15.7	56.2	0.2	5.0	14.0	0.3
2000	15.7	54.9	0.9	4.0	13.1	0.2
2001	23.8	48.3	0.9	5.1	10.4	0.3
2002	30.9	45.9	2.7	5.3	9.2	0.3
2003	30.1	46.7	3.7	6.3	9.5	0.4
2004	24.6	47.2	3.1	6.3	9.6	0.3
2005	27.3	44.7	7.5	7.1	8.2	0.6
2006	32.7	42.9	11.6	7.8	8.5	0.5
2007	34.8	40.4	23.3	9.7	11.3	0.9
2008	38.3	36.2	23.7	9.4	9.6	0.7
2009	35.7	38.9	23.0	9.8	8.8	0.7
2010	33.9	39.7	19.5	10.0	8.7	0.8
2011	40.1	35.0	23.7	9.1	8.9	0.8
All	32.5%	46.2%	9.1%	7.6%	10.3%	0.5%

Table 7
Key dates for the proposal, passage and compliance of Norway's gender quota law

<u>October 15, 1999</u>
First public hearing on mandated gender representation on corporate boards. The Ministry of Children, Family and Gender Equality initiates a review of the entire Gender Equality Act of 1978, including a proposal for a 25% gender quota for listed company boards.

<u>July 2, 2001</u>
Second public hearing on board gender quotas, now presented as a separate issue. The quota, which is to become part of corporate law instead of gender equality law, mandates a 40% representation of each gender on the boards of ASA firms.

<u>February 22, 2002</u>
In an interview in the daily newspaper VG, the Trade and Industry Minister declares that he is "tired of" male directors dominating boards and supports a board gender quota.

<u>March 8, 2002</u>
The Ministry of Trade and Industry announces that the government will continue the work towards a quota law proposal. The private sector is encouraged to voluntarily increase female board representation, and a substantial increase is said to eliminate the need for a mandatory quota.

<u>Spring of 2003</u>
Several programs are initiated to increase the number of female directors and to improve the skills of prospective board members. An online database of women interested in board memberships is established, containing about 3,500 women in April, 2003.

<u>June 13, 2003</u>
The Ministry of Children, Family and Gender Equality presents a law proposal for a 40% gender quota for shareholder-appointed directors on ASA boards.

<u>November 27, 2003</u>
The gender quota law is passed in Parliament with broad majority. Importantly, the law contains a clause that voids the law if ASAs successfully comply by July 1, 2005. The law contains no sanctions in case of non-compliance.

<u>December 9, 2005</u>
At this point, only 15% of ASA directors are female. The government for the first time mandates a quota. Moreover, the quota law for the first time contains a penalty for non-compliance: forced liquidation without prior notification. (A few days earlier, the Prime Minister made a public statement suggesting that the law would contain fines for non-compliance, if mandated (VG, December 1, 2005).)

<u>January 1, 2006</u>
The quota law holds that all new ASAs have to comply with the the law by this date. Pre-existing ASAs, however, are given two years to comply.

<u>January 1, 2008</u>
Mandatory compliance for all ASA by this date. The Norwegian Business Register sends a letter to the remaining 77 non-complying ASA, who comply by April, 2008.

Table 8
Abnormal stock returns to portfolios of domestic and foreign firms

The table reports average daily abnormal event-day stock return AR estimated for equal-weighted portfolios of domestic and foreign firms over seven 3-day event periods (-1,0,1). All firms are listed on the Oslo Stock Exchange. Each event date 0 is defined in Table 7) and occur during the years from the proposal to the passage and ultimate compliance of the Norway's gender quota law. The estimation period starts 1-Oct-1998 (one year before the first announcement date), and ends on the trading day just after the last announcement date (13-Dec-2005). The estimated three-day cumulative abnormal returns equals for window k is given by $3AR_k$, where each of the seven the event parameters AR_k, $k = 1, ..7$ are estimated simultaneously using the following market model:

$$r_t^e = \alpha + \sum_{k=1}^{7} AR_k d_{k,t} + \beta_1 W_{t+1}^e + \beta_2 W_t^e + \beta_3 W_{t-1}^e + \varepsilon_t$$

where (r_t^e is the daily portfolio excess return (difference in log closing prices minus the one-day Norwegian interbank offered rate (NIBOR0; if a closing price is missing, we use the average of the bid-ask spread; all prices are adjusted for split/revers split and dividends). To be included in the portfolio for event window k, a firm must have return observations on all days in window k and also have at least 100 return observations in the year preceding the event window (from day -6 to -255). W^e is the excess return on the MSCI world stock market index (converted to NOK using the daily NOK/USD exchange rate) entered with lead $(t+1)$ contemporaneous (t) and lagged $(t-1)$ values, respectively. $d_{k,t}$ is a dummy variable which takes on a value of one on each trading day in the k^{th} 3-day event window and zero otherwise. Robust standard errors (White estimator) are reported in parenthesis (stars indicate significance levels: *** 1%, ** 5%, *10%).

	Firms in portfolio return r_t^e					
Event day (0) and market exposures	Domestic on OSE (1)	Foreign on OSE (2)	Long Domestic Short Foreign (3)	Domestic on OSE (4)	Foreign on OSE (5)	Long Domestic Short Foreign (6)
A: Average daily portfolio abnormal returns (AR)						
15-Oct-1999	-0.008*	-0.007	-0.001	-0.006	-0.003	-0.003
	(0.005)	(0.006)	(0.002)	(0.006)	(0.008)	(0.002)
2-Jul-2001	0.001	0.002	-0.001	-0.001	-0.001	0.001
	(0.004)	(0.003)	(0.003)	(0.003)	(0.002)	(0.004)
22-Feb-2002	-0.007***	-0.005***	-0.001	-0.006***	-0.005***	-0.001
	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)	(0.001)
8-Mar-2002	0.007	0.007	-0.001	0.006	0.007	-0.001
	(0.005)	(0.007)	(0.005)	(0.005)	(0.007)	(0.005)
13-Jun-2003	-0.004	-0.003	-0.001	-0.004	-0.003	-0.001
	(0.003)	(0.004)	(0.002)	(0.003)	(0.003)	(0.002)
27-Nov-2003	0.003	0.004*	-0.001	0.003	0.004	-0.001
	(0.003)	(0.002)	(0.004)	(0.003)	(0.003)	(0.004)
9-Dec-2005	0.003	0.004*	-0.001	0.003	0.004	-0.001
	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.002)
B: Portfolio risk exposures (β)						
W_{t+1}^e (β_1)				-0.022	0.034	-0.056*
				(0.022)	(0.037)	(0.029)
W_t^e (β_2)	0.363***	0.480***	-0.117***	0.355***	0.462***	-0.107***
	(0.025)	(0.045)	(0.033)	(0.025)	(0.045)	(0.033)
W_{t-1}^e (β_3)				0.147***	0.242***	-0.096***
				(0.021)	(0.040)	(0.034)
Constant (α)	0.000	0.001	-0.000	0.000	0.001	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Regression R^2	0.177	0.097	0.009	0.206	0.122	0.018
No. of tradedates	1796	1796	1796	1796	1796	1796
Average no. of firms	147.6	21.4		147.6	21.4	

Table 9
Multifactor abnormal stock returns to portfolios of domestic and foreign firms

This table repeats the estimation reported in Table 8, but with the following multifactor model:

$$r_t^e = \alpha + \sum_{k=1}^{7} AR_k d_{k,t} + \beta_1 W_{t+1}^e + \beta_2 W_t^e + \beta_3 W_{t-1}^e + \beta_4 HML_t + \beta_5 SMB_t + \beta_6 MOM_t + \varepsilon_t$$

where the additional risk factors are the Fama-French value (HML) and size (SMB) factors (Fama and French, 1992) and the Carhart momentum factor (MOM) Carhart (1997). Each of these factors are constructed using the universe of OSE-listed stocks only (available from the web-page of Bernt A. Odegaard at the University of Stavanger).

	Firms in portfolio return r_t^e		
Event day and factor exposures	Domestic on OSE (1)	Foreign on OSE (2)	Long Domestic Short Foreign (3)
A: Average daily portfolio abnormal returns (AR)			
15-Oct-1999	-0.006	-0.003	-0.003
	(0.006)	(0.008)	(0.002)
2-Jul-2001	-0.002	-0.002	0.000
	(0.003)	(0.003)	(0.003)
22-Feb-2002	-0.007***	-0.006***	-0.001
	(0.001)	(0.002)	(0.001)
8-Mar-2002	0.005	0.004	0.001
	(0.003)	(0.005)	(0.004)
13-Jun-2003	-0.003	-0.002	-0.002
	(0.004)	(0.004)	(0.001)
27-Nov-2003	0.004	0.004***	-0.001
	(0.003)	(0.002)	(0.004)
9-Dec-2005	0.002	0.004	-0.001
	(0.003)	(0.002)	(0.002)
B: Portfolio risk exposures (β)			
W_{t+1}^e (β_1)	-0.021	0.048	-0.069**
	(0.021)	(0.037)	(0.029)
W_t^e (β_2)	0.293***	0.370***	-0.077**
	(0.025)	(0.046)	(0.034)
W_{t-1}^e (β_3)	0.123***	0.200***	-0.077**
	(0.020)	(0.040)	(0.033)
HML (β_4)	-0.152***	-0.147***	-0.005
	(0.022)	(0.042)	(0.032)
SMB (β_5)	-0.134***	-0.268***	0.134***
	(0.026)	(0.045)	(0.036)
MOM (β_6)	-0.043*	-0.078*	0.034
	(0.024)	(0.042)	(0.030)
Constant (α)	0.000*	0.001**	-0.000
	(0.000)	(0.000)	(0.000)
R^2	0.265	0.159	0.028
N	1796	1796	1796

Table 10
Abnormal return estimation using the methodology of Ahern and Dittmar (2012)

This table presents average abnormal returns as defined by AD (Ahern and Dittmar, 2012). They estimate abnormal returns as the sum of industry-adjusted return over the five days centered on February 22, 2002: $R_{i,t} - R_{I,t}$ where $R_{i,t}$ is the raw return to the i^{th} listed Norwegian firm in their sample on day t, and $R_{I,t}$ is the average return on U.S. listed firms in the same industry as the i^{th} Norwegian firm on the same day. The sum of (any) abnormal return observations for firm i over the five day event window is the estimated cumulative abnormal return (CAR) of that firm. *Female directors* > 0 is the subsample of Norwegian listed companies with at least one female director in 2002. U.S. market data are from CRSP, U.S. industry codes (GICS) codes are from CRSP/Compustat merged, and the Norwegian market data in this table are from Compustat Global. Panel A lists the abnormal returns as they are reported by AD in their Table III. Panel B reports our abnormal return estimates using the sample of firm names provided to us by Ken Ahern and their industry-adjusted abnormal return definition. We do not otherwise have access to the AD data, and use our own board data from the Norwegian Business Registry at end-year 2001 to construct *Female directors* > 0. As Panel B shows, our classification differs from that of AD by one firm. Panel C repeats the exercise reported in Panel B using instead a three day event window. Statistical significance is reported as p-values in parenthesis (based on null hypothesis of equal mean and unequal standard deviation in the two groups) and is also indicated by stars: *** 1%, ** 5%, *10%.

	All firms	No female directors	Female directors > 0	Difference
	(1)	(2)	(3)	(2)-(3)
A: Percent average abnormal return estimates reported by AD				
Mean	-2.573***	-3.547***	-0.024	-3.523***
	(0.001)	(0.001)	(0.977)	(0.008)
Observations	94	68	26	
B: Our estimates, AD sample and abnormal return definition (5 day CAR)				
Mean	-2.817***	-3.714***	-0.592	-3.122**
	(0.000)	(0.000)	(0.585)	(0.034)
Observations	94	67	27	
Mean, excl. $\|car\|$ >20%	-2.035***	-2.643***	-0.592	-2.051
	(0.002)	(0.001)	(0.585)	(0.127)
Observations	91	64	27	
C: Our estimates, AD sample and abnormal return definition (3 day CAR)				
Mean	-2.445***	-3.087***	-0.775	-2.312
	(0.003)	(0.004)	(0.426)	(0.103)
Observations	90	65	25	
Mean, excl. $\|car\|$ >20%	-1.593**	-1.923**	-0.775	-1.147
	(0.013)	(0.019)	(0.426)	(0.361)
Observations	87	62	25	

Table 11
Cross-sectional regressions with firm-specific event-induced abnormal return as dependent variable

The table reports cross sectional regressions of the abnormal return parameter AR estimated as in Table 8 but for each individual listed sample firm. *Shortfall female directors* is computed as Max(0,quota - share female directors at end of most recent fiscal year), where quota is the share of women required by the law (in 1998 quota = 25%, else 40%). *Board size* is the total number of shareholder representatives on the board at the end of the most recent fiscal year relative to each announcement date. *Ownership concentration* is the share owned by the largest shareholder at the end of the most recent fiscal year relative to each announcement date (ownership data from 2001; ownership concentration variable in columns (1) and (2) valued in 2001). In column (8), the dependent variable is the cumulative abnormal return over three key events: 13-jun-2003 (law proposal), 27-nov-2003 (majority vote in the Parliament), and 09-dec-2005 (mandated by the Government). The explanatory variables in column (8) are valued in 2002. Each regression contains sector dummies (coefficients not reported). Robust standard errors (White estimator) reported in parenthesis; stars indicate significance levels: *** 1%, ** 5%, *10%.

	15-oct-1999	02-jul-2001	22-feb-2002	08-mar-2002	13-jun-2003	27-nov-2003	09-dec-2005	Cumulative
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
A: Dependent variable is abnormal return								
Shortfall female directors	0.0001	0.0000	-0.0001	0.0002	-0.0001	-0.0001	0.0000	0.0000
	(0.0002)	(0.0002)	(0.0002)	(0.0001)	(0.0002)	(0.0001)	(0.0001)	(0.0002)
Board size	-0.0005	-0.0015	0.0019	-0.0007	0.0016	-0.0020	-0.0011	-0.0005
	(0.0013)	(0.0022)	(0.0029)	(0.0014)	(0.0015)	(0.0015)	(0.0012)	(0.0023)
Ownership concentration	-0.0144	0.0050	0.0081	0.0102	-0.0124	-0.0197	0.0012	-0.0352**
	(0.0121)	(0.0160)	(0.0082)	(0.0132)	(0.0145)	(0.0129)	(0.0143)	(0.0174)
Constant	-0.0071	-0.0076	-0.0038	-0.0376***	-0.0203	-0.0148	-0.0344***	-0.0811***
	(0.0154)	(0.0216)	(0.0194)	(0.0103)	(0.0143)	(0.0162)	(0.0096)	(0.0273)
Sector fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.14	0.09	0.07	0.32	0.14	0.15	0.14	0.25
Number of firms	96	132	131	129	123	115	108	100
B: Dependent variable is abnormal return divided by its (time-series) standard error								
Shortfall female directors	0.0154	0.0071	-0.0201	0.0180	0.0147	-0.0137	0.0069	0.0108
	(0.0187)	(0.0168)	(0.0136)	(0.0150)	(0.0124)	(0.0169)	(0.0100)	(0.0290)
Board size	-0.0738	-0.0223	0.1074	-0.0749	0.2282*	-0.2812*	-0.0722	-0.1743
	(0.1194)	(0.1405)	(0.1371)	(0.1242)	(0.1199)	(0.1659)	(0.0923)	(0.2791)
Ownership concentration	-2.0695*	-0.0463	-1.4372	1.4048*	-0.5553	0.1938	-1.5659**	-1.8006
	(1.2210)	(1.0939)	(1.6371)	(0.8260)	(0.8674)	(0.9886)	(0.7491)	(1.6316)
Constant	-0.9531	-0.7983	2.0021*	-7.1479***	-4.0103***	1.2830	0.7159	-1.8008
	(1.1496)	(1.3000)	(1.0632)	(0.9150)	(1.2043)	(1.7717)	(0.8681)	(2.9294)
Sector fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.09	0.07	0.10	0.22	0.09	0.27	0.18	0.21
Number of firms	96	132	131	129	123	115	108	100

Table 12
Percent female directors and Tobin's Q

Q is adjusted for median industry Q in Norway. Standard errors clustered by firm in parentheses.

	2005	2006	2007	2008	2009
	(1)	(2)	(3)	(4)	(5)
A: Instrumental variables regressions: dependent variable = Tobin's Q					
Percent female dir.	1.050	0.360	-1.318	-1.596**	-1.424**
	(1.905)	(1.309)	(0.835)	(0.668)	(0.606)
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes
N	308	392	471	541	603
B: Reduced-form regressions: dependent variable = Tobin's Q					
2004 dummy x percent female dir. in 2002	-0.291	-0.455	-0.466	-0.491	-0.506
	(0.357)	(0.386)	(0.411)	(0.420)	(0.428)
2005 dummy x percent female dir. in 2002	-0.344	-0.397	-0.360	-0.370	-0.380
	(0.520)	(0.520)	(0.521)	(0.523)	(0.524)
2006 dummy x percent female dir. in 2002	.	-0.291	-0.333	-0.326	-0.324
	.	(0.653)	(0.638)	(0.636)	(0.635)
2007 dummy x percent female dir. in 2002	.	.	1.011*	0.995*	0.981*
	.	.	(0.544)	(0.539)	(0.537)
2008 dummy x percent female dir. in 2002	.	.	.	1.038**	1.023**
	.	.	.	(0.512)	(0.509)
2009 dummy x percent female dir. in 2002	.	.	.	.	0.574
	.	.	.	.	(0.515)
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes
R^2	0.020	0.007	0.025	0.040	0.039
N	308	392	471	541	603
C: First-stage regressions: dependent variable = percent female directors					
2004 dummy	0.045***	0.048***	0.047***	0.047***	0.046***
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
2005 dummy	0.133***	0.135***	0.135***	0.134***	0.134***
	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)
2006 dummy	.	0.224***	0.224***	0.224***	0.224***
	.	(0.019)	(0.019)	(0.019)	(0.019)
2007 dummy	.	.	0.355***	0.355***	0.355***
	.	.	(0.014)	(0.014)	(0.014)
2008 dummy	.	.	.	0.382***	0.382***
	.	.	.	(0.012)	(0.012)
2009 dummy	.	.	.	.	0.379***
	.	.	.	.	(0.010)
2004 dummy x percent female dir. in 2002	-0.069	-0.076	-0.073	-0.073	-0.073
	(0.083)	(0.084)	(0.083)	(0.083)	(0.083)
2005 dummy x percent female dir. in 2002	-0.272**	-0.274**	-0.274**	-0.275**	-0.275**
	(0.106)	(0.106)	(0.106)	(0.106)	(0.106)
2006 dummy x percent female dir. in 2002	.	-0.475***	-0.476***	-0.478***	-0.479***
	.	(0.099)	(0.100)	(0.100)	(0.100)
2007 dummy x percent female dir. in 2002	.	.	-0.688***	-0.688***	-0.689***
	.	.	(0.092)	(0.092)	(0.093)
2008 dummy x percent female dir. in 2002	.	.	.	-0.836***	-0.836***
	.	.	.	(0.089)	(0.089)
2009 dummy x percent female dir. in 2002	.	.	.	.	-0.889***
	.	.	.	.	(0.093)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes
R^2	0.313	0.458	0.641	0.697	0.716
N	308	392	471	541	603

Table 13
Number of nonfinancial firms converting from ASA to AS, 2000 to 2009

Column (1) reports the annal number of listed ASA that convert to AS each year, while column (2) reports the number of non-listed ASA that convert to ASA. A converting firm is a firms that is registered as ASA in the current year and then registered as AS the following year, given that the firm is in our sample in both years. Firms in the financial sector are excluded, as are firms that go bankrupt or disappear due to acquisitions (consolidated Norwegian domiciled firm whose foreign owner changes or that becomes stand-alone, and stand-alone firm that switches to consolidated Norwegian domiciled firm).

Year	Listed (1)	Non-listed (2)	All (3)
2000	2	9	11
2001	2	5	7
2002	6	3	9
2003	0	7	7
2004	0	10	10
2005	8	14	22
2006	3	14	17
2007	2	3	5
2008	2	3	5
2009	2	0	2
Sum	27	68	95

Table 14
Probit estimation of the conversion decision

Each converting firm is is matched to the five closest non-converting ASA firms in our sample in the current year. Matching is performing using propensity scores based on four firm characteristics: revenue, book value of total assets, sector and listing status. All explanatory variables are valued in the current year. Female dir. is the share of female directors. Listed is a dummy equal to one if the firm is a listed ASA, zero if a non-listed ASA. Board power is the average director power across all directors on the board, see Table **??**. Female dir. power is the average director power across female directors on the board, set to zero if there are no female directors on the board. CEO power is the power of the CEO. Board size is the total number of directors on the board. Log(Assets) is the natural logarithm of book value of total assets. Log(Firm age) is the natural logarithm if firm age. Leverage is book value of total debt divided by book value of total assets. ROA is operating result over book value of total assets. Ownership concentration the fraction of equity held by the largest stockholder. IFRS is a dummy variable equal to one if the firm reports accounts in IFRS, else zero (zero before 2005). Robust standard errors (White estimator) reported in parenthesis; significance level indicated by stars: *** 1%, ** 5%, *10%.

	(1)	(2)	(3)	(4)
Female dir.	-0.494	-0.714	-0.972	-1.488
	(0.373)	(0.482)	(0.723)	(0.931)
Listed		-0.048	-0.139	-0.168
		(0.202)	(0.215)	(0.306)
Female dir.*Listed		0.552	0.202	0.149
		(0.815)	(0.894)	(1.088)
Board power			2.920***	3.048***
			(0.976)	(1.166)
Female dir. power			2.392*	3.081**
			(1.409)	(1.529)
CEO power			-0.356	-1.043
			(0.750)	(0.824)
Female dir.*Female dir. power			-4.241	-5.320
			(5.127)	(5.869)
Board size				0.011
				(0.061)
Log(Assets)				0.077
				(0.053)
Firm age				0.035
				(0.072)
Leverage				-0.007
				(0.025)
ROA				-0.017
				(0.116)
Cash/Current assets				-0.225
				(0.268)
Ownership concentration				0.876***
				(0.297)
IFRS				-0.412
				(0.299)
Year fixed effects	No	No	No	Yes
Sector fixed effects	No	No	No	Yes
Constant	-0.811***	-0.801***	-1.358***	-1.710**
	(0.082)	(0.092)	(0.240)	(0.715)
Pseudo R^2	0.003	0.005	0.038	0.099
Log-likelihood	-234.364	-234.116	-225.480	-197.633
Observations	483	483	479	430

A Network centrality from graph theory

A network of individuals can be graphically represented by nodes connected by lines. Each node is an individual, and connections between individuals are the lines between the nodes. Such graphical representations of networks can be translated into matrix form to facilitate measurement of the centrality of each node in the overall network. In this Appendix, we outline the calculation of five common centrality measures: Degree centrality, Eigenvector centrality, PageRank, Closeness centrality, and Betweenness centrality.

A.1 Centrality based on adjacency matrix

With N nodes in the network, an adjacency matrix is a $N \times N$ matrix $\mathbf{A}$ where entry a_{ij} is equal to 1 if node i is connected to node j, else zero. Connections in a network can be directed or undirected. A directed connection is one where a node i connects to node j, but j does not connect back to i. For example, in a network of web-pages, a particular web-page i can include a hyperlink pointing to another web-page j, but web-page j may not contain a hyperlink connecting back to i. An undirected network is one where all connections are reciprocal; if i connects with j, then it follows that j connects to i. A network of directors is an undirected network. In an undirected network, the adjacency matrix $\mathbf{A}$ is symmetric.

Degree centrality counts the number of other nodes directly connected to a node. The vector containing degree centrality for each node i in the network is then simply the vector of row sums of the adjacency matrix,

$$degree(i) = \sum_{j \neq i} a_{ij}$$

Eigenvector centrality is also based on the adjancency matrix, but in addition to counting first order connection like degree centrality, eigenvector centrality also takes into account the relative importance of each of these connections. This measure is calculated by determining the eigenvector of the adjacency matrix $\mathbf{A}$ corresponding to the dominant (largest) eigenvalue λ_{dom} of $\mathbf{A}$; the vector containing the eigenvector centrality of each node in the network is the vector $\mathbf{x}$ such that

$$\mathbf{x} = \lambda_{dom}^{-1} \mathbf{A}\mathbf{x}$$

PageRank is a modification of eigenvector centrality to disconnected networks. In disconnected networks it is not be possible to reach any node from any starting point; there are isolated sub-components and isolated nodes. Starting in one of the isolated sub-components of the network we are only able to reach nodes in that sub-component, but not other nodes in the network outside this particular sub-component. In this case, eigenvector centrality will return a centrality score for only one of the network's sub-components, allocating zero centrality to all other nodes. One solution is PageRank, the algorithm underlying the Google search engine (Page, Brin, Motwani, and Winograd, 1999). The first step is to normalize each column in the adjacency matrix by the column sum; each column in the normalized adjacency matrix $\mathbf{A}^*$ sums to one.

The second step is to construct a random transition matrix $\mathbf{B}$, where each entry $b_{ij} = 1/N$. The third step is to combine these two matrices linearly to produce a new matrix $\mathbf{C} = [1-\delta]\mathbf{A}^* + \delta\mathbf{B}$, giving a small weight δ to the random transition matrix; standardly $\delta = 0.15$. Next, we find the eigenvector of the dominant eigenvalue of this new combined matrix $\mathbf{C}$ as the vector $\mathbf{x}$ such that

$$\mathbf{x} = \lambda_{dom}^{-1} \mathbf{C}\mathbf{x} = \lambda_{dom}^{-1} \Big([1-\delta]\mathbf{A}^* + \delta\mathbf{B} \Big) \mathbf{x}$$

It can be shown that largest eigenvalue of the combined matrix $\mathbf{C}$ is 1 (Perron-Frobenius theorem), and therefore we are looking for the $\mathbf{x}$ such that

$$\mathbf{x} = \Big([1-\delta]\mathbf{A}^* + \delta\mathbf{B}\Big)\mathbf{x},$$

which more easily lends itself to an intepretation of $\mathbf{x}$ as the solution to a system of linear equations. Finally, we normalize this vector by the sum of the elements in the vector to produce the PageRank of each node in the overall network.

A.2 Centrality based on shortest path

Closeness centrality measures the distance from a node to all the other nodes in the network. This measure is calculated by first constructing a distance matrix $\mathbf{D}$. With N nodes in the network, $\mathbf{D}$ is a $N \times N$ matrix where entry d_{ij} is equal to number of steps k in the shortest path from node i to node j. The standard closeness measure is the inverse of the sum of shortest paths from a node to each of the $N-1$ other nodes in the network; the inverse of the row sums of the distance matrix $\mathbf{D}$

$$closeness(i) = \frac{1}{\sum_{j \neq i} d_{ij}}$$

This standard closeness measure needs to be modified when applied to disconnected networks. The problem is that the distance to an isolated node is infinity, which gives a closeness centrality of zero for all nodes (because each sum of distances would include infinity at least once). A simple and transparant adjustment to overcome this issue is to set the maximum distance in the network equal to the number of nodes in the network. The distance from any node to an isolated node, in a disconnected network containing N nodes, would then be N steps.

Betweenness centrality measures whether a node is on many shortest paths between pairs of nodes in the network. This measure is calculated by constructing the $N \times 1$ vector b where entry b_i is equal to the total number of shortest paths, between all other nodes j and k, that node i lies on.

Centrality measures based on shortest path (like closeness and betweenness) fail to capture influence and information diffusion in a less desirable way, especially when applied to very large networks. Borgatti (2005) shows that betweenness is highly accurate when applied to networks where things can reasonably be assumed to flow only along shortest paths, like a package delivery system. In contrast, eigenvector centrality does not assume a predetermined path of traffic in the network.

Walden (2013) shows that closeness is not correlated with information diffusion across large networks with many agents, whereas eigenvector centrality is closely correlated with such information diffusion. The reason is that shortest path measures focus mainly on higher order connections, and in a large network the vast majority of agents will be far away from any given agent. Heemskerk and Fennema (2009) offer a similar argument against the use of betweenness in large networks. Indeed, Barnea and Guedj (2009) find that eigenvector centrality encompasses the information contained both in degree and betweenness centrality.

For these reasons, eigenvector centrality is emerging as the centrality measure of choice in current applications of graph theory to finance: Ahern (2013) capture systematic risk through inter-sectoral trade by showing that stock returns of central industries co-vary more closely with market returns; Ahern and Harford (2014) find that economy-wide merger waves are driven by merger activity in central industries; Ozsoylev, Walden, Yavuz, and Bildik (2014) find that more central investors in an empirical information network derived from similar trading behavior earn higher returns and trade earlier with respect to information events.

A.3 Simple example

To get a closer understanding of how these five different centrality measures are calculated, consider the boards of four separate firms.

- The board of one firm contains person C and D.
- The board of one firm contains person D and E.
- The board of one firm contains person A, B and H.
- The board of one firm contains F, G and H.

Because some of these persons sit on multiple boards, we can construct a meaningful network of these interlocking directors. Each person is a node, and two nodes are connected with a line if these two persons sit on the same board. This network is graphically in Figure (3).

Table 1 reports the five centrality measures for each node in this network calculated in R using the relevant functions from the package `igraph`. For such a simple network containing only eight nodes we can easily calculate each of our five centrality measures to check our understanding of each measure.

Degree centrality simply counts the number of direct connections for each node. Nodes A, B, D, F, and G each have two connections, and therefore each of these nodes have a degree centrality of 2. Nodes C and E only have one connection each (they are both connected to D), and therefore have a degree centrality of 1. Node H is connected to four other nodes, and therefore has degree centrality of 4.

Eigenvector centrality is simply the eigenvector corresponding to the largest eigenvalue of the adjacency matrix. The adjancency matrix for our network of 8 persons is given by The largest

	A	B	C	D	E	F	G	H
A	0	1	0	0	0	0	0	1
B	1	0	0	0	0	0	0	1
C	0	0	0	1	0	0	0	0
D	0	0	1	0	1	0	0	0
E	0	0	0	1	0	0	0	0
F	0	0	0	0	0	0	1	1
G	0	0	0	0	0	1	0	1
H	1	1	0	0	0	1	1	0

eigenvalue of this matrix is 2.561, and the corresponding eigenvector gives us the eigenvector centrality of each node in the network. Note that only nodes in the largest connected sub-component are included in the calculation; the centrality of each node in the smallest sub-component (C, D and E) is set to zero.

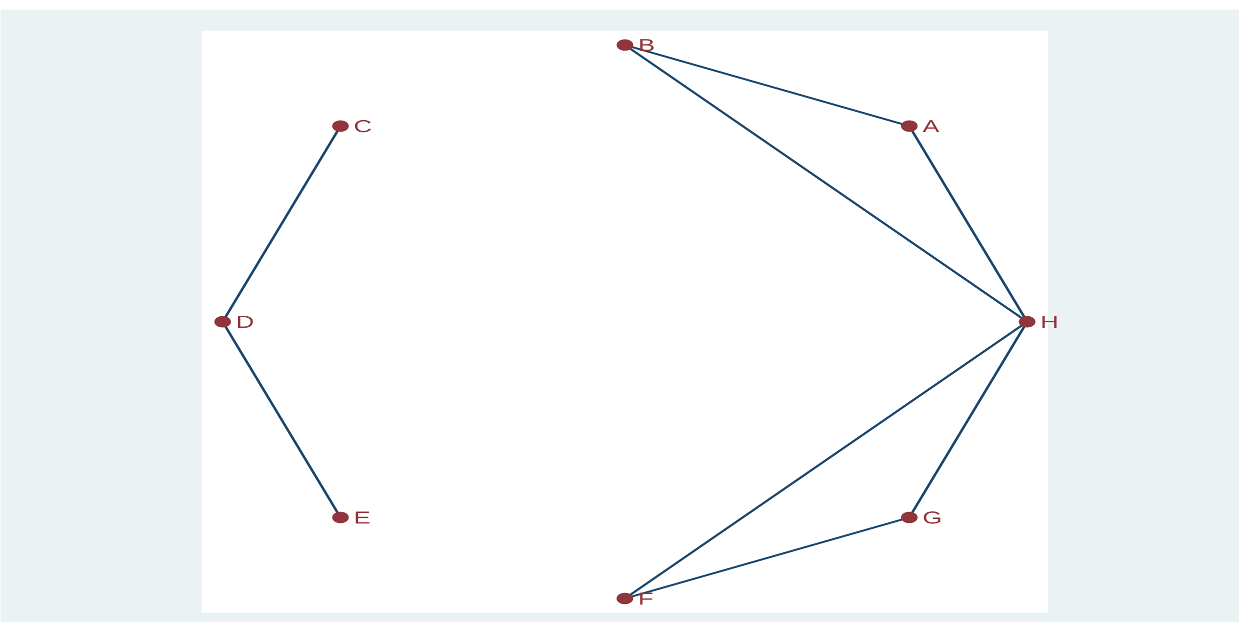
To find *PageRank*, we first normalize each column in the adjacency matrix by the column sum to produce the normalized adjacency matrix The second step is to construct a 8×8 random transition matrix $\mathbf{B}$, where each entry $b_{ij} = 1/8$. The third step is to combine these two matrices $\mathbf{A}^*$ and $\mathbf{B}$ linearly to produce a new matrix $\mathbf{C} = [1 - \delta]\mathbf{A}^* + \delta\mathbf{B}$, where $\delta = 0.15$. The fourth step is to find the eigenvector corresponding to eigenvalue=1 of this new combined matrix $\mathbf{C}$. Finally, we

	A	B	C	D	E	F	G	H
A	0	1/2	0	0	0	0	0	1/4
B	1/2	0	0	0	0	0	0	1/4
C	0	0	0	1/2	0	0	0	0
D	0	0	1	0	1	0	0	0
E	0	0	0	1/2	0	0	0	0
F	0	0	0	0	0	0	1/2	1/4
G	0	0	0	0	0	1/2	0	1/4
H	1/2	1/2	0	0	0	1/2	1/2	0

normalize the resulting eigenvector by the sum of the elements in the vector to produce PageRank. Note that this modification of eigenvector centrality is guaranteed to offer a comparable centrality measure for every node in the network.

The *Closeness centrality* of a node is the inverse of the distance from that node to all the other nodes in the network. If there is no path to a particular node, then the distance to that node is set equal to the number of nodes in the network. For example, node A is one step from B, one step from H, two steps from G, two steps from F, and eight (N=8) steps from each of C, D and E as there is no path from A to these nodes. The closeness centrality of A is therefore $1/(1+1+2+2+8+8+8) \approx 0.0333$. *Betweenness centrality* counts the number of shortest path through a node. For example, the shortest path between C and E is through D. Since D is not on any other shortest path, then the betweenness score of D is one. C and D are not on any shortest paths, between any other pairs of nodes, so each of these node's betweenness is zero.

Figure 3
Network graph



Appendix Table 1
Centrality measures

Node	Degree	Eigenvector	PageRank	Closeness	Betweenness
A	2	0.3941	0.1064	0.0333	0
B	2	0.3941	0.1064	0.0333	0
C	1	0.0000	0.0963	0.0233	0
D	2	0.0000	0.1824	0.0238	1
E	1	0.0000	0.0963	0.0233	0
F	2	0.3941	0.1064	0.0333	0
G	2	0.3941	0.1064	0.0333	0
H	4	0.6154	0.1996	0.0357	4