

Network connections and board seats

– are female networks less valuable?

Emma von Essen^{*1,2} and Nina Smith^{1,3,4}

¹Department of Economics and Business Economics, Aarhus University

²Swedish Institute for Social Research, Stockholm University

³IZA Institute of Labor, 53113 Bonn, Germany

⁴CESifo (Center for Economic Studies), Munich, Germany

Abstract

We investigate how sizes of professional networks' affects the probability of appointment to a supervisory board, and whether the effect is gendered. Using an employer-employee data set of the Danish labour market, 1995-2011, we find larger networks to associate with a higher probability of becoming a first-time director. The effect is larger for men. One explanation is that men, compared to women, have more connections to larger and listed firms, and other males – attributes that increase the appointment probability. Also, women who have connections to incumbent directors before being appointed director have more labour market experience than for other directors.

Keywords: board of directors, networks, gender

JEL: J16, J24, G34

*We are grateful for useful comments from Aleksandra Gregoric, Tor Eriksson, Matthew Linqvist, seminar participants at the Swedish Institute for Social Research at Stockholm University, the department of Economics and Business Economics at Aarhus University, and participants at EALE 2019. We also want to thank for help from our Research Assistants at Aarhus University.

I. Introduction

It is well known that matches between employers and employees of regular jobs often run through network information and referrals (Granovetter, 1973; Kramarz and Skans, 2014; Dustmann et al., 2016; Brown et al., 2016; Hensvik and Skans, 2016; Pallais and Sands, 2016). Recruitments to leadership positions, and particularly positions as directors of corporate boards, are seldom publicly announced in the market. The importance of professional network connections for matches is likely to be more pronounced here, where firms often rely on information from incumbent directors or executives (Granovetter, 2017). There is little to no economic research on network properties explaining the gender gap in top positions, in particular corporate board positions. If women do not have the same amount of connections as men, or their contacts do not bring referrals in the same way as for men, it may lead to fewer women becoming a director.

In this paper, we take the first step on this by asking how the size of coworker networks – weak ties – affect the potential of becoming members of a supervisory board of directors for men and women, and whether the effect differs between the genders. Previous research and public reports analyse the gender gap on the board of directors by use of the largest listed companies, and there is reason to believe that this is not sufficient for the understanding of the representation of women on boards of directors in general (Adams, 2017). This study investigates the appointments of directors to corporate supervisory boards in all firms with at least 50 employees in Denmark (medium-sized firms) using a sizeable employer-employee dataset, 1995-2011. The data set includes all individuals at risk of becoming a director, defined as all individuals that manage other people at their primary workplace.

Our empirical examination of networks and board appointment is conducted in three steps. We first describe the individuals at risk of being appointed to a board and the group of individual directors. We then estimate the impact of the size of the professional

networks on becoming a director for the first time and then including subsequent times, separately for men and women. The calculated network sizes per year for each individual is then used as the main regressors. Following the business literature on professional networks we construct the following four types of networks using individual work histories i) *coworkers board network*, which are coworkers who have become a director within the subsequent three years, ii) *executive network* which is the cumulative number of connections to other top executives in past and present jobs, iii) *co-worker executive network* are coworkers who have become top executives within the subsequent three years and iv) *board network* which is the number of unique relations in a given year to other board members (only defined for individuals who have had at least one board position). We then associate the network sizes with the information of whether the individual was appointed to a board of director the following year, controlling for a broad set of individual and employer characteristics, including human capital variables, industry and management fixed effects as well as individual fixed effects. Our results suggest that more professional connections increase the likelihood of becoming a first-time director of a corporate board, and the increase is larger for men than for women. Probing further into the data, we suggest that one reason for the gendered effect of network size is that the structure of women and men's networks differ. Women have more connections to other women and more links related to family firms, whereas men have more connections in larger and listed firms. The positive effects of networks on appointments are found for larger and listed firms as well as for male connections. In a third step, we explore whether having a connection to an incumbent director before being appointed to a board associate with lower formal qualifications. In contrast to previous literature, we find that directors with a connection to a sitting director in the board to which she was appointed, have more extended labour market experience, but a similar level of education, compared to directors with no such link. This gap is only present among women.

To abide by good corporate governance, firms in Denmark as well as in many European countries, employ a dual board system, where the board of directors has power as the highest authority in the company (Oxelheim et al., 2013). None of the members of the executive board (i.e. the CEO and other top executives) are formal members of the board of directors (sometimes denoted the supervisory board) in the company. The main tasks of the board of directors are to hire, fire and control the CEO and the executive board, and to define the strategy of the company (Adams et al., 2010). The supervisory directors have therefore been the group targeted by governmental policies so far (Adams, 2017). Previous explanations of the underrepresentation of women in top management positions include the lack of human capital – the shortage of women’s education, labour force participation and management experiences – or that formal and informal selection of directors disfavour women (Blau and Kahn, 2017; Adams, 2017; Kunze and Miller, 2017; Bertrand et al., 2010; Goldin, 2014). The business literature, in contrast to the economic literature, has a long tradition of studying the lack of women in corporate boards, where business contacts, such as connections to other directors or executives, are put forward as a crucial qualification (Burke, 1997; Singh and Vinnicombe, 2004; Sheridan and Milgate, 2005; Terjesen et al., 2009; Adams and Funk, 2012; Dunn, 2012; Adams and Kirchmaier, 2016; Smith and Parrotta, 2018; Miller, 2018). A recent survey by the Confederation of Danish Industry (Dansk Industri) echoes the current research explanations. Corporate directors of the largest firms state that the three main reasons why few women are recruited to their boards are i) too few women in the pipeline, ii) too few women with the relevant educational competencies and iii) too few women in my network (Leclercq Vrang and Larsen, 2018).

The paper is structured as follows, in the coming section, we expand the discussion on previous literature. In Section III. we present the institutional setting of Danish corporate boards. In Section IV., we describe the data, measures and in section V. we show the descriptive statistics for the firms and individuals in our sample. In Section

VI., we show how the size of coworker networks can predict first-time and subsequent appointment probabilities to corporate boards. Section VII. presents additional analyses, and Section VIII. ends the paper with a concluding discussion.

II. Previous literature

Our paper relates to the strand of literature investigating how networks affect recruitments and other labour market outcomes.

The sociologist Mark Granovetter and many others to follow have pointed out the importance of networks in the job matching process. Generally, 50-60% of regular jobs are obtained through contacts (Granovetter, 1973, 1995; Loury, 2006; Holzer, 1988), and explanations can include both supply-side and demand-side factors. Contacts can be used by job seekers as information about available positions, or by firms as information on unobservable productivity of possible job candidates. Many studies have confirmed referral-based hiring across skill levels, occupations and socioeconomic backgrounds (e.g. Montgomery, 1991; Mortensen and Vishwanath, 1994; Oyer and Schaefer, 2011). A few studies combine the supply and demand sides, for example, Kramarz and Skans (2014); Dustmann et al. (2016); Brown et al. (2016).

The effect of connections based on family or friendship (strong ties) seems to differ from the impact of having weak ties – such as coworkers (Granovetter, 1973). Family connections seem to aid young workers in getting their first job (Kramarz and Skans, 2014). In contrast, links to coworkers seem more relevant concerning subsequent jobs where the referral can carry information on, for example, the unobserved ability of the individual (Hensvik and Skans, 2016). Hensvik and Skans (2016) show that firms use networks of incumbent workers to discriminate between prospective workers' abilities, assuming high-ability workers know other high-ability workers (confirming the theory by Montgomery (1991)). Only few studies focus on top jobs. For example, Kramarz and

Thesmar (2013) find a correlation between CEOs social school network and that of his or her supervisory directors. And, in an unpublished manuscript, (Guedj and Barnea, 2009) find the connections between CEOs to increase the likelihood of obtaining a future executive position.

Explaining the gendered top positions through networks, Bjerck (2008) introduces a dynamic model where firms can observe workers' skills across time. If men and women differ in i) average skills, ii) how precise they can signal their skill to others, or iii) how often they can signal their skill, equally skilled men and women can have different likelihoods of reaching the top jobs – despite lack of discrimination in promotions. This model suggests that the size of the network matters. If women have fewer connections, they have fewer opportunities to make their skills visible and lower chances to be appointed to a board.¹

Network contacts could reduce classical statistical discrimination (Phelps, 1972) by making employers less dependent on group averages in productivity (Calvo-Armengol and Jackson, 2004), predicting a decrease of gendered appointments and hiring. This line of argument, however, disregards that referrals might be gendered. Here, the business literature illustrates the gender gap in characteristics of network connections and how it relates to appointments to top positions (Zhu and Westphal, 2014; Doldor et al., 2015; O'Neil et al., 2011; Ibarra, 1992) – with men having more powerful connections and female networks devalued compared to men's networks (O'Neil et al., 2011; Ibarra, 1992). In similar vein, sociology research illustrates that the gendered occupational sorting and work trajectories lead men and women to have different coworker networks, such as diverse characteristics and status. (Holzer, 1987; Marsden and Campbell, 1990; Mencken and Winfield, 1999). Formation of network and referrals in hiring are also found to suffer from preferences of homophily (Fernandez and Sosa, 2005; Brown et al., 2016). In

¹Other models look at different types of valuable information about the referrals or the mechanisms of the transmission process (Simon and Warner, 1992; Dustmann et al., 2016; Galenianos, 2013; Brown et al., 2016).

Marmaros and Sacerdote (2002), men are shown to use contacts at the gender-specific social organisations at universities (fraternities) twice as much as women use sorority contacts when finding jobs. Moreover, a recent economic field experiment in a university setting show that men refer men and women refer women to work positions, which may exacerbate gender differences in occupations (Eriksson et al., 2015).

Formal productivity signals, such as type and level of education can be substituted by referrals signalling unobserved ability of the candidate (Casella and Hanaki, 2006). Hensvik and Skans (2016) find evidence of this substitution. Employees hired through referrals have less formal ability and more unobserved ability compared to other employees. If referrals are used as a substitute for formal productivity, we should observe that directors recruited by referrals have less formal education than other directors.

III. Institutional setting in Denmark

The average size of Danish companies is relatively small. In 2017, 169,000 firms were registered with positive employment (see www.statistikbanken.dk). Only 4458 firms, i.e. 2.5 % of all firms with positive employment, had more than 50 employees. These firms, however, cover around 70 % of all private-sector employment. Family-owned companies constitute a substantial share of private-sector companies, but there exists no authoritative statistics on the number of family-owned or family-run companies. According to Bennedsen et al. (2007), around 33 % of Danish non-limited liability firms are family-dominated firms, defined by the CEO having family ties to the owner. The share of family-run firms is considerably higher since most smaller firms are family firms (Bennedsen et al., 2007). The number of firms listed on the Danish stock exchange has been declining in the last decade. In 2018 less than 140 companies are listed on the Copenhagen stock exchange (www.euroinvestor.dk).

All corporate firms are obliged to have a board with at least three members who are

formally chosen by the shareholders on the general assembly with a maximum of a four-year term. Further, Danish law requires that the employees in the company nominate some board members who are elected by the employees (excluded from our sample). During the last decade, the guidelines for good corporate governance have implied more focus on the number of board positions of directors, the independence of board members, and diversity of the boards of directors in Danish companies. Denmark has no binding quota or target on gender diversity during the sample period.²

IV. Data and measures

Our administrative register data from *Statistics Denmark* cover the work histories of all individuals employed aged 16–65 from 1995 to 2011. We match individual workers to the firms where they have their primary occupation. From the *Danish Business Authority* (Erhvervsstyrelsen), we use the information on who sits on a board with whom in a given period for individuals born in Denmark. We use an anonymous id of each director in the Danish Business Authority to match the individual with his or her primary workplace found in the data from Statistics Denmark. Appointment to a board of directors is a rare event. For the population of the Danish labour force participants, the average appointment rate into the first board of directors is 0.04 % – most individuals never get promoted to a board of directors. In line with previous literature, directors are most often recruited among managers in other firms or individuals with prior management experience. To create a sample of interest that can guide us in investigating the probability of being appointed into a board of directors, we limit the sample to include all individu-

²Gender diversity is discussed in a guideline on good corporate governance for listed firms introduced in 2008. From December 2013 (out of our sample period), Danish law requires the largest firms (1,395 firms in 2016 according to Erhvervsstyrelsen (2017)) to set ambitious targets for the female share on boards of directors and the executive boards. The annual reports for the companies which are covered by the law have to include figures on female shares in management positions and information on the actions or policies that the company has taken to fulfil the intention of the law, i.e. to have more women in management positions. There are, however, no sanctions if the companies do not meet their ambitious targets.

als in the Danish labour market with any management position as the main occupation. We let new managers in the period enter the sample, and managers that grow older than 65 stays in the sample. We also restrict the recruiting boards to be in firms with at least 50 employees to avoid including boards of firms without regular business activity, for example holding companies and small firms with a more informal board governance structure. Public-sector firms differ in many respects from corporate firms, including board recruitment. We exclude the appointments to boards of the public-sector firms and focus on the corporate board firms, i.e. firms which have a board of directors as the highest decision-making authority in the company. Individual managers in public-sector firms can potentially become appointed to a board of directors in a corporate firm, and we thus keep them in the employer-employee data set. When looking at appointments to a board of directors, we also exclude the appointments of employee-elected board members (EEBM) since they represent the employees of the firms and not the shareholders and abide by a different recruitment process. Table 1 displays the number of individual managers, appointing firms and individual directors in our sample.

Table 1: Number of firms, individual and director observations in our sample.

	(1)	(2)	(3)
	No. observations	No. observations	No. observations
	1995-2011	1995	2011
All individuals	4230150	185976	305309
potential directors and directors			
Firms with a board of directors	56161	2779	3059
at least 50 employees			
Individual directors	129822	6676	7625

Our data includes a rich array of background characteristics, which allows us to explore the gender gap in promotions and networks across the 17 years. Information on the individual workers includes occupational level, tenure at the workplace, labour market experience, experience as a manager, education level, civil status, age and number of children. We construct three management categories, reflecting the vertical level of

the occupation defined as i) Chief Executive Officer (CEO), ii) Other Top Executive (OTE) and iii) Pool of Potential (POP). OTE are top managers besides the CEO that are in the management board of the firm. These two occupational groups represent what is referred to as the executive suite. POP is defined as individuals who have a management position below the executive suite (pool of potential directors).³

For the individuals who are directors, we have additional information per year on the number of boards on which they sit. For the firms with more than 50 employees we have information on the share of women on the board, whether it is a family-run firm or not, industry sector, and whether the firm is listed or not. Below we describe how we measure appointments to the board of directors and the networks.

A Measure of appointments to a board of directors

Our primary outcome measure captures getting into a board of directors for the first time. Using the individual as starting point, we go through all boards and define the individual as being appointed in year t if he or she was not a member of a board in any of the firms in $t - 1$ but is a board member in time t . Then we drop the individual after he or she is appointed to a corporate board of directors. Individuals can be appointed to a new board of directors and be a board member in many firms at the same time. Appointments to a new board of directors likely differ from appointments to a board of directors for the first time. Our second outcome measure, therefore, captures being appointed to any board. Here, we count an individual as being appointed in year t if he or she was not a member of the board in firm j in $t - 1$ but is a board member of firm j in time t .

Across the 17 years, the average share of first-time appointments in the sample is

³We use a similar definition of the management categories as Smith et al. (2013) and Smith and Parrotta (2018). From Statistics Denmark's occupational codes, so-called Disco codes, the following are used to define CEO: Disco codes 121, 1210, 121000-121020 and Other Top Executives: Disco codes 122-123, 1220-1239, 122000-123900. The Pool of Potential is specified as the first digit of Disco code is 1, but not included in the group of CEO or Other Top Executive. <https://dst.dk/en>

0.21 % and 0.45% for appointments into any board. Table 2 illustrates the probability of appointment to a board of directors for the first time as well as to any board, per year, for men and women⁴. Being appointed is even rarer for women. On average, 51 women and 521 men are appointed to their first board of directors per year, reflecting that the chances of getting on the first board are around 4-5 times higher for male managers compared to their female peers, see Table 2.

Table 2: Rate of appointments to a board of directors in per cent 1995 and 2011, by gender

	First-time appointment		Any appointment	
	Men	Women	Men	Women
	Mean	Mean	Mean	Mean
1995	0.331	0.068	0.703	0.105
2011	0.208	0.079	0.510	0.123
All years	0.341	0.088	0.768	0.138
<i>N</i>	2872806	1131845	3079868	1151247

We calculate rate of appointment considering the full population of men and women in management positions respectively, being at risk of becoming appointed. For the sample of first-time appointments the number of observations is lower since we exclude the individual from the sample when he or she becomes a director.

B Measures of professional networks

We construct the following four professional networks. First, *the coworker board network* at time t tracks the coworkers of individual i , from his or her primary job at time $t - 3$, which from $t - 3$ and the following three years are members of or appointed to a board of directors. This network measure captures the potential of being referred by past or present coworkers who have become directors. If firms use incumbent directors' knowledge to recruit new directors, having more connections should increase an individual's chances of being appointed to a new board. These coworkers could have observed individual i 's ability as a potential director. Three years capture the average tenure of

⁴In the sample of first appointments, we drop individuals that were appointed before 1995. Some individuals may have had their first-time appointment and then exited the set of directors before 1995. In these cases, we will count their appointment after 1995 as their first-time appointment.

a board position. To create this network for the years 1995-2011, we have information on the individuals workplaces since 1992.

Second, *the executive network* at time t is a cumulative count variable of all the number of connections individual i has to other top executives in his past and present primary jobs until time t . For individual i , we created a list of top executives of each workplace from 1995 to 2011, where individual i was also a top executive. By top executive, we mean individuals in CEO and other top executive positions. A positive top executive network requires having had an executive position at least once as of 1995 until time t . The network captures the potential of being referred to the supervisory board by other top executives with whom individual i has worked. Third, *the executive coworker network* at time t tracks the coworkers of individual i , from his or her primary job at time $t - 3$, which from $t - 3$ and the following three years are appointed to a top executive position in any firm. This network captures the potential of past coworkers transferring information to current directors of individual i 's productivity. Again, the three years catch the average tenure of a board position.

The fourth network, *the board network*, captures the unique relations at time t to other board members in all boards where individual i sits as a director. We create a list of the unique number of connections to the other directors in every board where individual i is a director by year. Thus, to have a positive board network at time t , an individual needs to be a director of at least one board at time t . This network is only relevant when looking at the potential of being promoted to any board by referrals by other directors that have observed individual i 's work as a director.

Table 3 shows the share of individuals with at least one connection in the respective networks and the average number of connections by gender. Most network connections stem from previous colleagues who have become appointed to a director on a corporate board or a top executive position. In general, a lower share of women has a positive network and fewer connections than men. Given a positive network, the distribution

of connections is, however, similar for men and women (see Figure 3 in the Appendix). The number of connections given a positive network for men and women is also stable across the period for all networks, except for the executive network that by definition increases (see Figure 4 in the Appendix).

Table 3: The share with a network and the number of connections by gender, 1995-2011.

	(1)		(2)	
	Men		Women	
	Mean	Std.	Mean	Std.
Positive Coworker board network	0.433	0.495	0.408	0.491
Positive Executive network	0.160	0.367	0.056	0.230
Positive Coworker exec. network	0.444	0.497	0.394	0.489
Positive Board network	0.037	0.189	0.008	0.092
No. Coworker board connections	0.596	1.823	0.415	1.526
No. Exec. connections	1.042	2.973	0.293	1.447
No. Coworker exec. connections	0.979	2.607	0.591	2.114
No. Board connections	0.173	1.194	0.030	0.408
Observations	3079868		1151247	

V. Descriptive statistics

We start our empirical analysis by describing the individuals at risk of becoming a director and the directors in our dataset.

A The individuals at risk of being appointed

Our sample of individual managers comprises mostly of lower-level managers (POP). Table 4 shows that in 2011, 94% of men and 98% of women had a management position but were not a member of an executive board. From the table, it is clear that the share of men in the executive suite, i.e. CEO and OTE, is much larger compared to that of women.

The qualifications among male and female managers seem to differ. A larger share of women has at least a bachelor's degree than men. When recruiting directors to boards,

not only the level but also the type of educational qualities are important. STEM (science technology, engineering and medicine) is a type of education highly valued in leadership positions since it is expected to bring in specific competencies. Also, degrees in Economics, Business and Law are considered valuable director assets. Adams and Kirchmaier (2016) show that the low representation of women in STEM can have long-term consequences for corporate leadership. We include Economics, Business and Law in the STEM variable and label it STEM+. Table 4 shows that in 2011, 12% of men and 4% of women have a STEM degree or a degree in Economics, Business and Law. Men and women at risk of being appointed appear similar in other characteristics, such as being married or the number of children. Men at risk of being appointed to a board of director are, on average, two years older compared to female managers.

Table 4: Descriptive statistics of individuals in our sample, 1995 and 2011.

	1995				2011			
	Men		Women		Men		Women	
	Mean	Std.	Mean	Std.	Mean	Std.	Mean	Std.
CEO position	0.024	0.154	0.003	0.056	0.017	0.131	0.004	0.060
OTE position	0.052	0.222	0.016	0.127	0.043	0.202	0.019	0.137
POP position	0.924	0.265	0.980	0.139	0.940	0.238	0.977	0.149
Experience (years)	17.606	9.604	14.303	8.433	22.266	11.367	20.393	10.645
Exp. as CEO (years)	0.102	0.542	0.015	0.187	0.243	1.251	0.040	0.392
Exp. as OTE (years)	0.211	0.723	0.066	0.388	0.548	1.747	0.192	1.001
STEM+ education	0.091	0.288	0.013	0.115	0.118	0.323	0.041	0.197
Age	46.080	10.695	43.679	10.040	50.584	10.996	48.435	10.830
Share being married	0.849	0.358	0.750	0.433	0.835	0.372	0.749	0.434
Number of Children	1.810	1.120	1.675	1.090	1.910	1.102	1.710	1.048
Age of youngest child	13.130	10.824	12.912	10.616	15.475	12.370	15.582	12.306
Observations	141244		44732		215299		90013	

Having experience from the executive suite (top management position) is by previous literature considered one of the most valuable qualifications for getting into a board of directors. Table 5 confirms this expectation. The appointment rates into a board of directors for the first time are considerably higher for CEOs, and OTEs compared to

POP. This pattern are starker among men than among women.

Table 5: Appointment in per cent, by occupational level and gender, 1995-2011.

	Men	Women
<i>First appointment</i>		
CEO	4.046	1.946
OTE	1.450	0.961
POP	0.257	0.071
<i>Any appointment</i>		
CEO	6.574	2.885
OTE	2.504	1.359
POP	0.563	0.108

Appointment rates are scaled by 100.

Figure 1 shows the share of women on the boards of the recruiting firms. The share has been almost stable during the period 1995–2011. After a slight decline after 1995, the share of women lies around 15% from the year 2000 and onwards.

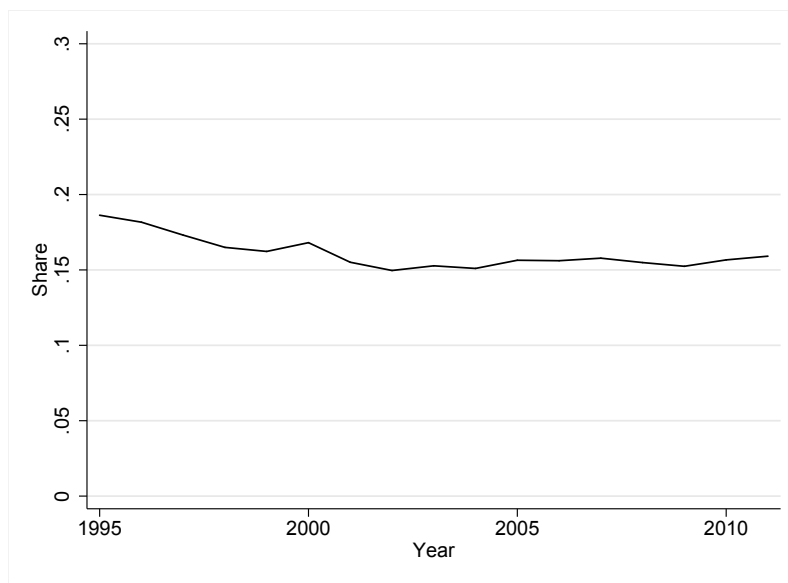


Figure 1: Share of female directors on corporate boards of Danish firms, 1995-2011.

B The appointed individual directors

Before probing into how networks associate with appointments to boards of directors, we want to know who the directors in our sample are. Table 6 shows that they are slightly older and have more years of labour market experience compared to the individual managers (Table 4). 18% have a STEM+ education, which is much higher than for the entire sample. On average, a director sits on 1.4 boards and have about seven years of experience as a director.⁵

Table 6: Individual characteristics of directors, 1995-2011.

	All directors		Male directors		Female directors	
	Mean	Std.	Mean	Std.	Mean	Std.
No. Boards	1.434	1.148	1.457	1.182	1.169	0.556
No. Chairmanships on a board	0.235	0.675	0.246	0.695	0.109	0.349
Exp. as board member	7.059	4.576	7.096	4.583	6.624	4.470
Labour market experience	22.601	10.261	22.768	10.340	20.639	9.061
Exp. as CEO	1.818	2.940	1.902	2.998	0.835	1.880
Exp. as OTE	1.431	2.447	1.420	2.435	1.556	2.581
Age	51.329	10.000	51.501	9.981	49.311	10.000
Share in STEM +	0.184	0.388	0.195	0.396	0.054	0.226
Observations	129822		119640		10182	

Accounting for the individual characteristics, we explore how the number of network connections associates with the probability of getting into a board of directors and whether this effect differs by gender.

VI. Measuring the effect of network size on appointment probability

To understand the relationship between the size of co-worker networks and appointments into corporate boards, we first test this in a linear regression framework. Because we

⁵The variable “experience as a board member” includes the years in which a person has sat on at least one board. The variable is a point-in-time- measure of experience in the sense that it does not reflect the average duration of a completed board position (spell). Instead, using the notation from spell-analyses, it suffers from an interruption bias (the spell is not completed) as well as a length bias (board positions with a long duration tend to be overrepresented in our sample).

have no credible identification strategy for accounting for the endogeneity of network formation, we view these analyses as descriptive and exploratory attempts to provide the first documentation of network size and the likelihood of being appointed to a board of director using a large population data.

$$P_{i,j,t} = \alpha + N'_{i,j,t-1}\beta + (W_i * N_{i,j,t-1})'\gamma + X'_{i,j,t}\delta + \gamma_j + \phi_i + \epsilon_{i,j,t} \quad (1)$$

P_{ijt} captures whether or not individual i working in industry j is appointed to a board of directors for the first time in a year t . Skills or competencies that might matter for appointment can vary depending on which industry the individual is a manager in. $W_i = 1$ if the individual i is a woman, 0 otherwise. X_{ijt} is a set of time-varying individual and firm-specific control variables. N_{ijt-1} is a vector of variables of the size of the respective networks for i at time $t - 1$. In the estimations, we interact the respective network variables with a dummy variable for being a woman. ϕ_i is the time constant individual effect.

We use the following vector of control variables: First, the group of individual *family controls* include a dummy variable for whether the individual is married or not, the number of children and the age of the youngest child. We employ a set of *employer controls* describing the firm where the individual is employed, including the size of the firm, the size squared, the share of women employed in the firm, a dummy for whether the firm is family-run or not, and a dummy for whether the firm is within the public sector or not. Firms with two or more family members in the board of directors or in the executive suite are considered a family-run firm. We use *industry fixed effects*, through dummy variables for the respective industry where the individuals have their workplaces. We have five industry categories: Primary, Manufacturing, Trade and Transport, Finance

and Private Services, and Other. Further, we include the following *human capital controls* age, age squared, years of labour market experience and experience squared, being a CEO or Other Top Executive and the experience of being a CEO or OTE. Here, we include occupational fixed effects by six dummies reflecting different job categories: Human resources, Finance, Sales, IT and R&D, Production, and Other. To take educational type into account, we use seven education categories: No education, Humanities, Social sciences, Natural sciences, Technical and Engineering, Health Sciences, and Vocational education. In some estimations, the alternative variable STEM+ is included.

Most individuals in the labour market are never appointed to a corporate board, and a linear approximation might not be the ideal specification for a binary outcome. But, considering the size and nature of our sample, we prefer a linear model, see discussion in Angrist and Pischke (2009) for an extended discussion. Though individual fixed effects reduce the omitted variable bias, we cannot account for time-variant omitted variables.⁶

A Gender and network effects on appointments to a board of directors

Columns one and two of Table 7 present OLS regressions of the probability of being appointed to a first board, without and with covariates and columns three and four show the results with individual fixed effects. The estimations include individuals who are potentially ‘at risk’ of becoming appointed, who have not yet obtained a board position in year t-1, and thus, the variable board network is not included in the estimations. Columns 5-8 show OLS and FE estimations, respectively for any appointments.

The estimated gender gap is about 0.13% in first-time appointments (column 2). The overall appointment rate was 0.34 (0.09)% for men (women) implying that a sizable part of the gender gap (around 50%) is ‘explained’ by network variables and individual characteristics (Table 2). The estimated network effects in the fixed effect estimations

⁶A separate concern is the interaction effects in non-linear models being difficult to interpret as marginal effects (Williams, 2009). Also, a conditional fixed-effects logit only utilize the individuals that change the status of the dependent variable, i.e. the estimation would not include the individuals that never become director.

where gender only go through the interaction term resemble that of the OLS. In the fixed-effect estimations in column four, any additional network connection is positive for the probability of the first-time appointment for men. It also holds for women, except for the coworker executive network where the effect is negative for women (adding the interaction coefficients and the network coefficients for the respective networks). The interaction terms of gender and connections are negative for all network types, implying that women's networks are, on average, less efficient compared to those of men. If men expand their coworker board network, it increases their future probability of being appointed for the first time by 0.033 percentage points.

Considering the baseline allows us to shed light on the effect of the network coefficients. Suppose we think that men and women can be considered as separate recruitment pools, then the effect of an additional network connection is calculated using their respective baseline appointment rates. The male average appointment rate is 0.34% (see Table 2). Additional coworkers who become a board member thus increases his probability of being appointed to a board of directors for the first time with 0.033 percentage points or 10%. For women, the baseline is lower, 0.09% (see Table 2), and the effect of additional coworker board connections are also lower compared to that of men. If women have additional coworkers who becomes board members, she increases her probability of getting appointed with 0.011 percentage points or 12% – suggesting a substantial effect of network connections for both men and women. The impact of the executive network is by far the largest for both men and women, compared to other network relations. Additional colleagues that are executives increase the chances with 0.24 percentage points for men (70%) and $0.24 - 0.6 = 0.18$ percentage points for women (200%). Hence, additional executives in the network double women's chances of being appointed into a board of directors for the first time.

The critical channel for a woman to get her first appointment seems to be the executive-suite and holding a top executive position. The effect on first-time appoint-

ments of being a CEO is 0.004 percentage points larger compared to being a lower management position (POP) – or 190 % using the overall appointment rate of 0.21 %. An additional year of experience as a CEO (or OTE) increases the probability of becoming a first-time director with 0.010 percentage points or 470%.⁷

The network mechanisms behind selection into any board (first and subsequent) seem to differ from the first-time appointments. Here, executive network connections do not seem to increase the chances of being promoted. Column 8 show that in the FE estimation, one more connection to another director (board network) increases the chance of another board position by 0.09 percentage points for men, and there seem to be no gender differences in this effect. For the coworker network and executive network variables, the coefficients are numerically much smaller and insignificant. An additional coworker executive connection, however, increases the chance of a board position by 0.03 percentage points for men, while it decreases the chances by 0.004 percentage points for women. The gender difference is significant. For appointments to any board, there are some interesting differences between OLS and FE estimations. In general, the OLS coefficients tend to be larger and more positive compared to the FE coefficients. The variable ‘number of board positions’, which the individual holds before a new appointment, displays this pattern. In the OLS regressions, the coefficient is positive. At the same time, it is significantly negative in the FE estimation, reflecting that individuals with many board positions seem to have unobservable skills which imply that they tend to become more often appointed than individuals with few board positions, echoing Adams (2017) and a recent unpublished manuscript by Matveyev (2016). For women, this effect is even larger than for men. The interaction term between the woman dummy and number of boards is significantly negative, indicating that female board members

⁷We test whether this result is due to differences between male and female experience as an executive. Tables 14 and 15 in the Appendix include interactions between gender and experience as an executive, CEO or other Top Executive respectively. It does not change the results of the network effects; the effect of a network size is still lower for women. The effect of having experience as a CEO on the appointment probability is positive, but smaller for women compared to that of men. The experience as Other Top Executive does not display the same gendered pattern.

are less probable than their male peers to get new board positions. When controlling for the unobserved time constant individual heterogeneity, board members with more positions tend to have a lower chance of a new board position, and this negative effect is significantly more negative for female board members compared to male peers. Thus, board members (mainly male board members) with many positions seem to have high chances of new appointments because of unobserved abilities or board competences, but not because more board positions in itself imply a higher possibility of a new board position.

Draft.

Table 7: OLS and LS-FE: Network and gender in first-time and any appointments.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	First	First	First	First	Any	Any	Any	Any
	time	time	time	time	time	time	time	time
Woman	-0.0016*** (0.0000)	-0.0013*** (0.0001)	-0.0015*** (0.0001)	-0.0014*** (0.0001)	-0.0015*** (0.0001)	-0.0014*** (0.0001)	-0.0015*** (0.0001)	-0.0014*** (0.0001)
Size of Board Network/100					0.4597*** (0.0345)	0.4695*** (0.0345)	0.0917 (0.0469)	0.0924* (0.0469)
Woman \times Size of B.N./100					-0.1490 (0.1096)	-0.1556 (0.1096)	0.1081 (0.1734)	0.1123 (0.1733)
Size of Coworker Board Network/100	0.0465*** (0.0036)	0.0435*** (0.0036)	0.0382*** (0.0040)	0.0333*** (0.0040)	0.0956*** (0.0057)	0.0866*** (0.0057)	-0.0149* (0.0074)	-0.0143 (0.0074)
Woman \times Size of C.B.N./100	-0.0223*** (0.0053)	-0.0168** (0.0053)	-0.0212*** (0.0058)	-0.0222*** (0.0058)	-0.0534*** (0.0082)	-0.0447*** (0.0082)	0.0189 (0.0100)	0.0184 (0.0100)
Size of Executive Network/100	0.1361*** (0.0030)	0.1078*** (0.0052)	0.3777*** (0.0084)	0.2439*** (0.0124)	0.1975*** (0.0039)	0.2560*** (0.0066)	-0.0166 (0.0109)	-0.0108 (0.0163)
Woman \times Size of E.N. /100	-0.0356*** (0.0078)	-0.0250** (0.0078)	-0.1044*** (0.0239)	-0.0635** (0.0238)	-0.0747*** (0.0091)	-0.0477*** (0.0090)	0.0120 (0.0294)	-0.0084 (0.0293)
Size of Coworker Executive Network/100	-0.0087*** (0.0023)	-0.0106*** (0.0024)	0.0066* (0.0026)	0.0035 (0.0026)	-0.0228*** (0.0034)	-0.0210*** (0.0035)	0.0332*** (0.0045)	0.0295*** (0.0045)
Woman \times Size of C.E.N./100	0.0064 (0.0064)	0.0026 (0.0026)	-0.0061 (0.0061)	-0.0086* (0.0061)	0.0135** (0.0061)	0.0068 (0.0068)	-0.0354*** (0.0068)	-0.0333*** (0.0068)

	(0.0035)	(0.0035)	(0.0041)	(0.0041)	(0.0049)	(0.0048)	(0.0063)	(0.0063)
Number of board positions					0.0428***	0.0400***	-0.0313***	-0.0317***
					(0.0012)	(0.0012)	(0.0019)	(0.0019)
Woman × No. of board positions					-0.0206***	-0.0194***	-0.0377***	-0.0380***
					(0.0036)	(0.0036)	(0.0071)	(0.0071)
Chief Executive Officer		0.0246***		0.0043***		0.0149***		0.0102***
		(0.0012)		(0.0011)		(0.0011)		(0.0012)
Other TE		0.0068***		-0.0015***		0.0042***		0.0046***
		(0.0004)		(0.0004)		(0.0005)		(0.0006)
Experience CEO		0.0022***		0.0103***		0.0009***		-0.0015***
		(0.0002)		(0.0004)		(0.0002)		(0.0003)
Experience TE		-0.0009***		0.0004*		-0.0026***		0.0003
		(0.0001)		(0.0002)		(0.0001)		(0.0002)
Family controls	No	Yes	No	Yes	No	Yes	No	Yes
Employer controls	No	Yes	No	Yes	No	Yes	No	Yes
Industry fixed effects	No	Yes	No	Yes	No	Yes	No	Yes
Human capital controls	No	Yes	No	Yes	No	Yes	No	Yes
Individual fixed effects	No	No	Yes	Yes	No	No	Yes	Yes
Observations	4003953	4003953	4003953	4003953	4230150	4230150	4230150	4230150

* $p < 0.05$, ** $p < 0.01$, ***. Standard errors in parentheses.

In sum, the overall pattern from Table 7 suggests that the number of network connections is more important when looking at the first-time appointment compared to any appointment. On the margin, women benefit less than men from a larger number of network connections. One key channel seems to be connections to executive members. In the next sections, we focus on the event of the first appointment.

B Why are the female networks less effective?

The question arising from the results presented above is why women's network connections seem less effective compared to those of men. Earlier empirical studies in the field of business and management indicated that there may be quality differences between men and women's networks in the sense that men form connections with more powerful individuals compared to women (e.g. Zhu and Westphal, 2014; Doldor et al., 2015; O'Neil et al., 2011; Ibarra, 1992). There may also be discriminatory effects at work where female networks are simply valued lower compared to male networks (O'Neil et al., 2011; Ibarra, 1992). In the model by Montgomery (1991) the recruiting agent (the CEO, chairman of supervisory board or nomination committee) may believe that referral on a woman's productivity stemming from female network members is less reliable or of less value for the board than referrals on male peers. That belief might reflect taste discrimination, statistical discrimination or belief-based stereotyping mechanisms in line with Bordalo

et al. (2019). In their paper, they suggest that gender stereotypes contribute to gender gaps in self-assessment and assessment of other's competences.

Similarly, female directors and executives might not help other females to become a director to the same extent as their male counterparts (Eriksson et al., 2015). The reason for this discriminatory behaviour sometimes denoted the 'queen bee syndrome', can be that female board members consider themselves as a minority group. Therefore, it may be too risky for them to refer and help other minority group members (women) in their network. Alternatively, minority groups below the critical mass may have different interaction processes where token mechanisms may explain why female networks are less efficient (Kanter, 1977). The reasons behind women's less effective networks can thus be both supply and demand aspects (Adams, 2017). We cannot separate these aspects in our data, but we can discuss the mechanisms in a heterogeneity analysis.

In this section, we probe into the following aspects: i) the quality and composition of female and male connections, ii) the characteristics of women and men, and iii) the characteristics and behaviour of the recruiting firm. We restrict the results to the first appointment.

B.1 The quality and composition of female and male connections

To capture the quality of the network, we first re-estimated Table 7 using network controlling for the number of indirect connections. We measure the indirect connections of individual i as the unique connections of each of individual i 's respective connections. The individual connection in the second step (a colleague of a colleague) is defined in the same way as the original network measures. The indirect network connection reflects the possible effect of knowing other individuals that in turn, know individuals in powerful positions. The results from this exercise remain qualitatively similar to the results from Table 7 and do not provide any insights on why women's connections are associated with a lower probability of being appointed to a board compared to the connections of men.

See Table 18 in the appendix.

To further analyse the quality of the networks, we look at the type of network connections of men and women. Women’s network connections could, for example, contain a larger share of women compared to male networks, a larger part of relations stemming from non-listed firms, small firms or family firms, and these network connections may for different reasons be less valuable than male connections, or connections coming from large, listed firms.

Table 8: Share of connection characteristics in each network by gender, 1995-2011.

Type of connection	Coworker		Executive		Coworker	
	Board Network		Network		Executive Network	
	Men	Women	Men	Women	Men	Women
Female	0.122	0.183	0.081	0.189	0.089	0.135
Listed firm	0.125	0.123	0.040	0.022	0.080	0.091
Family firm	0.214	0.182	0.330	0.407	0.311	0.305
Large firm	0.664	0.717	0.309	0.204	0.451	0.470

Firms with more than 250 employees are considered large. Firms with two or more family members in the board of directors or in the executive suite are considered a family firm. Parents, children, married couples, siblings and cousins are family.

Table 8 shows that there are differences in the composition of male and female coworker networks. The starkest difference is that women tend to have considerably more female connections compared to their male counterparts – in all networks. Women also have fewer links to listed firms and large firms. The same tendency is seen for executive networks, where women have much more executive contacts from family firms (41% for women and 33% for men), while men have a larger share of relations stemming from large firms. The share with network relations to listed firm executives is by nature small for all, but for men, the amount is double of that for women (4 per cent compared to 2 per cent). For coworker networks, the gender differences are smaller, but still, females tend to have considerably more females in their networks, compared to their male peers.

If network relations to men, listed firms, large firms and non-family firms are considered more valuable – there are thus qualitative differences in male and female network compositions. The critical question is whether this evidence can explain the observed pattern in Table 7? In Table 9, the fixed-effect model on the first appointment is re-estimated, but now estimating separate models for different subsets of networks. In columns 1 and 2, we look at family and non-family connections, columns 3 and 4 at listed firm versus non-listed firm connections, columns 5-6 at links to medium and large firms, and finally in columns 7-8 at male and female connections.

Draft.

Table 9: LS-FE: Network and gender in first-time appointment split by connection characteristics.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Family firm Non-family firm		Listed firm	Non-listed firm	Medium size firm	Large size firm	Male	Female
	connections	connections	connections	connections	connections	connections	connections	connections
C. B. N./100	0.0541*** (0.0118)	0.0299*** (0.0043)	0.0311** (0.0114)	0.0312*** (0.0043)	0.0650*** (0.0103)	0.0238*** (0.0046)	0.0348*** (0.0045)	0.0884*** (0.0151)
Woman × C. B. N./100	-0.0259 (0.0187)	-0.0211*** (0.0062)	-0.0269 (0.0180)	-0.0204*** (0.0060)	-0.0358* (0.0159)	-0.0184** (0.0067)	-0.0234*** (0.0066)	-0.0706*** (0.0187)
E. N./100	0.0206 (0.0155)	0.2228*** (0.0129)	0.2525*** (0.0359)	0.1991*** (0.0122)	0.0526*** (0.0135)	0.2671*** (0.0168)	0.2628*** (0.0134)	0.2395*** (0.0520)
Woman × E. N./100	-0.0885** (0.0325)	-0.0610 (0.0326)	-0.0728 (0.1091)	-0.0609* (0.0242)	-0.0594* (0.0267)	-0.0621 (0.0509)	-0.0488 (0.0285)	-0.2264** (0.0863)
C. E. N./100	0.0052 (0.0056)	0.0060 (0.0033)	0.0320** (0.0112)	0.0036 (0.0027)	0.0088* (0.0042)	0.0074 (0.0041)	0.0043 (0.0029)	0.0423*** (0.0127)
Woman × C. E. N./100	-0.0159 (0.0083)	-0.0104* (0.0053)	-0.0215 (0.0179)	-0.0093* (0.0043)	-0.0169* (0.0067)	-0.0107 (0.0063)	-0.0091 (0.0047)	-0.0556** (0.0175)
Family controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Employer controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Human capital controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4003953	4003953	4003953	4003953	4003953	4003953	4003953	4003953

C.B.N = Coworker board network, E.N. = Executive Network, C.E.N. = Coworker executive network

* $p < 0.05$, ** $p < 0.01$, ***. Standard errors in parentheses.

Table 9 explains part of the question of why female networks seem to be less efficient than male networks for board appointments. In the most powerful network, the executive network, there are large differences between the impact of executive network relations stemming from family firms (no significant coefficient) and from non-family firms, which increases the appointment probability by 0.22 percentage points. Table 8 showed that 41% of female executive network connections come from family firms. In comparison, for men, it was only 33% – possibly explaining part of the negative interaction effect for female executive networks found in Table 7. Also, the coefficient of the executive network in Table 9 is larger for network relations from listed and large firms, i.e. types of network relations which, according to Table 8, are more frequent for men than for women. The same result is found for network connections to males.

Interesting to note is that for these four characteristics of a network, i.e. columns 2, 3, 6 and 7, the female interaction term for executive networks is non-significant. It implies that if women had this type of network, it might be as efficient for them as for their male peers in the appointment process. The same pattern is not found for connections to what might be called the less professional companies (family firms, non-listed firms or smaller firms). Here, the interaction term is negative.

Interestingly, columns 8 show that having female network connections (executives, coworker board or coworker executive network) is beneficial for males in their chances of getting appointed into their first board. But not for women. For all three networks the interaction term is significantly negative and of almost the same size numerically as the positive main network effects for males – implying no positive impact for women from having other females in the network. The network variables we estimate are intimately connected to the work histories of the individuals and the work histories of their respective coworkers. Based on the register data used in this study, we are not able to reveal deeper causes of this effect. Pushing the association further in the next section we view the gendered network effects through the characteristics of the individual.

B.2 The characteristics of women and men

In Table 10 we split the sample by i) whether the individual is an executive, ii) works for a public-sector firm, and iii) is below the age of 50 or not.⁸

Table 10: LS-FE: Network and gender in first-time appointment split by individual characteristics.

	(1)	(2)	(3)	(4)	(5)	(6)
	CEO/OTE	POP	Public sector	Non-public sector	Age < 50	Age \geq 50
C. B. N/100	0.0903 (0.0530)	0.0299*** (0.0037)	0.0275*** (0.0073)	0.0355*** (0.0047)	0.0386*** (0.0060)	0.0221*** (0.0057)
Woman \times C. B. N/100	-0.1002 (0.1322)	-0.0184*** (0.0054)	-0.0215* (0.0099)	-0.0205** (0.0072)	-0.0241** (0.0082)	-0.0162* (0.0079)
E. N. /100	0.3069*** (0.0276)	0.1851*** (0.0095)	0.1069 (0.1429)	0.2402*** (0.0127)	0.2685*** (0.0187)	0.1930*** (0.0222)
Woman \times E. N. /100	-0.1536** (0.0515)	-0.0213 (0.0312)	-0.1369 (0.2754)	-0.0608* (0.0247)	-0.1389*** (0.0288)	0.0533 (0.0601)
C. E. N. /100	-0.0119 (0.0254)	-0.0024 (0.0023)	-0.0077 (0.0062)	0.0014 (0.0029)	0.0029 (0.0038)	-0.0019 (0.0038)
Woman \times C. E. N. /100	0.0382 (0.0568)	-0.0049 (0.0036)	0.0004 (0.0082)	-0.0101* (0.0047)	-0.0071 (0.0054)	-0.0017 (0.0071)
Family Controls	Yes	Yes	Yes	Yes	Yes	Yes
Employer controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Human Capital Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	157568	3846385	987039	3016914	2230597	1773356

C.B.N = Coworker board network, E.N. = Executive Network, C.E.N. = Coworker executive network

* $p < 0.05$, ** $p < 0.01$, ***. Standard errors in parentheses.

⁸We also estimated the effect of below the age of 40 or not. The results are similar and can be viewed in Table 16 in the Appendix.

There are differences between network effects among the groups shown in Table 10. Focusing on the most robust network relation, executive relations, there is a large and positive coefficient for all groups, except for individuals who are employed in the public sector, for men as well as women. The result stands in contrast to the theories saying that women with a different background than traditional board members may have better chances of getting appointed into a board of directors, (Doldor et al., 2015). Male executives seem to benefit from a sizeable executive network – their chances of being appointed increase by 0.31 percentage points from one more relation. According to Table 5, the average first appointment rate for male executives was 4% for CEOs and 1.5% for OTEs, implying that one more executive network relation increases the chance of a new board position by 5-10%. The female interaction effect is significantly negative but since the female first-time appointment rates are also about half the male appointment rates according to Table 5, the relative size of the executive network effect is about the same for male and female executives. This case also holds for young females aged less than 50. Young males face a mostly positive and significant effect from more executive network relations. The female interaction effect is significantly negative, indicating that the impact for a young female executive is positive but smaller compared to that of their male counterparts (0.2685-0.1389). Thus, the individual characteristics do not seem to be a critical underlying explanation of why women’s networks are less effective.

B.3 The characteristics of the recruiting firms

Turning to the characteristics of the private sector firms to understand why women’s networks seem less effective for board appointments, we split the sample by appointments to various firm types.

First, Denmark has a substantial share of family-run private-sector companies. Confirming Bennedsen et al. (2007) we have a large share of family-run firms in our sample – 42%. In smaller family-controlled firms, board members are often related to the owners

(Bennedsen et al., 2007). The decision-making process, as well as the objective of the boards of family firms, may differ from non-family firms, affecting the gender gaps in recruitment to a board of directors. We define a family-run firm as having two or more family members on the board of directors or among the top executives. We consider parents, children, married couples, siblings and cousins being family.

Second, firms with many employees might use a more formalised recruitment process to recruit new board members compared to smaller firms that usually run the recruitment process internally. Large firms may have nomination committees or use head-hunters. The development of the share of female directors might differ depending on the size of the firm. Figure 2 shows the percentage of female directors separately for medium-sized firms with 50-250 employees and large-sized firms with more than 250 employees. The share of female directors is lower among the larger firms compared to the medium-sized firms, but the groups are converging across time. Larger firms have increased their share of female directors since the year 2005, while the female share has slightly decreased for medium-sized firms.

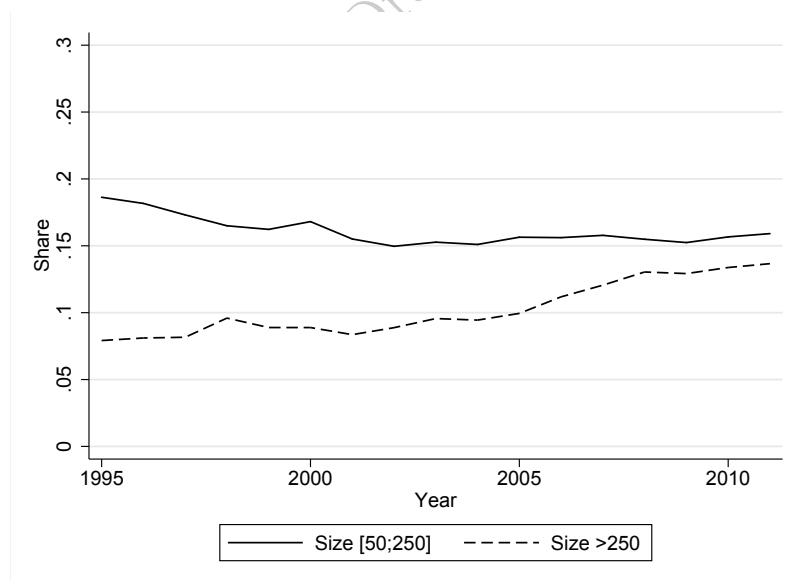


Figure 2: Share of women on corporate boards, split by size of firm.

Third, also listed and non-listed firms have different recruitment processes compared to non-listed firms. In our sample, only three percent of the firms are listed. Table 13 provide descriptive figures of the recruiting firms.

Previous literature suggests that women are more focused on strong ties, such as family-related or close friendships, rather than weak ties. However, our results indicate that female network relations are, in contrast, less effective in family firms compared to non-family firms concerning appointments into the board of directors of these companies. A clear pattern for appointments to listed and large firms compared to non-listed and smaller firms emerges in Table 11. For men, network relations are less effective in recruitment to listed and large firms compared to non-listed and medium-sized firms. Further, for the listed and large firms, all the female network interaction effects are insignificant. At the same time, they tend to be significant and negative for smaller and medium-sized firms and non-listed firms. The result suggests that the size of professional networks might play less of a role in appointments of directors in larger firms and listed firms compared to smaller and non-listed firms. The professional search firms might not use the professional network contacts of the directors and executives of the firm in the selection of potential candidates. The smaller and non-listed firms seldom use headhunters or nomination committees and using search firms seem to lead more women to be appointed (Adams, 2017, p.62). The evidence presented in Table 11 proposes that these firms are more subject to unconscious bias or gender stereotypes about women (Fernandez-Mateo and Fernandez, 2016) compared to other firms.

Table 11: LS-FE: Networks and gender in first time appointments split by characteristics of the recruiting firm, 1995-2011.

	(1)	(2)	(3)	(4)	(5)	(6)
	Family firm	Non-family firm	Listed firm	Non-listed firm	Medium firm	Large firm
C.B.N./100	0.0104*** (0.0022)	0.0235*** (0.0034)	0.0021** (0.0007)	0.0314*** (0.0040)	0.0223*** (0.0030)	0.0065*** (0.0017)
Woman \times C.B.N./100	-0.0100** (0.0033)	-0.0122* (0.0049)	-0.0025 (0.0014)	-0.0199*** (0.0056)	-0.0178*** (0.0042)	-0.0025 (0.0025)
E.N./100	0.0632*** (0.0081)	0.2013*** (0.0100)	0.0035** (0.0012)	0.2414*** (0.0124)	0.1456*** (0.0095)	0.0636*** (0.0050)
Woman \times E.N./100	-0.0491*** (0.0120)	-0.0276 (0.0209)	-0.0010 (0.0018)	-0.0632** (0.0238)	-0.0386* (0.0179)	0.0015 (0.0118)
C.E.N./100	0.0018 (0.0016)	0.0032 (0.0022)	-0.0005 (0.0003)	0.0041 (0.0026)	0.0007 (0.0020)	0.0012 (0.0010)
Woman \times C.E.N./100	-0.0029 (0.0023)	-0.0074* (0.0035)	-0.0003 (0.0006)	-0.0083* (0.0041)	-0.0008 (0.0032)	-0.0034 (0.0018)
Family controls	Yes	Yes	Yes	Yes	Yes	Yes
Employer controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Human capital controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4003953	4003953	4003953	4003953	4003953	4003953

C.B.N = Coworker board network, E.N. = Executive Network, C.E.N. = Coworker executive network

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ Standard errors in parentheses.

In sum, our results suggest that women's network sizes have less of an impact on board appointments since their network composition differs from that of men. Men

seem to have connections to listed and larger firms as well as to other men. From the perspective of the recruiting firm, we see that the gendered effect is mostly present in family firms, medium-sized firms and non-listed firms. The impact of networks across individual qualifications does not seem to vary substantially. For example, the relative size of the effect of networks for executives vs non-executives is similar for women and men.

So far, we have investigated the association between the size of networks and appointments to supervisory boards using a sample of individual managers. We can only observe the links, not establish whether any of the links were used in the appointment process. To understand whether a director with a link differs from a director without a link, in the next section, we compare their formal qualifications.

VII. Formal qualifications of directors with and without network relations.

We look at the sample of recruited directors and ask if being recruited through a connection requires less formal qualifications compared to being recruited without such a link and whether this is gendered. Previous network literature has suggested that referrals through network connections can serve as a substitute for formal qualification for a job. Employees hired through network connections have less formal and more informal qualifications compared to others (Montgomery, 1991; Hensvik and Skans, 2016). The result by Hensvik and Skans (2016) suggests that when firms hire individuals for regular high-skilled jobs, firms substitute formal ability with unobserved ability. Employees hired through referrals have less formal ability and more unobserved ability compared to others. We cannot directly measure whether a link to an incumbent director implies a referral, and we do not have an explicit measure of unobserved skills. Still, we can compare the level of formal qualification between the group of directors who got promoted

having a connection with incumbent director of the recruiting firm and the group that did not have such a connection. We cannot, however, tell if they have higher unobserved capabilities compared to other directors.

If there is a substitution when corporate firms recruit directors to boards, we should observe that the directors recruited by referrals (with a connection) have less formal education compared to the other directors. Women tend to have higher formal education than their male peers, but much fewer network connections to incumbent board members, and they are much more seldom to find in the executive suites. Thus, it is an essential question whether formal human capital competencies can substitute for network relations? To this end, we estimate the following model within the pooled sample of first-time directors:

$$Q_{i,t} = \gamma_0 + \gamma_1 \text{Connection}_{i,t-1} + \gamma_2 \text{Woman}_{i,t} + \gamma_3 \text{Connection}_{i,t-1} * \text{Woman}_{i,t} + X'_{i,t} \gamma_4 + \epsilon_{i,t} \quad (2)$$

Qualifications (Q) are measured as years of labour market experience, share in STEM+ education, years of experiences as an OTE and as a CEO. $\text{Connection}_{i,t-1}$ is a variable assuming the value one if the entrant director in the period before being appointed was connected to at least one of the incumbent board members or executive members of the specific firm to which he or she was recruited. $W_{i,t}$ is a variable for individual i being a woman, and the $X_{i,t}$ is a set of individual and firm characteristics, year dummies and industry dummies, and $\epsilon_{i,t}$ is the error term.

Table 12 shows the results for the executive board network. First, we note that, for the set of first-time directors without a connection, females compared to males have lower qualifications.

Table 12: OLS. Does network connections substitute formal qualifications? First-time promotions

	(1)	(2)	(3)	(4)
	Exp.	STEM + Exp.	as CEO	Exp. as OTE
Woman	-1.7009*** (0.1598)	-0.0090** (0.0032)	-0.0651*** (0.0126)	-0.0735*** (0.0189)
Executive Connection	0.1274 (0.2567)	-0.0110* (0.0056)	0.0900 (0.0688)	1.0197*** (0.0948)
Woman \times Executive Connection	2.9551*** (0.6617)	0.0033 (0.0098)	-0.0949 (0.1232)	-0.2144 (0.2264)
Full set of controls	Yes	Yes	Yes	Yes
Observations	20144	20144	20144	20144

* $p < 0.05$, ** $p < 0.01$, ***. Standard errors in parentheses.

Table 12 suggests that first-time male directors with a direct executive connection have a slightly lower share of STEM+ degree but more years of experience as an OTE compared to male directors without such a connection. For these two outcomes, the same is true for women – the gender gap is not significant. As for years of labour market experience, women with a connection to an incumbent director have about three more years of experience compared to female directors without such a link ($0.29551 + 0.1274$). There is no such gap for men. Expanding the sample to include all promotions, not only the first time, we find similar results for the executive network connections. See Table 17 in the Appendix.

Summing up, the results from Table 12 suggest no straightforward substitution between formal qualifications and network connections. If anything, first-time female directors that had a link have more labour market experience compared to first-time female directors hired through other means, while there is no such difference for male directors.

VIII. Discussion and conclusion

It is well known that network connections matter for recruitment to regular jobs as well as for individuals finding a job (e.g. Granovetter, 1973). Still, there is little empirical evidence on how networks associate to recruitment into top positions, and in particular, the gender gap therein. Recruitment to leadership positions and particularly positions as directors of corporate supervisory boards is seldom publicly announced in the market, and firms often rely on connections of the CEO or other top executives and incumbent directors (Granovetter, 2017).

We investigate how the size of professional networks can affect the probability of becoming member of a board of directors in a corporate firm and whether this effect differs between men and women. We have a large employer-employee data set of the Danish labour market, covering the period 1995-2011. The share of female directors in Danish firms has been stable at around 15% during this period. By using individual work histories, identifying individuals who are directors and match them with other directors and their work colleagues, we define four measures of networks, capturing the size of each network: i) *coworkers board network*, which are coworkers who have become a director within the subsequent three years, ii) *executive network* which is the cumulative number of connections to other top executives in past and present jobs, iii) *co-worker executive network* are coworkers who have become top executives within the subsequent three years and iv) *board network* which is the number of unique relations in a given year to other board members (only defined for individuals who have had at least one board position).

Possible endogeneity of network formation makes it difficult to identify the causal impact of the size of connections on promotions (Manski, 1993). Unobserved heterogeneity might bias our results of network size. Some individuals might have a high ability to be recruited and an increased ability to form useful networks, for example, by choice of

workplace. Managers may be more able than others and thus more likely to end up as a director in a large firm. The sample is restricted to managers to in part account for this concern. Also, firms with specific features might recruit directors with particular characteristics. A firm with a liberal corporate culture might be more inclined to bring women in as directors or a firm that face challenges might look for a director well-connected to the executives or directors of other firms. Looking into sub-samples of connections of the individuals as well as sub-samples of firms, we try to limit this concern. Although we cannot claim a causal relationship, the richness of our administrative data delivers large variability. It allows for an exciting investigation of the association of networks and recruitment to boards. To our knowledge, this paper is one of the first to probe into how the size of professional networks associated with the gender gap in director promotions.

We show that during the period 1995-2011, there are, on average more women than men without a positive professional network, and there is a stable gender gap with a male advantage in the number of connections in all four networks. Our main finding is that having more connections to executives or to coworkers who are board members or executives increases the probability of getting promoted into a supervisory board. The results are gendered with a larger return to networks for men compared to women. The effect is particularly robust when looking at first-time promotions.

We suggest that one fundamental reason why women's networks are less efficient in bringing them promotions is that the characteristics of men's and women's networks differ – reflecting gendered work histories. Men have relatively more male network connections and women tend to have somewhat more female connections for all four types of networks. Men also tend to have relatively fewer network connections related to family firms and more relations to large firms and listed firms, compared to their female peers. These characteristics are central to the efficiency of the network. The results reveal that the positive network effects are larger for connections related to listed firms, large firms and non-family firms – the under-represented characteristics in women's network

relations. We also investigate the quality of having male or female network connections. Here, we do not find much difference between male and female network relations for men – both networks tend to have significantly positive effects on promotion chances. However, for women, it is different: Male network relations increase their chances of being promoted, while female network relations tend not to affect women’s chances of board appointments. Thus, having female network relations only favours men but has a significantly lower effect on female potential board member’s chance of becoming appointed to a board. One hypothesis may be that women as a minority group are reluctant to refer to other women because this may be considered riskier than to refer to a majority group member, a man. This might be an exciting avenue for future research.

To understand if directors with a connection differ from other directors and whether this is gendered, we investigate whether having a tie to someone in a top position of the firm the year before becoming a director is associated with different qualifications compared not having such a connection. Previous studies on regular job appointments showed that workers with a tie to an incumbent coworker had lower formal qualifications and higher unobserved (to the employer) capabilities than workers without such a link (Hensvik and Skans, 2016). That result, however, does not seem to carry over to board appointments. We find no indication of the substitution of formal qualification for network connections. Our study suggests that female directors with an executive tie to the recruited firm prior to being appointed director also tend to have more extended labour market experience. There is no such gap for men. It might again reflect a risk of referring a member of a minority group (a woman). Future studies could investigate if individuals in top positions face a higher risk of punishment if the referral was not a good match, such as lower future appointments.

In conclusion, this study shows no easy way for women to enter the board room. The large group of female managers will probably also in the future have difficulties in getting the same board positions as their male counterparts who tend to occupy the executive

suites, despite having accumulated educational and labour market experience in the last decades. From this perspective, one solution is to increase women's connections to other board members by a binding gender quota for the board of directors like Norway, Iceland and many other European countries. However, unless the quota covers the vast number of family-owned firms and other non-listed companies, it may not make much difference for most companies and potential female board members. Alternatively, policies minimizing gender stereotypes and statistical discrimination may be the right instrument – though these types of policies are probably much more complicated to implement in practice and have a much longer time perspective than gender quotas for the board of directors. The use of headhunting in parts of the appointment process firms might be one such avenue. To design an effective policy, we need future research to dig further into the black box of the gendered process of networks and board promotions.

Draft.

Bibliography

- Adams, Renée B. 2017. Boards, and the directors who sit on them. In *The handbook of the economics of corporate governance*, vol. 1. Elsevier, 291–382.
- Adams, Renée B and Patricia Funk. 2012. Beyond the glass ceiling: Does gender matter? *Management Science* 58 (2):219–235.
- Adams, Renée B, Benjamin E Hermalin, and Michael S Weisbach. 2010. The role of boards of directors in corporate governance: A conceptual framework and survey. *Journal of Economic Literature* 48 (1):58–107.
- Adams, Renée B and Tom Kirchmaier. 2016. Women on boards in finance and stem industries. *American Economic Review* 106 (5):277–81.
- Angrist, Joshua and Jörn-Steffen Pischke. 2009. *Mostly harmless econometrics: an empiricists guide*. Princeton: Princeton University Press.
- Bennedsen, Morten, Kasper Meisner Nielsen, Francisco Pérez-González, and Daniel Wolfenzon. 2007. Inside the family firm: The role of families in succession decisions and performance. *The Quarterly Journal of Economics* 122 (2):647–691.
- Bertrand, Marianne, Claudia Goldin, and Lawrence F Katz. 2010. Dynamics of the gender gap for young professionals in the financial and corporate sectors. *American Economic Journal: Applied Economics* 2 (3):228–255.
- Bjerk, David. 2008. Glass ceilings or sticky floors? statistical discrimination in a dynamic model of hiring and promotion. *The Economic Journal* 118 (530):961–982.
- Blau, Francine D and Lawrence M Kahn. 2017. The gender wage gap: Extent, trends, and explanations. *Journal of Economic Literature* 55 (3):789–865.
- Bordalo, Pedro, Katherine Coffman, Nicola Gennaioli, and Andrei Shleifer. 2019. Beliefs about gender. *American Economic Review* 109 (3):739–73.

- Brown, Meta, Elizabeth Setren, and Giorgio Topa. 2016. Do informal referrals lead to better matches? evidence from a firm's employee referral system. *Journal of Labor Economics* 34 (1):161–209.
- Burke, Ronald J. 1997. Women on corporate boards of directors: A needed resource. *Journal of Business Ethics* 16 (9):909–915.
- Calvo-Armengol, Antoni and Matthew O Jackson. 2004. The effects of social networks on employment and inequality. *The American Economic Review* 94 (3):426–454.
- Casella, Alessandra and Nobuyuki Hanaki. 2006. Why personal ties cannot be bought. *American Economic Review* 96 (2):261–264.
- Doldor, Elena, Susan Vinnicombe, Renuka Hodigere, and Diana Bilimoria. 2015. Human capital and professional network effects on women's odds of corporate board directorships. *Gender in Management: An International Journal* 30 (7):523–550.
- Dunn, Paul. 2012. Breaking the boardroom gender barrier: the human capital of female corporate directors. *Journal of Management & Governance* 16 (4):557–570.
- Dustmann, Christian, Albrecht Glitz, Uta Schönberg, and Herbert Brücker. 2016. Referral-based job search networks. *The Review of Economic Studies* 83 (2):514–546.
- Erhvervsstyrelsen. 2017. Lov om måltal og politikker for det underrepræsenterede køn, evalueringsrapport 2017. <https://www.ft.dk/samling/20171/almde1/ERU/bilag/164/1882904.pdf>, Last access on 2021/01/15.
- Eriksson, Karin Hederos, Lukas Kvissberg, Erik Polano, and Anna Sandberg. 2015. Gender dynamics in referral-based hiring: A field experiment .
- Fernandez, Roberto M and M Lourdes Sosa. 2005. Gendering the job: Networks and recruitment at a call center 1. *American Journal of Sociology* 111 (3):859–904.

- Fernandez-Mateo, Isabel and Roberto M Fernandez. 2016. Bending the pipeline? executive search and gender inequality in hiring for top management jobs. *Management Science* 62 (12):3636–3655.
- Galenianos, Manolis. 2013. Learning about match quality and the use of referrals. *Review of Economic Dynamics* 16 (4):668–690.
- Goldin, Claudia. 2014. A grand gender convergence: Its last chapter. *The American Economic Review* 104 (4):1091–1119.
- Granovetter, Mark. 1995. *Getting a job: A study of contacts and careers*. University of Chicago Press.
- . 2017. *Society and economy: Framework and principles*. Harvard University Press.
- Granovetter, Mark S. 1973. The strength of weak ties. *American Journal of Sociology* 78 (6):1360–1380.
- Guedj, Ilan and Amir Barnea. 2009. Director networks. In *Efa 2007 ljubljana meetings paper*.
- Hensvik, Lena and Oskar Nordström Skans. 2016. Social networks, employee selection, and labor market outcomes. *Journal of Labor Economics* 34 (4):825–867.
- Holzer, Harry J. 1987. Informal job search and black youth unemployment. *The American Economic Review* 77 (3):446–452.
- . 1988. Search method use by unemployed youth. *Journal of Labor Economics* 6 (1):1–20.
- Ibarra, Herminia. 1992. Homophily and differential returns: Sex differences in network structure and access in an advertising firm. *Administrative Science Quarterly* :422–447.

- Kanter, Rosabeth Moss. 1977. Some effects of proportions on group life. In *The gender gap in psychotherapy*. Springer, 53–78.
- Kramarz, Francis and Oskar Nordström Skans. 2014. When strong ties are strong: Networks and youth labour market entry. *The Review of Economic Studies* 81 (3):1164–1200.
- Kramarz, Francis and David Thesmar. 2013. Social networks in the boardroom. *Journal of the European Economic Association* 11 (4):780–807.
- Kunze, Astrid and Amalia R Miller. 2017. Women helping women? evidence from private sector data on workplace hierarchies. *Review of Economics and Statistics* 99 (5):769–775.
- Leclercq Vrang, Anna and Richard B. Larsen. 2018. Bestyrelsesformænd: Vi skal have flere kvindelige topledere. *DI Analyse* .
- Loury, Linda Datcher. 2006. Some contacts are more equal than others: Informal networks, job tenure, and wages. *Journal of Labor Economics* 24 (2):299–318.
- Manski, Charles F. 1993. Identification of endogenous social effects: The reflection problem. *The review of economic studies* 60 (3):531–542.
- Marmaros, David and Bruce Sacerdote. 2002. Peer and social networks in job search. *European Economic Review* 46 (4):870–879.
- Marsden, Peter V and Karen E Campbell. 1990. Recruitment and selection processes: The organizational side of job searches. *Social Mobility and Social Structure* :59–79.
- Matveyev, Egor. 2016. The labor market for corporate directors. *Available at SSRN 2667968* .
- Mencken, F Carson and Idee Winfield. 1999. Employer recruiting and the gender composition of jobs. *Sociological Focus* 32 (2):201–220.

- Miller, Amalia R. 2018. Women and leadership. *The Oxford handbook of women and the economy* :539–559.
- Montgomery, James D. 1991. Social networks and labor-market outcomes: Toward an economic analysis. *The American Economic Review* 81 (5):1408–1418.
- Mortensen, Dale T and Tara Vishwanath. 1994. Personal contacts and earnings: It is who you know! *Labour economics* 1 (2):187–201.
- O’Neil, Deborah A, Margaret M Hopkins, and Sherry E Sullivan. 2011. Do women’s networks help advance women’s careers? *Career Development International* .
- Oxelheim, Lars, Aleksandra Gregorič, Trond Randøy, and Steen Thomsen. 2013. On the internationalization of corporate boards: The case of nordic firms. *Journal of International Business Studies* 44 (3):173–194.
- Oyer, Paul and Scott Schaefer. 2011. Firm/employee matching: An industry study of american lawyers .
- Pallais, Amanda and Emily Glassberg Sands. 2016. Why the referential treatment? evidence from field experiments on referrals. *Journal of Political Economy* 124 (6):1793–1828.
- Phelps, Edmund S. 1972. The statistical theory of racism and sexism. *The American Economic Review* 62 (4):659–661.
- Sheridan, Alison and Gina Milgate. 2005. Accessing board positions: A comparison of female and male board members’ views. *Corporate Governance: An International Review* 13 (6):847–855.
- Simon, Curtis J and John T Warner. 1992. Matchmaker, matchmaker: The effect of old boy networks on job match quality, earnings, and tenure. *Journal of Labor Economics* 10 (3):306–330.

- Singh, Val and Susan Vinnicombe. 2004. Why so few women directors in top uk board-rooms? evidence and theoretical explanations. *Corporate Governance: An International Review* 12 (4):479–488.
- Smith, Nina and Pierpaolo Parrotta. 2018. Why so few women on boards of directors? empirical evidence from danish companies in 1998–2010. *Journal of Business Ethics* 147 (2):445–467.
- Smith, Nina, Valdemar Smith, and Mette Verner. 2013. Why are so few females promoted into ceo and vice president positions? danish empirical evidence, 1997–2007. *Industrial & Labor Relations Review* 66 (2):380–408.
- Terjesen, Siri, Ruth Sealy, and Val Singh. 2009. Women directors on corporate boards: A review and research agenda. *Corporate Governance: An International Review* 17 (3):320–337.
- Williams, Richard. 2009. Using heterogeneous choice models to compare logit and probit coefficients across groups. *Sociological Methods & Research* 37 (4):531–559.
- Zhu, David H and James D Westphal. 2014. How directors' prior experience with other demographically similar ceos affects their appointments onto corporate boards and the consequences for ceo compensation. *Academy of Management Journal* 57 (3):791–813.

A Appendix

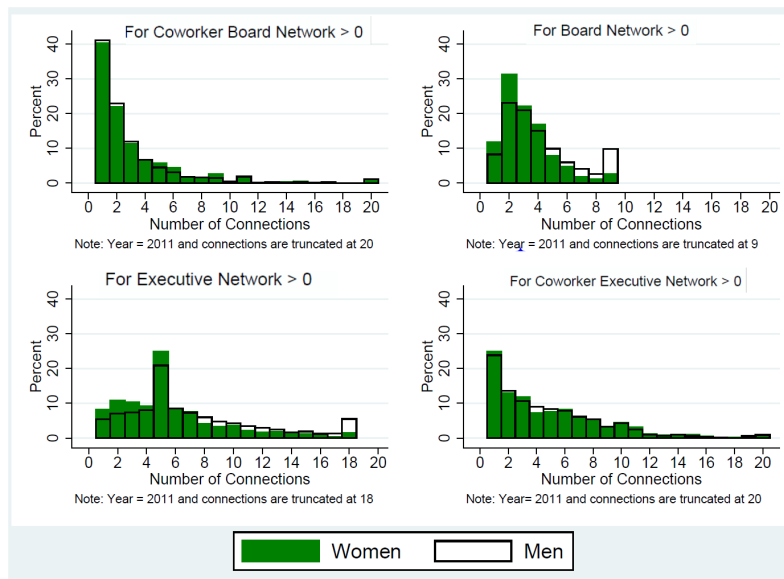


Figure 3: Distribution of the number of network connections for men and women, given a positive network in 2011.

Draft.

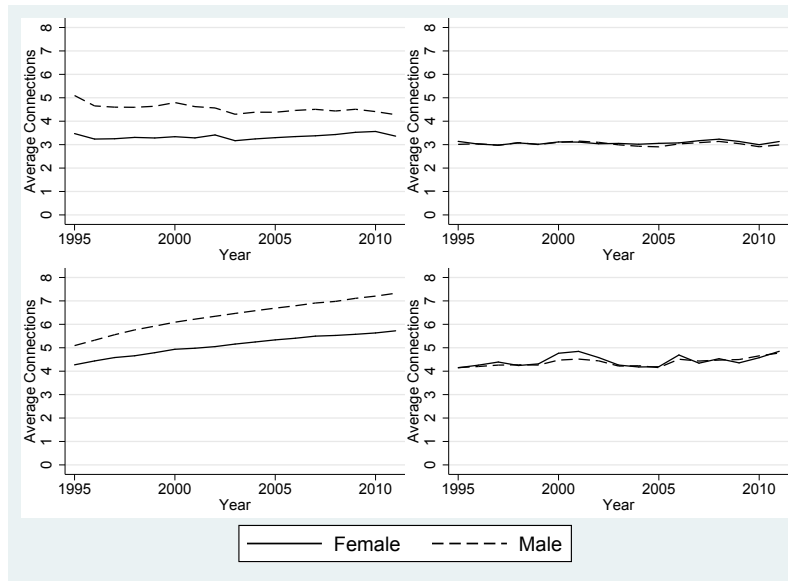


Figure 4: Average number of connections given a positive network in the Danish labour market split by gender, 1992-2011. The top left corner depicts the board network, the top right corner the coworker board network, the bottom left corner the executive network, and the bottom right corner the coworker executive network.

Table 13: Descriptive statistics of the recruiting firms, 1995-2011

	Mean	Std.
No. employees	218.443	716.647
Share of female employees	0.322	0.218
Listed firm	0.029	0.169
Family-run firm*	0.421	0.494
<i>Industry</i>		
Primary	0.166	0.372
Manufacturing	0.327	0.469
Trade and Transport	0.301	0.459
Finance and Private Service	0.155	0.362
Others	0.051	0.221
<i>Board characteristics</i>		
Board size	4.047	1.959
No. female chairmen	0.030	0.170
Observations	56161	

* Family firm is a dummy variable that takes the value 1 if there are two or more family members in the board of directors or in the executive suite. We consider parents, children, married couples, siblings and cousins being family.

Table 14: OLS and LS-FE: First time appointments into a board of directors by networks and gender.

	(1) OLS Appointed	(2) OLS Appointed	(3) LS-FE Appointed	(4) LS-FE Appointed
Woman	-0.0016*** (0.0000)	-0.0013*** (0.0001)		
Scaled Coworker Board Network	0.0463*** (0.0036)	0.0438*** (0.0036)	0.0382*** (0.0040)	0.0332*** (0.0040)
Woman × Scaled Coworker Board Network	-0.0221*** (0.0053)	-0.0172** (0.0053)	-0.0209*** (0.0058)	-0.0218*** (0.0058)
Scaled Executive Network	0.1363*** (0.0030)	0.1091*** (0.0056)	0.3783*** (0.0084)	0.2416*** (0.0130)
Woman × Scaled Executive Network	-0.0358*** (0.0078)	-0.0367** (0.0135)	-0.1050*** (0.0239)	-0.0452 (0.0344)
Scaled Coworker Executive Network	-0.0087*** (0.0023)	-0.0108*** (0.0024)	0.0065* (0.0026)	0.0035 (0.0026)
Woman × Scaled Coworker Executive Network	0.0064 (0.0035)	0.0025 (0.0035)	-0.0062 (0.0041)	-0.0088* (0.0041)
Chief Executive Officer		0.0260*** (0.0013)		0.0046*** (0.0012)
Woman × Chief Executive Officer		-0.0163*** (0.0031)		-0.0046 (0.0029)
Other TE		0.0071*** (0.0004)		-0.0016*** (0.0004)
Woman × Other TE		-0.0022* (0.0010)		0.0007 (0.0010)
Experience CEO		0.0021*** (0.0002)		0.0105*** (0.0004)
Woman × Experience CEO		0.0007 (0.0006)		-0.0032** (0.0012)
Experience Other TE		-0.0010*** (0.0001)		0.0005* (0.0002)
Woman × Experience Other TE		0.0006** (0.0002)		-0.0001 (0.0005)
Family controls	No	Yes	No	Yes
Employer controls	No	Yes	No	Yes
Industry fixed effects	No	Yes	No	Yes
Human capital controls	No	Yes	No	Yes
Observations	4004651	4004651	4004651	4004651

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ Standard errors in parentheses.

Table 15: OLS and LS-FE: Appointments into a new board by networks and gender

	(1) OLS	(2) OLS	(3) LS-FE	(4) LS-FE
Woman	-0.0016*** (0.0001)	-0.0015*** (0.0001)		
Scaled Board Network	1.6003*** (0.0195)	1.5157*** (0.0198)	-0.5767*** (0.0297)	-0.5825*** (0.0298)
Woman × Scaled Board Network	-0.7348*** (0.0644)	-0.7047*** (0.0656)	-0.6820*** (0.1044)	-0.6787*** (0.1045)
Scaled Coworker Board Network	0.0944*** (0.0058)	0.0868*** (0.0058)	-0.0133 (0.0073)	-0.0126 (0.0073)
Woman × Scaled Coworker Board Network	-0.0519*** (0.0082)	-0.0438*** (0.0082)	0.0199* (0.0099)	0.0198* (0.0099)
Scaled Executive Network	0.2244*** (0.0039)	0.2783*** (0.0070)	-0.0324** (0.0109)	-0.0284 (0.0171)
Woman × Scaled Executive Network	-0.0927*** (0.0091)	-0.1515*** (0.0159)	0.0117 (0.0295)	0.0252 (0.0431)
Scaled Coworker Executive Network	-0.0222*** (0.0035)	-0.0206*** (0.0035)	0.0311*** (0.0045)	0.0279*** (0.0045)
Woman × Scaled Coworker Executive Network	0.0132** (0.0049)	0.0062 (0.0049)	-0.0359*** (0.0063)	-0.0343*** (0.0063)
Chief Executive Officer		0.0189*** (0.0011)		0.0083*** (0.0013)
Woman × Chief Executive Officer		-0.0088** (0.0030)		-0.0058 (0.0035)
Other TE		0.0044*** (0.0005)		0.0043*** (0.0006)
Woman × Other TE		0.0004 (0.0011)		-0.0005 (0.0014)
Experience CEO		0.0015*** (0.0002)		-0.0017*** (0.0003)
Woman × Experience CEO		0.0009 (0.0005)		-0.0029* (0.0013)
Experience Other TE		-0.0029*** (0.0001)		0.0005* (0.0002)
Woman × Experience Other TE		0.0020*** (0.0002)		-0.0002 (0.0006)
Family controls	No	Yes	No	Yes
Employer controls	No	Yes	No	Yes
Industry fixed effects	No	Yes	No	Yes
Human capital controls	No	Yes	No	Yes
Observations	4231115	4231115	4231115	4231115

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ Standard errors in parentheses.

Table 16: LS-FE First Appointments by subgroups.

	(1)	(2)	(3)	(4)	(5)	(6)
	CEO/OTE	POP	Public sector	Non-public sector	Age < 40	Age \geq 40
C.B.N./100	0.0908 (0.0529)	0.0298*** (0.0037)	0.0275*** (0.0073)	0.0354*** (0.0046)	0.0343*** (0.0093)	0.0280*** (0.0046)
Woman \times C.B.N./100	-0.1010 (0.1323)	-0.0181*** (0.0054)	-0.0215* (0.0099)	-0.0203** (0.0071)	-0.0147 (0.0122)	-0.0218*** (0.0066)
E.N./100	0.3088*** (0.0275)	0.1862*** (0.0095)	0.1048 (0.1423)	0.2408*** (0.0127)	0.2626*** (0.0368)	0.2309*** (0.0144)
Woman \times E.N./100	-0.1557** (0.0516)	-0.0224 (0.0312)	-0.1362 (0.2750)	-0.0613* (0.0247)	-0.3112*** (0.0408)	-0.0022 (0.0326)
C.E.N./100	-0.0125 (0.0255)	-0.0023 (0.0023)	-0.0077 (0.0062)	0.0014 (0.0029)	0.0056 (0.0055)	-0.0014 (0.0030)
Woman \times C.E.N./100	0.0391 (0.0568)	-0.0050 (0.0036)	0.0004 (0.0082)	-0.0102* (0.0047)	-0.0142 (0.0075)	-0.0057 (0.0049)
Individual Family Controls	Yes	Yes	Yes	Yes	Yes	Yes
Employer controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Human Capital Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	157575	3847076	987047	3017604	956786	3047865

C.B.N = Coworker board network, E.N. = Executive Network, C.E.N. = Coworker executive network

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ Standard errors in parentheses.

Table 17: OLS. Does network connections substitute formal qualifications?

	(1)	(2)	(3)	(4)
	Exp.	STEM + Exp.	as CEO	Exp. as OTE
Panel A: Board Network				
Woman	-1.3091*** (0.1375)	-0.0050 (0.0028)	-0.1862*** (0.0170)	-0.1177*** (0.0201)
Board Connections	0.4076* (0.1980)	0.0180** (0.0059)	0.2925*** (0.0539)	0.1087* (0.0438)
Woman \times Board Connections	1.9211* (0.7618)	0.0187 (0.0235)	-0.1679 (0.1547)	0.2508 (0.2057)
Observations (directors)	38267	38267	38267	38267
Panel B: Executive Network				
Woman	-1.3778*** (0.1388)	-0.0045 (0.0029)	-0.1850*** (0.0171)	-0.1130*** (0.0181)
Executive Connection	0.6531*** (0.1826)	0.0012 (0.0047)	-0.0086 (0.0580)	1.0500*** (0.0647)
Woman \times Executive Connection	2.4368*** (0.5976)	-0.0066 (0.0105)	-0.2370* (0.1174)	-0.0074 (0.2187)
Observations (directors)	38267	38267	38267	38267

* $p < 0.05$, ** $p < 0.01$, ***. Standard errors in parentheses.

Table 18: OLS and LS-FE Regression Coefficients for First Promotion direct and indirect

	(1)	(2)	(3)	(4)
	First	First	First	First
	promotion	promotion	promotion	promotion
Woman	-0.0013***	-0.0013***		
	(0.0001)	(0.0001)		
Board Network/100				
Woman × Board Network/100				
Coworker Board Network/100	0.0240***	0.0191**	0.0333***	0.0344***
	(0.0056)	(0.0063)	(0.0054)	(0.0059)
Woman × Coworker Board Network/100	-0.0170**	0.0064	-0.0217***	-0.0268**
	(0.0053)	(0.0096)	(0.0058)	(0.0097)
Executive Network/100	0.0942***	0.0950***	0.2008***	0.2006***
	(0.0069)	(0.0070)	(0.0152)	(0.0154)
Woman × Executive Network/100	-0.0242**	-0.0327**	-0.0598*	-0.0572
	(0.0078)	(0.0112)	(0.0238)	(0.0311)
Coworker Executive Network/100	0.0005	0.0017	0.0044	0.0024
	(0.0035)	(0.0038)	(0.0037)	(0.0040)
Woman × Coworker Executive Network/100	0.0032	-0.0029	-0.0093*	0.0004
	(0.0035)	(0.0060)	(0.0041)	(0.0066)
Indirect Coworker Board Network/100	0.0042***	0.0052***	-0.0001	-0.0004
	(0.0009)	(0.0011)	(0.0008)	(0.0010)
Indirect Executive Network/100	0.0041**	0.0038*	0.0103***	0.0103***
	(0.0014)	(0.0015)	(0.0023)	(0.0024)
Indirect Coworker Executive Network/100	-0.0034***	-0.0037***	0.0000	0.0006
	(0.0007)	(0.0009)	(0.0008)	(0.0009)
Woman × Indirect Coworker Board Network/100		-0.0048**		0.0014
		(0.0017)		(0.0017)
Woman × Indirect Executive Network/100		0.0034		-0.0004
		(0.0041)		(0.0072)
Woman × Indirect Coworker Executive Network/100		0.0016		-0.0029
		(0.0014)		(0.0015)
Family controls	Yes	Yes	Yes	Yes
Employer controls	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes
Human capital controls	Yes	Yes	Yes	Yes
Observations	4003953	4003953	4003953	4003953

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ Standard errors in parentheses.