How Network Effects Determine the Evolution of Interlocking Directorates

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Abstract:

In inter-organizational networks, some ties matter more than others. Here we argue that the value of a network tie is contingent on the position of this tie in the larger network structure and not only on the attributes of alter. We build a firm-oriented actor-based model of network change to test how such five endogenous and three exogenous effects drive network formation. We use the SIENA package of network analysis to apply our model on the network of interlocking directorates in the Netherlands over the past 15 years. We find strong results for endogenous network effects. Homophily rather than preferential attachment drives the formation of interlocking directorates. And contrary to our expectations, firms do not seek broker positions in the network but prefer to have ties with firms that are already in their direct network neighbourhood. This results in higher levels of cohesion and redundant ties. The strategic behaviour we uncover suggests that firms and their board members seek cohesive elite networks with the high-status business community rather than in-between broker positions.

Keywords: interlocking directorates; boards of directors; corporate governance; network evolution; SIENA

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1. Introduction

The network of the board interlocks constitutes an important organisational resource for the firm (Bazerman & Schoorman, 1983; Ljungquist, 2007). Managers tend to align their external ties with firm strategy, and interlocking directorates provide a means to do this (Geletkanycz & Hambrick, 1997). Subsequently the interaction in these elite social networks are consequential for the strategic decision-making process in boardrooms (Davis & Greve, 1997; Ruigrok, Peck, & Keller, 2006; Stevenson & Radin, 2009). Heracleous and Murray conclude that 'the strategic role of director, and especially interlocking directors, would be more effectively fulfilled if directors consciously create and exploit interlocks to ensure that networks deliver the highest possible strategic benefits to the firms and their partners' (Heracleous & Murray, 2001, p.151). If firms make choices about forming, maintaining or dissolving an interlock, the question is on what basis they make this decision. In this paper we explore how endogenous network effects can determine the evolution of interlocking directorates. Typically, studies try to understand the formation or (dis)continuation of a board tie as a function of firm covariates such as debt or solvency (see for example Mizruchi & Stearns, 1988). The problem with this approach is that there is no clear-cut relation between board interlocks and firm performance. The studies that try to pinpoint this relation have rendered mixed results and are criticized for looking for simple relations in what essentially is a highly complex social context (Dalton, Daily, Johnson, & Ellstrand, 1999; Withers, Corley, & Hillman, forthcoming). We suggest another mechanism that drives network formation. Granovetter (1973) convincingly argued that the strength of (weak) ties comes from their position in the wider network structure. This suggests that when firms engage in board interlocks, they take into consideration that some network ties are strategically more advantageous than others. There are endogenous network effects that drive the evolution of the network of interlocking directorates.

The set of interlocking directorates is an elite social network spanning the 'command posts' of our economies: the 'traditional centres of societal power that regulate, oversee and aim to maintain social order in society and economy' (Zald & Lounsbury, 2010, p.964). This

means that corporate governance goes beyond the confinements of the firm and includes inter-organizational networks as well (see Hambrick, Werder, & Zajac, 2008; Heinze, 2004). This view of corporate governance is in line with a growing understanding among scholars that, 'atomized, price-taking actors, with perfect and symmetrical information assumed by neo-classical theory, did not seem to exist empirically. Social relations seemed to be crucial to the functioning of markets and market actors in a myriad of ways' (Fligstein & Dauter, 2007). When corporate governance is embedded in a network of social elite relations through interlocking directorates, the question is what the underlying generative mechanisms. Without a proper understanding of the generating mechanisms behind network formation all that so often remains are unsubstantiated suggestions of universality based on purely empirical fittings (Stumpf & Porter, 2012). At the same time investigating the generating mechanisms of interlocking directorates also allows us to respond to Zald and Lounsbury who 'encouraged a reengagement with fundamental questions about elites and the organizational infrastructures they operate in and use to wield influence' (Zald & Lounsbury, 2010, p.964). Therefore we investigate the evolution of the network of interlocking directorates over the past 15 years. We take into account both network structure and network process (Wincent, Anokhin, Örtqvist, & Autio, 2010) as the main goal of the paper is to increase our understanding of what drives the formation and evolution of board interlocks.

The contribution of a particular interlock to the network position of a firm is dependent on a number of other network factors: how central is the firm with which the interlock is created, are there already other (indirect) ties with this firm or group of firms, et cetera. We argue that an interlock between two firms is the result of the position of this tie within the wider network structure. In order to test this assumption we introduce a firm-oriented dynamic network approach to study the decline of board interlocks over the period 1996 – 2011. The main actors in the model we developed are the firms. The strategic choices of firms concerning the continuation or dismissal of board ties extend beyond the confinement of that particular tie and are made in relation to the network structure. The relational changes are, at least partly, the result of the structural positions of the actors within the network (Snijders, Van de Bunt, & Steglich, 2010, p.2). Choices are made 'under the assumption that firms are driven by the expected amount of utility derived from the selection of specific partners, taking

the present network configuration and the theoretically desired outcome explicitly into account' (Van de Bunt & Groenewegen, 2007, p.464).

The structure of the network is the dependent variable and we intend to determine the generating mechanisms behind the evolution of the corporate network. Section two suggests eight underlying mechanisms that may drive the formation and (dis)continuation of board interlocks. The first five are endogenous factors: they consider the contribution of a tie within the larger network structure. In addition, we include three exogenous effects that have a likely impact on interlock formation as well. We keep the model relatively simple and straightforward. The purpose is to assess the extent to which the network dynamics that we empirically observe can be explained by these eight basic mechanisms. Section three further explicates the model, including the operationalization of the nine mechanisms and a description of the data and the main properties of the network of interlocking directorates.The empirical case we consider is that of the Netherlands. A small and highly internationalised country, the Netherlands showed high levels of board interlocks during the 1970s, followed by a subsequent and rather rapid decline (Heemskerk, 2007). We built a dataset covering the network of board interlocks among the 250 largest corporations in the Netherlands at four periods in time: 1996, 2001, 2006 and 2011. The methodological tool to map the mechanisms behind the changing states of the network is SIENA (Snijders, 2005), a stochastic actor-driven model. We are not aware of other studies that have used Siena for the longitudinal study of board interlocks before. Subsequently, section four shows the results of the analysis. We first discuss three models that we will reject. The final model we developed turns out to be robust, although some of the results run contrary to what we expected. In the fifth and final section we discuss the implications of the findings for the study of interlocking directorates and for network science and management studies more broadly.

2. Eight drivers of network formation

Decline of the interlocking directorate

Board interlocks were generally considered a legitimate instrument for inter-organizational networking until the 1970s. But with the growing appreciation of the market as coordinating mechanism, board interlocks transformed from an advantage to a liability. Arms-length

flexible relations replaced durable inter-organizational ties such as board interlocks. Multiple directorships were increasingly seen as an impairment to an individual's ability to successfully perform their tasks as director (Davis & Mizruchi, 1999; Heemskerk, 2007). The 'busyness thesis' argues that multiple directorships reduce oversight of management and, as a result, the firm's market value (Ferris, Jagannathan, & Pritchard, 2003, p.2). In a more generalised version, board interlocks are not compliant with good governance and best practices because they increase the power of managers over the shareholders. Thus, a common feature of corporate governance codes is to limit the number of board positions a director can have. Against this backdrop it is not so surprising that the main and recurrent finding of studies that analyse corporate board networks is that by and large, networks of interlocking directorates are in decline (e.g. Carroll & Klassen, 2010; Chu & Davis, 2011; Heemskerk, 2007; Kogut, 2012). With an on-going focus on shareholder value and stock market performance we can expect that in the period under consideration the perceived cost of having an arbitrary interlock has increased. An arbitrary interlock is a link with another firm that does not have a network position or other property that makes it especially attractive to have a tie with. Therefore, the first driving mechanism behind the evolution of board interlocks we anticipate is an overall tendency for firms to be less likely to create arbitrary interlocks. The remaining mechanisms turn to the core question of this paper: what are the mechanisms that determine how the remaining board interlocks are created? The additional endogenous mechanisms that we suggest follow three strategic benefits that board interlocks can create: reputation, brokerage, and social cohesion.

Reputation

If a firm shares board members with another firm that is well respected and has a high status, this status may reflect on the connected firm. This is further enhanced by the high personal status of the director who creates the interlock. Status signalling is important for firms operating in competitive markets. For instance, prestigious boards signalling good reputation have been linked with less under-pricing at initial public offerings (Certo, Daily, & Dalton, 2001). A simple approach of the reputation effect suggests preferential attachment. Preferential attachment is a common feature of complex network dynamics and means that

well-connected actors are more likely to attract additional ties than less connected actors (Barabási & Albert, 1999; Newman, 2001). Board interlocks with well-connected boards add to the reputation of a firm. A first mechanism that might be in place is therefore that firms are more likely to engage in interlocks with other firms that already have central position in the network.

However, while preferential attachment is a common feature of a wide array of complex networks, *social* networks appear to be different. In most non-social networks, degree of connectivity is negatively correlated (disassortive mixing), but in most social networks degree is positively correlated (assortative mixing)(Newman & Park, 2003, p.7; see also Stumpf & Porter, 2012). Assortative mixing results in homophily, where a contact between similar people occurs at a higher rate than among dissimilar people (McPherson, Smith-Lovin, & Cook, 2001). The interaction with people who are like ourselves reinforces the dividing lines between those who are like us and not like us, between the ingroup and the outgroup, between high-reputation and low-reputation. For corporations, the idea that 'birds of a feather flock together' means that there is a hierarchy in the corporate network between central, high reputation firms and more peripheral, low reputation firms. Well-connected firms will be more likely to share directors with each other than with peripheral firms because they try to recruit high reputation directors. The high reputation directors in turn will be more inclined to accept board positions at well-connected board because this further adds to their status. The homophily mechanism implies that there is a divide within the corporate elite between well-connected high status firms and more peripheral lower status firms and that this divide is maintained as part of the network dynamic. Therefore, the third driving mechanism is that firms seek similar others in terms of network connectivity when they decide to create or maintain a board interlock.

Brokerage

When a network structure is in place, it can benefit an actor in two different and largely opposite ways: through brokerage and through closure. Brokerage is beneficial for the information position of a firm while closure provides a social context. Interlocking directorates are a source of environmental information through business scanning, as directors gain

experience on the corporate environment through the boards they serve on (Useem, 1982, p.209). Firms with well-networked boards are more responsive to environmental uncertainty (Boyd, 1990). By providing information directors 'cushion' the uncertainty of the environment (Zahra & Pearce, 1989). Linkages through interlocks stabilize the environment's exchanges and reduce uncertainty in the process (Pfeffer & Salancik, 1978). Hence, firms who interlock with strategically related firms gain better advice, counsel and environmental information (Westphal, 1999).

A brokering position is strategically advantageous because it enables the arbitration of information flows between groups of firms that connect through the broker. Brokers span structural holes in a network (Burt, 1992). They build a central position through non-redundant ties: unique ties to other firms who in turn do not connect to each other. The broker can accrue rent through its position and brokerage is associated with a wide range of benefits (Burt, 2004). Given the well-studied benefits of brokerage as social capital the fourth mechanism of network formation is that firms seek brokerage positions in the network.

Social cohesion

While brokerage underscores the importance of an in-between position in the network structure, cohesive network structures can also be beneficial. Contrary to brokerage, cohesion underscores the importance of redundant ties: ties that do not add to the connectivity of the network. Redundant ties allow for a repeated reinforcement of the sense of solidarity and norms that govern the corporate elite. This allows for a sense of common obligations and coordinated economic action via the corporate network (Coleman, 1988), facilitates economic interaction and enhances trust (Mizruchi, 1996). At a more general level, a dense network of board interlocks provide a social context through which business practices diffuse (Davis, 1991; Shropshire, 2010). A good position in the network of interlocking directorates puts a corporate board at the forefront of corporate governance innovations and best practices. However, there are a number of reasons why we expect that firms are not keen on ties that bind them within cohesive sub structures of the network. First, redundant ties do not add to the information function of interlocks, as it is opposite to brokerage discussed above. Second, engaging in cohesive structure hampers the advantage

of flexibility that the brokered network brings, as its structure can be altered faster (Heracleous & Murray, 2001: 152). Third, ties that contribute to dense sub structures in the network may be a sign of the notorious 'Old Boys Network', which in turn has a negative effect on the status signalling function of interlocks. Therefore, the fifth mechanism is that firms do not prefer to be a member of cohesive subgroups in the network. Firms seek connections with more distant network partners.

National business communities

Next to the five exogenous mechanisms we include three additional exogenous factors. First, networks of interlocking directorates traditionally bring together national corporate elites in distinct, relatively unconnected national networks (Stokman, Ziegler, & Scott, 1985). Even in the closing decades of the 20th century international networks of interlocking directorates remained thin and best described as superstructures that rest on rather resilient national bases (Carroll & Fennema, 2002). Only very recently has there been a growing transnational network of board interlocks, but the growth takes place within the confinement of the European area (Carroll, Fennema, & Heemskerk, 2010; Heemskerk, 2011; forthcoming). If indeed board interlocks are still primarily geared towards a national business community, we expect that board interlocks are more likely to connect firms with a clear national origin, rather than (subsidiaries of) foreign firms that are have become part of big business within a country.

The second exogenous effect we expect to play a role is whether a firm is listed on the national stock exchange. Following the national business community argument, the largest stock listed firms are the most prominent exponents of a national business community and, from a status and information perspective, the most sought after firms for board interlocks. These considerations suggest that stock listing has a positive effect on interlock formation. However, there are also reasons to expect that the relation is the other way around. Listed firms are more visible and have to conform to societal pressures because of this visibility (Pfeffer & Salancik, 1978, p.168). We already mentioned that board interlocks are typically considered to be opposed to good corporate governance best practices. And listed firms have been shown to comply with the corporate governance code rather well (Akkermans et al., 2007). Consequently, it is conceivable that being listed has a negative

effect on interlock formation. Listed firms might be more reluctant to engage in the corporate network, because it is more visible to outsiders if they happen to cross the borders of legitimacy. The final effect we take into account is firm size. Size matters in picking an alliance partner (Van de Bunt & Groenewegen, 2007). Big firms tend to have more resources, which make them interesting for a resource dependent interlock. On the other hand, big firms might be more reluctant to engage in the corporate network, because it is more visible to outsiders if they happen to cross the borders of legitimacy. Basically the same argument as we have used with the stock exchange effect. Table 1 list the five endogenous and three exogenous effects on network formation and its expected impact. The measures for each effect are discussed in the next section.

[Insert Table 1 about here]

3. Methods, Model specifications and Data

Modelling network evolution

The methods and heuristics of social network analysis serve as the toolbox for our analysis. Social network analysis is concerned with social actors (the nodes) that are in some way related. When two nodes are connected, a tie exists. Here we consider corporate boards as nodes, which are connected by shared members, the ties. This is a uni-mode projection of the bipartite affiliation network that consists of the boards, the members, and their membership affiliations. In terms of data structure, the ties between the boards are considered undirected. Analysing interlocks in an undirected manner seems to be closer to reality when considering how inter-firm collaboration comes into being (Van de Bunt & Groenewegen, 2007, p.475). In our model firm *a* picks firm *b* based on the amount of utility firm *a* can gain from the interlock, containing exogenous and endogenous contemplations. Firm *b* then decides, also regarding the amount of utility, whether it will engage in the interlock (we thus use an actor-oriented unilateral initiative and reciprocal confirmation model). We apply the actor-oriented statistical network model SIENA. The model is stochastic in the sense that the sequential states of the network are determined by both predictable action as well as an element of randomness. It is actor-driven because the changes in the network are in terms of actors who alter their

network ties (Knecht, 2008, p.27). For a mathematical account of Siena see Snijders, Steglich & Schweinberger (2007).

Network ties are designated by Y_{ij} as *i* and *j* constitute actors. The data is binary: a firm can have a tie to another firm or not. Y_{ij} = 1 or 0, depending on whether there is at least one interlock between *i* and *j.* The matrix $Y = (Y_{ij})$ of the $n \times n$ adjacency matrix represents the total network.

Change in the network is modelled as a Markov process. We follow the common approach in existing dynamic network models that model individual development (Van de Bunt & Groenewegen, 2007, p.464-466) and use a discrete number of micro steps to represent the process. At any discrete point in time, either there is no change or a firm changes the interlock with another firm. At each step, one firm can change one outgoing tie. This means that the process is decomposed into the smallest possible component of network change. In the model tie, changes are not subject to coordination, as this would negate the premise that changes are made via the configuration of the network and the firm covariates (see Snijders, Van de Bunt, & Steglich, 2010).

The objective function defines the probabilities of change in the network and is a linear function of components, called effects. Network change is dependent on the network position of firm *i* and its covariates and the network position of alter firm *j* and its covariates. A higher value of an effect represents a preference of the focal actor for that state of the network. All estimations are done by SIENA (Simulation Investigation for Empirical Network Analysis), more specifically the *rsiena* package, which is run in the statistical software [R]. The results are based on 2000 iterations and 5 subphases.

Measuring the eight mechanisms

The set of mechanisms developed in the previous section serve as the basis for the network objective function. For each mechanism we use a specific network measure. Table 1 gives an overview of the mechanisms, the measures and the expected effect. In order to investigate the general popularity of interlocks we look at the degree effect. The degree effect represents the balance of whether having an arbitrary tie is worth it in terms of benefit versus costs

(Snijders, Van de Bunt, & Steglich, 2010). In general, we expect that firms are not interested in an arbitrary interlock, and hence expect a negative degree effect in the model.

For reputation we include two effects. First, preferential attachment implies that firms seek board interlocks with firms with a high degree. These much sought after firms are subject to the rich-get-richer effect. We measure this by the squared degree of alter (Snijders et al., 2010) and expect a positive effect. Second, homophily implies that firms seek board interlocks with similar others. Here we assume that similarity is signalled by number of board interlocks. We measure this by assortivity of degree connectivity (Snijders et al., 2010) and expect a positive effect of assortivity. Homophily might cancel out preferential attachment.

The brokerage effect is the preference for actors to position themselves in-between unconnected parts of the network. We use betweenness centrality as measure and expect a positive effect, as the focal actor prefers a higher degree of brokerage. Betweeness is calculated by taking the ratio of the number of shortest paths from actor *i* through actor *k* to actor *j*, and all the shortest paths from *j* to *k,* excluding the paths that go through *k.* The sum of the ratio for all *i* and *k* in the network gives actor *k*'s betweeness (Bruggeman, 2008, p.77).[1]

For social cohesion we measure transitive closure. The transitive ties effect measures transitivity for actor *i* by counting the number of other actors *h* for which there is at least one intermediary *j* forming a transitive triplet of this kind. As such it is a more relaxed measure of local cohesion than the classical representation of transitive triplets. While the transitive triplets effect postulates that more intermediaries will add proportionately to the tendency to transitive closure, the transitive ties effect expects that given the existence of one intermediary, extra intermediaries will not further contribute to the tendency to form the tie i → h (Snijders, Van de Bunt, & Steglich, 2010, p.48).[2] We expect that the transitive ties effect is negative because firms do not prefer cohesive substructures.

For the sixth – and first exogenous – mechanism we created a dummy for each firm whether or not they are originally from the Netherlands. We expect that being a Dutch firm will have a positive effect on board interlock formation. Similarly we created a dummy for listed firms, where a firm's score is 1 if it is listed at the Dutch AEX (large firms) or AMX (medium size firms). The effect of a listing can be positive or negative. A negative effect would indicate that stock listed firms follow good governance practices closely, while a positive effect

indicates that the status of large stock listed firms make them especially attractive as a partner for board interlocks. The final effect is size. First we ranked all firms by their size in all four waves (assets for financials and turnover for non financials). Subsequently we average the rank of each firm over the waves. If a firm's average rank is in the top half of all the firms, we consider it to be a large firm. Big firms were assigned value 1 and relatively small firms a value of 0. A positive size effect indicates firms increasingly prefer relatively big firms in their interlock pool.

Data

The basic structure of the data concerns four waves. The years included are 1996, 2001, 2006 and 2011. The dataset was constructed following the common practice of stratified sampling (Stokman, Ziegler, & Scott, 1985). Following the same conventions, each wave contains the 200 largest industrial and service firms of the Netherlands in terms of total revenue and the 50 biggest financial firms in terms of total assets. Both listed and non-listed firms are included. For 1996 and 2001 we used the existing dataset as described and analysed by Heemskerk (2007), the 2006 and 2011 networks were compiled for the purpose of this study. Firms without significant economic activities (notably administrative units and mailbox firms) are not included and subsidiaries of firms that are part of the largest 250 firms are excluded as well. In the Netherlands the corporate governance system allows for both a one tier and a two-tier board structure, although the latter is dominant. Here we included both the executive directors at the level of the board (raad van bestuur) and the supervisory directors (raad van toezicht). Only members with voting power were included. One important benefit from the Dutch case is that board interlocks typically do not go together with ownership relations. Board interlocks are not the reflection of an underlying ownership relation (Heemskerk, 2007).

As a starting point for the datasets we retrieved information on board composition from the Amadeus and Orbis database of Bureau van Dijk. We subsequently verified all information using annual reports, corporate websites, chamber of commerce records and personal inquiry at the firm's headquarters (particularly helpful for non-listed firms). This step filtered out roughly 10 percent of the inaccurate information on board composition that was in

the original commercial dataset. This means that although information on board composition is increasingly readily available, the quality of the commercial databases are still too low to be able to directly use their data without an additional check of its quality. Subsequently, all distinct individuals were manually identified, merging the several positions into unique records. This step created the bipartite affiliation network of boards and the directors. All the waves were converted to uni-modal networks. The final step was to convert all the waves to adjacency matrices as a suitable format for SIENA. Not all firms are present during all the waves. In total 462 firms are in the top 250 of firms at one time or another. Entry and exit is handled via structural zeros. A firm with a structural zero in is not present in that wave. Mergers and acquisitions are handled by merging the firms on the first wave the firms are both in.

Network descriptives

Table 2 presents an overview of the main network descriptives. In order to provide some historical depth the table also includes the earlier descriptives on the network in 1976 from Heemskerk (2007). As we expected a thinning of the network of board interlocks already present during the period up to 2001 continues during the first decade of the 21st century. However, the pace of the decline slows down. Between 1996 and 2001 the number of interlocks declined by 38%, slowing down to a 22% decrease in the 2001 – 2006 period and finally a 16% decrease between 2006 and 2011. At the same time, the set of firms engaging in board interlocks have stayed remarkably stable since 2001, at about 140. Apparently it was during the closing years of the 20th century that the network of board interlocks saw most of its decline.

Whereas the total number of directors has been steadily decreasing between 1996 and 2006 (Δ 96-01: -2.3%, Δ 01-06: -7.2%), there has actually been a 7.5% increase in directors up until 2011. This seems to reflect that firms have taken on some extra in-house expertise to combat the effects of the economic crisis. While the number of supervisory board positions shows a steady decline, it was the executive positions that grew in number over the past years. Kouzes & Posner (2009) find that it is during uncertain times that firms look for

strong leaders and guidance. The rise in executive positions signals this call for leadership during uncertain times.

[Insert table 2 about here]

4. Empirical results

Table 3 presents the results of four different versions of the model. The last columns gives the final model that turns out to be statistically robust and theoretically viable. For each model the Table lists the estimated parameters, the standard error and the model fit. The model fit considers the difference between the values that SIENA simulates and the values that are actually observed, with zero indicating a perfect simulation of the evolution of the network. As SIENA is stochastic in nature this will not happen. Convergence is considered good at 0.3 levels and excellent when the t-ratios are less than 0.1 (Snijders, Van de Bunt, & Steglich, 2010). Thus, next to significance it is crucial to consider the convergence as well.

Model 1 serves as a base line model and includes only the three exogenous effects and the degree effect. The model has excellent convergence and all effects are significant. This suggests that it makes sense to include the exogenous effects in the objective function. Model two and three include all the other mechanisms except that they both include only one of the two reputation indicators. Model two includes preferential attachment and model three assortivity (homophily). Model two shows a significant effect of preferential attachment as well as firm size. However the convergence of this model is unacceptable (see model fit preffential attachment) and therefore needs to be rejected. Model three however does have acceptable convergence levels for all effects. Assortivity has a significant albeit modest effect. Interestingly, the size effect vanishes. This suggests that in creating interlocks, firms care more for partners with network centrality than firm size. When we leave out size in model 4, the convergence is excellent for all parameters, except for betweeness which is still well below the .3 threshold. The simulated parameters are sufficiently close to the observed networks. The covariance correlations are all well below 0.9 and hence acceptable. We use model four to test out expectations

[Insert Table 3 about here]

Rate

The rate parameter models the 'speed' by which the network changes. The difference in the speed of evolution fits the socio-economic changes that took place during those periods.[3] The first period 1996 – 2001 was one of relative comfort with years of sustained growth. Internationalisation of business and new standards of good governance did lead to a reduction in board interlocks but the overall the rate of change was not extraordinary high compared to the other periods. The 2001 – 2006 period on the contrary was one of considerable upheaval. First, the dot.com bubble burst led to a steep decline in stock markets all across the globe. Yet soon thereafter the economy picked up and we saw a period of growth. In this sense the 2001-2006 period has seen two ends of economic conjuncture. The larger rate parameter parallels the turbulent environment when firms adapt their boards to match the changing environment. Even though the overall decline in interlocks is less than in the previous period, the rate parameter is higher. In the last period under consideration, 2006-2011, the rate parameter is higher than the first but lower than the middle period. The financial crisis of 2008 is obviously a marking moment in this period. Yet, the effects of the crisis do not show in an extreme reorganisation of the network of board interlocks by 2011. The number of interlocks steadily declines, but not at high speeds.

Testing the hypotheses

The first expectation we made is that while firms will still engage in interlocks, the costs of doing so have increased. The results of the model confirm this mechanism. The degree parameter indicates that a declining tendency to form interlocks has been an important generating mechanism behind the evolution of the network. Results for the degree effect are very strong, significant and show a negative direction, which matches the hypothesis.

We already saw how homophily is more important than preferential attachment. In networks of interlocking directorates, firms connect with similar others rather than with the most connected others. When preferential attachment is included but not assortivity, the model has an unacceptable high covariance (model 2). When both preferential attachment and assortivity are included, preferential attachment shows no significant effects (not included

in the table). The assortivity effect however shows the expected positive and significant result. Firms prefer similar others when they engage in board interlocks. This implies that there is a hierarchy in the network, where central firms flock together and keep peripheral firms outside the core of the network. This finding strengthens the importance of assortative mixing as opposed to non-assortative in social networks.

Subsequently we hypothesized that firms would seek broker positions in the network. The results of the simulation show that this does not seem to be the case. The betweenness effect is significant but, contrary to what we expected, negative. Firms do not search for brokerage positions in the Dutch network of interlocking directorates. Quite the contrary. As an opposite to network brokerage, we expected that firms would not have a preference for a cohesive network position. However, the transitive ties effect turns out to be strong, positive and significant. In fact, it is the strongest effect in the model next to the overall degree effect. Firms prefer cohesive network structures when considering board interlocks.

The two exogenous effects included in the final model also show significant effects. First, the practice of board interlocks tends to be a tool for the formation of national business communities Being a Dutch firm increases the likelihood of interlock formation. Firms from a foreign origin who extend their business to the Netherlands are typically not embedded in the corporate elite network. Second, firms that are listed on the Dutch stock exchange are particularly popular. This suggest that the advantages of ties with stock listed firms (such as better access to market resources and business scan) outweighs the potential disadvantages following concerns of legitimacy and compliance with norms of good corporate governance. Quite on the contrary, the large stock listed Dutch firms are well sought after board interlock partners.

5. Discussion, limitations and conclusion

The aim of this article has been to uncover the underlying mechanisms that drive change in the network of interlocking directorates. The results lend support to our thesis that the value of a particular board interlock is related to the position of this link in the broader network, and that firms do indeed consider this when making decisions about board composition. Some interlocks matter more than others due to the contribution they make to

the network. Firms do not invest in arbitrary interlocks but in those ties that add value from a network perspective.

Reputation is an important driver for network formation. Here, homophily is more of a driving mechanism than the more general effect of preferential attachment. This underscores the swelling critique of simply searching for similar statistical and topological features across complex networks (e.g. Stumpf & Porter, 2012). It is imperative that we understand how network processes and network structures are interrelated. When it comes to creating interlocking directorates there is a tendency for firms to connect with others of similar centrality and reputation. Thus, to the extent that reputation is a driver for interlock formation, the most reputable and well-connected firms are primarily geared towards each other. Similarly the less-connected firms also seek connections among each other. This implies a level of hierarchy in the network where the most central firms form a hard core within the broader network structure. This orientation of the central firms to each other (and, consequently, of the peripheral firms to each other as well) might signal a dividing line within the corporate community.

Firms actually avoid spanning structural holes in the network of interlocking directorates, contrary to a wide range of literature that sees brokering as the most important source of social capital in social networks. On the contrary, firms prefer to have ties with firms that are already in their network neighbourhood. Firms seek social closure rather than brokerage. This inclination of firms to create interlocks with other firms in their neighbourhood is particularly interesting in the light of the consistent finding that board interlock networks are ‘small worlds’ where high local clustering goes together with small average distances (Conyon & Muldoon, 2006; Davis, Yoo, & Baker, 2003; Kogut & Walker, 2001). The empirical literature is mostly concerned with the topological features of these small world networks and how they compare across countries (Kogut, 2012). Our findings hint at a generating process that lies behind these small world networks. Firms do not seek strategically advantageous positions where they can broker information, but use board interlocks to build a cohesive social network. This leads to dense pockets with high clustering. However, the assortivity effect means that high reputation and low reputation firms will form different clusters. The few

connections that are likely to exist between these clusters create the linchpins of the small world (Watts, 1999).

The findings thus suggest that brokerage might be an overestimated as a generating function of social networks. Perhaps this is not so strange because strategically seeking brokerage positions asks for a large investment. After all in order know what brokerage positions are, an actor needs to have a good overview of the larger network structure. This kind of meta knowledge might be relatively easy to accomplish in a network that is clustered or segmented along easily identifiably attributes such as sector, industry or product. But in the case of interlocking directorates that span businesses and industries this is much more difficult and hence more costly. The model that we present does show that firms are segmented in the network by degree: high degree firms tend to link with high degree firms and low degree with low degree. And while low degree firms are probably keen on establishing ties with high degree firms, this is not likely to happen because the high degree firms relate to each other (indeed, homophily rather than preferential attachment drives the network evolution). This brings is to another issue: the importance of status and reputation. Firms seek first and foremost reputation when they build ties with other networks. The contribution we make here is that reputation is not merely an attribute of another firm, but is the result of the position of the ties in the wider network. Reputation, after all, is embedded in social structures.

The theoretical implications are twofold. For (social) network theory our work lends support to the thesis that tie formation is – at least in part – a function of its position in the larger network studies. It is not only about how a network tie gives an actor access to resources of another actor, but also how this tie strengthens the position in relation to other ties in the network. Although this notion can be traced back to the seminal work of Granovetter, it remains under utilised in the current literature on social network formation. For corporate governance theory the findings show that corporate boards remain strongly embedded in a larger social elite network structure. These networks form the daily reality for the group of people who occupy the command posts of our economy. The contribution that we make is that still in the first decade of the 21st century, corporate board members seek and build a business community. Notwithstanding the overall decline in board interlocks the main

underlying mechanism that drives network formation is aimed at generating cohesive elite communities.

This study has been a first step in applying longitudinal actor-based models of network dynamics to interlocking directorates. The findings of this study cannot be readily generalized across other corporate networks. Corporate networks have a specific institutional context that varies with the shape that capitalism took in the particular setting (Aguilera & Jackson, 2010; Hall & Soskice, 2001). Therefore, it would be worthwhile to repeat the current study in different national contexts. The results of a comparative study of network dynamics across countries promise to provide insights into why certain network structures change and others remain stable. Also, it can serve as input for more contextualised case studies that can account for the interdependencies between institutional arrangements (Aguilera & Jackson, 2010). A further extension would be to take into account the transformation of corporate elite networks from the national towards the transnational level. Heemskerk (forthcoming) for instance shows that between 2005 and 2010 the European corporate elite network increased. Firms consider themselves increasingly European and are no longer bound to the national context. If applied to the entire European network of board interlocks, the model that we developed here can be extended to include the inclination of firms to engage in transnational (European) over national board interlocks, as a mechanism that drives the network dynamic.

Another future path of research that is perhaps most promising is to move towards a full bipartite analysis of network evolution. Here we focused on the analysis of the firm-to-firm network of interlocking directorates. The model that we introduced shows that endogenous network effects play an important role in the evolution of interlocking directorate networks. However, some of the effects can be understood both from a personal perspective and from a corporate perspective. With the analysis we conducted here we cannot establish whether for instance the homophily effect is due to assortative mixing of firms with firms, or directors with directors. Johnson *et. al.* (2011) for instance show how the status of currently board members is associated with the ability to add new directors who also have high status. Here assortivity renders network connections through interpersonal dynamics. Hence our model is only a first step towards a more fine-grained bi-partite board-to-director network analysis that helps to understand how firm decision-making drives the effects that we found.

The boards of the largest corporations in our societies are crucial policy and strategy forming bodies and their acts and activities have repercussions that go well beyond the confinements of individual corporations. The recent financial and subsequent economic crisis is a case in point. With this study we showed how corporate directors remain embedded in a social network structure of interlocking directorates. The evolution of this network is well understood through a small set of endogenous network effects. The results re-established that corporate governance takes place within a broader environment of a corporate elite network that connects the command posts of the largest firms in our economies. For the burgeoning literature on board composition the results of our study suggest that it might be important to take into account network effects if you want to understand why certain directors are invited to a board instead of others. The strong effect of transitive ties suggests that the notorious 'Old Boys Network' is still in place. This in turn is important for the study of corporate governance. Not only do board interlocks remain a common element connecting boards across big business, there is also no indication that listed firms are susceptible to the critique on the practice of interlocking directorates. For the corporate elite, interlocking directorates remain a well-established practice to position themselves, and the boards they serve on, strategically within the broader business community. How this strengthens the power and legitimacy of these firms and directors is a promising question for further research.

Endnotes:

[1] Unfortunately, SIENA does not limit influence in its betweenness effect. This means that long paths are as equally important in the measurement of betweenness as short paths. But for longer paths the contribution to the brokerage position becomes questionable (Burt, 2010). To see whether the betweenness effect can be included, the correlation coefficient between betweenness and 2-betweenness (where only paths of one or two lengths are considered) was calculated for 1996. The high correlation coefficient is 0.82, which makes us confident in the use of the SIENA measure of betweenness.

[2] We considered using the balance effect to measure local cohesion, which expresses a preference for firms to have ties with other firms who have a similar set of ties. However, including balance in the model led to unacceptable high levels of covariance, because it takes into account both transitive triplets and a quadratic function of the degree (Snijders, 2005, p.230).

[3] The Jaccard coefficient considers the amount of changes in relation to the observations. All periods have a low Jaccard coefficient (<0.3), which means there are many changes given the number of observations. In an analysis of a normal friendship network these Jaccard scores would be unsatisfactory. Here however we feel the low coefficient is less of a problem. Unlike many social relations, board appointments typically last four years and are commonly extended for another one or two periods. This decreases the problem of missing observations. In addition, the overall trend is one of ongoing decrease in interlocks due to the degree effect. This means that it is difficult to imagine that we did not observe a sudden spike in interlocks.

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Table 1: Mechanisms, measures and predicted effects

	Mechanism	Measure	Predicted effect on interlock formation and maintenance
1	Decline of board interlocks	Degree	-
2	Homophily	Assortivity of connectivity	+
3	Preferential attachment	Sqrt degree of alter	+

4	Brokerage	Betweenness	+
5	Cohesion	Transitive ties	-
6	National Business Community	Dutch firms	+
7	Stock Listed	Listed AEX or AMX	-/+
8	Size	Relatively big or relatively small firm	-/+

Table 2: Descriptives of the Network of interlocking directorates

	1976	1996	2001	2006	2011
Number of firms	*250*	250	250	250	250
Number of directors	*2223*	1773	1733	1617	1739
Number of positions	*2804*	2228	2042	1885	1971
Executive positions	*906*	851	897	859	955
Non-executive positions	*1898*	1377	1145	1026	1016
Firms with Interlocks	*194*	196	137	143	140
Interlocks	*952*	775	481	375	315